Plant Archives Vol. 25, Supplement 2, 2025 pp.2058-2062 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.259

PERFORMANCE OF GARDEN PEA GENOTYPES FOR GROWTH, YIELD AND QUALITY CHARACTERS IN THE BUNDELKHAND REGION OF UTTAR PRADESH, INDIA

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(Date of Receiving : 14-03-2025; Date of Acceptance : 22-05-2025)

ABSTRACT

The present study evaluated the performance of 30 garden pea (*Pisum sativum* var. *hortense* L.) genotypes under the agro-climatic conditions of the Bundelkhand region of Uttar Pradesh, during the Rabi season of 2021-22. The experiment was conducted at the Vegetable Research Farm of RLBCAU, Jhansi, employed a Randomized Block Design with three replications. Growth, yield, and quality parameters were analyzed, revealing significant variability among genotypes. Plant height ranged from 42.93 cm (Kashi Nandani) to 119.27 cm (Aman), while pod yield per plant varied from 43.40 g (Kashi Nandani) to 79.60 g (GS-10). Genotypes like Kashi Samarth and Pea TS-10 exhibited high pod numbers (17.20 and 16.10, respectively), whereas GS-10 and AS-10 showed superior pod weight and yield. Protein content ranged from 12.80% (Pea TS-10) to 21.30% (IC 208366), highlighting nutritional differences. Early-flowering genotypes like Pusa Sree (32.67 days) were suitable for short-duration cropping, while late-flowering types like Aman (59.00 days) offered prolonged vegetative growth. The findings suggest that genotypes such as GS-10, Kashi Samarth and Pea TS-10 are well-adapted to Bundelkhands conditions, combining high yield, quality, and stress tolerance. This study provides valuable insights for selecting optimal pea varieties to enhance productivity in the region.
Keywords **:** Garden pea, genotypes, yield, quality, Bundelkhand.

Introduction

Garden pea (*Pisum sativum* var. *hortense* L.), a member of the family Leguminosae with a diploid chromosome number of 2n = 2x = 14, it is a prominent cool-season legume crop (Abdel and Salem., 2021). It holds considerable agronomic importance and possesses a well-documented domestication history, with its centre of origin traced to regions such as Ethiopia, the Mediterranean basin, and Central Asia (Langlie *et al.*, 2014). Green peas are a valuable source of nutrition, providing significant amounts of digestible protein (7.2%) and carbohydrates (15.77%). They are also rich in essential micronutrients, including folic acid, ascorbic acid, and vitamin K (Thamburaj and Singh, 2005). As a rich protein source, green peas play a crucial role in vegetarian diets. Primarily consumed as fresh pods, a significant portion of peas is processed through canning, freezing, or dehydration for off-season availability. A key feature of garden peas is their ability to fix nitrogen through root nodules, making them an important component in crop rotation systems, particularly with groundnut and soybean. With the declining availability and increasing costs of chemical fertilizers, peas are increasingly utilized as soil-enhancing crops. Green peas have relatively low water requirements, approximately 300 mm, which makes them a sustainable crop for cultivation. The global annual production of peas is approximately 21.77 million tons, with China being the largest producer, contributing 12.2 million tons (FAO, 2022). India follows with a production of 6,592 metric tons. In India, garden peas are cultivated across 606 thousand hectares, yielding a productivity of 10.0 metric tons per

hectare (Anonymous 2022-23). Uttar Pradesh is the leading state in India for garden pea production, covering an area of 239.11 thousand hectares and producing 2,745.28 metric tons. In the Bundelkhand region, Jhansi district contributes significantly to pea production, yielding 329.39 metric tons from 27.96 hectares. The Bundelkhand region has significant potential for pea cultivation as a fresh vegetable. However, this potential remains underutilized, likely due to a lack of comprehensive knowledge regarding the genotypes that are best suited to the regions prevailing agro-climatic conditions. Before recommending any specific variety for cultivation in the region, it is essential to evaluate different genotypes, focusing on their genotypic suitability and yield. The performance of pea genotypes can vary across different locations due to differing agro-climatic conditions, meaning that the growth and yield of a genotype may not be consistent across all regions. Given the aforementioned factors, there is a need to conduct an experiment to assess the performance of various pea genotypes under the agro-climatic conditions of the Bundelkhand region in Uttar Pradesh. This will help identify and recommend the most suitable genotype for cultivation in the region.

