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Evaluation of efficacy of bowl traps (bluish and yellowish) in collection of cash crop pollinators (Order: Hymenoptera) from irrigated areas of district Bhakkar and Layyah, Punjab, Pakistan

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Abstract
Extensive surveys were carried out during 2015-2016 in irrigated areas of District Bhakkar and Layyah. The main purpose of the research was to estimate the efficiency of bluish and yellowish bowl traps for the collection of hymenopteran insects. Bowl traps containing detergent were used and neither attractants nor pheromones were used. Eight hotspots were selected from each respective district and each hotspot was further divided into four replicates and insects were collected from each hotspot. *Andrena, Nomia* and *Halictus* bees were highly attracted towards the bluish and yellowish bowls while *Apis, Lasioglossum, Megachila, Osmia* bees, and *Polistes* and *Campsomeriella* wasps were not. The mustard crop in District Bhakkar, yellowish bowl contained *Andrena* (24/ sample) while *Campsomeriella* (5/ sample) in bluish bowls. Yellowish bowls were highly efficient in collection of hymenopteran pollinators than bluish bowls.

Keywords: Bluish bowl, yellowish bowl, *Polistes, Apis,* mustard, maize

1. Introduction

In agroecosystems of District Bhakkar and Layyah a good diversity of hymenopteran pollinators is present and it is the need of the hour to explore this diversity which will promote crop production practices. The aim of this study was to find out the efficiency of bowl traps for pollinators' collection in irrigated areas of District Bhakkar and Layyah. Pakistan is an agricultural country and agriculture accounts a good role in GDP. It has agricultural lands which are irrigated by Indus river basin system which is the largest irrigation system in the world. District Bhakkar lies between 31.6230° N and 71.0626° E and District Layyah lies between 30.968° N and 70.943° E. Sugar industry and agriculture are the major source of income for the people living here and also improve the living standards of the people of these areas. Bhakkar district and Layyah district have two areas: Kaccha area along the Indus River and Thal desert area in the plain region. The major crops of irrigated areas are wheat, cotton, mustard, maize and cotton.

A pollinator is an organism which transfers pollen from one flower to another flower and thus helps the plants in making seeds and fruits. Hover flies, butterflies, moths, Bees, pollen wasps and flower beetles are important pollinators [34, 8, 22]. In agroecosystems pollinators like honey bees and other hymenopterans increase crop productivity [25, 29, 38, 41, 49]. 1500 crop species of the world are directly or indirectly pollinated by hymenopterans and other pollinators which account for 15-30% of world food production [25]. 60 crop species are pollinated by insects in Pakistan [19]. Kunjwal *et al.,* [26] examined that in mustard crop (*Brassica juncea*) 30 species of insect pollinators visited and *Apis mellifera* was condensely present. Amount of viable pollen and pollinator foraging behavior affect the reproductive capacity of plants [44]. Hymenoptera is the diverse group of insects and contained more than 100,000 species and their pattern of diversity, abundance and distribution is dependent on nutritional supply and other factors [2]. The hymenopteran pollinator families Apidae, Vespidae, Megachilidae, Formicidae, and Sphecidae were abundantly present in various parts of India [37, 20].

Cotton is known as 'White Gold' and is one of the most important cash crop and backbone of Pakistan and adds 8.2% value in agriculture and contributes a good source of foreign

