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.

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 [23] observed that honeybee pollination increased the number of seeds by 4.07 per pod in mustard. Delbrassine and Rasmont [24] 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 [25] 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 [26]. 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. [27] 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 [28]. 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.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of pods per plant</th>
<th>Number of seeds per pod</th>
<th>Siliqua length</th>
<th>Thousand seed weight</th>
<th>Oil content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Pollination</td>
<td>176.5±15.35</td>
<td>179.8±14.606</td>
<td>14.36±0.44</td>
<td>13.3±4.52</td>
<td>5.39±0.12</td>
</tr>
<tr>
<td>(13.31) b</td>
<td>(13.44) b</td>
<td>(3.92) b</td>
<td>(3.667) b</td>
<td>(2.529) a</td>
<td>(2.542) a</td>
</tr>
<tr>
<td>Planned Pollination</td>
<td>223.6±40.29</td>
<td>224.9±43.599</td>
<td>16.26±0.59</td>
<td>16.785±0.443</td>
<td>5.71±0.07</td>
</tr>
<tr>
<td>(14.94) a</td>
<td>(14.991) a</td>
<td>(4.15) a</td>
<td>(2.417) a</td>
<td>(2.590) a</td>
<td>(2.581) a</td>
</tr>
<tr>
<td>Pollinators’ exclusion</td>
<td>146.87±16.82</td>
<td>152.39±17.02</td>
<td>10.67±0.47</td>
<td>10.725±0.715</td>
<td>4.88±0.73</td>
</tr>
<tr>
<td>(14.14) a</td>
<td>(12.568) e</td>
<td>(3.41) b</td>
<td>(3.423) b</td>
<td>(2.421) b</td>
<td>(2.367) b</td>
</tr>
<tr>
<td>CD</td>
<td>0.840</td>
<td>0.920</td>
<td>0.073</td>
<td>0.476</td>
<td>0.087</td>
</tr>
<tr>
<td>SE(m)</td>
<td>0.274</td>
<td>0.300</td>
<td>0.024</td>
<td>0.155</td>
<td>0.028</td>
</tr>
</tbody>
</table>

* 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.

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References