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Performance of organically grown garden pea varieties in the south Chhotanagpur plateau of eastern India

A.K. Dutta* and S.K. Majee

*Ramakrishna Mission Vivekananda Educational and Research Institute, School of Agriculture and Rural Development, Faculty Centre for Agriculture, Rural and Tribal Development, Ramakrishna Mission Ashrama, Morabadi, Ranchi-834008, Jharkhand, India, *E-mail: avijitkumardutta@gmail.com*

Abstract

Garden pea is one of the most popular winter vegetables in India and the south Chhotanagpur plateau of eastern India is well-known for its quality production. However, indiscriminate uses of different agrochemicals in the production cycle of the crop reduces its quality. Besides, the high cost concerning chemical farming is practically out of reach to the small and marginal farmers of the eastern Indian plateau. In this context, low-cost involving alternative approach of organic farming that has the potential to produce quality yield is gaining popularity. The experiment consisted of seven commonly cultivated garden pea varieties of the region, namely, V_1:GS-10, V_2: HAEP-1, V_3: HAEP-2, V_4: Swarna Mukti, V_5: Swarna Amar, V_6: Azad Pea-3 and V_7: Azad Pea-1 grown through the application of three organic liquid manures *viz.* T_1: *Shasyagavya* (10 %); T_2: *Sanjeevani* (10 %); T_3: *Enriched Sanjeevani* (10 %) and including control (T_4) where no liquid formulation was applied during *rabi* growing season of two consecutive years (2017-18 and 2018-19) by adopting Factorial RBD experimental design. Different growth, yield, and quality attributing characters of the crop were studied and found to be significant under different treatments. Results revealed that V_5 is the best-performing variety in terms of green pod yield (19.55t ha^{-1}). However, when treatment and varietal interactions were taken into consideration, T_3V_6 was the best combination with green pod yield of 23.10 t ha^{-1}. Quality attributes like TSS, starch, protein and ascorbic acid content of green peas were significantly better independently under different treatments than control. From the findings, it may be concluded that Swarna Amar and Azad Pea-3 were highly responsive to organic liquid manure especially '*Enriched Sanjeevani'* in terms of their growth, yield and quality traits expressions in the south Chhotanagpur plateau of eastern India.

Key words: Garden pea, *Pisum sativum* var. *hortense*, Sanjeevani, Shasyagavya, growth, yield, quality

Introduction

Garden pea (*Pisum sativum* var. *hortense* L.) is a popular winter vegetable legume of the family Fabaceae. It is commonly used in the human diet as a vegetable because of its richness in protein (21-25 %) with high levels of amino acids, especially lysine and tryptophan. Ethiopia, the Mediterranean region, and Central Asia are considered as primary centers of origin of *P. sativum* with a secondary center of diversity in the Near East (Vavilov, 1949). China, India, USA, France, Egypt, UK, Pakistan, Algeria, Peru, Turkey, Russian Federation, and Italy are major producers of the vegetable pea of the world. India occupies the 2nd position in the global production of garden pea (just after China) with the production share of 15 % from only 12.09 % area.

Southern Chhotanagpur region of eastern Indian plateau has a remarkable share of garden pea production with the productivity of about 15 t ha^{-1}, which is quite higher than the national average of around 10 t ha^{-1}. Generally, garden pea is grown through chemical farming in most of the commercial growing areas of our country. Though, chemical fertilizers increase crop production; their overuse has hardened the soil, decreased fertility, polluted air and water, and released greenhouse gases, thereby, bringing hazards to human health and the environment as well. On the other hand, existing technology of organic farming where FYM and compost are used as sources of nutrient supply, the productivity of soil depletes during the transitory period (until fertility, structure and microbial activity of soil have been restored) leading to low yield levels in the initial years of cultivation. Besides, in the light textured soils of arid and semi-arid regions, bulky organic materials remain in under decomposed state for years due to inherent deficiency of soil organic carbon and microbial biomass responsible for decomposition of these materials.

