

Influence of sowing time on phenology, thermal indices and yield of field pea varieties (*Pisum sativum* L.) in Gangetic delta of West Bengal

Somdatta Achar¹, Mrityunjay Ghosh¹, R Nath¹, Saon Banerjee², SK Gunri¹, Tarun Sarkar³, and N Mudi³

¹Department of Agronomy,
²Department of Agricultural
Meteorology and Physics,
Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur,
Nadia 741252, West Bengal, India

*Email: somdattaachar@gmail.com

Received: September 16, 2022
Accepted: November 03, 2022

Handling Editor:
Dr Narendra Kumar, ICAR-Indian
Institute of Pulses Research, Kanpur

ABSTRACT

The effect of two sowing dates on phenology, growth and yield of four field pea varieties was studied during *rabi* season of 2021-22. The average phenophase duration from sowing to >50% emergence, >50% emergence to >10% flowering, and >10% flowering to >10% podding were 6.2, 47.9 and 9.1 days, respectively. Mean summed GDD and PTU for fieldpea varieties at different phenophases were 122.1°C day and 1356.4°C hour (sowing to >50% emergence), 822.5°C day and 9359.4°C hour (>50% emergence to >10% flowering) and, 154.5°C day and 1481.1°C hour (>10% flowering to >10% podding). Genetic variation among the four varieties was noted in number of branches/plant (11.7-16.5), pod length (5.2-6.1 cm), number of seeds/pod (2.7-3.8) and 1000 seed weight (159.4-168.3 g), except protein content. Field pea sown on 24 November produced higher grain yield (785.5 kg/ha) due to significant improvement in plant population (35.3 plants/m²) and 1000 grain weight (169.6 g), and that yield was 5.9% greater over early November sowing. Based on yield performance, it can be concluded that IPFD 6-3 recorded the highest yield (818.0 kg/ha) followed by IPFD 12-2 (787.5 kg/ha).

Key words: Field pea, Phenology, Sowing date, Thermal indices, Variety, Yield

INTRODUCTION

Field pea (*Pisum sativum* L.), commonly known as *matar*, in the form of unbroken or *dal* are utilized in different ways for human consumption. In India, it was grown in 11.5 lakh ha with a production of about 10.36 lakh tonnes during 2012-2017 (DPD, 2017). Uttar Pradesh accounts for 50% of area and production of field pea, while Madhya Pradesh, Haryana, Punjab, Bihar, Himachal Pradesh, Maharashtra, Odisha and Karnataka are other pea producing states.

In the state of West Bengal, field pea is cultivated in around 0.14 lakh ha area with a production of 0.17 lakh tonnes and average productivity of 11.89 q/ha (ATARI, 2017). The double cropping systems adopted by the farmers in lower *gangetic* plains of West Bengal usually include *kharif* rice followed by rapeseed-mustard, *boro* rice, potato, lentil, chickpea, wheat, etc. during *rabi* season in last three decades. However, the growing need for affordable, high-quality protein and the role of field pea in rotations for sustainable agriculture makes the crop as an alternative option in rice-fallow situation and particularly in red and laterite

region in the state (Bhattacharya and Patra, 2001). The time of harvesting of *kharif* paddy determines the time of sowing of *rabi* crops, such as late October to mid-November for field pea in West Bengal; but earlier or late sowing causes drastic reduction in yield and net profit compared to timely sowing. The temperature and photoperiod are considered as fundamental units to influence the phenology of the crop over climatic variations. Besides, there are some high-yielding varieties of field pea released in last two decades; but majority of farmers are unaware about them and are still cultivating the low-yielding local field pea varieties. So, comprehensive study is needed to work out optimum time of sowing of field pea for obtaining maximum yield, and selection of varieties suitable for early, timely or late sowing in particular agro-climatic region.

