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A comparative analysis of efficacy of Hand nets and Bowl Traps (bluish and yellowish) in collection of Hymenopteran Pollinators (Phylum: Arthropoda) from different Cash Crops of Irrigated Areas of District Bhakkar and Layyah, Punjab, Pakistan

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Abstract
A detailed survey was carried out during 2015-2016 in irrigated areas of District Bhakkar and Layyah. The present research purpose was to compare the efficiency of bowl traps and hand nets (aerial nets) in the collection of hymenopteran pollinators. From each respective district eight hotspots were selected and each hotspot was further divided into four replicates and bowl traps containing detergent were used in each replicate and pollinators were collected by the help of bowl traps and hand nets. Bowl traps were highly significant in sampling of hymenopteran pollinators than hand nets. *Sceliphron* (23, 33), *Delta* (5, 4) and *Vespa* (4, 7) were sampled by hand nets only from district Bhakkar and Layyah. *Andrena* had total number of 58/ samples and 98/ samples respectively while *Nomia* showed the total abundance of 25 and 21 respectively, and were highly attracted towards the bowls traps in District Bhakkar and Layyah. Genus *Apis*, caught in the aerial nets, had total abundance of 83/ sample and 57/ sample in District Bhakkar and Layyah respectively.

Keywords: Bowl traps, hand net, *Campsomeriella, Apis,* cotton, wheat

1. Introduction

In District Bhakkar and Layyah, a vast diversity of hymenopteran pollinators is present and to promote crop yield and crop practices, it is necessary to explore this diversity. The aim of this study was to compare and analyze the efficiency of bowl traps and hand net for hymenopteran pollinators' collection in irrigated areas of District Bhakkar and Layyah. District Bhakkar geographically lies between 31.6230º N and 71.0626º E and District Layyah lies between 30.968º N and 70.943º E coordinates. Many crops and wild flowers are pollinated by insect pollinators and thus maintain critical ecosystem balance [25]. 15-30 % of world food production is due to pollination of 1500 crop species of the world by hymenopterans and other pollinator animals [21]. Honey bees and other hymenopterans pollinators increase significant crop yield in agroecosystems [21, 24, 30, 33, 38]. Organic cotton fields showed more yield than conventional cotton fields due to a diverse assemblage of bee species [27]. Terrestrial ecosystem has main component of terrestrial arthropods. It has been a topic of hot debates that what would be the best approach to collect terrestrial arthropods [40]. For collection of insect pollinators, a different array of sampling techniques is used but across different habitat types, no single method is being applied by different researchers to collect pollinator insects [25]. Netting skills and observations of a researcher are the main factors in collection of insects [31]. Bowl traps are used efficiently in attracting and collection of insects and are polyethylene plastic bowls filled with soapy water [1, 28, 22, 37, 7, 27, 4]. Bowl traps are specifically good in catching bees but bees (genus *Colletes*) are less attracted towards bowl traps while Halictid bees (family Halictidae) are more attracted towards bowl traps [37].

Bowl trapping method is a valuable tool around the world in insect collection and is becoming progressively significant and popular [11, 10]. The diversity of various types of species can be analyzed by bowl trapping and this is very easy and simple method and not dependent on the

insect collectors' skills and is time saving [34, 7]. The bluish and yellowish bowls efficiently captured insects but insect capturing ratio varied and the colour of the trap had prominent effect on the insect collection [13, 5, 19] and wasps and bees were trapped by yellowish bowls efficiently [17]. Cane *et al.,* [7] observed the insect bee fauna of Creosote bush and concluded that pan traps were less efficient in collecting insects than use of nets and also reported that bee fauna was collected by netting techniques and pan traps and there was no comparison between effectiveness of netting techniques and pan traps due to netting difficulties at Creosote bush. Aerial pan traps were useful in collection of insect bee species in agricultural land [25]. Aerial nets were reliable techniques in Creosote bush bee communities [6]. The objective of the present research was to determine the efficiency of bowl traps and hand nets in collection of hymenopteran pollinators from different cash crops so to choose the right option in capturing the insects which will be helpful in increasing crop yield through proper utilization of hymenopteran insect pollinators.