Exchange [1]. Bee species' diversity in conventional farming is important in cotton crop yield [31, 46]. Maize has low contents of proteins and essential amino acids and so is grown for biofuel and fodder. Bees are unable to differentiate the pollen as low and high quality food contents but search for maize pollen as a food source [17]. Millet pollen are so numerous which attract a large number of insects especially honey bees [19, 36]. Larger and smaller bees are able to pollinate wheat flowers although wheat is non-pollinated dependent crop [19, 18]. The most common and effective method in collection of insects particularly bees is bowl trapping method and is progressively becoming a valuable tool around the world [11, 10]. Saunders and Luck [42] and Cane *et al.,* [6] reported that diversity and activities of different types of species could be measured by bowl trapping and also stated that this method was not dependent on the skills of insect collectors and was time saving and very easy and simple method. Bowl traps are polyethylene plastic bowls filled with water containing odourless detergent or soaps [32, 27]. Grundel *et al.,* [13], Campbell and Hanula [5] and Kevan [24] experimentally proved that colour of the trap had strong effect on the insect collection and bluish and yellowish bowl insect capturing ratio was varied and captured insects very efficiently. Yellowish bowls had more accuracy and efficiency in collection of insects like bees and wasps [21]. The objective of the study was to determine the efficiency of bowl traps in collection of hymenopteran pollinators so as to increase the crop production through proper utilization of hymenopteran insect.

2. Materials and Methods

2.1 Field Surveys

A detailed survey of irrigated areas of district Bhakkar and Layyah was conducted during 2015-2016 in order to check the crop types and hymenopteran pollinators and wheat, maize, millet, mustard, and cotton were selected for the study of hymenopteran pollinators. Field experiments were performed in two seasons, autumn season 2015 (from mid-September to mid-November) and spring season 2016 (from mid-February to mid-April).

2.2 Field Plan and data collection

Study areas were divided into two blocks, block A district Bhakkar and block B district Layyah along the the Indus belt (Kaccha areas) and each block was further divided into eight hotspots. District Bhakkar was divided into hotspots Ali Lak, Subhan Chowk, Basti Majoka, Jhok Shah Mohammad, Dajal, Khichi Khurd, Basti Nourang Khan, Basti Mulan Wali and District Layyah was divided into hotspots Basti Umar Wali, Chughtai Nagar, Sheihn Wala, Sargani Nasheb, Basti Qazi Rajan Shah, Nasheb Dostoo Khoo, Basti Shadoo Khan, Mouza Sumra Nasheb.

Afield of minimum 0.5 acres of respective crops was designed for the collection of hymenopteran pollinators in each hotspot. Each crop field was further divided into four replicates. Bluish and yellowish bowl traps were placed properly in a cross manner on the ground for about two hours in a 12m^2 area of respective replicate. Time was noted at the start and end of morning session in each respective field. Data was recorded in the morning session before 1200 pm. The distance between two hotspots was approximately 5 Km.

Per day two hotspots were studied from one district and then next two hotspots were studied in other district and data was collected continuously and consecutively except when weather conditions were not suitable for the insect collection. For pollinators' collection two types of bowl traps like bluish and yellowish bowls containing 3% detergent (locally available Bonus Tristar) were used. Pollinators were collected from each hotspot and were placed in a Styrofoam box in a proper manner and tagging and were identified in the laboratory by the help of Published Hymenopteran identification keys (Fig. 1).

Y. bowl arrangement and detergent

B. bowl showing captured insects

Y. bowl placed in a replicate

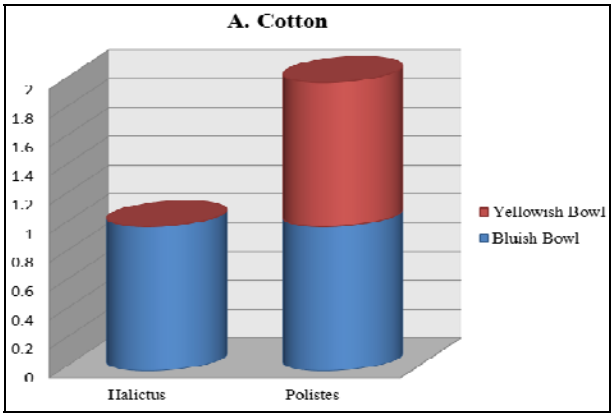
B. bowl in a replicate filled with detergent

