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Calibration of *Apis Mellifera* Hives for Pollination of Brassica Crop at Rawalpindi

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Abstract

The response of honeybee (*Apis mellifera L.*) pollination on canola yield with reference to most suitable number of bee hive need per unit area of crops in order to meet optimum pollination needs and better economic yields by comparing number of hives and yield components an experiment was conducted at Beekeeping and Hill Fruit Pests Research, Station Rawalpindi during 2017-18 in complete randomized block design with two sets of four treatments for comparison: 1 hive acre^{-1}, 2 hives acre^{-1}, 3 hives acre^{-1} and 0 hive acre^{-1}. The hives were kept inside the experimental area. Parameters were assessed: pollination density, pollinator's diversity, agronomic and economic yield. In case of pollination density, the cumulative mean abundance bee species revealed that at 1200 hours, *Apis mellifera* was the most abundant and frequent visitor with a mean population of 8.69 bees/plant followed by *A. dorsata* (0.72), Syrphid fly (0.2) and other pollinators. Minimum bee population was observed during 1400 hours, mainly due to the closure of flowers and partially due to high temperature (>35°C). Pollinator diversity revealed that *A. mellifera* was the most dominant pollinator of Brassica crop with highest abundance (71%). *A. dosata* ranked 2nd (16%) followed by *A. florea* (6%) respectively.

Keywords: Honeybee, Bee Hives, Standardization, Pollination, Canola, Seed Yield.

Major classification: Food Science (Healthy food)

1. Introduction

Pollination is a most essential ecosystem service provided by insects, resulting in sustainability and permanence of the bionetwork. Pollination increases fruit setting, enhanced capacity of seed germination, and better quality of seed / fruit. When quality production increases; it has direct effect on human health. Nearly 75% of the main crop species of the world rely on pollinators for fruit and seed set. (Klein et al., 2007) Pollinators supply 35% to global food volume and play a key role in supplying vital nutrients for human subsistence (Klein et al. 2007; Gallai 2008).

The statistical value of insect pollinated crops of Himalayan region of Pakistan was reported about 954.59 million US$ (Partap et al., 2012). Crop-plant species vary considerably in their pollination supplies and, hence, their dependence on pollinating insects (Morse and Calderone 2000). The production of the 84% crop species cultivated in Europe depends directly on insect pollinators especially the bees. Biotic pollination improves the fruit and seed quality and quantity of about 70% of 1330 tropical crops. (Williams, 1994).

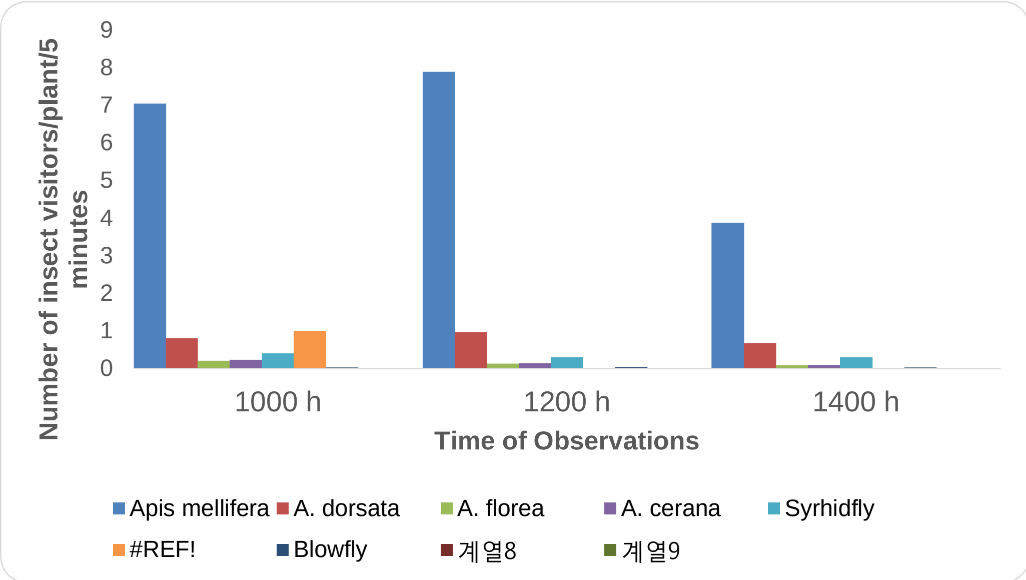

Figure 1: Overall average numbers of insect visitors (Mean ± SE) at different time intervals on *Brassica napus* during 2019.