2. Materials and Methods

2.1 Field Surveys and data collection

During 2015-2016, a comprehensive survey of irrigated areas of district Bhakkar and Layyah was done to evaluate the crop types and hymenopteran pollinators and for this purpose millet, mustard, wheat, maize and cotton were selected for the study of pollinators. Experimental areas were divided into two blocks, block A district Bhakkar and block B district Layyah and each block was further divided into eight hotspots and District Bhakkar had hotspots of Ali Lak, Subhan Chowk, Basti Majoka, Jhok Shah Mohammad, Dajal, Khichi Khurd, Basti Nourang Khan, Basti Mulan Wali while District Layyah had hotspots of Basti Umar Wali, Chughtai Nagar, Sheihn Wala, Sargani Nasheb, Basti Qazi Rajan Shah, Nasheb Dostoo Khoo, Basti Shadoo Khan, Mouza Sumra Nasheb respectively.

The data was collected in two seasons, autumn season and spring season, autumn season from mid-September to mid-November, 2015 and spring season from mid-February to mid-April, 2016. From each hotspot, a crop field of minimum 0.5 acres was selected for the collection of hymenopteran insect pollinators and each experimental field was further divided into four replicates. An area of $12m^2$ was selected from each respective replicate and bluish and yellowish bowl traps were placed properly on the ground in a cross manner for about two hours and data was collected in the morning session before noon and time was recorded at the start and end of morning session. About 10 minutes were taken in each replicate during morning session and insects were collected by the use of hand nets (aerial nets). Bowl traps were filled with 3% locally available detergent (Bonus Tristar) and were placed in each field properly. Six bluish and yellowish bowls with a white bowl in the centre of Hardboard (14 inches × 12 inches size) were laid on the ground in a specific crop field and each bowl size was 3.5 inches in diameter with 2.0 inches height. Hand net circle size was 9 inches in diameter and handle 15.5 inches in length with white small meshed size was used in collection of insects. Two hotspots were selected from one district per day and then next two hotspots were observed in other district continuously and consecutively except weather conditions. The collected pollinators were properly tagged and were placed in a Styrofoam box in a proper manner and were identified in the laboratory by the help of Published Hymenopteran keys and were preserved according to standard taxonomic methods.

2.2 Identification of Insect Pollinators

Hymenopteran pollinators were identified by the help of Published Taxonomic keys like Gupta [14], Siddiqui *et al.,* [36], Buck *et al.,* [3], Saini *et al.,* [32], Prokop *et al.,* [29], Gupta and Jonathan [16], Engel [9], Michener [23], Gupta [15], Kentucky 4-H Entomology [18], Goulet and Huber [12], Buchmann *et al.,* [2], Pascarella [26], Choate [8], Scott and Stojanovich [35]. After identification hymenopteran pollinators were preserved as sample future study.