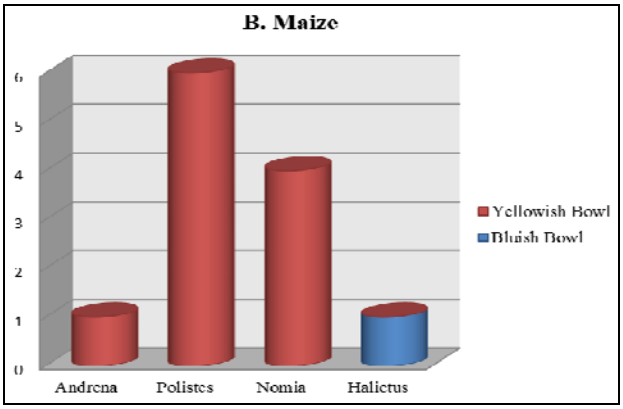
2.3 Insect Preservation
Hymenopterans were preserved by the help of taxonomic standard methods. According to the size of the insect, Hymenopterans were pinned by use of entomological pins of various sizes. Pin was inserted in right of midline of thorax. Different insects were mounted according to their size in the insect collection box after pinning insects were spread on the spreading board. Collector name, collection date, locality and other details were labeled on the paper and attached to the long pins.

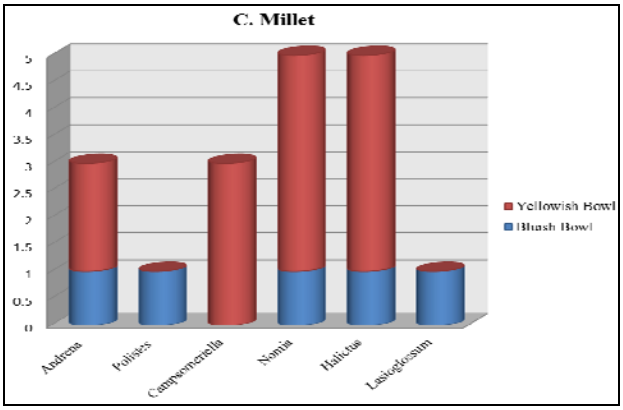
2.4 Insect Identification
Pollinators were identified by the help of Published Taxonomic keys of Hymenoptera like Siddiqui *et al.,* [45], Gupta [14], Saini *et al.,* [40], Buck *et al.,* [4], Prokop *et al.,* [35], Gupta and Jonathan [16], Michener [28], Engel [9], Goulet and Huber [12], Gupta [15], Kentucky 4-H Entomology [23], Buchmann *et al.,* [3], Choate [7], Pascarella [30], Scott and Stojanovich [43]. After identification pollinators were preserved for sample and future study.

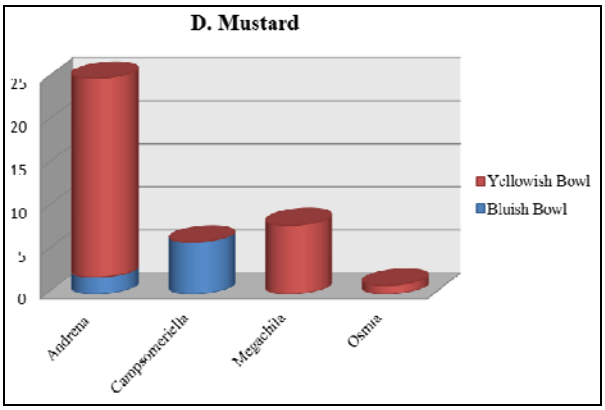
2.5 Meteorological Data
To analyze the humidity (%), rainfall (mm) and temperature (C°), meteorological data was collected from Meteorological Department of District Bhakkar and Layyah because these factors are crucial in insect diversity, distribution and reproduction.

