



Extent and pattern of seed setting in faba bean under self and open pollination arrangement and its influence on seed production

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ABSTRACT

Faba bean is cheapest sources of protein and other nutrients including minerals, cool season legume crop. To know the magnitude of cross-pollination, an experiment was conducted with seven genotypes, under control/self and open-pollinated condition at ICAR Research Complex for Eastern Region Patna during cool seasons 2016-17. Experiments on faba bean are being regularly conducting since the cool season of 2007-08. Results revealed that seed yield and yield attributing traits has been reduced under the controlled/self-pollinating condition as compare to open/cross-pollinated condition, though the reduction was not same for all tested genotypes. The magnitude of yield reduction was in the range of 13.3 to 41.7 percent. Harvest Index was also gets diminished from maximum 49.2 to 21.7% with reduction of minimum 37.8 % to maximum 50.7%. It was also observed that honey bee (*Apis mellifera*) was the major pollinator bee. Results clearly indicate that apoides play a decisive role in the realization of potential yield by the cross-pollination mechanism of allogames faba bean.

Keywords : Allogamy, Pollination *Vicia faba*, Seed setting

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INTRODUCTION

Faba bean (*Vicia faba*) is known for its rich source of low-cost protein, carbohydrate minerals, vitamins and quality crude fibres (Singh and Sundaram, 2015). It is among the oldest crops in the world. Globally, it is third most important feed grain legume. Currently, 58 countries produce this bean on large scale (Singh et al., 2014). In spite of its numerous advantages, India it is still underutilized crop and yet to be utilized so far, the principal reason behind this maybe its low productivity, though it is seen as an agronomically viable alternative crop to cereal, with a potential of fixing free nitrogen upto 300 kg N ha⁻¹. Since, faba bean is a diploid species, 2n=12 (six homologous pairs) and partly allogamous species. Inadequate pollination is considered as a major obstacle to achieving the potential yield and improved seed quality of faba bean.

The importance of bees in the cross-pollination of this plant and the improvement of its production has been demonstrated and recognized by several authors, being self-fertile with about equal amount of self and cross-pollination occurring depending on the presence of insect pollinators (Stoddard and Bond, 1987).

Besides the honey bee (*Apis mellifera*), there are more than 3500 species of solitary bees which also called pollen bees which act as efficient pollinators. Some of the important pollen bees are Digger Bees (*Andrena*, *Colletes*, and other species), Bumblebees (*Bombus* spp.), Sweat bees (Halictidae family) Alkali bee (*Nomia melanderi*), Squash Bees (*Peponapis pruinosa*), Leafcutter Bees (*Megachile* spp.), Carpenter Bees (*Xylocopa* spp.) which have been reported from worldwide. Pollen bees have a number of advantages over honeybees as pollinators. Among the pollinating insects of *Vicia faba*, the wild bee *Eucera*

pulveracea Dours, violet carpenter bee (*Xylocopa violacea*) and honey bee (*Apis mellifera*) are the most abundant and seemed to be the most effective pollinator (Pierre et al., 1999). Philippe, 1991; Pierre et al., 1999 reported that this vegetable is usually visited by 80% honey bee, 50% of solitary bees and 15% of bumblebees. Here in India at Patna condition honey bee *Apis mellifera* L is a major pollinator. The importance of bees in the cross-pollination of this plant for the improvement of its production has been demonstrated by several authors (Svendsen and Brodsgaard, 1997). Cross-pollination in faba bean by various pollinator bees are reported to range from 8% to 84%, with an average of 35% in this crop (Bond and Poulsen 1983).

Faba bean being cool season leguminous crop contains unique floral structure, which produces extra floral nectarines located on the undersides of the stipules. Numerous studies have shown the value of honey bees as pollinators of faba bean in Australia and overseas, here in India being underutilized crop, a very limited study on this aspect has been done. Hence to know the seed production of faba bean, under self and open pollination this experiment was undertaken.

MATERIALS AND METHODS

To know the extent and pattern of self and open pollination on the yield attributes, and seed yield performance of faba bean, an experiment was undertaken at airport experimental farm of ICAR Research Complex for Eastern Region Patna during cool seasons 2016-17. At this research farm experiment on faba bean were taken every year since 2007-08. Hence there is no dearth of the pollinating agent. This experiment was undertaken with two recently released (2015) faba bean varieties namely Swarna Suraksha and Swarna Gaurav, along with five promising faba lines namely RCPBF1, RCPBF2, RCPBF3, RCPBF4 and RCPBF5. A field experiment was

conducted under open and controlled pollination conditions. To create such environment under open pollinated plots portion of the field was fully cover with anet. The dimension of the net was 3.0 X2.5 X1.2M. In the earmarked plots for control environment, net was placed 10 cm beneath the soil to avoid remote possibility of pollinator entry by any means (Fig.1). Data was recorded with respect to yield attributes viz., Pod length (cm) number of pods per plant, number of seeds per pod, Seed yield (g/plant), Harvest Index and Seed yield (kg/ha).

