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Pollinator diversity, abundance and their stay time in onion, *Allium cepa* L.

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Abstract
Field studies were conducted at Benakanakonda village near by Krishi Vigyana Kendra (KVK), Hanumanamatti, Haveri. To document the diversity and abundance of insect pollinators on onion flowers. Totally, there were 666.17 pollinators visiting the onion plot at different times in a day. Among them, Hymenopterans contributed 87.79 per cent (83.55 pollinators), followed by Dipterans 8.62 per cent (8.20 pollinators), Lepidopterans 1.91 per cent (1.82 pollinators) and others 1.66 per cent (1.59 pollinators). Four species of honey bees belonging to Apidae constituted the largest group of pollinators visiting the onion crop. For the dominant group the onion crop served as a source of both pollen and nectar followed by twelve other families of insect pollinator visited the onion crop and in the absence of dominant pollinators affected the pollination of onion crop. The stay time in term of seconds /umbel varied from 2.9 in *A. dorsata* to 12.5 in *A. florae.* The stay time appeared to be conversely related to the bee size, for instance, *A dorsata* a larger bee could carry at a time higher amounts of nectar and pollen. *A. florae*, a smaller bee had more stay-time but removed only small quantity of nectar and pollen from the umbels of onion.

Keywords: Pollinators, diversity, stay time, umbel, hymenoptera

Introduction
Insect pollinators play a crucial role in effecting optimum pollination of many crops thus contributing to both increased productivity and quality. The availability of natural insect pollinators is decreasing rapidly due to the continuous use of pesticides and decline of necessary habitat (Richards, 2001) [15]. Pollinators provide an essential ecosystem service that contributes to the maintenance of biodiversity and ensures the survival of plant species including crop plants. Insect pollination is necessary for many cross pollinated crops especially in the case of hybrid seed production e.g. onion (*Allium cepa* L.) (Mayer and Lunden, 2001) [10]. The role of managed honey bee (*Apis cerana* L.*)* in onion pollination has widely been documented by many authors (Kumar *et al*. 1989; Rao and Suryanarayans, 1989;) [8, 14] but managed bee pollination is not always possible in all environments. Conserving alternate native pollinators can be a good option in areas which are very hot or very cold and dry land regions of northern Karnataka which is major hub of onion seed production, where stationery bee keeping can not be practiced because of prevailing dry climatic conditions and lack of forage.

Consequently, native pollinators should be assessed for their pollination potential, so as to conserve and manage the most efficient native pollinators to produce maximum crop yield. Pollinator species and their composition may vary with geographical area, latitude and time (Ollerton and Louise, 2002). Most of the experiments on the onion have been done in caged conditions using different bees but very few studies have been done in open field conditions. Onion flowers are protandrous and pollen is shed within 2-3 days before the stigma is receptive (Lesley and Ockendon, 1978) [9], therefore, self-pollination within a flower is not possible. In order for pollination to occur, pollen must come from another flower of the same or a different plant (Zdzislaw *et al.*, 2004) [17]. Thus, cross-pollination is common in onion (Chandel *et al.*, 2004) [2], which results in early seed set and higher yields. Wind is not a factor of significance in onion pollination (Erickson and Gabelman, 1956) [3] and onion does not produce quality seed if insects do not visit the flowers (Chandel *et al*., 2004) [2]. Non-availability of pollinators during the flowering period of onion causes only 17% fruit setting and free availability of pollinators increased fruiting up to 73% (Rao and Sunyanarayana, 1989) [14].

Cross-pollination is obligatory in the fertilization of male-sterile onions used in hybrid seed production (Van der Meer and Van Bennekom, 1968) [16]. Onion suffers severe inbreeding depression with drastic decrease in growth bulb size, and seed production after only two cycles of self-pollination within a plant (Jones and Davis, 1944). In onion when the flowering begins, only a few flowers open each day on an umbel, but the number increases until at full bloom where 50 or more florets may be open on a single day (Moll, 1954) [11]. Apart from honeybees, onion flowers are visited by bumblebees, dipterans and butterflies (Jablonski *et al*., 1982) [7]. In various regions of India (Chandel *et al*., 2004) [2], syrphids are important contributors in the process of pollination along with the most effective *Apis dorsata* and *Apis florea*.

