The objectives, methodology and salient findings of the study are presented briefly.
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6. SUMMARY

Mites are cosmopolitan arachnids, notorious for their status as pests, pathogens, predators and biocontrol agents. Most of the mites can easily be distinguished by their small body size and four pairs of legs. In accordance to their diverse roles and habitats, these have specialized body parts which help them survive in their preferred habitat. Study and control of mites affecting agriculture farmlands have always been given serious consideration owing to the great economic loss they bring to farm produce both during pre-and post harvest seasons.

However, the available information on this important group of arachnids is extremely limited. Inadequate taxonomic knowledge of these minute organisms make their identification extremely difficult and thus restricts the efficient IPM diagnostics and their utilization in biocontrol programmes. Hence, the present study was undertaken with objectives of survey and collection; study of important cereal associated mites, description and redescription of species and finally formulation of key for the identification of species facilitated by computer aided diagnostics on a multimedia enabled platform.

A critical review of literature, tracing the history of mites from its inception till date, has been presented. Further, major modifications in mite classification, details on major contributors and contributions to acarological studies, mite pests and predators on cereal crops from the world, their systematic placement, habitat, host preferences and bionomics have been recorded. Taxonomic review of the 13 families collected with emphasis on taxonomy, biology and ecology have been deliberated in the second chapter. In this, the observations and results of earlier workers have been presented in chronological sequence. These reinforce the necessity for detailed studies on the mites associated with cereal agroecosystems. Thus, detailed studies were undertaken on the biodiversity and taxonomy aspect.

The source material, which formed the basis of the investigations and the procedure adopted for collection, mounting and preparation of material for final microscopic studies, comprises the third chapter. For the present study, plant samples
were collected from farm fields, primarily from the northern states of the country. About 119 localities under 21 districts of Haryana, 46 localities in 12 districts of Punjab, IARI farm fields and the rich floral belt of Yamuna Biodiversity Park in Delhi, parts of Jammu, Uttar Pradesh and Uttarakhand were surveyed. More than 132 one-day field trips were conducted, apart from the daily field visits of IARI farm lands. Berlese funnel was used for extractions of mites from soil samples. Preserved specimens available at the NPC, Division of Entomology, IARI, New Delhi were also studied. Thus, more than 500 slides were prepared with approximately 2500 mites mounted on these.

The results of the studies on mites associated with cereals has been compiled in Chapter four. This study has yielded information on 283 species which have been segregated into two checklists. These provide details on the taxonomy and distribution of all cereal mites, with emphasis to the most accepted names and synonyms. The information on the host, nature of damage and their bionomics have been compiled, consolidated and comprehended in the form of a checklist with details classified.

Taxonomic studies led to the identification of 22 species under 17 genera in 13 families. Three species new to science and five new record are the significant findings of this study. All the species are provided with illustrations, focussing on latest terminology and classification. Several new characters have been appended to the species description in accordance to the latest pattern followed for the various mite families, thus, filling gaps in morphological characterization of the species. More than 100 line diagrams were drawn, their scale determined and arranged on plates for species diagnostics. 22 photographic images have been processed and digitized.

Key to the various superorders, orders, suborders, superfamilies, families, tribes, genera and species have been formulated with an updated nomenclature and classification, augmenting these with more reliable set of characters based on the latest system of classification.

An illustrated diagnostic keys to the 13 families studied have been developed and characters from the superorder level have been traced individually for each family.
and marked with specific highlighters to facilitate easy and quick comprehension. More than 200 coloured illustrations have been prepared and used in the key for describing the characters defined for the 2 superorders, 3 orders, 3 suborders, 12 superfamilies and 13 families of mites collected from cereal agroecosystems. The keys developed using Adobe Photoshop Elements® 2.0 are hyperlinked with their respective descriptions in the text. This is the most important highlight of the study as the details have been handled through a unique and novel approach leading to digitization.

A multimedia enabled diagnostic key of the 13 families, 17 genera and 22 species collected in the present study from cereal agroecosystems has been built in HTML language through Microsoft Office Publisher® 2007. A 51 MB filtered web page has thus been produced transcending over 67 HTML pages incorporating 168 JPEG pictures.

The checklist of mites associated with cereals has been converted into Microsoft Office Access® 2007 based 7 MB filtered database including 1615 records and 4 tables, encompassing details on the species, genera, families, host, nature of damage, bionomics and distribution of the 283 species known from cereal agroecosystems. Forms have been designed to query and retrieve information on single species from the database and present it in the form of a comprehensive report. This again is unique as it will provide a single window for diagnosis enabling authentic identification and thus providing an easy and quick hand to the salient details of biodiversity that will be essential for any application.

Chapter five discusses the salient findings of the present study, focusing on its advancement and achievements over previous such observations. The checklist, species diagnostics, illustrated keys, multimedia enabled diagnostic keys and species specific information retrieval system of the database are thus the first of its kind. The various discrepancies in the systematic studies are also duly presented, providing an uploaded platform.