The organic farming system in India is not new and is being followed from ancient time by using locally available resources in a natural way. It is estimated that 65 % of the country's cropped areas are organic by default as the small farmers have no choice but to farm without chemical fertilizers and pesticides as they cannot afford these (Muthukumaran, 2006). Most of the farmers of the south Chhotanagpur plateau region are tribal with very poor economic background. Hence, it is imperative to evolve an alternative technology of low-cost organic farming that provides reasonable yields while restoring the fertility of soil during the transitory period. Different liquid organic formulations like *Sanjeevani, Shasyagavya*, *Panchagavya* or even *BD-501* have such production potential to cope up with the lower yield level during the transition phases of organic cultivation of the crop (Dutta *et al.*, 2018; Mahto and Dutta, 2018; Tripathy and Dutta, 2019). The genetic entity of the crop

and the growing environment, determine the composition of nutritionally and functionally valuable compounds in the crop. Thereby, the nutritional response of different varieties of a crop is not static when they are allowed to grow with the application of different organic liquid inputs. Hence, few commonly grown garden pea varieties were included in the present investigation.

The current research was executed considering the ill effects of conventional chemical farming, benefits of organic farming and socioeconomic condition of the small and marginal pea farmers of the south Chhotanagpur plateau of eastern India.

Materials and methods

The present experiment was conducted during *rabi* season of two consecutive years (Year-I: 2017-18 and Year-II: 2018-19) at the organic experimental farm of Agriculture, Rural and Tribal Development Faculty Centre, Ranchi located at 23.23^{0}N latitude and 85.23^{0}E longitude to observe the influence of different organic liquid formulations on growth, yield and quality of different commonly grown garden pea varieties. The experiment was designed in Factorial-RBD by adopting seven varieties of the crop and four organically designed treatments (including control) with three replications. Seven varieties thereby selected for the study, namely, V_1: GS-10, V_2: HAEP-1, V_3: HAEP-2, V_4: Swarna Mukti, V_5: Swarna Amar, V_6: Azad Pea-3 & V_7: Azad Pea-1 and four treatments, *viz.* T_1: *Shasyagavya* (10 %); T_2: *Sanjeevani* (10 %); T_3: *Enriched Sanjeevani* (10 %) & T_4: Control [without any organic liquid manure] were allocated in 84 experimental plots (3.0 x 2.4 m) keeping 20 cm (P-P) and 30 cm (R-R) spacing. The investigation encompassed the basal application of organic manure in the form of FYM @ 5 t ha^{-1} (in all treatments) along with four times [started at 3 weeks after sowing and thereafter thrice at 15 days interval] split application of organic liquid inputs @ 1.0 Lm^{-2} running experimental plot as per the treatments. Different growth and yield attributes of the crop, *viz.,* plant height (cm), days to 50 % flowering, pod length (cm), number of seeds pod^{-1}, green pod yield (t ha^{-1}), and quality contributing traits like TSS (^{0}Brix), starch (%), protein (%) and ascorbic acid content (mg 100 g^{-1}) were analyzed by adopting standard methodologies *viz.,* ERMA hand refractometer for TSS, Anthrone reagent method for starch, Kjeldahl method for protein and titrimetric method by using dye for ascorbic acid estimation. Both years data thus obtained were subjected to statistical analyses and their pooled values were considered for interpretations.

Results and discussion

Growth attributes (vegetative and reproductive): Plant height of seven garden pea varieties under the influence of four organically designed non-chemical approach of farming practices indicated 'V_4' as the best performer (54.25 cm) followed by 'V_5' (54.00 cm) and 'V_1' (52.75 cm), while 'V_6' emerged as the poor performing variety with the lowest plant height of 39.67 cm (Table 1). When treatments were taken into account, T_3 recorded the highest plant height (50.43 cm). The plant height

Table 1. *Per se* performance of vegetative and reproductive growth attributes of garden pea varieties recorded under different treatment conditions

