CHAUDHARY DEVI LAL UNIVERSITY, SIRSA ACT, 2003

***[**Haryana Act No. 9 of 2003**]**

{Published in Haryana Govt. Gazette(Extraordinary), April 2, 2003}

AN

ACT

to establish and incorporate a (teaching-cum-affiliating University) at Sirsa to facilitate and promote higher education with special emphasis in emerging areas of Information Technology and Computer Education, Bio-technology, Environmental Studies, Technology and Management Studies, and also to achieve excellence in these and connected fields.

BE it enacted by the Legislature of the State of Haryana in the Fifty-fourth Year of the Republic of India as follows:-

Short title and commencement

1. (1) This Act may be called Chaudhary Devi Lal University Sirsa Act, 2003

(2) It shall come into force on such date as the Government may, by notification in the Official Gazette, appoint.

Definitions.

2. In this Act and in all Statutes, Ordinances and Regulations made thereunder unless the context otherwise requires-

(a) "college" means a college maintained by, or admitted to the privileges of, the University under this Act;

(b) "employee means any person appointed by the University, and includes teachers and all other staff of the University;

(c) "Government" means the Government of the State of Haryana;

(d) "institution" means an academic institution, not being a college, maintained by, or admitted to the privilege of the University;

(e) "principal" means the head of a college, and includes, when there is no principal, a vice-principal duly appointed as such and in the absence of the principal or the vice-principal the person for the time being duly appointed to act as the principal;

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*1. Amended by Haryana Act No. 18 of 2008, received the assent of the Governor of Haryana on the 17th April, 2008.

2. Amended further by Haryana Act No. 21 of 2008, received the assent of the Governor of Haryana on the 30th April, 2008.

3. Amended further by Haryana Ordinance No. 2 of 2010, promulgated by the Governor of Haryana on the 29th April, 2010.

(f) "recognised teachers" mean such persons as are approved by the University for the purpose of imparting instruction in a college or an institution admitted to the privileges of the University;

(g) "Statutes", "Ordinances" and "Regulations" mean respectively the Statutes, Ordinances and Regulations of the University made under This Act;

(h) "University" means Chaudhary Devil al University Sirsa as incorporated under this Act; and

(i) "University teachers" mean professors, readers, lecturers and such other persons as may be appointed for imparting instructions or conducting research in the University or in any college or institution

maintained by

the University and are designated as teachers by the Ordinances.

Incorporation

3. (1) There shall continue to be a body corporate by the name of Chaudhary Devi Lal University comprising of the Chancellor and the Vice-Chancellor of the University, and the members of the Court, the Executive Council and the Academic Council and all persons, who may hereafter become or be appointed as such officers or members, so long as they continue to hold such office or membership.

(2) The University shall have perpetual succession and a common seal with power to acquire, hold and dispose of property and to contract, and may by the said name sue or be sued.

Territorial exercise of Powers.

4. (1) The limits of the area within which the university shall exercise its powers shall be such as the Government may, from time to time, by notification, specify:

Provided that different areas may be specified for different faculties.

(2) Notwithstanding anything contained in any other law for the time being in force, any college situated within the limits of the area specified under sub-section (1) shall, with effect from such date as may be notified in this behalf by the Government, be deemed to be associated with, and admitted to, the privileges of the University and shall cease to be associated in any way with, or be admitted to, any privileges of any other University, and different dates may be notified for different colleges:

Provided that-

(i) any student of any college associated with, or admitted to, the other

University before the said date, who was studying for any degree or

Diploma examination of that University shall be permitted to complete

his course in preparation thereof and the University shall hold for such

students examinations in accordance with the curricula of study in force

in that University for such period as may be prescribed by the Statutes

, Ordinances or Regulations;

(ii) any such student may, until any such examination is held by the

University, be admitted to the examination of the other University

and be conferred the degree, diploma or any other privilege of that

University for which he qualifies on the result of such examination

Bar on conferring, granting or issuing degrees, diplomas or certificates by unauthorized institutions.

5. (1) Notwithstanding anything contained in this Act or any other law, for the time being in force, no person or institution, other than the University, shall confer, grant or issue or hold himself or itself out as entitled to confer, grant or issue any degree, diploma or certificate in the specified areas of knowledge assigned to it within the territorial jurisdiction of the University which is identical with or is a colourable imitation of any degree, diploma or certificate conferred, granted or issued by the University.

(2) Contravention of the provision of sub-section(1) shall be an offence.

(3) Where an offence under this section has been committed by an institution, every person incharge of, and responsible to, the institution for the conduct of its business at the time of the

commission of the offence, shall be deemed to be guilty of the offence and shall be liable to be proceeded against as per the University rules.

(4) Notwithstanding anything contained in sub-section(3), where an offence under this section has been committed by an institution and it is proved that the offence has been committed with the consent or connivance of, or that the commission of the offence is attributable to any neglect on the part of any partner, director, manager, secretary or other officer of the institution, such partner, director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation- For the purpose of this section "institution" means any body corporate and includes a firm or other association of individuals.

Powers and functions of University.

6. The University shall exercise the following powers and perform the following functions, namely:--

(a) to provide for research and instruction in such branches of Learning as the University may think it fit and take such steps as it considers necessary for the advancement of learning and dissemination of knowledge;

(b) to hold examinations and grant such degree, diplomas and other academic distinctions or titles to persons as may be laid down in the Statutes, Ordinances or Regulations;

(c) to confer honorary degrees or other distinctions on approved persons in the manner laid down in the Statutes;

(d) to institute prizes, medals, research studentships, exhibitions and fellowships;

(e) to receive gifts, donations or benefactions from the Government and to

receive gifts, donation and transfers of movable or immovable property

from transferors, donors, testators, as the case may be; and to create such

corpus fund with the donations so received for the welfare of the

University

(f) to institute principalships, professorships, readerships, lectureships, and to

create other posts of any description required by the University and to

appoint persons to such posts.

(g) to co-operate with educational and other institutions in India and abroad

having objectives similar to those of the University in such manner as may

be conducive to their common goals;

(h) to provide instructions, including correspondence and such other courses,

To such persons as are not members of the University, as it may determine

(i) to approve persons for imparting instructions in any college institution

admitted to the privileges of the University;

(j) to maintain colleges located within the limits of the area referred to in sub-

Section (1) of section 4 or, subject to the provisions of sub-

section (2) of

that section, admit to its privileges colleges not maintained by the

University but located within the said area and to withdraw the same;

(k) to declare a college, an institution or a department as autonomous college

or institution or department, as the case may be;

(l) to borrow with the approval of the Government, on the security of the

Property of the University, money for the purposes of the University.

(m) to supervise, control and regulate the residence, conduct and discipline of

the students of the University and of colleges and institutions within the

jurisdiction of the University;

(n) to deal with any property belonging to, or vested in the University, in such

manner as the University may deem fit for advancing the objects of the

University;

(o) to assess the needs of the State and country in terms of subjects, fields of

specialization, levels of education and training of manpower both on short

and long term basis and to initiate necessary programmes to meet those

needs.

(p) to organize advanced studies and research programmes based on a deep

understanding of the trends in such branches of learning as the University may think fit;

(q) to promote research, design and developmental activities that have a relevance to social needs and the development programmes of the State;

(r) to initiate measures to enlist the co-operation of industries and Government employees to provide complementary facilities;

(s) to provide for continuous experimentation in imparting knowledge, organization of training and preparation of text-books and other instructional materials;

(t) to arrange for progressive introduction of continuous evaluation and re-orientation of the subjects in educational measurement;

(u) to further entrepreneurial ability among its students;

(v) to educate the public with regard to the requirement of, and opportunities for the advancement of learning and dissemination of knowledge;

(w) to make special arrangements for the education of women students and

the students belonging to weaker sections of the society, in particular

Scheduled Castes and Scheduled Tribes as the University may consider

Desirable;

(x) to frame Statutes, Ordinances or Regulations and alter, modify or

Rescind the same for all or any of the aforesaid purpose; and

(y) to d all such things as may be necessary, incidental or conducive to the

the attainment of all or any of the objects of the University.

University open to all races, castes and creeds.

7. The University shall be open to all persons irrespective of sex, race, creed, caste or class; and no test or condition shall be imposed as to religion, belief or profession in admitting or appointing members, students, teachers, workers, or in any other connection whatsoever and no benefaction shall be accepted which in the opinion of the authorities of the University involves conditions or obligations opposed to the spirit and objectives of this provisions:

Provided that nothing contained in this section shall be deemed to prevent the University from making any special provisions in respect of weaker sections of the Society and in particular Scheduled Castes and Scheduled Tribes.

Teaching of University.

8. All teaching in the University shall be conducted by and in the name of the University, in accordance with the Statutes, Ordinances and Regulations made in this behalf.

Officers of University.

9. The following shall be the officers of the University, namely:- (i) the Chancellor, (ii) the Vice-Chancellor, (iii) the Registrar; and (iv) such other persons in the service of the University as may be declared by the Statutes to be Officers of the University.

Chancellor

10. (1) The Governor of Haryana by virtue of his office shall be the Chancellor of the University.

(2) The Chancellor shall be the head of the University.

(3) The Chancellor shall, if present, preside over the convocation of the University for conferring degrees and meetings of the Court.

(4) The Chancellor shall have the right-

(i) to cause an inspection to be made, by such person or persons as he may

direct, of the University, its buildings, laboratories and equipment and

of any college or institution maintained by the University and also of

the examinations, teaching and other work conducted or done by the

University; and

(ii) to cause an inquiry to be made in like manner in respect of any matter

connected with the administration of finances of the University,

colleges or institutions.

(5) The Chancellor shall, in every case, give notice to the University of his intention to cause an inspection or inquiry to be made and on receipt of such notice, the University shall have the right to make such representation to the Chancellor as it may consider necessary.

(6) After considering the representation, if any, made by the University, the Chancellor may cause to be made such inspection or inquiry as if referred to in sub-section(4).

(7) Where any inspection or inquiry has been cause to be made by the Chancellor, the University shall be entitled to appoint a representative who shall have the right to be present and to be heard at such inspection or inquiry.

(8) The Chancellor may, if the inspection or inquiry is made in respect of the University or any college or institution maintained by it, address the Vice-Chancellor with reference to the result of such inspection or inquiry, and the Vice-Chancellor shall communicate to the Executive Council the views of the Chancellor and the action to be taken thereon as advised by the Chancellor.

(9) The Executive Council shall communicate through the Vice-Chancellor to the Chancellor such action, if any, as it proposes to take or has taken upon the result of such inspection or inquiry.

(10) Where the Executive Council does not, within a reasonable time, taken action to the satisfaction of the Chancellor, the Chancellor, may, after considering any explanation furnished or representation made by the Executive Council, issue such directions as he may think fit and the Executive Council shall comply with such directions.

(11) Without prejudice to the foregoing provisions of this section, the Chancellor, may be order in writing, annul any proceedings of the University, which in his opinion are not in conformity with this Act, the Statutes or the Ordinance:

Provided that before making any such order he shall call upon the University to show cause why such an order should not be made, and if any cause is shown within a reasonable time, he shall consider the same.

(12) The Chancellor may, at any time, require or direct the University to act in conformity with the provisions of this Act and the Statutes, Ordinances and Regulations made thereunder.

(13) The powers exercised by the Chancellor under sub-section(11) and sub-section(12) shall not be called in question in any civil court.

(14) Any employee of the University who is aggrieved by the decisions of the Executive Council or the Vice-Chancellor in respect of any disciplinary action taken against him, may address a memorial to the Chancellor in such manner as may be prescribed by Statutes and the decision of the Chancellor shall be final.

(15) The Chancellor shall have such other powers as may be prescribed by the Statutes.

Vice-Chancellor

11.[1]**[**(1) The Vice-Chancellor shall be appointed solely on academic considerations. He shall be a distinguished educationist having commitment to the values for which the University stands and abilities to provide leadership to the University by his academic worth, administrative competence and moral stature.**]**

(1A). The Government shall constitute a Selection Committee consisting of one nominee of the Chancellor and two nominees of the Executive Council, which shall prepare a panel of at least three names, in alphabetical order, from which the Chancellor shall appoint the Vice-Chancellor, on the advice of the Government. The terms and conditions of service of the Vice-Chancellor, shall be determined by the Chancellor, on the advice of the Government.

(2) The Chancellor may, on the advice of the Government, cause an inquiry to be held in accordance with the principles of natural justice, and remove the Vice-Chancellor from office, if he is found on such inquiry, to be a person patently unfit to be continued in such office.

(3) The Vice-Chancellor shall hold office for a period of three years which may be renewed for not more than one term:

Provided that no person shall, be appointed to, or continue in, the office of the Vice-Chancellor if he has attained the age of [2]**[**68**]** years.

[3]**[**(4) If the Vice-Chancellor is unable to perform his duties owing to his temporary incapacity on account of illness or any other reason, or the office of the Vice-Chancellor falls vacant due to death or otherwise, the Pro Vice- Chancellor shall perform the duties of the Vice-Chancellor until the existing Vice-Chancellor is able to resume his office or until a regular Vice-Chancellor is appointed as the case may be. In the absence of both Vice-Chancellor and Pro Vice-Chancellor, the Chancellor shall make such arrangements for the duties of the Vice-Chancellor to be performed by some authority until Vice-Chancellor or Pro Vice-Chancellor joins.**]**

(5) The Vice-Chancellor shall be the principal executive and academic officer of the University and shall exercise general supervision and control over the affairs of the University and give effect to the decisions of all the authorities of the University.

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1. Added by Haryana Act No. 21 of 2008, assented to by the Governor of Haryana on the 30th April, 2008 and published in Haryana Govt. Gaz.(Extra.) May, 6, 2008.

2. Amended by Haryana Ordinance No. 2 of 2010, promulgated by the Governor of Haryana on the 29th April, 2008 published in Haryana Govt. Gaz.(Extra.), April, 30, 2010.

3. Amended by Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.

(6) The Vice-Chancellor may, if he is of the opinion that immediate action is necessary on any matter, exercise any power conferred on any authority of the University by or under this Act, except in the matters involving creation or abolition of a Faculty, Department, or post, the matter involving appointment or removal of an employee:

Provided that the Vice-Chancellor before exercising powers under this section shall record in writing the reasons, why the matter cannot wait till the meeting of the authority concerned:

Provided further that if the authority concerned is of the opinion that such action ought not to have been taken, it may refer the matter to the Chancellor whose decision thereon shall be final.

Provided further that any person in the service of the University who is aggrieved by the action taken by the Vice-Chancellor under this sub-section shall have the right to represent to the Executive Council within one month from the date on which decision on such action is communicated to him and thereupon the Executive Council may confirm, modify or reverse the action taken by the Vice-Chancellor. The employee shall be informed that the action has been taken under emergency powers.

(7) The Vice-Chancellor shall exercise such other powers and perform such other duties as may be prescribed by the Statutes or Ordinances.

Pro Vice -Chancellor

[1]**[11-A**. (1) The Pro Vice-Chancellor shall be appointed by the Chancellor on the advice of the Government on such terms and conditions of service determined by him on the advice of the Government. He shall not be below the rank of a Professor.

(2) The Pro Vice-Chancellor shall hold office for a period of three years which may be renewed for not more than one term:

Provided that no person shall be appointed to, or continue the office of

the Pro Vice-Chancellor if he has attained the age of [2]**[**68**]** years.

(3) The Pro Vice-Chancellor shall exercise such duties as are assign to him by the Vice-Chancellor.**]**

Registrar

12. (1) The Registrar shall be appointed by the Chancellor on the advice of the Government.

(2) The Registrar shall be Chief Administrative Officer of the University. He shall work directly under the superintendence, direction and control of the Vice-Chancellor.

Other officers

13. The manner of appointment and powers and duties of other officers of the University shall be such as may be prescribed by the Statutes.

Creation of teaching

14. Notwithstanding anything contained in this Act, the University

and non-teaching posts.

shall not create any teaching and non-teaching post or revise the pay scale of the teaching and non-teaching employees without obtaining the prior approval of the Government.

Authorities of University.

15. The following shall be the authorities of the University namely:-

(i) the Court;
(ii) the Executive Council;
(iii) the Academic Council;
(iv) the Finance Committee;
(v) the Faculties;
(vi) the Academic Planning Board; and
(vii) such other authorities as may be declared by the Statutes to be the authorities of the University.

1. Inserted by Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.

2. Amended by Haryana Ordinance No. 2 of 2010, promulgated by the Governor of Haryana on the 29th April, 2008 published in Haryana Govt. Gaz.(Extra.), April, 30, 2010.

Court

16. (1) The constitution of the Court, and the term of office of its members shall be prescribed by the Statutes.

(2) Subject to the provisions of this Act, the Court shall have the following powers and functions, namely:-

(a) to review, from time to time, the broad policies and programmes of the University and to suggest measures for the improvement and development of the University.

(b) to consider and pass resolution on the annual report, annual budget and the annual accounts of the University and on the audit report of such accounts.

(c) to advise the Chancellor in respect of any matter which may be Referred to it for advice; and

(d) to perform such other functions as may be prescribed by the Statutes.

Executive Council

17. (1) The Executive Council shall be the principal executive body of the University.

(2) The constitution of the Executive Council, the term of office of its members and its powers and duties shall be such as may be prescribed by the Statutes.

[1] **[**Provided that the Pro Vice-Chancellor shall be the ex-officio member of the Executive Council.**]**

Academic Council

18. (1) The Academic Council shall be the principal academic body of the University and shall, subject to the provisions of this Act, the Statutes and Ordinances, co-ordinate and exercise general supervision over all academic policies of the University.

[1] **[** Provided that the Pro Vice-Chancellor shall be the ex-officio member of the Academic Council.**]**

(2) The constitution of the Academic Council, the term of office of its members and its powers and duties shall be such as may be prescribed by the Statutes.

Faculties.

19. The constitution and functions of the faculties shall be such as may be prescribed by the Statutes.

Finance Committee

20. The constitution of the Finance Committee, the term of office of its members, and its powers and duties shall such as may be prescribed by the Statutes.

[1] **[**Provided that the Pro Vice-Chancellor shall be the ex-officio member of the Finance Committee.**]**

Academic Planning Board.

21. The constitution and functions of the Academic Planning Board shall be such as may be prescribed by the Statutes.

Statutes and their scope

22. Subject to the provisions of this Act, the Statutes may provide for all or any of the following matters, namely:-

(a) the constitution, powers and functions of the authorities and other Bodies of the University as may be constituted from time to time.

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1. Amended by Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.

(b) the classification, mode of appointment, powers and duties of the teachers and the officers of the University;

(c) the conditions of the service including provision for pension or provident

Fund or insurance scheme for the benefit of the employees of the

University;

(d) the conferment of honorary degrees;

(e) the establishment and abolition of Faculties and Departments;

(f) the institution of fellowships, scholarships, studentships, exhibitions,

medals and prizes;

(g) the maintenance of discipline among the students ;

(h) the conditions under which colleges and institutions may be admitted to

the Privileges of the University and the withdrawal of the same;

(i) the delegation of powers vested in the authorities or officers of the

University; and

(j) all other matters which by this Act, are to be or may be provided for, by

the Statutes.

Statutes how made

23. (1) On the commencement of this Act, the Statutes of the University shall be those as set out in the Schedule:

Provided that the authorities of the University constituted under the Statutes framed before the commencement of this Act shall continue to exercise all the powers and perform all the functions under this Act till such authorities are constituted in terms of the Statutes set out in the Schedule referred to above.

(2) The Government or the Executive Council may, from time to time, make new or additional statutes or may amend or repeal the statutes in the manner hereafter provided in this section:

Provided that the Executive Council shall not make, amend

or repeal any Statute, affecting the status, powers or constitution of any authority of the University until such authority has been given an opportunity of expressing an opinion in writing on the proposed changes, and any opinion so expressed shall be considered by the Executive Council.

(3) The Academic Council may propose to the Executive Council a draft of any Statute relating to academic matters for consideration by the Executive Council.

(4) Every new Statute or addition to the Statute or any amendment or repeal of a statue shall require the approval of the Chancellor who may approve, or the Executive Council shall have no validity until it has been assented to by the Chancellor.

(5) Notwithstanding anything contained in the foregoing sub-sections, the Chancellor, either suo motu or on the advice of the Government, may direct the Executive Council, to make, amend or repeal the Statutes in respect of any matter specified by him and if the Executive Council fails to implement such a direction within 60 days of its receipt, the Chancellor may, after considering the reasons, if any, communicated by the Executive Council for its inability to comply with such direction, make amend or repeal the Statutes suitably.

Ordinances and their scope

24. Subject to the provisions of this Act and the Statutes, Ordinances may provide for all or any of the following matters, namely:-

(a) the admission of students to the University and their enrolment as Such;

(b) and for admission to the examinations, degrees and diplomas of the University; and further to make progressively the fee structure so flexible that the courses could become self-

financing to the

extent possible;

(c) the conditions under which students shall be admitted to the

degree or diploma courses and to the examinations of the

University and shall be eligible for degrees and diplomas;

(d) the fees to be charged fro courses of study in the University and

for admission to the examinations, degrees and diplomas of the

University; and further to make progressively the fee structure so

Flexible that the courses could become self-financing to the

Extent possible;

(e) the conditions of the award of fellowships, studentships,

exhibitions medals and prizes;

(f) the conduct of examinations, including the terms of office and

manner of appointment and the duties of examining bodies,

examiners and moderators;

(g) the conditions of residence of students of the University; and

(h) all other matters which by this Act or the Statutes are to be made

or may be provide for by the Ordinances.

Ordinance how made

25. (1) The Ordinances shall be made, amended, repealed or

added to by the Executive Council:

Provided that no Ordinance shall be made:-

(i) affecting the admission or enrolment of students or prescribing examinations to be recognized as equivalent to the University examinations; and

(ii) affecting the conditions, mode of appointment or duties of Examiners or the conduct or standard of examination or any courses of study; unless the draft of such an Ordinance has been proposed by the Academic Council.

(2) The Executive Council may return to the Academic Council for reconsideration, either in whole or in part, any draft proposed by the Academic Council under sub-section(1) along with its suggestion:

Provided that the Executive Council shall not amend the draft proposed by the Academic Council itself. It may, however, reject such draft when submitted to it by the Academic Council for the second time.

(3) All Ordinances made by the Executive Council shall have effect from such date as it may direct and every Ordinance made shall be communicated, as soon as may be, to the Chancellor.

Regulations

26. (1) The authorities of the University may make Regulations consistent with this Act, the Statutes and the Ordinances-

(a) laying down the procedure to be observed at their meetings; and

(b) providing for all matters which by this Act, the Statutes or the

Ordinances are to be prescribed by Regulations.

(2) Every authority of the University shall make Regulations providing for giving of notice to the members of such authority of the dates of meetings and of the business to be considered at meetings and for the keeping of a record of the proceedings of the meetings.

Annual Report

27. The annual report of the University giving details of broad programmes, policies and finances, amendments of Statutes and Ordinances made during the year under report, shall be prepared under the directions of the Executive Council and shall be submitted to the Court on or after such date as may be prescribed by the Statutes and the Court shall consider the report in its annual meeting.

Annual Accounts

28. (1) The annual accounts and the balance-sheet of the University shall be prepared under the directions of the Executive Council and shall once at least every year and at intervals of not more than 15 months be audited by the Director, Local Audit, Haryana or any other auditor that may be appointed by the Government. The annual accounts when audited shall be published in the Haryana Government Gazette and a copy of the annual accounts along with the report of the Director, Local Audit, Haryana or the auditor shall be submitted to the Court and the Chancellor along with the observations of the Executive Council. Any observations made by the Chancellor on the annual accounts shall be brought to the notice of the Court and observations of the Court, if any, shall after being considered by the Executive Council, be submitted to the Chancellor.

(2) The annual accounts and the balance sheet of the University shall also be submitted to the Government at the time of its submission to the Chancellor.

Conditions of service of officers and teachers.

29. (1) Every salaried officer and teacher, except the Vice-Chancellor, shall be appointed under a written contract, which shall lodged with the University and any dispute arising out of a contract between the University and any of the officers or teachers shall, at the request of the teacher or officer concerned or at the instance of the University, be referred to a Tribunal of arbitration consisting or one member appointed by the Executive Council, one member nominated by the officer or teacher concerned and one nominee of the Chancellor. The decision of the majority of the members of the Tribunal shall be final and no suit shall lie in any civil court in respect of the matter decided by the Tribunal.

(2) Every such request shall be deemed to be a submission to arbitration within the meaning of the Arbitration and Conciliation Act, 1996(Act 26 of 1966)

Pension, provident fund and insurance fund.

30. (1) The University shall institute, for the benefit of its officers, teachers and other employees, pension, provident fund and insurance fund as it may deem fit.

(2) Where any provident fund and insurance fund have been so constituted, the provisions of the Provident Fund Act, 1925(Act 19 of 1925), shall be applicable to it as if it were a Government Provident Fund.

Vacancy not to invalidate proceedings

31. No act done, or proceeding taken, under this Act by any authority or other body of the University shall be invalid merely on the ground-

(a) of any vacancy or defect in the constitution of the authority or body; or

(b) of any defect or irregularity in election, nomination or appointment of a person acting as a member thereof; or

(c) of any defect or irregularity in such act or proceeding, not affecting the merits of the case.

Certain disputes to be referred to Chancellor

32. If any question arises whether any person has been duly elected or appointed as, or is entitled to be, a member of any

authority or other body of the University, the matter shall be referred to the Chancellor whose decision thereon shall be final

Powers to remove difficulties.

33. If any difficulty arises with respect to the establishment of the University or in connection with the first meeting of any authority of the university or otherwise in first giving effect to the provisions of this Act, the Government may, at any time, before any authority of the University has been constituted by order, make any appointment or do anything, consistent, so far as may be, with the provisions of this Act, which appears to it necessary or expedient for the purposes of removing the difficulty, and every such order shall have effect as if such appointment or action had been made or taken in the manner provided in this Act.

Mode of proof of University record.

34. Notwithstanding anything to the contrary contained in the Indian Evidence Act, 1872(1 of 1872), or in any other law for the time being in force, a copy of any receipt, application, notice, order, proceedings, resolution of any authority or committee of the University, or other documents in possession of the University, or any entry in any register duly maintained by the University, if certified by the Registrar, shall be received as evidence of such receipt, application, notice, order, proceedings, resolution, document or the existence of entry in the register and shall be admitted as evidence of the matters and transactions therein where the original thereof would, if produced have been admissible in evidence.

Protection of action taken in good faith

35. No suit or other legal proceedings shall lie against any officer or employee of the University for anything which is in good faith done or intended to be done in pursuance of any of the provisions of this Act, the Statutes or Ordinances.

Vesting of properties

36. (1) All properties, movable and immovable and all the interests of whatsoever nature and kind therein, vested in the Kurukshetra

University relating to Chaudhary Devi Lal Post-Graduate Regional Centre, Sirsa and the course run thereunder and the posts created, filled before the commencement of this Act, shall vest in the University.

(2) All debts, obligations and liabilities incurred, all contracts entered into and all matters and things engaged to be done in respect of Kurukshetra University relating to Chaudhary Devi Lal Post-Graduate Regional Centre, Sirsa , shall be deemed to have been incurred, entered into, or engaged to be done by, with or for the University.

THE SCHEDULE

(Statutes of Chaudhary Devi Lal University, Sirsa)

(*See Section 23*)

Powers and duties of the Vice- Chancellor.

1. (i) The Vice-Chancellor shall be ex-officio Chairman of the Executive Council, the Academic Council and the Finance Committee, and shall, in the absence of the Chancellor, preside over the convocations of the University held for conferring degrees and over the meetings of the Court. The Vice-Chancellor shall be entitled to be present at, and to address, any meeting of any authority of other body of the University, but shall not be entitled to vote thereat, unless he is member of such authority or body.

(ii) It shall be the duty of the Vice-Chancellor to see that the provisions of the Act, the Statutes, the Ordinances and the Regulations are duly observed and he shall take all necessary steps to ensure such observance.

(iii) The Vice-Chancellor shall have the power to convene or cause to be convened meetings of the Court, the Executive Council, the Academic Council and the Finance Committee and any other authority or body of the University.

(iv) The Vice-Chancellor shall exercise general control over the affairs of the University and shall give effect to the decision of the authorities of the University.

(v) The decision of the Vice-Chancellor regarding seniority for nomination to the various authorities or bodies of the University, shall be final.

Registrar

2. (i) The Registrar shall be ex-officio Secretary of the Executive Council and Faculties but not be deemed to be a member of any of these authorities, and shall be ex-officio Member-Secretary of the Court and the Academic Council.

(ii) When the office of the Registrar is vacant or when the

Registrar is by reason of illness, or any other cause is unable to perform the duties of his office, the duties of the officer shall be performed by such person as the Vice-Chancellor may appoint temporarily for the purpose till the regular appointment is made the Chancellor on the advice of Government.

(iii) It shall be the duty of the Registrar-

(a) to be the custodian of the records, common seal and such other property of the University as the Vice-Chancellor shall commit to his charge;

(b) to issue all notices convening meetings of the Court, the Executive Council, the Academic Council, the Faculties and of any Committee appointed by any authority of the University.

(c) to keep the minutes of all meetings of the Court, the Executive Council, the Academic Council, the Faculties and any Committee appointed by the authorities of the University;

(d) to conduct the official correspondence of the Court, the Executive Council, the Academic Council and the Faculties;

(e) to supply to the Chancellor copies of the agenda, the minutes of the meetings of the authorities of the University as soon as they are issued;

(f) to perform such other duties as may, from time to time, be assigned to him by the Vice-Chancellor.

(iv) The Registrar shall have power to administer warning or to impose the penalty of censure or withholding of increments upon such of the employee, excluding teachers of the University and the academic staff, as may be specified in the orders of the Executive Council and to suspend them pending enquiry:

Provided that no such penalty shall be imposed unless the person concerned has been given a reasonable opportunity of showing cause against the action proposed to be taken against him.

(v) An appeal shall lie to the Vice-Chancellor against any order of the Registrar imposing any of the penalties specified in clause (iv).

(vi) In case the inquiry discloses that a punishment, beyond the powers of the Registrar is called for, the Registrar shall, upon conclusion of the inquiry make a report to the Vice-Chancellor along with his recommendations:

Provided that an appeal shall lie to the Executive Council against an order of the Vice-Chancellor imposing any penalty.

(vii) The Registrar shall be the authorized officer to enter into agreements, sign documents and authenticate records on behalf of University and shall act in such capacity when the appropriate authority of the University has taken a decision in the matter. The Registrar shall also exercise such other powers and perform such

other duties as may be prescribed by Statutes or the Ordinances.

Other officers of the University

3. The following persons in the service of the University are also declared to be the officers of the University, namely:-

(a) Proctor;
(b) Chief Warden;
(c) Dean of Students' Welfare, if any;
(d) Dean, Academic Affairs;
(e) Dean of Colleges;
(f) Librarian;
(g) Controller of Examination;
Finance Officer.

Proctor, Chief Warden, Dean of Students' Welfare, Dean Academic Affairs.

4. The Proctor, the Chief Warden, the Dean of Students' Welfare, Dean Academic affairs shall be appointed by the Executive Council, on the recommendations of the Vice-Chancellor, from amongst the teachers of the University, who shall not be below the rank of Professor on such terms and conditions as the Vice-Chancellor may recommend to the Executive Council:

Powers and duties of the Vice- Chancellor.

Provided that the term of Dean, Academic Affairs shall be two years extendable by another one year, if deemed proper, by the Executive Council, on the recommendations of the Vice-Chancellor.

Dean of Colleges

5. The Dean of Colleges, if any, shall be a whole time salaried officer of the University and shall be appointed by the Executive Council, on the recommendations of Vice-Chancellor, on such terms and conditions as may be prescribed by the Statutes. He shall discharge such duties as may be assigned to him by the Vice-Chancellor from time to time.

Finance Officer

6. (1) The Finance Officer shall be a whole-time salaried officer of the University and shall be appointed by the Executive Council on the recommendations of the Selection Committee, on

such terms and conditions as may be prescribed by the Statutes.

(2) The Finance Officer shall be ex-officio Secretary of the Finance Committee, but shall not be deemed to be a member of such committee.

(3) When the office of the Finance Officer is vacant or when the Finance Officer is by reason of illness or any other cause is unable to perform the duties of his offices, the duties of the officer shall be performed by such person as the Vice-Chancellor may appoint for the purpose.

(4) The Finance Officer shall-

(a) exercise general supervision over the funds of the University and shall advise it as regards its financial policy; and

(b) perform such other functions as may be assigned to him by the Executive Council or as may be prescribed by the Statutes.

(5) Subject to the control of the Executive Council, the Finance Officer shall-

(a) hold and manage the property and investments of the University including trust and endowed property;

(b) ensure that the limits fixed by the Finance Committee for recurring and non-recurring expenditure for a year are not exceeded and that all moneys are expended on the purpose for which they are granted or allotted;

(c) be responsible for the preparation of annual accounts and the budget of the University and for their presentation to the Executive Council;

(d) keep a constant watch on the state of the cash and bank balances and on the state of investments;

(e) watch the progress of the collection of revenue and advise on the method of collection to be employed;

(f) ensure that the registers of buildings, land, furniture and equipment are maintained uptodate and that stock checking of equipment and other connected materials in all offices, special centres, specialised laboratories, colleges and institutions maintained by the University is conducted;

(g) bring to the notice of the Vice-Chancellor any unauthorized expenditure and other financial irregularities and suggest action to be taken against the person responsible for it;

(h) call for from any officer, centre, laboratory, college or institution maintained by the University, any information or returns that he may consider necessary for the performance of his duties.

(6) The receipt of the Finance Officer or of the person or person duly authorized in this behalf by the Executive Council for any money payable to the University shall be sufficient discharge for payment of such money.

Controller of

7. (i) The Controller of Examinations, shall be whole time

Examinations

salaried officer of the University and shall be appointed by the Executive Council, on the recommendations of the Establishment Committee, on such terms and conditions as may be prescribed by the Executive Council.

(ii) It shall be the duty of the Controller of Examinations-

(a) to conduct examinations in a disciplined and efficient manner;

(b) to arrange for the setting of papers with strict regard of secrecy;

(c) to arrange for the evaluation of answer-sheets in accordance with the planned time schedule for results;

(d) to constantly review the system of examinations in order to enhance the level of impartially and objectivity with a view to making it better instrument for assessing the attainments of students;

(e) any other matter connected with the system of examinations which may, from time to time, be assigned to him by the Vice-Chancellor.

Librarian

8. The Librarian shall be whole time salaried officer of the University and shall be appointed by the Executive Council on the recommendations of the Establishment Committee on such terms and conditions as may be prescribed by the Executive Council.

Court and its constitution

9. The Court shall consist of the following members, namely:-

(A) Ex-Officio members:-

(h) The Chancellor;

(ii) The Vice-Chancellor;

(iii) The Secretary to Government, Haryana, Finace

Department, or a

Nominee not below the rank of Director/Joint Secretary;

(iv) The Secretary to Government, Haryana, Education Department or a

Nominee not below the rank of Joint Secretary;

(v) Higher Education Commissioner or in his absence Joint Director

Colleges;

(vi) Director General Health Services or his nominee not below the rank of

Joint Director;

(vii) The Director of Technical Education, Haryana;

(viii) The Dean of Faculties;

(ix) The Dean of Colleges;

(x) The Registrar;

(xi) Dean of Students' Welfare, if any;

(xii) The Controller of Examinations;

(xiii) Dean of Academic Affairs;

(xiv) Librarian;

(xv) Finance Officer

(B) Other members-

(i) two persons to be elected by the Haryana Vidhan Sabha from

amongst its members;

(ii) professors of the University not exceeding ten, on the basis of

Seniority by rotation;

(iii) five teachers to be elected from amongst the readers and lecturers of

The University of whom at least two shall be readers;

(iv) one principal from the colleges of education admitted to

the

privileges of the University, on the basis of seniority, by rotation;

(v) one principal to be elected from amongst themselves by the

principals holding their posts in substantive capacity in colleges,

other than colleges of education, included in each of the four zones

to be demarcated by the Vice-Chancellor;

(vi) four teachers other than principals to be elected from amongst

themselves by the teachers holding their posts in a substantive capacity

in colleges included in each of the four zones to be demarcated by the

Vice-Chancellor:

Provided that not more than one teacher under this sub-clause, shall

belong to any one college;

(vii) Secretary, Chaudhary Devi Lal University Students' Union and two

Secretaries to be elected from amongst themselves by secretaries to be

elected from amongst themselves by secretaries of the Students' Union

in Colleges for the period from the date of election till 31st May of the

academic year;

(viii) Fifteen representatives (ten from amongst eminent

academicians and five

Representatives from industry, commerce, medicine,

engineering etc.) to

Be nominated by the Chancellor, for a term of three years;

(ix) one of the principals of colleges maintained by the University, by rotation

for a term of three years;

(x) two persons elected from amongst themselves by the representatives of

the managements of non-Government colleges. The representatives of the

managements shall be from amongst the members of the concerned

managements.

(C) (1) The Registrar shall be the Member-Secretary of the Court:

Provided that no salaried servant of the University, including its allied institutions, shall be eligible for election or nomination under any of the preceding sub-clauses except sub-clauses (ii) to (vi) and (ix) and that if any person elected or and nominated under any of the preceding sub-clauses except sub-clauses (ii) to (vi) and (ix) is subsequently appointed to any salaried post in the University or its allied institutions, he shall cease to be a member of the Court:

Provided further that no person shall be eligible for nomination or election to the Court except under sub-clause (vii) unless he has attained the age of 25 years.

(2) Save as otherwise expressly provided, the members of the Court, other than ex-officio members, shall hold office for a term of two years.

(3) At all meetings of the Court two-fifths of the members shall form a quorum.

(4) If the required number of members for purposes of quorum is not present within half-an-hour after the appointed time

of the meeting, the meeting shall not be held and the Registrar shall make a record of that fact.

(5) The method of election shall be by simple majority voting by ballot and the elections shall be conducted in accordance with the rules framed by the Vice-Chancellor.

Meetings of the Court.

10. (1) The Court shall meet at least once a year.

(2) A special meeting of the Court may be convened at any time, by the Chancellor, the Vice-Chancellor or on a written request by one-third of its member.

Executive Council and its constitution

11. The Executive Council shall consist of the following persons, namely:-

I. Ex-officio members-

(i) The Vice-Chancellor;

+(i a) The Pro Vice-Chancellor;

(ii) The Secretary to Government, Haryana, Finance Department, or a nominee not below the rank of the Director/Joint Secretary;

(iii) The Secretary to Government, Haryana Education Department or a nominee not below the rank of the Director/Joint Secretary;

(iv) The Secretary to Government, Haryana, Technical Education Department or a nominee not below the rank of Director/Joint Secretary.

II. Other members-

(a) Five Deans of the Faculties one from each of the following categories:

++ (i) Dean, Faculty of Physical Sciences and Dean Faculty of Life Sciences, by rotation;

(ii) Dean, Faculty of Commerce & Management and Social Sciences by rotation;

(iii) Dean, Faculty of Humanities and Law by rotation;

(iv) Dean, Faculty of Indic Studies and Education, by rotation;

(v) Dean, Faculties of Engineering & Technology and

Medical

Sciences by rotation;

*****(aa) Dean Academic Affairs

(b) two principals(other than the Deans of the Faculties) of colleges, out of

whom one shall be from a women's college, by rotation, on the basis

of seniority of age;

(c) one teacher (other than a principal) of a college to be elected by the

members of the Court from amongst themselves;

(d) one out of the professors of the University Teaching Departments other

than Deans under sub-clause (a), by rotation for one year, on the basis

of seniority;

(e) two teachers of the University Teaching Departments other than

professor to be elected from amongst themselves out of whom at least

one shall be Reader;

(f) four persons as the Chancellor's nominee from amongst distinguished

Educationists of national or international eminence or distinguished

serving/retired civil servants.

III. (i) The Registrar shall be ex-officio Secretary of the Executive Council.

(ii) Two-fifths of the members will form a quorum.

(iii) Save as otherwise expressly provided, the members of the

Executive

+ Added in view of Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.

++Amended vide resolution no. 5 of 21st meeting of the Executive Council held on the 19.02.2008. Received the assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/2421 dated 26.03.2008.

*** Amended vide resolution no. 1 of 18th meeting of the Executive Council held on the 09.07.2007. Receieved the assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/4989 dated 22.08.2007**

Council, other than Ex-officio members, shall hold office for a term of

two years.

IV. Any member who cease to hold the qualifications by virtue of which he

was elected or nominated as member to the Executive Council shall cease

to be a member thereof.

Decision of Executive Council

12. Any decision of the Executive Council in the matters involving additional financial liability and those relating to the annual budget of the University shall hold good only if at least one representative of the Government is present at the time of taking such decision and has consented to that decision.

Powers of the Executive Council

13. The Executive Council shall exercise the following powers, namely:-

(a) to hold, control and administer the revenue, property and funds of the

University;

(b) to create teaching and academic posts, to determine the number and

Emoluments of such posts and to define the duties and conditions of

Service of Professors, Readers, Lecturers and other academic staff and

Principals of colleges and institutions maintained by the University:

Provided that in the matters of creation of new post involving

additional Financial liability shall hold good if the representative of the

Government as given below:-

Finance Secretary or in his absence his representative;

OR

Education Secretary or in his absence his representative, is present

at the time of taking such decision and has consented to that

decision:

Provided further that in case the Government representative from

the Finance/ Higher Education Department is not present in two

consecutive Meetings even after the proper notice, then the Executive

Council may Approve the proposal regarding creation of posts:

Provided further that in respect of the number, qualifications and the

emoluments of teachers and academic staff, the Executive Council shall

take action after consideration of the recommendations of the Academic

Council and the Finance Committee.

(c) to appoint professors, readers, lectures, other academic staff and

principals of colleges and institutions maintained by the University, on

the recommendations of the Selection Committees constituted for the

purpose and to fill in temporary vacancies therein;

(d) to create administrative, ministerial and other posts and to make

Appointments thereto, in the manner prescribed by the Statutes;

(e) to manage and regulate the finances, accounts, investments, property,

Business and all other administrative affairs of the University and for

that purpose to appoint such agents as it may thin fit;

(f) to invest any money belonging to the University including any

unapplied income in such stocks, funds, shares or securities as it shall

from time to time, think fit or in the purchase of immovable property

in India with the like powers of varying such investments from time

to time;

(g) to transfer or accept transfer of any movable and immovable property

on behalf of the University;

(h) to provide buildings, premises, furniture and apparatus and other

means needed, for carrying on the work of the University;

(i) to select a common seal for the University;

(j) to delegate any of its powers to the Vice-Chancellor, the Registrar or

Such other employee or authority of the University or to a committee

Appointed by it, as it may deem fit;

(k) to enter into, vary, carry out, or cancel contracts on behalf of the

University;

(l) to make, amend or repeal the Statutes;

(m) to make decisions regarding maintenance of discipline among

students;

(n) to exercise all powers of the University not otherwise provided for

by the Act, the Statutes, or the ordinances.

Academic Council and its constitution

14. The Academic Council shall consist of the following persons, namely:-

I. Ex-officio members-

(i) The Vice-Chancellor;

+ (i a) The Pro Vice-Chancellor;

*****(ii) The Higher Education Commissioner , Haryana or the Joint Director

(Colleges), Haryana or any nominee of the Higher Education

Commissioner not below the rank of Deputy Director Colleges;

(iii) The Registrar;

(iv) The Deans of Faculties;

(v) The Deans of the Students' Welfare, if any;

(vi) The Dean, Academic Affairs;

(vii) The Dean of Colleges;

+ Added in view of Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.

***Amended as per orders of the State Government conveyed by the Higher Education Commissioner, Haryana, Panchkula vide Memo. no. 18/171-2008 UNP(I) dated 04.12.2008. Received the assent of Hon'ble Chancellor vide no. HRB-UA-30(4)-08/9021 dated 07.10.2008**

(viii) The Chairpersons of the Departments;

(ix) The Chief Warden of University Hostels;

(x) The Proctor;

(xi) The Controller of Examinations, if any;

(xii) Librarian of the University Library;

(xiii) One out of the principals of colleges maintained by the University,

By rotation, provided that he is not a member of the Executive

Council;

(xiv) Professor(s) Emeritus appointed by the University/Emeritus Fellow

Appointed by the University Grants Commission (but without having

Right to vote or seek election).

II. Other members-

(i) one professor appointed by the University from each Department, by

Rotation, on the basis of seniority;

(ii) one University reader from each faculty, by rotation, on the basis of

seniority;

(iii) one University lecturer from each faculty, by rotation, on the basis of

Seniority;

(iv) one principal and three teachers to be elected from amongst themselves

by the principals and teachers respectively, holding their posts in

substantive capacity in the colleges included in each of the

constituencies mentioned below:-

(a) Government colleges, other than the colleges of Education;

(b) Colleges of Education;

(c) Non-Government colleges, other than the colleges of

Education, in

Each of the four zones to be demarcated by the Vice-Chancellor:

Provided that not more than one teacher elected under this clause

Shall belong to any one college;

(v) five educationists of national or international eminence to be nominated

By the Vice-Chancellor, from outside the University, provided that not

More than one of them shall be from the same field;

(vi) three person elected by the Court from amongst its own members;

(vii) president, Chaudhary Devi Lal University Students' Union and two

presidents to be elected from amongst themselves by the presidents

of the students' Unions in the colleges for the period from the date the

date of election till 31st May of the Academic Year:

Provided that the members coming under this sub-clause shall

not participate in the meeting at the time the Academic Council

considers the appointment of examiners.

III. (1) The Registrar shall be the Member-Secretary of

Academic Council

(2) Two-fifths of the members will form a quorum.

(3) Save as otherwise expressly provided, the members of the Academic

Council, other than Ex-officio members, shall hold office for a term

of two years.

