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Impact of Different Sowing Dates on Growth and Pod Yield of Vegetable Pea under Sub-Himalayan Foothills Region of India

Udit Kumar[1], Nishiprabha Behera[1], K. Prasad[2], Pramila[1], Dharminder[3], Kaushal Kishor[3], R.K. Tiwari[4], Bharati Upadhaya[4], Sunil Kumar[5], Vivek Kumar[3]

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ABSTRACT

Background: The optimum sowing date is crucial among the different agronomic procedures for maximizing output. Optimizing a crop's planting time may be one of the most significant climate resilient tactics for increasing production and hence it becomes necessary to study the crop growth behaviors in changing climatic conditions. The proposed field investigations were undertaken to study the influence of different sowing dates on yield of vegetable pea.

Methods: Field investigations were undertaken during *Rabi* seasons of 2020-21 and 2021-22 at the Vegetable Research Farm, Department of Horticulture, Dr. Rajendra Prasad Central Agricultural University, Pusa (85.67°E - 25.98°N.), which comes under sub-Himalayan foothills region of India. The research study was performed in randomized block design with three replications consisting of eight different sowing dates of vegetable pea. cv. Azad Pea-3 at 10 days interval between each sowing dates. Observations were made on various growth and yield attributing parameters.

Result: Results revealed that the parameters under study were substantially affected by various sowing dates. Second week of sowing in November in the years produced maximum plant height at 60 DAS (83.77 cm), number of branches per plant (3.97), number of nodules per plant at flowering (26.13), number of green pods per plant (20.80), 10 pods weight (75.67 g) and pod yield (52.06 q/ha).

Key words: Growth, Pod yield, Sowing time, Vegetable pea.

INTRODUCTION

Vegetable pea (*Pisum sativum* L.*)* or green peas or vegetable peas is one of the oldest cultivated crops grown all over the world for its tender green pods and immature seeds. Pea is a major cool season vegetable crop in family Fabaceae (Leguminaceae). Due to its low requirements for water, chemicals, and fossil fuels and also its capacity to symbiotically fix atmospheric nitrogen, pea cropping has significant advantages in sustainable farming systems (MunierJolain and Carrouee, 2003). In India, vegetable pea is cultivated in an area of 567.7 thousand hectares from which annual production is 5852.5 thousand metric tonnes. In Bihar, pea is grown over 11.9 thousand hectares with 66.3 thousand metric tonnes of annual production (Anonymous, 2020; Kumar *et al*., 2024). Green seeds can be consumed as fresh or alternatively might be used after processing (canning, freezing and dehydration) for use during off season and has great potential in domestic and export market. Vegetable pea is typically a cool season crop of temperate and subtropical regions but can also be grown in mild climate of the tropics.

Pea, like other crops, is influenced by weather along with various climate complexities because it cannot thrive in the summer heat or lowland tropical climates, however grows well in cooler and higher altitude tropical areas (Oplinger *et al*., 1991). Green peas could be cultivated in temperatures ranging from 10 to 30°C, but they perform best at temperature between 13-18°C and are frost resilient for the initial vegetative growth stages, although the flowers and pods are harmed later on. Temperatures above 25.6°C during flowering and pod setting, according to Wien (1997), reduced pea flower, pod number and yield. For pea seeds germination, the ideal temperature is around 22°C. Germination can occur at temperature conditions as low as 5°C, although at a slower pace (Sirwaiya *et al*., 2018). Temperatures exceeding 20°C reduce the production besides quality of immature seeds. Temperature fluctuations during germination increase plant mortality due to desiccation (Sharma *et al*., 1997), while higher

[1]Department of Horticulture, PG College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa-848 125, Bihar, India. [2]Department of Horticulture, Tirhut College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Dholi, Pusa-848 125, Bihar, India. [3]Department of Agronomy, PG College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa-848 125, Bihar, India. [4]Krishi Vigyan Kendra, Birauli, Samastipur-848 125, Bihar, India. [5]Department of Genetics and Plant Breeding, Veer Kunwar Singh College of Agriculture, Buxar-802 136, Bihar, India.

Corresponding Author: Udit Kumar, Department of Horticulture, PG College of Agriculture, Dr. Rajendra Prasad Central Agricultural University, Pusa-848 125, Bihar, India. Email: udit@rpcau.ac.in

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temperatures cause plants to flower earlier, contributing to poor yield (Gajenra *et al*., 1995). At high temperatures seed N accumulation is significantly constrained due to a shorter seed-filling period and a lower seed dry-matter accumulation rate (Larmure and Munier-Jolain, 2019). Vegetable pea is a cool loving crop and on shortening of winter the crop may be affected in one way or the other. This has resulted in shifting of optimum sowing dates and affected the growth and phenology of crop at different stages. With the rise in global temperature, pea seed yield is decreasing and the developing seeds are shown to be aborted when exposed to high temperatures (Jeuffroy, 1990). Optimizing a crop's planting time may be one of the most significant climate resilient tactics for increasing production and hence it becomes necessary to study the crop growth behaviours in changing climatic conditions. The goal would be to undertake sowing at a period when there is the greatest chance of receiving a favourable condition for the maturation and growth of seed. Keeping in view of the above aspects, the proposed investigation was undertaken to study the influence of different sowing dates on growth and yield of vegetable pea under sub-himalayan foothills region of India.