Materials and Methods

The present investigation was carried out during Rabi season of 2021-22 at Vegetable Research Farm of Vegetable Research Farm of Rlbcau, Jhansi, Uttar Pradesh. Rani Lakshmi Bai Central Agricultural University (RLBCAU) is situated in the Bundelkhand agro-climatic zone (6) of Uttar Pradesh. The experimental site is situated at 25.31° N latitude and 78.33° E longitude at an altitude of 227 m above mean sea level. The Experiment Material Comprised of 30 Genotypes, which was collected from ICAR-IIVR, Varanasi, ICAR-IIHR, Bangalore, ICAR-IARI, New Delhi, Csau&T Kanpur, Gbpuat, Pant Nagar, Vpkas Almora and PAU, Ludhiana, and different private seed companies. Seeds were sown in second week of October with spacing of 30 cm x 10 cm. FYM (25 t ha^{-1}) and NPK (30:60:60 kg ha^{-1}) were applied in the experimental plots. Nitrogen (N), phosphorus (P), and potassium (K) were supplied through calcium ammonium nitrate (CAN), single superphosphate (SSP), and muriate of potash (MOP), respectively. Farmyard manure (FYM) was applied during field preparation, 20 days prior to sowing, while the full dose of N, P, and K was applied two days before sowing. Standard agronomic practices and plant protection measures were followed as per the recommended schedule. The experiment was conducted using a Randomized Block Design with three replications. The observations were recorded on five randomly selected competitive plants from each plot in every replication for the traits mentioned in table 1. The oven-dried green pea seed samples were finely ground and passed through a sieve to obtain a uniform powder for nitrogen analysis. Nitrogen concentration was estimated using the Kjeldahl method, as described by Jackson (1973). The protein content in the seeds was determined by multiplying the nitrogen content of the seeds by a constant factor of 6.25. The data were averaged and subjected to statistical analysis for variance using the method outlined by Panse and Sukhatme (1995).

Result and Discussion

The evaluation of growth characters among the genotypes revealed significant variation (Table 1). Plant height ranged from 42.93 cm in Kashi Nandani to 119.27 cm in Aman, followed by IC 208366 (96.00 cm) and Pusa Pragati (95.37 cm). The genotypes showing vigorous vertical growth, likely beneficial for biomass accumulation and efficient light interception. Similarly, Neupane *et al.*, (2024) reported highest plant height (91.28 cm) in genotype BKS peas and the lowest plant height (61.57 cm) was observed in the genotype PB-89. The wide variation observed in plant height is consistent with the findings of previous studies by Pandey *et al.* (2017), Thapa *et al.* (2020), and Luitel *et al*. (2021), which emphasize the significance of genetic diversity and its impact on this trait. These genotype-specific variations offer valuable prospects for breeding and selection programs focused on optimizing plant height to meet specific agricultural goals.

Primary branches per plant varied from 1.33 to 2.93, with IPFD-11-5 exhibiting the highest branching, followed by followed by Kashi Samarth (2.73) and Arka Priya (2.53), whereas, the minimum primary branches recorded in Kashi Uday, PSM-3 and IC 305309 (1.33). The observed increase in the number of primary branches can be attributed to enhanced cell division, leading to a higher number of vegetative buds on the main stem. Environmental factors, including moisture and temperature, also contributed to promoting vegetative growth. These results are consistent with previous research, Raj *et al.*, 2020 and Sharma *et al.*, 2020, which has emphasized the influence of environmental conditions on pea plant development and the formation of primary branches. The number of nodes per plant ranged from 10.20 in Arkel to 15.00 in Aman, supporting the idea that genotypes like Aman possess more nodal points and thus greater potential for pod development.

