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Maximizing seed yield and quality in Indian mustard (*Brassica juncea* L.) through supplementary insect pollination

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ABSTRACT

An investigation was undertaken during *Rabi* 2021-22 in the Department of Seed Science and Technology, FAS, SOADU, Bhubaneswar to study the impact of various supplementary pollination techniques *viz.* 1. Open pollination (OP) with spray application of 5% honey solution, 2. OP with spray application of 10% jaggery solution, 3. OP without any spray application, 4. Intensive pollination with honey bees (*Apis cerana indica*) and 5. Pollinators exclusion, on seed yield and quality in Indian mustard (*Brassica juncia* L.). The field experiment was conducted following RBD with four replications. Appropriate agronomic practices were followed for raising seed crops. Observations were recorded on five yield attributing traits *viz*. number of siliqua per plant, length of siliqua, number of healthy and wrinkle seeds per siliqua and 1000-seed weight; two seed yield parameters *viz*. per plant and per hectare seed yield; seven seed quality attributes *viz*. germination percentage, shoot and root length of seedling, dry weight of seedling, seed vigour indices (SVI-I & SVI-II) and storability of seed; and two biochemical seed quality traits *viz*. oil and protein content of the seed. A significant effect of planned pollination methods was observed on most of the yield and quality traits. The mean number of siliqua per plant, siliqua length, healthy seeds per siliqua, 1000-seed weight, seed yield per plant and per hectare, seed germination percentage, shoot and root length of seedling, dry weight of seedling, SVI-I and SVI-II, oil content of seed and germination percentage of seed after four months of storage were highest in OP with spray application of honey solution (80, 5.70 cm, 15.03, 3.80 g, 11.83 g, 8.7 q, 97.25%, 3.2 cm, 2.9 cm, 2.6 mg, 593.0, 252.9, 34.8% & 85, respectively) followed by OP with spray application of jaggery solution (77.15, 5.18 cm, 14.10, 3.85 g, 10.05 g, 6.83 q, 94, 2.9 cm, 2.6 cm, 2.4 mg, 517.1, 225.7, 33.4% & 80, respectively) in comparison to pollinators exclusion (62.68, 4.38 cm, 11.73, 3.08 g, 6.60 g, 5.54 q, 79, 2.3 cm, 2.3 cm, 1.8 mg, 364.4, 142.1, 31.2% & 67, respectively) which showed the lowest values for all these traits. OP without any spray application and intensive pollination with honeybees resulted in moderate enhancement of all these traits. Thus, it may be concluded that for achieving higher seed yield and quality in this crop, insect pollinators may be attracted by spray application of honey or jaggery solution to the seed crop of mustard during the flowering period.

***Key words**: Indian mustard, Seed production, Supplementary insect pollination, Seed*

Introduction

Pollination is an important reproductive process in flowering plants where two dissimilar reproductive units (gametes) were brought together for effecting fertilization and seed set. In cross-pollinated species,

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the floral structures restrict transfer of pollens to the stigma of same flower and pollination is usually accomplished by pollens from other flowers borne on same or different plants. The cross-pollination requires some external abiotic and biotic agents to perform the process of pollen movement among flowers. The abiotic agents include wind and water whereas the biotic agents include insects and birds. Among the insects, the honey bees are the predominant pollinators. The insect polulation in the cropped area an important consideration to cause effective cross-pollination in the entomophilous crops. Ineffective cross-pollination is a major constraint in commercial seed production. Several investigators (Jay, 1986 and Currie, 1997) have shown the potential of spraying certain substances on target crops to attract pollinators and enhance crop yields.

Among the entomophilous crops of economic importance, Indian mustard or rai (*Brassica juncea* L) is a widely grown oilseed crop in the world. Although this species is self-compatible, considerable extent of cross-pollination does occur in this crop. Being an entomophilous species, supplementary insect pollination often helps in enhancing seed yield and quality in this crop (Sinha and Singh, 2010). Keeping this in view, an investigation was undertaken to study the influence of supplementary insect pollination methods on quality seed production in mustard.