RESULTS AND DISCUSSION

Effect of self and open-pollinated environment on yield attributing traits of faba bean

The observation was taken data were recorded with respect to yield attributes viz., pod per plant, pod length, seeds per pod, seed yield per plant, and results were summarized and presented in table 1. It was clearly evident from the results that every yield attributes have to perform better under open pollinated environment. Pod length was reduced under control pollination was ranged in between 4.0 to 8.2 %. Similarly in case of pods per plant was also get hampered under self-pollination, and it was reduced in the range of 13.3 to 37.5 % as compared to open pollination environment. Likewise, previous yield attributing traits, seeds per plant

was also getting diminished under self-pollination over open pollination situation. The reduction was ranged 4.5 to 9.5 %. The similar manner was also followed by the seed yield per plant, as it is the outcome of previously discussed yield attributing traits (Table 1).

It is worth to mention here that trend in yield attribute under self and open-pollinated condition is same but the magnitude of response is different for different characters. This might be due to that, the plants that were accessible to pollinators provided more pods per plant, more seeds per pods; the pods were longer and the seeds were heavier than the controlled plants.

The average weights of the crop seeds as well as the average weight of seeds per plant were higher in the case of plants subject to open/cross-pollination and in the presence of bees compared to plants subject to the self alone (Pierre *et al.*, 1999). Pollination by bees made an impact on the number of developed seeds.

In an experiment, Philippe, (1991) demonstrates that the absence of pollinating insects during the flowering of the bean has hurt the average number of seeds per plant at 15.1 instead of 23.9. Their visits increased seed yield either by facilitating self-fertilization by the mechanical trigger and by allowing the crossings in intervening as vehicle pollen between flowers or between plants.

Table 1: Yield attributes of faba bean genotypes under open pollinated and self- pollinated condition

Genotype	Pod length (cm)		Reduction (%)	Pods / plant		Reduction (%)	Seeds/ pod		Reduction (%)	Seed yield (g/plant)		Reduction (%)
	OP	SP		OP	SP		OP	SP		OP	SP	
Swarna	4.9	4.6										
Suraksha			6.5	77.6	66.8	16.2	2.31	2.21	4.5	46.7	39.7	14.9
Swarna Gaurav	5.3	4.9	8.2	86.7	70.5	23.0	2.24	2.11	6.2	51.5	44.5	13.5
RCPBF1	5.1	4.8	6.3	57.1	50.4	13.3	2.55	2.39	6.7	35.4	33.4	5.7
RCPBF2	5.2	5.0	4.0	54.8	45.4	20.7	2.53	2.34	8.1	32.6	29.5	9.4
RCPBF3	4.6	4.4	4.5	61.3	52.5	16.8	2.36	2.22	6.3	38.6	33.2	13.9
RCPBF4	4.8	4.6	4.3	69.4	54.7	26.9	2.36	2.21	6.8	43.4	31.0	28.5
RCPBF5	5.1	4.9	4.1	80.7	58.7	37.5	2.33	2.13	9.4	45.2	26.6	41.2

Effect of self and open-pollinated environment on Faba bean seed yield

Perusal of results presented in table 1 clearly vindicates that faba bean seed production was greatly influences under self and pollinated conditions. All the seven tested genotypes have responded with the variation of environment. Maximum faba bean seed yield was noticed in case of open-pollinated condition as compared to open-pollinated circumstance.

Maximum seed production (2333.5 kg/ha) was recorded with Swarna Gaurav variety under open-pollinated environment.

Likewise, lowest seed yield was obtained (1312.9 kg/ha) in the promising line RCPBF2 under self-pollinated condition (Table 2).

Maximum yield reduction under self-pollinated environment was 41.7 per cent in case of RCPBF5, though the yield reduction under self-pollinated condition was ranged in between 13.3 to 41.7 % (Fig. 3). The difference in the response by different genotypes under both the tested environment may due to its floral structure, duration of flowering, weather conditions etc. which affects frequency and duration of the visit of pollinator bee.



Fig.1: Faba bean varieties and advanced line under controlled and open-pollinated system

Since Inadequate pollination has been proved major constraint to the potential yields and pollinators may play a prominent role in improving *Vicia faba* production. It has been found that the numbers of pods, as well as the seed yield obtained by cross-pollination, are higher than those obtained by self (Philippe, 1991; Varis, 1996).