MATERIALS AND METHODS

A field experiment was conducted to know the effect of sowing time on phenology, thermal indices and yield of field pea during *rabi* season of 2021-22 on an upland sandy-clay loam soil at Krishi Vigyan Kendra at Mulakhop, Nandakumar, Purba

Medinipur (22°10'44"N latitude, 87°52'13"E longitude and 6.0 m above mean sea level), West Bengal, India. Two sowing dates (4 November and 24 November) assigned in main plots and 4 varieties (IPFD 11-5, IPFD 10-12, IPFD 12-2 and IPFD 6-3) in sub-plots were conducted in split-plot design with replicated thrice. Seeds @ 60 kg/ha of four field pea varieties inoculated with *Rhizobium* culture and were sown at 40 cm × 10 cm from row to row and plant to plant spacing in the experimental plots (4 m × 3 m) as per sowing time schedule. The standard crop management practices like application of uniform fertilizer dose of 20:40:40 kg/ha of N:P₂O₅:K₂O, two hand weedings at 20 and 40 days after sowing (DAS) were adopted. Three phenophases (*viz.* >50% emergence, >10% flowering and >10% podding) of field pea varieties at different sowing dates were noted by regular field visit. The daily meteorological data for the period of investigation (November, 2021 to February, 2022) were collected from the Regional Meteorological Centre, Kolkata; India Meteorological Department. The total summed growing degree days (GDD) [$GDD = \{(T_{max} + T_{min}) / 2\} - T_b$] for entire life cycle was determined by taking a base temperature of 5°C; while photothermal units (PTU) [PTU = GDD × Day length] was calculated by the standard equations (where, T_b is the base temperature). The plant height, yield attributed characters, grain and stover yield of field pea were recorded as per standard methods, and protein content (total N × 6.25) was determined by kjeldahl method (Sadasivam and Manikam, 2011). The statistical analysis of recorded data was done using online OPSTAT software following the procedures described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Phenology

The results revealed that the emergence of seedlings of fieldpea in late sown (24 November) plots was relatively faster (4.2 days) compared to early November sowing (8.2 days) in the experiment (Table 1). The crop sown on 4 November took 46.2 days for vegetative phase from >50% emergence to >10% flowering, and 8.6 days from >10% flowering to >10% podding, which were increased by 3.4 days and 1.0 day, respectively for delayed sown crop (24 November) in the investigation. In the context, it could be noted that flowering in pea was mainly related to the photoperiod and mean temperature during the vegetative period (Roche *et al.*, 1998). Similarly, the number of days to 50%

flowering of 4 edible podded pea genotypes was gradually increased due to delay in sowing from 21 October (83.0) to 20 November (102.2) at Palampur, Himachal Pradesh (Eshane *et al.*, 2022).

The average duration of phenophases in field pea were: 6.2 days (sowing to >50% emergence), 47.9 days (>50% emergence to >10% flowering) and 9.1 days (>10% flowering to >10% podding) in the experiment. Based on the time taken from sowing to >10% podding, four field pea varieties could be arranged as: IPFD 6-3 (66.2 days) > IPFD 11-5 (65.2 days) > IPFD 12-2 (62.8 days) > IPFD 10-12 (58.3 days).

Growing degree days (GDD)

Mean GDD for fieldpea from sowing to >50% emergence, >50% emergence to >10% flowering, and >10% flowering to >10% podding were 122.2, 822.5 and 154.5°C day, respectively (Table 1). Late sown crop (24 November) accumulated less GDD from sowing to >50% emergence (82.8°C day) and >50% emergence to >10% flowering (779.16°C day), but it required more heat units (178.3°C day) during the period from >10% flowering to >10% podding than early November sown crop. Late sown crop (24 November) recorded more days (49.6) during the vegetative period but accumulated less GDD (779.2°C day) due to less mean daily temperature during the period (20.5°C *vs.* 22.4°C) compared to early sown crop. Devi *et al.* (2019) also reported that total accumulated GDD was reduced due to delay in sowing of 3 pea varieties from December 1 to December 15 in mid hills of Himachal Pradesh.