	Plant height (cm)			Days to 50 % flowering		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
Variety						
V_1	53.00	52.50	52.75	43.25	42.24	42.75
V_2	45.50	46.00	45.75	43.50	45.00	44.25
V_3	43.00	41.00	42.00	42.88	38.96	40.92
V_4	54.25	54.25	54.25	42.50	39.50	41.00
V_5	52.00	56.00	54.00	39.50	42.50	41.00
V_6	40.17	39.17	39.67	44.00	46.00	45.00
V_7	41.00	43.00	42.00	40.40	41.60	41.00
SEm(±)	1.41	1.60	0.67	0.40	0.61	0.52
CD (P≤0.05)	3.97	4.51	1.91	1.12	1.72	1.48
Treatment						
T_1	45.50	49.36	47.43	40.28	42.30	41.29
T_2	47.00	45.20	46.10	39.68	39.18	39.43
T_3	49.86	51.00	50.43	42.82	38.90	40.86
T_4	45.82	43.90	44.86	46.62	48.42	47.52
SEm(±)	0.57	0.97	0.51	0.91	1.28	0.40
CD (P≤0.05)	1.60	2.71	1.44	2.54	3.57	1.12
Interaction (Treatment x Variety)						
T_1V_1	54.00	50.00	52.00	41.00	43.00	42.00
T_1V_2	45.25	48.75	47.00	44.50	41.50	43.00
T_1V_3	43.65	43.00	43.33	38.40	35.60	37.00
T_1V_4	54.00	52.00	53.00	38.80	41.20	40.00
T_1V_5	53.50	57.50	55.00	44.00	42.00	43.00
T_1V_6	42.00	41.34	41.67	43.60	44.40	44.00
T_1V_7	39.00	41.00	40.00	41.20	38.80	40.00
T_2V_1	53.00	49.00	51.00	42.10	39.90	41.00
T_2V_2	47.00	49.00	48.00	43.00	41.00	42.00
T_2V_3	42.50	39.50	41.67	41.20	36.80	39.00
T_2V_4	54.00	52.00	53.00	40.50	35.50	38.00
T_2V_5	51.00	53.00	52.00	35.00	39.00	37.00
T_2V_6	36.00	34.00	35.00	44.70	39.30	42.00
T_2V_7	41.00	43.00	42.00	37.20	36.80	37.00
T_3V_1	60.00	56.00	58.00	41.00	43.00	42.00
T_3V_2	44.00	48.00	46.00	45.20	42.80	44.00
T_3V_3	41.00	45.00	43.00	38.30	39.70	39.00
T_3V_4	62.00	60.00	61.00	42.00	40.00	41.00
T_3V_5	60.00	58.00	59.00	34.90	37.10	36.00
T_3V_6	43.00	41.00	42.00	45.00	43.00	44.00
T_3V_7	43.00	45.00	44.00	39.00	41.00	40.00
T_4V_1	48.00	52.00	50.00	47.50	44.50	46.00
T_4V_2	41.00	43.00	42.00	50.10	45.90	48.00
T_4V_3	42.00	38.00	40.00	47.98	49.42	48.70
T_4V_4	51.00	49.00	50.00	44.00	46.00	45.00
T_4V_5	49.50	50.50	50.00	46.20	49.80	48.00
T_4V_6	41.50	38.50	40.00	51.10	48.90	50.00
T_4V_7	42.75	41.25	42.00	46.65	47.34	47.00
SEm(±)	0.75	0.73	1.35	0.45	0.44	1.05
CD (P≤0.05)	2.13	2.05	3.82	1.27	1.25	2.97

in almost all cases of treatment-varietal interactions recorded higher under the influence of T_3 treatment. Such observation may probably be due to availability of higher plant nutrients in '*Enriched Sanjeevani*' as compared to other organic liquid inputs. The finding of present investigation on plant height closely matched with earlier observations of Reddy *et al.* (1998), Negi *et al.* (2006), Jitender (2011), Mishra (2014) and Vijay Kumar *et al.* (2018). T_3V_4 appeared as the outstanding variety and treatment interaction with the highest plant height of 61 cm followed by T_3V_5(59 cm). The plant height of garden pea varieties as recorded in the present investigation under organic management condition through application of organic liquid formulations corroborate well with the earlier findings of Dutta *et al.* (2018). However, in almost all cases, the varietal interaction with 'T_4' revealed poor plant height as compared to its respective organically designed treatment counterparts. In case of days to 50 % flowering, 'V_3' needed minimum duration of 40.92 days followed by 'V_7' (41days), whereas 'V_6' required the maximum period of 45

Table 2. *Per se* performance of yield attributes of garden pea varieties recorded under different treatment conditions