Materials and Methods

The field experiment was conducted in the Agriculture Research Station of SOADU located at Binjhagiri, Bhubaneswar during 2021-2022 and the laboratory studies were performed in the PG laboratory of the Department of Seed Science and Technology, Faculty of Agricultural Science, SOADU, Bhubaneswar. The field experiment was laid out in Randomized Block Design with five treatments and four replications. Recommended package of practices was adopted for raising the experimental crop.

The experimental material consisted of Indian mustard (*Brassica juncia* L.), the seeds of which were collected from the All India Co-ordinated Research Project of rapeseed and mustard, OUAT, Bhubaneswar. The treatments consisted of five supplementary pollination methods *viz*. open pollination with spray of 5% honey solution (T_1), open pollination with spray of 10% jaggery solution (T_2), open pollination without application of any spray solution (T_3), intensive pollination with honeybee (T_4) and pollinator's exclusion/control (T_5). For T4 and T5, the plots (5m x 2m) were covered with double layered mosquito net cages of size 5m x 2m x 2m. The spray solutions were applied twice, first at 10% and second at 50% flowering stage of crops. Appropriate crop husbandry practices were adopted for raising the seed crop.

Observations were recorded on four yield attributing traits *viz*. number of siliqua per plant, siliqua length, number of seeds per siliqua and 1000-seed weight; two yield parameters viz., seed yield per plant and per hectare; seven seed quality attributes *viz*. seed germination percentage, shoot and root length of seedling, dry weight of seedling, seed vigour indices (SVI-I & SVI-II) and storability of seed and two seed biochemical parameters namely oil and protein content.

Results

Yield attributes and yield

Significant variations among the treatments (pollination methods) were observed in respect of all the seed yield-attributing traits under study. Supplementary open pollination with the application of honey solution resulted in the highest expression of all treats followed by that with the application of jaggery solution as pollinators attractant.

Open pollination with honey solution produces the highest number of siliqua per plant (80), siliqua length (5.70 cm), number of healthy seeds per siliqua (15.03) and 1000-seed weight (3.80 g), while these mean values were 77.15, 5.18 cm, 14.10 and 3.85 g for open pollination with the application of jaggery solution. Similarly, moderate enhancing effects in respect of these traits were observed in open pollination without the application of any spray solution and intensive pollination with honeybees. On the other hand, the lowest values for these characters were observed with pollination without the involvement of insect pollinators (PE).

The per plant and per hectare seed yield were observed to be the highest (11.83 g & 8.70 q) in open pollination with the application of honey solution followed by (10.05 g & 6.82 q) open pollination with the application of jaggery solution (Table 1). Open pollination without any chemical application and intensive pollination with honeybees resulted in moderate yield enhancement in comparison to the

pollinators exclusion method.

Quality parameters of freshly harvested seed

Among the pollination methods studied, open pollination with spray of honey solution exhibited the highest seed germination (97.25%), shoot length (3.2 cm), root length (2.9 cm) and seedling dry weight (2.6 mg). followed by open pollination with the application of jaggery solution with higher seed germination (94.00%), shoot length (2.9 cm), root length (2.4 cm) and seedling dry weight (2.4 mg). The other two pollination techniques, *i.e*. open pollination without spray application and with the provision of honeybee colonies exhibited moderate enhancing effects on these seed quality attributes, while the lowest values for all these traits were observed with the pollinators exclusion method.

The seed vigour is measured in terms of seed SVI-I and SVI-II. It also differed significantly among the pollination methods. The highest seed vigour values (SVI-I=593 & SVI-II=252.9) were observed with OP with honey application followed by (SVI-I=517.1 & SVI-II=225.7) with OP with jaggery application (Table 2). The other two pollination methods namely, OP and BP resulted in moderate enhancement of seed vigour, while the PE showed the lowest value in respect of this trait. The quality improvement of seeds in various treatments was attributed to production of well developed, bold and matured seeds due to efficient supplementary pollination.