The main purpose of this investigation was to study the diversity and their abundance of most frequent pollinators of the onion and exploring their pollination effectiveness with respect to their stay time in perspective of conserving and managing the best pollinators for onion pollination.

Material and methods

The investigation was made on onion crop raised during *rabi - summer* of 2010-2011during flowering period in farmers fields at Benakanakonda village near by Krishi Vigyana Kendra (KVK), Hanumanamatti, Haveri (14^0 17', 15^0 01", 75^0 35" to 75^0 50', 750 m amsl). The experimental plot was kept free from any sprays. The pollinators visiting the crop were collected using insect collection nets. Sweepings throughout the flowering period at two days intervals from 0600 to 1800 h of the day at two hourly intervals for 5 minutes. The collected insects (five insects) were preserved as dry specimen and identified with the help of the insect taxonomist, Department of Entomology, UAS, Dharwad. The data recorded for different groups were in accordance with the family and order of the insects wise.

Abundance of different insect visitors/pollinators on onion crop were studied during the flowering period. The total number of different insect visitors visiting the onion flowers in a square meter area (approximately 55-60 flowers) for five minutes at hourly intervals were recorded and stay-time (seconds) for dominated groups of pollinators of 15 insects were observed, using a hand telly counter and stopwatch following the method given by Free (1993) [4].

Results and discussion

Pollinator fauna in onion cultivated ecosystem of Haveri

Different pollinators that visited onion flower is presented Table 1 to 3. As many as four groups of pollinators *viz*., Hymenopterans, Diptera, Lepidopterans and others were recorded at different hours during the study.

At 1000 hr, total number of pollinators visited were 142.66 which contributed 21.41 per cent of total pollinators visited within a day. Among pollinators, Hymenopterans were the main pollinating group constituting 90.22 per cent followed by Dipterans (6.47%), Lepidopterans (2.01%) and others (1.30%). The number of pollinators visited at 1200 hr were 98.65 which accounted for 14.80 per cent of total pollinators visited onion plot within a day out of which Hymenopterans constituted 85.86 per cent, followed by Dipteran (10.36%), Lepidoterans (1.98%) and others (1.80%). (Table 1 &2)

Further, total number of pollinators observed at 1400 hr were 87.80 constituting 13.17 percent of the total pollinators within a day. Among them Hymanopterans contributed 85.86 per cent followed by dipterans (10.36%), Lepidopterans (1.98%) and others (1.80%). At 1600 hr, number of pollinators visited were 84.05 which indicated that a slight decrease in the activity of pollinators in the afternoon. Further, the trend of dominance by different pollinators remained more or less the same as at other timings of the day.

Totally, there were 666.17 pollinators that visited the onion plot at different times in a day. Among them, Hymenopterans contributed 87.79 per cent (83.55 pollinators), followed by Dipterans 8.62 per cent (8.20 pollinators), Lepidopterans 1.91 per cent (1.82 pollinators) and others 1.66 per cent (1.59 pollinators) (Table 1 to 2). The pollinator fauna in onion ecosystem revealed that more than 80% of the pollinators belonged to Hymenoptera and 6 to 10%, to Diptera and 1 to 3% Lepidoptera. Therefore, Hymenoptera constituted the dominant group and efforts must be made to conserve honey bees and non honey bees for pollination of onion in the study area. (Table 2)

The present findings are in line with Mohan Roa and Suryanarayana (1989) [14], Singh and Dharamwal (1970), Chandel *et al*., 2004 [2], Bohart *et al*., (1970) [1] and Jadhav (1981) [6] who reported that Hymenoptera were the most prominent group of pollinators on onion, on carrot (Priti and Sihag 1997). But did not agree with the findings of Hwang *et.al* (1998) reported that flies were most frequent pollinator on onion may be due to the change in the insect fauna in the temperate region compared to tropical region. Four species of honey bees belonging to Apidae constituted the largest group of pollinators visiting the onion crop. For the dominant group the onion crop served as a source of both pollen and nectar followed by twelve other families of insect pollinator visited the onion crop and in the absence of dominant pollinators affected the pollination of onion crop.

