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Possible impact of paclobutrazol on field pea (*Pisum sativum* L) yield and yield attribute

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Abstract
Field pea (*Pisum sativum* L) is a multipurpose and nutritious legume that act as an important part of human agriculture and nutrition. The protein-rich seeds of the field pea are a common food in many cultures which make them a valuable source of nutrition. Field pea is also a crucial part of sustainable agricultural systems due to its capacity to fix atmospheric nitrogen and hence increasing soil fertility. Paclobutrazol, a growth retardant that inhibit stem elongation and shorten the height of a plant. It also modifies the canopy structure by enhancing the number of branches and increase seed yield in plants. Application of Paclobutrazol on field peas variety 'VL-42 (L)' through foliar spray delayed the appearance of first flower with such a trend that increased in number of days with increase in concentration. Paclobutrazol treatment was found to synchronise the flowering in the field peas. Paclobutrazol @90 ml/ha was the best treatment with highest yield, highest pods per plant and highest seeds per pod and also the most effective treatment to produce the highest yield.

Keywords: Field Pea, foliar spray, paclobutrazol, yield

Introduction
Field pea (*Pisum sativum*) has long been an important part of human agriculture and nutrition. It is a multipurpose and nutritious legume. This cool-season annual plant, which is a member of the Fabaceae family, has been planted throughout the world, enhancing both gastronomic customs and environmentally friendly farming methods. Field peas stand out for their historical significance, nutritional richness, and environmental advantages. The protein-rich seeds of the field pea, a common food in many cultures, make them a valuable source of nutrition, especially for vegetarian and vegan diets. Furthermore, it is a crucial part of sustainable agricultural systems due to its capacity to fix atmospheric nitrogen through symbiotic partnerships with soil microorganisms, increasing soil fertility. Pea crop is known to add 50-60 kg residual nitrogen ha^{-1} in soil (Erman *et al.* 2009) [1].

Paclobutrazol is a growth retardant which interferes with the biosynthesis of gibberellins a classical plant hormone that promote vegetative growth in plants. Paclobutrazol treated plants caused the level of gibberellins to decline in plant, as a result, stem elongation was inhibited and the plants became shorter in height (Hua *et al*. 2014; Jagadhane *et al*. 2016; Kim, 1991; Mansurgolu *et al*. 2009; Setia *et al*. 1995) [3, 4, 5, 6, 8]. Paclobutrazol modified the canopy structure of a plants by enhancing the number of branches (primary, secondary and tertiary) (Setia *et al*., 1995) [8]. The seed yield per plant also increased mainly due to increase in the number of siliquae per plant. (Hua *et al*., 2014; Setia *et al*., 1995) [3, 8]. The total soluble sugar, sucrose, and starch content in the stem, leaf and bud organs were significantly increased by paclobutrazol application at the initial flowering stage. Paclobutrazol also increased total dry matter of plants and partitioning coefficients.

Materials and Methods
The experiment was carried out in A-B block of district seed farm during rabi season in 2021-2022 in Bidhan Chandra Krishi Viswavidyalaya at Kalyani, West Bengal. The farm is situated in the New Alluvial Zone of the West Bengal and geographically located at 22.56°N latitude and 88.32°E longitude at an altitude of 9.75m above mean sea level. The soil of farm is Gangetic alluvium and physically of sandy loam nature.

The pH of the soils of the different location of the firm ranges between 6.9 and 7.0 with inherent nitrogen, phosphorus, potassium and the organic carbon are 220 kg/ha, 40 kg/ha, 250 kg/ha and 0.51% respectively. Field pea variety 'VL-42 (L)' was taken as experimental material for the study and as a variety of a rabi season crop, it was sown on the 21st Nov 2021 and harvested on the 10th March 2022. Application of Paclobutrazol through foliar spray was done at 40 days after sowing before flowering in different concentration (0, 60, 90, 120 ml/ha). The crop was harvested 110 days after sowing to estimate the yield and yield attributes parameters. The mean data in all the cases were subjected to statistical analysis following randomised block design with three replications using OPSTAT software version 7.1.