MATERIALS AND METHODS

The investigations were undertaken during *Rabi* seasons of 2020-21 and 2021-22 at Vegetable Research Farm, Department of Horticulture, Dr Rajendra Prasad Central Agricultural University, Pusa, which comes under sub-Himalayan foothills region of India, situated at North latitude of 25.97°, East longitude of 85.86° and altitude of 52.05 meters above mean sea level. Throughout the period of investigations for two years, average precipitation of 135.3 mm, relative humidity (Max. 94.92% and Min. 61.74%), average daily maximum temperature of 25.20°C, minimum temperature 13.09°C and total sunshine hours of 803.3 was recorded. The studies were performed in randomized block design with three replications for vegetable pea cv. Azad Pea-3 at eight sowing dates *viz*. T_1:12th Oct, T_2: 22nd Oct, T_3: 1st Nov, T_4: 11th Nov, T_5: 21st Nov, T_6: 1st Dec, T_7: 11th Dec and T_8: 21st Dec in the both years. 20 tonnes FYM/ha was incorporated into the soil at time of land preparation followed by application of recommended dose of N, P_2O_5 and K_2O @ 60:60:60 Kg/ha at time of sowing. Vegetable pea seeds were sown at an interval of 10 days in plots of 6 m × 1.5 m by maintaining a spacing of 30 cm between the rows and 10 cm between the plants. Manual hand weeding at initial phase of crop growth *i.e* at 25 DAS and subsequently at 45 DAS was enough to keep the experimental plot was weed free. The field was irrigated during flowering and pod formation stages of crop and also according to the conditions of the soil. To assess the impact of different sowing dates, observations on various characteristics such as growth, length of various phases and pod yield related parameters were recorded during period of investigations. Within each treatment and for each replication five plants were randomly selected and tagged properly for recording of related observations from these labelled plants. The data collected on different observations for each treatment were subjected to "Analysis of variance," as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Different sowing dates showed a significant impact on various growths as well pod yield and its attributing parameters.

Plant stand was influenced by different date of sowing. Mean plant stand was varied from 76.92-94.65 (Table 1). The treatment T_6 exhibited maximum plant stand (94.65%) and this was statistically at par with T_5 (89.35%) and T_7 (91.38%) while minimum plant stand was obtained in T_1 sowing (76.92%). Plant stand was noticed lower in the case of earlier planting dates. This could be on account of prevalence of high temperature during sowing to stand establishment period of crop which caused decreased germination percentage, seedling emergence, aberrant seedlings, low seedling vigour and poor radical as well as plumule development in germinated seedlings

Table 1: Influence of different sowing dates on growth parameters (years 2020-21, 2021-22 and pooled).

Treatment	Plant stand (%)			Plant height at 60 DAS			Number of branches per plant			Number of nodules per plant at flowering		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	77.61	76.23	76.92	62.07	63.73	62.90	1.53	1.60	1.57	19.97	20.07	20.02
T_2	78.30	78.91	78.61	73.87	73.81	73.84	3.03	3.07	3.05	23.93	23.20	23.57
T_3	80.30	79.16	79.73	77.90	77.20	77.55	3.60	3.53	3.57	24.93	25.33	25.13
T_4	82.78	84.78	83.78	82.91	83.77	83.34	4.03	3.97	4.00	26.47	26.13	26.30
T_5	88.59	90.11	89.35	80.43	80.48	80.46	3.47	3.40	3.44	21.90	21.77	21.84
T_6	95.77	93.53	94.65	76.22	76.17	76.20	3.17	3.27	3.22	17.93	18.03	17.98
T_7	90.69	92.07	91.38	72.31	74.43	73.37	3.30	3.40	3.35	16.97	17.10	17.04
T_8	85.91	87.80	86.86	67.95	67.87	67.91	2.87	2.80	2.84	19.37	19.17	19.27
SE(m)±	3.80	3.95	2.56	3.48	3.51	2.61	0.15	0.15	0.20	1.03	1.11	0.92
CD (p≤0.05)	11.54	11.99	7.38	10.56	10.64	7.53	0.45	0.45	0.59	3.14	3.36	2.64
CV (%)	7.75	8.02	7.36	8.12	8.13	8.59	8.21	8.26	15.98	8.36	8.99	10.50

(Hasanuzzaman *et al*., 2013) and hence resulted in poor crop stand. Considering such effect of temperature similar results were obtained by (Singh and Kumar 1979; Weier *et al*., 1982; Bewley, 1997; Sharma *et al*., 1997; Dhall, 2017 and Lamichaney *et al*., 2021).

