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Effect of sowing dates on qualitative traits in Vegetable Pea (*Pisum sativum* L.)

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ABSTRACT

The effect of sowing dates on the qualitative traits of Vegetable pea (Pisum sativum L.) was investigated to determine how planting time influences the qualitative traits of vegetable pea. Twenty genotypes of Vegetable pea were used in the experiments which were collected from NBPGR New Delhi, IARI New Delhi and different districts of Bihar (Begusarai, Samastipur, Bhagalpur etc.). In this study, vegetable peas were sown at different dates i.e., 15th October, Last week of October, and 1st week of November and various qualitative traits, including TSS Content, Total Sugar, Reducing Sugar, Protein Content and ascorbic acid were assessed. These all qualitative traits were observed minimum for IC-342046 and maximum for 5438/P-2110 which was at par with all four checks (Pusa Prabhat, Arkel, GS-10, and Punjab 89). When comparing early-planted vegetable pea on October 15th to other sowing dates, noticeably larger TSS Content, Total Sugar, Reducing Sugar, Protein Content and ascorbic acid was found which indicates that the sowing date determined the level of qualitative traits in vegetable pea. The current study found that early sowing dates generally produced better qualitative characteristics in vegetable pea. Predicting the ideal time to plant might be challenging due to unseasonable rains, temperature fluctuations, or frost events. The development of crop management techniques that can adjust to climatic variability and harsh weather events is aided by research on sowing dates. Farmers can better adapt to variations in temperature and precipitation patterns by modifying the time of sowing.

Keywords: *Pea, Qualitative, Genotypes, Effect, Total Sugar, TSS, Protein, RBD, NBPGR, Sowing dates, Ascorbic Acid, Reducing Sugar.*

Introduction

Around the world, peas (*Pisum sativum* L.) are a popular and nutrient-dense food that is grown during the cool season. The crop is cultivated for both ripened seeds and green pods. Pods are sweet, crunchy, have a hint of flavour, and don't have pod parchment. When consumed as a vegetable or as soup, it is a very good diet for humans. For this, green pods' immature seeds are typically utilized. Additionally, farm animals receive wholesome green food from pea herbage when it is harvested shortly after the pods are picked. It is typically used as a raw vegetable as well as in processed, dehydrated, and canned forms. In India, it is mostly grown as a summer vegetable in the highlands and as a winter crop in the plains of North India. India is the world's biggest producer and importer of leguminous crops [6], [33], [26].

The United States, China, India, Russia, and Canada are the major pea-growing nations. India ranks fifth in terms of production and fourth in the region. India produces 796735 tons of dried peas annually on an area of 616508 hectares [14]. Major pea-growing states in India include Uttar Pradesh, Madhya Pradesh, Jharkhand, Punjab, Himachal Pradesh, West Bengal, Haryana, Bihar, Uttarakhand, Orissa, and Karnataka [30]. Green leaves, green pods, and seeds are the edible portion. One common veggie is green peas, pods, or immature seeds. It has a significant quantity of fibre and antioxidants and is also very nutrient-dense. It may also help prevent some chronic illnesses including cancer and heart disease, according to a study. The high protein and fibre content of green peas makes them a highly satisfying dish. It possesses a number of qualities that could promote normal blood sugar regulation [11]. According to [7], 100 grams of green peas have 0.4 grams of fat, 14.5 grams of carbohydrates, 25 milligrams of calcium and 5.4 grams of protein.

For every crop, vegetative growth, and output, the timing of the sowing is crucial. The ideal sowing period guarantees the efficient use of moisture, temperature, light, etc. from seed germination to final harvest. Temperature fluctuations based on the date of planting had a substantial impact on pea seed quality, crop development, flowering duration, pod formation, seed setting, total dry matter production, and yield, according to [2]. [1] observed that late sowing increased the starch content of green pea seeds. Pod yield is decreased when peas are sown later or earlier than is ideal [22]. Early seeding dates yielded the highest economic return, while late seeding dates yielded the lowest return. The production was 38% lower than usual due to late sowing and excessive temperatures [35]. According to [21], seed yields must be decreased if the temperature rises beyond 25°C during the flowering and pod-filling stages.