Based on accumulated GDD, four varieties could be arranged as: IPFD 11-5 (1184.65°C day) > IPFD 6-3 (1125.61°C day) > IPFD12-2 (1076.06°C day) > IPFD10-12 (1010.40°C day). Perusal of data revealed that all four fieldpea varieties accumulated 1000-1200°C day GDD from sowing to >10% podding stage in lower gangetic plains of West Bengal. But Devi *et al.* (2019) reported less GDD (869.5-986.8°C day) for 3 pea varieties under two sowing dates (1 and 15 December) at Nauni, Himachal Pradesh.

Photothermal unit (PTU)

Sowing time had significant influence on accumulation of PTU during the emergence period only, where late sown crop (24 November) had less PTU (905.13°C hour) compared to early November sowing (1807.64°C hour) (Table 1). Field pea crop sown on 4 November accumulated higher total PTU of 13490.61°C hour, which was 2587.33°C

hour greater over 24 November sowing in the investigation.

Mean cultivar summed PTU at different phenophases were recorded as: 1356.38°C hour (sowing to >50% emergence), 9359.43°C hour (>50% emergence to >10% flowering) and 1481.13°C hour (>10% flowering to >10% podding), but varietal differences for PTU for all 3 phenophases were found non-significant.

Growth attributes

Among two dates, late sowing (24 November) resulted in higher plant height throughout the cropping period as well as at maturity as compared to early sowing on 4 November in the experiment

(Table 2). It might be due to the fact that field pea, being cool season crop, accelerated its vegetative growth under low temperature condition when sown in late November (25.6°C day/15.5°C night) compared to early November sowing (27.4°C day/17.1°C night). However, field pea sown in 1st fortnight of November at Patiala, Punjab could produce taller plants with greater branching habit and more number of leaves/plant than earlier (2nd fortnight of October) or later sowing (2nd fortnight of November) (Singh *et al.*, 2020). IPFD 6-3 produced the taller plants (66.0 cm) and had better branching habit (16.5 branches/plant) than other 3 varieties tested in the investigation. Sharma *et al.* (2020) observed that Arkel recorded lowest plant height

Table 1. Effect of sowing date and variety on phenology and thermal indices of field pea

Treatment	Sowing to >50% emergence	>50% emergence to >10% flowering	>10% flowering to >10% podding
Phenophase duration (days)			
Sowing date			
4 November	8.2	46.2	8.6
24 November	4.2	49.6	9.6
CD (P=0.05)	2.41	NS	NS
Variety			
IPFD 11-5	5.2	49.0	11.0
IPFD 10-12	6.7	43.2	8.5
IPFD 12-2	5.5	48.7	8.7
IPFD 6-3	7.3	50.7	8.2
CD (P=0.05)	NS	3.97	NS
Growing degree days (C day)			
Sowing date			
4 November	161.5	865.8	130.7
24 November	82.8	779.2	178.3
CD (P=0.05)	38.55	50.48	NS
Variety			
IPFD 11-5	104.8	838.5	241.3
IPFD 10-12	127.6	756.0	126.8
IPFD 12-2	111.1	838.4	126.5
IPFD 6-3	145.2	856.9	123.5
CD (P=0.05)	NS	55.97	NS
Photothermal unit (C hour)			
Sowing date			
4 November	1807.6	10290.1	1392.9
24 November	905.1	8428.8	1569.4
CD (P=0.05)	426.62	NS	NS
Variety			
IPFD 11-5	1164.9	9103.2	1792.8
IPFD 10-12	1415.7	9942.8	1380.0
IPFD 12-2	1233.4	9100.1	1413.5
IPFD 6-3	1611.5	9291.6	1338.2
CD (P=0.05)	NS	NS	NS

NS=Non significant

Table 2. Effect of sowing date and variety on yield attributes and yield of field pea