Table 2: Faba bean seed yield (Kg/ha) under self and open-pollinated environment

Genotype	Seed yield (Kg/ha)		Yield reduction (%) in Self pollinated filed
	Open pollinated	Self pollinated	
Swarna Suraksha	2041.2	1774.1	15.1
Swarna Gaurav	2333.5	1931.6	20.8
RCPBF1	1587.6	1401.1	13.3
RCPBF2	1558.6	1312.9	18.7
RCPBF3	1732.5	1494.4	15.9
RCPBF4	1905.1	1437.7	32.5
RCPBF5	2047.5	1445.2	41.7

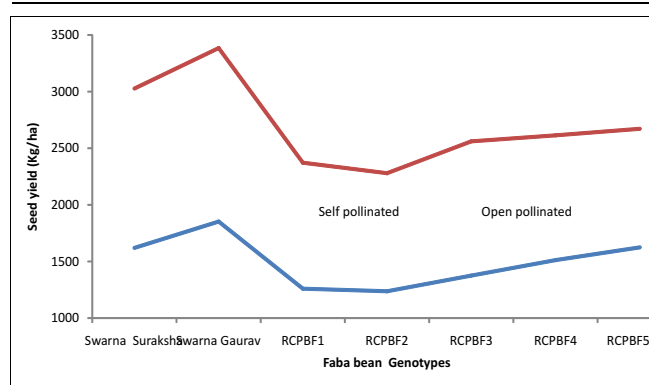


Fig.2: Faba bean Seed production under self and open-pollinated condition

Effect of self and open-pollinated environment on Harvest Index

Harvest index is an important economic yield deciding parameters, in general, influenced by yield attributing traits, and nature of economic produce. It is interesting to note that in case of faba bean, it was influenced up to great extent due to nature of pollination. Data recorded in this regard is presented in Table 3.

Harvest index was in general higher in in case of open-pollinated filed as compared to controlled pollinated filed, and it was ranged in between 40.6 to 49.2 % whereas the value for self-pollinated filed it was ranged in between 21.7% to 28.3 %. Maximum harvest Index (49.2%) was recorded in case of promising genotype RCPBF2 under the open pollinated condition, similarly lowest harvest index (21.7%) was recorded in case of genotype RCPBF1. It was also found that the trend in harvest index of different genotypes under open pollinated conditions and self-pollinated conditions was not same (Fig. 3). The reduction in the harvest index was varied from 37.8 % in case of RCPBF5 to 51.6 % in case of promising genotype RCPBF1.

Table 3: Yield reduction under self- pollinated condition v/s open pollinated conditions.

Genotype	Harvest Index (%) under self-pollinated plot over open		
	Open pollinated conditions	Self-pollinated conditions	(HI %) Reduction %
Swarna Suraksha	46.7	23.0	50.7
Swarna Gaurav	47.1	24.9	47.1
RCPBF1	44.8	21.7	51.6
RCPBF2	49.2	25.0	49.2
RCPBF3	46.7	27.5	41.1
RCPBF4	40.6	27.3	32.8
RCPBF5	45.5	28.3	37.8

Several workers reported amplification seed setting rate consequent upon an upsurge in seed production has been reported to the tune of 19-52%. Several authors (Philippe, 1991; Varis, 1996 and Pierre et al., 1999) have been reported that Apoides, which composed of honeybees *Apis mellifera*, bumble bees, and diverse solitary bees, play a major role in pollination of faba bean.

However, in comparison to the honey bee, the bumblebees are regarded as the best pollinators of the bean because of their speed of their flights and their hairy body is more suitable to transport pollen under Austria condition (Pierre et al., 1999).

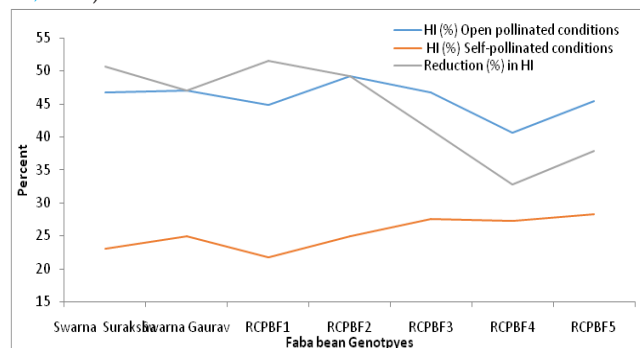


Fig.3: Harvest Index (%) under the self and open-pollinated condition

CONCLUSION

Open pollination not only increases seed production but also increases yield attributes traits. By this way, one may avoid inbreeding depression which is common phenomenon under self-pollination. It is concluded that to optimise faba bean production, cross-pollination is key especially in case of allogames faba bean cultivars. Major pollinator was one other than honey bee (*Apis mellifera*) under Patna condition.

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