(4) The method of election shall be by simple majority voting by ballot

and the elections shall be conducted in accordance with the rules

framed by the Vice- Chancellor.

Powers of Academic Council.

15. (1) The Academic Council shall exercise the following powers, namely:-

(a) to exercise general supervision over the academic policies of the

the University and to give directions regarding methods of

instructions, evaluation of research of improvements in academic

standards;

(b) to consider matters of general academic interest either on its own

initiatives or on reference by the Chancellor, the Vice-Chancellor,

the Executive Council or a Faculty and to take appropriate action

thereon;

(c) to recommend to the Executive Council, the creation and abolition

of teaching posts;

(d) to prescribe syllabi and courses of study for various examinations

on the recommendations of the faculties;

(e) to frame such regulations consistent with the Statutes and

Ordinances regarding the academic functions of the University,

discipline, residence, admissions, awards of fellowships,

studentships, scholarships, medals and prizes, fee concessions,

corporate life and attendance; and

(f) to exercise such other powers and perform such other duties as may

Be conferred or assigned to Academic Council by the Act, the

Statutes, or the Ordinances.

(2) All decisions of the Academic Council concerning syllabi, courses of

studies, and the conducting of examinations so far as they are not

provided for the Statutes and Ordinances shall be final

Composition of Finance Committee

16. (1) The Finance Committee shall consist of the following persons, namely:-

I. Ex-officio members-

(a) the Vice-Chancellor (Chairperson);

***** (aa) the Pro Vice-Chancellor;

(b) the Secretary to Government, Haryana, Finance Department,

or a

or a nominee not below the rank of Director / Joint Secretary;

(c) the Secretary to Government, Haryana, Education Department, or a

Nominee not below the rank of Director/ Joint Secretary;

(d) the Secretary to Government, Haryana, Technical Education Department

or a nominee not below the rank of the Director / Joint Secretary;

II. Other members-

(a) one outside member having expertise in finance to be nominated by the

Chancellor on the recommendation of the Vice-Chancellor;

(b) two Deans of Faculties to be nominated by the Vice-Chancellor;

(2) The Registrar will be the Member-Secretary of the Committee.

(3) Nominated member of the Finance Committee shall hold office for a

term of two years.

(4) Three member, out of whom at least one member shall be a Government

nominee, shall form the quorum.

Functions and powers of the Finance Committee.

17. (1) The Finance Committee shall examine the accounts and scrutinize the proposals for expenditure and shall submit the annual budget to the Executive Council for approval. No expenditure in the budget shall be incurred by the University without the prior approval of the Finance Committee which shall fix limits for the total recurring and non-recurring expenditure shall be incurred by the University in excess of the limits so fixed.

(2) It shall examine and recommend to the Executive Council the creation of teaching and other posts.

(3) The annual accounts and the official estimate of the University shall be

laid before the Finance Committee for its consideration and comments thereon and thereafter submitted to the Executive Council for approval.

Faculties of University

18. There shall be the following Faculties:-

+(1)Faculty of Humanities
(2) Faculty of Social Sciences
(3) Faculty of Life Sciences.

*** Added in view of Haryana Act No. 18 of 2008, assented to by the Governor of Haryana on the 17th April, 2010 and published in Haryana Govt. Gaz.(Extra.), Apr 25, 2008.**

+ Amended vide resolution no. 10 of 17th meeting of the Executive Counicl held on 10.06.2007. Received the assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/3951 dated 25.06.2007.

(4) Faculty of Education.
++(5) Faculty of Physical Sciences.
+(6) Deleted.
(7) Faculty of Engineering and Technology.
(8) Faculty of Law.
(9) Faculty of Commerce and Management.
*****(10) Deleted.
*****(11) Faculty of Medical and Allied Sciences. Such other Faculties as the

Executive Council on the recommendation of the Academic Council,
may prescribe by Satutes.

Constitutions of Faculties.

19. (1) Each Faculty shall consist of -

(i) Dean of Faculty- (Chairperson);
(ii) Chairman of the Departments included in that Faculty;

(iii) One Professor from each Department on the basis of seniority by

rotation;

(iv) One Reader and one Lecturer appointed or recognized by the

University in the Departments included in the Faculty by rotation

according to seniority;

(v) Two Principals of Colleges/Institutes admitted to the privileges of

the University on the basis of seniority by rotation.

(2) Members nominated shall hold office for two years:

Provided that the Executive Council, at the request of the Academic Council, may increase the number of members of a Faculty.

******(3) Branch In-charge of the Academic Branch not below the rank of Assistant Registrar may act as Secretary of the Faculties.

(4) Two-fifths of the members in each Faculty shall form the quorum.

Dean of Faculties

20. (1) There shall be a Dean of each Faculty who shall be appointed by the Vice-Chancellor. The Dean shall be appointed in rotation on the basis of seniority amongst the Professors in various Departments comprising the Faculty:

Provided that a Professor appointed as Dean, will get his next turn after all the Professors in the Faculty, have been appointed as Dean in order of their seniority:

Provided further that in case there is no Professor in the Faculty, the Dean shall be appointed from amongst the Readers in the Concerned Departments.

(2) Suitable remuneration shall be attached to the office of the Dean who shall hold office for a term of three years.

++ Amended vide resolution no. 10 of 17th meeting of the Executive Council held on 10.06.2007. Received assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/3951 dated 25.06.2007.

+ Deleted vide resolution no. 16 of 24th meeting of the Executive Council held on 28.06.2008. Received assent of the Hon'ble Chancellor vide no. HRB-UA 35(i)-08/7768 dated 01.09.2008.

*** Amended vide resolution no. 1 of 18th meeting of the Executive Council held on 09.07.2007. Received assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/4989 dated 22.08.2007.**

****Amended vide resolution no. 24 of 30th meeting of the Executive Council held on 21.11.2009. Received assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/16576 dated 16.12.2009.**

(3) The Dean shall convene meetings of the Faculty and will preside over them.

(4) The Dean shall be responsible for the co-ordination of teaching therein and the execution of the decision of the Faculty.

(5) He shall have the right to be present and to take part in discussion at any meeting of committee of the Faculty.

Powers of the Faculties.

21. Subject to the control of the Academic Council, the powers of

the faculty shall be-

(a) to co-ordinate teaching and research work of the University in the

Departments assigned to the Faculty;

(b) to recommend to the Academic Council courses of studies and syllabi for

the different examinations after necessary reports from the Boards of

studies;

(c) to receive reports from the Department for the creation and abolition of

posts and to forward them to the Academic Council with such

recommendations as it may consider reasonable;

(d) to discuss and suggest to the Academic Council schemes for the

advancement of standards of teaching and examination; and

(e) to deal with any matter that may be referred to it by the Academic

Council or the Vice-Chancellor or the Dean of the Faculty.

Chairpersons of Departments.

22. (1) Each teaching department shall have a Chairperson who shall be appointed by the Vice-Chancellor for a period of three years by rotation:

Provided that-

(a) if a Department has two or more Professors, the Chairpersonship shall

rotate by seniority only among the Professors:

Provided that a Professor appointed as Chairman will get his next

turn after all the Professors in the Departments have been appointed as

Chairperson in order of their seniority;

(b) if a Department has only one Professor, the Chairpersonship shall rotate

between the Professor and the Senior most Reader;

(c) if a Department has no Professor, the Chairpersonship shall rotate

between the two senior most Readers;

(d) the Vice-Chancellor, if he considers it necessary for any administrative

reason, may deviate from the principle of seniority, in which case he

will report the matter to the Executive Council at its next meeting.

(2) In the case of Department where no teacher is eligible for appointment as Chairperson of for such Departments where instruction is imparted only upto the

Under-Graduate level in the colleges, the Dean of the concerned Faculty shall be the Chairperson.

(3) In case a senior person is on long leave the next eligible person will be appointed as Chairperson of the Department and he will continue as such till the completion of his term, even if the senior person returns from leave during that period. However, the senior person will be eligible for appointment as Chairperson after the expiry of the term of the present incumbent.

(4) In case the Chairperson of the Department by reasons of illness, absence or any other cause, is unable to perform the duties of his office, the duties of the office shall be performed by the next eligible person, unless, the Vice-Chancellor orders otherwise.

(5) In case a person refuses to accept the offer of appointment

as Chairperson or resigns on his own, he will not be eligible for appointment as Chairperson of the Department till his turn comes agains after the completion of the rotation circle among the eligible teachers.

(6) If the Vice-Chancellor deems it necessary, he may appoint the next eligible person as Chairperson irrespective of the fact that the term of the present Chairperson has not yet expired, in which case he will report the matter to the Executive Council at its next meeting.

Appointments.

23. (1) All appointments to teaching posts shall be made by the Executive Council on the recommendations of the Selection Committee.

(2) Appointments to Class-A posts (non-teaching/technical) shall be made by the Executive Council, on the recommendation of the Establishment/Selection Committee.

(3) (i) Appointments to post other than Class-A shall be made by the

Vice-Chancellor after complying with the due procedure laid

down in the rules or orders.

(ii) Appointments on daily wages in respect of class C and D

employees shall be made by the Registrar after complying with

the due procedure laid down in the rules or orders.

(4) Notwithstanding anything contained in clauses (1), (2) and (3) above, the Vice-Chancellor may, where he considers necessary, make and adhoc or temporary appointment for a period not exceeding six months, if it is not possible or desirable to make regular appointment. Where the appointing authority is the Executive Council, the decision taken by the Vice-Chancellor shall be reported to the Executive Council in its next meeting.

Selection Committees.

24. (1) A Selection Committee for any appointment of

Professor/Reader/Lecturer specified below shall consist of -

(i) The Vice-Chancellor;

(ii) The Dean of the Faculty;

(iii) The Chairperson of the Department concerned, if he is Professor;

(iv) The senior-most Professor in the Department except where Otherwise decided by the Vice-Chancellor;

(v) Three persons, not connected with the University, nominated by the Vice-Chancellor from a panel of names drawn up by the Academic Council on the basis of their special knowledge of, or interest in the subject with which the Professor will be concerned:

Provided that the Vice-Chancellor may add more names to the panel in special circumstances and report these to the Academic Council at its next meeting.

+(vi) An Academician, who is nominee of the Chancellor.

(2) The panel of names drawn up by the Academic Council and the additions, if any, made thereto by the Vice-Chancellor, as provided in the Statutes, shall be subject to approval of the Chancellor:

Provided that in case one of the experts fails to turn up at Selection Committee, after accepting the invitations to attend the same, the proceeding of the meeting shall not be invalidated:

Provided further that the proceedings of the meeting of a Selection Committee shall not be invalidated in case of any of the Ex-Officio members of the Selection Committee fails to attend the meeting.

(3) The Vice-Chancellor shall preside at the meetings of a Selection Committee and the Registrar shall act as its Secretary. The meeting of a Selection Committee shall be convened by, or under the directions of the Vice-Chancellor.

(4) The Selection Committee shall consider and submit to the Executive Council the recommendations as to the appointment referred to it. If the Executive Council is unable to accept the recommendations made by the Committee, it shall record its reasons and submit the case to the Chancellor for final orders.

++(5) Notwithstanding anything contained in Statutes, the Executive Council may invite a person of high academic distincition and professional attainments to accept a post of Professor in the University, on such terms & conditions as it deems fit and on the person agreeing to do so, appoint him to the post.

Establishment Committee

25. The constitution of the Establishment Committee shall be determined by the Ordinances.

26. (1) The Academic Planning Board shall consist of-

(a) Vice-Chancellor;

(b) Not more than seven persons of high standing in education who shall be appointed by the Chancellor on the recommendations of the Vice-Chancellor for a term of two years;

(c) The Registrar shall be the Secretary to the Board.

(2) The recommendations of the Board shall be implemented after they are approved by appropriate authorities of the University.

(3) It shall advise on the planning and development of the University particularly in respect of the standards of educations and research in the University.

+ Amended vide resolution no. 22nd meeting of the Executive Council held on 30.03.2007. Received assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/2591 dated 20.04.2007.

++ Amended vide resolution no. 3 of 18th meeting of the Executive Council held on 09.07.2007. Received assent of the Hon'ble Chancellor vide no. HRB-UA-30(1)-07/4989 dated 22.08.207.

Convocation

27. Convocation of the University for conferring of degrees and for other purposes shall be held in such manner as may be laid down by the Executive Council from time to time, by means of an Ordinance

Provided that every proposal to confer an honorary degree shall be a subject to the confirmation of the Chancellor.

Departments.

28. There shall be University Teaching Departments duly created by the Academic Council on the recommendation of the Vice-Chancellor in the various Faculties of the University.

Assignment of Department of studies to Faculties.

29. The Departments of Studies shall be assigned to various Faculties by the Academic Council on the recommendation of the Vice-Chancellor.

Board of Studies

30. (1) Every Department included in a Faculty, shall have two boards of Studies, one for Under-Graduate Studies and the other

for Post-Graduate Studies and Research.

(2) The Board of Under-Graduate Studies shall consists of-

(i) The Chairperson of the Department;

(ii) One Professor appointed or recognized by the University in the Department, to be nominated by the Vice-Chancellor, by rotation according to seniority;

(iii) One Reader and one Lecturer appointed or recognized by the University in the Department, to be nominated by the Vice-Chancellor, by rotation, according to seniority:

Provided that no such teacher shall be nominated for two consecutive terms:

Provided further that a teacher who has been nominated as a member of the faculty shall not be nominated under this sub-clause.

(iv) six teachers (including principals) of Under-Graduate Courses from the colleges in the subject concerned, to be nominated by the Vice-Chancellor, by rotation, according to seniority, to be determined by the length of Under-Graduate teaching experience ensuring that there is not more than one such member from any one college;

(v) two outside experts to be nominated by the Vice-Chancellor on the recommendation of the Chairperson of the Department;

Provided that the Executive Council at the request of the Academic Council may increase the number of members of a Board of Under-Graduate Studies, under sub-clause (v) above.

(3) The Board of Post-Graduate Studies and Research shall consist of-

(i) the Chairperson of the Department;

(ii) all the Professors appointed or recognized by the University in the Department;

(iii) two Readers and two Lecturers appointed or recognized by the University in the Department to be nominated by the Vice-Chancellor by rotation according to seniority;

(iv) two teachers including the Heads of the Post-Graduate Departments in colleges admitted to the privileges of the University in the subject concerned with at least 10 years teaching Experience, out of which 5 years shall be as Post-Graduate Degree Teacher, to be nominated by the Vice-Chancellor, by rotation According to seniority to be determined by the length of Post - Graduate Teaching experience.

Provided that if the number of colleges having Post Graduate Department is more than six, then one more teacher of the subject Concerned will nominated but not more than one such member Shall be from the same college;.

(v) two outside experts to be nominated by the Vice-Chancellor, on the recommendation of the Chairman of the Department:

Provided that the Executive Council at the request of the Academic Council, may increase the number of members of a Board of Post-Graduate Studies under sub-clause(v) above.

(4) (i) The Board of Under-Graduate Studies shall recommend to the Academic Council, through the Faculty concerned, courses and Syllabi of studies and text books for the various subjects for Under-Graduate courses and the Board of Post-Graduate Studies Shall make such recommendations in respect of the courses for Post-Graduate classes and Research Degrees.

(ii) The Boards of Studies shall also make recommendations to the Academic Council, regarding the appointments of paper-setters And examiners for the Under-Graduate or the Post-Graduate Courses, as the case may be.

(iii) The Board of Studies shall deal with any other matter that may be referred to them by the Faculty. The Chairperson of the Department shall be the Chairperson of the Board. Members, Other than ex-officio members, shall hold office for two years:

Provided that a person whose book or any other publication

is to be the subject of consideration before the Board, shall not

be attached to the Board.

Provided that a person who, in one way or the other, is

Involved in publication of cheap notes, guides or help books shall

Not be eligible to be a member of a Board of Studies.

Withdrawal of degree /diploma etc.

31. A degree, diploma, certificate and other academic distinctions may be withdrawn by the University-

(a) if the candidature of the person concerned has been cancelled or result

quashed in accordance with the manner laid down by the Ordinance;

or

(b) if the candidate has misbehaved at a convocation of the University;

provided that the question whether a person has misbehaved in terms

of this Statute shall be finally decided by the Vice-Chancellor; or

(c) when sufficient evidence is laid before the Academic Council

showing that any person on whom a degree or diploma etc. was

conferred by the University has been convicted of what is in their

opinion a serious offence.

The Academic Council may recommend to the Executive

Council that such a degree or diploma be cancelled.

Withdrawal of approval, recognition of teachers.

32. Approval, recognition to a teacher may be withdrawn by the University-

(a) if the teacher fails to perform duties in accordance with the manner laid down by the Ordinances;

(b) if sufficient evidence is laid before the Executive Council that the Teacher has committed an act which in their opinion is a serious Offence, the Executive Council may withdraw approval, recognition of the teacher.

Gratuity, ex-gratia grant etc.

33. The University shall provide for the benefits of its officers, teachers and other employees, gratuity, ex-gratia grant etc. on the pattern of the Government.

Fellowships, Scholarships, Medals and Prizes.

34. The number and value of fellowships, scholarships, medals and prizes to be awarded shall be determined by the Executive Council either on its own initiative or on the recommendations of the Academic Council or Finance Committee.

Limitation of term of membership.

35. (1) Notwithstanding anything contained in these Statutes, a person, who is a member of any authority or body of the University in his capacity as a member of a particular authority or body or as a holder of particular appointment, shall hold office so long only as he continues to be a member of that particular authority or body or the holder of that particular appointment, as the case may be:

Provided that a teacher-member of any authority or body of the University who resigns his service or proceeds on leave for six months shall cease to be a member of the respective body a substitute shall be appointed. If the period of his leave is less than six months, his membership will be held in abeyance till his return or the expiry of the period of six months, whichever is later. No substitute member will be appointed or elected, where the membership is held in abeyance.

Dean of Faculties

(2) If a teacher is on leave for a period of six months or more, he shall not be eligible for nomination or re-election for that particular vacancy. He will,

however, be eligible for nomination or election in a vacancy which may arise after his return from leave.

Termination of membership etc

36. Notwithstanding anything contained in these Statutes or the Ordinances of the University, no person, who has been convicted of any offence involving moral turpitude or has been dismissed for misconduct from a Government or Semi-Government institution or from a University or an educational institution of any kind, shall be eligible to become, or to continue as a member of any authority of this University or of any committee appointed by the University. A person under suspension shall not be allowed to sit in any meeting of the above authorities or committee during the period of his suspension.

Disqualification of membership

37. If a person is debarred by the Academic Council from any work of the University on account of any kind of malpractice on his part in connection with a University examination, such a person will be disqualified to become, or to continue as a member of any body or authority of the University so long as the bas lasts.

Delegation of administrative and financial powers to the officers/teachers/ employees of the University.

38. (1) The officers, teachers and other employees of the University may exercise, subject to the control of the Vice-Chancellor and the superior officers concerned, such administrative and /or financial powers, as the Executive Council may delegate through Ordinances or Rules and Regulations or by resolutions adopted by it.

(2) The Vice-Chancellor or the Registrar, with the approval of the Vice-Chancellor, may delegate to an officer, teacher or any other employee of the University such powers as he considers necessary which have been vested in them by the Statutes, Ordinances and Regulations.

New Statute 39.* Conditions of service of University Employees.

"Conditions of service of University employees shall be those as may be prescribed in the Ordinances governing the Services and Conduct Rules for University Teachers and Non-Teaching Employees".

New Statute 40.* Honoris Causa Degrees.

"If the Vice-Chancellor and not less than two-thirds of the other members of the Academic Council recommend that an Honoris Causa Degree be conferred on any person on the ground that he/she is in their opinion, by reason of eminent position and academic attainments, a fit and proper person, to receive such degree and this recommendation is endorsed by the Executive Council and approved by the Chancellor, the Academic Council/Executive Council may confer on such person the Honoris Causa Degree, so recommended, without requiring him/her to undergo any examination.

* New Statutes 39 and 40 added vide Resolution No. 3 and 12 of 35 meeting of the Executive Council dated 28.11.2010 respectively. Consented by the Hon'ble Chancellor vide No. HRB-UA-30(11)- 07/1090 dated 24.05.2011

NEW STATUTE 41*: MAINTENANCE OF DISCIPLINEAMONG THE STUDENTS.

(1) All powers relating to discipline and disciplinary action are vested in the Vice-Chancellor. He/she may delegate all or such of his/her powers as he/she deems proper to the Dean, Students' Welfare, Proctor, Chief Warden and to such other person as he/she may specify in this behalf.

(2) The detailed rules for maintenance of discipline among the students of the University and Colleges maintained by /affiliated to the University will be prescribed by the Executive Council through Ordinances.

NEW STATUTE 42*: CONDITIONS OF ADMISSION OF COLLEGES / INSTITUTES TO THE PRIVILEGES OF THE UNIVERSITY AND THE WITHDRAWAL OF THE SAME.

1. The University shall recognize, for admission to its privileges, such colleges as may be decided upon by the Executive Council from time to time.
2. An application for grant of recognition shall be made by the Higher Education Commissioner, Haryana or an Officer authorized by him/her in this regard, in the case of Govt. College and by the Chairman or any other authority appointed for the purpose by the Governing Body of the College in the case of in Non-Govt. College.
3. The Society / Trust or the Higher Education Commissioner, Haryana, as the case may be, applying for recognition / affiliation for a new College shall make an application on the form prescribed by the University, to the Registrar and shall satisfy the Executive Council:
   a) that unless it is a Govt. College, the College shall have a regularly constituted governing body as provided in the Ordinances;
   b) that unless it is a Govt. College, the qualifications of teaching and non-teaching staff, their pay scales and the conditions governing their tenure of the office are in accordance with the Statutes / Ordinances / Rules prescribed by the University. Every teacher appointed in a Non-

Govt. affiliated College shall be subject to the approval of the Vice-Chancellor in the manner prescribed by the University;

c) that the buildings in which the College is to be located are suitable and that provision will be made in conformity with the rules of the University (i) for the residence of the students, not residing with their parents / guardians in the College or in the lodgings approved by the College and (ii) for their supervision and physical welfare.

d) that the provision has been or shall be made within the specified period for a library according to University norms.

e) that where recognition is sought in any branch of experimental science, arrangements have been made or will be made in conformity with the rules of the University for imparting instruction in that branch of science in a properly equipped laboratory or museum.

f) that the provision will, so far as circumstances may permit, be made for the residence of the Head of College and some members of teaching staff in or near the College or the place provided for the residence of students;

g) that financial resources of the College are such as to make due provision for its continued maintenance.

h) that the required amount of endowment fund has been deposited with the Higher Education Commissioner, Haryana;

i) that the recognition / affiliation of the College having regard to the educational facility provided by other Colleges in the same neighbourhood will not be injurious to the interest or education;

j) that the College shall charge only those fees and funds as prescribed by the University from time to time; and

k) that the College shall faithfully observe the provisions of the Act, Statutes, Ordinances and Regulations of the University and the instructions issued by the University from time to time.

The application shall further contain an assurance that after the College is recognized, no transference of management shall be made except with the prior approval of the University and that all changes in the teaching staff shall forthwith be reported to the University for approval.

4. The existing recognised Colleges shall have to obtain the prior approval of the Vice-Chancellor for making any changes in the existing teaching staff.

5. Other conditions for admission of Colleges to the privileges of the University and for withdrawal of such privileges shall be those as prescribed in the Ordinances / Rules & Regulations by the Executive Council from time to time.

***New Statutes (41 and 42) added vide Resolution No. 9 of 36th meeting of Executive Council dated 24.02.2011 and consented by the Hon'ble Chancellor vide No. HRB-UA-30(1) 07/12 dated 05.04.2011**

NEW STATUTE 43*: ESTABLISHMENT OF COLLEGES / POST-GRADUATE AND RESEARCH INSTITUIONS.

1. The University may establish / maintain such College(s), Post-graduate and Research Institution(s), within its territorial jurisdiction, for providing instruction in various areas of knowledge, as the Executive Council may decide from time to time.

2. Such College(s) / Institution(s) shall consist of the Department(s) or subject(s) of study as may be assigned to it / them.

3. The Executive Council if it deems necessary, may constitute for each of these Colleges / Institutions, a Managing Committee which shall manage the College / Institution, subject to the general control and supervision of the Executive Council and in accordance with the Act, the Statutes, the Ordinances and the Rules / Regulations of the University, and the administrative control of such a College / Institution may be vested in a Principal / Director, whether or not a Managing Committee has been set up, with such powers and functions as may be defined by the Executive Council.

***New Statute (43) added vide Resolution No. 9 of 36th meeting of Executive Council dated 24.02.2011 and consented by the Hon'ble Chancellor vide No. HRB-UA-30(1) 07/12 dated 05.04.2011**

Science of the Total Environment 690 (2019) 717–729

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Real-time monitoring of air pollutants in seven cities of North India during crop residue burning and their relationship with meteorology and transboundary movement of air

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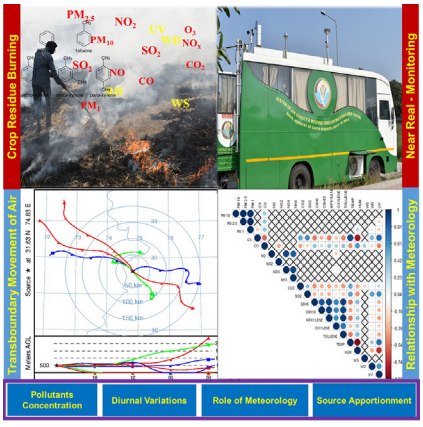
HIGHLIGHTS

- Crop residue burning affect air quality in Asia and specifically in IGP, India.
- Monitored real-time 16 air pollutants during crop residue burning in seven cities
- Pollutants levels found to be elevated during the crop residue burning.
- Emission of pollutants during crop residue plays major role in secondary pollutants.
- Crop residue burning and vehicles were identified as major sources of air pollutants.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 9 April 2019
Received in revised form 5 June 2019
Accepted 14 June 2019
Available online 15 June 2019

Editor: Pavlos Kassomenos

ABSTRACT

Air pollutants emissions due to the burning of crop residues could adversely affect human health, environment, and climate. Hence, a multicity campaign was conducted during crop residue burning period in Indo Gangetic Plains (IGP) to study the impact on ambient air quality. Seventeen air pollutants along with five meteorological parameters, were measured using state of the art continuous air quality monitors. The average concentration of PM_{10}, $PM_{2.5}$, and PM_1 during the whole campaign were 196.7 ± 30.6, 148.2 ± 20, and 51.2 ± 8.9 μgm^{-3} and daily average concentration were found several times higher than national ambient air quality standards for 24 h. Amritsar had the highest average concentration of $PM_{2.5}$ (178.4 ± 83.8 μgm^{-3}) followed by Rohtak and Sonipat

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https://doi.org/10.1016/j.scitotenv.2019.06.216

Keywords:
Biomass burning
IGP
Atmospheric loading
PM_1
VOCs
Climate change

(158.4 ± 79.8, 156.5 ± 105.3 μgm^{-3}), whereas Chandigarh recorded the lowest concentration (112.3 ± 6.9 μgm^{-3}). The concentration of gaseous pollutants NO, NO_2, NO_x, and SO_2 were also observed highest at Amritsar location, i.e., 6.6 ± 2.6 ppb, 6.2 ± 0.7 ppb, 12.7 ± 3.0 ppb, and 7.5 ± 3.3 ppb respectively. The highest average O_3 and CO were 22.5 ± 19.3 ppb and 1.5 ± 1.2 ppm during the campaign. The level of gaseous pollutants and Volatile organic compounds (VOCs) found to be elevated during the campaign, which can play an important role in the formation of secondary air pollutants. The correlation of meteorology and air pollutants was also studied, and O_3 shows a significant relation with temperature and UV ($R = 0.87$ and 0.74) whereas VOCs shows a significant correlation with temperature ($R = -0.21$ to -0.47). Air quality data was also analyzed to identify sources of emissions using principal component analysis, and it identifies biomass burning and vehicular activities as major sources of air pollution.

1. Introduction

Recent, Global Burden of Disease reports ranks air pollution as a leading cause of premature mortality and morbidity, especially in developing countries, which is an alarming situation (Cohen et al., 2017). The anthropogenic activities including solid biomass burning are major sources of air pollution, but these activities have been practiced since many years (J. Chen et al., 2017; Ravindra et al., 2019a). Apart from solid biomass fuel, other sources include exhust and non-exhaust emissions from vehicle, burning of crop residue in agricultural fields (Ravindra, 2019; Ravindra et al., 2019b, 2019c; Ravindra and Mor, 2019; Sidhu et al., 2017; Bhargava et al., 2018). Burning of crop residue leads to the emission of air pollutants such as particulate matter (PM_{10}, $PM_{2.5}$, PM_1), trace gases, Volatile organic compounds (VOCs) along with greenhouse gases (GHGs) in the atmosphere (Ravindra et al., 2019a). Apart from detrimental health effects, these pollutants also play an important role in changing the atmospheric chemistry regionally and globally (Ravindra and Smith, 2018; Gurjar et al., 2016; Ravindra et al., 2015). Hence, there is a need to understand the impact of air pollutants emissions during crop residue burning on climatic processes (Ramanathan and Carmichael, 2008; Ramanathan and Feng, 2009; Kumar et al., 2011).

In India around 24% of generated crop residue is burned in open fields (Ravindra et al., 2019a), leading to episodic very poor air quality in Indo Gangetic Plains (IGPs) as reported by Ram et al. (2012a, 2012b, 2016) and Pachauri et al. (2013). Burning of crop residues in agricultural fields after harvesting also leads to severe regional air pollution events (Cheng et al., 2014, W. Chen et al., 2017). Table 1 depicts the concentration of various pollutants during crop residue burning in India based on literature review, and their concentration found significantly high. Similarly, Mittal et al. (2009) also observed elevated levels of suspended particulate matter (SPM), SO_2, and NO_2 during crop residue burning period in Patiala, India. Singh et al. (2010a) highlighted the increase in the concentration of organic pollutants during stubble burning period. The higher fraction of $PM_{2.5}$ (55% to 64%) in RSPM may arise due to crop residue burning as reported by Awasthi et al. (2011). Kharol et al. (2012) reported increased aerosol loading and Black Carbon (BC) concentration during the agricultural burning activities.

Crop residue burning elevates the VOCs concentrations up to 1.5 times higher than the annual average during post-harvesting seasons in northwest IGP (Chandra and Sinha, 2016). Zhang et al. (2008) reported the annual emissions of polychlorinated dibenzo-p-dioxins and dibenzofurans during crop residue burning in China and highlighted that these emissions could contribute up to 10% to 20% of the total emissions of these toxic pollutants. Tang et al. (2013) reported 39% enhancement in ozone levels on sunny days and 27% on rainy days due to open crop residue burning in China. This shows that the concentration of pollutants during crop residue burning is highly influenced by the meteorological parameters, including their long-range transportation.

Witham and Manning (2007) showed that the impact of long-range transport of pollutants during agricultural residue burning on a regional episode of high air pollution. Similarly, Badarinath et al. (2009a, 2009b) reported that crop residue burning in IGP could affect the air quality over the south coast and Arabian sea coast of India using multi-satellite data. Kaskaoutis et al. (2014) also highlighted that long-range transport of crop residue burning influence the atmospheric conditions in Indian sub-continent. As discussed above, there are several studies, which monitor air quality only at one location having selected air pollutants. Hence, there is a need to conduct a study having major air polltants (particulates, VOCs and other gases) covering a wide geographical area.

Considering the above gap, the current study measures the near real-time concentration of various air pollutants along with meteorological parameters during crop residue burning in North India to better understand the impact of crop residue burning on air quality. Further, efforts were made to identify the major sources of air pollution using PCA and the impact of crop residue burning on regional air quality using HYSPLIT models. The finding of the current study will be useful to better understand the temporal and spatial distribution of air pollutants during crop residue burning period and to plan comprehensive air quality improvement strategies under National Clean Air Programme (NCAP, 2019).

2. Methodology

2.1. Study locations

The study was conducted in IGP having Punjab, Haryana, and Chandigarh states. Punjab and Haryana are known as the food bowl of the country. The sampling campaign was conducted from 27th October to 6th December 2016, having 7 cities to reflect geographical variations, as shown in Fig. 1 and Table 2. Chandigarh is an urban location, and sampling was conducted on the campus of Panjab University. In Fatehgarh Sahib and Bathinda measurements were done near agricultural fields at rural locations. Sampling in Amritsar was done in Guru Nanak Dev University campus, which is situated at outskirts of the city. Sirsa, Rohtak, and Sonipat are semi-urban location and sampling was done in the campus of Chaudhary Devi Lal University, Maharshi Dayanand University, and Deenbandhu Chhotu Ram University respectively. All the sites were situated away from major highways as that may influence the measurements of pollutants.

2.2. Sampling and instrumentation

The simultaneous and continuous measurement of various air pollutants and meteorological parameters was conducted using the System of Air Quality Forecasting and Research (SAFAR) mobile van laboratory on vehicles. The measured air pollutants include particulate matter (PM_{10}, $PM_{2.5}$ and PM_1), Black Carbon (BC), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), Ozone (O_3), oxides of nitrogen (NO, NO_2, NO_x), ammonia (NH_3), benzene, ethylbenzene, m-, p-xylene, o-Xylene and toluene. The meteorological parameters monitored were temperature, rain, relative humidity, wind speed wind direction, and ultraviolet radiation (UV). The data is time-resolved and

Table 1
The concentration of various pollutants at various location in India during crop residue burning period.

Location	Pollutants concentration										Season	Year	Reference	Comment
	TSP μgm^{-3}	RSPM μgm^{-3}	PM_{10} μgm^{-3}	$PM_{2.5}$ μgm^{-3}	SO_2	NO_2	O3	BC $\mu g\ m^{-3}$	OC	EC	Benzene	Toluene				
Patiala								5–25					Winters (Oct-Nov)	2008	Kharol et al., 2012	
Hisar (Urban)	177.4 ± 63.9								33.0 ± 17.9	3.8 ± 1.4			Winters	2004	Rengarajan et al., 2007	
Manora Peak	27.1 ± 8.3								4.8 ± 1.1	0.81 ± 0.22			December			
													Winters	2004	Rengarajan et al., 2007	
													December			
Patiala (rural)			160 ± 1.31, 154 ± 7.98	98 ± 1.49, 85 ± 3.54									Winter, Summer	2009–2010	Awasthi et al., 2010	During Harvesting Season
Patiala			180.3 ± 45.6	123.1 ± 25.5	9.3 ± 11.4	35.1 ± 33.9							Winter	2009	Agarwal et al., 2012	During Harvesting Season
							75 ± 14 (ppbv)	3049 ± 1122 ng/m3					Winter and Summer	2007–09	Kumar et al., 2011	Fire-Impacted Periods
Nainital (high altitude site)				147.6									Winter	2011–12	Kumar et al., 2018	
Amritsar																
Patiala		166.4 ± 6.9						10.3 ± 3.2					Winter	2008–10	Sharma et al., 2017	November month average
Kanpur			247 ± 97	189 ± 82									Winter	2008–09	Ram et al., 2012a	Oct-Nov
Mohali			276	104							1.7 nmol mol^{-1}	2.7 nmol mol^{-1}	Summer	2012	Sinha et al., 2014	May 2012

have a frequency of 5 min and then binned for the one-hour interval for further analysis. The van has a setup in which all the analyzers assembled within it by Environment S.A. (France) except BC analyzer.

The particulate matter was monitored based on the principle of Beta-ray Absorption method using suspended particulate beta gauge monitor (M101M+) whereas BC was monitored using EA-12 Aethalometer (Everise Technology Ltd.). The NOx analyzer (Chemiluminescent Nitrogen Oxide Analyzer, AC32M) works on the principle of chemiluminescence for analyzing the NO or NO_X concentration within a gaseous sample. The CO and CO_2 were measured using Non-Dispersive Infra-Red detectors using Gas Filter Correlation Carbon Monoxide Analyzer (CO 12M) whereas SO_2 was monitored using UV Fluorescent Sulfur Dioxide Analyzer (AF22M) UV-based ozone analyzer (UV Photometric Ozone Analyzer, O3-42M) work on the principle that ozone particles absorb UV light at a wavelength of 254 nm. The wavelength of 254 nm was created and passed through an air chamber. The amount of UV light absorbed is proportional to the amount of ozone present in that airspace. The amount of UV light absorbed in the chamber is interpreted as ozone concentration. The BTEX Analyzer (VOC72M) was used for VOCs measurement. It separate the targeted compounds based on gas chromatography and analyzed them using photoionization detection. The various meteorological parameters were also monitored using an automatic weather station (LSI LASTEM) installed in SAFAR mobile van.

2.3. Quality assurance/quality control

The instruments equipped in SAFAR mobile van laboratory on vehicles were maintained and operated as per the standard specifications. The instruments were US EPA approved and certified by Bureau Veritas Certification (ISO9001) for quality control. The US EPA's Standard Operating Procedures were adopted for instrument calibration and maintenance. The calibration frequency of the instruments was four weeks. More details about SAFAR can be found at http://safar.tropmet.res.in/ (SAFAR, 2019). The detailed information about the calibration procedure can be found by referring to title 40 of the Code of Federal Regulations (CFR) part 50. http://www.law.cornell.edu/cfr/text/40/part-50 (LII, 2019).

3. Results and discussion

3.1. Site-specific variations of pollutants

The crop residue burning period for Kharif crop in northern states of India usually starts in the beginning of second half of October and lasts for 6 to 8 weeks (Awasthi et al., 2010, 2011) The concentration of various pollutants at different locations during the crop residue burning campaign (27th October to 6th December 2016) is shown in Fig. 2.

3.1.1. Particulate matter and Black Carbon

The concentration of particulate matter was found significantly higher than the national ambient air quality standards of 100 and 60 μgm^{-3} for PM_{10} and $PM_{2.5}$ respectively for 24 h at all the locations during the campaign period. The highest average concentration of PM_{10} was observed in Amritsar 252.22 ± 108.14 μgm^{-3} followed by Sonipat and Bathinda as 213.67 ± 151.49 and 204.04 ± 70.80 μgm^{-3}, whereas Chandigarh reported the lowest average concentration of coarser particles as 151.45 ± 106.40 μgm^{-3}. Further, the highest average concentration of $PM_{2.5}$ was also observed in Amritsar 178.44 ± 83.81 μgm^{-3}. Rohtak, which is a semi-urban location, observed the highest PM_1 concentration as 62.29 ± 38.26 μgm^{-3}. The average lowest concentration of 151.45 ± 106.40, 112.27 ± 6.89 and 37.12 ± 8.76 μgm^{-3} for PM_{10}, $PM_{2.5}$ and PM_1 respectively was in Chandigarh which is an urban location whereas at the rural location of Fatehgarh Sahib the concentration of PM_{10} and $PM_{2.5}$ was 197.07 ± 61.35 and 149.12 ± 49.97 μgm^{-3} as shown in Supplementary Table S1. The Bathinda rural location has the

lowest $PM_{1,}$ with a concentration of 51.07 ± 17.18 μgm^{-3}. The results show that crop residue burning in north India significantly contribute to atmospheric aerosols and hence these sources should be given priority under NCAP to reduce particulate pollution.

During the rice crop residue burning period the monthly average concentrations (based on 24 h daily average) of suspended particulate matter ranged from 303 ± 13 μgm^{-3} to 547 ± 152 μgm^{-3} in Patiala (India) was reported by Singh et al. (2010b). Around 66% increase in PM_{10} levels and 78% in $PM_{2.5}$ levels from background concentration in the study area was reported by Awasthi et al. (2011) during rice crop residue burning period in a rural area of Punjab. Similarly, a high concentration of $PM_{2.5}$ (246 μgm^{-3}) was reported by Rajput et al. (2011) during paddy crop residue burning in Patiala, India. During crop reside burning of paddy straw, the average concentration of particulate matter reaches more than twice more as compared to the period of non-burning. The concentration of PM_{10} and $PM_{2.5}$ before the paddy burning period were reported by Agarwal et al. (2012) in Patiala, India as 96.1 ± 4.7 μgm^{-3} and 54.6 ± 4.1 μgm^{-3} which reaches to 180.3 ± 45.6 μgm^{-3} and 123.1 ± 25.5 μgm^{-3} respectively during burning period.

The highest average concentration of Black Carbon (BC) was observed in Amritsar as 13.01 ± 6.0 μgm^{-3} followed by Chandigarh (12.68 ± 6.09 μgm^{-3}) and Rohtak (11.20 ± 4.90 μgm^{-3}). The lowest levels of BC were recorded in Bathinda as 8.40 ± 5.90 μgm^{-3} during the campaign. In Patiala region of IGP, the mass concentrations of BC ranges from 8.50 to 19.60 μgm^{-3} was reported during rice residue burning period by Singh et al. (2014). Similarly, Kharol et al. (2012) also reported higher concentration of BC (above 20 μgm^{-3}) during rice burning period in Patiala and associated it with regional burning practices in agricultural fields. The higher levels of particulate matter and BC during crop residue burning period shows that the air quality in the region significantly affected by these activities and can play a role in changing atmospheric chemistry by participating in heterogeneous chemical reactions, scatter sunlight, providing nuclei for cloud droplets (Andreae and Crutzen, 1997; Ramanathan et al., 2001). BC in atmosphere results in an increase in top-of-the-atmosphere radiative forcing, atmospheric solar heating and surface dimming which will affect the atmospheric activities (Ramanathan and Carmichael, 2008; Sreekanth et al., 2007; Singh et al., 2018)

3.1.2. Gaseous pollutants

Highest levels of O_3 was recorded in Bathinda (19.70 ± 16.00 ppb) whereas the levels of NO, NO_2, NOx, NH_3, SO_2 were found highest in Amritsar (6.60 ± 2.65, 6.24 ± 0.71, 12.73 ± 3.01, 2.65 ± 0.83 and 7.52 ± 3.25 ppb) respectively. The lowest concentration of O_3, NO and NOx were recorded in Sonipat (15.61 ± 15.75, 3.50 ± 1.10 and 8.67 ± 1.24 ppb) whereas levels of NO_2 and NH_3 (4.70 ± 0.47 ppb and 1.81 ± 0.44 ppb) were found lowest in Rohtak. The concentrations (24 h) of SO_2 and NO_2 in Patiala (India) during rice residue burning period ranges from 8 ± 7 μgm^{-3} to 55 ± 34 μgm$^{-3,}$ and 12 ± 4 μgm^{-3} to 91 ± 39 μgm^{-3} respectively was reported by Singh et al. (2010b).

Table 2
Sampling locations, types, and duration of sampling.

Locations	Dates of sampling	Type of location
Chandigarh (L1)	27 Oct–03 Nov 2016	Urban
Fatehgarh Sahib (L2)	03 Nov–09 Nov 2016	Rural
Amritsar (L3)	09 Nov–15 Nov 2016	Semi-Urban
Bathinda (L4)	16 Nov–21 Nov 2016	Rural
Sirsa (L5)	21 Nov–26 Nov 2016	Semi-Urban
Rohtak (L6)	26 Nov–03 Dec 2016	Semi-Urban
Sonipat (L7)	03 Dec–06 Dec 2016	Semi-Urban

The concentration of CO and CO_2 were 1.46 ± 1.16 ppm and 327.23 ± 31.95 ppm at Rohtak, showing the highest among all the locations. The similar concentrations of CO were reported by Sahai et al. (2010) during paddy residue burning period at Pantnagar and Ludhiana, India as 1.90 ± 0.69 ppmv and 1.35 ± 0.53 ppmv respectively. The average CO concentrations of 552 ± 113 ppb was reported by Chandra and Sinha (2016) post paddy harvesting period in northwest IGP region. The higher emissions of CO during crop residue burning and its long residence time can affect the atmospheric chemistry to a great extent. The concentration of CO, $O_{3,}$ and SO_2 were within limits (2 mgm^{-3}, 100 μgm^{-3} (8 h) and 80 μgm^{-3} (24 h)) of NAAQS of India for which only standard limits are available, but found elevated as compared to non-burning days during the campaign.

3.1.3. VOCs

The urban location of Chandigarh has the highest average levels of benzene (1.56 ± 0.50 μgm^{-3}), whereas the highest average concentration of ethylbenzene, m-, p-xylene and o-xylene (1.62 ± 1.31 μgm^{-3}, 2.18 ± 2.28 μgm$^{-3,}$ and 1.76 ± 5.32 μgm^{-3}) respectively were observed in Rohtak. The highest concentration of toluene (5.27 ± 1.00 μgm^{-3}) was reported in Amritsar. The rural location of Fatehgarh Sahib reported the lowest concentration of all monitored VOCs except toluene, which had the lowest concentration in Sonipat. Pandey and Sahu (2014) highlighted that crop residue burning has foremost emissions of isoprene (80%) and toluene (72%) among burning of various biomasses. The average concentrations of 2.51 ± 0.28 ppb and 3.72 ± 0.41 ppb of benzene and toluene was reported by Chandra and Sinha (2016) post

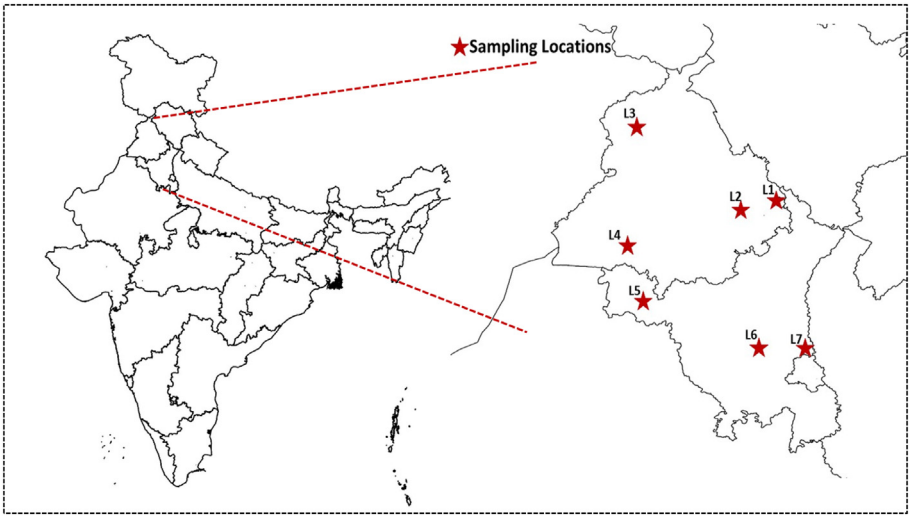

Fig. 1. Study area and locations of various sampling sites during the campaign.