3. Results and Discussion

The present study indicated that 13 genera were found in District Bhakkar and Layyah each and genera represented in District Bhakkar were *Andrena, Polistes, Sceliphron, Delta, Campsomeriella, Nomia, Halictus, Lasioglossum, Megchila, Osmia, Xylocopa, Apis* and *Vespa* while *Andrena, Polistes, Sceliphron, Delta, Campsomeriella, Nomia, Halictus, Lasioglossum, Megchila, Osmia, Lithurgus, Apis* and *Vespa* were presented in District Layyah. Genera *Andrena* and *Nomia*, caught in the bowl traps, were the most represented genera of District Bhakkar and Layyah and *Andrena* had total number of 58/ samples and 98/ samples respectively while *Nomia* showed the total abundance of 25 and 21 respectively. Genus *Apis*, trapped in the aerial nets, had total abundance of 83 and 57 in District Bhakkar and Layyah respectively while *Polistes* and *Sceliphron* had maximum number of 23 each in District Bhakkar while 38 and 33 in District Layyah. Bowl traps had accuracy over hand nets in attracting and capturing different hymenopterans. *Sceliphron* (23, 33), *Delta* (5, 4) and *Vespa* (4, 7) were taken by the use of hand nets only from district Bhakkar and Layyah. Genus *Osmia* encountered a total number of 9 in bowl traps and 15 in hand net from district Bhakkar while 18 numbers in bowl traps only in district Layyah. *Xylocopa* (3) was presented only in district Bhakkar and was trapped by aerial nets. *Lasioglossum* and *Megachila* were encountered from district Bhakkar and Layyah by the use of bowl traps only and had a total number of 3, 3 and 10, 11 respectively. Among wasps genera, genus *Campsomerilla* was the most frequently occurred genus in bowl traps (22, 16) from both districts respectively while 7/ sample and 4/ sample in hand nets' use. From mustard fields of District Bhakkar and Layyah, 6 and 4 genera were recovered and different bee and wasp species were attracted towards the bowl traps while *Apis* (10, 3/ sample) and *Sceliphron* (5/ sample) samples were collected by aerial nets only. Cotton plants had low abundance of genera and had two genera *Polistes* and *Halictus* from District Bhakkar and three genera *Polistes*, *Sceliphron* and *Apis* from District Layyah and *Halictus* with 1 sample from bowl traps while *Apis* with 2 samples from bowl traps and 4 samples from hand net were collected. Bees and honey bees were less attracted toward cotton flowers due to heavily use of pesticides [20]. A little work is done on bowl traps and hand nets in trapping of hymenopteran pollinators on cash crops and comparison between these two sampling techniques, so the present study findings were analyzed on the basis of available data. From Creosote bush, different bees were collected at three sampling sites by the use of aerial nets and showed diversity index of 0.86, 0.84 and 0.90 respectively [6].

Bowl traps were highly significant in attracting bees and wasps in District Bhakkar and Layyah and had value of 126 and 81 bees while wasps showed a total number of 42 and 17 respectively. These results were in accordance with the study of Popic *et al.,* [28] which showed the abundance of bees (1233) and wasps (375). Saunders and Luck [34] and Gollan *et*

al., [10] indicated that yellowish bowls were reliable in collection of insects. The total abundance of genus *Apis*= 5, *Halictus*= 39, *Andrena* =2, *Lasioglossum*= 268 from both yellowish and bluish bowls out of total 3617 captured insects among 51 species from maize fields [39]. Grundel *et al.,* [13] reported a total of 3159 bees in yellowish bowls. Density of bees in yellowish bowls was 5.90 while density of wasps was 2.3 [17]. Genus *Apis* was less attracted to bowls and contained a total of 7 and 9 in numbers. Honey bees (*Apis mellifera)* were less attracted towards the bowls [11]. *Andrena*, was highly observed genus in the bowl traps with of a value of 58 and 98 respectively from both districts. In Southern Brazil, Halictine bees were highly encountered bee species among 745 collected different species from Semi deciduous forest [11] and the present study results did not match with the above mentioned results.