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Insufficient research has been done on garden peas for qualitative traits. Thus, it is now essential to carry out research to enhance pea quality. Therefore, determining the ideal time to plant is crucial for the quality cultivation of pea [15].

Material and Methods

The influence of sowing dates on qualitative traits in Vegetable pea (*Pisum sativum* L.) was investigated in a field experiment conducted during the Rabi season of 2020–2021 at the Experimental Farm of the Nalanda College of Horticulture, Noorsarai, Nalanda, Bihar, India. The experimental site was located at 25.27 latitude and 85.45 longitude, 57 meters above mean sea level, approximately 10 km from the Nalanda district headquarters and 65 km from Patna city. Twenty genotypes of Vegetable pea were used in the experiments which are collected from different places as given in table 1.

Three replications and a Randomized Block design were used to set up the experiment on three different dates i.e., 15th October, the Last week of October and 1st week of November. The row-to-row and plant-to-plant spacing were 30 cm and 10 cm respectively. The plot was 3 m by 2 m in size. The fertilizer dosage that was advised was 20:60:40 kg/ha (N:P:K). Regular monitoring was conducted, and intercultural practices including weeding and hoeing were carried out. Observations were documented and all cultural procedures were routinely observed during crop growth. The data after biochemical analysis was recorded for biochemical parameters e.g., total sugar (%), Reducing sugar (%), Protein content (%), TSS content (%) and Ascorbic acid (mg/100g). From each plot, five plants were chosen at random and tagged. A digital hand refractometer (0-32°Brix) was used to record the total soluble solids. According to [24], the TSS was calculated and displayed as an average. Ascorbic acid was estimated by the 2, 6-Dichlorophenol-Indophenol Visual Titration Method from the following formula:

mg of ascorbic acid per 100 g or ml = (Titre x Dye factor x Volume made up x 100) / (Aliquot of extract taken for estimation x Wt. or Volume of sample taken for estimation)

Total sugar (%), and reducing sugar (%) were calculated by Lane and Eynon Method. The foundation of the Lane and Eynon technique is the idea that Fehling's solution can be reduced by lowering sugars. Fehling's solution consists of an alkaline Rochelle salt (sodium potassium tartarate) and copper sulphate. The cupric hydroxide that forms in an alkaline solution is complexed with Rochelle salt, which stops it from precipitating. Under experimental conditions, the complexed cupric hydroxide is reduced to red, insoluble cuprous oxide by reducing sugars. The end-point of the reaction is detected by an oxidation-reduction indicator, often methylene blue. The calculation of the Fehling's solution factor is the initial stage in the Lane and Eynon method's estimation of reducing sugars. The Fehling factor is the amount of inverted sugar, expressed in grams, needed to completely diminish Fehling's solution, which is typically 5 milliliters of Fehling's A and B solutions. Reducing sugars and non-reducing di- and oligosaccharides, such as sucrose, are included in total sugars. These are transformed into reducing sugars upon mild acid hydrolysis. Strong acids hydrolyze starch, converting it to glucose. The amount of protein was estimated by Lowry's method.

To determine the critical difference (CD) between the various treatment means, the obtained data was subjected to Analysis of Variance (ANOVA) in RBD using Fisher's test. OPSTAT was used to verify that there were significant differences between treatments at $p \leq 0.05$.

Results & Discussion

One important agronomic component that affects crop growth, development, and yield is the timing of sowing. The time of sowing has a major effect on the quantitative characteristics of peas (*Pisum sativum* L.), such as biomass and yield, as well as the qualitative characteristics, such as flavor, nutritional value, and biochemical constitute. The synthesis of proteins, carbohydrates, and other essential substances can be impacted by changes in the plant's exposure to external factors like temperature and light, which might result from early or late sowing. There are comparable differences for TSS Content, Total Sugar, Reducing Sugar, Protein Content and ascorbic acid analyzed in three different sowing dates, which indicates the influence of sowing dates on the qualitative characters of Vegetable pea.