3. Results and Discussion
Detailed study has revealed that in District Bhakkar bees and wasps were highly attracted towards the yellowish bowls and condensely present and bees accounted a total abundance of 41 while wasps showed a total number of 12. A little information is available on bowl traps in collection of cash crop pollinators, so on the basis of available data, these findings were resembled to the study of Popic *et al.,* [32] which indicated the richness of bees (1233) and wasps (375). Out of total 3617 captured insects among 51 species from maize fields, the total abundance of genus *Andrena* was 2, *Apis*= 5, *Halictus*= 39, *Lasioglossum*= 268 from both yellowish and bluish bowls [50]. From bean crops, Prababhvati and Khadri [33] evaluated that yellowish bowl displayed high efficiency in collection of insects Apidae= 24, Vespidae= 0, Halictidae= 50, Megachilidae= 3 Scoliidae= 1 while bluish bowl exhibited 38, 1, 11, 1 and 1 respectively. Kapkoti *et al.,* [21] evaluated that density of bees in yellowish bowls was 5.90 while density of wasps was 2.3. Grundel *et al.,* [13] collected a total of 3159 bees in yellowish bowls. Saunders and Luck [42] and Gollan *et al.*, [10] reported that yellowish bowls were highly efficient in collection of insects. Genus *Apis* was less attracted to bowls and bluish bowl contained a total of 3 while yellowish bowl had a total of 4 number of Genus *Apis.* Goncalves and Oliveira [11] investigated that honey bees (*Apis mellifera)* were less attracted towards the bowls. Highly encountered genus was *Andrena*, 21 in bluish bowls and 37 in yellowish bowls. Popic *et al.,* [32] noted that Halictine bees (678) were more frequent in yellowish bowls. Halictine bees, 12 in bluish bowls and 30 in yellowish bowls, were in abundance while Megachilid bees, 5 in bluish bowls and 14 in yellowish bowls, were less encountered from bowls. Halictine bees were most encountered bees among 745 collected different species from Semi deciduous forest fragments in Southern Brazil [11]. Gollan *et al.*, [10] estimated that 50 species of Halictid bees were collected out of 1267 collected bees in New South Wales, Australia. Popic *et al.,* [32] studied that abundance of Halictid bee was 678 while *Megachile bees* was 6. During our research in District Layyah, yellowish bowls represented a slight low attraction of hymenopteran insects than bluish bowl. These results were also resembled to the study of Wheelock [50], Tuell *et al.,* [48], Wilson *et al.,* [51], Roulston *et al.,* [39] and Toler *et al.,* [47].









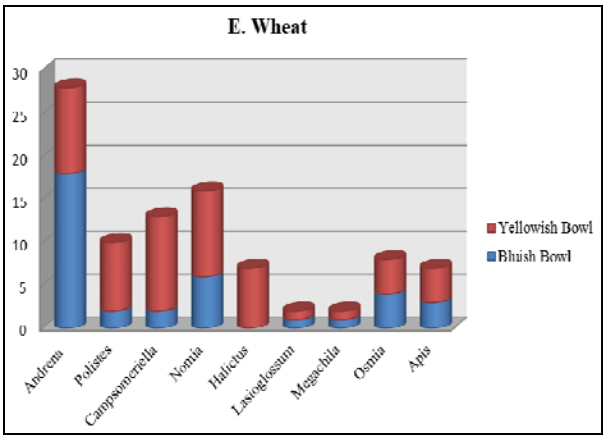


Fig 2: (A-E). Bluish and yellowish bowls showing abundance of hymenopterans from different crops of irrigated areas of District Bhakkar.