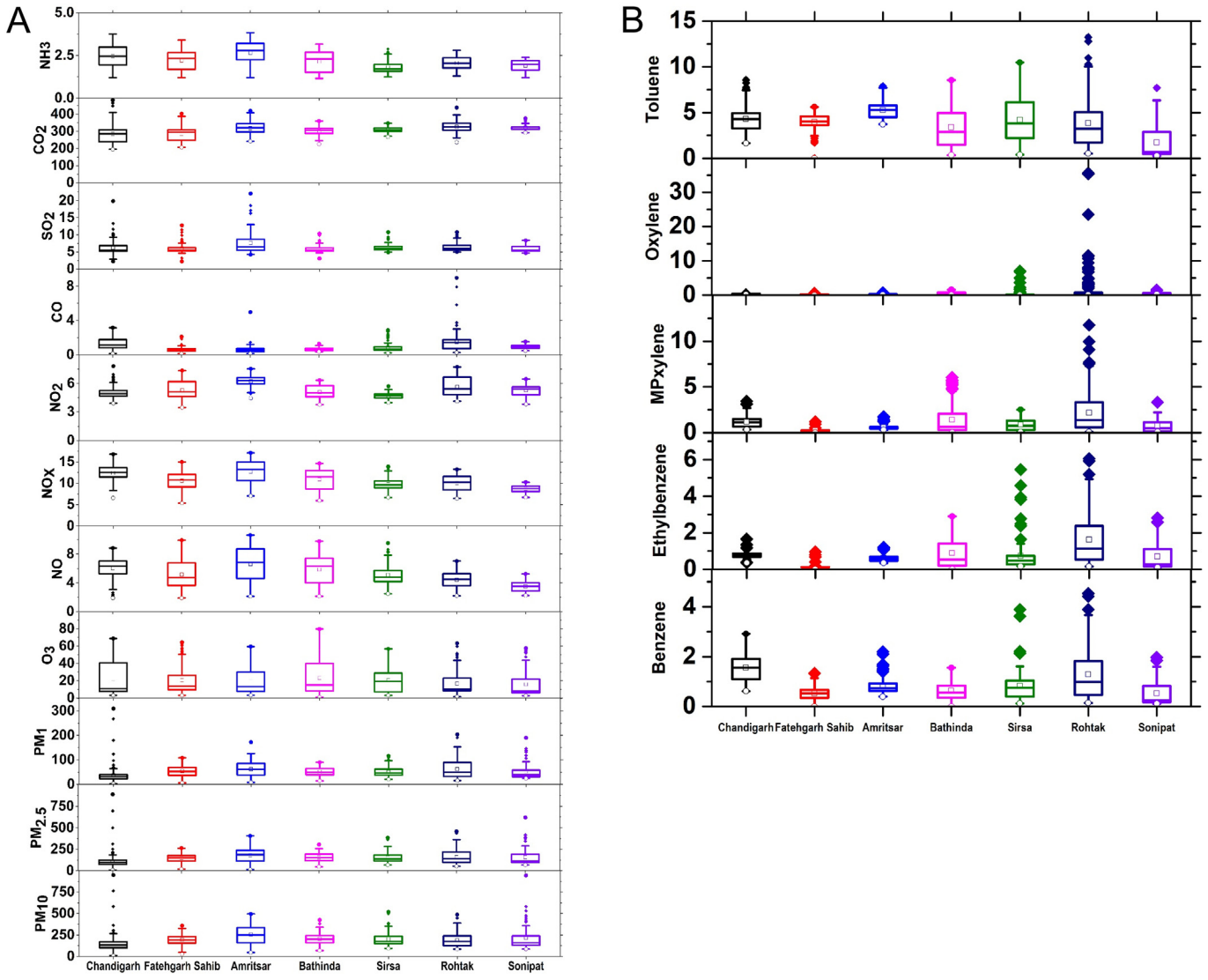

Fig. 2. (a). Concentration of various pollutants at various locations during whole campaign (b). Concentration of various VOCs at various locations during whole campaign.

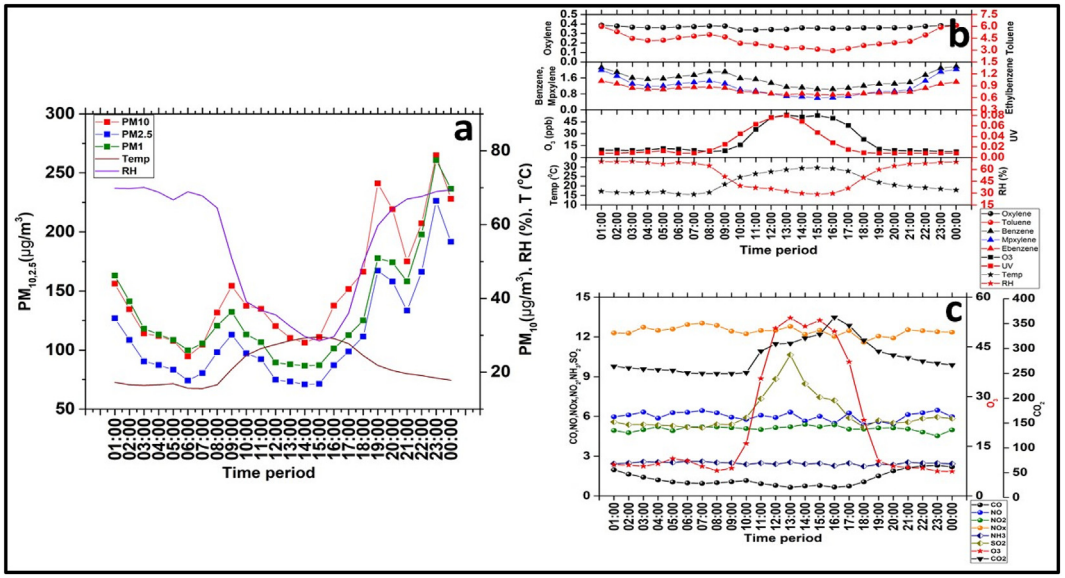

Fig. 3. Diurnal Variation in various PM, gaseous and VOCs emissions along with meteorological parameters at Chandigarh location (27 Oct 2016–03 Nov 2016).

paddy harvesting period in northwest IGP region which are on the higher side.

3.2. Diurnal pattern of various air pollutants

3.2.1. Particulate matter and Black Carbon

The highest hourly average concentration of PM_{10} (519 ± 403 μgm^{-3}) during the campaign was reported at Sonipat (08:00–09:00 am) whereas lowest as 94.7 ± 40 μgm^{-3} (5:00–06:00 am) was in Chandigarh. The peak value of the hourly average concentration of PM_{10} during the whole campaign was 948 μgm^{-3}, which was in Chandigarh on Diwali day. The highest hourly concentration of $PM_{2.5}$ and PM_1 was also in Sonipat with 336 ± 262 μgm^{-3} and 119 ± 82 μgm^{-3} between 8:00 am to 9:00 am whereas the lowest hourly average was in Chandigarh as 70.9 ± 15 μgm^{-3} and 21.7 ± 4.9 μgm^{-3} during 1:00 to 2:00 pm. The higher trends in Sonipat location in morning hours may be due to higher vehicular emissions as there is a huge inflow of trucks and cars toward Delhi NCR in morning hours. Fig. 3 shows the diurnal variation in PM and meteorology (27 Oct–03 Nov) and the pattern how with the increase in temperature the PM concentration decreases. The increased concentrations ranging from 30 to 300% during night time were reported by Rastogi et al. (2014) for various pollutants, including $PM_{2.5}$ during the diurnal study of crop residue burning in the IGP region.

Fig. 4 shows the diurnal variation in Black Carbon concentration at various locations. The results show that gradual build-up starts at evening hours and peaks till midnight. The trend was more or less same in all the locations and can be linked with crop residue burning as the most of burning activities took place after the closure of government offices, i.e., 17:00 h as these activities are prohibited in the region. Further, considering the duration between 22:00 to 06:00 as night and 06:00 to 22:00 as daytime, the diurnal pattern was studied. The results show that Chandigarh, Fatehgarh Sahib, Rohtak, and Sonipat locations have high finer PM concentration at night time, whereas rest 3 locations show a significantly higher concentration of fine particles at day time.

3.2.2. Gaseous pollutants

As shown in Fig. 3 diurnal pattern of ozone (O_3), oxides of nitrogen (NO, NO_2, NO_x), ammonia (NH_3), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2) was studied. The rural location Fatehgarh

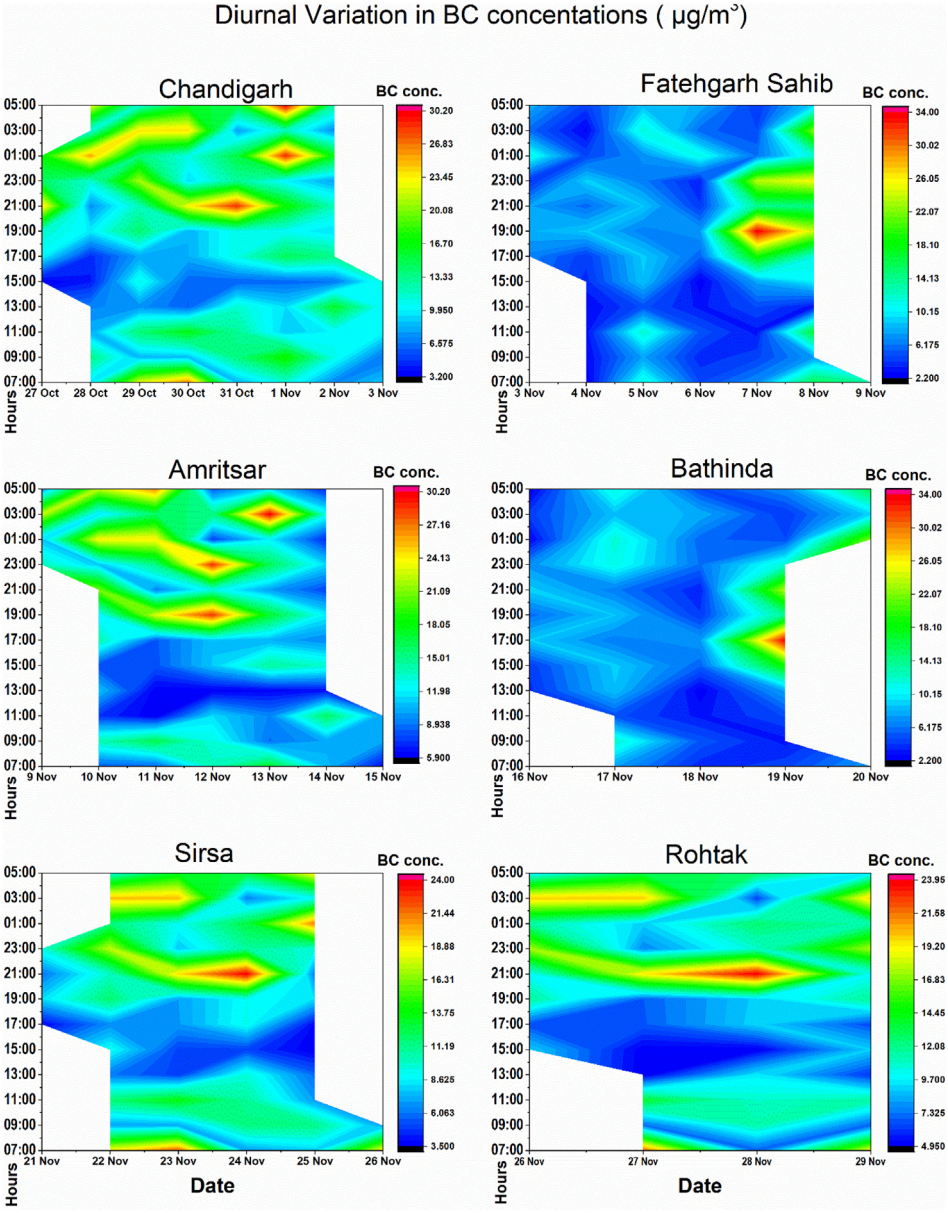

Fig. 4. Diurnal variation in Black Carbon concentration at various locations.

Sahib had the highest average hourly concentration of O_3 as 58.9 ± 4 ppb between 3:00 to 4:00 pm whereas the lowest was in the rural location of Bathinda as 4.5 ± 2 ppb during 10:00 to 11:00 pm. In general, the higher levels of ozone are at daytime, whereas for other gases level increase in night time (Wang et al., 2002). Here the lower level of ozone in morning hours seems to be linked with fogy conditions which reduce

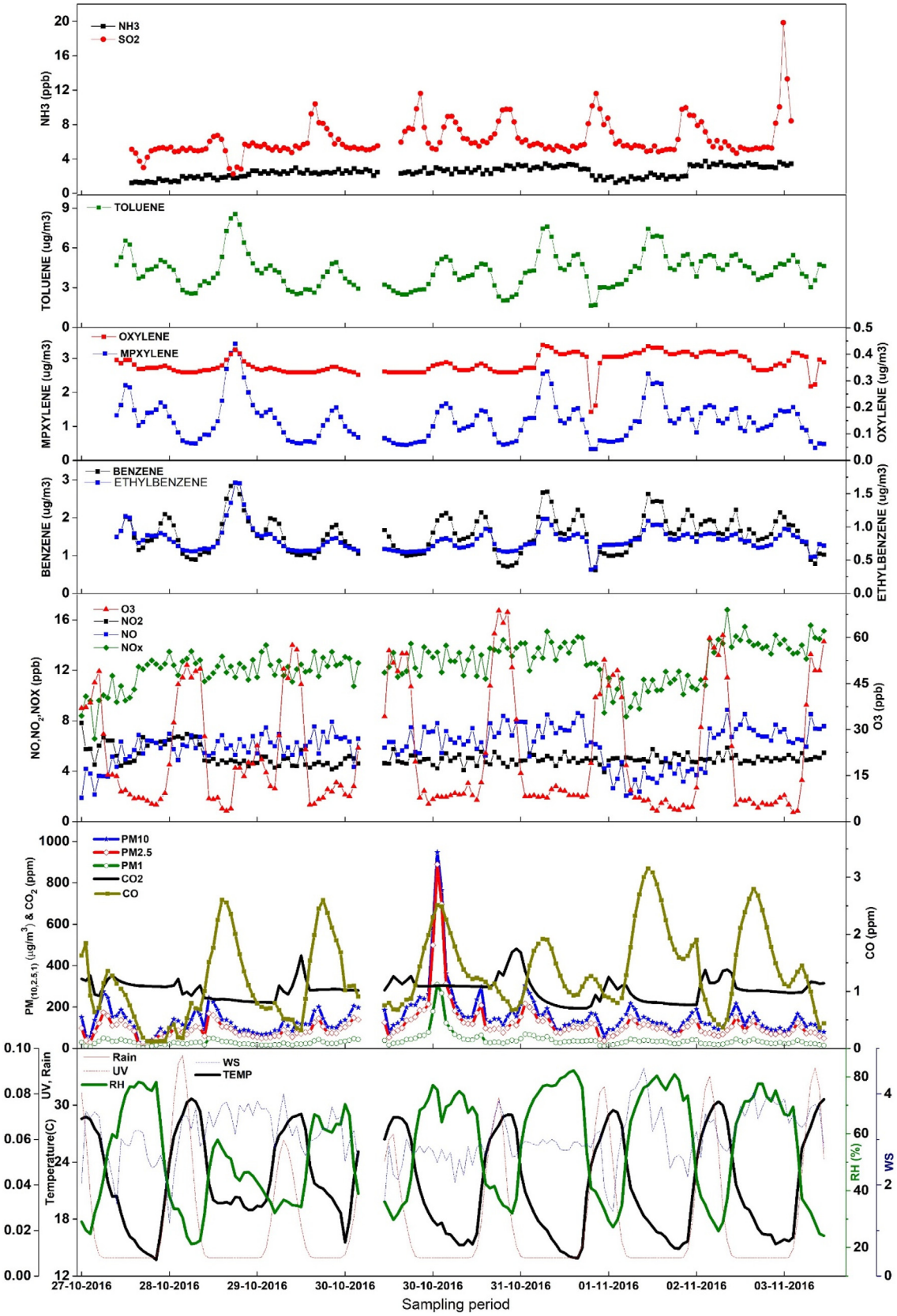

Fig. 5. Variation in concentration of various pollutants with metrological parameters in Chandigarh (L1).

the photochemical activity (Kumar et al., 2016). The average hourly concentration of NO, NO_2, NOx, NH_3 and SO_2 was highest in Amritsar as 7.4 ± 1.4, 6.6 ± 2.3, 14 ± 2.5, 3 ± 0.7 ppb and 12.5 ± ppb respectively in between 7:00 am to 8:00 am (foggy condition)and from 12:00 to 1:00 pm for SO_2. The higher levels of these pollutants at night time and in the early morning in winters when the boundary layer is low can be linked with the accumulation of locally emitted pollutants (Cheung and Wang, 2001). The hourly average concentration of 2.6 ± 2.5 ppm of CO monitored in Rohtak, which was the highest between 6:00 pm to 7:00 pm during the whole campaign. The increase in concentrations SO_2 in the afternoon and late afternoon can be linked with the transportation of large plumes (Cheung and Wang, 2001). Fig. 3 shows the diurnal variation of gaseous pollutants in Chandigarh. The variation in diurnal behavior of these gases in winter mainly influenced by lower temperature and solar radiation, which slow down the atmospheric process (Wang et al., 2002).

3.2.3. Volatile organic compounds (VOCs)

The diurnal pattern of benzene, ethylbenzene, m-, p-xylene, o-xylene, and toluene was also studied during the sampling period. Fig. S1. shows the diurnal variation in the concentration of various VOCs at a different location during the campaign. The variation in VOCs concentration shows similar patterns in all the location expect Rohtak where the VOCs peaks at daytime, whereas in all other location the VOCs are low in the daytime. The similar patterns may indicate similar emissions source and similar mechanism of dispersion (Khoder, 2007). The highest hourly average concentration of VOCs expect toluene were also observed in Rohtak. The benzene, ethylbenzene, m-, p-xylene, o-Xylene has 2.7 ± 1.54 μgm^{-3}, 3.3 ± 2 μgm^{-3}, 4.2 ± 2.1 μgm^{-3}, 6.6 ± 14.2 μgm^{-3} average hourly concentrations in Rohtak respectively between 1:00 pm to 2:00 pm, whereas Sirsa shows the higher hourly average concentration of toluene (7.7 ± 1.8 μgm^{-3}) at night time The highest contribution among all VOCs was of toluene in all the locations. These higher levels can be related to vehicular activity in the vicinity of the study locations. The rural location of Fatehgarh Sahib showed the lowest average hourly concentration of benzene, ethylbenzene, m-, p-xylene, and o-Xylene in the noon hours whereas Sonipat showed the lowest average hourly concentration of toluene in morning hours (06:00 to 09:00) as 0.3 ± 0.3 μgm^{-3} which was lowest during the whole campaign. Fig. 3. shows how the concentration of O_3 and various VOCs varies with meteorological parameters during the day and night time in Chandigarh location. Except for rural locations, in all other sites, the diurnal variations of VOCs showed two peaks. The peak start building in morning hours (07:00–10:00) and evening hours after 17:00 h. The morning peaks may be due to the increase in vehicular activity. In the afternoon, the VOCs levels decrease probably due to the dilution caused by atmospheric activities in the presence of sunlight (Khoder, 2007). The presence of benzene and toluene at the all the location can be used as tracers of incomplete combustion (Li et al., 2018).

3.3. Meteorology and air quality

The meteorological parameters always play an important role in the dispersion of air pollutants and influence the concentration of the pollutants in the atmosphere. Lower boundary layer during winter help building of air pollutants near ground level and mixing of pollutants with winter fog results in smog events (Niranjan et al., 2007; Sreekanth et al., 2018). The variation in the concentration of various pollutants with metrological parameters in Chandigarh location as a representative graph is shown in Fig. 5. The figure shows how concentration and the pattern of various pollutants vary period. The values of various meteorological parameters and plots of wind roses showing wind direction, wind speed, and wind frequency for various locations during the campaign is shown in Table 3 and Fig. 6, respectively. At Chandigarh, the wind direction was frequent, mainly southeast, and had an average speed of 3.07 ± 0.7 ms^{-1}. At Fatehgarh Sahib and Amritsar, the average wind speed was 3.24 ± 0.86 $ms^{-1,}$ and 2.81 ± 1.28 ms^{-1} and direction blew from east-southeast and south-southeast. In Bathinda, the wind speed is slow and calm as an average of 1.64 ± 0.73 ms^{-1} and frequent direction were west and east. At Sirsa, the winds speed was comparative high as 3.69 ± 1.52 ms^{-1} and mainly from the north direction. At Rohtak, the wind direction varies from north-northwest to south-southwest whereas at Sonipat the wind directions were west-northwest with an average speed of 1.86 ± 0.81 ms^{-1} and 3.27 ± 0.68 ms^{-1} respectively. The average temperature and relative humidity (RH) recorded was varies from 13.7 ± 9.5 to 21.6 ± 5.6 degree centigrade and 50.3 ± 18.7% to 66.12 ± 22.81%, respectively, at various locations during the whole campaign. The Sonipat location has the higher average RH values where monitoring was done on the first of December whereas Rohtak has the lowest average RH. Amritsar and Bathinda locations have encountered little precipitation during monitoring, and the rainfall was recorded as 0.003 ± 0.045 mm and 0.76 ± 1.81 mm. The UV was in the range of 0.022 ± 0.021 to 0.017 ± 0.016 Wm^{-2}.

3.3.1. Correlation between meteorology and air quality

The regression analysis was done to find the correlation of the various pollutants and meteorological data by evaluating their correlation coefficients. As shown in Fig. 8, the O_3 shows good correlation with temperature and humidity at all locations. The increase in temperature and decrease in RH, O_3 concentration increases. The benzene also shows a correlation with other VOCs in most of the sites. The correlation matrix of various air pollutants and meteorological parameters for the Chandigarh location as a representative is shown in Supplementary Table S2. This matrix helped in understating the significant correlation between the various parameters.

3.3.2. Impact of transboundary movement of air on air quality

To understand the transportation pathway of the air mass over the different locations, a 48 h airmass backward trajectories were computed using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model of the National Oceanic and Atmospheric Administration (NOAA), USA (Stein et al., 2015; Rolph et al., 2017). The back-trajectories were calculated for each location at 5:30 IST at the boundary layer of 500 m above ground level. Backward trajectory (48 h) of air masses at Amritsar from 9 to 15 November 2017 is shown in Fig. 7 as representative. Fig. 7 also shows the fire and thermal anomalies on 11 November 2016 using Aqua and Tera satellite data having MODIS sensor onboard. It is quite evident from the figure that most of the air masses originated within 200 km, where significant crop residue burning

Table 3
Meteorological parameters recorded during campaign.

Meteorological parameters	L1	L2	L3	L4	L5	L6	L7
	27Oct-03Nov	03Nov-09Nov	09Nov-15Nov	16Nov-21Nov	21Nov-26Nov	26Nov-03Dec	03Dec-06Dec
Temperature (°C)	21.6 ± 5.6	20.1 ± 5.1	19.5 ± 5.1	13.7 ± 9.5	21.1 ± 5.6	19.3 ± 5.4	16.8 ± 5.5
Relative humidity (%)	54.4 ± 20.1	64.7 ± 2.0	64.1 ± 20.0	56.3 ± 22.82	50.3 ± 18.7	63.6 ± 27.8	66.12 ± 22.81
Rainfall (mm)	0	0	0.003 ± 0.045	0.76 ± 1.81	0	0	0
Wind speed (ms^{-1})	3.07 ± 0.7	3.24 ± 0.86	2.81 ± 1.28	1.64 ± 0.73	3.69 ± 1.52	1.86 ± 0.81	3.27 ± 0.68
UV(Wm^{-2})	0.02 ± 0.028	0.02 ± 0.024	0.017 ± 0.016	0.022 ± 0.021	0.020 ± 0.020	0.019 ± 0.019	0.020 ± 0.018

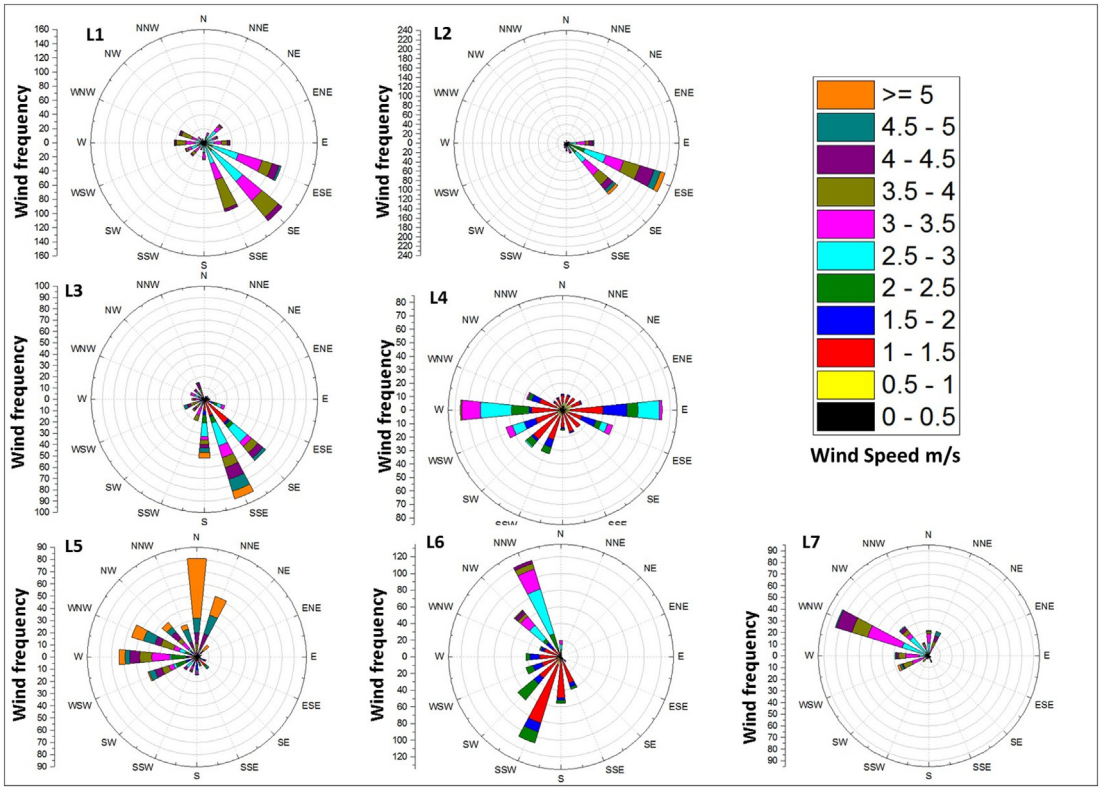

Fig. 6. Wind roses plot of various locations during the sampling period.

events were recorded. Badarinath et al. (2009a, 2009b) highlighted that in climate change studies the long-range transportation of atmospheric pollutants is an important factor as it not only impacts the atmospheric chemistry in regional but also on a global scale.

4. Source apportionment

4.1. Principal component analysis

The approach of principal component analysis (PCA) was applied to identify the emission sources. PCA application transforms the variables of the original dataset to smaller set having the liner combinations and accounts for having most of the variances of the original dataset which have most of the information of it (Ravindra et al., 2008; Jain et al., 2017, 2018). Factor analysis was performed with varimax rotation and Keiser normalization using SPSS 24.0 software. Factor having an eigen value >1 were considered as shown in Supplementary Table 3. The PCA results are shown in Supplementary Table 3, having the first two factors as they explain maximum variance (Ravindra et al., 2006, 2008).

Chandigarh site has high factor loading of CO, O_3, C_6H_6, Toluene, m-, p-xylene with 33% of the variance for Factor 1, whereas, factor 2 has high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1). CO is a product of incomplete combustion and may be from vehicular and biomass combustion (Guo et al., 2004). Benzene (C_6H_6) is emitted from vehicles in urban areas and from open biomass and solid biomass fuels burning in rural areas (Guo et al., 2004). Whereas in Fatehgarh Sahib Factor 1 has high factor loading of fine particulate matter ($PM_{2.5}$,

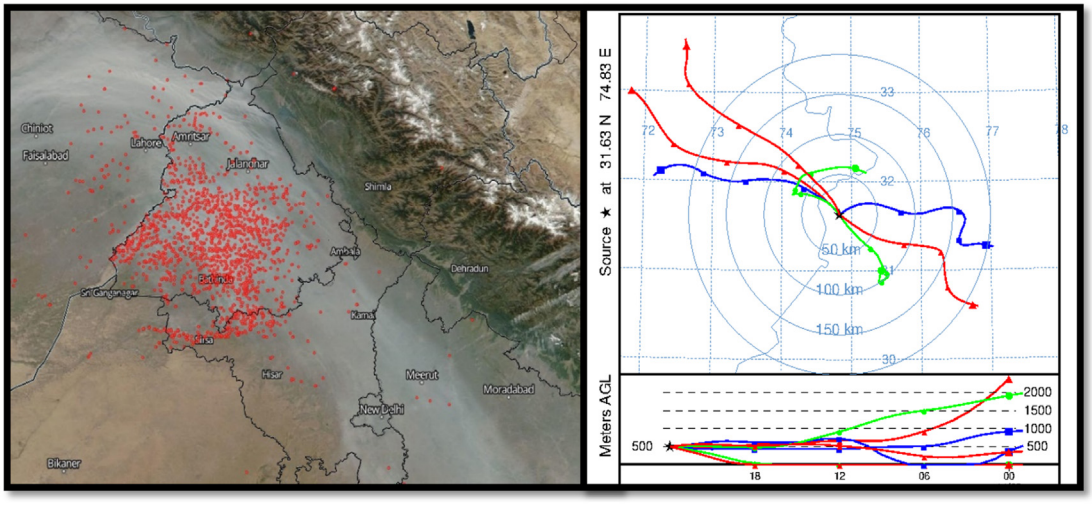

Fig. 7. MODIS (Aqua and Tera) fire and thermal anomalies on 11 November 2016 (left) and 48 h backward trajectory of air masses at Amritsar from 9 to 15 November 2016 (right).

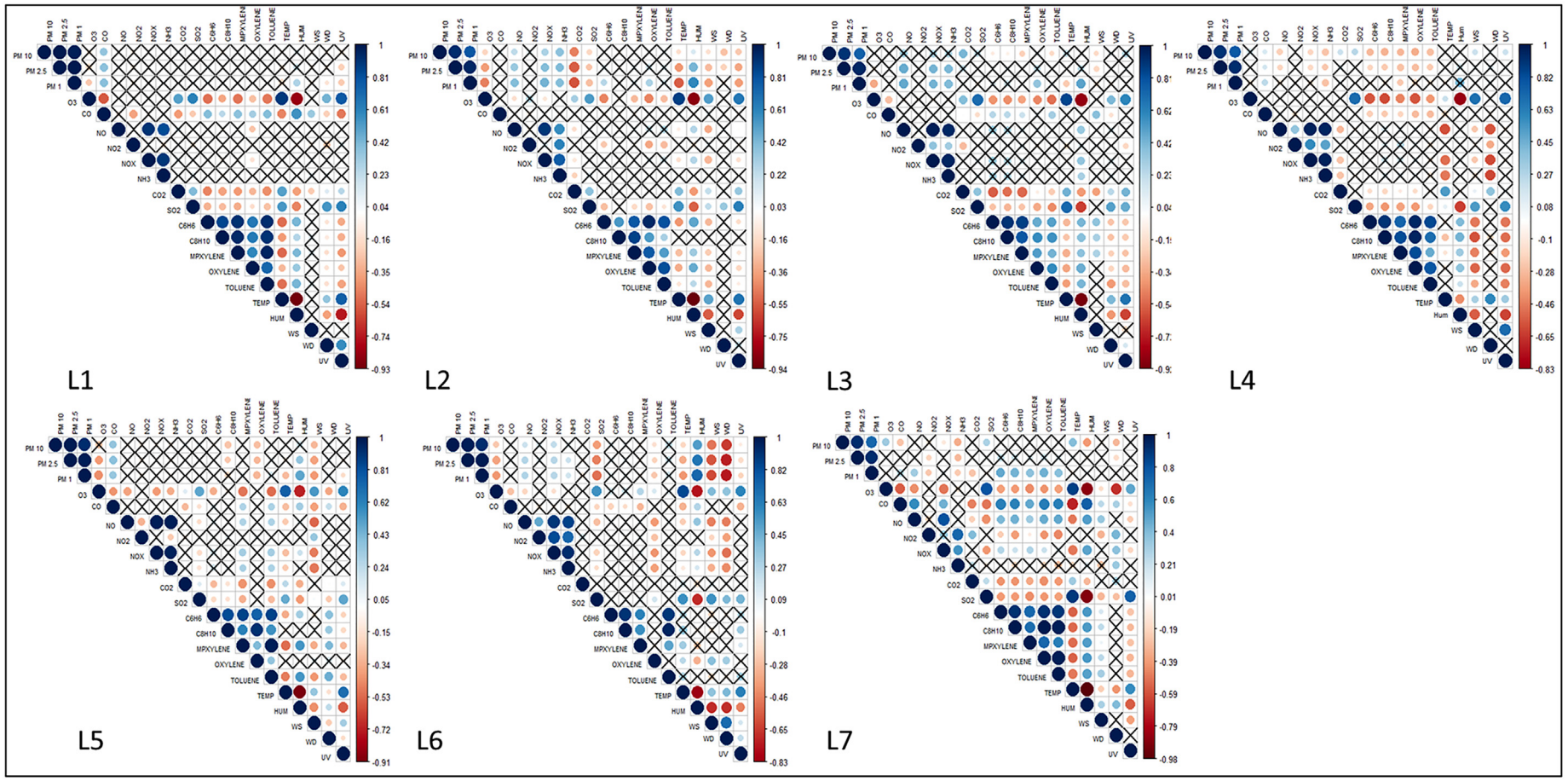

Fig. 8. Correlation plot of various air pollutants and meteorological parameter.

PM_1), O_3, C_6H_6, o-Xylene, and explaining 32% of variance whereas the factor 2 has higher factor loading of NH_3 and again for C_6H_6. As reported by Guo et al. (2004), benzene in rural areas may be related to biomass and biofuel burning.

At Amritsar location, Factor 1 has high factor loading of O_3, C_6H_6, C_8H_{10}, m-, p-xylene explaining 31% of variance whereas factor 2 has higher factor loading of particulate matter, NO, NOx and NH_3. For Bathinda location Factor 1 has high factor loading of O_3, C_6H_6, C_8H_{10}, toluene, m-, p-xylene, o-Xylene and explaining 33% of variance whereas factor 2 has higher factor loading of NO, NOx and NH_3. The NOx emissions can be related to vehicular activities, whereas VOCs emissions may be linked to industrial and biomass burning activities.

In Sirsa Factor 1 has high factor loading of O_3, Toluene, m-, p-xylene, o-Xylene and explaining 30% of variance whereas factor 2 has very high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1). Whereas in Rohtak, Factor 1 has a high factor loading of fine particulate matter ($PM_{2.5}$, PM_1) and SO_2 explaining 30% of the variance, whereas factor 2 has a high factor loading of C_6H_6, C_8H_{10}, toluene. For Sonipat location Factor 1 has high factor loading of O_3, CO, SO_2, C_6H_6, C_8H_{10}, toluene, o-m-p-xylene, explaining 40% of variance whereas factor 2 has very high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1) and NH_3. The high loading factor of ozone in all the location can be linked to the transformation of VOCs results from vehicular activities/biomass burning and NOx results from vehicular activities.

4.2. $PM_{2.5}/PM_{10}$ and VOC characteristic ratios

The $PM_{2.5}/PM_{10}$ during the whole campaign ranges from 0.69 to 0.83, which was highest at Rohtak and lowest at Amritsar, as shown in Table 4. The average $PM_{2.5}/PM_{10}$ ratio shows that about (69–83%) of PM_{10} is made up of $PM_{2.5}$, and the presence of finer particle is higher in air. The higher ratios may be linked with the formation of secondary aerosols. The lower mixing height in winters helps in the agglomeration of precursors of secondary aerosol and enhances their formation (Strader et al., 1999) in which aqueous chemistry during high relative humidity also played an important role (Hu et al., 2016). Wang et al. (2019) also reported that in polluted days of the winter season, there is a higher formation of secondary aerosols as compare to normal days. Amritsar location also experienced little rainfall during the sampling, which could result in the setting of particles. Awasthi et al. (2011) reported that smaller particles fraction dominates during crop residue burning period and $PM_{2.5}$ contributes around 55% to 64% of total RSPM. The higher $PM_{2.5}/PM_{10}$ ratio indicates the presence of freshly emitted aerosols.

The emission sources of various VOCs can be compared using interspecific ratios (Table 4) (Hoque et al., 2008; Tiwari et al., 2010). The presence of highly reactive VOCs in the atmosphere shows low concentration in day time due to photochemical reactions, whereas the less reactive VOCs accumulate during daytime (Rad et al., 2014). The T/B ratio ranges from 2.7 to 7.6, which is generally used to determine the photochemical age of air masses. The values were much higher in Fatehgarh Sahib, Amritsar, Bathinda and Sirsa locations which indicates the closeness to the emissions sources and have the influence of young air masses (Bruno et al., 2006; Roukos et al., 2009), The value of T/B < 2 indicates the higher influence of vehicle exhaust emissions whereas the higher values indicate about other sources such as biomass burning, industry emissions (Singh et al., 2016; Hui et al., 2018). The o-X/B ratio ranges from 0.2 to 1.3 were found at different sampling sites, which can be used as an indicator to estimate the regional transport rate of VOCs (Monod et al., 2001). The higher o-X/B ratio indicates toward the sources closer to the study area and implies that photochemical processes have a lower impact on the pollutants concentrations whereas lower ratios indicated the occurrence of transported and aged air masses, having an active photochemical reaction (Tiwari et al., 2010; Singh et al., 2016).

Similarly, the m,p-X/EB ratios indicate toward the sources closer to the study area and m,p-X/EB ratios < 3 indicates higher regional transport rates (Feng et al., 2018). In the current study, the m,p-X/EB ratios range from 0.9 to 1.7. Here the VOCs characteristics ratios indicate that the air quality was influenced by sources such as biomass burning other than vehicular emissions, and the emissions sources were both local as well as regional transported.

Table 4
$PM_{2.5}/PM_{10}$ and VOC concentration ratios during campaign (Toluene/benzene (T/B), m,p-xylene/benzene (m,p-X/B), oxylene/benzene (o-X/B), and o-X/EB concentration ratios at various locations).

Location	$PM_{2.5}/PM_{10}$	T/B	EB/B	m,p-X/B	o-X/B	o-X/EB	m,p-X/EB
Chandigarh	0.73	2.75	0.51	0.76	0.23	0.45	1.48
Fatehgarh Sahib	0.76	7.63	0.25	0.42	0.37	1.46	1.69
Amritsar	0.69	6.27	0.74	0.69	0.36	0.48	0.94
Bathinda	0.76	5.30	1.42	2.22	0.86	0.60	1.56
Sirsa	0.76	5.13	0.88	1.07	0.50	0.57	1.22
Rohtak	0.83	2.98	1.25	1.68	1.35	1.09	1.35
Sonipat	0.74	3.25	1.36	1.58	1.00	0.74	1.17

5. Conclusion

Air pollution is one of the serious concerns these days due to its impact on climate and health. Further, crop residue burning affects air quality in Asia and specifically in IGP, India. Considering this, 17 air pollutants during crop residue burning were monitored in near real-time along with meteorology parameters in seven cities to better understand their correlation. Pollutants levels found to be elevated during the crop residue burning. PM and BC emissions during crop residue burning found much higher (24 h limits). The monitored level of gases and VOCs were found below 24 h limits, but these them can play an important role in the formation of secondary air pollutants depending on their residence time and meteorological conditions. Air quality data was also analyzed to identify sources of emissions using principal component analysis, and it identifies biomass burning and vehicular activities as major sources of air pollution. The finding of the current study will be useful to better understand the temporal and spatial distribution of air pollutants during crop residue burning period and to plan comprehensive air quality improvement strategies under National Clean Air Program.

Acknowledgments

RK would like to thank Department of Health Research (DHR), Indian Council of Medical Research (ICMR), Ministry of Health and Family Welfare via Letter number V-25011/25(19)2013/HR dated 16 October 2014, for providing the Fellowship Training Programme in Environmental Health under Human Resource Development Health Research Scheme. TS is thankful to the University Grant Commission (UGC), New Delhi for providing the financial assistance to carry out the Ph.D. research work. The authors are thankful to local hosts for providing logistics support at sampling locations. We are also thankful to Dr. Sudesh Chaudhary from Deenbandhu Chhotu Ram University of Science and Technology, Sonipat, Haryana. The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and READY website (http://www.ready.noaa.gov) used in this publication. Indian Institute of Tropical Meteorology, Pune is supported by the Ministry of Earth Sciences (MoES), Government of India, New Delhi.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scitotenv.2019.06.216.