Internodal length, ranging from 3.39 cm to 6.94 cm, was highest in Aman and IC 208366, signifying taller stature but potentially lower pod density; thus, a balanced internodal length may be preferable. The observed increase in internodal length can be attributed to enhanced cell division, which facilitates the formation of additional vegetative buds along the main stem. This finding is consistent with the work of Armstrong and Pate (1994)., who also highlighted the role of cell division in influencing internodal length. Furthermore, Khichi et al., 2017 reported significant variation in internodal length across different pea varieties, underscoring the genetic diversity associated with this trait.

Days to first flowering and 50% flowering ranged from 32.67 days to 59.00 days and 36.67 to 72.67 days, respectively, with early-flowering genotypes like Pusa Sree and Kashi Uday ideal for short-duration cropping, while late-flowering types like Aman may benefit from prolonged vegetative growth and delayed maturity. The observed variation in days to 50% flowering is consistent with earlier reports by Kanwar *et al*., 2020, highlighting the combined influence of genetic variability and environmental factors on this phenological trait in garden pea cultivars. The substantial variation in growth characters among genotypes highlights the potential for selecting ideal plant types. Taller, well-branched genotypes with moderate internodal length and appropriate flowering times can be targeted for either high biomass production or suitability in short-duration cropping systems.

Yield Attributes and Yield

The data presented in Table 1 revealed a significant variation in yield-contributing traits among the evaluated genotypes. The number of pods per plant ranged from 8.80 in Kashi Uday to 17.20 in Kashi Samarth and Pea TS-10 (16.10) also performing well. The observed variation in pod number per plant suggests that certain genotypes may be more favourable for selection based on pod productivity, assuming other agronomic traits are optimized. This increased pod count may be associated with smaller pod size, which typically demands fewer nutrients compared to larger pods. The variability in this trait is likely influenced by an interplay of genetic makeup, soil fertility, and prevailing climatic conditions. These findings are consistent with previous research by Sirwaiya and Kushwah, (2018) and Nagar *et al*., 2022, they also highlighted the roles of genetic diversity, environmental conditions, and cultivation practices in determining pod number per plant in garden pea. Pod length ranged from 6.39 cm in Aman to 10.70 cm in GS-10, and pod width from 0.96 cm in Arka Priya to 1.25 cm in Kashi Nandini; the superior pod dimensions of GS-10 suggest robust ovary development and enhanced sink strength, whereas shorter and narrower pods in Arka Priya reflect limited resource allocation. The observed variation in pod length across different genotypes aligns with the findings reported by Devi *et al.,* (2021), highlighting the underlying genetic diversity associated with this key agronomic trait. Average Pod Weight ranged from 3.50g to 6.03g. The maximum average Pod weight was observed in AS-10(6.03g) followed by Pencil Matar (5.80g), GS-10 (5.56). Whereas the minimum Average Pod Weight was observed in IC 395309 (3.50g).; heavier pods likely result from better seed fill and nutrient translocation, while lighter pods indicate poor filling and possibly fewer seeds. Pod yield per plant (g/plant) ranged from 43.40 g to 79.60 g. The maximum pod yield per plant (g/plant was recorded in GS-10 (79.60 g) followed by Pea TS 10 (77.23 g), Kashi Samarth (76.433 g), whereas the minimum pod yield per plant (g/plant) was recorded in Kashi Nandani (43.40g) it may be attributed to a combination of higher pod number, pod size, and weight. Similarly, Phom *et al.,* (2014) recorded significant variations were observed among the genotypes in terms of yield performance, with genotype PEVAR-1 exhibiting the highest pod yield per plant (29.67 g) and per hectare (56.60 quintals), indicating its superior productivity potential. Pod yield per plot (kg) ranged from 2.61 kg to 4.78 kg with mean of 3.34 kg. The maximum pod yield per plot was recorded in GS-10 (4.78 kg) followed by Pea TS-10 (4.63 kg) and Kashi Samarth (4.59 kg), whereas the minimum pod yield per plot found in IC208366 (2.61 kg) in Kashi Nandini. The 100 seed weight ranged from 28.60 g to 50.30 g with mean of 35.8. The maximum 100 seed weight observed in PSM-3 (50.30 g). Whereas the minimum 100 seed weight observed in PSM-2 (28.60 g). Seeds per pod ranged from 4.00 in Aman to 10.20 in GS-10, indicating the latters higher ovule fertilization and seed set, while shelling percentage varied from 34.30% in PSM-2 to 57.00% in Pusa Sree, with higher shelling in Pusa Sree reflecting efficient conversion of pod biomass into edible seeds and lower values in Pant P 66 pointing to poor seed-to-pod ratio.