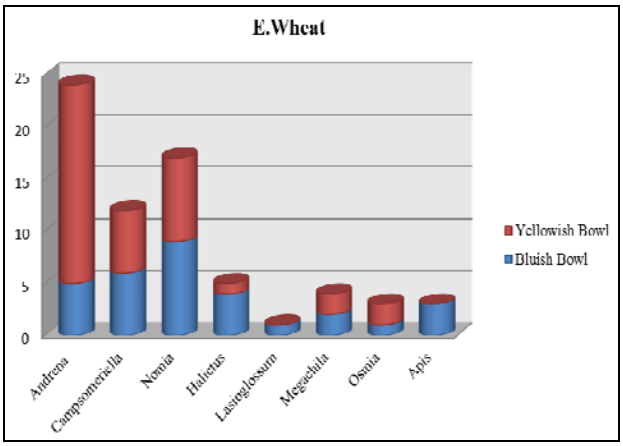
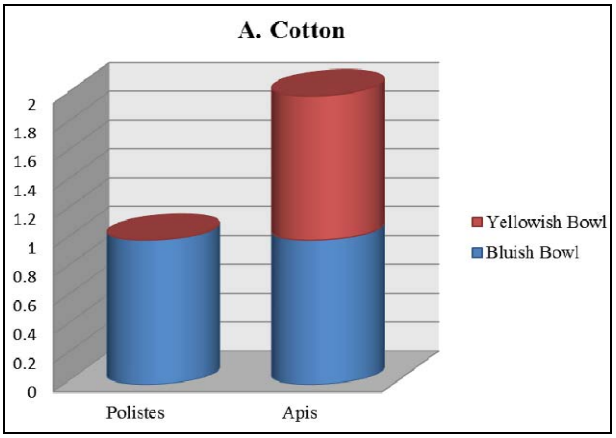
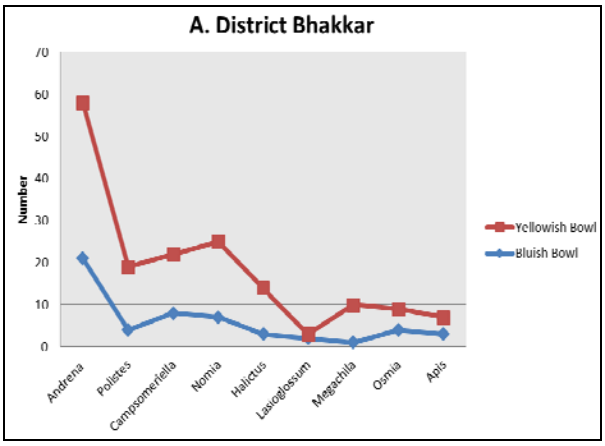
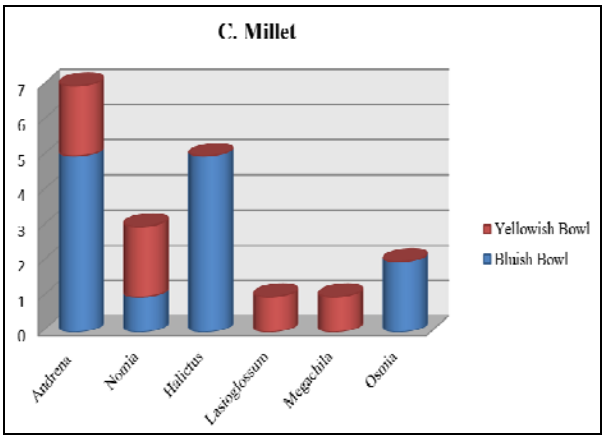
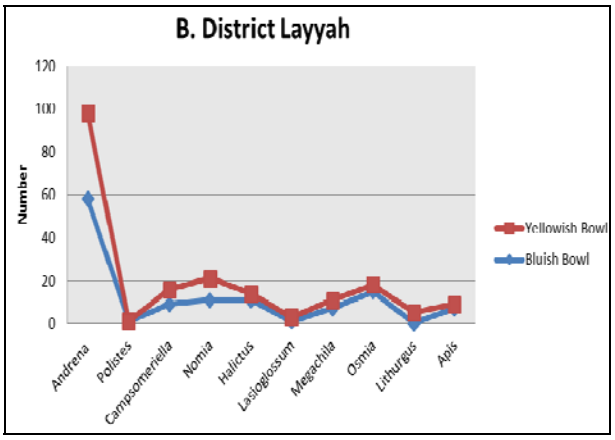


