



E-ISSN: 2320-7078  
P-ISSN: 2349-6800  
JEZS 2016; 4(5): 994-998  
© 2016 JEZS  
Received: 12-07-2016  
Accepted: 13-08-2016

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## Estimation of abundance, distribution pattern and diversity of cash crop hymenopteran pollinators (Superfamily: Apoidea; Vespoidea) from irrigated areas of district Bhakkar and Layyah, Punjab, Pakistan

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### Abstract

Detailed surveys were conducted during 2015-2016 in irrigated areas of District Bhakkar and Layyah. The main objective of the research was to estimate the abundance, pattern distribution and diversity of hymenopteran insects. Bowl traps containing detergent and hand nets were used in collection of insects. Eight hotspots were selected from each respective district and each hotspot was further divided into four replicates and insects were collected from each hotspot. A total of 7 families of order hymenoptera containing 13 genera from district Bhakkar and 14 genera from district Layyah were collected from respective crops of cotton, maize, millet, mustard and wheat. The maize crop expressed a rich diversity of hymenopterans (2.327) and wheat was the second crop showed the hymenopteran diversity (1.863) from district Bhakkar. Genus *Apis* was highly abundant in all crop fields and showed a total abundance of 4903 and 5780 from district Bhakkar and Layyah respectively. *Nomia* bees had maximum abundance of 124 from district Layyah while wasps *Polistes* (305) and *Sceliphron* (397) were highly encountered specimen in district Layyah.

**Keywords:** Abundance, diversity, *Polistes*, *Apis*, mustard

### 1. Introduction

The purpose of this study was to explore the diversity, abundance and pattern distribution of hymenopteran insects in the irrigated areas of District Bhakkar and Layyah from different crops, because no detailed previous experiments were carried out in order to know hymenopterans and this research would be helpful in utilization of insects to increase crop productivity in these backward areas of these districts. The world food crops are dependent on pollinators and 87 out of 124 principle human used crops are pollinated by wild bees and domestic bees [20, 18]. Hymenopterans are the important flower visitors of significant flowering crops and have a crucial role of pollination in the crop ecosystems [9, 37, 22].

Hymenopterans' diversity, abundance and pattern of distribution is dependent on nutritional supply and other factors and are a diverse group of insects and contained more than 100,000 species, and bees and wasps were abundant in mustard fields and belonged to 5 families [2]. Rajkumari *et al.*, [32] and Kannagi *et al.*, [17] study revealed that in Jorhat District of Assam, India, 21 families, 42 genera and 50 species of hymenopterans were recorded. In *Brassica juncea* crops, hymenopterans were abundant and belonged to 15 species of *Apis* and non-*Apis* bees and scoliid wasps [10]. After soybean and oil palm, mustard and rapeseed are the most significant crops which are pollinated by insects especially hymenopterans [1]. Feral honey bees and wild bees are major pollinators of cotton crops and are helpful in increasing crop productivity in organic farms than conventional farms [30]. The following objectives were defined: to collect different hymenopteran insects by using bowl traps and hand nets and to measure the abundance, diversity and pattern distribution of hymenopteran pollinators.

### 2.1 Materials and Methods

A detailed survey of irrigated areas of district Bhakkar and Layyah was conducted during 2015-2016 in order to collect the hymenopteran pollinators and wheat, maize, millet, mustard, and cotton were selected for the study.

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The study irrigated areas were divided into two blocks, block A district Bhakkar and block B district Layyah along the Indus belt (Kaccha areas) and each block was further divided into eight hotspots. A field 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<sup>2</sup> 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 visible data was also recorded and was strengthened by use of hand nets and bowl traps.

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 and were preserved by the help of taxonomic standard methods.

Pollinators were identified by the help of Published Taxonomic keys of Hymenoptera like Siddiqui *et al.*, [35], Gupta [12], Saini *et al.*, [33], Buck *et al.*, [5], Prokop *et al.*, [31], Gupta and Jonathan [14], Michener [27], Engel [8], Goulet and Huber [11], Gupta [13], Kentucky 4-H Entomology [19], Buchmann *et al.*, [4], Choate [6], Pascarella [29], Scott and Stojanovich [34] and Department of Entomology, Arid University was also visited and an expert opinion was taken from the family Vespidae expert.