Table 1: Insect species visited on *Brassica napus* flowers at Rawalpindi

S. No	Name of the species	Order	Family	Total Abundance	Percentage (%)
1.	*Apis mellifera*	Hymenoptera	Apidae	660	71
2.	*Apis dorsata*		Apidae	150	16
3.	*Apis florae*		Apidae	55	6
4.	*Coccinella*	Coleoptera	Coccinellidae	22	3
5.	*Aulacophora foveicollis*		Chrysomelidae	40	4

Pakistan is spending millions of dollars on the import of edible oil, which is a major drain on the foreign exchange reserves of the country (Shahzad and Rashid, 2006). The native oil manufacture of the country could not match the growing demand of population. The edible oil utilization was 2.764 million tons of which 0.857 million tons (31%) came from local income and 1.907 million tons (69%) were imported (Anonymous, 2006). Rape and mustard group of crops contribute about 21 % of the domestic edible oil but their area is continuously decreasing. These have registered reduction of 46.0 % in area and 23 % in production. One of the major reasons for downward trends in area is the low density of pollinator's population including honeybee per unit area. (Oilseeds Development strategy, 1995). The indiscriminate use of pesticides has declined pollinator's population to great extent (Medrzycki et al., 2013).

Apis mellifera is the only most abundant ecologically important introduced pollinator and is mostly managed for honey production (Fries and Stark, 1983). Therefore, there is vast scope of improving the pollination of crops by designing and implementing strategies to manage economically important insect pollinator's especially native bees for seed and fruit production in agricultural ecosystem (Keith et al., 2013). The Honeybee, Apis mellifera L., is of great economic importance in terms of increased yield and quality of commercially grown insect pollinated and also assists self-pollinated crops in the world (Free, 1993).

This study was designed to examine the role of managed honeybee Apis mellifera L. pollinator in increasing seed yield of canola crop by providing most suitable number of bee hive need per unit area of crops in order to meet optimum pollination needs and better economic yields by comparing number of hives and yield components. The findings of this research will therefore contribute to the definition of general guidelines to maintain or improve canola/brassica crop pollination with respect to the beehive or bee population size.

2. Materials and Methods

The study was carried out to determine the density of Apis mellifera for maximum crop pollination in the fields of Brassica there were two sets of four treatments for comparison: 1 hive/acre, 2 hives/acre, 3 hives/acre and 0 hives/acre. The hives were kept inside the experimental area marked in the study field. Pollination density, pollinator diversity, pods per plant, seeds per plant, weight of 100 pods seeds and economic yield were determined. After assessing the agronomic yield the economic yield calculated. The economic yield was obtained from the net income, which was found out by using the following formula:

$$\Delta NI = P \times \Delta Y - CY \times \Delta Y - Ch \times \Delta H$$

Where:

ΔNI = Increase in number of hives

P = Price that farmer obtains from each metric tons of the crop

ΔY = Yield increased in metric tons because of addition of hives

CY = Cost of producing each tons of yield

Ch= Cost of renting hive

ΔH = Addition of hives

Economic yield

1 hive acre^{-1} = $P \times \Delta Y - CY \times \Delta Y - Ch \times \Delta H$

$= 100{,}000 \times 0.090 - 36{,}231 \times 0.090 - 1000 \times 1$

$= 9{,}000 - 3{,}260 - 1000$

Net income = 4,740/

2 hives acre^{-1} = $P \times \Delta Y - CY \times \Delta Y - Ch \times \Delta H$