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Department of CSE - PhD Topics' Areas

Sr.	Name of Scholar	Awarded/ Ongoing	Topic Name	Thematic Area
1	Sanjeev Tuteja	Awarded	Software Testing Stratergies and Techniques: The Divide Between Practice and Theory	Software Testing
2	Pardeep Kumar	Awarded	Cloud Based Computer Laboratory : A Pedagogical Model for Computer Science Curriculum	Cloud Computing
3	Poonam Chaudhary	Awarded	Network Fault Detection with the help of Data Mining in Mobile Communication	Data Mining
4	Ajit Singh	Awarded	Data Security in the Modern Cryptosystem	Network Security
5	Omda Kumar	Awarded	Study and Design of some Data Mining Tools for Judiciary and Police Administration	Data Mining
6	Rajesh Kumar	Awarded	Effectiveness of Information and Communication Technology in Education System (A study of Technical Education in Haryana	ICT in Education
7	Sanjay	Awarded	Role of Computer and Information and Communication Technology in Agriculture Sector	ICT in Agriculture
8	Dhirendra Sharma	Awarded	Applications of Information Technology in University System (A case study of western Himalayan Region)	ICT in Universities
9	Sapna	Awarded	Human Involvement in Data Mining Process: Integration of Domain Speciific Knowledge in the Analysis of Large data Sets	Data Mining
10	Pardeep Kumar	Awarded	Desiging of Some Data Mining Tools for Business Intelligence in Insurance Companies in India	Data Mining
11	Subhash Chander	Awarded	Assessing the impact of E-Governance Projects in Rural and Semi Urban Areas: A Case study of Punjab	e-Governance
12	Saroj Bala	Awarded	Applications of Information Technology in Crimes: Some Issues and Challenges	Cyber Criminology
13	Rajesh Kumar Garg	Awarded	Designing the embedded systems: Role fo Simulation and Modeling	Embedded Systems
14	Sameer	Submitted	Security of Data Sharing in Cloud Computing	Cloud Computing
15	Baljit Kaur	Ongoing	Design of Technological framework for Business Intelligence in Medium and Large Enterprises	Business Intelligence

16	Ram Gopal	Ongoing	Hybrid Text Mining Approach to Prediction of Customer Behaviour in e-Shopping	Data Mining
17	Parveen Gorya	Ongoing	Predicting the Consumer Behaviour: A Web Mining Technique for E-Commerce	Data Mining
18	Surender Kumar	Ongoing	Digital Signature and Hash Function based approach for secure routing in VANET	Network Security
19	Kulbhushan	Ongoing	An Efficient Approach for finding duplicate Bugs in Open Source Software	Open Software
19	Sameer	Submitted	Security of Data Sharing in Cloud Computing	Cloud Computing
20	Suhashini	Ongoing	Blockchain Based Framework and Approach for Global Healthcare System	Blockchain
21	Dupinder Kaur	Ongoing	A Novel approach for the database creation and validation using Master Data Management	Data Integrity
22	Sanjay Singh	Ongoing	On Development of A framework for a Mobile Based Intelligent Tutoring System	Artificial Intelligence
23	Divya	Ongoing	An Artificial Intelligence Based approach to Efficient Data Retrieval in Big Data Analytics	Artificial Intelligence
24	Jasjit Singh	Ongoing	A Machine Learning Model for Prediciton of Heart Disease	Machine Learning
25	Vikash Khobra	Ongoing	Effective Kernel Selection for Classification and Regression Techniques in Machine Learning Domain	Machine Learning

3.4.6 Number of books and chapters in edited volumes published per teacher during the last five years (15)						
3.4.6.1: Total number of books and chapters in edited volumes / books published, and papers in national/international conference-proceedings year wise during the last five year						
Sl. No.	**Name of the teacher**	**Title of the paper**	**Title of the proceedings of the conference**	**Year of publication**	**Core Area**	**ISBN/ISSN number of the proceeding**
1	Dr. Harish Rohil	-	Edited Book published by International Publisher	2015	Computer Networks	ISBN: 978-981-09-5247-1
2	Dr. Harish Rohil	A Novel Framework for Cloud Computing Enabled Laboratory	2019 6th International Conference on Computing for Sustainable Global Development (INDIACom)	2019	Clouding Computing	ISBN: 978-93-80544-34-2
3	Neha Midha Vikram Singh	Classification of E-commerce Products Using RepTree and K-means Hybrid Approach	Big Data Analytics - Proceedings of CSI 2015	2017	Data Miniing	ISBN: 978-981-10-6620-7
4	Dilbag Singh, DupinderKaur	Improving shared cache performance using variation of bitset insertion policy	Proceedings of Lecture notes in network and Systems	2017	Big Data Analytics	ISBN: 978-981-10-3226-4
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6	Dr. Harish Rohil	-	Edited Book published by National Publisher	2021		ISBN: 978-93-90937-03-5
7	Divya, Vikram Singh, Naveen Dahiya	Blockchain-based Federated Machine Learning for Solving IoT Security Problems	Published in Applications of Blockchains and Big IoT Systems	2022	Machine Learning	ISBN 9781774637456
8	Ruchi Mittal, Varun, Vikram Singh, Jaiteg Singh, Amandeep	Integrating Genetic Algorithm with Random Forest for Improving the Classification Performance of Web Log Data	Sixth International Conference on Parallel, Distributed and Grid Computing (PDGC2020), November 6-8, 2020, Jaypee University of Information Technology, Solan	2020	Machine Learning	ISBN 9781728171326
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10	Divya, Vikram Singh, Naveen Dahiya	A Novel Approach for Predicting Popularity of User Created Content Using Geographic-Economic and Attention Period Features	Proceedings of *International Conference on Artificial Intelligence (ICAIA-2020) In Advances in Intelligent Systems and Computing*	2020	Artifical Intelligence	ISBN 9789811549915

11	Surender Kumar Vikram Singh	A Review of Digital signature and hash function based approach for secure routing in VANET	*International Conference on Artificial Intelligence and Smart Systems* (ICAIS)	2021	Wireless Network	ISBN 9781728195377

	Title of paper	Name of the	Name of journal	Year of pu	Core Area	ISSN number	Is it listed in UGC Care list/Scopus/Web of	
1	Unstructured Data in Business Intelligence Systems: A Study of Data Quality and Information Quality	Baljit Kaur, Vikram Singh	*Design Engineering*	2021	Businees Intelligence	0011-9342	Peer Reviewed	
2	Impact of Social Media on Learning Motivation	Vikram Singh, Varun Malik	STM Journal of Current Trends in Information Technology	2021	Social Computing	2249-4707	Peer Reviewed	
3	Indian Cybersecurity Turf: A 2020 Position	Vikram Singh, Varun Malik	STM Journal of Network Security	2021	Cyber Security	2395–6739	Peer Reviewed	
4	A Contemplative Perspective on Federated Machine Learning: Taxonomy, Threats & Vulnerability Assessment and Challenges	Divya, Vikram Singh, Naveen Dahiya	*ournal of King Saud University - Computer and Information Sciences*	2021	Machine Learning	1319-1578	SCIE, Scopus	
5	Review of Trust-based Security Models for Packet Routing in Wireless Sensor Networks	S. Rani, Dinesh Kumar, Vikram Singh	*Turkish Journal of Computer and Mathematics Education*	2021	Network Security	1309-4653	Peer Reviewed	
6	Risk Analysis in Software Cost Estimation: A Simulation-Based Approach	Vikram Singh, Varun Malik, Ruchi Mittal	*Turkish Journal of Computer and Mathematics Education*	2021		1309-4653	Peer Reviewed	
7	Machine Learning Based Hybrid Model For Heart Disease Prediction	Jasjit Singh Samagh, Dilbag Singh	Annals of the Romanian Society for Cell Biology	2021	Machine Learning	ISSN: 1583-6258	https://www.scopus.com/sourceid/19700167901 (Scopus)	
8	Blockchain Based Framework for Secure Data Management in Healthcare Information Systems	Dilbag Singh, Suhasini Monga	Annals of the Romanian Society for Cell Biology	2021	Block Chain	ISSN: 1583-6258	https://www.scopus.com/sourceid/19700167901 (Scopus)	
9	IMPLEMENTATION ON ENHANCING IRIS BASED SECURITY SYSTEM USING EDGE DETECTION MECHANISM	Charanjeet Kaur Mr. Gopal Sharma	International Journal of Advance Research in Science and Engineering	2021	Network Security	2319-8354	Others	
10	STE-AMM: Secret Twist Encryption Standard Access Mechanism Model in Cloud Environment; Sameer and Harish Rohil	Sameer, Dr. Harish Rohil	Journal of Communications	2021	Cloud Computing	1796-2021 (Online); 2374-4367 (Print)	Indexed: Indexing in Scopus, DBLP, CrossRef, EBSCO, Google Scholar etc.; Double Blind Peer Reviewed Open Access Journal (refereed, online, digital, e-Journal)	
11	Model of Enhanced Aarogya Setu App to Make it A Permanent Health App for Indian Citizens	Himanshu Mishra, Dr. Manju and Dr. Harish Rohil	International Journal for Research in Engineering Application & Management	2021	Clinical Computing	2454-9150	Indexed: Indexing in UGC, DOAJ, EBSCO, Google Scholar etc.; Peer Reviewed Open Access Journal (refereed, online, digital, e-Journal)	
12	Extended Feature Set Construction for Efficient Triaging of Bug Reports of Open Source Software	Kulbhushan Bansal, Dr. Harish Rohil	IT in Industry	2021	Open Source Software	2203-1731	Indexed: Indexing in ESCI;	
13	A Two-Tier Security Model for IoT Based Devices	Dilbag Singh and Snehlata	International Journal of Scientific Research in Computer Science, Engineering and Information Technology	2021	Network Security	2456-3307		
14	Business Intelligence: Need and Usage in Indian Corporate Sector	Baljit Kaur, Vikram Singh	*Journal of Critical Reviews*	2020	Businees Intelligence	0038-111X	Peer Reviewed	
15	Increasing BI Capabilities with FRM based Recommendations	Baljit Kaur, Vikram Singh	Solid State Technology	2020	Businees Intelligence	ISSN 0038-111X	Peer Reviewed	
16	DEVELOPMENTS IN INTELLIGENT TUTORING SYSTEMS 2010-202	Sanjay Singh, Vikram Singh	JOURNAL OF CRITICAL REVIEWS	2020	Artificial Intelligence	ISSN: 2394-5125	https://www.scopus.com/sourceid/21100920227 (Scopus)	

17	A Novel Approach to Student Profiling in Intelligent Tutoring Systems	Sanjay Singh, Vikram Singh	Wesleyan Journal of Research	2020	Artificial Intelligence	0975-1386	Peer Reviewed	
18	Identification of Security Threats in Business Intelligence Environment	Baljit Kaur, Vikram Singh	Wesleyan Journal of Research	2020	Businees Intelligence	0975-1386	Peer Reviewed	
19	Fog Computing-Based Approach to Enhance the Protection of Cloud Content During Transit	Shashikant, Vikram Singh	Journal of the Maharaja Sayajirao University of Baroda	2020	Cloud Computing	0025-0422	UGC CARE	
20	Data profiling model for assessing the quality traits of Master Data Management	Dilbag Singh, DupinderKaur	International Journal of Recent Technology and Engineering	2020		ISSN : 2277-3878	https://www.scopus.com/sourceid/21100889873 (Scopus)	https://ugccare.unipune.ac.in/Apps1/User/WebA/CAREList (UGC-CARE List Group-||)
21	A comprehensive review of heart disease prediction using machine learning	Dilbag Singh, Jasjit Singh Samagh.	Journal of critical reviews	2020	Machine Learning	ISSN: 2394-5125	https://www.scopus.com/sourceid/21100920227 (Scopus)	https://www.researchgate.net/publication/343745941_A_COMPREHENSIVE_REVIEW_OF_HEART_DISEASE_PREDICTION_USING_MACHINE_LEARNING
22	A Prologue to natural computing in remote sensing	Mrs. Sakhsi Dhingra	Journal of Interdisciplinary Mathematics	2020		ISSN: 0972-0502	https://www.scopus.com/sourceid/19700186891 (Scopus)	
23	Different computational perspective of test suite minimization in software testing	Neeru Ahuja, Pradeep Kumar Bhatia	International journal of scientific and Technology Research	2020		2277-8616	Others	
24	EDES-ACM: Enigma Diagonal Encryption Standard Access Control Model for Data Security in Cloud Environment	Sameer, Dr. Harish Rohil	International Journal of Advanced Computer Science and Application	2020	Cloud Computing	2156-5570 (Online)	Indexed: Indexing in Scopus, Web of Science, ESCI;	
25	An Intelligent Grey Wolf Optimizer: A Nature Inspired Technique in Intrusion Detection System	Durgesh Srivastav, Rajeshwar Singh, Vikram Singh	Journal of Advancements in Robotics	2019	Network Security	ISSN 2455-1872	Peer Reviewed	
26	XOR and IP Filter Based Steganography for Secure Data Transmission in Cloud Environment	Chandni, Vikram Singh	Journal of Emerging Technologies and Innovative Research	2019	Cloud Computing	ISSN 2349-5162	UGC Approved	
27	Steganography in Cloud Security: A Review,	Chandni, Vikram Singh	Journal of Emerging Technologies and Innovative Research	2019	Cloud Computing	ISSN 2349-5162	UGC Approved	
28	Analysis of different Hybrid methods for Intrusion Detection System	DurgeshSrivastav, Rajeshwar Singh, Vikram Singh	International Journal of Computer Sciences and Engineering	2019	Network Security	ISSN: 2347-2693 (E)	https://www.ijcseonline.org/IJCSEUGCJournalno.pdf.pdf (UGC Approved)	UGC Approved
29	Reverse Watermarking in Cloud Security	Kapil Kumar, Vikram Singh	Journal of Emerging Technologies and Innovative Research	2019	Network Security	ISSN: 2349-5162	http://jetir.org/jetir%20ugc%20approval.pdf (UGC Approved)	UGC Approved
30	Reverse Watermarking Technique to Enhance Cloud Data Security	Kapil Kumar, Vikram Singh.	Journal of Emerging Technologies and Innovative Research	2019	Network Security	ISSN: 2349-5162	http://jetir.org/jetir%20ugc%20approval.pdf (UGC Approved)	UGC Approved
31	Performance Evaluation of Entropy Based Graph Network Intrusion Detection System	Durgesh Srivastav, Rajeshwar Singh, Vikram Singh	Journal of Advanced Research in Dynamical & Control Systems,	2019	Network Security	ISSN: 1943-023X	https://www.researchgate.net/publication/332319836_Performance_Evaluation_Of_Entropy_Based_Graph_Network_Intrusion_Detection_System_E-Ids	Scopus
32	A Review of remotely sensed satellite image classification	Mrs. Sakhsi Dhingra	International Journal of Electrical and Computer Engineering	2019		ISSN: 2088-8708	https://www.scopus.com/sourceid/21100373959 (Scopus)	
33	The Hybridization of Neural Network and Particle Swarm Optimization for Natural Terrain Feature Extraction	Mrs. Sakhsi Dhingra	International Journal of Innovative Technology and Exploring Engineerring	2019	Artificial Intelligence	ISSN: 2278-3075	https://www.scopus.com/sourceid/21100889409 (Scopus)	
34	Investigating role of BBF, RanSac, GSO in forensic image processing (A Review)	Sharda Rani, Vikram Singh, Sakshi Dhingra	International Journal of Research and Analytical Reviews	2019	Digital Forensics	ISSN: 2348 – 1269	https://ijrar.org/ijrar%20ugc%20approval.pdf (UGC Approved)	UGC Approved
35	Integration of Multilayer Cryptography Techniques in Order to increase the Security in Cloud Computing	Himanshi Jindal, Raghuvinder	International Journal of Research and Analytical Reviews	2019	Cloud Computing	2348-1269	Others	

36	Security of Advance QR code Biometric System Using steganography techniques	Kiran Rani, Raghuvinder	International Journal of Research and Analytical Reviews	2019	Network Security	2348-1269	Others	
37	A Review On Advance Cryptography To Secure The Graphical Content	Veerpal Kaur, Dr. Kapil Kumar Kaswan	International Journal of Research and Analytical Reviews (IJRAR)	2019	Network Security	ISSN 2349-5138	Others	
38	A Review Of Watermarking In Image Processing	Priya Darshini Mehra,, Dr. Kapil Kumar Kaswan	international journal of Advance research in science and engineering	2019	Network Security	ISSN: 2319-8354	Others	
39	Cloud Scheduling Using Hard Constraints Based Genetic Algorithm	Sumit, Dr. Kapil Kumar Kaswan	International Journal of Research and Analytical Reviews (IJRAR)	2019	Cloud Computing/AI	E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
40	Diabetes prediction for the patient based on jrip technique	Amandeep Singh, Dr. Kapil Kumar Kaswan,	International Journal of Research and Analytical Reviews (IJRAR)	2019	Clinical Computing	E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
41	A Review On Different Scheduling Techniques For The Cloud Efficiency	Sumit, Dr. Kapil Kumar Kaswan,	International Journal of Research and Analytical Reviews (IJRAR)	2019	Cloud Computing	E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
42	A Review On Different Data Mining And Classification Techniques For Predictions	Amandeep Singh, Dr. Kapil Kumar Kaswan	International Journal of Research and Analytical Reviews (IJRAR)	2019	Data Mining	E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
43	INTEGERATION OF PSO AND KMEAN APPROACH TO GET OPTIMIZED VALUES DURING CROP PRICE PREDICTION	Virender Singh, Avinin der Singh	International Journal of Research and Analytical Reviews	2019	Data Mining	E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
44	IMPLMENTATION OF VOICE RECOGNITION SYSTEMS CONSIDERING ZERO CROSSING LEVEL AND SHORT ENERGY LEVEL	Manoj Kumar, Avini nder Singh	International Journal of Research and Analytical Reviews	2019		E-ISSN 2348-1269, P-ISSN 2349-5138	Others	
45	Leach Protocol & Its Improvement on Leach-RE (Residual Energy Protocol) In Wireless Sensor Network	Manisha,San geeta Rani,Davinde r Singh	International Journal of Scientific Development and Research	2019	Wireless Sensor Network	2455-2631	Others	
46	A Review of DWT and PCA based Digital Watermarking Schemes	Nidhi Chawla, Vikram Singh	International Journal of Engineering and Advanced Technology	2018	Network Security	ISSN: 2249-8958	https://www.scopus.com/sourceid/21100899502 (Scopus)	Scopus
47	A Novel Video Watermarking Scheme Based on DWT and PCA	Nidhi Chawla, Vikram Singh	International Journal of Engineering and Advanced Technology,	2018	Network Security	ISSN: 2249-8958	https://www.scopus.com/sourceid/21100899502 (Scopus)	Scopus
48	Attacks on Cloud Data: A Big Security Issue	Poonam Devi	International Journal of Scientific Research in Network Security and Communication	2018	Cloud Computing	2321-3256	https://www.ijsrnsc.org/ugc_approved.php	
49	REVIEW ON DIGITAL INDIA INITIATIVE AND CHALLENGES	Dr. Kuldeep Kumar	International Journal of Management, Technology And Engineering	2018	Digital India	2249-7455	Others	
50	MPACT OF DIGITAL INDIA, A FLAGSHIP SCHEME OF GOVERNMENT OF INDIA ON THE SOCIETY	Dr. Kuldeep Kumar	International Journal of Management, Technology And Engineering	2018		2249-7455	Others	
51	Image Processing Based Bacterial Colony Counter	Bhavika Jagga Dr. Dilbag Singh	International Journal of Scientific Research in Computer Science, Engineering and Information Technology	2018	Nature Inspired Computing	2456-3307		
52	Enhanced Multifactor Authentication Scheme	Devender Kumar, Vikram Singh	International Journal of Engineering Trends and Technology	2017	Network Security	E-ISSN: 2231-5381	https://www.scopus.com/sourceid/21101000284(Scopus)	
53	Non-Invertible Online Signature Verification System Using Hadamard Transform	Harleen, Raghuvinder	International Journal of Engineering Development and Research	2017	Network Security	2321-9939	Others	
54	Comparative Analysis of GPSR and GPVR Protocol for Various Parameters in VANET with Power Control	Bhumika Mehta , Raghuvinder	International Journal on Recent and Innovation Trends in Computing and Communication	2017		2321-8169	Others	
55	Fast Skin Color Based Face Detection With Improved Morphology And Tracking For Securit Applications	Navneet Kaur, Sangeeta Rani	INTERNATIONAL JOURNAL OF ENGINEERING DEVELOPMENT AND RESEARCH	2017	Network Security	514-520	Others	
56	Designing Simulator for Irrigation Management	Rajesh Kumar Dr. Dilbag Singh	International Journal of Engineering Trends and Technology	2017		2231 5381		

57	A Survey on Lossless Text Data Compression Techniques	Mamta Rani, Vikram Singh	International Journal of Advanced Research in Computer Engineering & Technology	2016		ISSN 2278-1323	Peer Reviewed	
58	Improved Dynamic Round Robin Process Scheduling	Sumit Dalal, Vikram Singh	International Journal of Advanced Technology in Engineering and Science	2016		ISSN 2348-7550	Peer Reviewed	
59	E-Waste (Management) Rules, 2015 – A Critical Analysis	Vikram Singh	International Journal of Research in Electronics and Computer Engineering	2016	Green Computing	ISSN 2393-9028	Peer Reviewed	
60	An Enhanced Text Compression System Based on ASCII Values and Huffman Coding	Mamta Rani, Vikram Singh	International Journal of Computer Science Trends and Technology	2016		ISSN 2347-8578	Peer Reviewed	
61	LUNG TUMOR DETECTION USING WATERSHED ALGORITHM	Amandeep Verma, Vikram Singh	International Journal of Innovative Research in Science & Engineering	2016	Clinical Computing	ISSN 2454-9665	Peer Reviewed	
62	Role of Link Expiration time to make reliable link between the nodes in MANETs: A Review	Dr.Harish Rohil	International Journal of Applied Engineering Research	2016		ISSN: 0973-4562	https://www.scopus.com/sourceid/21100217234 (Scopus)	
63	A Level Set Based Efficient Brain Tumor Classification Using Self Organising Map	Priyanka, Raghuvinder	International Journal of Research (IJR)	2016	Clinical Computing	2348-6848	Others	
64	An Approach of Color Based Image Segmentation Technique for Differentiate Objects using MATLAB Simulation	Preeti Rani, Raghuvinder	International Journal of Advanced Research in Computer and Communication Engineering	2016		2278-1021	Others	
65	Enhanced of Multilayer Security using Wireless AD-HOC Network in Network Routing	Preeti Makkar , Raghuvinder	International Journal for Research Publication and Seminars (JRPS)	2016	Network Security	2278-6848	Others	
66	Performance Evaluation of Congestion Control Protocols TCP-RENO, Vegas,LP, Westwood in Wireless Network	Alka khurana, Raghuvinder	International Journal of Advanced Technology in Engineering and Science(IJATES)	2016		2348-7550	Others	
67	Pixel Based Quality Improvement of Black & White Noisy Images	Kavita Rani, Raghuvinder	International Journal of Advanced Research in Computer and Communication Engineering	2016		2278-1021	Others	
68	Video Stegnography Techniques-A Review	Kapil Kumar Kaswan, Dr. Roshan Lal	International Journal Of Innovative Research In Science And Engineering	2016	Network Security	Issn 2454-9665.	Others	
69	Evalution of downlink packet schedulling startgeies for LTE networks	Heena Chitkara , Sangeeta Rani		2016	Mobile Computing	2454-9665	Others	
70	Hadoop: An Effective Framework for Big Data Analytics	Dilbag Singh Chirag Goyal	International Journal of Computer Applications	2016	Big Data Analytics	0975 8887		
71	Map Reduced Model for Topic Sensitive Page Ranking	Dupinder Kaur	International Journal of Science technology & Engineering	2016	Big Data Analytics	2349-784X		
72	Variations in rounds keeping same density in Homogeneous and Heterogeneous LEACH	Yashpal Tada, Manju, Vikram Singh	National Conference on Innovative Trends in Computer Science Engineering	2015		: 2349-7688	Peer Reviewed	
73	A Data Mining Tool for Network Fault Detection,	Poonam Chaudhary, Vikram Singh	International Journal of Computer Science & Communication	2015	Data Mining	ISSN 0973-7391	Peer Reviewed	
74	Analysing the Behaviour of a Telecom User using Rough Set Theory	Haridas Kataria, Vikram Singh	International Journal of Latest Technology in Engineering, Management & Applied Science	2015		ISSN 2278-2540	Peer Reviewed	
75	Data Mining Techniques for Fault Detection in Mobile Communication Networks	Poonam Chaudhary, Vikram Singh	International Journal of Information Technology & Knowledge Management	2015	Data Mining	ISSN 0973-4414	Peer Reviewed	
76	A Survey on Classification Techniques in Data Mining, International Journal of Computer Science & Management Studies	Neha Midha, Vikram Singh	IJCSMS (International Journal of Computer Science & Management Studies)	2015	Data Mining	ISSN 2231-5268	Peer Reviewed	
77	To Enhance the Medical Images Using Aura Transformation	Sakshi Narang, Raghuvinder	International Journal of Research (IJR)	2015	Clinical Computing	2348-6848	Others	

78	Image Hiding Steganography with Digital Signature Framework	Raj kumari, Raghuvinder	International Journal of Research (IJR)	2015	Network Security	2348-6848	Others	
79	A Review on Various Gesture Recognition Techniques For Real Time Application	Sandeep, Raghuvinder	North Asian International Research Journal of Science	2015		2454-7514	Others	
80	A Motion Vector Based Efficient Parity Lsb Technique And Huffman Coding For Efficient Video Steganography	Kapil Kumar Kaswan,Dr Roshan Lal	International Journal of Latest Trends in Engineering and Technology	2015	Network Security	ISSN: 2278-621X.	Others	
81	Review on Ethical Hacking	Neeru Ahuja	International Journal of Innovative Research in computer and communication engineering	2015	Network Security	2320-9801	Others	
82	Empirical Performance Evaluation Methodology and its Application to Page Segmentation Algorithms: A Review	Pinky Gather, Avininder Singh	International Journal of Advanced Research in Computer Engineering & Technology	2015		ISSN: 2278 – 1323	Others	

Sr. No.	Name	Regn. No.	Supervisor	Topic	Date of Award	
1	Promila Bishnoi	614087510002	Dr. Rani Devi	Effect of sewage water irrigation on some nutritional and anti-nutritional quality of fodder	11-11-2013	Environmental impact study
2	Rinki	614087510003	Dr. Rani Devi	Environment impact assessment of pesticides in diet of infants and children	11-11-2013	Agrochemical impact study
3	Priyanka	115375001	Dr. Rani Devi	Temporal and spatial dynamics of soil desurfacing due to brick kilns using remote sensing technique	2015	Environmental monitoring
4	Pawan Kumar	115375002	Dr. Rani Devi	An integrated approach for the effective treatment of water and wastewater	01-12-2017	Industrial waste management
5	Manisha	115375004	Dr. Rani Devi	Effect of crop residue and irrigation water quality on recently reclaimed sodic soil fertility, crop productivity and air quality interface of rice-wheat cropping pattern.	01-12-2017	Agriculture waste management
6	Alok Kumar	115375003	Dr. Rani Devi	Future design forecasting for improvement and upgradation of sewage treatment plants of Haryana.	30-08-2018	Environmental modelling
7	Sangeeta	115375005	Dr. Rani Devi	Effect of sugar industry effluents on soil characteristics and wheat crop.	30-08-2018	Environmental impact study

8	Savita Verma	115375007	Dr. Anju	Trace Elemental contamination and speciation in terrestrial environment around a coal fired thermal power plant, Bathinda	30-08-2018	Environmental monitoring
9	Seema	115375008	Dr. M.K. Kidwai	Physiochemical and microbiological analysis of different water sources used for drinking purpose in district Fatehabad-Haryana	30-08-2018	Environmental monitoring
10	Monika	115375011	Dr. M.K. Kidwai	Effect of mancozeb on mustard (Brassica) species grown in semi-arid region of Haryana	30-08-2018	Agrochemical impact study
11	Kamlesh	115375009	Dr. M.K. Kidwai	Investigation of drinking water quality parameters from different sources in Bhiwani district Haryana	31-01-2019	Environmental monitoring
12	Shaveta Kakkar	115375006	Dr. Anju	Removal of pollutants from pulp and paper industry effluents using adsorbents prepared from its solid wastes	14-04-2019	Zero emission
13	Mr. Sekhar	2017035500171407	Dr. Anju	Trace elemental distribution and speciation in terrestrial environment around khetri copper mines Rajasthan, India	On-going	Environmental monitoring
14	Mr. Ravinder Kumar	2017035500108407	Dr. M.K. Kidwai	Effect of Carbendazim on *Trigonella foenum-graecun* L. in semi arid region of Haryana.	On-going	Agrochemical impact study

Title of paper	Name of the author/s	Name of journal	Year of publication	ISSN number	core specilization
Heavy metals uptake by Wheat and Mustard crops grown in surrounding of a Coal-fired Thermal power plant, Bathinda (Punjab) India	Verma S., Anju	Indian Journal of Environmental Protection	2021	ISSN: 0253 – 7141	Bioaccumulation/Bioremediation of pollutant
Optimization of Swiss blue dye removal by cotton boll activated carbon: Response surface methodological approach	Rani R., Summaiya, Malik A., Garg V.K., Singh L., Dhull S. B.	Toxin Reviews	2021	Print ISSN: 1556-9543 Online ISSN: 1556-9551	Agro-waste management
Fluoride and nitrate in groundwater of rural habitations of semi-arid region of northern Rajasthan, India: A Hydrogeochemical, Multivariate statistical and Human health risk assessment perspective	Jandu A., Malik A., Dhull S. B.	Environmental Geochemistry and Health	2021	Electronic ISSN: 1573-2983, Print ISSN: 0269-4042	Hydrogeochemistry, source apportionment , Health risk assessment
Groundwater hydro-geochemistry, quality, microbiology and human health risk assessment in semi-arid area of Rajasthan, India: A Chemometric approach	Khan N., Malik A., Nehra K.	Environmental Monitoring and Assessment	2021	Electronic ISSN: 1573-2959, Print ISSN: 0167-6369	Hydrogeochemistry, source apportionment, Health risk assessment
Assessment of groundwater hydro-geochemistry, quality and human health risk in arid area of India using chemometric approach	Malik N., Malik Anju, Bishnoi S.	Arabian Journal of Geosciences	2021	Electronic ISSN 1866-7538 Print ISSN 1866-7511	Hydrogeochemistry, source apportionment, Health risk assessment
In-situ utilization of inorganic solid wastes of pulp and paper industry for removal of chemical oxygen demand and color from its alkali extracted effluent	Shaveta Kakkar , Anju Malik, Sanju Bala Dhull	Indian Journal of Environmental Protection	2021	ISSN: 0253 – 7141	Zero emission
Areview on nutrientional profile and processing of faba bean (Vicia faba L.)	Mohd Kashi Kidwai, sanju bala Dhull, Rashed Noor, Prince Chawla and Pawan	Legume Science	2021	Online ISSN:2639-6181	legume and pulses study
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Solid-state fermentation of lentil (*Lens culinaris* L.) with *Aspergillus awamori* : Effect on phenolic compounds, mineral content, and their bioavailability	Sanju Bala Dhull,Sneh Punia,Mohammad Kashif Kidwai,Maninder Kaur,Prince Chawla,Sukhvinder Singh	Legume Science	2020	Online ISSN:2639-6181	legume and pulses study
Oat starch: Physico chemical Morphological Rheological characteristics, and its application: a Review	Sneh Punia, K. S. Sandhu, Sanju Bala Dhull, A. Siroha, S. Purewal, M Kaur, and	International Journal of Biological Macromolecule	2020	ISSN: 0141-8130	Macromolecules characterization
Heavy metal tolerance and adaptability assessment of indigenous filamentous fungi isolated from industrial wastewater and sludge samples	Pawan Kumar Rose and Rani Devi	Beni-Suef University Journal of Basic and Applied Sciences	2018	ISSN: 2314-8535	Bioremediation
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Treatment of pulp and paper mill effluent using low cost adsorbents: An overview	Kakkar S, Malik Anju, and Gupta S.	Journal of Applied and Natural Science	2018	ISSN : 0974-9411 (Print), 2231-5209 (Online)	Zero emission
Assessment of water quality around a coal fired thermal power plant, Bathinda (Punjab), India	Verma S., Anju	Journal of Applied and Natural Science	2018	ISSN : 0974-9411 (Print), 2231-5209 (Online)	Hydrochemistry
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Effect of mancozeb on mustard (Brassica juncea L.): An Invitro study	Monika and Kidwai M.K	Tropical Plant Research	2017	2349 – 1183 ISSN (P): 23	Agrochemical impact study
A study of concentration of sugar mill effluents on properties of soil and types of micro-organisms present in the soil	Sangeeta, Rani Devi and Gita	Current Botany	2017	ISSN: 2220-4822	Zero emission
Plant Species Composition and Diversity at the Aravalli Mountain Range in Haryana, India	Pawan Kumar Gaury & Rani Devi	Journal of Biodiversity	2017	ISSN: 0976-6901	Biodiversity
Study of effect of sugar mill effluent on fenugreek (Trigonella foenum-graecum) varieties.	Kamlesh and Kidwai M.K	International journal of Environment ,Agriculture and Biotechnology	2016	ISSN: 2456-1878	Environmental impact study
Suitability assessment of drinking water with special attention toward fluoride of five block of district Fatehabad Haryana India	Seema and Kidwai M.K	Journal of Advance studiesin Agriculture, Biology and environment sciences	2016	ISSN:2455-0221(P), 2394-2606(O)	Environmental monitoring
Spatial Variation of Physico-Chemical Properties of Desurfaced Soils Due To Brick Kilns in NCR (India)	Priyanka Singh, Rani Devi, Hooda, R.S.	International Journal of Multidisciplinary Approach and Studies	2016	ISSN NO:: 2348 – 537X	Environmental monitoring
temporal and spatial dynamics of soil desurfacing due to brick kilns effecting micronutrient status using gis and soil analysis	Priyanka Singh, Rani Devi, Hooda R.S.	INTERNATIONAL JOURNAL OF AGRICULTURE SCIENCES	2016	ISSN : 0975-3710 (Print) E-ISSN : 0975-9107 (Online)	Environmental monitoring
Impact of soil desurfacing on the physico-chemical properties of the soil of the study area in Haryana	Priyanka Singh, Rani Devi, Hooda R.S.	International Journal of Multidisciplinary Research and Development	2015	e-ISSN: 2349-4182 p-ISSN: 2349-5979	Environmental monitoring
Soil Desurfacing Induced Spatiotemporal Land Use/Land Cover Change in Study Area in the Year 2007 -2012	Priyanka Singh, Rani Devi, Hooda, R.S.	International Journal of Multidisciplinary Research and Development	2015	e-ISSN: 2349-4182 p-ISSN: 2349-5979	Environmental monitoring
Efficiency improvement of Sludge Drying Bed - Design Modification of present system	Alok Kumar Saran, Rani Devi	International Journal of Multidisciplinary Research and Development	2015	e-ISSN: 2349-4182 p-ISSN: 2349-5979	Environmental modelling
Spatiotemporal variation in land use / land cover pattern as influenced by soil desurfacing due to brick kilns in NCR	Priyanka Singh, Rani Devi, Hooda, R.S.	International Journal of Advanced Scientific and Technical Research	2015	ISSN 2249-9954	Environmental monitoring
Dynamics of soil desurfacing due to brick kilns and suggestive management techniques	Priyanka Singh, Rani Devi, Hooda, R.S.	International Journal of Multidisciplinary Research and Development	2015	e-ISSN: 2349-4182 p-ISSN: 2349-5979	Environmental monitoring

Hydrochemistry and Water Quality Assessment of Gro	Shalu, Sunita Punia and Anju Malik	Pollution Research	2015	0257-8050	Environmental monitoring			
Adsorption Isotherm Study of Cadmium on Dairy Sludge Based Adsorbent	Pawan Kumar Rose and Rani Devi	International Journal for Innovative Research in Science & Technology	2015	ISSN (online): 2349-6010	Industrial waste management			

3.4.6 Number of books and chapters in edited volumes published per teacher during the last five years (15)							
3.4.6.1: Total number of books and chapters in edited volumes / books published, and papers in national/international conference-proceedings year wise during the last five year							
Sl. No.	**Name of the teacher**	**Title of the book/chapters published**	**Title of the paper**	**Year of publication**	**ISBN/ISSN number of the proceeding**	**Name of the publisher**	Specilization
1	Dr. Anju	Fenugreek: Biology and Application	Fenugreek (Trigonella foenum-graecum): Nutritional, Health Properties and Food Uses	2021	ISBN 978-981-16-1196-4 ISBN 978-981-16-1197-1	Springer: https://link.springer.com/chapter/10.1007/978-981-16-1197-1_10	Legume and pulses study
2	Mohammad Kashif Kidwai, Ajay Singh, Tanu Malik, Sanju Bala Dhull and Sneh Punia.	Essential Fatty Acids Sources, Processing Effects, and Health Benefits	Essential Fatty Acid Bioavailability: A Dietary Perspective	2021	ISBN 978-0-367-33540-3 (Hardbook) ISBN: 978-0-429-32111-5 (ebook)	CRC: https://www.routledge.com/Essential-Fatty-Acids-Sources-Processing-Effects-and-Health-Benefits/Dhull-Punia-Sandhu/p/book/9780367335403	lipid and functional food
3	M . K. Kidwai, V Nain, Aman jyoti, N Grover, A. Kamboj	Principles of Biochemistry	Enzymes	2021	ISBN:978-81-948287-1-6	SLM publishers	Functional food
4	N. Grover, M. Nehra, M. K. Kidwai	Principles of Biochemistry	Antioxidants	2021	ISBN:978-81-948287-1-6	SLM publishers	Functional Food
5	Mohd. Kashif Kidwai and Sanju Bala Dhull	Fenugreek Biology and Applications	Heavy Metals Induced Stress and Metabolic Responses in Fenugreek (Trigonella foenum-graecum L.) Plants	2021	ISBN 978-981-16-1196-4 ISBN 978-981-16-1197-1 (eBook)	Springer: https://link.springer.com/chapter/10.1007/978-981-16-1197-1_15	Stress plant physiology
6	Priyanka Singh and Rani Devi	Physical Environment "Atmospheric, Aquatic and Terrestrial Environment" (Teaching Guide Manual for PG students)	---	2020	ISBN: 978-93-84502-99-7	Agri-Biovet Press, New Delhi: https://www.amazon.in/PHYSICAL-ENVIRONMENT-ATMOSPHERIC-AQUATIC-TERRESTRIAL/dp/9384502995	Physical environment
7	Dr. Anju	Essential Fatty Acids: Sources, Processing Effects, and Health Benefits	Enrichment of Essential Fatty Acids in Food	2020	ISBN 9780367335403	CRC: https://www.routledge.com/Essential-Fatty-Acids-Sources-Processing-Effects-and-Health-Benefits/Dhull-Punia-Sandhu/p/book/9780367335403	Legume and pulses study

8	Mohd Kashif Kidwai and Seema	Social media: Divergent Paradigm	Role of social media in spreading awareness about environmental issues	2020	ISBN:978-93-85958-31-1	The Readers Paradise	Environmental awareness
9	K. Bajwa, S. S. Bajwa and Mohd Kashif Kidwai	Social media: Divergent Paradigm	The Role of Mass media in environmental crisis and ecological sustainability	2020	ISBN:978-93-85958-31-1	The Readers Paradise	Environmental awareness
10	Dr. Rani Devi	Plant Microbes Interface	An Overview of Effective Concentration of Industrial Effluent for Improving Crop Production and its Effect on Mico-bio zone of soil	2019	ISBN 978-3-030-19831-2	Springer: https://link.springer.com/chapter/10.1007/978-3-030-19831-2_18	Environmental impact study
11	Dr. Anju	Nanobiotechnology in Bioformulations	Application of Gum Arabic in Nanoemulsion for Safe Conveyance of Bioactive Components	2019	ISBN: 978-3-030-17060-8	Springer: https://link.springer.com/chapter/10.1007/978-3-030-17061-5_3	nanotechnology
12	Dr. Anju	Nanobiotechnology in Bioformulations	Nanoemulsions: A Promising Tool for Dairy Sector.	2019	ISBN: 978-3-030-17060-8	Springer: https://link.springer.com/chapter/10.1007/978-3-030-17061-5_4	nanotechnology
13	Dr. Anju	Plant Biotechnology: Recent Advancements and Developments	Biotechnological Strategies for Remediation of Toxic Metal(loid)s from Environment.	2017	ISBN: 978-981-10-4731-2.	Springer: https://link.springer.com/chapter/10.1007%2F978-981-10-4732-9_16	Bioremediation
14	Mohd. Kashif Kidwai and Manju Nehra	Plant Biotechnology: Recent Advancements and Developments	Biotechnological Applications of Trichoderma Species for Environmental and Food Security	2017	ISBN: 978-981-10-4731-2.	Springer: https://link.springer.com/chapter/10.1007/978-981-10-4732-9_7	Bioremediation
15	Priyanka Singh and Rani Devi	Environmental Studies (For Undergraduates)	---	2016	ISBN 978-93-84871-017	DBH Publisher and Distributors, New Delhi	Environmental studies
16	Ashish Kumar Sharma, Verjesh Kumar Magotra and Alok Kumar saran	Mathematics with MATLAB	---	2016	ISBN 978-3-330-02266-9	Lambert Academic Publishing: https://www.lap-publishing.com/catalog/details/store/gb/book/978-3-330-02266-9/mathematics-with-matlab	Environmental Modelling

Department of Biotechnology (Ph.D. Students List)

S/No.	Name	Supervisor/Co-supervisor	Title of the thesis	Date of award	Broad Area
1.	Deepika	Dr. R.K. Salar/ Dr. B. Parkash	Studies on characterization of molecular genetic biodiversity and population structure of indian grey cattle breeds *(bos indicus)* utilizing microsatellitr and candidate gene loci	14.06. 2012	Animal Biotechnology
2.	Dalip Kumar	Dr. R.K. Salar/ Dr. R.C.Trivedi	Evaluation of heavy metals biosorption efficiencies of certain microorganisms in multi-metallic aquatic environment	07.08. 2012	Microbial Biotechnology
3.	Suresh Kumar	Dr. R.K. Salar	Studies on biodegradation of xenobiotic compounds using microbial consortia	29.07. 2013	Microbial Biotechnology
4.	Ashok Kumar	Dr. J. S. Duhan/ Dr.S.K. Singh	Bioethanol production from starchy parts of tuberous plants	03.07. 2013	Microbial Biotechnology
5.	Alok Kumar	Dr. Kiran Nehra/ Dr. Dilip Monga	Molecular detection of inoculum source of cotton leaf curl virus disease (clcud)	16.12. 2013	
6.	Deepika Chaudhary	Dr. J. S. Duhan/ Dr. Subhash Kajla	Micropropagation and assessment of genetic diversity in different cultivars of banana using PCR based technology.	02.09. 2013	Tissue Culture
7.	Anita Rani Gill	Dr. Priyanka Siwach	Studies on micropropagation and genetic transformation in ficus religiosa l. Using agrobacterium rhizpgenes	23.07. 2013	Medicinal Plant Biotechnology
8.	Pooja Sharma	Dr. Priyanka Siwach	Cloning and characterization of APETALA 2 promoter from Arabidopsis thaliana and Brassica juncea.	26.11. 2015	Genomics
9.	Jarnail Singh	Dr. J. S. Duhan/ Dr. Prem Singh Yadav	Isolation, culture and characterization of umbilical card stem cells from buffaloes	06.03. 2013	Animal Biotechnology
10	Girish Chander Pandey	Dr. Priyanka Siwach/ Dr. Ratan Tiwari	Identification of genomic region for the traits associated with terminal heat tolerance in bread-wheat	07.05. 2014	Wheat Biotechnology

11	Priyanka Banerjee	Dr. S.K. Gahlawat/ Dr. R.K. Vijh	Identification of quantitative trait loci (otl) for somatic cell score in buffaloes	25.09. 2013	Animal Biotechnology
12	Praveen Kumar Dubey	Dr. S.K. Gahlawat/ Dr. R.S. kataria	Sequence characterization and expression analysis of toll-like receptor genes in indian buffalo (bubalus bubalis)	15.05. 2012	Animal Biotechnology
13	Jyoti Joshi	Dr. R.K. Salar/ Dr. M.S.Tantia	Genetic characterization and structuring of buffalo population of Indo-Genetic plains using molecular markers.	02.09. 2013	Animal Biotechnology
14	Leena	Dr. Priyanka Siwach	Antibiotic Resistance Modifying Activity and Antioxidative activity of Some Indian Medicinal Plants.	26.04. 2016	Medicinal Plant Biotechnology
15	Khushboo Sethi (project fellow)	Dr. Priyanka Siwach	Association mapping of fiber traits in *Gossypium arboreum* L. accessions using SSR and ISSR markers	26.04. 2016	Cotton genomics
16	Rajni Dahiya	Dr. S.K. Gahlawat	Genetic Diversity, expression analysis and association of myxovirus resistance gene (Mx) with susceptibility vis-à-vis resistance against equine influenza virus in horses	30.08. 2018	Animal Biotechnology
17	Salima Sihag	Dr. J. S. Duhan	Micropropagation of *Aloe vera* and assessment of genetic diversity in different cultivars of aloe using PCR based technology	30.11. 2021	Plant Biotechnology
18	Pooja	Dr. J. S. Duhan	Enhancement of antioxidant potential of cereals and pulses by solid state fermentation	05.11. 2018	Microbial Biotechnology
19	Rajesh Kumar Dahiya	Dr. R.K. Salar	Studies on the genomic diversity of *Theileria equi* among different geographic isolates	05.11. 2018	Animal Biotechnology
20	Mukesh Kumar (Lecturer)	Dr. R.K. Salar	Production and Characterization of Purified Bacterial Tannase for its Commercial Applications	2016	Microbial Biotechnology
21	Kaushalaya Ghosh	Dr. S.K. Gahlawat/ Dr. P. S. Yadav	Studies on stemness properties of cultured buffalo amniotic membrane cells.	22.07. 2016	Animal Biotechnology
22	Ravinder Kumar	Dr. R.K. Salar	Analysis of genetic diversity in aloe (*Aloe vera* L.) genotypes using molecular markers	30.01. 2018	Plant Biotechnology
23	Satish Kumar	Dr. S.K. Gahlawa	Cryobiological effects and apoptotic gene expression on cumulus oocyte	31.12. 2015	Animal Biotechnology

	(lecturer)	t	complexes in sheep (*Ovis aries*)		
24	Sushma Kumari Pawar	Dr. J. S. Duhan	Molecular Characterization of Durable Adult Plant Resistance to Stripe Rust in Bread Wheat	26.04. 2016	Plant Biotechnology
25	Swati Panwar	Dr. Raj Kumar Salar/ Dr. Subhash Kajla	Micropropagation, sex determination and assessment of genetic diversity in *carica papaya* L.	18.01. 2020	Plant Biotechnology
26	Sheetal Saini	Dr. Priyanka Siwach/ Dr. Harisankar Singha	Expression of recombinant equine cytokines and analysis of their biological activities	05.01. 2021	Immunology
27	Amit Kumar	Dr. S.K. Gahlawat/ Dr. Vineeta Singh	Characterization of *dhfr* and *dhps* genotypes in field isolates of *plasmodium falciparum* and their correlation with gametocytes	08.08. 2019	Animal Biotechnology
28	Pardeep Kumar	Dr. J. S. Duhan	Bioaugmentation of phenolics and antioxidant potential of peanut waste (peanut press- cake) by fermentation with GRAS fungal and bacterial strains.	5.11.2 018	Microbial Biotechnology
29	Naresh Kumar	Dr. Raj Kumar Salar	Vincristine loaded folic acid-chitosan conjugated nanoparticles for cancer therapy against non-small cell lung cancer (NSCLC)	05.11. 2018	Nano biotechnology
30	Pooja Bansal (PGT Biology)	Dr. Joginder Singh Duhan	Biogenesis of nanoparticles and its potential in controlling plant pathogenic diseases	30.08. 2018	Nanotechnology
31	Mr. Sukhvinder Singh	Dr. Raj Kumar Salar	Modulation of antioxidant activity and DNA damage protection of pearl millet using solid state fermentation with filamentous fungi.	31.01. 2019	Microbial Biotechnology

