Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 1515-1518

Received: 10-05-2020
Accepted: 12-06-2020

Harpreet Sekhon
Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Yendrembam K Devi
Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Ravinder Nath
Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Satinder Kaur
Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Corresponding Author:
Harpreet Sekhon
Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India

Impact of different modes of pollination on the productivity of Indian mustard (*Brassica juncea* L.) in Punjab

Harpreet Sekhon, Yendrembam K Devi, Ravinder Nath and Satinder Kaur

Abstract
A significant effect of planned pollination was observed on quality and quantity of *Brassica juncea* var. PBR-357 yield. The mean number of pods per plants, number of seeds per plants, siliqua length, thousand seed weight and oil content during 2018-19 and 2019-20 was significantly highest in Planned pollination with *A. mellifera* (223.6 pods/plant and 224.92 pods/plant, 16.26 seeds/pod and 16.79 seeds/pod, 5.71 cm and 5.66 cm, 5.23 gm and 5.125 gm and 41.01%, respectively) followed by open pollination (176.5 pods/plant and 179.8 pods/plant, 14.36 seeds/pod and 13 seeds/pod, 5.39 cm and 5.46 cm, 4.84 gm and 4.93 gm and 37.99%, respectively) and pollinators' exclusion (146.87 pods/plant and 152.39 pods/plant, 10.67 seeds/pod and 10.72 seeds/pod, 4.88 cm and 4.60 cm, 4.11 gm and 4.17 gm and 25.98%, respectively) during 2018-19 and 2019-20 on *Brassica juncea* var. PBR-357.

Keywords: *Apis Mellifera*, open pollination, planned pollination, pollinators' exclusion, quality and quantity

Introduction
Maintenance of biodiversity in the ecosystem emphasizes the need of pollination among crops. Pollination is carried out by various pollinating agents like insects, animals, birds, water, air, etc. in the ecosystem. About 70-80% major crops are cross pollinated, thus emphasizing the importance of pollinators. The productivity is widely affected by the type of pollinators; therefore, honeybees are specifically used for planned pollination in crops. World's total food production (15-30%) is influenced by the animal pollinators' viz. honeybees, bats and birds [1, 2]. It stated that €153 billion is the global economic value per year due to insect pollination [3].
Honeybees are superior pollinators of *Brassica* due to their floral consistency, hairy and suitable body size, thoroughness and their pollinating speed [4]. By introducing honeybees in the fields, the farmers would obtain the adequate pollination services [5]. Rather than honeybees, many more insect pollinators such as flies, butterflies and beetles etc. have also been reported in cruciferous crops [6, 7, 8, 9, 10, 11, 12, 13].
Though India is the leading producer of oilseeds worldwide, but it still imports 40 percent of vegetable oil from other countries to fulfill the demands of growing population. Additionally, per capita consumption of edible oil is likely to reach 23.1 kg by 2030 from the present level of 13.4 kg [14]. Thus, there is urgent need to increase mustard productivity in the country. But, increase in production of rapeseed mustard is possible either by increasing area under this crop or through increase in crop yield by releasing more high yielding varieties. Increasing crop area will cost decrease in other crops area, henceforward there is scope for increasing the productivity by pollination as high yielding cultivars are regularly been upgraded from time to time.
Planned crop pollination with addition the honeybees is considered to be the most significant input because without pollination services all the other filed operations, post pollination efforts such as application of growth regulators, herbicides, fungicides or insecticides will be just useless. All the agronomic field operations are designed to conserve yield losses not to increase the crop yield. Among all crop produce enhancing benefits, insect pollination plays a vital role in upholding a sustainable and profitable agriculture with least environmental disturbances. Per cent pod set, seed yield, seed weight, speed of ripening and seed quality are known to be higher when bee pollination is optimized.

Materials and Methods

The field investigation was conducted at Entomology farms of Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara (Punjab) situated at 31.2551° N, 75.7050° E during 2018-19 and 2019-20. *B. juncea* PBR-357 variety was sown in plot size of 3.5m (L) ×3.5m (B) following all recommended package and practices [15]. The crop was kept unsprayed throughout the blooming period.

Three different modes of pollination viz. Open pollination (OP), planned pollination with *Apis Mellifera* (BP) and Pollinators' exclusion (PE) were tested. In planned pollination, *A. mellifera* colony of 3 bee frame strength with 2 brood frames was kept. BP and PE plots were covered with anti-insect net using bamboos.

The yield data was recorded for number of pods/plant, number of seeds/pod, siliqua length, thousand seed weight and oil content in each treatment.

Each treatment was replicated 8 times in randomized block design (RBD) and data analysis was done by using ANOVA for Randomized Block Design after using square root and angular transformation where needed.