Treatment	Plant height (cm)	Population (No./m ²)	No. of branches/plant	No. of seeds/pod	1000 seed weight (g)	Grain yield (kg/ha)	Stover yield (kg/ha)	Protein content (%)
Sowing date								
4 November	57.2	32.9	13.6	3.3	157.0	741.4	1998.9	17.0
24 November	66.9	35.3	14.5	3.6	169.6	785.5	2119.5	17.4
CD (P=0.05)	4.95	1.39	NS	NS	3.14	14.79	11.61	NS
Variety								
IPFD 11-5	61.7	33.0	15.3	2.7	163.9	716.8	1929.4	17.3
IPFD 10-12	54.8	36.0	12.7	3.7	159.4	731.5	1988.5	17.4
IPFD 12-2	65.5	34.0	11.7	3.8	161.6	787.5	2136.0	16.5
IPFD 6-3	66.0	33.5	16.5	3.7	168.3	818.0	2183.1	17.5
CD (P=0.05)	1.79	1.77	2.42	0.70	3.63	17.06	8.73	NS

NS=Non significant

because of its shorter vegetative phase with earliest flower initiation (37.5-48.7 days) in all 3 zones at different altitudes (600 m, 1375 m and 1800 m altitude) in Himachal Pradesh, while Arka Kartik being longer duration one produced tallest plants with less branching habit. So, it is understood that the vegetative growth of pea largely depends on combined effects of varietal characters and agro-climatic peculiarities of the region.

Grain yield and quality

With delay in sowing from early November to late November, the number of seeds/pod was slightly increased from 3.3 (4 November) to 3.6 (24 November) in the experiment (Table 2). At maturity, IPFD 6-3 produced maximum number of branches (16.5) in a plant being at par with IPFD 11-5 (15.3); while IPFD 12-2 had least branches/plant (11.7). At both sowing dates, IPFD 6-3 recorded maximum 1000 grain weight (164.6 g and 172.0 g). Field pea sown on 24 November produced higher grain yield (785.5 kg/ha) due to significant improvement in plant population (35.3/m²) and test weight (169.6 g) (Table 2). However, Ahmed *et al.* (2020) opined that the optimum time of sowing of field pea might be 13 November due to higher seed yield (827.7 kg/ha) rather than early sowing (29 October) or late sowing (28 November) at Mymensingh, Bangladesh. Based on yield performance, four varieties could be arranged as: IPFD 6-3 (818.0 kg/ha) > IPFD 12-2 (787.5 kg/ha) > IPFD 10-12 (731.5 kg/ha) > IPFD 11-5 (716.8 kg/ha). Among four varieties, IPFD 6-3 produced maximum grain yield (818.0 kg/ha) which was 30.4, 86.5 and 101.1 kg/ha greater over IPFD 12-2, IPFD 10-12 and IPFD 11-5, respectively. The maximum grain yield of IPFD 6-3 could be attributed to maximum number of branches/plant (16.5) accommodating more pods

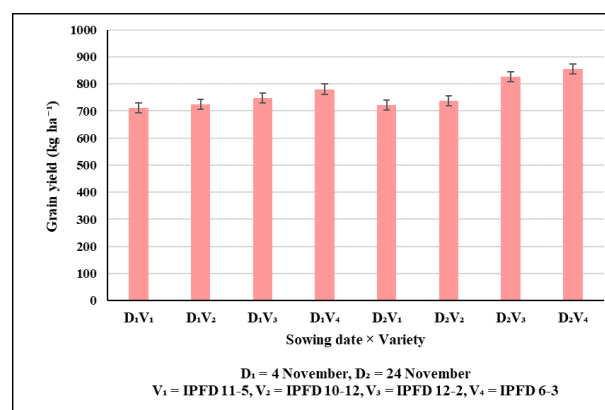


Fig. 1. Interaction effect of sowing date and variety on grain yield of field pea

and 1000 seed weight (168.3 g). Moreover, IPFD 6-3 produced the maximum grain yield (780.9 and 855.0 kg/ha) at both sowing dates (Fig. 1). This finding indicated that IPFD 6-3 might be recommended for acquiring >800 kg/ha grain yield in gangetic delta region of West Bengal. With delay in sowing from 4 November to 24 November, the stover yield was increased progressively from 1998.9 to 2119.5 kg/ha in the experiment. Like grain yield, the highest stover yield was recorded with IPFD 6-3 at both sowing dates (2176.8 and 2189.3 kg/ha) during *rabi* season. Protein content remained unaffected due to different sowing times and four varieties had non-significant variation in protein content (16.5-17.5%) in the investigation. Majid *et al.* (2017) identified four field pea genotypes (SKUA-P-RF-36, SKUA-P-RF-113, SKUA-P-RF-55 and SKUA-P-RF-34) for having greater protein content than check variety (Shalimar Pea 1) in Kashmir valley.