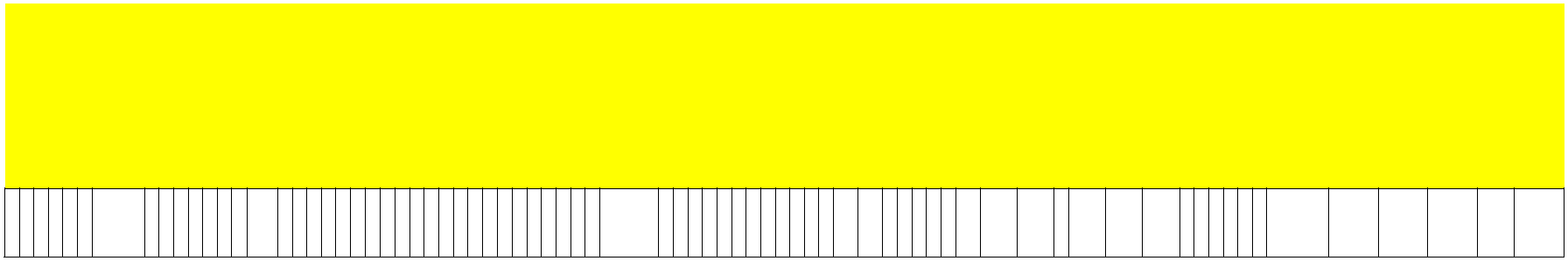
Sd.-
Chairperson

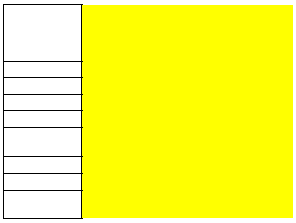
	Title of paper	Name of the author/s	Year of publication	ISSN number	Is it listed in UGC Care list/Scopus/Web of Science /other	
	FACULTY OF LIFE SCIENCES					**Thematic area**
1	Intron-Exon boundary junction in human genome have in-built unique structural and energetic signals	Akhilesh Mishra, Priyanka Siwach, Pallavi Misra, Simran Dhiman, Parul Srivastava and B. Jayaram	2021	0305-1048	Scopus	Genome Annotation
2	Challenges and Advances in Molecular Diagnosis of Myopathies and Dystrophies in Perspective of Their Use in Developing Countries: Past, Present, and Future	Shivangi Attri, Suresh K Gahlawat	2021	797-807	Scopus	Diagnostics
3	cting role of founder mutation p. V727M in GNE in Indian HIBM co	Shivangi Attri, Vikas Sharma, Amit Kumar, Chaitenya Verma, Suresh Kumar Gahlawat	2021	**1733-1744**	Scopus	Medical Biotechnology
4	Elucidation of genetic diversity and population structure of sixty genotypes of *Aloe vera* using AFLP markers	Kumar, R., Salar, R. K., Naik, P. K., Yadav, M., Kumar, A., Kumar, A.,Chhokar, V.	2021	0254-6299	Scopus	Medicinal Plant Biotechnology
5	UPPER EXPOSED PREDUNCLE LENGTH VARIATION STUDIES IN WHEAT CULTIVARS IN RESPONSE TO HEAT STRESS AT VARIED SOWING TIMES	Surinder Paul and Joginder Singh Duhan	2021	e-ISSN:2581-6063	Others	Wheat Biotechnology
6	Proximate Composition, Polyphenols and Antioxidant Activity of Solid State Fermented Peanut Press Cake. Preparative Biochemistry & Biotechnology.	Joginder Singh Duhan, Prince Chawla, Suresh Kumar, Aarti Bains and Pardeep Kumar Sadh	2020	Print ISSN: 1082-6068 Online ISSN: 1532-	Scopus	Solid state Fermentation
7	Solid state fermented peanut press cake: assessment of biochemical properties, mineral bioavailability, and its application in sweetened yogurt cheese. Biocatalysis and Agricultural Biotechnology	Joginder Singh Duhan, Prince Chawla, Suresh Kumar, Aarti Bains and Pardeep Kumar Sadh	2020	ISSN: 187881 81	Scopus	Solid state Fermentation
8	A novel method *SEProm* for prokaryotic promoter prediction based on DNA structure and energetics	Akhilesh Mishra, Sahil Dhanda, **Priyanka Siwach**, Shruti, B Jayaram	2020	**1367-4803 / 1460-2059**	Scopus	Genome Annotation
9	Solid-state fermentation of pearl millet with *Aspergillus oryzae* and *Rhizopus azygosporus* : effects on bioactive profile and DNA damage protection activity.	Purewal, S.S., **Salar, R.K.,** Bhatti, M.S., Sandhu, K.S., Singh, S.K. and Kaur, P.	2020	2193-4126 (Print) 2193-4134 (Online)	Scopus	Solid state Fermentation
10	Effect of Production Parameter on Release of Phenolic Content of Peanut Press Cake Fermented with *A. oryzae* and *A. awamori.* 9(2): 434-444. (2019)	Joginder Singh Duhan, Pooja Saharan and Pardeep Kumar Sadh	2020	e- ISSN: 2230-7605 and p-ISSN: 2321-3272	**Scopus**	Solid state Fermentation
11	Bio-enrichment of phenolic, flavonoids content and antioxidant activity of commonly used pulses by solid-state fermentation. *Journal of Food Measurement and Characterization,*	Pooja Saharan; Pardeep Sadh, Surekha Duhan and Joginder Singh Duhan	2020	ISSN: 2193-4126 (Print) 2193-4134 (Online)	Scopus	Solid state Fermentation
12	Assessment of Fermentation Based Enrichment of Bioactive compounds and Antioxidant Activity of Commonly Used Cereals. 8(2): 1-10. (2018	Pooja Saharan, Pardeep Kumar Sadh, Joginder Singh Duhan	2019	p- ISSN: 2249-1570;e-ISSN: 2277-9396	**Others**	Fermenatation
13	Investigating immunomodulating activities of recombinant horse IL-2, IL-18 and IFN-γ in peripheral blood mononuclear cells (PBMCs)	Sheetal Saini, Harisankar Singha, **Priyanka Siwach** and B. N. Tripathi	2019	**0367-6722**	Scopus	Immunology
14	Recombinant horse IL-4 and IL-10 induced a mixed inflammatory cytokine response in horse peripheral blood mononuclear cells (PBMCs)	Sheetal Saini, Harisankar Singha, **Priyanka Siwach** and B. N. Tripathi	2019	**0972-8988 / 2231-0916**	**Scopus**	Immunology
16	Real-time monitoring of air pollutants in seven cities of North India during crop residue burning and their relationship with meteorology and transboundary movement of air.	Khaiwal Ravindra, Tanbir Singh, Sahil Mor, Vikas Singh, Tuhin KumarMandal, Manpreet Singh Bhatti, Suresh Kumar Gahlawat	2019	**0048-9697 / 1879-1026**	Scopus	Environmental Biotechnology
17	Fermented pearl millet: a product with enhanced bioactive compounds and DNA damage protection activity.	Purewal, S.S., Sandhu, K.S., **Salar, R.K.** and Kaur, P.	2019	2193-4126 (Print) 2193-4134 (Online)	Scopus	Fermenatation
18	Millets: a cereal grain with potent antioxidants and health benefits.	Kaur, P., Purewal, S.S., Sandhu, K.S., Kaur, M. and **Salar, R.K.**	2019	2193-4126 (Print) 2193-4134 (Online)	Scopus	Millets
19	Upgradation of tannase production by Klebsiella pneumoniae KP715242 through heat, UV, NTG and MMS induced mutagenesis for enhanced tannase activity.	Mukesh Kumar, V. Beniwal and **R.K. Salar**	2019	**0974-6455**	UGC Listed	Enzyme Biotechnology
20	Antimicrobial activity of zinc oxide nanoparticles synthesized from *Aloe vera* peel extract.	Chaudhary, A., Kumar, N., Kumar, R. and **Salar, R.K.**	2019	ISSN: 2523-3963 (Print) 2523-3971 (Online)	Scopus	Nanobiotechnology
21	Cloning, characterization and expression analysis of APETELA2 genes of Brassica juncea (L.) Czern	Sharma P, Watts A, Kumar V, Srinivasan R, Siwach	2018	**0019-5189 / 0975-1009**	Scopus	Genome characterization
22	Towards a universal structural and energetic model for prokaryotic promoter	Akhilesh Mishra, **Priyanka Siwach**, Pallavi Misra, B Jayaram, Manju Bansal, Wilma K. Olson, Kelly Thayer and David L. Beveridge	2018	**0006-3495 / 1542-0086**	Scopus	Genome annotation

24	Isolation and Characterization of Coccus Shaped Bacteria Causing Tain Rot Disease in Freshwater Prawn, Macrobrachium Rosenbergii	Vijayanti Jakhar, S.K. Gahlawat and R.C. Sihag	2018	**ISS:2320-7051**	Others	Microbial Biotechnology
25	Synthesis characterization and anticancer activity of vincristine loaded folic acid–chitosan conjugated nanoparticles on NCL-H460 non-small cell lung cancer cell line.	Kumar, N., **Salar, R.K.**, Prasad, M. and Ranjan, K.	2018	**2076-3417**	Scopus	Medicinal Plant Biotechnology
26	Risk factor analysis associated with *Theileria equi* infected equines in semi-arid and sub-humid ecological enzootic zones of India.	Dahiya, R. **Salar, R.K.**, Mandal, K.D., Kumar, R., Tripathi, B.N., Pal Y. and Kumar, S.	2018	**2405-9390**	Scopus	Animal Biotechnology
27	Tulsi (*Ocimum tenuiflorum*) seeds: in vitro DNA damage protection, bioactive compounds and antioxidant potential.	Kaur, P., Dhull, S.B., Sandhu, K.S. **Salar, R.K.** and Purewal, S.S.	2018	ISSN: 2193-4126 (Print) 2193-4134 (Online)	Scopus	Medicinal Plant Biotechnology
29	A low cost, high throughput gel electrophoresis method for separation of SSR markers in Aloe vera	Kumar, R., Salar, R.K., Kumar, A., Kumar, A. and Chhokar, V.	2018	ISSN (E): 2277- 7695 ISSN (P): 2349-8242	Others	Molecular Biotechnology
30	Agro-industrial wastes and their utilization using solid state fermentation: A review: Bioresources and Bioprocessing.5(1):1-15,	Pardeep Kumar Sadh, Surekha Duhan, Joginder Singh Duhan	2018	ISSN: 2197-4365 (Online)	Scopus	Solid state Fermentation
31	Fermentation approach on phenolic, antioxidants and functional properties of peanut press cake.Food Bioscience. 22: 113-120.	Pardeep Kumar Sadh, Prince Chawla, Joginder Singh Duhan	2018	ISSN: 2212-4292	Scopus	Fermenatation
32	Bio-enrichment of functional properties of peanut oil cakes by solid state fermentation using Aspergillus oryzae. J. Food Measurement and Characterization. 12(1); 622-633. https://doi.org/10.1007/s11694-017-9675-2	Pardeep K. Sadh, Prince Chawla, Latika Bhandari, Joginder S. Duhan	2018	ISSN: 2193-4126 (Print) 2193-4134 (Online)	Scopus	Solid state Fermentation
33	Management of wilt disease of chickpea *in vivo* by silver nanoparticles; biosynthesized by rhizospheric microflora of chickpea (*Cicer arietinum*). *Journal of Chemical Toxicology and Biotechnology*. (wileyonlinelibrary.com) DOI	Pawan Kaur, Rajesh Thakur, Joginder Singh Duhan and Ashok Chaudhary	2018	Print ISSN: 0268-2575. Online ISSN: 1097-4660	Scopus	Nanobiotechnology
34	Comparative pot studies of chitosan and chitosan-metal nanocomposites as nano-agrochemicals against fusarium wilt of chickpea (*Cicer arietinum* L.): A novel approach. *Biocatalysis and Agricultural Biotechnology*. 14:466-471	Pawan Kaur, Joginder Singh Duhan and Rajesh Thakur	2018	ISSN: 1878818 1	Scopus	Nanobiotechnology
35	Effect of Different Carbon Sources and Gelling Agents on *in vitro* Multiplication of *Aloe vera*. *Annals of Biology* 34 (1): 12-15.	Shalima Sihag, Subhash Kajla, Anil K. Poonia and Joginder Singh Duhan	2018	ISSN:097001 53	Scopus	Plant Biotechnology
36	Fermentation: A Boon for Production of Bioactive Compounds by Processing of Food Industries Wastes (By-Products). *Molecules* 23, 2560; doi:10.3390/molecules23102560	Pardeep Kumar Sadh, Suresh Kumar, Prince Chawla and Joginder Singh Duhan	2018	(ISSN 1420-3049)	Scopus	Fermenatation
37	Bio-augmentation of antioxidants and phenolic content of *Lablab purpureus* by solid state fermentation with GRAS filamentous fungi	Pardeep KumarSadh,PoojaSaharan,Joginder SinghDuhan	2017	SSN 2405-6537	Scopus	Solid state Fermentation
38	Biogenesis of silver nanoparticles using Aspergillus terreus, its cytotoxicity and potential as therapeutic against human pathogens	Pooja Bansal, Pawan Kaur, Surekha, Anil Kumar, Joginder Singh Duhan	2017	ISSN: 0975-8585	Others	Nanobiotechnology
39	Promoter Trapping and Deletion analysis show Arabidopsis thaliana APETALA2 Gene Promoter is bidirectional and functions as a pollen and ovule specific promoter in the reverse orientation	Pooja Sharma, Vajinder Kumar, Sunil K Singh, Shweta Thakur, **PriyankaSiwach**, YelenSreenivasulu Ramamurthy	2017	**0273-2289 / 1559-0291**	Scopus	Genome characterization
40	Linkage disequilibrium and association mapping of fiber quality traits in elite Asiatic cotton (*Gossypium arboreum*) germplasm populations	Khushboo Sethi, Priyanka **Siwach**, Surender Kumar Verma	2017	**1212-1975 / 1805-9325**	Scopus	Cotton Biotechnology
41	Leaf spot disease adversely affects human health promoting constituents and withanolide biosynthesis in *Withania somnifera* (L.) Dunal.	Singh, Varinder; Singh, Baldev; Sharma, Ashutosh; Kaur, Kulwinder; Gupta, Ajai; **Salar, R.K.**; Hallan, Vipin; Pati, Pratap	2017	**1364-5072 / 1365-2672**	Scopus	Medicinal Plant Biotechnology
42	Phenolic content, antioxidant potential and DNA damage protection of pearl millet (*Pennisetum glaucum*) cultivars of North Indian region.	**Salar, R.K.** and Purewal, S.S.	2017	ISSN: 2193-4126 (Print) 2193-4134 (Online)	Scopus	Crop Biotechnology
43	Bioactive profile, free-radical scavenging potential, DNA damage protection activity, and mycochemicals in Aspergillus awamori (MTCC 548) extracts: a novel report on filamentous fungi.	**Salar, R.K.,** Purewal, S.S. and Sandhu, K.S.	2017	2190-5738	Scopus	Microbial Biotechnology
44	Relationships between DNA damage protection activity, total phenolic content, condensed tannin content and antioxidant potential among Indian barley cultivars.	**Salar, R.K.,** Purewal, S.S. and Sandhu, K.S.	2017	1878-8181	Scopus	Crop Biotechnology
45	Fermented pearl millet (*Pennisetum glaucum*) with *in vitro* DNA damage protection activity, bioactive compounds and antioxidant potential.	**Salar, R.K.,** Purewal, S.S. and Sandhu, K.S.	2017	**0963-9969 / 1873-7145**	Scopus	Crop Biotechnology
46	Green synthesis of silver nanoparticles and its applications—A review.	Kumar, N., Salar, R. K., Kumar, R., Prasad, M., Brar, B. and Nain, V.	2017	ISSN: 0973-418X	Others	Nanobiotechnology
47	Isolation of a Novel Antimicrobial Compounds Producing Fungus Aspergillus niger MTCC 12676 and Evaluation of its Antimicrobial Activity against Selected Pathogenic Microorganisms	Singh, A., Kumar, M. and Salar, R.K. (2017)	2017	ne ISSN: 2581-6	Web of Science	Microbial Biotechnology

48	Optimization of DNA extraction protocol in various varieties of *papaya* for genotyping and molecular diagnosis	Panwar S., Kajla, S., Poonia, A. K., Salar, R. K.	2017	Print ISSN : 2319-2186. Online ISSN : 2322-0996	Others	Molecular Biotechnology
49	Comparative assessment of effect of fermentation on phenolics, flavanoids and free radical scavenging activity of commonly used cereals. *Biocatalysis & Agricultural Biotechnology.* 12: 236-240. DOI:10 .1016j bcab2017 10 013	Pooja Saharan, Pardeep Kumar Sadh, Joginder Singh Duhan	2017	ISSN: 1878-8181	Scopus	Crop Biotechnology
50	Microwave assisted quick synthesis method of silver nanoparticles using citrus hybrid "Kinnow", and antimicrobial activity against early blight of tomato. (2017). 18 (4): 650-655	Pooja Bansal, Pawan Kaur, Surekha, Anil Kumar and Joginder Singh Duhan	2017	ISSN 0972-3226	Scopus	Kinnow Biotechnology
51	Biogenesis of silver nanoparticles using *Fusarium pallidoroseum* and its potential against human pathogens. *Annal Biology.* 33 (2): 180-185	Pooja Bansal, Pawan Kaur and Joginder Singh Duhan	2017	ISSN:097001 53	Scopus	Nanobiotechnology
52	Simple sequence repeats (SSR) and interspersed sequence repeats (ISSR) markers for genetic diversity analysis among selected genotypes of *Gossypium arboreum* race 'bengalense	Khushboo Sethi**, Priyanka Siwach** and Surender Kumar Verma	2016	1684-5315	Others	Cotton Biotechnology
53	Effect of probiotics on immunological status of giant freshwater prawn (Macrobrachium rosenbergii de Man).	Jakhar, V., R.C. Sihag, R.C. and Gahlawat, S.K.	2016	**0367-6722**	Scopus	Immunology
54	Amnion Epithelial Cells of Buffalo (*Bubalus Bubalis*) Term Placenta Expressed Embryonic Stem Cells Markers and Differentiated into Cells of Neurogenic Lineage *In Vitro* .	Ghosh K, Selokar NL, Gahlawat, S.K., Kumar D, Kumar P. and Yadav PS.	2016	**1049-5398 / 1532-2378**	Scopus	Immunology
55	Differential expression of Toll-like receptor genes (TLR2 and TLR4) across different tissues of riverine buffalo.	Dubey, P.K.,Goyal, S.,Namita,Mishra, S.K.,Gahlawat, S.K.,Kataria, R.S.	2016	**0367-8318**	Others	Immunology
56	Biosynthesis of silver nanoparticles using Bifidobacterium bifidum NCDC 229 and evaluation of synergistic effect with penicillin against pathogenic bacteria.	Kumar, Ajay, Gahlawat, S.K., Naresh, K.	2016	2229-6441	Others	Nanobiotechnology
57	Optimization of extraction conditions and enhancement of phenolic content and antioxidant activity of pearl millet fermented with *Aspergillus awamori* MTCC-48.	**Salar, R.K.,** Purewal, S. S. and Bhatti, M.S.	2016	2405-6537	Scopus	Fermenatation
58	Synthesis and characterization of vincristine loaded folic acid–chitosan conjugated nanoparticles.	**Salar, R.K.,** and Kumar, N.	2016	2405-6537	Scopus	Nanobiotechnology
59	Improved production of tannase by *Klebsiella pneumoniae* using Indian gooseberry leaves under submerged fermentation using Taguchi approach.	Mukesh Kumar, A. Singh, V. Beniwal and **R.K. Salar**	2016	**2191-0855**	Scopus	Enzyme Biotechnology
60	Bio-ethanol production from sweet potato using co-culture of saccharolytic molds (Aspergillus spp.) and Saccharomyces cerevisiae MTCC170	A. Kumar, P. K. Sadh, Surekha, J. S. Duhan	2016	SSN : 2348-620	Others	Fermenatation
61	In vitro antimicrobial efficacy, free radical scavenging activity and antimutagenic potential of stem extract of Capparis decidua. World J. Pharmacy & Pharmaceutical Sciences	Joginder Singh Duhan, Manju Bhardwaj, Pardeep Kumar Sadh and Surekha	2016	SSN 2278 - 435	Scopus	Medicinal Plant Biotechnology
62	Nanotechnology: The new perspective in precision agriculture	Joginder Singh Duhan, Ravinder Kumar, Naresh Kumar PawanKaur, Kiran Nehra, Surekha Duhan	2016	ISSN 2215-017X	Scopus	Nanobiotechnology
63	Assessing genetic diversity among *Gossypium arboreum* L. genotypes using ISSR markers	Khushboo Sethi, **Priyanka Siwach**, Surender Kumar Verma and MeghaSihag	2015	0975-6299	Scopus	Cotton Biotechnology
64	Assessing genetic diversity among six populations of *Gossypiumarboreum* L. using microsatellites markers	Khushboo Sethi, **PriyankaSiwach**, Surender Kumar Verma	2015	0974-0430	Scopus	Cotton Biotechnology
65	Detection of *Pseudomonas fluorescens* from broth, water and infected tissues by loop-mediated isothermal amplification (LAMP) method.	Saharan, P., Duhan, J.S. and Gahlawat, S.K.	2015	1684-5315	Others	Diagnostics
66	Buffalo (*Bubalus bubalis*) term amniotic,c-membrane-derived cells exhibited mesenchymal stem cells characteristics in vitro.	Ghosh K, Kumar R, Singh J, Gahlawat S.K., Kumar D, Selokar NL, Yadav SP, Gulati BR and	2015	**1071-2690 / 1543-706X**	Scopus	Animal Biotechnology
67	Emergence of sulfadoxine-pyrimethamine resistance in Indian isolates of *Plasmodium falciparum* in the last two decades.	Kumar A, Moirangthem R, Gahlawat S.K., Chandra J, Gupta P, Valecha N, Anvikar A, Singh V	2015	**1567-1348 / 1567-7257**	Scopus	Microbial Biotechnology
68	Enhanced antibacterial activity of streptomycin against some human pathogens using green synthesized silver nanoparticles.	**Salar, R.K.,** Sharma, P. and Kumar, N.	2015	2405-6537	Scopus	Nanobiotechnology
69	Purification and characterization of thermophilic tannase from *Klebsiella pneumoniae* KP715242.	Mukesh Kumar, V. Beniwal and **R.K. Salar**	2015	1878-8181	Scopus	Enzyme Biotechnology
70	Improvement of DNA damage protection and antioxidant activity of biotransformed pearl millet (Pennisetum glaucum) cultivar PUSA-415 using Aspergillus oryzae MTCC 3107	Salar, R. K. and Purewal, S.S.	2016	1878-8181	Scopus	Crop Biotechnology
71	Optimization of tannase production by a novel Klebsiella pneumoniae KP715242 using central composite design.	Salar, R. K. and Purewal, S.S.	2015	2215-017X	Scopus	Enzyme Biotechnology
72	In vitro antioxidant and free radical scavenging activities of stem extract of Euphorbia trigona Miller	Salar, R. K., Sharma, P. and Purewal, S. S.	2015	33-8985(eISS	Others	Medicinal Plant Biotechnology

73	Assessment of Genetic Variability and Structuring of Riverine Buffalo Population (Bubalus bubalis) of Indo-Gangetic Basin. Animal Biotechnology.	Jyoti Joshi, R. K. Salar, Priyanka Banerjee, Upasna S, M. S. Tantia, and R. K. Vijh	2015	t ISSN: 1049-8	Scopus	Animal Biotechnology
74	Antidepressant Activity of Various Extracts from Seeds of Ocimum Basilicum Linn.	Basanti Brar, Joginder Singh Duhan and Pankaj Rakha	2015	ISSN No 2277 - 8179	UGC Listed	Medicinal Plant Biotechnology
75	Antimicrobial and free radical scavenging activity of selective medicinal plants combination	Joginder Singh Duhan, Akansha Rana , Pardeep Kumar Sadh, Pooja Saharan , Surekha	2015	SSN 2278 – 435	Scopus	Medicinal Plant Biotechnology
76	Detection of Pseudomonas fluorescens from broth, water and infected tissues by loop-mediated isothermal amplification (LAMP) method	Pooja Saharan, Joginder S. Duhan and Suresh K. Gahlawat	2015	ISSN 1684-5315	Others	Diagnostics
77	Analgesic activity of various extracts of leaves of Murraya koenigii Spreng.	Basanti Brar, Joginder Singh Duhan and Pankaj Rakha	2015	ISSN 2278 – 4357	Scopus	Medicinal Plant Biotechnology





3.4.6 Number of books and chapters in edited volumes published per teacher during the last five years (15)						
3.4.6.1: Total number of books and chapters in edited volumes / books published, and papers in						
Sl. No.	**Name of the teacher**	**Title of the book/chapters published**	**Year of publication**	**ISBN/ISSN number of the proceeding**	**Name of the publisher**	**Thematic area**
1	Punia, S., Siroha, A.K. Sandhu, K.S., Gahlawat, S.K. and Kaur, M.	Pearl Millet: Properties, Functionality and its Applications	2020	ISBN: 978-0-367-35486-2.	CRC Press, Taylor & Francis Group, USA (International): https://www.routledge.com/Pearl-Millet-Properties-Functionality-and-its-Applications/Punia-Siroha-Sandhu-Gahlawat-Kaur/p/book/9780367354862	**Food Biotechnology**
2	Punia, S., Siroha, A.K. Sandhu, K.S., Gahlawat, S.K. and Kaur, M.	Pearl Millet: A drought arrested Crop.	2020	ISBN: 978-0-367-35486-2.	CRC Press, Taylor & Francis Group, USA (International)	**Food Biotechnology**
3	Akhilesh Mishra, Priyanka Siwach, Poonam Singhal	Chemgenome2.1: An ab initio gene prediction software' in Gene Predcition: Methods and Protocols	2019	978-1-4939-9173-0	Springer: https://link.springer.com/protocol/10.1007%2F978-1-4939-9173-0_7	**Genome annotation**
4	Saini, N., Thakur A., Kaur P., Gahlawat S.K	Herbonanoceuticals: A Novel Beginning in Drug Discovery and Therapeutics	2019	ISBN: 978-3-030-17061-5	Springer: https://link.springer.com/chapter/10.1007/978-3-030-17061-5_7	**Therapeutics**
5	Suresh Kumar Gahlawat, Joginder Singh Duhan Raj Kumar Salar, Priyanka Siwach, , Suresh Kumar and Pawan Kaur	Advances in Animal Biotechnology and its Applications	2018	ISBN 978-981-10-4701-5	Springer: https://link.springer.com/book/10.1007/978-981-10-4702-2	**Animal Biotechnology**
6	Dr. Raj Kumar Salar	Thermophilic Fungi: Basic Concepts and Biotechnological Applications	2018	ISBN-10: 0815370709, ISBN-13: 978-0815370703	CRC Press, Taylor & Francis Group, USA (International): https://www.routledge.com/Thermophilic-Fungi-Basic-Concepts-and-Biotechnological-	**Microbial Biotechnology**

7	Kiran Nehra, Preti Yadav and Joginder Singh Duhan	In-Silico Drug Designing: Transition to Modern-Day Drug Discovery, In: Advances in Animal Biotechnology and its Applications	2018	ISBN 978-981-10-4701-5	Springer: DOI:10.1007/978-981-10-4702-2_5	**Bioinformatics**
8	Pardeep Kumar Sadh, Suresh Kumar Rohilla, Sandeep Kumar and Joginder Singh Duhan	Food Adulterations: Types, their Effects and Control, In: Quality Control and Waste Utilization for Agriculture and Dairy Products. Pp. 225-236	2018	ISBN: 978-93-85516-	New India Publishing Agency, New Delhi: https://www.nipabooks.com/info/9789387973206/quality-control-	**Foot Biotechnology**
9	Kumar, S. and Gahlawat, S.K.	Oocyte Cryopreservation: Paradigm in Assisted Reproduction Technology	2018	ISBN 978-981-10-4701-5	Springer: DOI:10.1007/978-981-10-4702-2_21	**Animal Biotechnology**
10	Suresh Kumar Gahlawat, Raj Kumar Salar, Priyanks Siwach Joginder Singh Duhan, Suresh Kumar and Pawan Kaur	Plant Biotechnology: Recent Advancements and Developments	2017	ISBN 978-981-10-4731-2 ISBN 978-981-10-4732-9 (eBook) DOI 10.1007/978-981-10-4732-9	Springer: https://link.springer.com/book/10.1007/978-981-10-4732-9	**Plant Biotechnology**
11	Pooja Suneja, Joginder Singh Duhan, Namita Bhutani and Surjit Singh Dudeja	Recent Biotechnological Approaches to Study Taxonomy of Legume Nodule Forming Rhizobia. in "Plant Biotechnology:	2017	ISBN 978-981-10-4731-2 ISBN 978-981-10-4732-9 (eBook) DOI 10.1007/978-981-	Springer: DOI:10.1007/978-981-10-4732-9_6	**Microbial Biotechnology**
12	Megha Sihag, Khushboo sethi, S. K. Gahlawat and Priyanka Siwach	Advances in computational tools for plant microRNA identification' in Plant Biotechnology	2017	ISBN: 978-981-10-4731-2	Springer: https://link.springer.com/content/pdf/bfm%3A978-981-10-4732-9%2F1.pdf	**Bioinformatics**
13	Sundeep Jaglan, Rakesh Yadav, Priyanka Siwach and Namita Singh	Recent updates on Molecular Biotechnological Intervention in Isabgol' in Plant Biotechnology: Recent Advancements	2017	ISBN: 978-981-10-4731-2	Springer: https://link.springer.com/content/pdf/bfm%3A978-981-10-4732-	**Medicinal Plant Biotechnology**
14	Saini, N., Gahlawat, S.K. and Lather, V.	Flavonoids: A Nutraceutical and Its Role as Anti-inflammatory and Anticancer Agent	2017	ISBN 978-981-10-4731-2	Springer: https://link.springer.com/chapter/10.1007/978-981-10-4732-9_13	**Neutraceutical**

PhDs Department of Commerce

Sr. No.	Student Name	Regn. No.	Thrust area	Thrust Area
1	Sushil Kumar	6050675 10001	Management of Earnings in The Corporate Sector in India: A Study of Selected Companies	Corporate Earnings
2	Sushil Bajaj	6050975 10004	Equity Derivatives in India: A Study of Investment Strategies, Volatility and Pricing	Derivatives
3	Chanpreet Kaur	6050975 10005	Advertising Effectiveness on Fast Moving Consumer Goods: An Empirical Study	Advertising
4	Pinki Rani	6050975 10003	Dividend Policy Behaviour in Indian Capital Markets: A Study of Selected Companies	Corporate Finance
5	Sonika Bansal	6050975 10007	Gender Issues in Indian Oranisations: A Study	Management
6	Gurnam Singh	6050675 10002	Relationship Between Capital Structure and Value of Firm: A Study of Selected Companies in India	Corporate Finance
7	Roma	6050975 10006	Competitiveness of Indian Reail Industry In Paradigm Shifts; An Empirical Study	Marketing
8	Madhu Chitkara	1148750 05	Customers' Perception towards Mobile Banking in India: A Comparative Study of Selected Public, Private and Foreign Banks	HRM
9	Rajinder Kumar Kapil	1148750 03	Impact of Indology on Business Strategies: An Empirical Study	Marketing
10	Naman Sethi	1148750 07	An Empirical Analysis of Investment Strategies in Indian Stock Market	Financial Markets
11	Kamlesh Rani	1148750 12	Impact of Emplyees-Management Relationship on Quality of Work Life in Banking Sector	HRM
12	Mukesh Kumar	1148750 04	Job Satisfaction of Workers in Brick Kiln Industry: A Study of Select Brick Kiln Units of Haryana State	HRM
13	Satbir Singh	1148750 13	A Study of Mobil Phone Services with Special Reference to Coustomers' Performance and Problems	Marketing
14	Amanpreet Kaur	1148750 10	Evaluation of Life Insurance Demand Determinats in Different Conditions of India	HRM
15	Rajesh Khurana	1148750 01	Stock Price Adjustments to Selected Corporate Announcements: A Study of Indian Corporate Sector	Financial Markets
16	Suman	1148750 02	Integration of Indian Stock Market With Selected Global Stock markets	Financial Markets
17	Bikramjit Singh	1148750 09	Patterns of Industrial Development: An Exploratory Study of Punjab and Haryana	HRM

18	Rakesh	114875006	Impact of Merger and Acquisitions on Profitability and Shareholders' Wealth: Evidence from Indian Corpoarte Sector	Corporate Finance
19	Samriti Kamboj	114875008	A Study of Financial Literacy and its Impact on Investment behaviour	HRM
20	Renu Sindhu	124875005	A Study of Human Resource Accounting Practices in Indian Corporate Sector	HRM
21	Parminder Singh	124875003	Impact of Mutual Funds and Foreign Instituional Investments on indian Stock Market	Financial Markets
22	Payal Sharma	124875007	A Study of Corporate Governance Practices in India	Corporate Finance
23	Swati	124875002	Impact of Capital Sturcture on Financial Performance of Corporate Sector in India	Corporate Finance
24	Kavita	124875001	Inter-Dependenc among Stock Exchanges Across the World: A Study with Special Reference to Risk-Return Relationship	Financial Markets
25	Mamta Rani	124875004	Impact of human, Social and Financial Capital on Performance of Micro, Small and Medium Enterprises-A Study of Haryana	HRM
26	Pawan Sharma	151487500001	Financial Inclusion In Bharat: An Exploratory Study of Banking Sector	HRM
27	Sudhanshu Gupta	124875009	Entrepreneurship Skills in Unorganized Sector: A Study of Selected Districts in Haryana	HRM
28	PARVEEN KUMAR	201703550017113 3	Analysis of Equity Return Behavior in India: An Empirical Study	Financial Markets
29	MEENAKSHI	201703550017112 5	Goods and Service Tax Act: Implementation and Implications in Haryana State	HRM
30	ARJU	201803550017480 5	Impact of Linkage between Green Human Resource Development Practices and Environment Issues on Work Life of Employees: A Study of Public Secor Undertakings of Haryana State	HRM
31	VINITA	201803550017473 2	A Study of Implementation of Labour Welfare Schemes at Construction Sites in Haryana	HRM
32	REKHA KUMRI	201803550017474 7	An Empirical Study of Dividend Practices in Indian Corporate Sector	Corporate Finance
33	SATYANAND	201803550017475 5	A Study of Smart Cities with Reference to Green marketing in Haryana State	HRM
34	RINKU	201803550017476 3	Role of Pardhan Mantri Koushal Vikas Yojana in Promoting Employability Skills in Haryana State	HRM

35	SUNITA	2018035500174771	Impact of Working Enviornment on Employee's Job Satisfaction: A Study of Haryana Power Sector	HRM
36	MEHAK SINGLA	2018035500174786	Performance Persistence of Socially Responsible Investments in India; A Study	HRM
37	KAMAL GOEL	20200355 00165716	A Study of Brand Equity among Non-Governmental Organizations (NGOs) with Special Reference to Consumer Choice behavior	Marketing
38	KAILASH CHANDER	20200355 00165771	Customers Perception towards Credit Culture of Banking Industry in Haryana State: A Study	HRM
39	SUDESH	20200355 00184331	Knowledge Management Orientation and Business Performance of SMEs in Delhi NCR	HRM

DEPARTMENT OF COMMERCE

	Title of paper	Name of the author/s	Name of journal	Year of publication
1	Promotion of Academic Integrity through Research and Publication Ethics: A Voyage by University Grants Commission	Dr. Surinder Singh	ORGANISER	2021
2	AN ANALYSIS OF FACTORS IMPACTING THE DIVIDEND PRACTICES OF INDIAN FIRMS: AN EMPIRICAL STUDY	Dr. D.P. Warne, Rekha Kumari	UTKAL HISTORICAL RESEARCH JOURNAL	2021
3	RELATIONSHIP OF FIRM CHARACTERISTICS AND DIVIDEND POLICY OF SELECTED OIL & GAS COMPANIES IN INDIA	Dr. D.P. Warne, Rekha Kumari	INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR)	2021
4	Asset pricing models: evidence from the Indian equity market	Dr. Kapil Choudhary	Afro-Asian Journal of Finance and Accounting: In Press (online Published)	2021
5	Risk & Return Analysis: Evidence from The Indian Equity Market	Dr. Kapil Choudhary	IOSR Journal of Economics and Finance (IOSR-JEF) Volume 12, Issue 4 Ser. VI (Jul. –Aug. 2021), PP 27-32	2021
6	Impact of Demonetisation on Indian Stock Market with Special Reference to NSE	Dr. Kapil Choudhary	Vidyabharati International Interdisciplinay Research Journal (Special Issue)	2021
7	AN APRAISAL OF THE EFFECTIVENESS OF TRAINING CLIMATE UNDER PRADHAN MANTRI KAUSHAL VIKAS YOJNA IN HARYANA	Dr. Kamlesh Rani	Anvesak	2021
8	Role of PMKVY in Promoting Employability Skills and Placement in Haryana State	Dr. Kamlesh Rani	International Journal of Economics Business and Human Behaviour Volume 2 (1) Jan-March, 2021, 1-16	2021
9	SUSTAINABLE DEVELOPMENT THROUGH SMART CITIES: THE NEED OF HOUR	Dr. Surinder Singh	Jamshedpur Research Review	2021
10	An Awareness Analysis of Goods and Services Tax (GST) Act in Haryana State	Dr. Surinder Singh	Journal of Interdisciplinary Cycle Research	2021
11	IMPLICATIONS OF GOODS AND SERVICES TAX ACT, 2017 ON INDIAN ECONOMY: A PERCEPTUAL ANALYSIS	Dr. Surinder Singh	HSB Research Review	2021

Research and Publication Ethics

Dividend practices

Dividend Policies

Equity Market

Equity Market

Stock Market

Skill development

Employability Skills

Smart cities

GST

GST

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	Title of paper	Name of the author/s	Name of journal	Year of publication
12	CORPORATE SOCIAL RESPONSIBILITY: A STUDY OF STATE BANK OF INDIA	Dr. Kamlesh Rani	OUR HERITAGE JOURNAL	2020
13	AN EMPIRICAL STUDY OF DIVIDEND BEHAVIOR : EVIDENCE FROM INDIAN MANUFACTURING FIRMS	Dr. D.P. Warne, Rekha Kumari	INDIAN MANAGEMENT STUDIES JOURNAL	2020
14	STEPS TAKEN BY RESERVE BANK OF INDIA AND GOVERNMENT OF INDIA INTENDED FOR FINANCIAL INCLUSION	Pawan Sharma, Dr. D.P. Warne	INTERNATIONAL JOURNAL OF TREND IN SCIENTIFIC RESEARCH AND DEVELOPMENT	2020
15	A CASE STUDY OF CORPORATE SOCIAL RESPONSIBILITY INITIATIVES OF TATA GROUP	Dr. D.P. Warne & Ankit Kumari	STUDIES IN INDIAN PLACE NAMES	2020
16	Financial literacy, investment Behaviour and socio-demographic variables	Dr. Kapil Choudhary	Int. J. Behavioural Accounting and Finance, Vol. 6, No. 3, 2021	2020
17	An Analysis of Awareness Level among Respondents towards Smart Cities and Green Marketing	Dr. Surinder Singh	Praxis International Journal of Social Science and Literature	2020

CSR

Dividend Practices

Financial Literacy

CSR

Financial Literacy

Smart Cities

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	Title of paper	Name of the author/s	Name of journal	Year of publication
18	Parental Attitude towards Telecasted Food Advertisements through Television: An Empirical Study of Rural Vicinity of Karnal of Haryana	Dr. Surinder Singh	International Journal of Research and Analytical Reviews (IJRAR)	2019
19	AGRICULTURAL CREDIT AS A TOOL OF FINANCIAL INCLUSION: A CONCEPTUAL VIEWPOINT	Dr. Surinder Singh	International Journal of Management, IT & Engineering	2019
20	Paradigm Shifts in Financial Inclusion in India: An Overview	Dr. Surinder Singh	International Journal of Research and Analytical Reviews (IJRAR)	2019
21	CORPORATE GOVERNANCE MECHANISMS IN INDIA: A CASE STUDY	Dr. Silender Singh	JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)	2019
22	Relationship between Capital Structure and Financial Performance of Manufacturing Companies in India.	Dr. Silender Singh	JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)	2019
23	PYRAMID OF SOCIO-ECONOMIC INVESTMENT O UNION GOVERNAMENT AND CORPORATE	Dr. Silender Singh	THINK INDIA JOURNAL	2019
24	A STUDY OF PERFORMANCE APPRAISAL SYSTEM OF HVPNL	Dr. Kamlesh Rani	JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)	2019
25	INTERDEPENDENCE AMONG INTERNATIONAL STOCK MARKETS: A STUDY ON STOCK MARKETS INTEGRATION	Dr. D.P. Warne, Kavita Rani	INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR)	2019
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28	Implementation of Goods and Services Tax (GST) in India: A Problematic View	Dr. Surinder Singh	Journal of Emerging Technologies and Innovative Research	2019

Advertising Behaviour

Financial Literacy

Financial Literacy

Corporate Governance

Financial Markets

Financial Markets

Performance Appraisal

Stock Market

Stock Market

Equity Market

GST

DEPARTMENT OF COMMERCE

	Title of paper	Name of the author/s	Name of journal	Year of publication
29	Impact of Social capital on performance of micro, small and medium enterprises: A case study of Haryana State.	Dr. Silender Singh	IAHRW INTERNATIONAL JOURNAL OF SOCIAL SCIENCES	2018
30	Individuality and Operational Strategy Planning Impact on Growth in Sales: A Case Study	Dr. Silender Singh	INTERNATIONAL JORNAL OF RESEARSH IN ECONOMICS AND SOCIAL SCIENCES (IJRESS)	2018
31	HUMAN RESOURCE ACCOUNTING AND DISCLOSURE PRACTICES IN INDIAN CORPORATE SECTOR	Dr. Silender Singh	INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)	2018
32	A STUDY OF HUMAN RESOURCE ACCOUNTING PRACTING EXAMINING THE EFFECT OF FINANCIAL PERFORMANCE ON SELECTED PRIVATE AND PUBLIC LISTED COMPANIES IN INDIA (2019)	Dr. Kamlesh Rani	INTERNATIONAL JORNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR)	2018
33	ASSOCIATION OF INDIAN STOCK MARKET WITH DEVELOPED STOCK MARKETS: AN EMPIRICAL EVIDENCE	Dr. D.P. Warne, Kavita	EMPEROR INTERNATIONAL JOURNAL OF FINANCE AND MANAGEMENT RESEARCH	2018
34	STOCK PRICE ADJUSTMENTS TO SELECTED CORPORATE ANNOUNCEMENTS: A STUDY OF DIVIDEND ANNOUNCEMENTS	Dr. D. P. Warne, Rajesh Khurana	Asian Journal of Management	2018
35	MUDRA YOJANA: A YOJANA OF ACCOMPLISHING DREAMS WITH SPECIAL REFERENCE OF HARYANA	Dr. D.P. Warne & Jitender	PRINTING AREA: INTERDISCIPLINARY MULTILINGUAL REFEREED JOURNAL	2018
36	FINANCIAL INCLUSION: AN INITIATIVE FOR PROGRESSIVE INDIAN ECONOMY	Jitender & Dr. D.P. Warne	PRINTING AREA: INTERDISCIPLINARY MULTILINGUAL REFEREED JOURNAL	2018
37	Impact of employees' life style disorder on organizational performance: A conceptual study	Dr. Kamlesh Rani	International journal of creative research thoughts.	2018
38	Impact of employees management relationship on quality of work life of bank managers	Dr. Kamlesh Rani	International research journal of human resources & social sciences. Vol. 5, issue 4, April 2018, 12-23	2018
39	Impact of working environment on job satisfaction of bank employees	Dr. Kamlesh Rani	Journal of Emerging Technologies and Innovative Research (JETIR), Vol. 5, issue 6. June 2018, 183-189	2018

DEPARTMENT OF COMMERCE

	Title of paper	Name of the author/s	Name of journal	Year of publication	
40	IMPACT OF DISTINCT VARIABLES ON QUALITY OF WORK LIFE: AN EXPLORATORY STUDY BASED ON EMPLOYEE"S PERSPECTIVE	Dr. Silender Singh	INTERCONTINENTAL JOURNAL OF HUMAN RESOURCE RESEARCH REVIEW	2017	organisational Behaviour
41	HUMAN RESOURCE INFORMATION DISCLOSURE PRACTICES IN FINANCIAL REPORT	Dr. Silender Singh	INTERCONTINENTAL JOURNAL OF HUMAN RESOURCE RESEARCH REVIEW	2017	HR Practices
42	MERGER AND ACQUISITIONS IN SELECTED BANKS IN INDIA	Dr. D. P. Warne, Pawan Sharma	INDIAN MANAGEMENT STUDIES JOURNAL	2017	Merger and Acquisitions
43	INTERGRATION OF INDIAN STOCK MARKET WITH SELECTED GLOBAL STOCK MARKETS	Dr. D.P. Warne & Suman	INDIAN JOURNAL OF ACCOUNTING	2017	Stock Markets
44	A Study Of Awareness About Retirement Planning Among Employees	Dr. Kapil Choudhary	International Journal of Management and Social Science Research Review Vol. 5, No. 6, June 2017, pp 281-296	2017	HR Practices
45	Women and Financial Literacy: An Empirical Study from Haryana	Dr. Kapil Choudhary	International Research Journal of Commerce and Law, Vol.04 Issue-8 (August, 2017), PP 12-20	2017	Financial Literacy
46	Review of Financial Literacy Skills of Women across the World	Dr. Kapil Choudhary	International Research Journal of Commerce and Law, Vol.04 Issue-8 (August, 2017), PP 21-29	2017	do —
47	A Study of Financial Literacy and Its Determinants: Evidence From India	Dr. Kapil Choudhary	Asian Journal of Accounting Perspectives, Vol. 10, (2017), pp. 52-72	2017	do —
48	Empirical analysis of latent variables effecting employees quality of work life: A study of public sector banks	Dr. Kamlesh Rani	The International Manager, International Journal of Recent trends in Management, Commerce, Accountancy, Economics, Public Administration, Politics, Law and Allied Researches. Vol. 4, issue 13, Jan-March 2017, 20-26.	2017	HR Practices
49	Impact of distinct variables on quality of work life: An exploratory study based on employee's perspective.	Dr. Kamlesh Rani	Intercontinental Journal of Human Resource Research Review	2017	do —