Fig 1: Planned pollination with *Apis Mellifera*

Fig 2: Open pollination.

Fig 3: Pollinators' exclusion (control)

Fig 4: *A. mellifera* colony in planned pollination

Results and Discussion

Impact of different modes of pollination on yield parameters of Indian mustard (*B. juncea*)

Number of pods per plant

The mean number of pods per plant in planned pollination with *Apis Mellifera* in both the seasons 2018-19 and 2019-20 (223.6 pods/plant and 224.92 pods/plant respectively) was considerably higher associated with the open pollination results (176.5 pods/plant and 179.8 pods/plant respectively) and lowest mean number of pods/plants were found in pollinators' exclusion (146.87 pods/plant and 152.39 pods/plants respectively). The mean number of pods were higher in second season 2019-20 might be due to more diversity and good weather conditions. The present study results are in agreement with [16, 17 and 18] who reported that pollination by *A. mellifera* had resulted in maximum number of pods per plant.

Number of seeds per pod

Planned pollination with *A. mellifera* was the utmost dominant mode of pollination in *B. juncea* as shown in the table no. 1, mean number of seeds per pods were highest in Planned pollination in both the seasons 2018-19 and 2019-20 (16.26 seeds/pod and 16.7 seeds/pod respectively), followed by open pollination (14.36 seeds/pod and 13 seeds/pod respectively) and least in pollinators' exclusion (10.67 seeds/pod and 10.715 seeds/pod respectively). Our results

corroborated with [18] who had stated that number of seeds/plant (828) upsurge in only bee pollination as compared to without bee pollination (626). Likewise, [19 and 20] observed that *B. juncea* seed yield increased 25 percent when plants were caged with bees in comparison to plants caged without bees. Verma and Joshi [21] observed that honeybee pollination increased the number of seeds by 4.07 per pod in mustard. Delbrassinne and Rasmont [22] found that 12.22 percent increase in number of seeds per pod due to pollination by *A. mellifera* in *B. juncea*. A 23.27 percent increase in number of seeds per pod was observed [23] from Konkan (Maharashtra) from the mustard field pollinated by *A. mellifera*. Highest fruit set was observed through hand pollination followed by honeybees. Similar findings were reported by Thakur and Rana [24]. They had observed higher fruit quality, weight of fruit, number of seeds per fruit, fruit size and test weight in honeybee pollination as compared to other modes of pollination.

Siliqua length

Pod length data also exposed the impact of planned pollination with *A. mellifera* as significant difference during 2018-19 and 2019-20 were observed in different modes of pollination. The mean data revealed that bigger size of pod was found in planned pollination (5.71 and 5.66 cm, respectively) followed by open pollination (5.39 and 5.46 cm, respectively) and smaller pod size in pollinators exclusion (4.88 and 5.60 cm, respectively). This can be linked to the higher number of seeds per plant which had increased its length.

Thousand seed weight

Thousand seed weight was highest in planned pollination in both the seasons 2018-19 and 2019-20, 5.23 grams and 5.12 grams, respectively, compared to other modes of pollination i.e. open pollination (4.84 and 4.93 g respectively) and pollinators' exclusion (4.11 and 4.17 g respectively). The present study results are strongly supported by [17] that seeds were heavier with bee pollination (4.42 g) and lighter without pollination (3.53 g). Singh *et al.* [25] noted that yield as well as seed weight approximately doubled providing additional income of 8-10 Lakh per ha in cauliflower due to planned pollination using honeybees. In Hybrid variety of rapeseed yield was increased by 5 ton per ha in presence of honeybees as compared to the treatment without bees [26]. In planned pollination the yield and seed weight were higher than that in other given treatments on Cauliflower [27]. Singh and Singh [28] found that *B. campestris* var. toria plots which are pollinated by bees produced three times heavier seed than self-pollinated ones. It was reported that pollination with honeybees (caged plots) produced heavier seeds than open pollinated plots in *B. juncea* [29].

Oil content

Mustard is predominantly cultivated for its oil, planned pollination with *A. mellifera* have shown significant results in increasing oil content, with 41.01 percent oil is extracted in 2018-19. In comparison to open pollination 37.99 and least amount has been extracted from pollinators' exclusion 25.98 during 2018-19. The present findings are in conformity that higher oil content in seeds pollinated by honeybees [30]. Likewise, Partap and Partap [31] stated that increased oil content and seed weight is recorded in bee pollination in comparison to hand pollination and without hand or bee pollination. Mahindru *et al.* [32] enlisted that planned pollination by *A. mellifera* increased oil content (8.31 %) in contrast to natural pollination and when *A. mellifera* was excluded from crop, oil content decreased by 2.39 percent.