Storability of seed

Storability of seed measured in terms of seed germination percentage, seedling growth and seed vigour indices after four months of storage also differed significantly among the pollination methods. Among the treatments, open pollination with spray of honey solution exhibited the highest seed germination (85%), seedling length (6.1 cm) and seed vigour index (SVI-I=519.1 and SVI-II=221.1) followed by open pollination with the application of jaggery solution exhibiting seed germination (80%), seedling length (5.5 cm) and seed vigour index (SVI-I=439.6 & SVI-II=191.9) (Table 3). The other two pollination techniques *i.e.*, open pollination without spray application and with the provision of honeybee colonies resulted in moderate enhancing effects on these seed quality attributes, while the lowest values for all these traits were observed with the pollinators exclusion method.

Table 1. Effect of supplementary pollination methods on yield attributing traits and seed yield in Indian mustard

Sl. No.	Treatment	No. of Siliqua per plant	Siliqua length (cm)	No. of healthy seeds/siliqua	No.of wrinkled seeds/siliqua	1000-seed weight (g)	Seed yield per plant (g)	Seed yield per hectare (q)
01	T_1	80.00	5.70	15.03	6.20	3.80	11.83	8.70
02	T_2	77.15	5.18	14.10	8.75	3.85	10.05	6.83
03	T_3	72.38	4.45	12.38	10.85	3.40	6.98	5.95
04	T_4	73.03	4.85	13.40	9.95	3.58	9.05	6.05
05	T_5	62.68	4.38	11.73	12.05	3.08	6.60	5.54
06	Mean	73.05	4.91	13.33	9.56	3.56	8.90	6.61
07	CD(5%)	6.204	0.555	1.802	1.520	0.526	1.609	0.973

Table 2. Effect of supplementary pollination methods on various seed quality parameters in Indian mustard

Sl. No.	Treatment	Germination (%)	Seedling shoot length (cm)	Seedling root length (cm)	Seedling dry weight (mg)	Seed Vigour Index- I	Seed Vigour Index- II	Oil content (%)
01	T_1	97.25(80.56)	3.2	2.9	2.6	593.0	252.9	34.8
02	T_2	94.00(76.08)	2.9	2.6	2.4	517.1	225.7	33.4
03	T_3	93.75(75.66)	2.7	2.5	2.3	487.3	215.7	32.2
04	T_4	92(73.63)	2.7	2.5	2.3	479.0	211.1	31.9
05	T_5	79(62.75)	2.3	2.3	1.8	364.4	142.1	31.2
06	Mean	91.20(72.74)	2.76	2.56	2.28	488.1	209.5	32.7
07	CD (5%)	2.664	0.606	NS	0.455	88.753	41.020	1.577

Figures in parentheses are transformed values

Table 3. Effect of supplementary pollination methods on seed quality parameters in Indian mustard after 4 months of storage

Sl. No.	Treatment	Germination (%)	Seedling length (cm)	Seedling dry weight (mg)	Seed Vigour Index- I	Seed Vigour Index-II
01	T_1	85.0 (67.21)	6.1	2.6	519.1	221.1
02	T_2	80.0 (63.44)	5.5	2.4	439.6	191.9
03	T_3	73.8 (59.21)	5.2	2.3	383.3	169.7
04	T_4	75.8 (60.53)	5.2	2.3	394.1	173.9
05	T_5	67.5 (55.24)	4.6	1.8	309.1	121.6
06	Mean	76.4 (60.94)	5.32	2.28	409.0	175.6
07	CD (5%)	4.258	0.936	0.455	70.989	34.709

Figures in parentheses are transformed values

Among the pollination, methods studied, higher seed oil content of 34.8% and 33.4% were observed in seeds produced in plants supplementary pollinated with the application of honey solution and jaggery solution, respectively. Similarly, the seed oil contents were 32.2% and 31.9% in the OP and BP. On the contrary, the lowest seed oil content of 31.2% was observed in PE. On the other hand, the pollination methods did not exhibit in a significant effect on the protein content of the mustard seed.