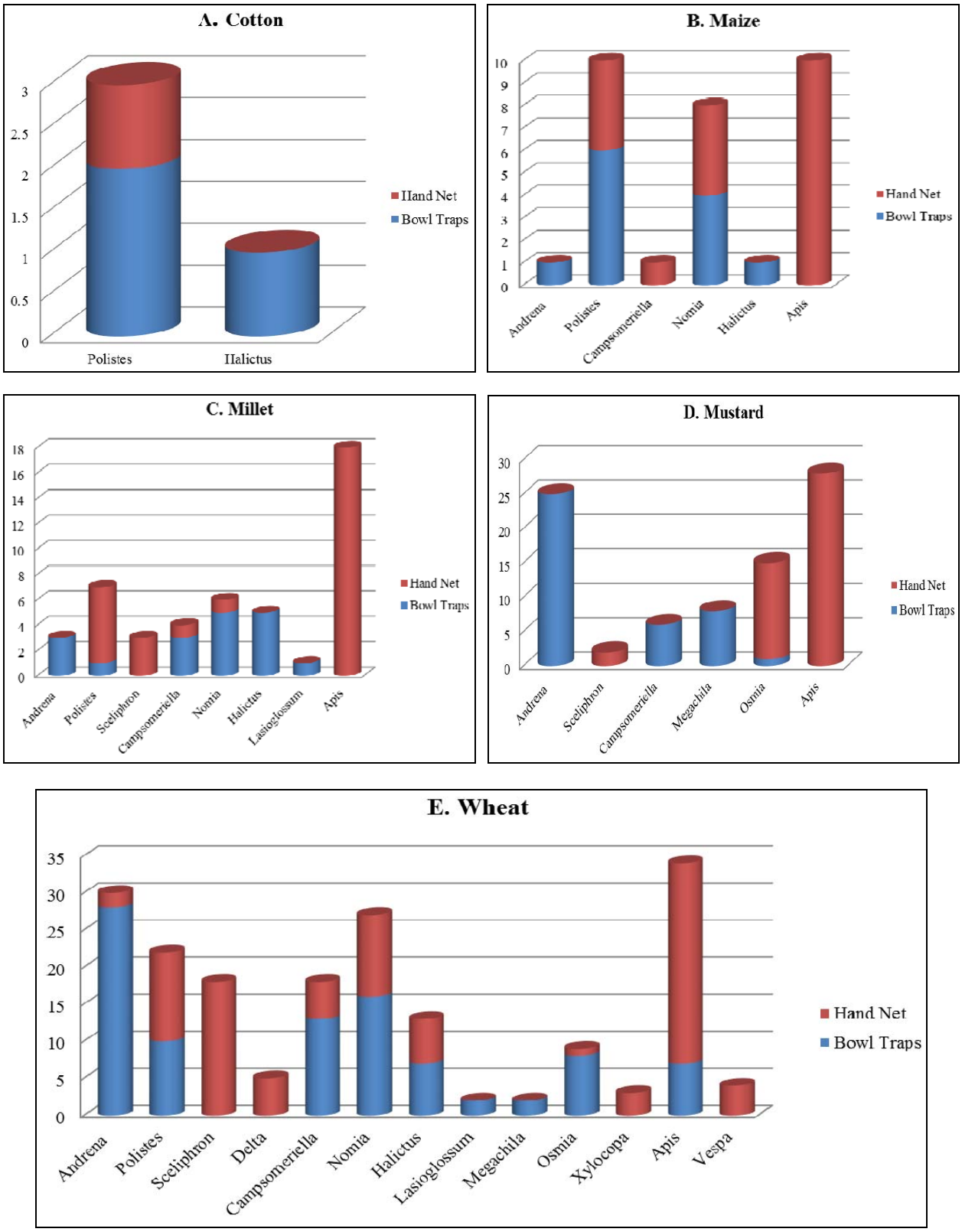


Fig 1 (A-E): Hand net and bowl traps showing abundance of hymenopterans from different cash crops of irrigated areas of District Bhakkar.