Table 1: Impact of different modes of pollination on the productivity of Indian mustard (*Brassica juncea* L.) during 2018-2020.

Treatment	Number of pods per plant		Number of seeds per pod		Siliqua length		Thousand seed weight		Oil content
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19
Open Pollination	176.5±15.35 (13.31) b	179.8±14.606 (13.44) [b]	14.36±0.44 (3.92) b	13±4.524 (3.667) [b]	5.39±0.12 (2.529) a	5.46±0.151 (2.542) [a]	4.84±0.045 (2.417) a	4.926±0.457 (2.433) [a]	37.99±0.59 (38.040) b
Planned Pollination	223.6±40.29 (14.94) a	224.92±35.599 (14.991) [a]	16.26±0.59 (4.15) a	16.7875±0.443 (4.217) [a]	5.71±0.07 (2.590) a	5.66±0.0818 (2.581) [a]	5.23±0.055 (2.496) a	5.125±0.315 (2.474) [a]	41.01±0.53 (39.798) a
Pollinators' exclusion	146.87±16.82 (14.14) a	152.39±17.029 (12.368) [c]	10.67±0.47 (3.41) b	10.725±0.715 (3.423) [b]	4.88±0.73 (2.421) b	4.602±0.235 (2.367) [b]	4.11±0.051 (2.261) b	4.1725±0.147 (2.274) [b]	25.98±0.41 (30.630) c
CD	0.840	0.920	0.073	0.476	0.087	0.040	0.011	0.077	0.330
SE(m)	0.274	0.300	0.024	0.155	0.028	0.013	0.004	0.025	0.108

* Figures in parentheses are the means of √n+1 transformation

** Figures in parentheses are the means of angular transformation

Conclusion

Present investigation concludes that planned pollination with *A. mellifera* in *B. juncea* was most efficient method of pollination as compared to open pollination/natural pollination and pollinators' exclusion in terms of yield parameters viz. number of pods/plants, number of seeds/plants, siliqua length, thousand seed weight and oil content. Henceforward, supplemental pollination with *A. mellifera* in mustard is recommended as it will help farmers in obtaining higher quality and quantity of produce. In addition to this, farmers can harvest honey, wax and propolis from the hives in end of the season as it will boost their profits.

The finding can also imply for the management of the insect pollination in different crops that can be a high potential for the conservation of the bee populations as well as the increase in the bee products.

Acknowledgement

The authors want to thank Department of Entomology, School of Agriculture, Lovely Professional University, Phagwara for supporting the research project and providing essentials to perform the experiment.

References

1. McGregor SE. Insect Pollination of Cultivated Crop Plants. Washington: US. Department of Agriculture-Agricultural Research Service, 1976.
2. Roubik DW. Pollination of cultivated plants in the tropics. Rome: FAO, 1995.
3. Gallai N, Salles JM, Settele J, Bernard EV. Economic valuation of the vulnerability of world agriculture confronted with pollinator decline. Ecol. Econ. 2009; 68:810-821.