	Pod length (cm)			Number of seeds pod^{-1}			Green pod yield (t ha^{-1})		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
Variety									
V_1	8.00	7.88	7.94	6.87	7.13	7.00	17.79	17.86	17.86
V_2	8.60	9.10	8.85	6.32	6.52	6.42	16.01	15.89	15.89
V_3	8.90	9.04	8.97	8.00	7.50	7.75	15.89	15.61	15.61
V_4	7.00	6.80	6.90	6.40	6.10	6.25	17.09	17.24	17.24
V_5	6.87	7.22	7.05	7.00	6.50	6.75	19.50	19.55	19.55
V_6	8.06	7.78	7.92	6.00	6.50	6.25	18.78	18.39	18.39
V_7	8.77	9.00	8.89	6.60	5.90	6.25	15.34	15.16	15.16
SEm(±)	0.19	0.22	0.12	0.15	0.13	0.26	0.37	0.38	0.29
CD (P≤0.05)	0.54	0.62	0.33	0.43	0.37	0.73	1.04	1.07	0.82
Treatment									
T_1	8.44	8.07	8.26	7.00	6.72	6.86	16.44	16.72	16.72
T_2	8.12	8.90	8.51	7.00	7.58	7.29	16.32	16.66	16.66
T_3	7.99	8.19	8.09	7.63	7.23	7.43	18.91	18.34	18.34
T_4	7.59	7.27	7.43	5.30	4.90	5.10	16.38	16.68	16.68
SEm(±)	0.10	0.19	0.09	0.29	0.34	0.20	0.37	0.24	0.22
CD (P≤0.05)	0.28	0.54	0.25	0.81	96	0.55	1.02	0.67	0.62
Interaction (Treatment x Variety)									
T_1V_1	7.99	9.14	8.57	7.10	6.90	7.00	18.35	18.06	18.06
T_1V_2	10.00	9.80	9.90	7.00	7.00	7.00	17.28	17.64	17.64
T_1V_3	9.43	10.23	9.83	8.00	8.00	8.00	17.45	17.22	17.22
T_1V_4	6.56	6.49	6.53	6.80	5.20	6.00	19.00	18.75	18.75
T_1V_5	7.00	6.00	6.50	7.00	7.00	7.00	17.01	17.22	17.22
T_1V_6	6.80	7.00	6.90	5.80	6.20	6.00	17.96	17.51	17.51
T_1V_7	10.02	9.18	9.60	7.00	7.00	7.00	10.68	10.84	10.84
T_2V_1	7.80	8.20	8.00	8.00	6.00	7.00	18.01	18.51	18.51
T_2V_2	9.33	9.73	9.53	6.50	7.50	7.00	18.22	18.11	18.11
T_2V_3	9.59	11.00	10.30	8.90	9.10	9.00	13.98	14.51	14.51
T_2V_4	7.00	6.80	6.90	7.20	6.80	7.00	14.20	14.60	14.60
T_2V_5	6.89	7.11	7.00	8.00	8.00	8.00	20.94	22.93	22.93
T_2V_6	8.70	8.30	8.50	5.90	6.10	6.00	13.78	12.82	12.82
T_2V_7	9.57	9.17	9.37	7.00	7.00	7.00	15.28	15.14	15.14
T_3V_1	7.98	8.02	8.00	8.30	7.70	8.00	19.00	18.83	18.83
T_3V_2	8.50	8.90	8.70	7.90	8.10	8.00	14.30	15.15	15.15
T_3V_3	8.78	8.22	8.50	9.10	8.90	9.00	17.50	17.25	17.25
T_3V_4	7.10	6.70	6.90	7.00	7.00	7.00	20.02	19.29	19.29
T_3V_5	6.89	7.11	7.00	6.10	5.90	6.00	20.98	20.42	20.42
T_3V_6	8.80	8.20	8.50	6.70	7.30	7.00	23.41	23.10	23.10
T_3V_7	10.00	8.00	9.00	6.90	7.10	7.00	13.70	14.35	14.35
T_4V_1	6.80	7.60	7.20	6.00	6.00	6.00	15.98	16.05	16.05
T_4V_2	7.47	7.07	7.27	4.00	3.33	3.67	13.00	12.65	12.65
T_4V_3	7.00	7.46	7.23	5.00	5.00	5.00	13.93	14.47	14.47
T_4V_4	7.00	7.54	7.27	4.90	5.10	5.00	16.25	16.50	16.50
T_4V_5	7.89	7.51	7.70	6.20	5.80	6.00	17.26	17.64	17.64
T_4V_6	7.65	7.89	7.77	5.90	6.10	6.00	19.04	20.14	20.14
T_4V_7	7.80	7.40	7.60	3.99	4.01	4.00	20.69	20.32	20.32
SEm(±)	0.12	0.13	0.24	0.14	0.15	0.52	0.32	0.32	0.58
CD ($P \leq 0.05$)	0.35	0.37	0.67	0.39	0.41	1.47	0.89	0.90	1.63