### 3. Results and Discussion

The present study revealed that the following genera *Sceliphron*, *Delta*, *Polistes*, *Campsomeriella*, *Vespa*, *Andrena*, *Nomia*, *Halictus*, *Lasioglossum*, *Megachila*, *Osmia*, *Lithurgus*, *Xylocopa* and *Apis* were recorded from District Bhakkar and Layyah. A total of 5678 insects specimen were collected from different crops of District Bhakkar and 6931 insects were collected from District Layyah. In District Bhakkar, from mustard crop 3089 hymenopteran of 13 genera were observed and the least noted insects of 16 numbers from the cotton crop while 5121 specimen were recorded from the mustard crop and 115 hymenopteran insects were collected from maize crop fields. Genus *Apis* was abundant in the

mustard fields and represented a total of 2929 individuals in the District Bhakkar and 4946 insect numbers from the District Layyah. The maize crops had the rich diversity of hymenopteran pollinators of 2.327.

The detailed surveys of District Bhakkar and Layyah in the cotton crops revealed that wasps were highly abundant than bees. Malerbo-Souza and Halak [24] findings were broadly in lines with the results of present research. Bruckner and Bienunkunde [3] reported that in the cotton fields Apidae family (38.04%) was abundant while Halictidae family was 22.51%. Naik [28] estimated that *Apis* bees were abundant in the cotton crops while *Xylocopa sp.*, *Sceliphron sp.*, *Polistes sp.* and other hymenopterans represented a total of 9.04%. The present study results did not match with the above mentioned results and it was due to use of pesticides and bees were highly sensitive to pesticides [21].

In the maize crops of District Bhakkar, genus *Apis* was highly abundant and represented a total of 408 specimens out of 528. These findings agreed with the observations of Malerbo-Souza [25] and Hofs *et al.*, [15]. In District Layyah, *Sceliphron* and *Polistes* were frequently occurred genera and these observations were similar to the findings of Howell [16]. The millet crops contained a rich number of *Apis* (506). The study of Sima and Srivastava [36] confirmed that *Apis* (75) was highly observed genus in the millet fields. *Apis* and Halictid bees were the most encountered bees in the millet fields and these results were similar to the findings of Leuck and Burton [23]. The present study indicated that *Apis* was the most observable genus in the mustard crops of irrigated areas of District Bhakkar and Layyah and showed dominance of 2929 and 4946 numbers. These results agreed with the work of Goswami and Khan [10], Bhardwaj *et al.*, [2] and Meesa [26]. In the wheat crop fields, *Apis* had dominance of 278 and 307 in District Bhakkar and Layyah respectively. The results of Sima and Srivastava [36] proved that *Apis* was highly observable genus with abundance of 72. The hymenopteran bees were frequently encountered specimens and these findings matched the work of Clough *et al.*, [7].

The pattern distribution of hymenopteran insects in District Bhakkar and Layyah revealed that family Apidae was abundant and Megachilidae was rare. The study of Rajkumari *et al.*, [32] confirmed that family Apidae was abundant and family Megachilidae was in few numbers. The diversity Index showed that the maize plants had maximum diversity of hymenopterans from district Bhakkar and had value of 2.327. These results were according to the observations of Howell [16] indicated that hymenopterans had diversity of 2.73 in the maize crops.

**Table 1:** Diversity and Abundance of Hymenopteran insects from Irrigated areas of District Bhakkar.

District Bhakkar								
Super family	Family	Genus	Cotton	Maize	Millet	Mustard	Wheat	Total
Vespoidea	Sphecidae	<i>Sceliphron</i>	3	33	24	25	61	146
	Vespidae	<i>Delta</i>	0	0	0	0	9	9
	Vespidae	<i>Polistes</i>	12	70	60	25	108	275
	Scoliidae	<i>Campsomeriella</i>	0	1	4	25	15	45
	Vespidae	<i>Vespa</i>	0	0	0	0	23	23
Apoidea	Andrenidae	<i>Andrena</i>	0	0	3	30	23	56
	Halictidae	<i>Nomia</i>	0	15	6	10	63	94
	Halictidae	<i>Halictus</i>	1	1	7	5	23	37
	Halictidae	<i>Lasioglossum</i>	0	0	1	5	2	8
	Megachilidae	<i>Megachila</i>	0	0	0	15	2	17
	Megachilidae	<i>Osmia</i>	0	0	0	15	19	34
	Apidae	<i>Xylocopa</i>	0	0	2	5	24	31
Apidae	<i>Apis</i>	0	408	1288	2929	278	4903	
Total	7	13	16	528	1395	3089	650	5678