Thus, the present study focused on the objectives of conducting surveys of rice, wheat, maize, pearl millet and sorghum agroecosystems of Punjab, Haryana and Delhi
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with special reference to major mite pests, conducting biosystematic studies of cereal associated mites, developing illustrated diagnostic keys for identification of the most important cereal mite pests and databasing and digitizing the inventory of their faunistic diversity culminating in a computer aided diagnostics. To summarize, the results and achievements are enlisted as follows:

1. A comprehensive checklist of 283 species of mites under 92 genera and 30 families prepared.
2. Latest taxonomy, species designation, updated names, synonyms, combinations and distribution presented.
3. Host preference, nature of attack and bionomics enlisted.
4. Highest number of species diversity recorded from Prostigmata.
5. Prostigmata recorded 203 species in 56 genera and 18 families.
6. Highest species diversity in Prostigmata belonged to Tetranychidae- 83 species.
7. Mesostigmata recorded 42 species in 17 genera and 6.
8. Highest species diversity in Mesostigmata belonged to Phytoseiidae- 25 species
9. Astigmata recorded 38 species in 19 genera and 6 families.
11. Maximum species diversity recorded on rice, followed by wheat, maize, sorghum and pearl millet.
12. Species diversity in farm fields was more than those recorded in storage.
13. Maximum species on cereals recorded from India – 85 species.
14. The Indian subcontinent contained 30.5% of the total Prostigmata, 59.5% Mesostigmata and 60.5% Astigmata from cereal agroecosystems.
15. 134 species from 55 genera under 23 families have been checklisted from rice agroecosystems alone depicting a 55% increase in the species checklisted by Joshi et al. (2002).
16. Eight tables constructed summarizing the data obtained from analysis of various parameters of the checklist.
17. Keys to superorder, order, suborder, superfamilies, families, genus and species follows the latest system of classification.
18. The keys have been modified from existing ones by augmenting more set of characters or have been formulated afresh.
19. Illustrated diagnostic key to 13 families with more than 200 illustrations have been prepared using Adobe Photoshop Elements® 2.0.
20. 39 plates have been developed enumerating the key to 13 families.
21. Illustrated key to families have been hyperlinked to their corresponding descriptions in the text- a novel approach towards digitization.
22. Detailed morphology of 22 species under 17 genera in 13 families studied.
23. Description of each species follows latest pattern specific for the family.
24. Morphometric studies conducted and details of additional set of characters provided.
25. Dorsal and ventral chaetotaxy with latest nomenclature depicted in figures and used in species description.
26. More than 100 line diagrams depicting important species diagnostic characters included.
27. Adobe Photoshop Elements® 2.0 used to enhance and set the line diagrams along with scale of magnification and legends culminating in 24 plates.
28. 22 photographic images taken using Canon Powershot camera attached to Leica DM 1000.
29. Photographic images processed and converted to .jpg format using Adobe Photoshop Elements® 2.0 and set on 6 Plates.
30. 3 new species and 5 new records from cereal agroecosystems recorded from the present study.
31. *Pronematus oryzae* Menon *et al.*, (Prostigmata: Tydeidae) was recorded from rice fields of IARI farm lands.
32. *Abacarus sorghi* sp. nov., (Prostigmata: Eriophyidae) was recorded from sorghum fields of IARI farm lands.
33. *Euseius sunilii* sp. nov., (Mesostigmata: Phytoseiidae) was recorded from rice fields of IARI farm lands.
34. *Coleoscirus buartsus* den Heyer (Prostigmata: Cunaxidae), first record from India, first record of species from India and first record from wheat.

35. *Pseudopygmephorus* near *shanghaiensis* Zou, Gao and Ma (Prostigmata: Neopygmephoridae), first record of genus and species from India and first habitat record from soil of rice, wheat and maize.

36. *Siteroptes graminicola* Mitrofanov, Shabanova and Sevastianov (Prostigmata: Pygmephoridae), first record of species from India.

37. *Stigmaeus unicus* Kuznetsov (Prostigmata: Stigmaeidae), first record of species from India and first habitat record from soil of wheat.

38. *Trochometridium* near *kermanicum* Mortazavi and Hajiqanbar (Prostigmata: Trochometridiidae), first record of family, genus and species from India and also first habitat record from soil of wheat and rice.

39. The record of *Trochometridium* near *kermanicum* from soil of agricultural farm lands is of significance as all other members of this family and genus have been associated with insects only.

40. A multimedia enabled diagnostic key of the 13 families, 17 genera and 22 species has been designed using Microsoft Office Publisher® 2007.

41. 51 MB filtered web page with 67 HTML pages and about 168 JPEG pictures created.

42. 7 MB filtered database created in Microsoft Office Access® 2007, with 1615 records and 4 tables; details on 283 species documented.

43. Queries and macros specified to retrieve species specific data from database.

44. A total of 3 papers published in National journals and two powerpoint presentations made in National and International Acarology Seminars.