days with statistically significant ($P \leq 0.05$) difference with other varieties. Among the four treatments, 'T_2' required the minimum period of 39.43 days for induction of flowering (Table 1) in different varieties of the crop as contrast to the maximum days of 47.52 required by 'T_4' for 50 % flowering. However, 'T_3V_5' recorded the minimum duration (36.00 days) for 50 % flowering. Such type of earliness in flowering with organic intervention in garden pea as recorded in this investigation showed close conformity with the earlier experimental finding of Reddy *et al.* (1998) but different from the observation of Dutta *et al.* (2018).

Yield attributes: Results showed 'V_3' as the best performer in terms of pod length (8.97 cm) followed by 'V_7'(8.89 cm) and 'V_2' (8.85 cm), whereas, 'V_4' emerged as the poor performing variety with pod length of 6.90 cm. Similarly, several organic treatments performed independently in the expression of pod length. In this context, 'T_2' recorded the highest pod length (8.51 cm) followed by 'T_1' (8.26 cm) [Table 2] and the finding corroborated well with the previous observations of Negi *et al.* (2006); Dutta *et al.* (2018). The pod length in almost all cases recorded higher under the influence of 'T_2'. The interaction effects showed 'T_2V_3' as the outstanding variety and treatment combination with pod length

Table 3. *Per se* performance of quality attributes of garden pea varieties recorded under different treatment conditions