Quality Parameters

Quality parameters exhibited substantial variation among the genotypes (Table 1). Protein content ranged from 12.80% in Pea TS-10 to 21.30% in IC 208366. The high protein content in IC 208366 suggests efficient nitrogen metabolism and storage protein accumulation, making it a potential candidate for

developing nutritionally enriched pea varieties. In contrast, the low protein content in Pea TS-10 could be due to limited protein biosynthesis or poor nitrogen use efficiency. Genotypes with high protein levels are valuable for enhancing the dietary value of peas, especially in regions where legumes are major protein sources. Similar to our findings Khichi *et al.* (2017) recorded maximum protein content (23.06%) in the genotype Palam Triloki and minimum in Jawahar Matar-2 (16.32%). Total Soluble Solids (TSS) ranged from 13.80 to 16.50 ^{0}Brix with a general mean of 15.33 ^{0}Brix. The maximum total soluble solid was shown in VL-7 (16.50 ^{0}Brix) followed by AP-3 (16.33 ^{0}Brix) and PC-531 (16.10 ^{0}Brix. Whereas, lowest total soluble solid was observed in the EC 6621 (13.80 ^{0}Brix) genotype. The higher TSS in VL-7 reflects greater sugar accumulation, contributing to better sweetness, flavor, and overall consumer preference, while the low TSS in EC 6621 may limit its appeal for fresh consumption. High TSS genotypes are ideal for table peas and processing industries, improving palatability and marketability. Moisture Percentage ranged from 70.90% to 81.90 % with mean of 74.84%. The maximum moisture percentage was observed in Pencil Matar (81.9%) followed by AS-10 (81.8%). Whereas the minimum Moisture Percentage was observed in IC 395309 (70.9%). Greater moisture in Pencil Matar implies enhanced succulence and freshness favorable traits for the green pea market but may pose challenges for storage and transportation. Lower moisture in Pant P 66 indicates less juiciness, which might affect consumer acceptability. Genotypes with high moisture content are suitable for immediate consumption and local markets, whereas those with lower moisture may be preferable for processing or longer shelf life.

Conclusion

The present study identified significant variability among 30 garden pea genotypes in terms of growth, yield, and quality traits under Bundelkhand agro-climatic conditions. High-yielding genotypes like GS-10, Pea TS-10, and Kashi Samarth demonstrated superior pod yield, pod weight, and adaptability, making them ideal for cultivation in the region. Early-flowering varieties such as Pusa Sree are suitable for short-duration cropping, while high-protein genotypes like IC 208366 offer nutritional benefits. These findings provide a basis for recommending suitable pea varieties to enhance productivity and meet regional demand. Further multi-location trials can validate these results for broader adoption.

Table 1 : Performance of garden pea genotypes for growth, yield and quality attributes