TSS Content (%)

TSS Content (%) was observed as minimum for IC-342046 (16.51) with a mean value of 20.47 (Table 2). The maximum TSS Content was observed for 5438/P-2110 (29.81) which were statistically at par with all four checks i.e., Pusa Prabhat (16.60), Arkel (24.36), GS-10 (22.81) and Punjab-89 (17.82). The early-planted crop had the highest total soluble solids content throughout the entire pod, which was noticeably higher than the crops sown on last Week of October and first Week of November [19], [13]. The TSS concentration of peas is largely determined by the temperature during the growth season, which might change based on the date of sowing. The impact of temperature on pea TSS and discovered and increased TSS accumulation was favoured by moderate temperature conditions throughout the sowing season. TSS accumulation in peas is similarly influenced by photoperiod or the length of daylight [29]. The effect of photoperiod on TSS in pea pods was investigated by [5] who found that higher TSS levels were the consequence of longer daylight exposure.

Total Sugar (%)

As shown in Table 2, the total sugar (%) was observed minimum for IC-342046 (0.54) with a mean value of 0.76. The total sugar (%) was observed maximum for 5438/P-2110 (1.01) which were statistically at par with all four checks i. e., Pusa Prabhat (0.54), Arkel (0.95), GS-10 (0.98) and Punjab-89 (0.62). Among three different sowing dates, the Total Sugar (%) was observed to some extent maximum for an early date of sowing (D_1) in contrast to the late sowing of vegetable pea (D_2 & D_3). Sowing dates had a substantial impact on the amount of total sugar content. When compared to other sowing dates, the early-planted crop on October 15th had a noticeably larger total sugar content [13].

Reducing Sugar (%)

Reducing Sugar (%) was observed as minimum for IC-342046 (0.14) & Pusa Prabhat (0.14) with a mean value of 0.36 (Table 3). The maximum Reducing Sugar (%) was observed for 5438/P-2110 (0.61) which were statistically at par with all four checks i.e., Pusa Prabhat, Arkel (0.55), GS-10 (0.58) and Punjab-89 (0.22). Among three different sowing dates, the Reducing Sugar (%) was observed maximum for first date of sowing (D_1) in comparison to the second and third sowing of vegetable pea (D_2 & D_3). The reduced sugar content was greatly impacted by the various planting dates. When comparing early-planted crops on October 15th to other sowing dates, noticeably larger reducing sugar content was found [13].

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Protein Content (%)

Protein content (%) is presented in table 3. The Protein content (%) was observed minimum for IC-342046 (10.43) with a mean value of 12.74. The Protein content (%) was observed maximum for 5438/P-2110 (18.16) which was statistically at par with all four checks i. e., Pusa Prabhat (10.48), Arkel (15.00), GS-10 (14.10) and Punjab-89 (11.16). Among three different sowing dates, the Protein content (%) was observed to some extent maximum for an early date of sowing (D_1) in contrast to the late sowing of vegetable pea (D_2& D_3). [25] and [16] reported similar findings. The researchers with different scientific experiments discovered that the protein content increased with earlier sowing dates and decreased with later sowing dates [19].

Ascorbic Acid (mg/100g)

The mean performance of twenty genotypes including checks of vegetable peas for Ascorbic Acid (mg/100g) for three different dates has been presented in table 4. The minimum Ascorbic Acid (mg/100g) was observed for IC-342046 (17.86) with a mean value of 22.08 and maximum Ascorbic Acid (mg/100g) for 5438/P-2110 (32.20) which were at par with all four checks i.e., Pusa Prabhat (17.91), Arkel (26.28), GS-10 (18.87), and Punjab-89 (18.87). Almost all genotypes sown in the first date of sowing (D_1) exhibited higher Ascorbic Acid (mg/100g) than both of the other dates of sowing (D_2 & D_3). [23] observed a similar observation for the effect of planting dates on pea yield and nutrient content, especially vitamin C. The findings showed that the date of planting had an impact on the amount of vitamin C, with earlier sowing producing higher amounts of vitamin C [19], [18].

Conclusion

The current study found that early sowing dates generally produced better qualitative characteristics, such as ascorbic acid, protein content, total sugar, reducing sugar, and TSS content. In comparison to other sowing dates (the last week of October and the first week of November), the first date of sowing D1 (15 October) produced the best performance for almost all qualitative features examined. This is probably because the early growing season offers more steady temperatures and sufficient moisture, which encourage the best possible seed growth. Early-sown crops tend to mature before the onset of extreme environmental stress, such as high temperatures or drought, which can adversely affect the biochemical composition of the pea plants. 5438/P-2110 contains high TSS percent, total sugar, reducing sugar percent, high protein and ascorbic acid followed by IC-415499, P-2999 etc. while lowest amount of the above qualitative characters was observed for IC-342046.