Pollinators stay time /Umbel in onion

To document the functional aspects of pollinators stay time / umbel in onion were recorded in farmer's field in Haveri district. The stay time in term of seconds /umbel varied from 2.9 in *Apis dorsata* to 12.5 in *Apisf lorea*. The stay time appeared to be conversely related to the bee size for instance *Apis dorsata* a larger bee could carry at a time higher amount of nectar and pollen. *Apis florae* a smaller bee had more stay time but removed only small quantity of nectar and pollen from the umbels of onion. The stay time of the other pollinators varied from 2.55 seconds per umbel to 9.33 seconds per umbel. The pollinating efficiency of *Apis dorsata* was high as its frequency to visit umbels of onion and other flowers were high and recovery of nectar and pollen was also high so the stay time was less (Table 3). Present findings are agreement with Imran and Waqar (2013) [5], on the basis of stay time per flower it was evident from the study that Brinjal is more preferred followed by ridge gourd and bitter gourd the least preferred by Apidae and Halictidae families. This is because the flowers of brinjal and bitter gourd offer more nectar and pollen than bitter gourd.

Table 1: Pollinator fauna in onion cultivated ecosystem

Hours	Number of pollinator/sq.mt/5min				Total	Percentage
	Hymenoptera	Diptera	Lepidoptera	Others		
600	74.15 (88.65)*	6.23 (7.44)	1.87 (2.23)	1.39 (1.67)	83.64	12.55
800	83.29 (88.26)	7.47 (7.92)	2.10 (2.22)	1.51 (1.60)	94.36	14.16
1000	128.71 (90.22)	9.23 (6.47)	2.87 (2.01)	1.86 (1.30)	142.66	21.41
1200	84.70 (85.86)	10.23 (10.36)	1.95 (1.98)	1.78 (1.80)	98.65	14.80
1400	75.38 (85.86)	9.10 (10.36)	1.73 (1.98)	1.58 (1.80)	87.80	13.17
1600	73.29 (87.19)	8.02 (9.54)	1.17 (1.39)	1.58 (1.88)	84.05	12.61
1800	65.36 (87.17)	7.15 (9.54)	1.06 (1.42)	1.41 (1.88)	74.98	11.25
Total	584.88	57.43	12.75	11.11	666.17	-
Mean	83.55	8.20	1.82	1.59	-	-
Percentage	87.79	8.62	1.91	1.66	-	-
SEm±	1.34	1.05	2.03	1.01	-	-
CD (0.05)	5.99	4.09	6.07	3.02	-	-

* Values in parenthesis indicates percentage

Table 2: Different species of insect pollinators visiting onion ecosystem

Order	Family	Scientific Name	Forage source
Hymenoptera	Apidae	*Apis dorsata* Fab.	P+N
		Apis cerana Fab.	P+N
		Apis florea Fab.	P+N
		Trigona iridipennis	N
	Formicidae	*Componotus compressus* Fab	N
		Oecophylla smargagdina Fab	N
	Xylocopidae	*Xylocopa fenestrate* Fab.	P+N
	Vespidae	*Eumenus* sp.	N
Diptera	Tachnidae	Unidentified	N
	Muscidae	*Musca domestica*	N
	Sacrophagidae	Unidentified	N
	Syrphidae	*Paragus* sp	N
Coleoptera	Coccinellidae	*Illeis cincta* Fab.	N
	Chrysomelidae	*Aulacophora abdominalis* Fab.	P
		Monolepta signata Oliv.	P
Lepidoptera	Papilionidae	*Papilio demoleus* L.	N
	Nymphalidae	*Danaus plexipus* L.	N
Neuroptera	Chrysopidae	*Chrysoperla carnea*	N

P: Pollen N: Nectar

Table 3: Stay-time of pollinators on onion flower

Order	Family	Scientific Name	Stay time (Sec/ flower ± SE)
Hymenoptera	Apidae	*Apis dorsata* Fab.	2.90±0.52
		Apis cerana Fab.	7.33±2.41
		Apis florea Fab.	12.5±0.44
		Trigona iridipennis	5.33±0.73
	Xylocopidae	*Xylocopa fenestrate* Fab.	8.20±0.43
	Vespidae	*Eumenus* sp.	6.30±1.20
Diptera	Tachnidae	Unidentified	8.44±0.58
	Muscidae	*Musca domestica*	2.55±0.90
	Syrphidae	*Paragus* sp	5.89±0.66
Lepidoptera	Papilionidae	*Papilio demoleus* L.	4.99±0.37
	Nymphalidae	*Danaus plexipus* L.	9.33±1.30

Mean ± SE; n=15 bees

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