Thus, it could be concluded that late (24 November) sown crop emerged early (4.2 *vs.* 8.2 days), but it took 3.4 days and 1.0 day more to reach flower initiation and pod development

stage, as compared to early November sown crop. Field pea sown on 24 November produced higher grain yield (785.5 kg/ha), which was 5.9% greater over 4 November sowing (741.4 kg/ha). IPFD 6-3 appeared as a promising variety due to high grain yield (818.0 kg/ha) and protein content (17.5%), while late November might be optimum time for sowing of field pea crop in *gangetic* delta region of West Bengal.

REFERENCES

- Ahmed B, Hasan AK, Karmakar B, Hasan S, Akter F, Saha PS and Haq E. 2020. Influence of date of sowing on growth and yield performance of field pea (*Pisum sativum* L.) genotypes. *Asian Research Journal of Agriculture*, **13** (2): 26-34.
- ATARI. 2017. Enhancing Pulse Productivity through Agro-Technologies under Clustered Frontline Demonstration Programme (Bihar, Jharkhand and West Bengal). (Eds. SK Roy, FH Rahman, PP Pal and J Basak). ICAR- Agricultural Technology Application Research Institute, Kolkata, India.
- Bhattacharya C and Patra PK. 2001. Evaluation of some derived pea varieties under late sown condition on the rice fallows of the Red and Laterite Zone of West Bengal. *Environment and Ecology*, **19** (2): 357-359.
- DPD. 2017. Field pea Production Technology (Eds. AK Tiwari, AK Shivhari and V Kumar). Directorate of Pulse Development, Government of India, Bhopal, India.
- Devi S, Singh M and Aggarwal RK. 2019. Thermal requirements and heat use efficiency of pea cultivars under varying environments. *Current World Environment*, **14** (3): 376-382.
- Eshanee, Sharma A, Sharma P, Sharma GD, Manuja S and Rana SS. 2022. Effect of sowing dates on phenological traits, yield and its contributing attributes on snow pea genotypes. *Legume Research*, DOI: 10.18805/LR-4817.
- Gomez KA and Gomez AA. 1984. *Statistical Procedures for Agricultural Research*, 2nd edition. John Wiley & Sons, Singapore.
- Majid A, Dar SA, Wani SH, Bhat MA, Ambardar VK and Lone AA. 2017. Genotype x environment interaction for seed yield and protein content in field pea genotypes under Kashmir conditions. *International Journal of Current Microbiology and Applied Sciences*, **6** (7): 3880-3884.
- Roche RI, Jeuffroy M and Ney B. 1998. A model to stimulate the final number of reproductive nodes in pea (*Pisum sativum* L.). *Annals of Botany*, **81**: 545-555.
- Sadasivam S and Manikam A. 2011. *Nitrogen analysis by microjeldahl method*. Biochemical Methods. New Age International (P) Ltd. Publishers. 3rd Edition, New Delhi.
- Sharma D, Chauhan A and Jarial K. 2020. Performance of pea varieties in different altitude ranges under north-western Himalayan region. *International Journal of Current Microbiology and Applied Sciences*, **9**(6): 3292-3302.
- Singh H, Lal M, Singh S and Singh T. 2020. Response of sowing time and fertilization on the growth parameters and yield of field pea (*Pisum sativum* L.) under irrigated conditions of Punjab. *Journal of Pharmacognosy and Phytochemistry*, **9** (6): 935-938.