Future Scope of the Experiment

Future research on how dates of sowing affect vegetable pea quality has a wide range of potential applications. Optimizing planting dates for higher-quality peas will be made possible by developments in precision agriculture, genetic enhancement, climate adaptation, pest control, and sustainable farming methods. In the end, this research will enable farmers to make well-informed choices that enhance crop quality and output while supporting commercially and environmentally sound agricultural methods.

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Table 1. Genotypes of Vegetable pea and their sources

Sl. No.	Genotypes	Sources	Sl. No.	Genotypes	Sources
1	P-3007	NBPGR	11	IC-382756	NBPGR
2	IC-291553	NBPGR	12	IC-381543	NBPGR
3	IC-342046	NBPGR	13	EC-382476	NBPGR
4	EC-269301	NBPGR	14	EC-384139	NBPGR
5	EC-387624	NBPGR	15	IC-415499	NBPGR
6	5438/P-2110	NBPGR	16	PS-01	Begusarai
7	IC-427130	NBPGR	17	Pusa Prabhat	IARI, Delhi
8	EC-598563	NBPGR	18	Arkel	IARI, Delhi
9	P-2999	NBPGR	19	GS-10	Samastipur
10	IC-291544	NBPGR	20	Panjab-89	Sabour

Table 2. Mean performance of 20 genotypes including checks of vegetable pea for TSS Content (%) and Total Sugar (%) during Rabi 2020-21 for three different dates.

Genotypes	TSS Content (%)				Total Sugar (%)			
	D1	D2	D3	Mean	D1	D2	D3	Mean
P-3007	20.20	19.97	19.85	20.01	0.83	0.80	0.75	0.79
IC-291553	18.30	18.08	17.95	18.11	0.69	0.65	0.62	0.65
IC-342046	16.70	16.48	16.35	16.51	0.57	0.54	0.50	0.54
EC-269301	17.40	17.18	17.05	17.21	0.62	0.58	0.56	0.59
EC-387624	22.20	21.95	21.85	22.00	0.98	0.96	0.90	0.95
5438/P-2110	30.00	29.78	29.65	29.81	1.04	1.01	0.98	1.01
IC-427130	20.30	20.02	19.95	20.09	0.84	0.80	0.78	0.81
EC-598563	17.80	17.58	17.45	17.61	0.65	0.62	0.58	0.62
P-2999	27.20	26.62	26.85	26.89	0.95	0.91	0.90	0.92
IC-291544	17.60	17.35	17.25	17.40	0.63	0.60	0.56	0.60
IC-382756	21.30	21.05	20.95	21.10	0.91	0.88	0.85	0.88
IC-381543	17.40	17.15	17.05	17.20	0.62	0.59	0.54	0.58

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EC-382476	22.00	21.78	21.65	21.81	0.97	0.94	0.90	0.94
EC-384139	18.20	17.95	17.85	18.00	0.68	0.65	0.62	0.65
IC-415499	27.30	27.17	26.95	27.14	0.87	0.85	0.83	0.85
PS-01	17.10	16.88	16.75	16.91	0.60	0.56	0.52	0.56
Pusa Prabhat	16.80	16.55	16.45	16.60	0.57	0.54	0.52	0.54
Arkel	24.55	24.33	24.20	24.36	0.96	0.95	0.93	0.95
GS-10	23.00	22.78	22.65	22.81	0.99	0.97	0.98	0.98
Panjab-89	18.00	17.82	17.65	17.82	0.66	0.63	0.58	0.62
Mean	20.67	20.42	20.32	20.47	0.79	0.76	0.73	0.76
Maximum	30.00	29.78	29.65	29.81	1.04	1.01	0.99	1.01
Minimum	16.70	16.48	16.35	16.51	0.57	0.54	0.50	0.54
C.V.	**0.232**				**0.59**			
C.D. 5%	**0.079**				**0.021**			
S.E.	**0.027**				**0.010**			

Table 3. Mean performance of 20 genotypes including checks of vegetable pea for Reducing Sugar (%) and Protein Content (%) during Rabi 2020-21 for three different dates.