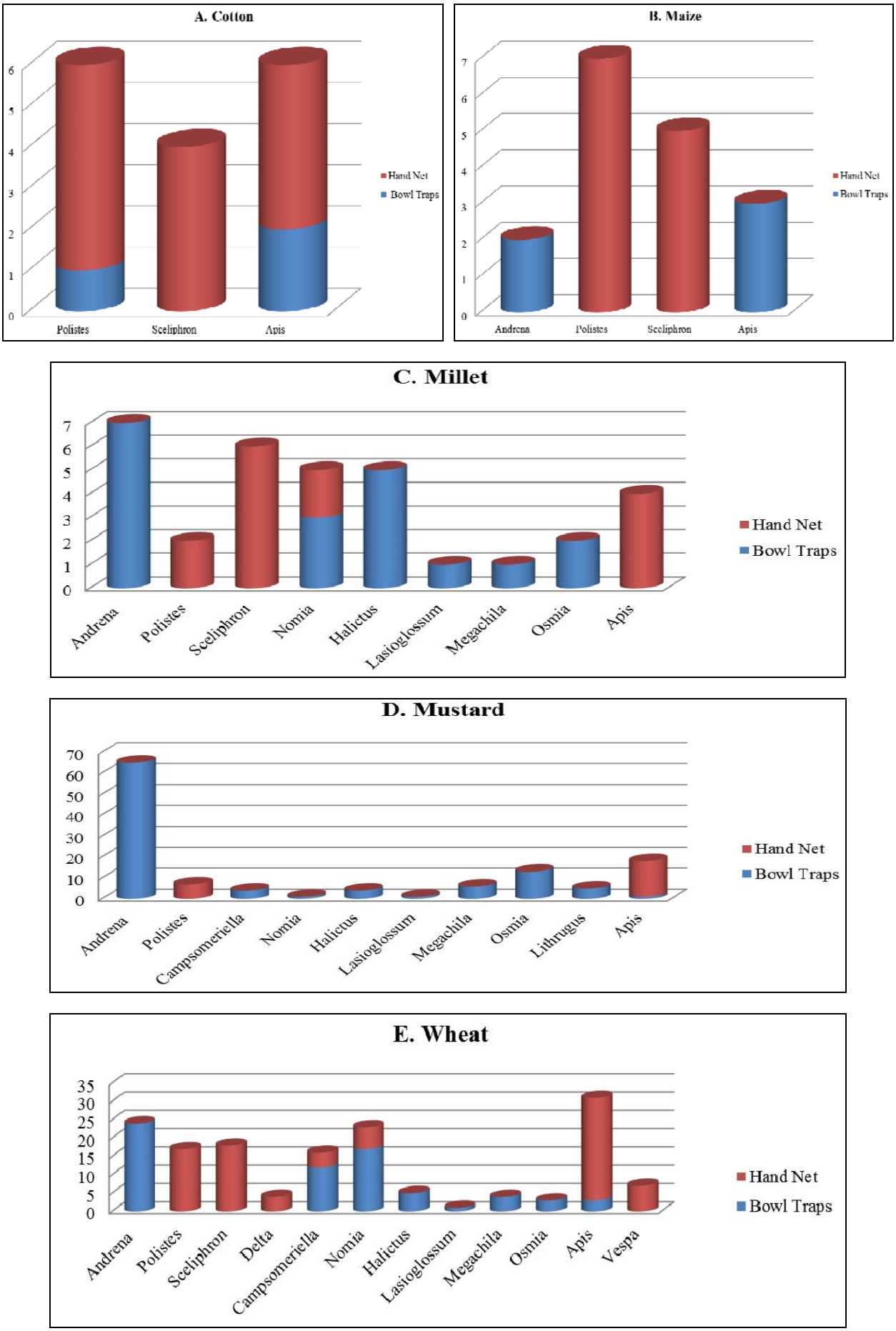
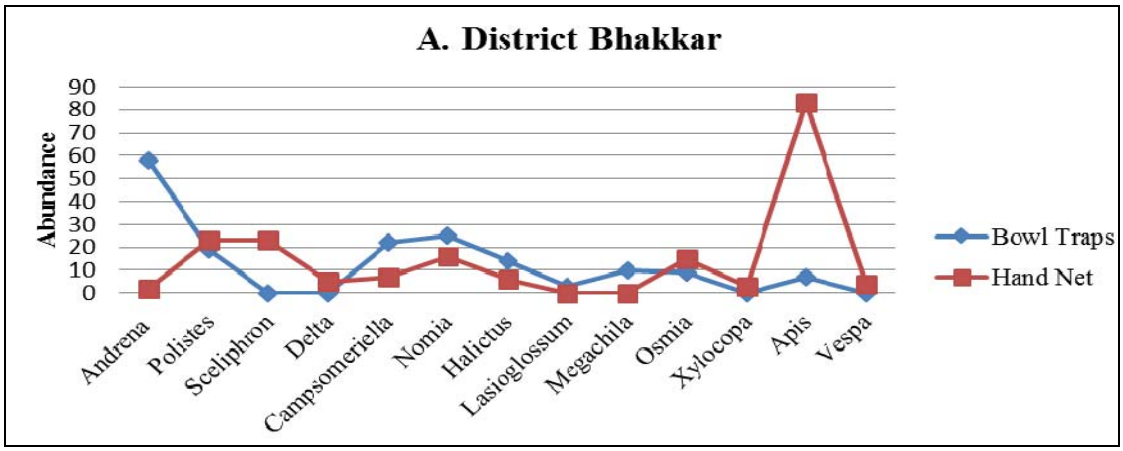