DEPARTMENT OF COMMERCE

	Title of paper	Name of the author/s	Name of journal	Year of publication
50	A STUDY OF EMPLOYEE -MANAGEMENT RELATIONSHIP IN INDIAN BANKING SECTOR	Dr. Silender Singh	INTERCONTINENTAL JOURNAL OF HUMAN RESOURCE RESEARCH REVIEW	2016
51	BOURSES REACTION TO MERGERS AND ACQUISITIONS ANNOUNCEMENTS: EVIDENCE FROM INDIA	Dr. D. P. Warne, Rajesh Khurana	INDRAPRASTHA JOURNAL OF MANAGEMENT	2016
52	MARKET REACTION TO BONUS ISSUE IN INDIA: AN EMPIRICAL STUDY	Dr. D. P. Warne, Rajesh Khurana	International journal of Innovations in Engineering and Technology	2016
53	MAKE IN INDIA: A DRIVE FOR CHANGE	Pawan Sharma, Dr. D.P. Warne	PUNJAB JOURNAL OF BUSINESS STUDIES	2016
54	GROWTH AND DEVELOPMENT IN RETAILING: AN EMPIRICAL STUDY IN INDIAN CONTEXT	Dr. D.P. Warne, Pawan Sharma	ZENTTH INTERNATIONAL JOURNAL OF BUSINESS ECONOMICS & MANAGEMENT RESEARCH	2016
55	ENTERPRENEURSHIP SKILLS IN HARYANA: AN EXPLRATORY STUDY	Dr. D.P. Warne and Sudhanshu Gupta	INTERNATIONAL JOURNAL OF SCIENCE, TECHNOLOGY AND MANAGEMENT	2016
56	A Review of the Empirical Literature on Stock Splits	Dr. Kapil Choudhary	International Journal of Management and Social Science Research Review Vol. 1. No. 3, March 2016, pp 73-75.	2016
57	A Literature Review on Impact of Merger and Acquisition	Dr. Kapil Choudhary	Intercontinental Journal of Finance Research Review, Vol. 4, No. 03, July-September 2016, pp.150-157	2016
58	A Review of Literature on Impact of Merger and Acquisition: Accounting Measured Based Studies	Dr. Kapil Choudhary	International Journal of Multidisciplinary Educational Research, Vol. 5, No. 10(2), Oct. 2016, pp.78-94	2016

Indian Banking System

Merger and Acquisition

Stock markets

Skill Development

Retailing

Skill Development

Stock Market

Merger and Acquisition

do —

DEPARTMENT OF COMMERCE

	Title of paper	Name of the author/s	Name of journal	Year of publication
59	DETERMINANTS OF INDUSTRIAL DEVELOPMENT: AN ANALYSIS OF PUNJAB	Bikramjit Singh & Dr. D.P. Warne	PUNJAB JOURNAL OF BUSINESS STUDIES	2015

Industrialisation

Commerce 3.4.6

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Year of publication	ISBN/ISSN number of the proceeding
1	Sudesh ,Silender Singh & Anil Ghanghas	Business Dynamics and innovations	Strategically refuelling SMEs to revive economy of India post COVID-19	---	2021	978-93-84783-63-1
2	Sudesh Puniya & Mrinmoy Roy	Vocal for local:How to succeed?	Knowledge Management Orientation to sustain in the era of disruption: A Conceptual Framework for Indian Organizations	---	2021	978-81-948719-2-7
3	Dr. (Prof.) Surinder Singh	COGNITIVE STYLES AND MULTIMEDIA LEARNING	---	---	2016	ISBN-978-93-848710-6-2

	Book	
Event management (4)	Event management	2021
Health Economics (5)	Health Economics	2021
Public Health Administration (6)	Epidemiology and Public Health Administration	2021

Department of Business Administration - Ph.D Topics & Area

Sr. No.	Name of Scholar	Awarded/Ongoing	Topic Name	Thematic Area
1	Komal	Awarded	"E-Banking in India-Progress and Prospects (A comparative study of PSBs, PSIBs and PSFBs)"	Banking
2	Krishana Kumar Khandelwal	Awarded	"Building Trust in E-Commerce: Adoption, Usage and Satisfaction Patterns in Virtual Market Environment"	E-Commerce
3	Shweta Sharma	Awarded	"Human Resource Retention Strategies: A Comparative Study of Domestic and Foreign Companies in India"	Employee Retention
4	Sakshi Mehta	Awarded	"Exploration of Financial Performance Determinants: A Study of Indian Corporate Sector"	Financial Management
5	Sakshi Goyal	Awarded	"Performance Appraisal of Depository System in India"	Securities Trading
6	Dharamveer	Awarded	"An Appraisal of Financial Administration of Universities (A Comparative Study of Universities in Haryana, Punjab and Himachal Pradesh since 1990-91 Onwards)"	Financial Management
7	Rajbir Singh Golia	Awarded	"Total Quality Management (TQM) in Technical Education: An Appraisal"	Quality Management
8	Vatsala Sharma	Awarded	"Role of Institutional Investors in Corporate Governance in India"	Corporate Governance
9	Jagbir	Awarded	“Enterprise Resource Planning (ERP): Critical Success Factors and Benefit Realization”	E-Businesst
10	Suman Bala	Awarded	“An Appraisal of Rural Development Schemes in Haryana”	Rural Management
11	Nidhi Turan	Awarded	“A Study of Organizational Stress in Indian Service Sector”	Stress Management
12	Suman Sahrawat	Awarded	“Corporate Perceptions and Practices about Work-Life Balance: A Study of Select Critical Factors”	Work Life Balance
13	Ram Paul Chander	Awarded	“HR Diversity in Indian Corporate Sector: A Comparative Study of MNCs and Domestic Companies”	Workforce Diversity
14	Naveen Goyal	Awarded	“Appraisal of HRD Practices In Indian Banks (A Comparative Study of Public, Private and Foreign Banks)”	Human Resource Development
15	Shilpa Khatkar	Awarded	"Institutional Credit Flow and Agri-Market Development in India"	Agri-Business
16	Suresh Kumar	Awarded	“Customer Relationship Management Practices in Indian Banking Sector: A Comparative Study of Public and Private Sector Banks”	Financial Management

Department of Business Administration - Ph.D Topics & Area

Sr. No.	Name of Scholar	Awarded/Ongoing	Topic Name	Thematic Area
17	Kumari Sapna	Awarded	"Stock Market Reactions to Corporate Events"	Stock Market
18	Poonam	Awarded	Evaluation of Marketing stratagies : A study of Indian Pharmantical Industry in the post WTO Era.	Marketing Management
19	Sanjay Raj	Awarded	An Indian Model of Management for Corporate Sector	Management
20	Sanjeev Kumar	Awarded	IMPACT OF CREATIVITY IN ADVERTISING: A STUDY OF SELECTED AWARD WINING ADVERTISEMENTS IN INDIA CONTEXT	Advertisement Management
21	Vinod Kumar	Awarded	Foreign Direct Investment in India: A Study of Enabling variables.	FDI
22	Neelam Rani	Awarded	Stock Price Beahviour Validuity of Efficient Market Theory (Evidence from the Indian Stock Market)	Stock Market
23	Sandeep	Awarded	Efficiency in Indian Stock Market : A Study with Special Rerfence of Day, week and month effects.	Stock Market
24	Parveen Kumar Thakur	Awarded	Teacher Burnout vis-à-vis Organizational Climate : A study of Professional Institutes in Haryana	Organizational Climate
25	Raj Rup Fuliya	Awarded	Disclosure and Tranceparency in Governance : Initiatives and Imperetives for Good Governace	Corporate Governance
26	Upasana Rai	Awarded	Managerial Capabilities and Business Performances: A Study of Women Entrepreneurs in NCR.	Entrepreneurship Development
27	Sunita	Awarded	Effect of the Fundamental Factors on Stock Proces of BSE-200 Companies : A Comparative Study of Normal and Recession Period.	Stock Market
28	Krishan Mohan	Awarded	Implementation of Total Quality Management in Supply Chain Activities.	Supply Chain Management
29	Mohina	Awarded	Appraisal of Credit Risk Management Practices: A Comparative Study of Public and Private Sector Banks.	Risk Management
30	Sahila Chaudhry	Awarded	A STUDY OF OPERATIONAL RISK IN E-BANKING IN INDIA	Risk Management
31	Rajesh Kumar	Awarded	Management of Work Force Diversity: A Study of IT and Telecom Sectors in India	Work force Diversity
32	Sanjay Taneja	Awarded	An appraisal of financial performance of banking sector in India: A comparative study of public, private and foreign banks	Financial Management

Department of Business Administration - Ph.D Topics & Area

Sr. No.	Name of Scholar	Awarded/Ongoing	Topic Name	Thematic Area
33	Shallu Mehta	Awarded	HR Practices and Employees' Motivation in Banking Sector: A Perceptual Analysis	Human Resource Practices
34	Neelam Kaushal	Awarded	A study of pay for performance practices in banking sector	Compensation Management
35	Nishtha	Awarded	Evaluation of Public Sector Governance Practices in Haryana: A Study with Reference to Right to Information	Corporate Governance
36	Amita Kohli	Awarded	Working and Operations of Primary Health Care Institutions in Haryana	Operations Management
37	Virender Singh	Awarded	Financial Inclusion initiatives and their Impact: A Study of Selected Banks in Haryana	Banking
38	Meenal	Awarded	A Study of Career Progression of Women Employees in Information Technology Sector in india	Career Planning
39	Khushbu	Awarded	Structural Diversification of India's Foreign Trade Portfolio: An Empirical Study	Foreign Trade
40	Nancy Arora	Awarded	A Study of Customers' Satisfaction from Bancassurance Services	Consumer Behaviour
41	Neeru Puniya	Awarded	Impact of Information Technology on Customers' Satisfaction: A Study of Public and Private Sector Banks	Consumer Behaviour
42	Neha Gulhar	Awarded	Effect of Organizational Culture on Job Satisfaction in I.T. Sector	Job Satisfaction
43	Samta Soni	Awarded	Service Quality and Customer Satisfaction: A Comparative Study of Public and Private Sector Banks	Consumer Behaviour
44	Amandeep Kaur	Awarded	Role of Microfinance Institutions in Promotion of Self Help Groups in Haryana	Micro Finance
45	Anupal Mongia	Awarded	Branding and Positioning Strategies of Business Schools: A Comparative Study of Public and Private Institutions in India	Brand Management
46	Arvind Kumar	Awarded	Impact of Brand Equity on Customer Relationship Management: A Study of Public Relations Industry in National Capital Region	Brand Management
47	Ashok Kumar	Awarded	Managerial Efficiency of Public Distribution System: A Comparative Study of the States of Haryana and Punjab	Management
48	Azad Singh	Awarded	Employee Attrition and Retention Strategies in Insurance Industry	Employee Retention
49	Kuldip Singh	Awarded	A Study of Indo-China Trade Relations	International Business

Department of Business Administration - Ph.D Topics & Area

Sr. No.	Name of Scholar	Awarded/Ongoing	Topic Name	Thematic Area
50	Pooja	Awarded	A Study of Talent Management Practices of Indian Service Sector	Talant Management
51	Reena Malik	Awarded	Branding and Positioning Strategies of Electronic News Media in India	Brand Management
52	Gaurav	Awarded	Impact of Television Digitization on Viewer Satisfaction and Marketers' Media Planning in India	Marketing Management
53	Parveen Kumar	Awarded	Relationship Marketing Strategies of Print vs. Online News Media	Marketing Management
54	Sushil Kumar	Awarded	Marketing of Mutual Fund Schemes: A Study with Special Reference to Retail Investors	Services Marketing
55	Deepak Kumar	Awarded	Impact of Credit Risk Management on Profitability and Liquidity of Public Sector Banks	Risk Management
56	Sarika Yadav	Awarded	Impact of Information and Communications Technology on Teaching-Learning Process in Business Schools: A Study of National Capital Region	Learning and IT
57	Sangeeta	Awarded	E-Recruitment Strategies using Social Networking Sites in India	Recruitmant and Selection
58	Rakesh Kumar	Awarded	Impact of Foreign Direct Investment on Productivity and Profitability of Private Sector Banks	FDI
59	Garima Singh	Awarded	ORGANIZATIONAL CITIZENSHIP BEHAVIOUR AND JOB PERFORMANCE: A STUDY OF EMPLOYEES IN PRIVATE SECTOR BANKS	Organizational Behaviour
60	Prashant Kumar	Awarded	Investment Behaviour of Women in Indian Stock Market	Stock Market
61	Nishant	Awarded	Microentrepreneurship through Microfinance: A Study of Haryana	Micro Finance
62	Ms. Julee	Awarded	"A Study of Combining Impact of Fundamental and Technical Analysis on Investment Decision of Investors in Indian Stock Market"	Stock Market
63	Ms. Bhavna Sharma	Awarded	"Frauds in Indian Banking: An Empirical Analysis of Select Issues"	Banking
64	Ms. Renu Bala	Awarded	"Employability Skills of Management Students: A Study of Academic and Industry Perspective"	Skills Management
65	Ms. Veena Gautam	Submitted	"Merger and Acquisitions in Indian Banking: An empirical Study of Select Issues".	Mergers and Acquisitions

Department of Business Administration - Ph.D Topics & Area

Sr. No.	Name of Scholar	Awarded/Ongoing	Topic Name	Thematic Area
66	Mr. Shri Krishan Duhan	Submitted	A Study of Buying Behaviour of E-Retail Consumbers	Consumer Behaviour
67	Mr. Surender Kumar Shilla	Ongoing	Impact of Real Estate Industry's Reforms on Retail Consumbers	Consumer Behaviour
68	TEJASWINI	Ongoing	An Empirical Study on Adoption of 'Fintech' in Haryana	Technology Acceptance Management
69	RAMNEET KAUR	Ongoing	Impact of Faculty Work Conditions and Job Satisfaction on Quality of Education: A Study of B-Schools in Haryana	Job Satisfaction and Quality
70	KAVITA	Ongoing	Rural Entrepreneurship in Haryana: An Empirical Analysis	Entrepreneurship Development
71	PREETI BHATIA	Ongoing	Retail Investors' Participation in Indian Stock Market: An Empirical Analysis	Stock Market
72	AARTI	Course Work Ongoing		
73	RAJESH	Ongoing	Impact of Corporate Governance Practices And Ownership Structure on Financial Performance : A Study of Selected Indian Companies	Corporate Governance
74	MADHU	Course Work Ongoing		
75	JATIN JAKHAR	Admitted through Course Work	Topic Pending before Dean, Facutly of Commerce & Management	
76	RENU	Course Work Ongoing		
77	SANJU	Course Work Ongoing		
78	PREETI	Course Work Ongoing		
79	MEHAK JINDAL	Course Work Ongoing		
80	Ali Mahdi Naeemah	Course Work Ongoing		
81	Ali Hasan Yaseen al khafaji	Course Work Ongoing		

	Title of paper	Name of journal	Year of publication	Link to article/paper /abstract of the article
1	Impact of FDI on the Productivity of Selected Indian Private Sector Banks	*Journal of Management Research and Analysis*	2020	http://www.jmraonline.com/uploads/121/5381_pdf.pdf
2	An Investigation of Challenges in Detecting Frauds faced by Indian Public Sector Banks	*International Journal of Mechanical and Production Engineering Research and Development*	2020	http://www.tjprc.org/publishpapers/2-67-1600152585-1129IJMPERDJUN20201129.pdf
3	Job Characteristics and Organizational Citizenship Behavior: A Study of Private Bank Employees	*International Journal of Computer Science & Management Studies (IJCSMS)- An Indexed, Referred, Peer Reviewed and Impact Factor Journal*	2019	http://www.ijcsms.com/journals/June2019(Volume40Issue03)_IJCSMSJune2019_1_8_Garima.pdf
4	Analysis of Investment Profile of Women Investors with Reference to Demographic Factors	*International Journal for Research in Engineering Application & Management (IJREAM)*	2019	http://ijream.org/papers/IJREAMV05I0856067.pdf
5	Factors Influencing the Investment Behavior of Women Investors: An Empirical Investigation	*The IUP Journal of Financial Risk Management*	2019	https://www.proquest.com/openview/7f6530c25749aa11f264e5225bb2dbc0/1.pdf?pq-origsite=gscholar&cbl=54459
6	Demographic Impact of Area on Entrepreneurial Attitude Female Student A Study	” International Journal of Engineering |Applied and Management Sciences Paradigms (IJEAM)	2019	**Offline Journal**
7	A Review Paper on the combining Impact of Fundamental and Technical Analysis on Investment Decision of Inverstors	International Journal of Engineering |Applied and Management Sciences Paradigms (IJEAM)	2019	**Offline Journal**
8	Effects of Personality Traits on Organizational Citizenship Behavior of Private Bank Employees	International Journal of Management Sciences (IJMRS’s)	2019	**Offline Journal**
9	A study of problems and challenges in widespread adoption of e-retailing	International Journal of Research in Engineering, IT and Social Sciences	2019	**Offline Journal**
10	Impact of Credit Risk on Profitability: A Study of Indian Public Sector Banks	*International Research Journal of Management and Commerce*	2018	https://1library.net/document/q2mrdo6y-impact-credit-profitability-study-indian-public-sector-banks.html
11	A Conceptual Review on Investment Behaviour of Women	*International Journal of Scientific Development and Research (IJSDR)*	2018	https://www.ijsdr.org/papers/IJSDR1809016.pdf
12	An Empirical Study of Indian Women in Public Banking Industry: Breaking the Glass Ceiling	*International Journal of Finance and Management Research*	2018	(PDF) EMPEROR INTERNATIONAL JOURNAL OF FINANCE AND MANAGEMENT RESEARCH Chief-In -Editor | ParmodSinghal - Academia.edu
13	A Study of Factors Affecting the Investors’ Decision in the Adoption of Mutual Funds	*Journal for Studies in Management and Planning*	2018	https://www.semanticscholar.org/paper/A-Study-of-Factors-Affecting-the-Investors%E2%80%99-in-the-Jangid-Bansal/c878a72b4c5c95392248ca6167504a19383fc24d
14	Impact of Institutional Credit on Income: A Study of Farmers in Haryana	*AMC INDIAN JOURNAL OF ENTREPRENEURSHIP, Indexed Quarterly*	2018	https://www.researchgate.net/publication/330560343_Impact_of_Institutional_Credit_on_Income_A_Study_of_Farmers_in_Haryana
15	Exploring Motivation-Opportunity (AMO) Perspective of High Performance Work System	*International Journal of Research in Management, Economics and Commerce*	2018	http://www.indusedu.org/pdfs/IJRMEC/IJRMEC_1635_49370.pdf
16	Exploration of High Performance Work System and Job Characteristics Theory in Indian Insurance Industry	*IJCRT*	2018	https://ijcrt.org/papers/IJCRT1801082.pdf
17	Microfinance in Haryana: Evaluation of Self Help Group-Bank Linkage Programme of NABARD in Haryana	*International Journal of Research in Management, economics and Commerce*	2018	http://indusedu.org/pdfs/IJRMEC/IJRMEC_1771_78470.pdf
18	Tax Planning Measures Adopted by Government and Non-Government Sector Employees: An Evaluation	*Emerging Trend in Social Science (A Referred, Multidisciplinary, National Journal)*	2018	Offline Journal
19	Impact of Emotional Intelligence on Job Satisfaction in Banking Sector	*International Journal of Research in Economics and Social Sciences*	2017	https://euroasiapub.org/wp-content/uploads/2017/04/4ESSFeb-4554.pdf

20	Analysis of Support Mechanism Related Barriers faced by Women Employees in IT Sector	*International Journal of Research in Economics and Social Sciences*	2017	https://euroasiapub.org/analysis-of-support-mechanism-related-barriers-faced-by-women-employees-in-it-sector/
21	Analysis of Risk of Fraud by Employees in Private Sector Banks	*International Journal of Research in Economics and Social Sciences*	2017	https://www.academia.edu/32655063/ANALYSIS_OF_RISK_OF_FRAUD_BY_EMPLOYEES_IN_PRIVATE_SECTOR_BANKS?auto=download
22	HR Problems in Talent Management	*International Journal of Science Technology and Management*	2017	http://data.conferenceworld.in/IIMTJune2017/P72-80.pdf
23	Problems of SHGs in Microfinance	*International Journal in Management and Social Science*	2017	https://www.indianjournals.com/ijor.aspx?target=ijor:ijmss&volume=5&issue=9&article=012
24	HR Viewpoint towards Talent Management Practices	*Asian Journal of Research in Business Economics and Management*	2017	https://www.indianjournals.com/ijor.aspx?target=ijor:ajrbem&volume=7&issue=9&article=015
25	A Comparative Study of Information Technology Related Problems Faced by the Customers While Availing Banking Services	*Emerging Trend in Social Science (A Referred, Multidisciplinary, National Journal)*	2017	Offline Journal
26	A study of electronic news media and its effect on marketers/advertisers in India	*International Journal of Science Technology & Management*	2017	1497103592_P209-213.pdf (ijstm.com)
27	Analyzing the Impact of Time Period on Customers' Satisfaction Level from Bancassurance Services in Banks	*Inter National Journal of Research Culture Society*	2017	http://ijrcs.org/wp-content/uploads/2017/06/201704003.pdf
28	Consumers' perception towards advertisement done by celebrities	*International Journal of Business Quantitative Economics and Applied*	2017	Offline Journal
29	Investors' Opinion Regarding the Factors Affecting the Investment Decision in Mutual Funds	*International Journal of Techno Management*	2017	https://www.ijtmr.com/docs/vol5/se17(2).pdf
30	Exploring the Influence of Mushrooming Growth of Business Schools on the Quality of Management Education in India	*International Journal of Science Technology and Management*	2017	http://www.ijstm.com/images/short_pdf/1497103645_P214-222.pdf
31	Factors Determinant Buying Behaviour of Students: In Online Context	*International Journal of Research in Management, Economics and Commerce*	2017	https://www.academia.edu/35892334/Factors_Determinant_Buying_Behaviour_of_Students_In_Online_Context
32	Exploring High Performance Work System from Relational Coordination Perspective	*International Journal of Research in Economics and Social Sciences (IJRESS)*	2017	**Offline Journal**
33	Risk of Frauds in Indian Banks in E-Banking Scenario	*Asia Pacific Journal of Research in Business*	2017	https://1library.net/document/yn04n9lq-risk-frauds-indian-banks-e-banking-scenario.html
34	Risk of Inadequate Customers' Security Practices in Indian Banks	*International Journal of Marketing and Management Research (3931*	2017	https://1library.net/document/q02evp3y-risk-inadequate-customers-security-practices-indian-banks.html
35	Monitoring and Control of Operational Risk in E-Banking,	Global Research Academy, London, UK	2017	Offline Journal
36	Talent Management Practices and Employees' Performance	*International Journal of Science Technology and Management*	2017	Offline Journal
37	A Comparative Study of Green Human Resource Management Practices adopted by Selected Public and Private Sector Banks	*Radix International Journal of Research in Economic and Business Management*	*2017*	Offline Journal
38	A Comparative Study of the Level of Job Stress among Employees of Public and Private Sector Insurance Companies	*Journal of Institute of Environment and Management*	*2017*	**Offline Journal**
39	Monitoring and Control of Operational Risk in E-Banking	*Multidisciplinary International Journal,* Global Research Academy, London, UK	*2017*	Offline Journal
40	A Comprehensive Review of Investment Behaviuor of Women investors' in Indian Stock Market	*Enlightened Voice (A Multi-disciplinary National Refereed Research Journal)*	2017	Offline Journal
41	Challenges Faced by Customers While availing Information Technology Enabled Services in Selected Public Sector and Private Sector Banks	Enlightened Voice	2017	**Offline Journal**
42	Impact on Talent Management Practices on Employees' Performance. *International Journal of Science*	*Technology and Management*	2016	http://www.ijstm.com/images/short_pdf/1472027306_252_IJSTM.pdf
43	Growth of Women Self Help Groups Under Bank-Linkage Programme in India	*International Journal of Science Technology and*	2016	http://www.ijstm.com/images/short_pdf/1472194107_259_IJSTM.pdf
44	Analysis of Risk of Breach of Security in E-Banking	*International Journal of Management and Social Sciences Research*	2016	http://financedocbox.com/Investing/84356091-Analysis-of-risk-of-breach-of-security-in-e-banking.html
45	Analysis of Liquidity Risk in E-Banking	*International Journal of Research in Economics and Social Sciences*	2016	https://euroasiapub.org/wp-content/uploads/2016/09/5ESSJuly-3908-1-2.pdf
46	Analysis of Factors Motivating Females to Join IT Sector	*Asia Pacific Journal of Research in Business*	2016	https://skirec.org/analysis-of-factors-motivating-females-to-join-information-technology-sector/

47	Risk of Hacking in E-Banking: A Study of Private Sector Banks	*International Journal of 360 Management Review*	2016	https://ij360mr.com/docs/vol4/ap16(4).pdf
48	Customers' Opinion toward Factors Affecting the PardhanMantri Jan-DhanYojana	*International Journal of Innovative Research & Development*	2016	http://www.i-scholar.in/index.php/IJIRD/article/view/142256/0
49	Bancassurance: An Empirical Study on Customer Satisfaction Towards Public and Private Sector Banks in Haryana	*Inter National Journal of Innovative Research and Studies*	2016	https://www.academia.edu/41439252/Bancassurance_An_Empirical_Study_On_Customer_Satisfaction_Towards_Public_And_Private_Sector_Banks_In_Haryana
50	Parents' Perception towards Effect of Advertisement on Children: An Observation with Unique Reference to Eatable Products	*International Journal of Knowledge and Research in Management & E-Commerce*	2016	https://www.semanticscholar.org/paper/Parents%E2%80%99-Perception-towards-Effect-of-Advertisement-Jangid-Kumar/87348785a2e99719ec5d0de1564a8b31fbd76358
51	Impact of Performance Parameters on Customers' Satisfaction Level of Bancassurance Services in Public and Private Sector Banks	*Inter National Journal for Innovative Research in Multidisciplinary Field*	2016	https://www.bartleby.com/essay/Impact-Of-Performance-Parameters-On-Customers-Satisfaction-FKABB9L2LBQW
52	Managing the Working Capital: Effectiveness and Profitability Impact	*Inter National Journal of Science Technology and Management*	2016	http://www.ijstm.com/images/short_pdf/1471851781_161ijstm.pdf
53	A study of employee attrition in Indian insurance industry	International Journal of Commerce and Management Research	2016	http://www.managejournal.com/archives/2016/vol2/issue8/2-8-18
54	PAST AND FUTURE INCEPTION OF INDIAN INSURANCE INDUSTRY	GlobalJournal of EngineeringScience andResearchManagement	2016	https://1library.net/document/y9558krz-past-and-future-inception-of-indian-insurance-industry.html
55	Consumer Protection Act, 1986: Issues and Challenges	*International Journal of Advance Research and Innovation*	2016	https://ijari.org/assets/papers/4/1/IJARI-BM-16-03-101.pdf
56	A Comparative Study of Factors Responsible for Job Stress in the Employees of Banking Sector	Enlightened Voice (A Multi Disciplinary National Research Journal, Dayanand College, Hisar)	2016	**Offline Journal**
57	A Study of Bankers' Viewpoint towards Factors Affecting the PardhanMantri Jan-DhanYojana in Selected Public Sectors Banks	*Redix International Journal of Banking , Finance and Accounting*	2016	Offline Journal
58	An Analysis of Problems faced by housing finance borrowers	Emerging Trends in Social Sciences	2016	**Offline Journal**
59	Present Operational Mechanism of Public Distribution System - A Case Study of Haryana	*IJETMAS*	2015	http://www.ijetmas.com/admin/resources/project/paper/f201511251448441071.pdf
60	Foreign Direct Investment and Its Impact on Gross Domestic Product: A Comparison of India and China	*International Journal of 360 Management Review*	2015	https://www.ij360mr.com/docs/vol3/oc15(3).pdf
61	Bankers Opinion Regarding Factors Responsible For Financial Performance of Indian Banking Sector	*International Journal of Techno-Management Research*	2015	https://www.ijtmr.com/docs/vol3/de15(1).pdf
62	Work Force Diversity: Impact of Diversity with Regard to Age in Telecom Sector in India	*International Journal of Management and Social Development*	2015	http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.669.6517&rep=rep1&type=pdf
63	Job Satisfaction among Female Teachers: A comparative study	*International Journal Of Core Engineering & Management (IJCEM)*	2015	http://ijcem.in/wp-content/uploads/2015/09/Paper-on-Female-School-teacher.pdf
64	Patients' attitude regarding government hospital: a study on general hospital sirsa	*RADIX INTERNATIONAL JOURNAL OF ECONOMICS & BUSINESS MANAGEMENT*	2015	Offline Journal
65	Impact of Foreign Direct Investment on Gross Domestic Product of India	Eclectic Explorations (A Multidisciplinary peer-reviewed University Research Journal), Volume 1	2015	Offline Journal
66	Mounting NPAs of Public and Private Sector Banks in India	Journal of KAIM	2015	Offline Journal
67	Pay for Performance as Motivation Tool: A Study of Selected Private Sector Banks	***Bi AnnualRefereedPCMAJournal of Business***	2015	Offline Journal
68	A Study on Fundamental Factors Affecting Share Prices of BSE- 200 Companies in Indian Corporate Sector	JCD Journal of Business Management and Research, JCD Institute of Business Management, Sirsa, Haryana	2015	**Offline Journal**
69	Impact of Institutional Credit on Income of Farmers (Paired Comparison of Income- Pre and Post Financial Assistance)	**Bi- Annual Refereed** Publication of Mata Gujri College, Sri Fatehgarh Sahib, *Punjab Journal of Business Studies*	2015	**Offline Journal**

70	Demographical Impact ofPay for Performance on Accountability Reinforcement: HR Issue in Selected Private Sector Banks	Punjab Journal of Social Science, an **Annual Refereed** Publication of Mata Gujri College, Sri Fatehgarh Sahib	2015	**Offline Journal**
71	A Study of Determinants of Indian Rupee Exchange Rate	**Bi- Annual Refereed** Journal of DAV Institute of Management, Faridabad, Haryana	2015	**Offline Journal**
72	Factors Affecting the Customers in Adoption of Insurance Policies with reference to Life Insurance Corporation of India	Redix International Journal of Economics & Business Management	2015	Offline Journal
73	Analysis of System Deficiencies in E-Banking	GE-International Journal of Management Research	2015	https://1library.net/document/q2mrok6y-analysis-of-system-deficiencies-in-e-banking.html
74	Customer Satisfaction Regarding Home Loans- A Comparative Study of ICICI Bank and SBI Bank	International Journal of Information Technology and Knowledge Management	2009	
75	Growth of Tax Revenue in India	International Journal of Information Technology and Knowledge Management	2009	
76	Quality of Work Life in Professional Institutions- A Study of Colleges in JCD Vidyapeeth Sirsa	Global Education Society and Development : An International Journal of Academicians	2010	
77	A Study of Factors Influencing Purchase Decision For Cell Phones	International e-Journal of Research in Computer Application and Management	2011	
78	Critical Factors and Its Impact on Demographic Variables to Maintain Work-Life Balance in Corporate Environment	Asia Pacific Journal of Research in Business Management	2011	
79	Attitude of People Towards Cell Phones and their Awareness Regarding Recent Launches	Global Education Society and Development: An International Journal of Academicians	2011	
80	Flexible Working Duration- A Tool for Work Life Balance: A Case Study About Selected Companies in Haryana	International Journal of Management and Science	2011	
81	A Study of Strategic HR Issues in Indian Banking Sector	International Journal of Engineering Sciences and Management	2011	
82	Relevance of Level of Management in Strategic Decision Making- A Study of Selected Banking and Insurance Companies in Haryana	International Journal of Engineering Sciences and Management	2011	
83	Difference in Gender Attitude in Investment Decision Making in India	International Journal of Research Journal of Finance and Accounting	2011	
84	A Study of Financial Assessment of Selected Banks in India	International Journal of Research in Finance and Marketing	2012	
85	Analytical Framework of the Factors Affecting Customer Satisfaction through E- Banking	Analytical Framework of the Factors Affecting Customer Satisfaction through E-Banking	2013	
86	India as Emerging Global Knowledge Economy by 2020	International Journal of Business Management and Research	2013	
87	Brand Awareness of Ready Made Garments: a Comparative Study of Males and Females	International Journal of Management, IT and Engineering	2013	
88	Consumers' Attitude Towards Online Shopping	ACADEMICIA: An International Multidisciplinary Research Journal	2014	
89	An Empirical Analysis of Financial Structure of State Bank of India	International Journal of Research in Management Science and Technology	2014	
90	Workforce Diversity: Impact of Diversity with Regard to Age in IT Sector in India	International Journal of Management: GGGI Management Review	2014	
91	Employees Aspiration Regarding Pay for Performance Practices: A Study of Selected Private Sector Banks in Haryana	International Journal of Management: GGGI Management Review	2014	
92	Impact of Students' Demographics on their Level of Satisfaction from Quality Education in Private Management Institutes in Haryana	International Journal of Business Management and Social Sciences Research	2014	

93	Investigating the Level of Association Between Corruption Perception Index and Development Indicators	International Journal of Research and Development in Technology and Management Science	2014
94	Workforce Diversity: Impact of Diversity with Regard to Gender in IT Sector in India	International Journal of Engineering and Management	2014
95	Mutual Fund Performance Evaluation: A Benchmark Comparison	International Journal of Multidisciplinary Consortium	2014
96	Workforce Diversity: Impact of Diversity with Regard to Gender in Telecom Sector in India	International Journal of Research in Management, Science and Technology	2014
97	A Working Note on the Fundamental Factors Affecting Share Prices of BSE- 200 Companies in Indian Corporate Sector	International Journal of Research in Management, Science and Technology	2014
98	Work Force Diversity: Impact of Diversity with Regard to Age in IT Sector in India	International Journal of Management: GGGI Management Review	2014

3.4.6 Number of books and chapters in edited volumes published per teacher during the last five years (15)

3.4.6.1: Total number of books and chapters in edited volumes / books published, and papers in national/international conference-proceedings year wise during the last five year

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Year of publication	ISBN/ISSN number of the proceeding	Name of the publisher
1	Dr. Rajneesh Ahlawat and Dr. Gaurav Jangra	Fundamentals of Marketing Management	---	2021	979-8639737008	Amazon Kindle International Publication
2	Gaur Dr. Arti	Paradigms of Multidisciplinary Research	A Study of New Technologies in the Banking sector	2019	978-93-84871-15-4	DBH Publishers and Distributors New Delhi
3	Gaur Dr. Arti	Paradigms of Multidisciplinary Research	Impact of LPG on Indian Economy	2019	978-93-84871-15-4	DBH Publishers and Distributors New Delhi
4	Gaur Dr. Arti	Management winning in a VUCA Word	Services Provided to Customers by Banks: A Comparative Study	2019	9-789388-237864	Excel India Publishers New Delhi
5	Gaur, Arti , Kaushal Neelam and Goyal Priyanka	Strategic Competency Mapping for Talent Management and Retention	Demographical Impact of Pay for Performacne on Accountability Reinforcement: A Tool for Employee Retention	2018	978-93-86608-21-5	Bharti Publications, New Delhi,
6	Gaur, Arti, Arora Nancy	Assemblage - An Anthology of Business and Management Research	Bancassurance: A Comparative Study of Customers' Satisfaction Level in Public and Private Sector Banks	2018	978-93-85504-66-2	Haryana School of Business GJUS&T Hisar,
7	Gaur, Arti,	A 360 ° Exploration of New Paradigms & Innovations in Research	India's Foreign Trade Basket (An Analytical Study of Commodity Composition	2018	978-93-84871-13-0	Published by DBH Publishers and Distributors New Delhi,
8	Gaur, Arti ,Arora, Nancy and Ritu	Economics of Information Technology: Emerging Trends and Prospects	A Study of the Perceptions and Awareness of Consumer Towards Online Shopping	2016	978-93-81771-41-9	Savera Publishing House, New Delhi
9	Gaur, Arti, Singla, Khushbu and Arora Nancy	Innovations and Global Human Resource Management Practices by 2050	Hiring Practices in Indian and Multinational Companies: An Analytical Framework	2016	978-93-86176-19-6	Bonfring, Tamil Nadu
10	Gaur, Arti and Sukhija, Sunita	Discovering New Horizons in Business, Management and Economics	Inter Industry Analysis of Fundamental Factors of BSE Stock Prices in India	2015	978-93-83905-84-3	Raj Publication
11	Gaur, Arti and Sukhija, Sunita	Effect of the Fundamental Factors on Stock Prices of BSE- 200 Companies: A Comparative Study of Normal and Recession Period		2015	978-93-84443-22-1	Research India Publications, New Delhi
12	Gaur Dr. Arti	Agricultural Credit: A Boon To The Farmers		2017	978-93-85046-06-3	Studium Press (India) Pvt. Ltd, New Delhi
13	Gaur, Arti and Khokhar, Julee	UGC NET/JRF/SLET MANAGEMENT (The objective way)			978-93-85958-70-0	Educational Publishers and Importer, New Delhi
14	Gaur, Arti and Kaushal, Neelam	Pay for Performance Practices in Banking Sector, (Performance Pay Framework		2018	978-613-9-58337-9	LAMBERT Academic Publishing, New Delhi
15	Gaur, Arti and Khatkar, Shilpa	Contemporary Researches in Business Management	Role of Institutional Credit in Agriculture Development in India	2009	978-93-80097-14-5	Vayu Education of India, New Delhi

Thurst Area

16	Gaur, Arti, Ghlawat, Suman and Azad, Meenakshi	Enhancing Organizational Growth Through Innovation and Creativity: Issues, Opportunities and Challenges	Role of Hierarchy in Organization for Competitive Advantage to Achieve Work-Life Balance in Corporate Environment	2011	978-93-81361-02-3	Excel India Publishers New Delhi
17	Gaur Arti and Ghlawat, Suman	Business Management- Key Research Issues	Impact of Experience in Maintaining Work Life Balance: A Study of Selected Companies in Haryana	2012	978-93-5062-001-4	Excel India Publishers New Delhi
18	Gaur Arti, Sukhija Sunita and Julee	Business Management- Key Research Issues	Overall Profitability Measurement of Major Private Banks in India	2012	978-93-5062-001-4	Excel India Publishers New Delhi
19	Gaur, Arti, Neelam and Kumar, Rajesh	Emerging Paradigms in Business Ethics	The Talent Supply Chain Management of Ageing Workforce: Ethical Implications for HRM Practitioners	2012	978-81-921391-9-7	Mata Gujri College affiliated to Punjabi University, Patiala
20	Gaur Arti, Sukhija Sunita and Ghalawat, Suman	Contemporary Issues in Service Marketing – Challenges for 21st Century	A Study on Customer Satisfaction Regarding Services Provided by Cellular Service Providers	2012	978-81-89630447	Global Research Publications, New Delhi
21	Gaur, Arti, Sukhija, Sunita, Ghalawat Suman and Julee	Innovation and Sustainability: Managing for Change	Evaluation of Financial Performance of Selected Private Banks in India	2012	978-81-924342-1-6	Global Alliance Publishers, Ghaziabad
22	Gaur, Arti and Rajesh	Changing Dynamics in the Global Village – 2013	Managing Multicultural Workforce : Challenges and Adjustments	2013	978-93-8256359-4	Bloomsbury Publishing India Private Limited, New Delhi
23	Gaur, Arti and Sunita Sukhija	Foreign Direct Investment in Retail Trade – Opportunities and Challenges	A Study on FDI Trends in Retail Sector in India	2013	978-93-806860-6-6	Shanlax Publications, Madurai, Tamil Nadu
24	Gaur, Arti and Sunita Sukhija	Researches in Business and Management(Academic and Professional Perspective)	A Study on Economic Putrefaction of Selected High-flying Banks in India	2013	978-93-81505-54-0	Wisdom Publications, Delhi
25	Gaur, Arti, Singla, Khushbu and Satyawan	Micro Finance and Micro Entrepreneurship	Microfinance Through SHG- Bank Linkage Programme in India: An Appraisal of Growth Journey of Two Decades in India	2013	978-93-81604-78-6	Vista International Publishing House, Delhi
26	Gaur, Arti and Rajesh	Private or Public: A Catalyst for Social and Economic Revolution	Impact of Privatization on Financial Performance	2013	978-93-83083-03	Excellent Publishing House, New Delhi
27	Gaur, Arti, Singla, Khushbu and Mittal, Nitesh	Women Entrepreneurship , Empowerment and Development	Empowering Women Through SHG-Bank Linkage Programme	2014	978-93-83842-23-0	Excel India Publishers New Delhi
28	Gaur, Arti, Arora, Nancy and Bhardwaj, Deepak	Coping with Uncertainty	Corporate Social Responsibility : An Indian Perspective	2014	978-93259-7838-6	Vikas Publishing House Ltd., New Delhi
29	Gaur, Arti, Singla, Khushbu and Bhagwan, Vishnu	Researches in Commerce and Management- A Deep Insight	A Comparative Analysis of Two Decades of SHG- Bank Linkage Programme in India	2014	978-81-8387-677-3	Serials Publications Pvt Ltd., New Delhi
30	Gaur, Arti, Singla, Khushbu and Arora Nancy	International Financial Reporting Standards on Current Indian Scenario	Adopting IFRS to Promote Efective Business Management Practices	2014	978-93-82339-67-0	Anuradha Prakashan, New Delhi
31	Kumar Rajesh, Gaur Dr. Arti	Emerging Dimensions of Human Resource management	Work Force Diversity : Impact of Diversity with Regard to Physical Disability in Telecom Sector in India	2014	978-93-84144-98-2	RIP Research India Publication, New Delhi

Name of the author/s	Name of journal	Year of publication	ISSN number	article/paper /abstract of	Key word
Bangar, S. P., Siroha, A. K., Nehra, M., Trif, M., Ganwal, V., & Kumar, S.	Coatings	2021	2079-6412	Coatings | Free Full-Text | Structural and Film-Forming Properties of Millet Starches: A Comparative Study (mdpi.com)	Millet
Bangar, S.P., Nehra, M., Siroha, A. K., Petrů, M., Ilyas, R. A., Devi, U., & Devi, P.	Foods	2021	2304-8158	Foods | Free Full-Text | Development and Characterization of Physical Modified Pearl Millet Starch-Based Films (mdpi.com)	Millet
Siroha, A. K., Bangar, S. P., Sandhu, K. S., Trif, M., Kumar, M., & Guleria, P.	Coatings	2021	2079-6412	Coatings | Free Full-Text | Effect of Cross-Linking Modification on Structural and Film-Forming Characteristics of Pearl Millet (Pennisetum glaucum L.) Starch (mdpi.com)	Millet
Nehra, M., Siroha, A. K., Punia, S., & Kumar, S.	Current Research in Nutrition and Food Science Journal	2021	2347-467X	Process Standardization for Bread Preparation using Composite Blend of Wheat and Pearl Millet: Nutritional, Antioxidant and Sensory Approach (foodandnutritionjournal.org)	Wheat

Punia, S., Kumar, M., Siroha, A. K., & Purewal, S. S.	Rice Science	2021	1672-6308	Rice Bran Oil: Emerging Trends in Extraction, Health Benefit, and Its Industrial Application | Elsevier Enhanced Reader	Rice
Sandhu, K. S., Siroha, A. K., Punia, S., Sangwan, L., Nehra, M., & Purewal, S. S.	*Carbohydrate Polymer Technologies and Applications*	2021	2666-8939	Elsevier Enhanced Reader	Sorghum
Bangar, S. P., Sandhu, K. S., Purewal, S. S., Kaur, M., Kaur, P., Siroha, A. K., ... & Kumar, M	*Journal of Food Processing and Preservation*	2021	1745-4549	Fermented barley bran: An improvement in phenolic compounds and antioxidant properties - Bangar - - Journal of Food Processing and Preservation - Wiley Online Library	barley
Punia, S., Sandhu, K. S., Grasso, S., Purewal, S. S., Kaur, M., Siroha, A. K., ... & Kumar, M.	*Foods*	2021	2304-8158	Foods | Free Full-Text | Aspergillus oryzae Fermented Rice Bran: A Byproduct with Enhanced Bioactive Compounds and Antioxidant Potential (mdpi.com)	rice bran
Sanju Bala Dhull, Mohd. Kashif Kidwai, Rashed Noor, Prince Chawla, Pawan Kumar Rose	Legume Science	2021	2639-6181	A review of nutritional profile and processing of faba bean (Vicia faba L.) (wiley.com)	faba bean
Sneh Punia Bangar, Adeleke Omodunbi Ashogbon, Sanju Bala Dhull, Rohit Thirumdas, Manoj Kumar, Muzaffar Hasan, Vandana Chaudhary, Srilatha Pathem	International Journal of Biological Macromolecules	2021	0141-8130	Proso-millet starch: Properties, functionality, and applications - ScienceDirect	Proso-millet