4. Delaplane KS, Mayer DF. Crop pollination by bees. Oxon: CABI Publication, 2000, 352.
5. Greenleaf SS, Kremen C. Wild bees enhance honeybees' pollination of hybrid sunflower. 2006; PNAS 37:13890-13895.
6. Thakur AK, Sharma OP, Garg R, Dogra GS. Comparative studies on foraging behavior of *Apis Mellifera* and *Apis cerana indica* on mustard. Indian Bee J. 1982; 44(4):91-92.
7. Robinson WE, Morse RA. The value of honeybees as pollinators of US crops. Am. Bee J. 1989; 129:477-487.
8. Bhalla OP, Verma AK, Dhaliwal HS. Insect visitors of mustard bloom (*Brassica campestris* var. sarson), their number and foraging behaviour under mid-hill conditions. J Entomol. Res. 1983; 7(1):15-17.
9. Mishra RC, Kumar J, Gupta JK. The effect of mode of pollination on yield and oil potential of *Brassica campestris* L. var. sarson with observations on insect pollinators in Himachal Pradesh, India. J Apic. Res. 1988; 27(3):186-189.
10. Parsad D, Hameed SF, Singh R, Yazdani SS, Singh B. Effect of bee pollination on the quantity and quality of rai crop, (*Brassica juncea* Coss.). Indian Bee J. 1989; 51(2):45-47.
11. Chaudhary OP. Abundance of wild pollinators on rapeseed and mustard. Insect Environ. 2001; 7(3):141-42.
12. Eastham K, Sweet J. Genetically modified organisms (GMOS): The significance of gene flow through pollen transfer. European Environment Agency: Environmental, 2002, 28.
13. Singh B, Kumar M, Sharma AK, Yadav LP. Effect of bee pollination on yield attributes and seed yield of toria (*Brassica campestris* var. toria) in Pusa, India. Environ. Ecol. 2004; 22(3):571-573.
14. Singh D. Genetic enhancement of mustard for seed yield and its sustainability. Paper presented in 2nd National Brassica Conference held on February 14-16, 2014 at Punjab Agricultural University, Ludhiana. 2014; pp. 18.
15. Anonymous. Package of Practice of Rabi crops, Punjab Agriculture University, 2019.
16. Thakur SS, Karnatak AK. Impact of insecticides and mode of pollination on yield components of Brassica campestris with assessment of insecticidal toxicity influencing behaviour of *Apis Mellifera* L. Thesis (Ph.D. Entomology) submitted to G.B.P.U.A. and T. Pantnagar, -263 145, (U.S. Nagar), Uttarakhand, India, 2005.
17. Atmowidi T, Buchori DM, Bambangsuryobroto, Hidayat PS. Diversity of insects in relation to seed set of mustard (*Brassica juncea* L. Cruciferae), Hayati. J Biosci, 2007, 155-161.0
18. Razzaq A, Abbasi KH, Jamal M, Aslam A, Malik K, Ullah MA. Evaluation of Pollination by Honeybee (*Apis Mellifera* L.) on Canola (*Brassica Napus* L.) Produce. J Sci. Tech. Res. 2019; 22(4):16833-16836.
19. Free JB, Nuttall PH. The pollination of oilseed rape (*Brassica napus* L.) and the behaviour of bees on the crop. J Agric. Sci. Camb. 1968; 71:91-94.
20. Fujita M. Influence of honeybees on the fructification of rape. Bull. Imp. Zootech. Exp. Stn. Chiba-Shi. 1939; 34:1 (in Japanese).
21. Verma SK, Joshi NK. Studies on honeybees in the pollination of cauliflower (*Brassica olercea* L. var. *Botryitis*). Indian Bee J. 1983; 45(3):45-55.
22. Delbrassinne S, Rasmont P. Cotribution to the study of pollination of rape, *Brassica napus* var. *oleiera* in Belgium. Bull. Rech. Agron. Gembloux. 1988; 23(2):123-152.
23. Sanas AP, Narangalkar AL, Godase SK, Dalvi VV. Effect of honeybee pollination on quantitative yield parameters of mustard (*B. juncea*) under Konkan condition of Maharastra. Green Farm. 2014; 5(2):241-243.
24. Thakur M, Rana RS. Studies on the role of insect pollination on cucumber yield. Pest Tech. 2008; 2(2):130-133.
25. Singh P, Singh KM, Shahi B. Doubling income of cauliflower seed producer farmers of vaishali district through pollination services by *Apis Mellifera* colonies. Int. J. Curr. Microbiol. Appl. Sci. 2018; 7:5242-5249.
26. Duran XA, Ulloa RB, Carrillo JA, Contreras, JL, Bastida s MT. Evaluation of yield component traits of honeybee pollinated (*Apis Mellifera* L.) Rapeseed Canola (*Brassica napus* L.). Chil. J Agric. Res. 2010; 70(2):309-314.
27. Rouf MA, Rahim MA, Siddique MA, Meah MB. Effect of honeybee pollination and curd scooping on seed yield of cauliflower, Bangladesh. J. Agric. Res. 2016; 41(2):251-258.
28. Singh RP, Singh PN. Impact of bee pollination on seed yield, carbohydrate composition and lipid composition of mustard seed. J Apic. Res. 1992; 31(3-4):128-133.
29. Latif A, Qayyrem A, Abbas M. The role of *Apis indica* in the pollination of toria and sarson (*Brassica campestris* var. toria and dichotoma). Bee World. 1960; 41:283-286.
30. Rajasri M, Kanakadurga K, Rani VD, Anuradha CH. Honeybees-Potential pollinators in hybrid seed production of sunflower. Int. J. Appl. Biol. Pharma. Tech. 2012; 3:216-221.
31. Partap U, Partap T. Pollination of apples in China. Bee Keeping Dev. 2000; 54: 67.
32. Mahindru N, Singh G, Grewal GS. Comparative abundance and foraging behaviour of insect pollinators of raya (*Brassica juncea* L.) and role of *Apis Mellifera* Linnaeus in crop pollination. J Insect Sci. 1998; 11(1):34-37.