Plant height at 60 DAS was maximum in T_4 sowing (83.34 cm) which was statistically at par with T_5 (80.46 cm), T_3 (77.55 cm) and T_6 (76.20 cm). Significantly lowest plant height (62.90 cm) was recorded in T_1 sowing. This was most likely owed to more assimilates being utilised to sustain increased height of vegetative growth. Higher temperature largely affects the pace of plant development, which increases to a point and then decreases (Howarth, 2005; Wahid *et al*., 2007). The period of rapid vegetative growth was delayed owing to effect of lower temperature. This is in agreement to the findings of (Srivastava and Singh, 1989; Sirwaiya and Kushwah, 2018; Haq and Ahmed, 2021).

Maximum number of branches plant^{-1} was produced from T_4 sowing (4.00) and this was found at par with T3 (3.57) and T_5 (3.44) sowing. Number of branches plant^{-1} was recorded lowest in case of T_1 sowing (1.57). This might be explained on account of prolonged vegetative period under low temperature that allowed formation of more branches along with impact of other prevailing weather conditions during the period of growth. Similar findings have been achieved by (Stanfield, 1965; Sirwaiya and Kushwah (2018).

Maximum number of nodules plant^{-1} at flowering was produced in T_4 sowing (26.30) and this was statistically at par with T_3 sowing (25.13). Meanwhile lowest was recorded in T_7 sowing (17.04). The possible explanation for this might be related to increase in soil temperature from solar radiation which favoured rhizobial growth. The prevalence of low temperature significantly lowered nodule growth rate, delayed nodule formation significantly, final nodule size, nodule activity and impacted nitrogenase activity (Schweitzer and Harper, 1980; Junior *et al*., 2005). Similar finding was also obtained by Dung (2012).

The results from the experiment indicated that sowing dates had exerted a significant influence on the number of days to first flowing, flowering to harvest and sowing to harvest of vegetable pea plant (Table 2). For first flowering, T_1 sowing took minimum number of days (29.50) and this was at par with T_3 sowing (30.00) and T_2 sowing (30.67) sowing. While it was maximum in case of T_6 sowing (49.00). This might be because of exposure of plants to warmer temperature which induced earlier reproductive development.

T_1 sowing took the least number of days from flowering to harvest (37.67) and this was at par with T_8 sowing (38.84), T_7 sowing (38.84) and T_2 sowing (39.17). Whereas T_6 sowing (43.00) took the most for the same. T_1 sowing took the least number of days from sowing to harvest (67.17) and this was at par with T_2 sowing (68.83) and T_3 sowing (70.84). Whereas T_6 sowing (88.50) took the maximum number of days from sowing to harvest. This might be because of slower growth under low temperature which prolonged this duration. These observations are similar with the findings of (Nonnecke *et al*., 1971; Srivastava and Singh, 1989; Guilioni *et al*., 2003; Bueckert *et al*., 2015; Bhandari *et al*., 2016; Kuznetsov *et al*., 2020).

Sowing date has exerted a significant effect on the number of green pods per plant (Table 3).T_4 sowing produced maximum number of green pods (20.39) plant^{-1} and this was statistically equivalent with T_5 sowing (18.07). Significantly lowest number of green pods plant^{-1} was produced in T_1 sowing (11.64). This might be owed to the mild temperature, longer growth duration which ultimately resulted in diversion of more energy towards more flowering and pod formation. Moreover flowering, pod formation along with its development was limited by high temperature on account of more sunshine hours during reproductive phase (Wien, 1997). The results are supported with the findings of Lambert and Linck (1958; Guilioni *et al*. (1997); Sadras *et al*. (2012); Bhandari *et al*., (2016); Sita *et al*. (2017); Jiang *et al*. (2020); Lamichaney *et al*. (2021); Haq and Ahmed (2021).

Length of pods was found to be highest in T_4 sowing (9.42 cm) and this was at par with T_3 (9.40 cm), T_5 (9.08 cm) and T_6 (8.85 cm), sowing. The pod length was shortest in case of T_1 (7.37 cm) sowing.

Under Punjab conditions, Randhir *et al*. (1996) observed that this could be attributed to low maximum temperature

Table 2: Influence of different sowing dates on reproductive parameters (years 2020-21, 2021-22 and pooled).