Fig 2 (A-E): Hand net and bowl traps showing abundance of hymenopterans from different cash crops of irrigated areas of District Layyah.



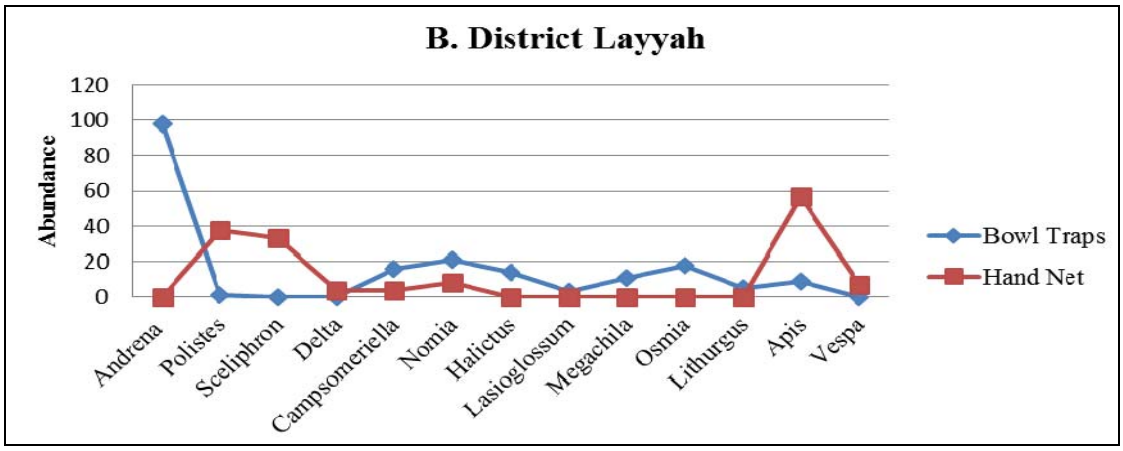


Fig 3 (A-B): Hand net and bowl traps showing abundance of hymenopterans in District Bhakkar and Layyah.

4. Conclusion

Bowl traps were more significant in collection of hymenopteran pollinators than hand nets. Bees were highly attracted towards bowl traps than wasps except *Campsomeriella*. *Sceliphron, Vespa* and *Delta* were sampled by aerial nets only and hand nets had more accuracy in collection of *Apis* and *Polistes*. Bowl traps attracted *Andrena* and *Nomia* bees more than other bees. *Lasioglossum* and *Megachila* bee samples were not collected by aerial nets in both districts. *Xylocopa* was sampled by hand nets in district Bhakkar only while *Lithurgus* was captured by bowl traps only in district Layyah. From cotton fields of District Bhakkar and Layyah, a small number of insects were collected due to less attraction of insects because of heavy pesticides were used in cotton crop fields.

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