Discussion

The flowering and seed developmental pattern in different treatments revealed that adequate bee and other insect population helped in causing efficient pollination of the crops and thereby increased the values of several yield attributes namely, number of siliqua per plant, number of healthy seeds per siliqua and seed weight which ultimately enhanced the seed yield. The quality improvement of seeds in various treatments was attributed to production of well developed, bold and matured seeds due to efficient supplementary pollination. Maintenance of high germinability and vigour of seeds during storage was the result of production of well developed, bold and matured seeds owing to efficient supplementary insect pollination in this crop. The present finding agrees with the results of similar studies by earlier workers in mustard (Mahadik *et al*., 2019; Subedi and Subedi, 2019; Sekhon *et al*., 2020; Yadav *et al*., 2021), rape seed (Bartomeus *et al*., 2014; Garratt *et al*., 2018), canola (Shakeel and Inayatullah, 2013) and sunflower (Bhatt *et al*., 1996)

Conclusion

From the present investigation, it is evident that supplementary insect pollination is effective in enhancing seed yield, seed qualities and oil content in the seed of Indian mustard. Both honey bees and other insects are useful insect pollinators in this crop.In areas of inadequate pollinators, some attractants *viz*. honey solution(5%) and jaggery solution(10%) may be sprayed on plants at the flowering stage of the crop to increase the pollinator population and effect better pollination and seed set.

References

Agrawal, P.K. 1993. *Hand Book of Seed Testing*. Deptt. of Agriculture & Cooperation, Ministry of Agriculture, GOI Publ. pp.340

Bartomeus, I., Potts, S.G., Ste ffan-Dewenter, I., Vaissiere, B.E., Woyciechowski, M., Krewenka, K.M. and Bommarco, R. 2014. Contribution of insect pollinators to crop yield and quality varies with agricultural intensification. *Peer J*. 2: 328.

Bhat, N.S., Gowda, J. and Virupakshappa, K. 1996. Influence of honeybee visits in seed yield and quality of sunflower. *National Conference on Tropical Bees and the Environment*. Dec. 19-21, held at Bangalore.

Currie, R.W. 1997. Pollination constraints and management of pollinating insects. In: *Pollen Biotechnology for Crop Production and Improvement*. (eds) Shivanna, K.R. and Sawhney, V.K., Cambridge University Press, New York, p 121-152.

Garratt, M., Bishop, J. and Degani, E. 2018. Insect pollination as an agronomic input: Strategies for oilseed rape production. *J Appl Ecol*. 55: 2834–2842.

Jay, S.C. 1986. Spatial management of honeybees on crops. *Ann. Rev. Entomol*. 31: 49-65.

Mahadik, P.B., Kulkarni, S.R. and Manchare, R.R. 2019. Impact of honey bees as pollinators on seed production of mustard (*Brassica juncea* L.). *Journal of Entomology and Zoology Studies*. 7(5): 1380-1383.

Sekhon, H., Devi, Y.K., Nath, R. and Kau, S. 2020. Impact of different modes of pollination on the productiv-

ity of Indian mustard (*Brassica juncea* L.) in Punjab. *Journal of Entomology and Zoology Studies.* 8(4): 1515-1518.

Shakeel, M. and Inayatullah, M. 2013. Impact of insect pollinators on the yield of canola (*Brassica napus*) in Peshawar. *Pakistan Journal of Agricultural and Urban Entomology.* 29(1): 1-5.

Sinha, S.N. and Singh, P.B. 2010. Insect pollination in seed crops. In: *Seed Science and Technology*, (eds.) Singhal, NC, Kalyani Publ. p 1-24.

Subedi, N. and Subedi, I.P. 2019. Pollinator Insects and their Impact on Crop Yield of Mustard in Kusma, Parbat, Nepal. *Journal of Institute of Science and Technology*. 24(2): 68-75.

Yadav, S., Painkra, G.P., Painkra, K.L. and Bhagat, P.K. 2021. Impact of Indian Honey Bee on Pollination of Mustard at Ambikapur (Chhattisgarh). *Int. J. Curr. Microbiol. App. Sci*. 10(04): 887-893.