Treatment	Days to first flowering			Days from flowering to harvest			Days from sowing to harvest		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	29.67	29.33	29.50	37.00	38.33	37.67	66.67	67.67	67.17
T_2	31.00	30.33	30.67	38.33	40.00	39.17	68.33	69.33	68.83
T_3	30.33	29.67	30.00	41.00	42.67	41.84	70.67	71.00	70.84
T_4	34.33	33.67	34.00	43.67	42.67	43.17	74.67	75.67	75.17
T_5	43.00	42.67	42.84	43.00	43.00	43.00	84.00	85.00	84.50
T_6	48.67	49.33	49.00	42.33	42.33	42.33	87.67	89.33	88.50
T_7	46.00	46.00	46.00	38.00	39.67	38.84	83.67	84.67	84.17
T_8	40.67	42.33	41.50	38.67	39.00	38.84	77.33	79.00	78.17
SE(m)±	1.40	1.21	1.25	1.34	1.14	1.34	2.33	2.31	1.79
CD (p≤0.05)	4.24	3.67	3.60	4.07	3.45	4.11	7.06	7.02	5.16
CV (%)	6.38	5.53	8.07	5.78	4.81	5.78	5.26	5.16	5.68

Table 3: Influence of different sowing dates on pod yield and its attributing parameters (years 2020-21, 2021-22 and pooled).

Treatment	Number of green pods per plant			Pod length (cm)			10 pods weight (g)			Pod yield (q/ha)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	11.27	12.00	11.64	7.03	7.37	7.20	48.37	50.33	49.35	38.10	39.62	38.86
T_2	15.77	13.73	14.75	7.60	8.00	7.80	61.63	56.33	58.98	44.90	43.47	44.19
T_3	17.10	16.33	16.72	9.40	9.40	9.40	68.23	70.03	69.13	47.10	48.79	47.95
T_4	19.97	20.80	20.39	9.53	9.30	9.42	76.33	75.67	76.00	52.71	52.06	52.39
T_5	17.90	18.23	18.07	9.03	9.13	9.08	67.17	74.03	70.60	47.91	51.01	49.46
T_6	14.97	15.43	15.20	8.80	8.90	8.85	71.63	67.17	69.40	49.47	48.39	48.93
T_7	13.50	14.33	13.92	8.47	8.73	8.60	50.77	65.83	58.30	39.03	44.53	41.78
T_8	10.90	12.97	11.94	8.07	8.53	8.30	49.57	52.43	51.00	38.48	41.66	40.07
SE (m)±	0.76	1.06	0.92	0.40	0.403	0.27	3.27	3.067	2.79	2.31	2.31	1.62
CD ($p \leq 0.05$)	2.31	3.23	2.64	1.22	1.22	0.77	9.93	9.30	8.05	7.02	6.99	4.66
CV (%)	8.59	11.91	14.66	8.24	8.04	7.63	9.12	8.30	10.89	8.80	8.65	8.72

experienced between the period from flowering to maturity which encounter milder temperatures, develop more slowly, grow for longer periods of time intercept more solar energy and subsequently assimilate more photosynthates towards pod and seed development. These observations are in accordance with the findings of Nonnecke *et al*. (1971; Jeuffroy *et al*. (1990); Siddique *et al*. (2002); Bhandari *et al*. (2016); Sita *et al*. (2017); Haq and Ahmed (2021).

The weight of 10 pods of vegetable pea was highest for T_4 sowing (76.00 g) which was statistically at par with T_5 (70.00 g), T_6 (69.40 g) and T_3 (69.13 g) and was significantly lowest for T_1 (49.35 g) sowing.

Pod yield was also recorded highest for T_4 sowing (52.39 q/ha) and was equivalent with T_5 (49.46 q/ha), T_6 (48.93 q/ha) and T_3 (47.95 q/ha), while lowest pod yield hectare^{-1} was obtained from T_1 sowing (38.86 q/ha). Pod yield is directly affected by number of branches plant^{-1}, number of pods plant^{-1}, pod length and pod weight which in turn are influenced by the maximum and minimum temperature as well as bright sunshine hours prevailing during flowering to harvest period of the crop. These matches with the findings as reported by Nonnecke *et al*. (1971); Pumphrey *et al*. (1979); Randhir *et al*. (1996); Wien (1997); Siddique *et al*. (2002); Moniruzzaman *et al*. (2007); Gantner *et al*. (2008); Sita *et al*. (2017); Kuznetsov *et al*. (2020); Lamichaney *et al*. (2021); Haq and Ahmed (2021).

CONCLUSION

The current investigations inferred that sowing of garden pea from 1st November to 1st December was effective in providing favorable meteorological conditions required for different phenophases which eventually led to maximization of pod yield under sub-Himalayan foothills region of India.

Conflict of interest

All authors declare that they have no conflicts of interest.

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