Genotypes	**Reducing Sugar (%)**				**Protein Content (%)**			
	D1	**D2**	**D3**	**Mean**	**D1**	**D2**	**D3**	**Mean**
P-3007	0.43	0.40	0.35	0.39	12.59	12.45	12.36	12.47
IC-291553	0.29	0.25	0.22	0.25	11.48	11.35	11.24	11.36
IC-342046	0.17	0.14	0.10	0.14	10.54	10.44	10.31	10.43
EC-269301	0.22	0.18	0.16	0.19	10.95	10.74	10.72	10.80
EC-387624	0.58	0.56	0.50	0.55	13.76	13.63	13.53	13.64
5438/P-2110	0.64	0.61	0.58	0.61	18.33	18.08	18.09	18.16
IC-427130	0.44	0.40	0.38	0.41	12.65	12.53	12.41	12.53
EC-598563	0.25	0.22	0.18	0.22	11.19	11.08	10.95	11.07
P-2999	0.55	0.51	0.50	0.52	16.69	16.54	16.45	16.56
IC-291544	0.23	0.20	0.16	0.20	11.07	11.14	10.83	11.02
IC-382756	0.51	0.48	0.45	0.48	13.23	13.24	13.00	13.16
IC-381543	0.22	0.19	0.14	0.18	10.95	10.96	10.72	10.88
EC-382476	0.57	0.54	0.50	0.54	13.64	13.44	13.41	13.50
EC-384139	0.28	0.25	0.22	0.25	11.42	11.24	11.19	11.28
IC-415499	0.47	0.45	0.43	0.45	16.75	16.54	16.51	16.60
PS-01	0.20	0.16	0.12	0.16	10.78	10.74	10.54	10.69
Pusa Prabhat	0.17	0.14	0.12	0.14	10.60	10.46	10.37	10.48
Arkel	0.56	0.55	0.53	0.55	15.14	14.95	14.90	15.00
GS-10	0.59	0.57	0.58	0.58	14.23	14.08	13.99	14.10
Panjab-89	0.26	0.23	0.18	0.22	11.30	11.10	11.07	11.16
Mean	0.39	0.36	0.33	0.36	12.86	12.74	12.63	12.74
Maximum	0.64	0.61	0.59	0.61	18.33	18.08	18.09	18.16
Minimum	0.17	0.14	0.10	0.14	10.54	10.44	10.31	10.43
C.V.	**0.23**				**0.381**			
C.D. 5%	**0.005**				**0.080**			
S.E.	**0.004**				**0.028**			

Table 4. Mean performance of 20 genotypes including checks of vegetable pea for Ascorbic Acid (mg/100g) during Rabi 2020-21 for three different dates.

Genotypes	**Ascorbic Acid (mg/100g)**			
	D1	**D2**	**D3**	**Mean**
P-3007	21.70	21.51	21.31	21.51
IC-291553	19.65	19.58	19.39	19.54
IC-342046	17.93	17.86	17.80	17.86
EC-269301	18.68	18.63	18.61	18.64
EC-387624	23.86	23.84	23.53	23.74
5438/P-2110	32.26	32.20	32.13	32.20
IC-427130	21.81	21.77	21.72	21.76
EC-598563	19.11	19.12	18.79	19.01
P-2999	29.25	29.18	29.12	29.18
IC-291544	18.90	18.81	18.78	18.83
IC-382756	22.89	22.87	22.65	22.80
IC-381543	18.68	18.63	18.30	18.53
EC-382476	23.64	23.57	23.38	23.53

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EC-384139	19.55	19.44	19.21	19.40
IC-415499	29.35	29.24	28.95	29.18
PS-01	18.36	18.28	18.20	18.28
Pusa Prabhat	18.04	17.94	17.75	17.91
Arkel	26.39	26.24	26.22	26.28
GS-10	24.72	24.62	24.32	24.55
Panjab-89	19.33	18.96	18.32	18.87
Mean	22.20	22.11	21.92	22.08
Maximum	32.26	32.20	32.13	32.20
Minimum	17.93	17.86	17.75	17.86
C.V.	**0.489**			
C.D. 5%	**0.179**			
S.E.	**0.062**			

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