Fig 3 (A-E): Bluish and yellowish bowls showing abundance of hymenopterans from different crops of irrigated areas of District Layyah









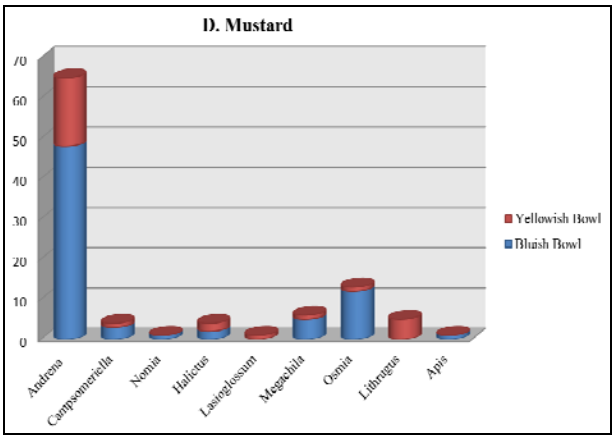


Fig 4 (A-B): Bluish and yellowish bowls showing number of hymenopterans in District Bhakkar and Layyah.

4. Conclusion

Bees were highly attracted towards yellowish and bluish bowls than wasps. *Andrena*, *Nomia* and *Halictus* bees were highly attracted towards the bluish and yellowish bowls while *Apis*, *Lasioglossum*, *Megachila*, *Osmia* bees and wasps *Polistes* and *Campsomeriella* were not. Yellowish bowls were highly efficient in collection of hymenopteran bee pollinators than bluish bowls. A small number of insects were collected from cotton fields of District Bhakkar and Layyah due to less attraction of insects in addition heavy pesticides were used in cotton crop fields.