Results and Discussion

The effect of paclobutrazol on flowering (Table 1) showed that the appearance of first flower took the least number of days in the control crop (45.00) and the number days was found to increase with increase in concentration of paclobutrazol in the treatments. Paclobutrazol @120 ml/ha took longest duration to flower (54.00). Similar pattern was observed in case of fifty percent flowering also. But if the flowering of 100% plants is taken into consideration, all the treatment appeared to be more or less the same. If the length of the flowering duration taken into consideration, it appeared that flowering in paclobutrazol treated crops were comparatively more synchronous than the control. Higher was the control greater was the synchrony in flowering. Similar trend was also reported by Jagadhane *et al*. (2016) [4] where delayed flowering in pigeon pea occurs due to paclobutrazol treatment.

The performance of the field pea variety 'VL-42 (L)' under different paclobutrazol treatments (Table 2) are as follows.

Table 1: Effects of paclobutrazol on days to flowering

Treatment	Days to			Length of flowering period
	First flower	50% flower	100% flower	
0 (control)	45.00	57.33	65.33	20.33
60 ml/ha	47.67	58.67	66.33	18.66
90 ml/ha	52.33	60.67	64.33	12.00
120 ml/ha	54.00	62.67	63.66	9.66
CD	2.56	2.69	NS	0.882

Table 2: Effects of paclobutrazol on yield and yield attributes

Treatment	Plant height (cm)	Pods/plant	Seeds/pod	Test weight (g)	Yield (g)
0 (control)	165.33	8.33	6.33	148.87	502.00
60 ml/ha	160.00	9.67	6.67	148.77	604.67
90 ml/ha	150.33	12.67	6.67	149.24	779.33
120 ml/ha	152.67	10.33	6.00	148.81	628.67
CD	4.92	0.98	0.59	NS	40.73

Plant height

The plant height was highest in the control (165.33) and it declined with increase in the concentration of paclobutrazol where paclobutrazol @120 ml/ha record the lowest (152.67). It appeared that paclobutrazol interfered with the elongation of the stem of the field pea genotype. This finding where also supported by Gimhavanekar *et al*. (2017) [2] in pigeon pea. All the treated chickpea plants were significantly shorter than the untreated control

Number of pods per plant

Number of pods per plant was lowest in the control (8.33) and all paclobutrazol treatments were higher in number of pods per plant with the highest observed in paclobutrazol @90 ml/ha (12.67). It appeared that paclobutrazol somehow caused to enhance the number of pods per plant. Pods are succession of the flowers. The greater number pods in plant might be either due to appearance of a greater number of flowers or greater proportion of pod setting or both. Greater number of pod due to paclobutrazol treatment was also reported by Jagadhane *et al*. (2016) [4] and Mikaberidze and Nardaleishvili (1999) [7].

Seeds per pod

The seeds per pod were lowest in Paclobutrazol @120 ml/ha (6.00) and highest in the lower doses of paclobutrazol that is 60 and 90 ml/ha (6.77 each). Interestingly, the control exhibited no significant difference with any of the treatments.

Test weight of seeds

Test weight of seeds did not differ significantly among the paclobutrazol treatments.

Seed yield

Seed yield was highest in paclobutrazol @ 90 ml/ha (779.33) and lowest in the control (502.00). All the paclobutrazol treated crops yielded significantly higher than control. Similar response of paclobutrazol also was reported by Jagadhane *et al*. (2016) [4], Mikaberidze and Nardaleishvili (1999) [7] and Tripathi *et al*. (2009) [9].

The variation due to paclobutrazol treatments was statistically significant in all the traits under study except test of seeds. It indicated that paclobutrazol influenced stem elongation, pod and seed development as well as yield of the field peas.

Conclusion

Foliar application of paclobutrazol in field peas delayed the appearance of first flower, however attainment of 100% flowering was reduced by its application as compared to control. Paclobutrazol treatment was found to synchronise the flowering in the field peas. Paclobutrazol @90 ml/ha was the best treatment with highest yield, highest pods per plant and highest seeds per pod, and also the most effective treatment to produce the highest yield.

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Competing interests
Authors have declared that no competing interests exist.

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