S. No.	Genotypes	DF1	DF50	NPB	INL	NNP	PH	PL	PW	NSP	SW	PR	M	TSS	SHL	DS1	DP1	APW	NPP	PYPT	PYP
1.	Kashi Uday	33.67	36.67	1.33	4.61	11.73	49.73	8.73	1.24	6.80	42.30	20.00	74.00	15.30	44.30	40.30	63.30	5.43	8.80	2.63	43.80
2.	Kashi Nandani	33.67	38.67	1.53	3.73	11.27	42.93	8.24	1.25	6.43	38.00	15.40	76.50	15.00	40.30	39.00	62.60	5.40	9.33	2.61	43.40
3.	Kashi Ageti	36.33	44.33	1.47	3.97	14.93	65.60	8.51	1.21	7.40	33.00	19.60	77.40	15.70	37.30	42.30	65.60	4.80	9.87	2.70	45.00
4.	Kashi Samarth	36.67	44.00	2.73	4.91	12.80	65.40	6.81	1.09	6.40	35.30	14.10	75.90	14.90	49.00	43.00	66.30	4.43	17.20	4.59	76.40
5.	Kashi Mukti	36.00	40.00	2.27	4.21	12.20	51.73	8.59	1.19	6.57	39.30	15.20	73.10	15.10	42.00	41.60	66.60	4.70	11.80	3.09	51.50
6	AP-3	38.67	43.33	2.20	4.48	13.40	68.80	8.27	1.08	7.07	37.60	20.50	71.60	16.30	46.60	42.00	55.60	5.03	11.50	3.27	54.50
7.	Arka Priya	48.33	54.00	2.53	4.17	13.47	73.40	8.19	0.96	7.27	32.30	21.10	75.50	14.90	44.00	51.60	70.30	5.20	13.20	3.95	65.90
8.	AP-1	45.33	49.00	2.40	3.64	13.83	58.40	6.49	1.15	4.77	42.00	20.00	77.60	15.50	43.00	48.30	67.30	4.90	10.50	3.04	50.70
9.	Pusa Sree	32.67	36.67	1.40	4.23	10.87	51.20	7.35	1.11	5.90	41.30	17.50	73.30	15.10	57.00	39.60	63.30	3.70	11.80	2.75	45.80
10.	Pusa Pragati	49.67	54.33	1.93	5.57	15.00	95.37	9.60	1.17	7.60	44.60	19.50	76.80	14.80	49.60	52.30	62.30	5.03	11.80	2.92	48.70
11.	Arkel	35.00	44.00	1.60	4.83	10.20	48.60	7.67	1.18	6.10	41.60	19.00	72.80	15.40	44.00	41.30	64.60	4.93	9.20	2.83	47.10
12.	PSM-3	33.67	40.67	1.33	3.87	10.93	48.53	8.12	1.14	6.20	50.30	18.40	73.50	15.80	53.00	39.60	64.00	5.03	11.80	3.11	51.90
13.	PSM-2	50.33	54.33	2.40	3.39	13.13	50.67	8.66	1.21	7.73	28.60	15.60	77.70	15.30	34.30	56.00	72.30	4.67	12.70	2.96	49.20
14.	NDVP -1	36.00	44.67	1.80	4.39	12.73	57.13	8.07	1.16	6.70	34.30	15.50	72.90	15.90	42.30	42.30	64.30	4.40	12.00	2.82	47.00
15.	VL-7	48.00	54.33	2.07	4.27	11.87	56.60	6.90	1.15	5.87	28.60	18.20	74.40	16.50	34.60	55.60	73.30	4.80	14.60	3.78	63.00
16.	PB-89	46.33	51.33	1.73	3.80	12.87	53.53	9.47	1.10	7.20	38.60	15.70	74.90	14.90	46.00	52.60	69.30	5.03	12.90	3.07	51.10
17.	AS-10	48.33	52.00	2.27	3.69	12.00	51.33	8.62	1.01	9.07	41.30	14.90	81.80	15.40	42.60	55.30	74.60	6.03	12.80	4.22	70.30
18.	PC-531	41.33	46.33	2.47	4.43	12.13	61.70	8.66	0.96	7.13	31.00	13.40	75.70	16.10	40.30	48.60	65.60	5.37	14.40	3.82	63.70
19.	IC 208366	47.67	55.00	2.53	6.52	13.87	96.00	6.54	0.96	6.53	32.60	21.30	71.30	15.80	52.30	54.60	72.60	4.03	12.80	2.62	43.70
20.	IC 395309	48.33	54.33	1.33	4.01	13.13	61.80	8.00	1.12	5.67	31.00	16.70	70.90	14.50	41.30	55.00	72.00	3.50	13.50	3.49	58.10
21.	EC 6621	47.67	52.67	1.67	4.45	12.23	59.60	7.03	0.96	6.63	30.00	13.80	73.20	13.80	35.30	56.30	76.60	3.90	14.20	2.99	49.90
22.	EC 243642	50.67	55.67	2.20	4.03	13.20	68.93	6.87	1.10	4.93	33.00	20.10	72.70	14.90	55.00	58.60	76.60	4.10	13.60	2.81	46.80
23.	EC 302842	49.00	53.00	1.93	4.40	12.13	68.27	8.29	1.13	6.07	33.30	18.50	71.10	15.10	34.60	57.60	77.00	4.30	11.80	2.68	44.60
24.	IPFD-10-12	53.00	59.33	2.40	4.89	12.27	71.36	6.75	1.04	6.00	34.00	20.00	72.00	15.80	55.60	62.00	72.60	4.33	13.20	3.41	56.80
25.	IPFD-11-5	54.00	58.33	2.93	5.36	12.13	71.27	6.83	1.06	5.33	29.00	19.50	73.00	15.90	45.30	63.00	73.30	4.10	14.40	3.89	64.80
26.	Aman	59.00	72.67	1.93	6.94	15.00	119.27	6.39	1.02	4.00	29.30	19.10	71.90	14.90	55.00	68.30	77.60	4.60	14.00	3.65	60.70
27.	Pencil Matar	48.00	51.67	1.73	4.05	12.98	60.67	9.53	1.00	9.07	41.30	14.20	81.90	14.90	50.60	55.60	73.60	5.80	12.50	3.76	62.70
28.	Pea TS -10	47.33	52.00	2.00	4.21	12.80	61.33	8.99	1.00	8.53	31.00	12.80	79.70	15.10	47.60	56.00	70.60	5.10	16.10	4.63	77.20