Sanju Bala Dhull, Tanu Malik, Ramandeep Kaur, Pradyuman Kumar, Naveet Kaushal, and Ajay Singh	Starch-Stärke	2021	1521-379X	Banana Starch: Properties Illustration and Food Applications—A Review (wiley.com)	Banana Starch
Tanu Malik, Ruchi Sharma, Paramjit SinghPanesar, Rakesh Gehlot, Ozlem Tokusoglu, Sanju Bala Dhull, Halil Vural, Ajay Singh	*Journal of Food Processing and Preservation*	2021	1745-4549	Nutmeg nutraceutical constituents: In vitro and in vivo pharmacological potential - Malik - - Journal of Food Processing and Preservation - Wiley Online Library	nutraceutica
Sneh Punia, Manoj Kumar, Anil Kumar Siroha, John F. Kennedy, Sanju Bala Dhull, William Scott Whiteside	Carbohydrate Polymers	2021	0144-8617	Pearl millet grain as an emerging source of starch: A review on its structure, physicochemical properties, functionalization, and industrial applications - ScienceDirect	Pearl millet
Navkiranjeet Kaur, Aarti Bains, Ravinder Kaushik, Sanju B. Dhull, Fogarasi Melinda, and Prince Chawla	*Nutrients*	2021	2072-6643	Nutrients | Free Full-Text | A Review on Antifungal Efficiency of Plant Extracts Entrenched Polysaccharide-Based Nanohydrogels (mdpi.com)	nanohydrogels
Mansuri M. Tosif, Agnieszka Najda, Aarti Bains, Ravinder Kaushik, Sanju Bala Dhull, Prince Chawla, and Magdalena Walasek-Janusz	*Polymers*	2021	2073-4360	Polymers | Free Full-Text | A Comprehensive Review on Plant-Derived Mucilage: Characterization, Functional Properties, Applications, and Its Utilization for Nanocarrier Fabrication (mdpi.com)	mucilage
Anchal Jandu, Anju Malik, & Sanju Bala Dhull	*Environmental Geochemistry and Health*	2021	0269-4042	Fluoride and nitrate in groundwater of rural habitations of semiarid region of northern Rajasthan, India: a hydrogeochemical, multivariate statistical, and human health risk assessment perspective (springer.com)	groundwater

Rekha Rani, Summaiya Tasmeem, Anju Malik, Vinod Kumar Garg, Lakhvinder Singh & Sanju Bala Dhull	*Toxin Reviews*	2021	1556-9543	Optimization of Swiss blue dye removal by cotton boll activated carbon: response surface methodological approach: Toxin Reviews: Vol 0, No 0 (tandfonline.com)	cotton
Vinita Sharma, Maninder Kaur, Kawaljit Singh Sandhu, Shamandeep Kaur and Manju Nehra	Carbohydrate Polymer Technologies and Applications	2021	2666-8939	Barnyard millet starch cross-linked at varying levels by sodium trimetaphosphate (STMP): Film forming, physico-chemical, pasting and thermal properties - ScienceDirect	Barnyard millet
Brij Lal Karwasra, Maninder Kaur, Kawaljit Singh Sandhu, Anil Kumar Siroha and Balmeet Singh Gill	*Journal of Food Processing and Preservation*	2021	1745-4549	Formulation and evaluation of a supplementary food (Panjiri) using wheat and flaxseed flour composites: Micronutrients, antioxidants, and heavy metals content (wiley.com)	supplementary food
Brij Lal Karwasra, Maninder Kaur, Balmeet Singh Gill	*International Journal of Biological Macromolecules*	2020	0141-8130	Impact of ultrasonication on functional and structural properties of Indian wheat (Triticum aestivum L.) cultivar starches - PubMed (nih.gov)	ultrasonication
Ishita Sharma, ArchanaSinhmar, Rahul Thory, Kawaljit Singh Sandhu, ManinderKaur, Vikash Nain, Ashok Kumar Pathera, PrafullChavan	Journal of Food Science and Technology	2021	0022-1155	Synthesis and characterization of nano starch-based composite films from kidney bean (Phaseolus vulgaris) | SpringerLink	nano starch

PrafullChavan, ArchanaSinhmar, ManjuNehra, Rahul Thory, Ashok Kumar Pathera, Antony AllwynSundarraj, Vikash Nain	Food Chemistry	2021	0308-8146	Impact on various properties of native starch after synthesis of starch nanoparticles: A review - ScienceDirect	starch nano parties
Vinita Sharma, ManinderKaur, Kawaljit Singh Sandhu, Vikash Nain, SandeepJanghu	Starch-Stärke	2021	1521-379X	Physicochemical and Rheological Properties of Cross-Linked Litchi Kernel Starch and Its Application in Development of Bio-Films | Scinapse	Litchi
HarleenGujral, ArchanaSinhmar, ManjuNehra, Vikash Nain, Rahul Thory, Ashok Kumar Pathera, PrafullChavan	International journal of biological macromolecules	2021	0141-8130	Synthesis, characterization, and utilization of potato starch nanoparticles as a filler in nanocomposite films - ScienceDirect	potato starch
Anil Panghal , Anjali OnakkaramadomShaji, , Kiran Nain, Mukesh Kumar Garg , Navnidhi Chhikara	Bioactive Compounds in Health and Disease (BCHD)	2021	2574-0334	https://ffhdj.com/index.php/BioactiveCompounds/article/view/865	scolusaonitifolins
Kumar, M., Potkule, J., Tomar, M., Punia, S., Singh, S., Patil, S., ... & Kennedy, J. F.	*Carbohydrate Polymer Technologies and Applications*	2021	2666-8939	Jackfruit seed slimy sheath, a novel source of pectin: Studies on antioxidant activity, functional group, and structural morphology | Elsevier Enhanced Reader	Jackfruit fruitsseed
Kumar, M., Tomar, M., Punia, S., Grasso, S., Arrutia, F., Choudhary, J., ... & Amarowicz, R.	*Trends in Food Science &*	2021	0924-2244	Cottonseed: A sustainable contributor to global protein requirements - ScienceDirect	Cottonseed

	Technology.				
Kumar, M., Dahuja, A., Tiwari, S., Punia, S., Tak, Y., Amarowicz, R., ... & Kaur, C	*Food Chemistry*	2021	0308-8146	Recent trends in extraction of plant bioactives using green technologies: A review - ScienceDirect	bioactives compound
Sandhu, K. S., Kaur, M., Punia, S., & Ahmed, J.	*International Journal of Biological Macromolecules*	2021	0141-8130	Rheological, thermal, and structural properties of high-pressure treated Litchi (Litchi chinensis) kernel starch - ScienceDirect	Litchi chinensis
Punia, S., Kumar, M., Sandhu, K. S., & Whiteside, W. S.	*Journal of Food Processing and Preservation*	2021	1745-4549	Rice-bran oil: An emerging source of functional oil - Punia - 2021 - Journal of Food Processing and Preservation - Wiley Online Library	Rice-bran oil:
Kumar, M., Tomar, M., Potkule, J., Verma, R., Punia, S., Mahapatra, A., ... & Kennedy, J. F.	*Food Hydrocolloids*	2021	0268-005X	Advances in the plant protein extraction: Mechanism and recommendations - ScienceDirect	protein extraction
Punia, S., & Kumar, M.	*Trends in Food Science & Technology*	2021	0924-2244	Litchi (Litchi chinenis) seed: Nutritional profile, bioactivities, and its industrial applications - ScienceDirect	Litchi seed

Kumar, M., Potkule, J., Patil, S., Saxena, S., Patil, P. G., Mageshwaran, V., ... & Kennedy, J. F.	*LWT-Food Science and Technology*	2021	0023-6438	Extraction of ultra-low gossypol protein from cottonseed: Characterization based on antioxidant activity, structural morphology and functional group analysis - ScienceDirect	gossypol protein
Kripa Roy, Rahul Thory, ArchanaSinhmar, Ashok Kumar Pathera, Vikash Nain	International Journal of Biological Macromolecules	-2020	0141-8130	Development and characterization of nano starch-based composite films from mung bean (Vigna radiata) - ScienceDirect	mung bean
Vikash Nain,ManinderKaur, Kawaljit Singh Sandhu, Rahul Thory, and ArchanaSinhmar	International Journal of Biological Macromolecules	-2020	0141-8130	(14) Development, characterization, and biocompatibility of zinc oxide coupled starch nanocomposites from different botanical sources | Request PDF (researchgate.net)	starch nanocomposites
Punia, S., Dhull, S.B., Sandhu, K.S., Kaur, M., Siroha, A. K.	Journal of Food Science and Technology	2020	0022-1155	Kinetic, rheological and thermal studies of flaxseed (Linum usitatissiumum L.) oil and its utilization,Journal of Food Science and Technology - X-MOL (x-mol.com)	flaxseed
Punia, S., Sandhu, K. S., Dhull, S. B., Siroha, A. K.,Purewal, S. S., Kaur, M., &Kidwai, M. K.	International Journal of Biological Macromolecules	2020	0141-8130	Oat starch: Physico-chemical, morphological, rheological characteristics and its applications - A review - ScienceDirect	oat starch

Siroha, A. K.,Punia, S., Kaur, M., &Sandhu, K. S.	International Journal of Biological Macromolecules	2020	0141-8130	A novel starch from Pongamia pinnata seeds: Comparison of its thermal, morphological and rheological behaviour with starches from other botanical sources - ScienceDirect	pongamia pinnata seeds
Siroha, A. K., Punía, S., Sandhu, K. S., &Karwasra, B. L.	ActaAlimentaria	2020	1393006	Physicochemical, pasting, and rheological properties of pearl millet starches from different cultivars and their relations in: Acta Alimentaria Volume 49 Issue 1 (2020) (akjournals.com)	Pearl millet
Sandhu, K. S., Siroha, A. K., Punia, S., & Nehra, M.	*Carbohydrate Polymer Technologies and Applications*	2020	2666-8939	Elsevier Enhanced Reader	Pearl millet
Sharma, V., Kaur, M., Sandhu, K. S., & Godara, S. K.	*International journal of biological macromolecules*	2020	0141-8130	Effect of cross-linking on physico-chemical, thermal, pasting, in vitro digestibility and film forming properties of Faba bean (Vicia faba L.) starch - ScienceDirect	Faba bean
Sandhu, K. S., Sharma, L., Kaur, M., & Kaur, R.	*International journal of biological macromolecules*	2020	0141-8130	Physical, structural and thermal properties of composite edible films prepared from pearl millet starch and carrageenan gum: Process optimization using response surface methodology - ScienceDirect	carrageenan gum

SanjuBalaDhull, Kawaljit Singh Sandhu, SnehPunia, ManinderKaur,Prince Chawla, Anju Malik	International Journal of Biological Macromolecules	2020	0141-8130	Functional, thermal and rheological behavior of fenugreek (Trigonella foenum–graecum L.) gums from different cultivars: A comparative study - ScienceDirect	fenugreek
AanchalAgarwal, Ashok K. Pathera, RavinderKaushik, Naveen Kumar,SanjuBalaDhull, SumitArora, Prince Chawla	Trends in Food Science and Technology	2020	0924-2244	Succinylation of milk proteins: Influence on micronutrient binding and functional indices - ScienceDirect	Milk
Prince Chawla, Naveen Kumar, AartiBains, SanjuBalaDhull, Mukul Kumar, RavinderKaushik, SnehPunia	International Journal of Biological Macromolecules	2020	0141-8130	Gum arabic capped copper nanoparticles: Synthesis, characterization, and applications - ScienceDirect	gam orabic
SanjuBalaDhull, ManinderKaur, Kawaljit Singh Sandhu	Journal of Food Science and Technology	2020	0022-1155	Antioxidant characterization and in vitro DNA damage protection potential of some Indian fenugreek (Trigonella foenum - graecum) cultivars: effect of solvents | SpringerLink	fenugreek
SanjuBalaDhull, SnehPunia, Mohd. KashifKidwai,ManinderKaur, Prince Chawla, Sukhvinder Singh Purewal, Monika Sangwan, and SunitaPalthania	Legume Science	2020	2639-6181	Solid-state fermentation of lentil (Lens culinaris L.) with Aspergillus awamori: Effect on phenolic compounds, mineral content, and their bioavailability - Dhull - 2020 - Legume Science - Wiley Online Library	lentils

SnehPunia, SanjuBalaDhull, Kawaljit Singh Sandhu, ManinderKaur, Sukhvinder Singh Purewal	Legume Science	2020	2639-6181	Kidney bean (Phaseolus vulgaris) starch: A review - Punia - 2020 - Legume Science - Wiley Online Library	Kidney bean
Sanju Bala Dhull, Sneh Punia, Manoj Kumar, Shivdeep Singh, & Parhlad Singh	*Starch-Stärke*	2020	1521-379X	Effect of Different Modifications (Physical and Chemical) on Morphological, Pasting, and Rheological Properties of Black Rice (Oryza sativa L. Indica) Starch: A Comparative Study (wiley.com)	black rice
Sneh Punia, Sanju Bala Dhull, Prince Kunner, Shashi Rohilla	International Journal of Biological Macromolecules	2020	0141-8130	Effect of γ-radiation on physico-chemical, morphological and thermal characteristics of lotus seed (Nelumbo nucifera) starch - ScienceDirect	Lotus seed starch
Lovepreet Kaur, Sanju Bala Dhull, Pradyuman Kumar, Ajay Singh	International Journal of Biological Macromolecules	2020	0141-8130	Banana starch: Properties, description, and modified variations - A review - ScienceDirect	Banana Starch
Deepika Singla, Ajay Singh, Sanju Bala Dhull, Pradyuman Kumar, Tanu Malik, Pankaj Kumar	International Journal of Biological Macromolecules	2020	0141-8130	Taro starch: Isolation, morphology, modification and novel applications concern - A review - ScienceDirect	Taro starch
Sneh Punia, Sanju Bala Dhull, Anil Kumar Siroha, & Manoj Kumar	*Journal of Food Processing and*	2020	1745-4549	Effect of shortening substitution with olive (Olea europaea) oil on textural properties, sensorial characteristics, and fatty acid composition of muffins - Punia - 2020 - Journal	olive Oil

	Preservation			of Food Processing and Preservation - Wiley Online Library	
Manju V Nehra, Vikash Nain BrijLalKarwasra	International Journal of Research and Analytical Reviews	2020	2348-1269	(14) Fruit industry waste: Raw material for antioxidant extraction | Request PDF (researchgate.net)	Fruits
SanjuBalaDhull, SnehPunia, Rajesh Kumar, Manoj Kumar KiranBala Nain, KanchanJangraChanchalChudamani	Journal of Food Science and Technology (JFST)	2020	0022-1155	https://link.springer.com/article/10.1007/s13197-020-04704-y	fenugreek
Kumar, M., Tomar, M., Punia, S., Amarowicz, R., & Kaur, C.	*Plant Foods for Human Nutrition*	2020	1573-9104	https://link.springer.com/content/pdf/10.1007/s11130-020-00859-3.pdf	punica granatum
Kumar, M., Tomar, M., Saurabh, V., Mahajan, T., Punia, S., del Mar Contreras, M., ... & Kennedy, J. F	*Trends in Food Science & Technology*	2020		Emerging trends in pectin extraction and its anti-microbial functionalization using natural bioactives for application in food packaging - ScienceDirect	Peetin
Nair, M. S., Tomar, M., Punia, S., Kukula-Koch, W., & Kumar, M.	*International Journal of Biological*	2020	0141-8130	Enhancing the functionality of chitosan- and alginate-based active edible coatings/films for the preservation of fruits and vegetables: A review - ScienceDirect	edible Coating

	Macromol ecules.				
Punia, S., Sandhu, K. S., & Kaur, M.	*Journal of Food Science and Technolog y*	2020		Quantification of phenolic acids and antioxidant potential of wheat rusks as influenced by partial replacement with barley flour (springer.com)	wheat
Punia, S.	*Internation al journal of biological macromole cules*	2020	0141-8130	Barley starch modifications: Physical, chemical and enzymatic - A review - ScienceDirect	Barley
ChandniDularia, ArchanaSinhmar, Rahul Thory, Ashok Kumar Pathera, and VikashNain	Internation al Journal of Biological Macromol ecules	-2019	0141-8130	Development of starch nanoparticles based composite films from non-conventional source - Water chestnut (Trapa bispinosa) - PubMed (nih.gov)	water chestnut
Punia, S., Sandhu, K. S., Siroha, A. K., &Dhull, S. B.	Pharma Nutrition	2019	2213-4344	Omega 3-metabolism, absorption, bioavailability and health benefits–A review - ScienceDirect	Omega-3 fortty acids
Siroha, A. K., Sandhu, K. S., Kaur, M., &Kaur, V.	Internation al Journal of Biological Macromol ecules	2019	0141-8130	Physicochemical, rheological, morphological and in vitro digestibility properties of pearl millet starch modified at varying levels of acetylation - ScienceDirect	Pearl millet

Punia, S., Siroha, A. K., Sandhu, K. S., &Kaur, M.	International Journal of Biological Macromolecules	2019	0141-8130	Rheological behavior of wheat starch and barley resistant starch (type IV) blends and their starch noodles making potential - ScienceDirect	Wheat
Siroha, A. K.,Sandhu, K. S., &Punia, S.	Quality Assurance and Safety of Crops & Foods	2019	1757-8361	Impact of octenyl succinic anhydride on rheological properties of sorghum starch | Quality Assurance and Safety of Crops & Foods (wageningenacademic.com)	Sorghum
Punia, S., Siroha, A. K., Sandhu, K. S., &Kaur, M.	International Journal of Biological Macromolecules	2019	0141-8130	Rheological and pasting behavior of OSA modified mungbean starches and its utilization in cake formulation as fat replacer - ScienceDirect	mungbean
Punia, S., Sandhu, K. S., &Siroha, A. K.	Journal of the Saudi Society of Agricultural Sciences	2019	1658-077X	Difference in protein content of wheat (Triticum aestivum L.): Effect on functional, pasting, color and antioxidant properties - ScienceDirect	Wheat
SnehPunia, &SanjuBalaDhull	International journal of biological macromolecules	2019	0141-8130	Chia seed (Salvia hispanica L.) mucilage (a heteropolysaccharide): Functional, thermal, rheological behaviour and its utilization - ScienceDirect	chia seeds
SnehPunia, Kawaljit Singh Sandhu, SanjuBalaDhull, &ManinderKaur	International Journal of Biological	2019	0141-8130	Dynamic, shear and pasting behaviour of native and octenyl succinic anhydride (OSA) modified wheat starch and their utilization in preparation of edible films - ScienceDirect	Wheat

	Macromolecules				
Prince Chawla, Naveen Kumar, RavinderKaushik, SanjuBalaDhull	Journal of Food Science and Technology	2019	0022-1155	Synthesis, characterization and cellular mineral absorption of nanoemulsions of Rhododendron arboreum flower extracts stabilized with gum arabic | SpringerLink	gum arbic
SanjuBalaDhull, SnehPunia, Kawaljit Singh Sandhu, Prince Chawla, RamandeepKaur, & Ajay Singh	Legume Science	2019	2639-6181	Effect of debittered fenugreek (Trigonella foenum-graecum L.) flour addition on physical, nutritional, antioxidant, and sensory properties of wheat flour rusk - Dhull - 2020 - Legume Science - Wiley Online Library	fenugreek
SnehPunia, SanjuBalaDhull, Kawaljit Singh Sandhu, &ManinderKaur	Legume Science	2019	2639-6181	Faba bean (Vicia faba) starch: Structure, properties, and in vitro digestibility—A review - Punia - 2019 - Legume Science - Wiley Online Library	Faba bean
Manju V. Nehra and Amanjyoti	Journal of Agriculture Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct201904103911%20%20%20%20%20Manju%20V%20Nehra%204%20%20%20%20%20%20%20%20%20%2013-16.pdf	water chestnut
Amanjyoti and Manju V. Nehra	Journal of Agriculture Engineering and Food	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct201905103236%20%20%20%20%20%20%20%20Amanjyoti%20%20%20%20%20%2034-38.pdf	algae

	Technology				
Manju V. Nehra and Amanjyoti	Journal of Agriculture Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct201905103818%20%20%20%20%20%20%20Manju%20V%20%20Nehra%20%20%20%20%20%20%20%20%20%20%20%20%20%20106-109.pdf	Biscuits
Manju V. Nehra and Amanjyoti	Journal of Agro ecology and Natural Resource Management	2019	2394-0794	Microsoft Word - 14 Manju V Nehra 2 64-(krishisanskriti.org)	black rice
ManjuNehra	Journal of Basic and Applied Engineering Research	2019	2350-0255	Microsoft Word - zd08 Manju Nehra 4 277-(krishisanskriti.org)	potato
Manju V. Nehra and Amanjyoti	Journal of Agricultural Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct2019051010zzza%2005%20%20Manju%20Nehra%202%20%20%20%20%20%20%20%20215-217.pdf	Pomegranate

Manju V. Nehra and Amanjyoti	Journal of Agricultural Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct2019051030zzzb06%20%20%20%20%20Manju%20Nehra%20%20%20%20%20%20218-220.pdf	fat
ManjuNehra and Amanjyoti	Journal of Agricultural Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct2019051049zzzc07%20%20%20%20%20%20Manju%20Nehra%203%20%20%20%20%20%20%20%20221-223.pdf	antioxidants
Manju V Nehra and Amanjyoti	Journal of Agricultural Engineering and Food Technology	2019	2350-0263	http://www.krishisanskriti.org/vol_image/25Oct201904105815%20%20%20%20%20%20%20%20Manju%20V%20%20Nehra%203%20%20%20%20%20%20%20%20%20%20%20%20%20%2017-20.pdf	oats
ManjuNehra, Amanjyoti, M.Goyal	Advances in applied research	2019	2349-2104	Nutrient composition and sensory evaluation of fried (pan fried) and microwaved (baked) rice chips from three rice cultivars-Indian Journals	rice
Manju V. Nehra, and Amanjyoti	Advances in applied Research	2019	2349-2104	Preparation and analysis of sensory attributes of cucumber-tomato sauce-Indian Journals	Cucumber
Punia, S.	*International journal of biological*	2019	0141-8130	Barley starch: Structure, properties and in vitro digestibility - A review - ScienceDirect	barley

	macromolecules				
Kaur, M., Punia, S., Sandhu, K. S., & Ahmed, J.	*International journal of biological macromolecules*,	2019	0141-8130	Impact of high pressure processing on the rheological, thermal and morphological characteristics of mango kernel starch - ScienceDirect	mango
Vikash Nain and Kawaljit Singh Sandhu	*International Journal of Pharma and Bio Sciences*	2018	0975-6299	IJPBS Article- Rheological Characterization of Starch Nanoparticles from Different Botanical Sources	Nano Particals
Siroha, A. K.,&Sandhu, K. S.	International Journal of Food Properties	2018	1532-2386	Full article: Physicochemical, rheological, morphological, and in vitro digestibility properties of cross-linked starch from pearl millet cultivars (tandfonline.com)	Pearl millet
PinderpalKaur, SanjuBalaDhull, Kawaljit Singh Sandhu, Raj Kumar Salar, Sukhvinder Singh Purewal	Journal of Food Measurement and Characterization	2018	2193-4134	Tulsi (Ocimum tenuiflorum) seeds: in vitro DNA damage protection, bioactive compounds and antioxidant potential | SpringerLink	Tulsi
SanjuBalaDhull and Kawaljit Singh Sandhu	Current Research in Nutrition and Food Science	2018	2322-0007	Wheat-Fenugreek Composite Flour Noodles: Effect on Functional, Pasting, Cooking and Sensory Properties (foodandnutritionjournal.org)	fenugreek

Kaur, M., Kaur, R., & Punia, S.	*International journal of biological macromolecules*,	2018	0141-8130	Characterization of mucilages extracted from different flaxseed (Linum usitatissiumum L.) cultivars: A heteropolysaccharide with desirable functional and rheological properties - ScienceDirect	flaxseed
Sandhu, K. S., & Punia, S.	*Journal of Food Measurement and Characterization*	2017	2193-4134	Enhancement of bioactive compounds in barley cultivars by solid substrate fermentation (springer.com)	Barley
Sandhu, K. S., Godara, P., Kaur, M., & Punia, S.	*Journal of the Saudi Society of Agricultural Sciences*	2017	1658-077X	Effect of toasting on physical, functional and antioxidant properties of flour from oat (Avena sativa L.) cultivars | Elsevier Enhanced Reader	Oats
Sandhu, K. S., &Siroha, A. K.	LWT-Food Science and Technology	2017	0023-6438	Relationships between physicochemical, thermal, rheological and in vitro digestibility properties of starches from pearl millet cultivars - ScienceDirect	Pearl millet
Siroha, A. K., &Sandhu, K. S.	Journal of Food Measurement and Characterization	2017	2193-4134	Effect of heat processing on the antioxidant properties of pearl millet (Pennisetum glaucum L.) cultivars | SpringerLink	Pearl millet
Kumar, Naresh, Raj Kumar Salar, Ravinder Kumar, Minakshi Prasad, BasantiBrar, and Vikash Nain	Nano Trends: A Journal of Nanotechn	2017	0973-418X	(14) (PDF) Green Synthesis of Silver Nanoparticles and its Applications—A Review (researchgate.net)	silver Nano Particle

	ology and Its Applications				
Anil Panghal, Vikas Kumar, SanjuB. Dhull, Yogesh Gatand NavnidhiChhikara	Current Research in Nutrition and Food Science	2017	2322-0007	Utilization of Dairy Industry Waste-Whey in Formulation of Papaya RTS Beverage (foodandnutritionjournal.org)	Whey
Anil Panghal, KiranVirkar, Vikas Kumar, Sanju B. Dhull, Yogesh Gatand NavnidhiChhikara	Current Research in Nutrition and Food Science	2017	2322-0007	Development of Probiotic Beetroot Drink (foodandnutritionjournal.org)	Beetroot
Punia, S., & Sandhu, K. S.	*International Journal of Pharma and Bio Sciences*	2016	0975-6299	IJPBS Article- PHYSICOCHEMICAL AND ANTIOXIDANT PROPERTIES OF DIFFERENT MILLING FRACTIONS OF INDIAN WHEAT CULTIVARS	Wheat
Sandhu, K. S., Punia, S., & Kaur, M.	*LWT-Food Science and Technology*	2016	0023-6438	Effect of duration of solid state fermentation by Aspergillus awamorinakazawa on antioxidant properties of wheat cultivars - ScienceDirect	Wheat
SanjuBalaDhull, PinderpalKaur, Sukhvinder Singh Purewal	Resource-Efficient Technologies	2016	2405-6537	Phytochemical analysis, phenolic compounds, condensed tannin content and antioxidant potential in Marwa (Origanum majorana) seed extracts - ScienceDirect	Marwa seed

Siroha, A. K., Sandhu, K. S., &Kaur, M.	Journal of Food Measurement and Characterization	2016	2193-4134	Physicochemical, functional and antioxidant properties of flour from pearl millet varieties grown in India | SpringerLink	Pearl millet
Sandhu, K. S., Sharma, L., & Kaur, M.	*LWT-Food Science and Technology*	2015	0023-6438	Effect of granule size on physicochemical, morphological, thermal and pasting properties of native and 2-octenyl-1-ylsuccinylated potato starch prepared by dry heating under different pH conditions - ScienceDirect	Potato
Kaur, M., Kaur, N., Kaur, M., & Sandhu, K. S. (2015).	*LWT-Food Science and Technology*	2015	0023-6438	Elsevier Enhanced Reader	Rice
Punia, S., & Sandhu, K. S.	Carpathian Journal of Food Science & Technology	2015	2066-6845	Vol_7(4)_2015.pdf (ubm.ro)	Barley
					FST 3.4.5 and 3.4.6

Sr. No.	Roll No. /Regn. No	Name	F/ Name	Session	Topic of Research	Thrust area of Research
1	115475004	Sneh Punia	Birbal Punia	2011 to 2016	Characterization of bioactive compounds, starch and proteins of wheat and	Wheat or barley
2	115475001	Anil Kumar Siroha	Rameshwar Dayal	2011 to 2017	Characterization of native and modified starches from pearl millet cultivars	Pearl Millet
3	1154750002	Vikash	Ramphal	2011 to 2018	Development and characterization of starch nanoparticles from, different b	Nanostrarch
4	115475003	Rahul Thory	Dalbir Singh	2011 to 2018	Characterization of bioactive compounds and starch from different Indian rice cultivars	Rice
5	115475005	Sanju Bala	Omparkash	2011 to 2018	Characterization of bioactive compounds, gums and proteins from seeds of different Indian fenugreek(Trigonella foenum-graecum) cultivars	Fenugreek
6	15154740001	Vinita Sharma	Murari Lal	2015 to 2021	Isolation, modification, characterization and utilization of starch from non-conventional sources.	Non-convential starch sources
7	0002/2020170355	Nishant Kumar	Rakesh Kumar	2017 to 2022	Characterization of Different Components and Selective Improvisation of Beers	Fruits & Cereals (Keenu, wheat etc.)
8	40001/201703550	Amanjyoti	Mahinder Singh	2017 to till date	Nutritional analysis of oleaginous algae from different reservoirs of Haryana	Oleaginous algea
9	40002/201803550	Ankita Chandak	Parveen Chandak	2018 to till date	Characterization of native and modified starches from Lotus (Nelumbo nu	Lotus seeds
10	40001/201803550	Pooja	Satyawan	2018 to till date	characterization of fenugreek(Trigonella foenum-graecum) gum hydrogel an	Fenugreek

Science of the Total Environment 690 (2019) 717–729

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Real-time monitoring of air pollutants in seven cities of North India during crop residue burning and their relationship with meteorology and transboundary movement of air

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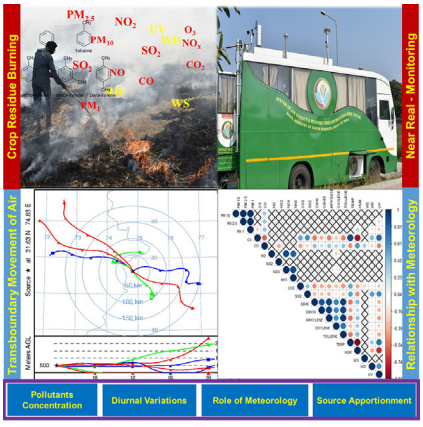
HIGHLIGHTS

- Crop residue burning affect air quality in Asia and specifically in IGP, India.
- Monitored real-time 16 air pollutants during crop residue burning in seven cities
- Pollutants levels found to be elevated during the crop residue burning.
- Emission of pollutants during crop residue plays major role in secondary pollutants.
- Crop residue burning and vehicles were identified as major sources of air pollutants.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 9 April 2019
Received in revised form 5 June 2019
Accepted 14 June 2019
Available online 15 June 2019

Editor: Pavlos Kassomenos

ABSTRACT

Air pollutants emissions due to the burning of crop residues could adversely affect human health, environment, and climate. Hence, a multicity campaign was conducted during crop residue burning period in Indo Gangetic Plains (IGP) to study the impact on ambient air quality. Seventeen air pollutants along with five meteorological parameters, were measured using state of the art continuous air quality monitors. The average concentration of PM_{10}, $PM_{2.5}$, and PM_1 during the whole campaign were 196.7 ± 30.6, 148.2 ± 20, and 51.2 ± 8.9 μgm^{-3} and daily average concentration were found several times higher than national ambient air quality standards for 24 h. Amritsar had the highest average concentration of $PM_{2.5}$ (178.4 ± 83.8 μgm^{-3}) followed by Rohtak and Sonipat

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https://doi.org/10.1016/j.scitotenv.2019.06.216

Keywords:
Biomass burning
IGP
Atmospheric loading
PM_1
VOCs
Climate change

(158.4 ± 79.8, 156.5 ± 105.3 μgm^{-3}), whereas Chandigarh recorded the lowest concentration (112.3 ± 6.9 μgm^{-3}). The concentration of gaseous pollutants NO, NO_2, NO_x, and SO_2 were also observed highest at Amritsar location, i.e., 6.6 ± 2.6 ppb, 6.2 ± 0.7 ppb, 12.7 ± 3.0 ppb, and 7.5 ± 3.3 ppb respectively. The highest average O_3 and CO were 22.5 ± 19.3 ppb and 1.5 ± 1.2 ppm during the campaign. The level of gaseous pollutants and Volatile organic compounds (VOCs) found to be elevated during the campaign, which can play an important role in the formation of secondary air pollutants. The correlation of meteorology and air pollutants was also studied, and O_3 shows a significant relation with temperature and UV ($R = 0.87$ and 0.74) whereas VOCs shows a significant correlation with temperature ($R = -0.21$ to -0.47). Air quality data was also analyzed to identify sources of emissions using principal component analysis, and it identifies biomass burning and vehicular activities as major sources of air pollution.

1. Introduction

Recent, Global Burden of Disease reports ranks air pollution as a leading cause of premature mortality and morbidity, especially in developing countries, which is an alarming situation (Cohen et al., 2017). The anthropogenic activities including solid biomass burning are major sources of air pollution, but these activities have been practiced since many years (J. Chen et al., 2017; Ravindra et al., 2019a). Apart from solid biomass fuel, other sources include exhust and non-exhaust emissions from vehicle, burning of crop residue in agricultural fields (Ravindra, 2019; Ravindra et al., 2019b, 2019c; Ravindra and Mor, 2019; Sidhu et al., 2017; Bhargava et al., 2018). Burning of crop residue leads to the emission of air pollutants such as particulate matter (PM_{10}, $PM_{2.5}$, PM_1), trace gases, Volatile organic compounds (VOCs) along with greenhouse gases (GHGs) in the atmosphere (Ravindra et al., 2019a). Apart from detrimental health effects, these pollutants also play an important role in changing the atmospheric chemistry regionally and globally (Ravindra and Smith, 2018; Gurjar et al., 2016; Ravindra et al., 2015). Hence, there is a need to understand the impact of air pollutants emissions during crop residue burning on climatic processes (Ramanathan and Carmichael, 2008; Ramanathan and Feng, 2009; Kumar et al., 2011).

In India around 24% of generated crop residue is burned in open fields (Ravindra et al., 2019a), leading to episodic very poor air quality in Indo Gangetic Plains (IGPs) as reported by Ram et al. (2012a, 2012b, 2016) and Pachauri et al. (2013). Burning of crop residues in agricultural fields after harvesting also leads to severe regional air pollution events (Cheng et al., 2014, W. Chen et al., 2017). Table 1 depicts the concentration of various pollutants during crop residue burning in India based on literature review, and their concentration found significantly high. Similarly, Mittal et al. (2009) also observed elevated levels of suspended particulate matter (SPM), SO_2, and NO_2 during crop residue burning period in Patiala, India. Singh et al. (2010a) highlighted the increase in the concentration of organic pollutants during stubble burning period. The higher fraction of $PM_{2.5}$ (55% to 64%) in RSPM may arise due to crop residue burning as reported by Awasthi et al. (2011). Kharol et al. (2012) reported increased aerosol loading and Black Carbon (BC) concentration during the agricultural burning activities.

Crop residue burning elevates the VOCs concentrations up to 1.5 times higher than the annual average during post-harvesting seasons in northwest IGP (Chandra and Sinha, 2016). Zhang et al. (2008) reported the annual emissions of polychlorinated dibenzo-p-dioxins and dibenzofurans during crop residue burning in China and highlighted that these emissions could contribute up to 10% to 20% of the total emissions of these toxic pollutants. Tang et al. (2013) reported 39% enhancement in ozone levels on sunny days and 27% on rainy days due to open crop residue burning in China. This shows that the concentration of pollutants during crop residue burning is highly influenced by the meteorological parameters, including their long-range transportation.

Witham and Manning (2007) showed that the impact of long-range transport of pollutants during agricultural residue burning on a regional episode of high air pollution. Similarly, Badarinath et al. (2009a, 2009b) reported that crop residue burning in IGP could affect the air quality over the south coast and Arabian sea coast of India using multi-satellite data. Kaskaoutis et al. (2014) also highlighted that long-range transport of crop residue burning influence the atmospheric conditions in Indian sub-continent. As discussed above, there are several studies, which monitor air quality only at one location having selected air pollutants. Hence, there is a need to conduct a study having major air polltants (particulates, VOCs and other gases) covering a wide geographical area.

Considering the above gap, the current study measures the near real-time concentration of various air pollutants along with meteorological parameters during crop residue burning in North India to better understand the impact of crop residue burning on air quality. Further, efforts were made to identify the major sources of air pollution using PCA and the impact of crop residue burning on regional air quality using HYSPLIT models. The finding of the current study will be useful to better understand the temporal and spatial distribution of air pollutants during crop residue burning period and to plan comprehensive air quality improvement strategies under National Clean Air Programme (NCAP, 2019).

2. Methodology

2.1. Study locations

The study was conducted in IGP having Punjab, Haryana, and Chandigarh states. Punjab and Haryana are known as the food bowl of the country. The sampling campaign was conducted from 27th October to 6th December 2016, having 7 cities to reflect geographical variations, as shown in Fig. 1 and Table 2. Chandigarh is an urban location, and sampling was conducted on the campus of Panjab University. In Fatehgarh Sahib and Bathinda measurements were done near agricultural fields at rural locations. Sampling in Amritsar was done in Guru Nanak Dev University campus, which is situated at outskirts of the city. Sirsa, Rohtak, and Sonipat are semi-urban location and sampling was done in the campus of Chaudhary Devi Lal University, Maharshi Dayanand University, and Deenbandhu Chhotu Ram University respectively. All the sites were situated away from major highways as that may influence the measurements of pollutants.

2.2. Sampling and instrumentation

The simultaneous and continuous measurement of various air pollutants and meteorological parameters was conducted using the System of Air Quality Forecasting and Research (SAFAR) mobile van laboratory on vehicles. The measured air pollutants include particulate matter (PM_{10}, $PM_{2.5}$ and PM_1), Black Carbon (BC), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2), Ozone (O_3), oxides of nitrogen (NO, NO_2, NO_x), ammonia (NH_3), benzene, ethylbenzene, m-, p-xylene, o-Xylene and toluene. The meteorological parameters monitored were temperature, rain, relative humidity, wind speed wind direction, and ultraviolet radiation (UV). The data is time-resolved and

Table 1
The concentration of various pollutants at various location in India during crop residue burning period.

Location	Pollutants concentration										Season	Year	Reference	Comment
	TSP μgm^{-3}	RSPM μgm^{-3}	PM_{10} μgm^{-3}	$PM_{2.5}$ μgm^{-3}	SO_2	NO_2	O3	BC $\mu g\ m^{-3}$	OC	EC	Benzene	Toluene				
Patiala								5–25					Winters (Oct-Nov)	2008	Kharol et al., 2012	
Hisar (Urban)	177.4 ± 63.9								33.0 ± 17.9	3.8 ± 1.4			Winters	2004	Rengarajan et al., 2007	
Manora Peak	27.1 ± 8.3								4.8 ± 1.1	0.81 ± 0.22			December			
													Winters	2004	Rengarajan et al., 2007	
													December			
Patiala (rural)			160 ± 1.31, 154 ± 7.98	98 ± 1.49, 85 ± 3.54									Winter, Summer	2009–2010	Awasthi et al., 2010	During Harvesting Season
Patiala			180.3 ± 45.6	123.1 ± 25.5	9.3 ± 11.4	35.1 ± 33.9							Winter	2009	Agarwal et al., 2012	During Harvesting Season
							75 ± 14 (ppbv)	3049 ± 1122 ng/m3					Winter and Summer	2007–09	Kumar et al., 2011	Fire-Impacted Periods
Nainital (high altitude site)				147.6									Winter	2011–12	Kumar et al., 2018	
Amritsar																
Patiala		166.4 ± 6.9						10.3 ± 3.2					Winter	2008–10	Sharma et al., 2017	November month average
Kanpur			247 ± 97	189 ± 82									Winter	2008–09	Ram et al., 2012a	Oct-Nov
Mohali			276	104							1.7 nmol mol^{-1}	2.7 nmol mol^{-1}	Summer	2012	Sinha et al., 2014	May 2012

have a frequency of 5 min and then binned for the one-hour interval for further analysis. The van has a setup in which all the analyzers assembled within it by Environment S.A. (France) except BC analyzer.

The particulate matter was monitored based on the principle of Beta-ray Absorption method using suspended particulate beta gauge monitor (M101M+) whereas BC was monitored using EA-12 Aethalometer (Everise Technology Ltd.). The NOx analyzer (Chemiluminescent Nitrogen Oxide Analyzer, AC32M) works on the principle of chemiluminescence for analyzing the NO or NO_X concentration within a gaseous sample. The CO and CO_2 were measured using Non-Dispersive Infra-Red detectors using Gas Filter Correlation Carbon Monoxide Analyzer (CO 12M) whereas SO_2 was monitored using UV Fluorescent Sulfur Dioxide Analyzer (AF22M) UV-based ozone analyzer (UV Photometric Ozone Analyzer, O3-42M) work on the principle that ozone particles absorb UV light at a wavelength of 254 nm. The wavelength of 254 nm was created and passed through an air chamber. The amount of UV light absorbed is proportional to the amount of ozone present in that airspace. The amount of UV light absorbed in the chamber is interpreted as ozone concentration. The BTEX Analyzer (VOC72M) was used for VOCs measurement. It separate the targeted compounds based on gas chromatography and analyzed them using photoionization detection. The various meteorological parameters were also monitored using an automatic weather station (LSI LASTEM) installed in SAFAR mobile van.

2.3. Quality assurance/quality control

The instruments equipped in SAFAR mobile van laboratory on vehicles were maintained and operated as per the standard specifications. The instruments were US EPA approved and certified by Bureau Veritas Certification (ISO9001) for quality control. The US EPA's Standard Operating Procedures were adopted for instrument calibration and maintenance. The calibration frequency of the instruments was four weeks. More details about SAFAR can be found at http://safar.tropmet.res.in/ (SAFAR, 2019). The detailed information about the calibration procedure can be found by referring to title 40 of the Code of Federal Regulations (CFR) part 50. http://www.law.cornell.edu/cfr/text/40/part-50 (LII, 2019).

3. Results and discussion

3.1. Site-specific variations of pollutants

The crop residue burning period for Kharif crop in northern states of India usually starts in the beginning of second half of October and lasts for 6 to 8 weeks (Awasthi et al., 2010, 2011) The concentration of various pollutants at different locations during the crop residue burning campaign (27th October to 6th December 2016) is shown in Fig. 2.

3.1.1. Particulate matter and Black Carbon

The concentration of particulate matter was found significantly higher than the national ambient air quality standards of 100 and 60 μgm^{-3} for PM_{10} and $PM_{2.5}$ respectively for 24 h at all the locations during the campaign period. The highest average concentration of PM_{10} was observed in Amritsar 252.22 ± 108.14 μgm^{-3} followed by Sonipat and Bathinda as 213.67 ± 151.49 and 204.04 ± 70.80 μgm^{-3}, whereas Chandigarh reported the lowest average concentration of coarser particles as 151.45 ± 106.40 μgm^{-3}. Further, the highest average concentration of $PM_{2.5}$ was also observed in Amritsar 178.44 ± 83.81 μgm^{-3}. Rohtak, which is a semi-urban location, observed the highest PM_1 concentration as 62.29 ± 38.26 μgm^{-3}. The average lowest concentration of 151.45 ± 106.40, 112.27 ± 6.89 and 37.12 ± 8.76 μgm^{-3} for PM_{10}, $PM_{2.5}$ and PM_1 respectively was in Chandigarh which is an urban location whereas at the rural location of Fatehgarh Sahib the concentration of PM_{10} and $PM_{2.5}$ was 197.07 ± 61.35 and 149.12 ± 49.97 μgm^{-3} as shown in Supplementary Table S1. The Bathinda rural location has the

lowest $PM_{1,}$ with a concentration of 51.07 ± 17.18 μgm^{-3}. The results show that crop residue burning in north India significantly contribute to atmospheric aerosols and hence these sources should be given priority under NCAP to reduce particulate pollution.

During the rice crop residue burning period the monthly average concentrations (based on 24 h daily average) of suspended particulate matter ranged from 303 ± 13 μgm^{-3} to 547 ± 152 μgm^{-3} in Patiala (India) was reported by Singh et al. (2010b). Around 66% increase in PM_{10} levels and 78% in $PM_{2.5}$ levels from background concentration in the study area was reported by Awasthi et al. (2011) during rice crop residue burning period in a rural area of Punjab. Similarly, a high concentration of $PM_{2.5}$ (246 μgm^{-3}) was reported by Rajput et al. (2011) during paddy crop residue burning in Patiala, India. During crop reside burning of paddy straw, the average concentration of particulate matter reaches more than twice more as compared to the period of non-burning. The concentration of PM_{10} and $PM_{2.5}$ before the paddy burning period were reported by Agarwal et al. (2012) in Patiala, India as 96.1 ± 4.7 μgm^{-3} and 54.6 ± 4.1 μgm^{-3} which reaches to 180.3 ± 45.6 μgm^{-3} and 123.1 ± 25.5 μgm^{-3} respectively during burning period.

The highest average concentration of Black Carbon (BC) was observed in Amritsar as 13.01 ± 6.0 μgm^{-3} followed by Chandigarh (12.68 ± 6.09 μgm^{-3}) and Rohtak (11.20 ± 4.90 μgm^{-3}). The lowest levels of BC were recorded in Bathinda as 8.40 ± 5.90 μgm^{-3} during the campaign. In Patiala region of IGP, the mass concentrations of BC ranges from 8.50 to 19.60 μgm^{-3} was reported during rice residue burning period by Singh et al. (2014). Similarly, Kharol et al. (2012) also reported higher concentration of BC (above 20 μgm^{-3}) during rice burning period in Patiala and associated it with regional burning practices in agricultural fields. The higher levels of particulate matter and BC during crop residue burning period shows that the air quality in the region significantly affected by these activities and can play a role in changing atmospheric chemistry by participating in heterogeneous chemical reactions, scatter sunlight, providing nuclei for cloud droplets (Andreae and Crutzen, 1997; Ramanathan et al., 2001). BC in atmosphere results in an increase in top-of-the-atmosphere radiative forcing, atmospheric solar heating and surface dimming which will affect the atmospheric activities (Ramanathan and Carmichael, 2008; Sreekanth et al., 2007; Singh et al., 2018)

3.1.2. Gaseous pollutants

Highest levels of O_3 was recorded in Bathinda (19.70 ± 16.00 ppb) whereas the levels of NO, NO_2, NOx, NH_3, SO_2 were found highest in Amritsar (6.60 ± 2.65, 6.24 ± 0.71, 12.73 ± 3.01, 2.65 ± 0.83 and 7.52 ± 3.25 ppb) respectively. The lowest concentration of O_3, NO and NOx were recorded in Sonipat (15.61 ± 15.75, 3.50 ± 1.10 and 8.67 ± 1.24 ppb) whereas levels of NO_2 and NH_3 (4.70 ± 0.47 ppb and 1.81 ± 0.44 ppb) were found lowest in Rohtak. The concentrations (24 h) of SO_2 and NO_2 in Patiala (India) during rice residue burning period ranges from 8 ± 7 μgm^{-3} to 55 ± 34 μgm$^{-3,}$ and 12 ± 4 μgm^{-3} to 91 ± 39 μgm^{-3} respectively was reported by Singh et al. (2010b).