**Table 2:** Diversity and Abundance of Hymenopteran insects from Irrigated areas of District Layyah.

District Layyah								
Super family	Family	Genus	Cotton	Maize	Millet	Mustard	Wheat	Total
Vespoidea	Sphecidae	<i>Sceliphron</i>	107	31	77	0	182	397
	Vespidae	<i>Delta</i>	0	1	0	1	9	11
	Vespidae	<i>Polistes</i>	16	66	37	44	142	305
	Scoliidae	<i>Campsomeriella</i>	0	0	0	37	30	67
	Vespidae	<i>Vespa</i>	0	0	1	1	11	13
Apoidea	Andrenidae	<i>Andrena</i>	0	2	7	60	42	111
	Halictidae	<i>Nomia</i>	0	0	6	0	118	124
	Halictidae	<i>Halictus</i>	0	0	5	0	29	34
	Halictidae	<i>Lasioglossum</i>	0	0	1	0	1	2
	Megachilidae	<i>Megachila</i>	0	0	1	10	16	27
	Megachilidae	<i>Osmia</i>	0	0	2	13	2	17
	Megachilidae	<i>Lithurgus</i>	0	0	0	9	0	9
	Apidae	<i>Xylocopa</i>	0	0	0	0	34	34
Apidae	<i>Apis</i>	6	15	506	4946	307	5780	
Total	7	14	129	115	643	5121	923	6931

**Table 3:** Pattern Distribution of Hymenopteran insects from Irrigated areas of District Bhakkar  
(Total no of individuals of species in a sample/ total no of individuals in the sample) 100.

District Bhakkar					
Super family	Family	Genus	Abundant	Occasional	Rare
Vespoidea	Sphecidae	<i>Sceliphron</i>		+	
	Vespidae	<i>Delta</i>			+
	Vespidae	<i>Polistes</i>		+	
	Scoliidae	<i>Campsomeriella</i>			+
	Vespidae	<i>Vespa</i>			+
Apoidea	Andrenidae	<i>Andrena</i>			+
	Halictidae	<i>Nomia</i>		+	
	Halictidae	<i>Halictus</i>			+
	Halictidae	<i>Lasioglossum</i>			+
	Megachilidae	<i>Megachila</i>			+
	Megachilidae	<i>Osmia</i>			+
	Apidae	<i>Xylocopa</i>			+
	Apidae	<i>Apis</i>	+		

**Table 4:** Pattern Distribution of Hymenopteran insects from Irrigated areas of District Layyah.  
(Total no of individuals of species in a sample/ total no of individuals in the sample) 100.

District Layyah					
Super family	Family	Genus	Abundant	Occasional	Rare
Vespoidea	Sphecidae	<i>Sceliphron</i>		+	
	Vespidae	<i>Delta</i>			+
	Vespidae	<i>Polistes</i>		+	
	Scoliidae	<i>Campsomeriella</i>		+	
	Vespidae	<i>Vespa</i>			+
Apoidea	Andrenidae	<i>Andrena</i>		+	
	Halictidae	<i>Nomia</i>		+	
	Halictidae	<i>Halictus</i>			+
	Halictidae	<i>Lasioglossum</i>			+
	Megachilidae	<i>Megachila</i>			+
	Megachilidae	<i>Osmia</i>			+
	Megachilidae	<i>Lithurgus</i>			+
	Apidae	<i>Xylocopa</i>			+
Apidae	<i>Apis</i>	+			

**Table 5:** Showing Shannon-Weiner Diversity Index ( $H' = -\sum p \ln p$ ) of Hymenopterans from different crops of irrigated areas of district Bhakkar and Layyah.

District	Cotton	Maize	Millet	Mustard	Wheat
Bhakkar	0.706	2.327	0.566	0.323	1.863
Layyah	0.419	1.049	0.791	0.211	1.270

**4. Conclusion**

Honey bees (family Apidae) were highly abundant in different crops of irrigated areas of District Bhakkar and Layyah. Non-Apis bees were less significant than honey bees. Scoliids wasps were only highly observed in the mustard and wheat

crop fields while *Polistes* wasps were present in all fields. The maize crops contained a rich diversity of hymenopteran insects than other crops.

**5. Acknowledgement**

The authors express their hearty gratitude for all those respectable persons for providing necessary facilities and guidance without which this survey was impossible.

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