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6. References

1. Azam S, Samiullah TR, Yasmeen A, Ud Din S, Iqbal A, Rao AQ *et al*. Dissemination of Bt. cotton in cotton growing belt of Pakistan. Int. J. Advancement in Life Sciences. 2013; 1(1):8-26.
2. Bhardwaj H, Thaker P, Srivastava M. Hymenopteran floral visitors as recorded from an agroecosystem near Bikaner, Rajasthan. *Global* J. Sci. Frontier Res. Agri. Bio. 2012; 12(3):19-34.
3. Buchmann SL, Bealmear S, Prajzner S, Wojcik V. Arizona bee identification guide- Pollinator Partnership.
4. Buck M, Marshall SA, Cheung DK. Identification Atlas of the Vespidae (Hymenoptera, Aculeata) of the northeastern Nearctic region. Canadian Journal of Arthropod Identification. 2008; 5(1).
5. Campbell JW, Hanula JL. Efficiency of Malaise traps and colored pan traps for collecting flower visiting insects from three forested ecosystems. Journal of Insect Conservation. 2007; 11(4):399-408.
6. Cane JH, Minckley RL, Kervin LJ. Sampling bees (Hymenoptera: Apiformes) for pollinator community studies: pitfalls of pan-trapping. Journal of the Kansas Entomological Society. 2000; 73(4):225-231.
7. Choate PM. Key to the Sub-orders of hymenoptera. University of Florida, Entomology Department.
8. Cunningham SA. Depressed pollination in habitat fragments causes low fruit set. Proc. R. Soc. Lond. Bio. Sci. 2000; 267:1149-1152.
9. Engel MS. A monograph of the Baltic amber bees and evolution of the Apoidea (Hymenoptera). Bulletin of the American Museum of natural History, 2001, 1-192.
10. Gollan JR, Ashcroft MB, Batley M. Comparison of yellow and white pan traps in surveys of bee fauna in New South Wales, Australia (Hymenoptera: Apoidea: Anthophila). Australian Journal of Entomology. 2011; 50(2):174-178.
11. Gonçalves RB, Oliveira PS. Preliminary results of bowl trapping bees (Hymenoptera, Apoidea) in a southern Brazil forest fragment. Journal of Insect Biodiversity. 2013; 1(2):1-9.
12. Goulet H, Huber JT. Hymenoptera of the world: An identification guide to families. *Res.* Branch Agri. Canada, 1993.
13. Grundel R, Frohnapple KJ, Jean RP, Pavlovic NB. Effectiveness of bowl trapping and netting for inventory of a bee community. Environmental Entomology. 2011; 40(2):374-380.
14. Gupta RK. Taxonomy and distribution of different honeybee species. In Beekeeping for Poverty Alleviation and Livelihood Security Springer Netherlands. 2014, 63-103.
15. Gupta R. A key for the identification of Indian genera of family Megachilidae (Hymenoptera: Apoidea). Journal of the Bombay Natural History Society. 1992; 89(3): 296-301.
16. Gupta SK, Jonathan JK. The fauna of India and the adjacent countries. *Hymenoptera: Scoliidae*. Zoological Survey of India, 2003.
17. Hocherl N, Siede R, Illies I, Gatschenberger H, Tautz J. Evaluation of the nutritive value of maize for honey bees. J Insect Psych. 2012; 58(2):278-285.
18. Holzschuh A, Steffan-Dewenter L. Diversity of flower visiting bees in cereal fields: affects farming system, landscape composition and regional context. J Appl. Ecol. 2007; 44:41-49.
19. Irshad M, Stephen E. Value of insect pollinators to agriculture of pakistan. Int. J Agro. Agri. Res. (ISAAR). 2013; 3:14-21.
20. Kannagi A, Sivakumar v, Santhi V, Borgia JF. Hymenopteran diversity in deciduous forest from South India. Int. J Biodiv. Cons. 2013; 5(10):666-670.
21. Kapkoti B, Joshi RK, Rawal RS. Kumaun, Western Himalaya, India. Current Science, 2016; 110(3):438-443.
22. Kato M, Kawakita A. Plant Pollinator interactions in New Caledonia influenced by introduced Honey Bees. American J. Bot. 2004; 91(11):1814-1827.
23. Kentucky 4-H Entomology, Key to common insect orders, University of Kentucky.
24. Kevan PG. Floral colors in the high arctic with reference to insect-flower relations and pollination. Canadian Journal of Botany. 1972; 50(11):2289-2316.
25. Kremen C, Williams NM, Thorp RW. Crop pollination from native bees at risk from agricultural intensification. PNAS. 2002; 99(26):16812-16816.
26. Kunjwal N, Kumar Y, Khan MS. Flowering-visiting insect pollinators of Brown Mustard, Brassica juncea (L.) Czern and coss and their foraging behavior under caged and open pollination. African J. Agri. Res. 2014; 9(16):1278-1286.
27. Leong J, Thorp RW. Colour-coded sampling: the pan trap colour preferences of oligolectic and nonoligolectic bees associated with a vernal pool plant. Ecological Entomology. 1999; 24(3):329-335.
28. Michener CD. (Ed) The bees of the world JHU Press. 2000, 1.
29. Muli E, Patch H, Frazier M, Frazier J, Torto B, Baumgarten T *et al*. Evaluation of the distribution and impacts of parasites, pathogens and pesticides on honey bee (Apis mellifera) population in East Africa. PLOS-ONE, 2014.
30. Pascarella JB. The bees of Florida Part 1. Entomology and Nematology Department, Valdusta State University, Valdusta, Georgia.
31. Pires VC, Silveira FA, Sujii ER. Importance of bee pollination for cotton production in conventional and organic farmes in Brazil. J Pollination Ecology. 2014 13(16):151-160.
32. Popic TJ, Davila YC, Wardle GM. Evaluation of common methods for sampling invertebrate pollinator assemblages: net sampling out-perform pan traps. PloS one. 2013; 8(6):e66665.
33. Prabhavati MK, Khadri SNN. Preliminary results of bowl trapping insects in field bean (Lablab purpureus) ecosystem. Asian J Bioscience. 2014; 9(2):208-212.
34. Primack RB. Variability in Newzealand montane and Alpine pollinator assemblages. Newzealand J Ecology. 1978; 1:66-73.
35. Prokop JAKUB, Nel ANDRÉ. New fossil Aculeata from the Oligocene of the České Středohoří Mts. and the Lower Miocene of the Most Basin in northern Czech Republic (Hymenoptera: Apidae, Vespidae). Sborník Národního Muzea v Praze, Řada B, Přírodní Vědy [Acta Musei Nationalis Pragae, Series B, Natural History]. 2003; 59(3-4):163-171.
36. Pushpalatha S, Hariprasad Y. Foraging behavior of Indian Honey bee (Apis cerana indica Fab.) in bee