Table 2
Sampling locations, types, and duration of sampling.

Locations	Dates of sampling	Type of location
Chandigarh (L1)	27 Oct–03 Nov 2016	Urban
Fatehgarh Sahib (L2)	03 Nov–09 Nov 2016	Rural
Amritsar (L3)	09 Nov–15 Nov 2016	Semi-Urban
Bathinda (L4)	16 Nov–21 Nov 2016	Rural
Sirsa (L5)	21 Nov–26 Nov 2016	Semi-Urban
Rohtak (L6)	26 Nov–03 Dec 2016	Semi-Urban
Sonipat (L7)	03 Dec–06 Dec 2016	Semi-Urban

The concentration of CO and CO_2 were 1.46 ± 1.16 ppm and 327.23 ± 31.95 ppm at Rohtak, showing the highest among all the locations. The similar concentrations of CO were reported by Sahai et al. (2010) during paddy residue burning period at Pantnagar and Ludhiana, India as 1.90 ± 0.69 ppmv and 1.35 ± 0.53 ppmv respectively. The average CO concentrations of 552 ± 113 ppb was reported by Chandra and Sinha (2016) post paddy harvesting period in northwest IGP region. The higher emissions of CO during crop residue burning and its long residence time can affect the atmospheric chemistry to a great extent. The concentration of CO, $O_{3,}$ and SO_2 were within limits (2 mgm^{-3}, 100 μgm^{-3} (8 h) and 80 μgm^{-3} (24 h)) of NAAQS of India for which only standard limits are available, but found elevated as compared to non-burning days during the campaign.

3.1.3. VOCs

The urban location of Chandigarh has the highest average levels of benzene (1.56 ± 0.50 μgm^{-3}), whereas the highest average concentration of ethylbenzene, m-, p-xylene and o-xylene (1.62 ± 1.31 μgm^{-3}, 2.18 ± 2.28 μgm$^{-3,}$ and 1.76 ± 5.32 μgm^{-3}) respectively were observed in Rohtak. The highest concentration of toluene (5.27 ± 1.00 μgm^{-3}) was reported in Amritsar. The rural location of Fatehgarh Sahib reported the lowest concentration of all monitored VOCs except toluene, which had the lowest concentration in Sonipat. Pandey and Sahu (2014) highlighted that crop residue burning has foremost emissions of isoprene (80%) and toluene (72%) among burning of various biomasses. The average concentrations of 2.51 ± 0.28 ppb and 3.72 ± 0.41 ppb of benzene and toluene was reported by Chandra and Sinha (2016) post

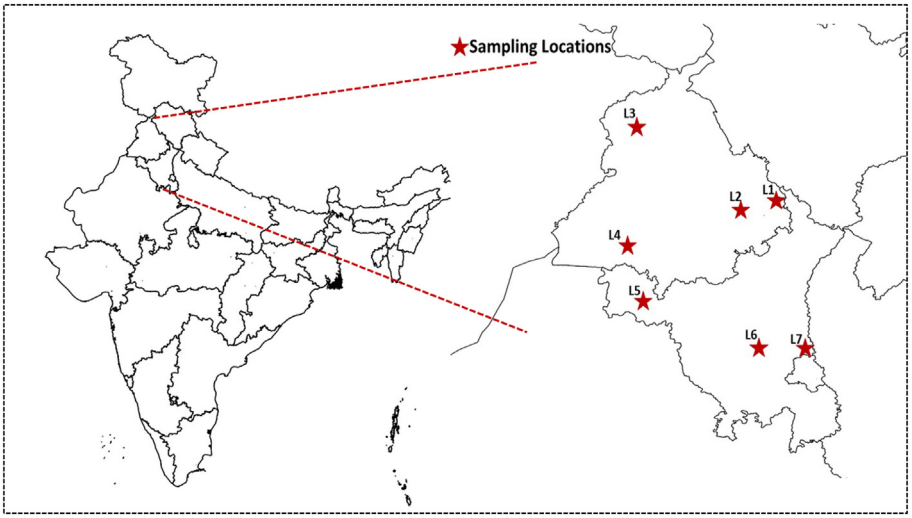

Fig. 1. Study area and locations of various sampling sites during the campaign.

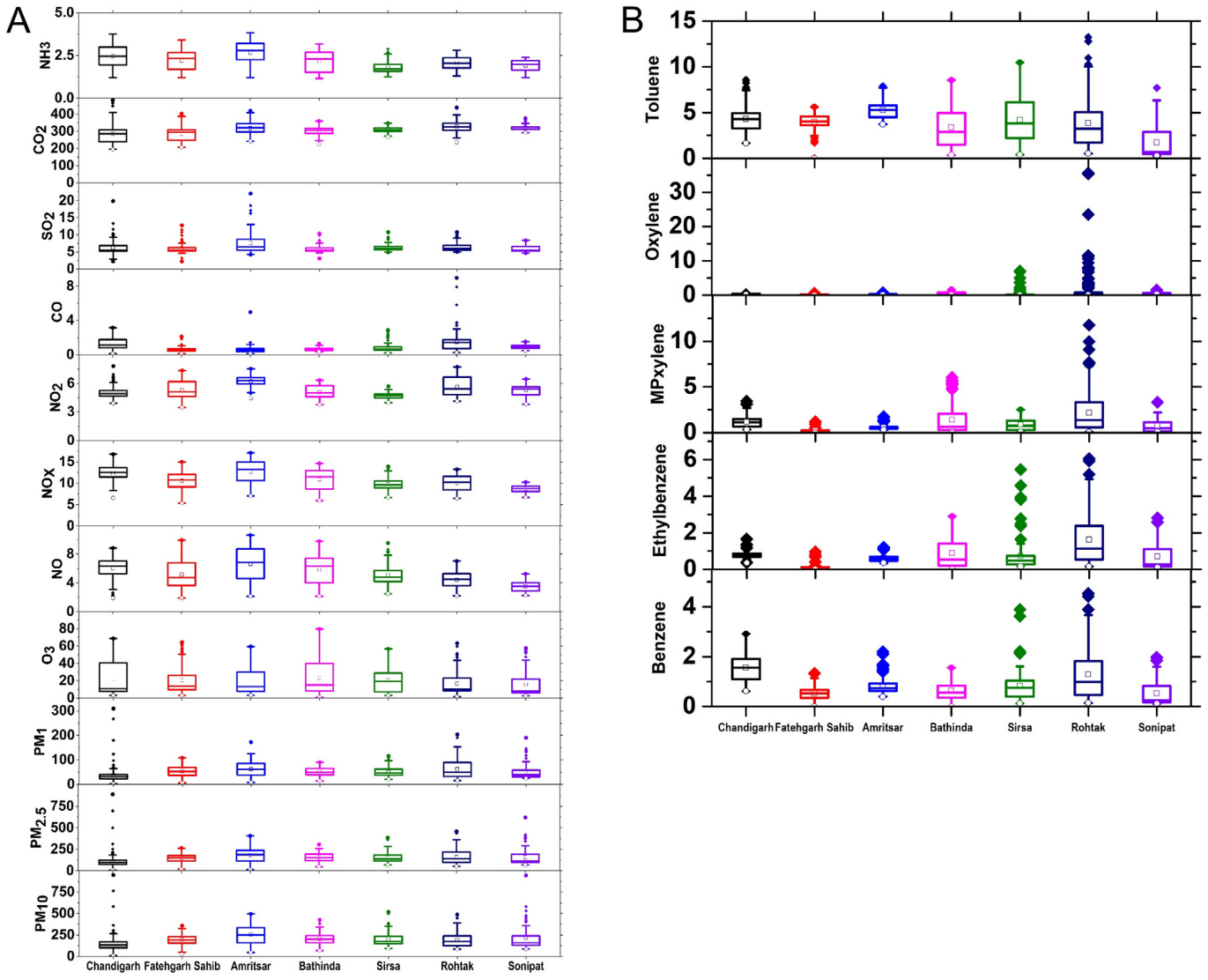

Fig. 2. (a). Concentration of various pollutants at various locations during whole campaign (b). Concentration of various VOCs at various locations during whole campaign.

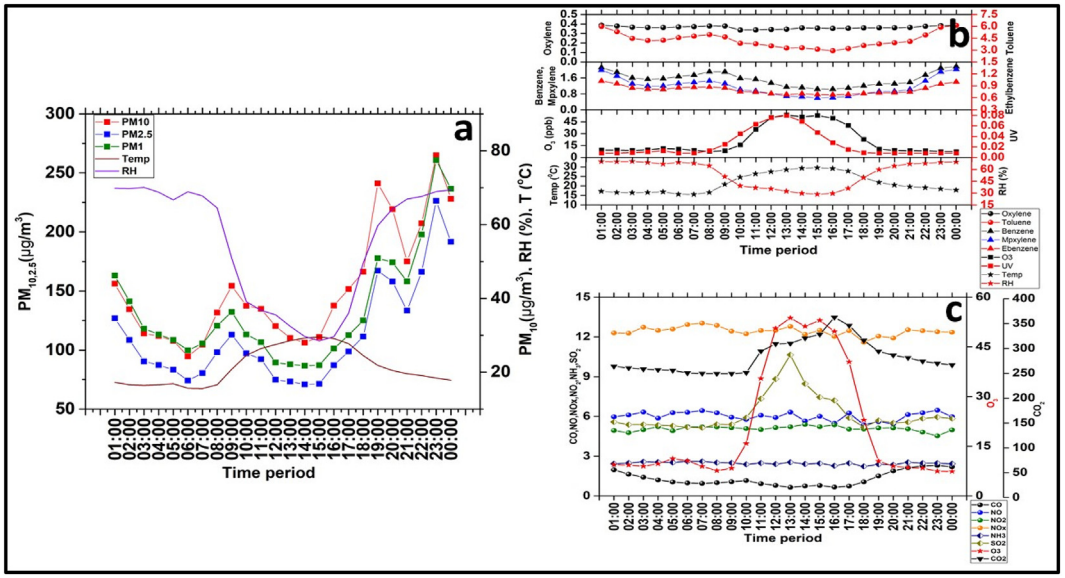

Fig. 3. Diurnal Variation in various PM, gaseous and VOCs emissions along with meteorological parameters at Chandigarh location (27 Oct 2016–03 Nov 2016).

paddy harvesting period in northwest IGP region which are on the higher side.

3.2. Diurnal pattern of various air pollutants

3.2.1. Particulate matter and Black Carbon

The highest hourly average concentration of PM_{10} (519 ± 403 μgm^{-3}) during the campaign was reported at Sonipat (08:00–09:00 am) whereas lowest as 94.7 ± 40 μgm^{-3} (5:00–06:00 am) was in Chandigarh. The peak value of the hourly average concentration of PM_{10} during the whole campaign was 948 μgm^{-3}, which was in Chandigarh on Diwali day. The highest hourly concentration of $PM_{2.5}$ and PM_1 was also in Sonipat with 336 ± 262 μgm^{-3} and 119 ± 82 μgm^{-3} between 8:00 am to 9:00 am whereas the lowest hourly average was in Chandigarh as 70.9 ± 15 μgm^{-3} and 21.7 ± 4.9 μgm^{-3} during 1:00 to 2:00 pm. The higher trends in Sonipat location in morning hours may be due to higher vehicular emissions as there is a huge inflow of trucks and cars toward Delhi NCR in morning hours. Fig. 3 shows the diurnal variation in PM and meteorology (27 Oct–03 Nov) and the pattern how with the increase in temperature the PM concentration decreases. The increased concentrations ranging from 30 to 300% during night time were reported by Rastogi et al. (2014) for various pollutants, including $PM_{2.5}$ during the diurnal study of crop residue burning in the IGP region.

Fig. 4 shows the diurnal variation in Black Carbon concentration at various locations. The results show that gradual build-up starts at evening hours and peaks till midnight. The trend was more or less same in all the locations and can be linked with crop residue burning as the most of burning activities took place after the closure of government offices, i.e., 17:00 h as these activities are prohibited in the region. Further, considering the duration between 22:00 to 06:00 as night and 06:00 to 22:00 as daytime, the diurnal pattern was studied. The results show that Chandigarh, Fatehgarh Sahib, Rohtak, and Sonipat locations have high finer PM concentration at night time, whereas rest 3 locations show a significantly higher concentration of fine particles at day time.

3.2.2. Gaseous pollutants

As shown in Fig. 3 diurnal pattern of ozone (O_3), oxides of nitrogen (NO, NO_2, NO_x), ammonia (NH_3), carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2) was studied. The rural location Fatehgarh

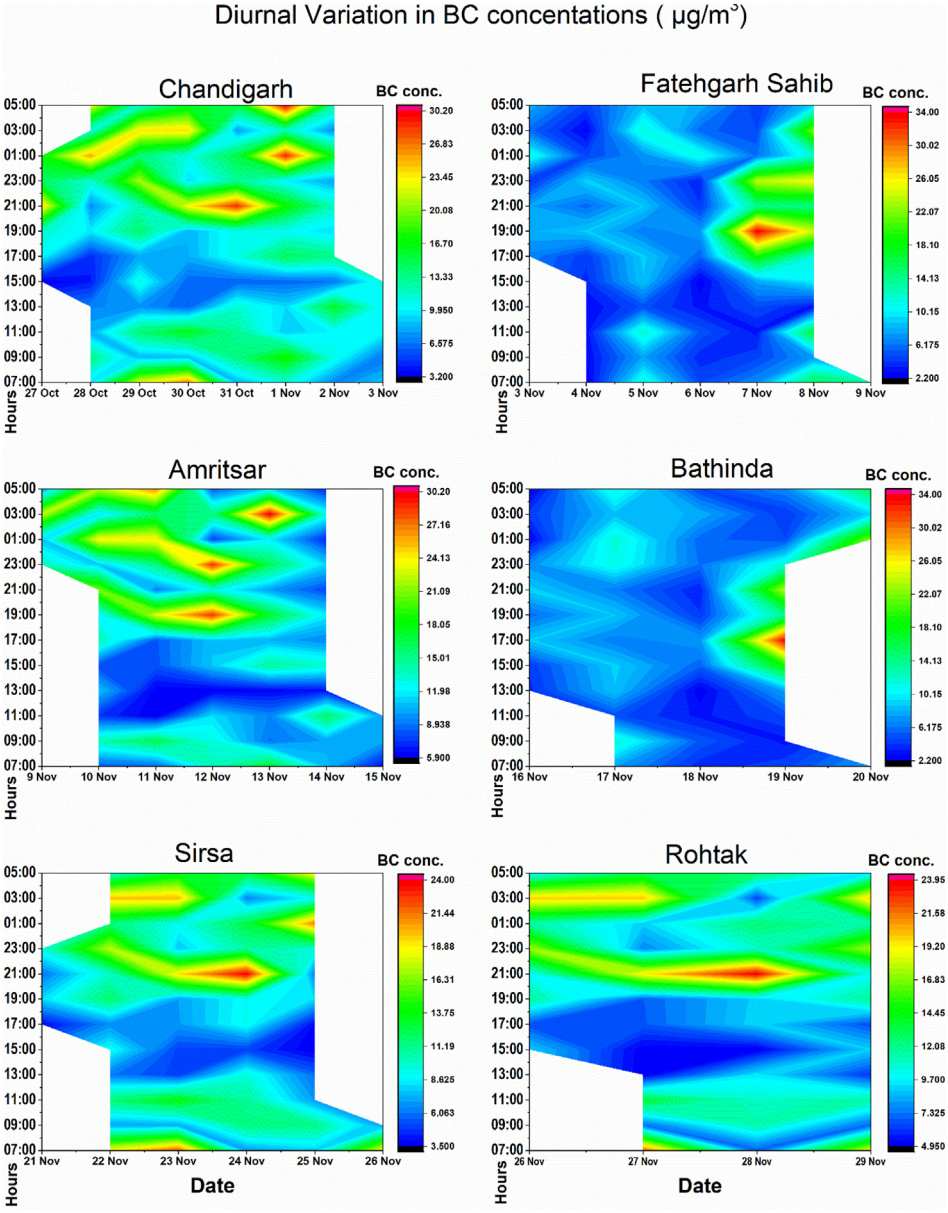

Fig. 4. Diurnal variation in Black Carbon concentration at various locations.

Sahib had the highest average hourly concentration of O_3 as 58.9 ± 4 ppb between 3:00 to 4:00 pm whereas the lowest was in the rural location of Bathinda as 4.5 ± 2 ppb during 10:00 to 11:00 pm. In general, the higher levels of ozone are at daytime, whereas for other gases level increase in night time (Wang et al., 2002). Here the lower level of ozone in morning hours seems to be linked with fogy conditions which reduce

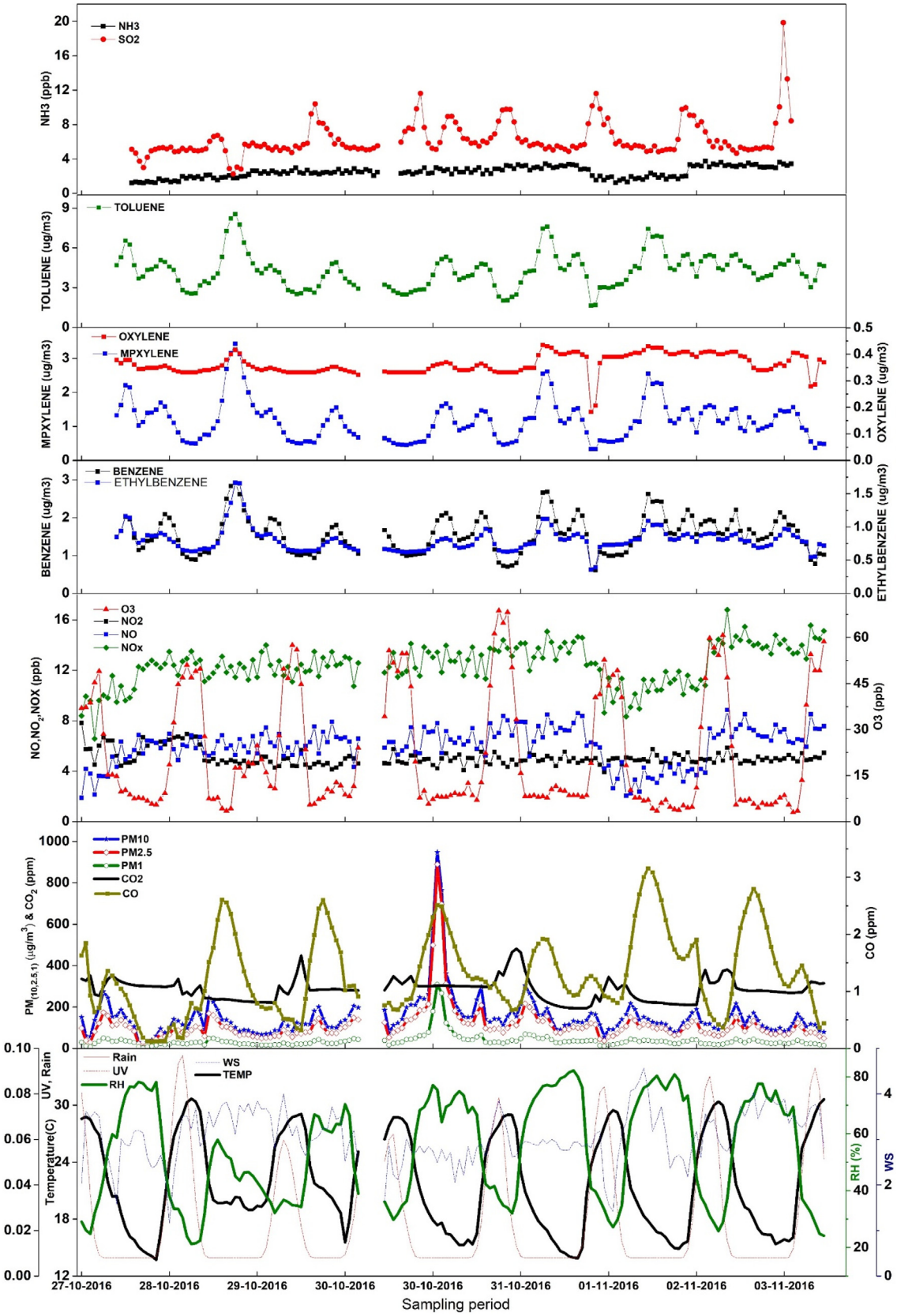

Fig. 5. Variation in concentration of various pollutants with metrological parameters in Chandigarh (L1).

the photochemical activity (Kumar et al., 2016). The average hourly concentration of NO, NO_2, NOx, NH_3 and SO_2 was highest in Amritsar as 7.4 ± 1.4, 6.6 ± 2.3, 14 ± 2.5, 3 ± 0.7 ppb and 12.5 ± ppb respectively in between 7:00 am to 8:00 am (foggy condition)and from 12:00 to 1:00 pm for SO_2. The higher levels of these pollutants at night time and in the early morning in winters when the boundary layer is low can be linked with the accumulation of locally emitted pollutants (Cheung and Wang, 2001). The hourly average concentration of 2.6 ± 2.5 ppm of CO monitored in Rohtak, which was the highest between 6:00 pm to 7:00 pm during the whole campaign. The increase in concentrations SO_2 in the afternoon and late afternoon can be linked with the transportation of large plumes (Cheung and Wang, 2001). Fig. 3 shows the diurnal variation of gaseous pollutants in Chandigarh. The variation in diurnal behavior of these gases in winter mainly influenced by lower temperature and solar radiation, which slow down the atmospheric process (Wang et al., 2002).

3.2.3. Volatile organic compounds (VOCs)

The diurnal pattern of benzene, ethylbenzene, m-, p-xylene, o-xylene, and toluene was also studied during the sampling period. Fig. S1. shows the diurnal variation in the concentration of various VOCs at a different location during the campaign. The variation in VOCs concentration shows similar patterns in all the location expect Rohtak where the VOCs peaks at daytime, whereas in all other location the VOCs are low in the daytime. The similar patterns may indicate similar emissions source and similar mechanism of dispersion (Khoder, 2007). The highest hourly average concentration of VOCs expect toluene were also observed in Rohtak. The benzene, ethylbenzene, m-, p-xylene, o-Xylene has 2.7 ± 1.54 μgm^{-3}, 3.3 ± 2 μgm^{-3}, 4.2 ± 2.1 μgm^{-3}, 6.6 ± 14.2 μgm^{-3} average hourly concentrations in Rohtak respectively between 1:00 pm to 2:00 pm, whereas Sirsa shows the higher hourly average concentration of toluene (7.7 ± 1.8 μgm^{-3}) at night time The highest contribution among all VOCs was of toluene in all the locations. These higher levels can be related to vehicular activity in the vicinity of the study locations. The rural location of Fatehgarh Sahib showed the lowest average hourly concentration of benzene, ethylbenzene, m-, p-xylene, and o-Xylene in the noon hours whereas Sonipat showed the lowest average hourly concentration of toluene in morning hours (06:00 to 09:00) as 0.3 ± 0.3 μgm^{-3} which was lowest during the whole campaign. Fig. 3. shows how the concentration of O_3 and various VOCs varies with meteorological parameters during the day and night time in Chandigarh location. Except for rural locations, in all other sites, the diurnal variations of VOCs showed two peaks. The peak start building in morning hours (07:00–10:00) and evening hours after 17:00 h. The morning peaks may be due to the increase in vehicular activity. In the afternoon, the VOCs levels decrease probably due to the dilution caused by atmospheric activities in the presence of sunlight (Khoder, 2007). The presence of benzene and toluene at the all the location can be used as tracers of incomplete combustion (Li et al., 2018).

3.3. Meteorology and air quality

The meteorological parameters always play an important role in the dispersion of air pollutants and influence the concentration of the pollutants in the atmosphere. Lower boundary layer during winter help building of air pollutants near ground level and mixing of pollutants with winter fog results in smog events (Niranjan et al., 2007; Sreekanth et al., 2018). The variation in the concentration of various pollutants with metrological parameters in Chandigarh location as a representative graph is shown in Fig. 5. The figure shows how concentration and the pattern of various pollutants vary period. The values of various meteorological parameters and plots of wind roses showing wind direction, wind speed, and wind frequency for various locations during the campaign is shown in Table 3 and Fig. 6, respectively. At Chandigarh, the wind direction was frequent, mainly southeast, and had an average speed of 3.07 ± 0.7 ms^{-1}. At Fatehgarh Sahib and Amritsar, the average wind speed was 3.24 ± 0.86 $ms^{-1,}$ and 2.81 ± 1.28 ms^{-1} and direction blew from east-southeast and south-southeast. In Bathinda, the wind speed is slow and calm as an average of 1.64 ± 0.73 ms^{-1} and frequent direction were west and east. At Sirsa, the winds speed was comparative high as 3.69 ± 1.52 ms^{-1} and mainly from the north direction. At Rohtak, the wind direction varies from north-northwest to south-southwest whereas at Sonipat the wind directions were west-northwest with an average speed of 1.86 ± 0.81 ms^{-1} and 3.27 ± 0.68 ms^{-1} respectively. The average temperature and relative humidity (RH) recorded was varies from 13.7 ± 9.5 to 21.6 ± 5.6 degree centigrade and 50.3 ± 18.7% to 66.12 ± 22.81%, respectively, at various locations during the whole campaign. The Sonipat location has the higher average RH values where monitoring was done on the first of December whereas Rohtak has the lowest average RH. Amritsar and Bathinda locations have encountered little precipitation during monitoring, and the rainfall was recorded as 0.003 ± 0.045 mm and 0.76 ± 1.81 mm. The UV was in the range of 0.022 ± 0.021 to 0.017 ± 0.016 Wm^{-2}.

3.3.1. Correlation between meteorology and air quality

The regression analysis was done to find the correlation of the various pollutants and meteorological data by evaluating their correlation coefficients. As shown in Fig. 8, the O_3 shows good correlation with temperature and humidity at all locations. The increase in temperature and decrease in RH, O_3 concentration increases. The benzene also shows a correlation with other VOCs in most of the sites. The correlation matrix of various air pollutants and meteorological parameters for the Chandigarh location as a representative is shown in Supplementary Table S2. This matrix helped in understating the significant correlation between the various parameters.

3.3.2. Impact of transboundary movement of air on air quality

To understand the transportation pathway of the air mass over the different locations, a 48 h airmass backward trajectories were computed using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model of the National Oceanic and Atmospheric Administration (NOAA), USA (Stein et al., 2015; Rolph et al., 2017). The back-trajectories were calculated for each location at 5:30 IST at the boundary layer of 500 m above ground level. Backward trajectory (48 h) of air masses at Amritsar from 9 to 15 November 2017 is shown in Fig. 7 as representative. Fig. 7 also shows the fire and thermal anomalies on 11 November 2016 using Aqua and Tera satellite data having MODIS sensor onboard. It is quite evident from the figure that most of the air masses originated within 200 km, where significant crop residue burning

Table 3
Meteorological parameters recorded during campaign.

Meteorological parameters	L1	L2	L3	L4	L5	L6	L7
	27Oct-03Nov	03Nov-09Nov	09Nov-15Nov	16Nov-21Nov	21Nov-26Nov	26Nov-03Dec	03Dec-06Dec
Temperature (°C)	21.6 ± 5.6	20.1 ± 5.1	19.5 ± 5.1	13.7 ± 9.5	21.1 ± 5.6	19.3 ± 5.4	16.8 ± 5.5
Relative humidity (%)	54.4 ± 20.1	64.7 ± 2.0	64.1 ± 20.0	56.3 ± 22.82	50.3 ± 18.7	63.6 ± 27.8	66.12 ± 22.81
Rainfall (mm)	0	0	0.003 ± 0.045	0.76 ± 1.81	0	0	0
Wind speed (ms^{-1})	3.07 ± 0.7	3.24 ± 0.86	2.81 ± 1.28	1.64 ± 0.73	3.69 ± 1.52	1.86 ± 0.81	3.27 ± 0.68
UV(Wm^{-2})	0.02 ± 0.028	0.02 ± 0.024	0.017 ± 0.016	0.022 ± 0.021	0.020 ± 0.020	0.019 ± 0.019	0.020 ± 0.018

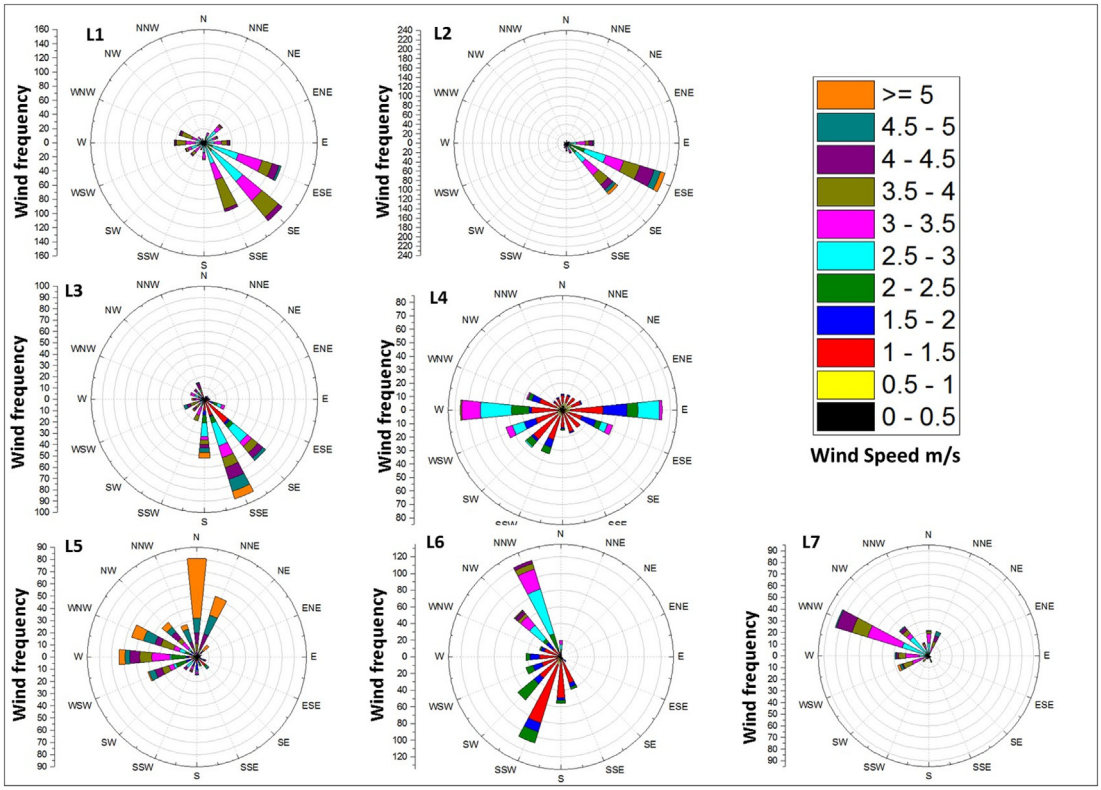

Fig. 6. Wind roses plot of various locations during the sampling period.

events were recorded. Badarinath et al. (2009a, 2009b) highlighted that in climate change studies the long-range transportation of atmospheric pollutants is an important factor as it not only impacts the atmospheric chemistry in regional but also on a global scale.

4. Source apportionment

4.1. Principal component analysis

The approach of principal component analysis (PCA) was applied to identify the emission sources. PCA application transforms the variables of the original dataset to smaller set having the liner combinations and accounts for having most of the variances of the original dataset which have most of the information of it (Ravindra et al., 2008; Jain et al., 2017, 2018). Factor analysis was performed with varimax rotation and Keiser normalization using SPSS 24.0 software. Factor having an eigen value >1 were considered as shown in Supplementary Table 3. The PCA results are shown in Supplementary Table 3, having the first two factors as they explain maximum variance (Ravindra et al., 2006, 2008).

Chandigarh site has high factor loading of CO, O_3, C_6H_6, Toluene, m-, p-xylene with 33% of the variance for Factor 1, whereas, factor 2 has high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1). CO is a product of incomplete combustion and may be from vehicular and biomass combustion (Guo et al., 2004). Benzene (C_6H_6) is emitted from vehicles in urban areas and from open biomass and solid biomass fuels burning in rural areas (Guo et al., 2004). Whereas in Fatehgarh Sahib Factor 1 has high factor loading of fine particulate matter ($PM_{2.5}$,

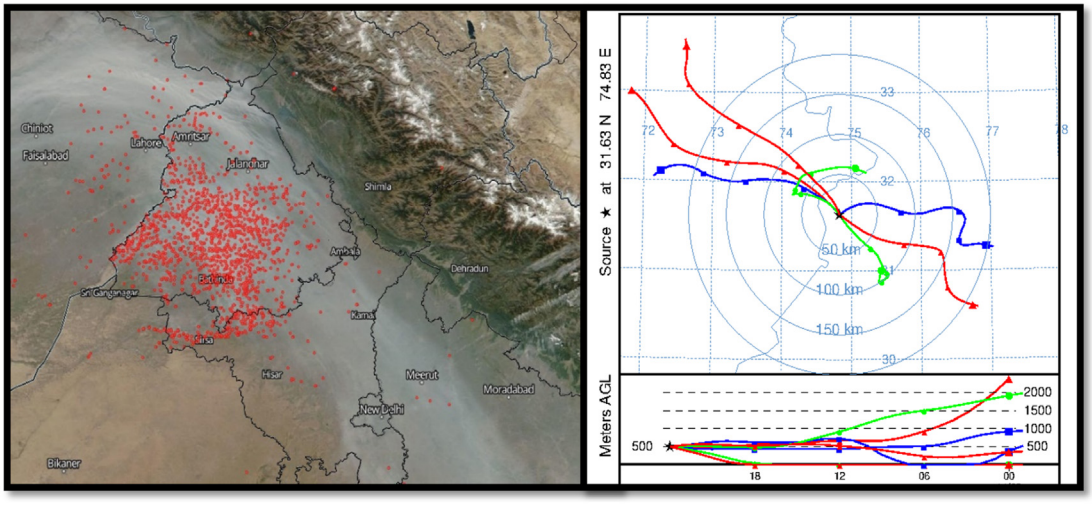

Fig. 7. MODIS (Aqua and Tera) fire and thermal anomalies on 11 November 2016 (left) and 48 h backward trajectory of air masses at Amritsar from 9 to 15 November 2016 (right).

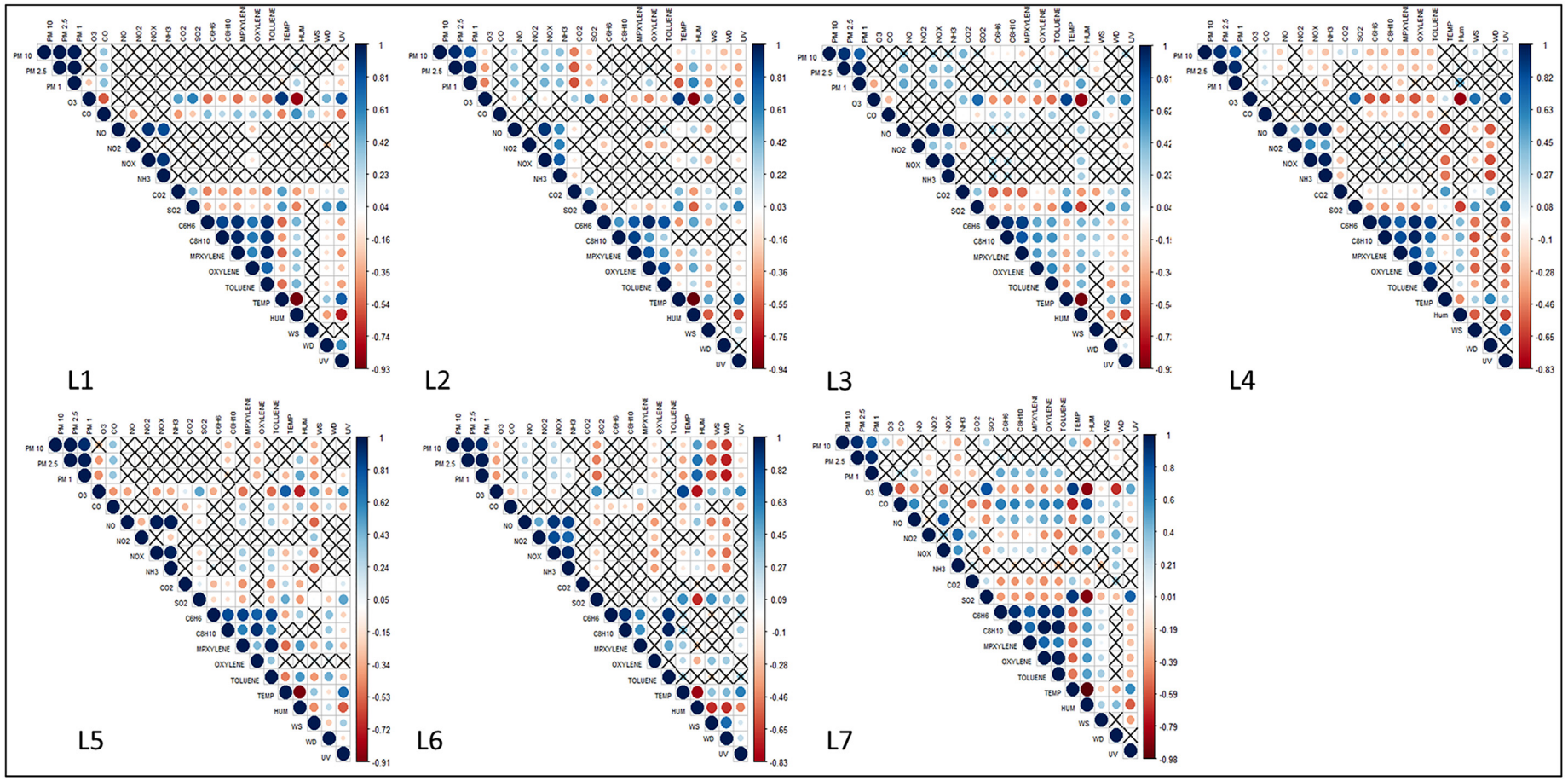

Fig. 8. Correlation plot of various air pollutants and meteorological parameter.

PM_1), O_3, C_6H_6, o-Xylene, and explaining 32% of variance whereas the factor 2 has higher factor loading of NH_3 and again for C_6H_6. As reported by Guo et al. (2004), benzene in rural areas may be related to biomass and biofuel burning.

At Amritsar location, Factor 1 has high factor loading of O_3, C_6H_6, C_8H_{10}, m-, p-xylene explaining 31% of variance whereas factor 2 has higher factor loading of particulate matter, NO, NOx and NH_3. For Bathinda location Factor 1 has high factor loading of O_3, C_6H_6, C_8H_{10}, toluene, m-, p-xylene, o-Xylene and explaining 33% of variance whereas factor 2 has higher factor loading of NO, NOx and NH_3. The NOx emissions can be related to vehicular activities, whereas VOCs emissions may be linked to industrial and biomass burning activities.

In Sirsa Factor 1 has high factor loading of O_3, Toluene, m-, p-xylene, o-Xylene and explaining 30% of variance whereas factor 2 has very high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1). Whereas in Rohtak, Factor 1 has a high factor loading of fine particulate matter ($PM_{2.5}$, PM_1) and SO_2 explaining 30% of the variance, whereas factor 2 has a high factor loading of C_6H_6, C_8H_{10}, toluene. For Sonipat location Factor 1 has high factor loading of O_3, CO, SO_2, C_6H_6, C_8H_{10}, toluene, o-m-p-xylene, explaining 40% of variance whereas factor 2 has very high factor loading of particulate matter (PM_{10}, $PM_{2.5}$, PM_1) and NH_3. The high loading factor of ozone in all the location can be linked to the transformation of VOCs results from vehicular activities/biomass burning and NOx results from vehicular activities.

4.2. $PM_{2.5}/PM_{10}$ and VOC characteristic ratios

The $PM_{2.5}/PM_{10}$ during the whole campaign ranges from 0.69 to 0.83, which was highest at Rohtak and lowest at Amritsar, as shown in Table 4. The average $PM_{2.5}/PM_{10}$ ratio shows that about (69–83%) of PM_{10} is made up of $PM_{2.5}$, and the presence of finer particle is higher in air. The higher ratios may be linked with the formation of secondary aerosols. The lower mixing height in winters helps in the agglomeration of precursors of secondary aerosol and enhances their formation (Strader et al., 1999) in which aqueous chemistry during high relative humidity also played an important role (Hu et al., 2016). Wang et al. (2019) also reported that in polluted days of the winter season, there is a higher formation of secondary aerosols as compare to normal days. Amritsar location also experienced little rainfall during the sampling, which could result in the setting of particles. Awasthi et al. (2011) reported that smaller particles fraction dominates during crop residue burning period and $PM_{2.5}$ contributes around 55% to 64% of total RSPM. The higher $PM_{2.5}/PM_{10}$ ratio indicates the presence of freshly emitted aerosols.

The emission sources of various VOCs can be compared using interspecific ratios (Table 4) (Hoque et al., 2008; Tiwari et al., 2010). The presence of highly reactive VOCs in the atmosphere shows low concentration in day time due to photochemical reactions, whereas the less reactive VOCs accumulate during daytime (Rad et al., 2014). The T/B ratio ranges from 2.7 to 7.6, which is generally used to determine the photochemical age of air masses. The values were much higher in Fatehgarh Sahib, Amritsar, Bathinda and Sirsa locations which indicates the closeness to the emissions sources and have the influence of young air masses (Bruno et al., 2006; Roukos et al., 2009), The value of T/B < 2 indicates the higher influence of vehicle exhaust emissions whereas the higher values indicate about other sources such as biomass burning, industry emissions (Singh et al., 2016; Hui et al., 2018). The o-X/B ratio ranges from 0.2 to 1.3 were found at different sampling sites, which can be used as an indicator to estimate the regional transport rate of VOCs (Monod et al., 2001). The higher o-X/B ratio indicates toward the sources closer to the study area and implies that photochemical processes have a lower impact on the pollutants concentrations whereas lower ratios indicated the occurrence of transported and aged air masses, having an active photochemical reaction (Tiwari et al., 2010; Singh et al., 2016).

Similarly, the m,p-X/EB ratios indicate toward the sources closer to the study area and m,p-X/EB ratios < 3 indicates higher regional transport rates (Feng et al., 2018). In the current study, the m,p-X/EB ratios range from 0.9 to 1.7. Here the VOCs characteristics ratios indicate that the air quality was influenced by sources such as biomass burning other than vehicular emissions, and the emissions sources were both local as well as regional transported.

Table 4
$PM_{2.5}/PM_{10}$ and VOC concentration ratios during campaign (Toluene/benzene (T/B), m,p-xylene/benzene (m,p-X/B), oxylene/benzene (o-X/B), and o-X/EB concentration ratios at various locations).

Location	$PM_{2.5}/PM_{10}$	T/B	EB/B	m,p-X/B	o-X/B	o-X/EB	m,p-X/EB
Chandigarh	0.73	2.75	0.51	0.76	0.23	0.45	1.48
Fatehgarh Sahib	0.76	7.63	0.25	0.42	0.37	1.46	1.69
Amritsar	0.69	6.27	0.74	0.69	0.36	0.48	0.94
Bathinda	0.76	5.30	1.42	2.22	0.86	0.60	1.56
Sirsa	0.76	5.13	0.88	1.07	0.50	0.57	1.22
Rohtak	0.83	2.98	1.25	1.68	1.35	1.09	1.35
Sonipat	0.74	3.25	1.36	1.58	1.00	0.74	1.17

5. Conclusion

Air pollution is one of the serious concerns these days due to its impact on climate and health. Further, crop residue burning affects air quality in Asia and specifically in IGP, India. Considering this, 17 air pollutants during crop residue burning were monitored in near real-time along with meteorology parameters in seven cities to better understand their correlation. Pollutants levels found to be elevated during the crop residue burning. PM and BC emissions during crop residue burning found much higher (24 h limits). The monitored level of gases and VOCs were found below 24 h limits, but these them can play an important role in the formation of secondary air pollutants depending on their residence time and meteorological conditions. Air quality data was also analyzed to identify sources of emissions using principal component analysis, and it identifies biomass burning and vehicular activities as major sources of air pollution. The finding of the current study will be useful to better understand the temporal and spatial distribution of air pollutants during crop residue burning period and to plan comprehensive air quality improvement strategies under National Clean Air Program.

Acknowledgments

RK would like to thank Department of Health Research (DHR), Indian Council of Medical Research (ICMR), Ministry of Health and Family Welfare via Letter number V-25011/25(19)2013/HR dated 16 October 2014, for providing the Fellowship Training Programme in Environmental Health under Human Resource Development Health Research Scheme. TS is thankful to the University Grant Commission (UGC), New Delhi for providing the financial assistance to carry out the Ph.D. research work. The authors are thankful to local hosts for providing logistics support at sampling locations. We are also thankful to Dr. Sudesh Chaudhary from Deenbandhu Chhotu Ram University of Science and Technology, Sonipat, Haryana. The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and READY website (http://www.ready.noaa.gov) used in this publication. Indian Institute of Tropical Meteorology, Pune is supported by the Ministry of Earth Sciences (MoES), Government of India, New Delhi.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.scitotenv.2019.06.216.

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