29.	Ganga -10	47.00	52.33	2.00	3.39	14.33	59.07	8.19	1.09	8.33	35.60	21.20	74.30	15.00	43.00	54.60	73.60	5.53	13.40	3.38	56.30
30.	GS -10	46.00	49.33	2.07	4.35	13.92	68.70	10.30	0.99	10.20	34.00	14.20	76.60	15.50	40.00	54.00	74.00	5.57	13.20	4.78	79.60
C.V		1.88	2.54	20.92	15.2	5.67	11.42	4.78	11.01	5.14	5.98	5.35	1.98	2.5	4.88	2.7	1.31	8.28	5.21	8.5	8.57
S.E.		0.48	0.73	0.24	0.39	0.42	4.21	0.22	0.07	0.18	1.24	0.54	0.86	0.22	1.27	0.79	0.53	0.23	0.38	0.17	2.76
C.D. 5%		1.36	2.07	0.69	1.1	1.18	11.9	0.63	0.2	0.5	3.51	1.54	2.42	0.63	3.59	2.7	1.48	0.65	1.08	0.47	7.81
Lowest Range		32.67	36.67	1.33	3.39	10.20	42.93	6.39	0.96	4.00	28.60	12.80	70.90	13.80	34.30	39.00	55.60	3.50	8.80	2.61	43.40
Highest Range		**59.00**	**72.67**	**2.93**	**6.94**	**15.00**	**19.27**	**10.30**	**1.25**	**10.20**	**50.30**	**21.30**	**81.90**	**16.50**	**57.00**	**68.30**	**77.60**	**6.03**	**17.20**	**4.78**	**79.60**

DF1-Days to first flowering, DF50-Days to 50% flowering, NPB- Number of primary branches per plant, INL-Internodal length, NNP- Number of nodes per plant, PH-Plant height, PL-Pod length, PW-Pod width, NSP-Number of seed per pod, SW-100 seed weight, PR-Protein content, M-Moisture percentage, TSS- Total soluble solid, SHL- Shelling percentage, DS1-Days to first pod setting, DP1-Days to first pod picking, APW-Average pod weight, NPP-Number of pod per plant, PYPT-Pod yield per plot, PYP-Pod yield per plant

Acknowledgement

The authors sincerely acknowledge the funding support from the Rani Lakshmi Bai Central Agriculture University, Uttar Pradesh, India – 284003.

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