pasturaging plants at Annamalainagar Ecosystem. Int. J. Recent Scientific Research. 2015; 6:6974-6976.
37. Rajkumari P, Sharmah D, Rehman A, Patgiri P. Diversity and distribution pattern of hymenopteran insects in Jorhat District, Assam, India. Int. J Sci. Res. 2014; 3(12):1938-1941.
38. Rogers SR. Bee species diversity enhances productivity and stability in a perrenial crop. PLOS-ONE, 2014.
39. Roulston TAH, Smith SA, Brewster AL. A comparison of pan trap and intensive net sampling techniques for documenting a bee (Hymenoptera: Apiformes) fauna. Journal of the Kansas Entomological Society. 2007; 80(2):179-181.
40. Saini MS, Rathor VS. A species checklist of family Halictidae (Hymenoptera: Apoidea) along with keys to its subfamilies, genera & subgenera from India. Int. J Environ. Sci., 2012; 3(1):134-166.
41. Sajjad S, Saeed S, Muhammad W, Arif MJ. Role of insects in cross-pollination and yield attributing components of Sesbania sesban. Int. J. Agric. Bio. 1191): 2009, 77-80.
42. Saunders ME, Luck GW. Pan trap catches of pollinator insects vary with habitat. Australian Journal of Entomology. 2013; *52*(2):106-113.
43. Scott HG, Stojanovich CJ. Stinging hymenoptera: Pictorial key to some common united states families, 100-119.
44. Shenkute AG. Behvioral response of honey bee (*Apis mellifera scutellata* Lep.) to wild pollinators on sunflower *(Helianthus annus L.)* (Doctoral Dissertation, Faculty of Natural and Agricultural Sciences, Unversity of Pretoria, Pretoria), 2009.
45. Siddiqui AJ, Bodlah I, Carpenter JM, Naeem M, Ahmad M, Bodlah MA. Vespidae (Hymenoptera) of the Pothwar region of Punjab, Pakistan. Zootaxa. 2015; 3914(5):501-524.
46. Tanda AS, Goyal NP. Insect pollination in Asiatic cotton (Gossypium arboreum). J Apicultural Research. 1979; 18:64-72.
47. Toler T, Evans EW, Tepedino VJ. Pan-trapping for bees (Hymenoptera: Apiformes) in Utah's West Desert: the importance of color diversity. The Pan-Pacific Entomologist. 2005; 81:103.
48. Tuell JK, Ascher JS, Isaacs R. Wild bees (Hymenoptera: Apoidea: Anthophila) of the Michigan highbush blueberry agroecosystem. Annals of the Entomological Society of America. 2009; 102(2):275-287.
49. Waser NM, Price MV. Pollinator choice and stabilizing selection for flower color in Delphinium nelsonii. Evolution, 1981, 376-390.
50. Wheelock MJ. Insect pollinators in corn and soyabean agricultural fields. Thesis of Master of Science (Entomology). Lowa State University Ames, Lowa, 2014.
51. Wilson JS, Griswold T, Messinger OJ. Sampling bee communities (Hymenoptera: Apiformes) in a desert landscape: are pan traps sufficient?. Journal of the Kansas Entomological Society. 2008; 81(3):288-300.