$= 100{,}000 \times 0.13 - 36{,}231 \times 0.13 - 1000 \times 2$

$= 13{,}000 - 4{,}710 - 2000$

Net income = 6,290/

3 hives acre^{-1} = $P \times \Delta Y - CY \times \Delta Y - Ch \times \Delta H$

$= 100{,}000 \times 0.19 - 36{,}231 \times 0.19 - 1000 \times 3$

$= 19{,}000 - 6883 - 3000$

Net income = 9,117/

3. Results and Discussions

Bee population is the main criteria for honey production. Fig. 1 showed average visitation frequency of different insect visitors per plant per 5 minutes at different time intervals during the whole flowering season of Brassica napus. The cumulative mean abundance of important bee species revealed that at 1200 hours, Apis mellifera was the most abundant and frequent visitor with a mean population of 8.69 bees/plant/ 5minutes followed by A. dorsata

(0.72 bees/plant/ 5 minutes), Syrphidfly (0.2 bees plant^{-1} 5 minutes^{-1}), A. cerana (0.1275 bees plant^{-1} 5 minutes^{-1}), A. florea (0.120 bees plant^{-1} 5minutes^{-1}) and blowfly 0.0275 bees plant^{-1} 5minutes^{-1}. Minimum bee population was observed during 1400 hours, mainly due to the closure of flowers and partially due to high temperature (>35°C).

Table 2: Means comparison of agro- morphological parameters of *Brassica napus*

Parameters	**Modes of Pollination**					
	1 hive acre^{-1}	**2 hives acre^{-1}**	**3 hives acre^{-1}**	**Control**	**F Value**	**Prob.**
Pods plant $^{-1}$	81.7±3.3 c	108.3±6.0 b	126.30±7.32 a	30.88±1.60 d	231.1	0***
Seeds plant $^{-1}$	802.2 ±22.7 b	1097.6 ±85.1 ab	1490.78 ±90.47a	301.06±21.60 c	18..25	0.0025**
Weight of 100 pods $^{-1}$	4.8±0.14 c	5.98±0.26 b	6.44±0.17 a	3.66±0.05 d	51.22	0.0002***

Means in rows/ columns sharing same letters are non-significant

Canola crop was found to be visited by 5 insect species belonging to two orders on B. napus during flowering season. These foragers comprised of three bees and two beetles. Bees were among the most abundant floral visitors with total abundance of 93% followed by Coccinella (3%) and Aulacophora foveicollis (4%). From present studies, it is evident that A. mellifera was the most dominant pollinator of Brassica crop with highest abundance (71%). This shows that A.mellifera is an efficient pollinator of this cross pollinated crop and farmer can get maximum benefits from their pollination services by allowing beekeepers to keep A. mellifera colonies near their fields. A .dosata ranked 2nd (16%) followed by A. florea (6%) in our study. Coccinella and Aulacophora foveicollis belonged to order coleopteran were found as casual visitor of the flowers and are not reported to participate in nectar or in pollen collector.

The mean comparison of present results given in Table 2. Illustrated the effect of canola plants exposed to A. mellifera along with other insects and canola plants kept under 1 hive acre^{-1}, 2 hives acre^{-1} and 3 hives acre^{-1} on agro- morphological parameters of B. napus var. PARC Canola. 3 hives acre^{-1}pollinated canola plants had significantly higher yields than 1 hive acre^{-1}and 2 hives acre^{-1}canola plants.

Table 3: Net income from different modes of pollination

Modes of Pollination	**Net income (PRs)**
1 hive acre^{-1}	4740
2 hives acre^{-1}	6290
3 hives acre^{-1}	9117

Economics is the key factor to do everything. Table-3 depicted that economic yield was increased as well as the number of hives acre^{-1} was increased. 3 hives acre^{-1} pollinated canola plants had maximum economic yields than 2 hives acre^{-1}and 1 hive acre^{-1}canola plants.

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