	TSS (^{0}Brix)			Starch (%)			Protein (%)			Ascorbic acid (mg 100 g^{-1})		
	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled	Year-I	Year-II	Pooled
Variety												
V_1	12.05	11.03	11.54	18.11	17.67	17.89	5.00	4.92	4.96	40.57	38.09	39.33
V_2	12.10	13.66	12.88	16.00	16.72	16.36	5.15	5.62	5.39	38.16	39.00	38.58
V_3	13.80	14.62	14.21	15.97	16.69	16.33	5.00	4.93	4.97	40.00	39.00	39.50
V_4	14.00	12.94	13.47	16.87	15.42	16.15	5.68	5.28	5.48	38.76	39.74	39.25
V_5	12.00	11.96	11.98	17.00	16.20	16.60	4.88	5.36	5.12	38.00	39.50	38.75
V_6	11.89	12.48	12.19	16.05	15.85	15.95	5.50	5.10	5.30	39.13	38.36	38.75
V_7	11.76	12.46	12.11	16.19	16.98	16.59	4.00	3.14	3.57	40.00	38.50	39.25
SEm(±)	0.23	0.27	0.16	0.19	0.18	0.20	0.13	0.19	0.19	0.23	0.14	0.35
CD ($P \leq 0.05$)	0.64	0.78	0.46	0.53	0.50	0.56	0.36	0.55	0.55	NS	NS	NS
Treatment												
T_1	13.00	11.89	12.45	16.48	18.97	17.73	5.00	5.84	5.42	38.96	39.70	39.33
T_2	14.00	11.97	12.99	18.00	17.44	17.72	6.00	5.40	5.70	38.35	40.03	39.19
T_3	12.60	13.04	12.82	17.59	18.59	18.09	5.79	5.99	5.89	40.00	40.28	40.14
T_4	11.93	12.55	12.24	13.00	12.33	12.67	3.00	2.72	2.86	38.00	37.14	37.57
SEm(±)	0.25	0.16	0.12	0.66	0.89	0.15	0.39	0.44	0.15	0.25	0.42	0.26
CD ($P \leq 0.05$)	0.71	0.44	0.35	1.85	2.50	0.42	1.12	1.25	0.41	0.69	1.18	0.74
Interaction (Treatment x Variety)												
T_1V_1	11.53	12.00	11.77	17.10	17.55	17.33	4.60	5.00	4.80	37.00	39.00	38.00
T_1V_2	13.54	11.72	12.63	19.08	18.98	19.03	5.53	4.92	5.23	38.41	37.59	38.00
T_1V_3	12.54	16.00	14.27	18.00	17.60	17.80	5.44	5.70	5.57	38.00	42.00	40.00
T_1V_4	13.21	12.44	12.83	17.66	18.79	18.23	6.00	5.14	5.57	38.22	37.88	38.00
T_1V_5	12.00	11.66	11.83	17.26	17.00	17.13	5.00	4.58	4.79	39.11	38.89	39.00
T_1V_6	11.36	12.89	12.13	17.44	17.02	17.23	8.00	7.76	7.88	40.00	40.00	40.00
T_1V_7	11.98	11.41	11.70	18.00	16.66	17.33	4.00	4.20	4.10	36.98	39.02	38.00
T_2V_1	11.12	11.48	11.30	17.00	18.00	17.50	3.98	3.66	3.82	36.66	36.00	36.33
T_2V_2	13.06	13.00	13.03	17.00	16.60	16.80	7.40	6.92	7.16	42.00	40.00	41.00
T_2V_3	16.40	14.80	15.60	19.00	17.85	18.43	6.00	5.58	5.79	41.00	45.00	43.00
T_2V_4	13.85	14.21	14.03	16.00	16.54	16.27	5.93	7.00	6.47	36.00	40.00	38.00
T_2V_5	12.00	12.54	12.27	19.00	19.34	19.17	8.06	7.62	7.84	36.11	37.88	37.00
T_2V_6	11.88	12.97	12.43	17.83	18.63	18.23	5.00	5.20	5.10	42.00	40.00	41.00
T_2V_7	12.76	11.70	12.23	18.05	17.29	17.67	3.48	4.00	3.74	40.98	43.02	42.00
T_3V_1	12.00	12.40	12.20	24.00	22.33	23.17	7.00	7.32	7.16	44.00	40.00	42.00
T_3V_2	14.00	13.00	13.50	17.54	17.20	17.37	6.26	6.00	6.13	38.33	37.67	38.00
T_3V_3	13.80	14.00	13.90	16.40	18.00	17.20	5.60	5.98	5.79	36.00	40.00	38.00
T_3V_4	12.99	14.66	13.83	17.77	17.49	17.63	7.24	7.08	7.16	40.90	41.10	41.00
T_3V_5	12.09	11.56	11.83	16.26	18.00	17.13	4.98	4.54	4.76	42.50	41.50	42.00
T_3V_6	12.26	12.00	12.13	15.40	15.46	15.43	6.26	6.06	6.16	38.01	37.99	38.00
T_3V_7	13.00	11.65	12.33	18.33	19.00	18.67	4.11	4.05	4.08	34.54	35.46	35.00
T_4V_1	10.39	11.41	10.90	14.01	13.13	13.57	4.18	3.98	4.08	37.51	38.49	38.00
T_4V_2	12.50	12.24	12.37	13.00	11.50	12.25	3.00	3.10	3.05	40.66	41.34	41.00
T_4V_3	12.16	13.98	13.07	12.00	11.78	11.89	2.69	2.73	2.71	36.20	35.80	36.00
T_4V_4	13.21	13.13	13.17	12.93	11.98	12.46	2.81	2.61	2.71	37.02	38.98	38.00
T_4V_5	12.23	11.71	11.97	12.64	13.28	12.96	2.94	3.22	3.08	36.71	37.29	37.00
T_4V_6	11.88	12.25	12.07	11.88	13.88	12.88	2.10	2.00	2.05	38.55	37.45	38.00
T_4V_7	12.43	11.91	12.17	13.03	12.34	12.69	2.33	2.41	2.37	37.12	38.88	38.00
SEm(±)	0.12	0.13	0.33	0.29	0.29	0.39	0.19	0.18	0.39	0.26	0.24	0.69
CD ($P \leq 0.05$)	0.35	0.37	0.93	0.83	0.82	1.11	0.53	0.51	1.09	0.73	0.67	1.97

of 10.30 cm followed by 'T_1V_2' (9.90 cm).

Regarding the number of seeds pod^{-1}, results revealed 'V_3' as the best performer (7.75 seeds pod^{-1}) followed by 'V_1' (7.00) and 'V_5' (6.75), as against the 'V_7' variety with lower number of seeds pod^{-1} (6.25). Besides varietal character, organic treatments had some effects over number of seeds pod^{-1}. In this context, 'T_3' recorded the highest number of seeds per pod (7.43). The number of seeds pod^{-1} in almost all cases recorded higher under the influence of 'T_3' (Table 2). Such findings may probably be due to higher available plant nutrients. Higher number of seeds pod^{-1} in pea grown through alternative approaches of farming was earlier reported by Dutta *et al.* (2018). The interaction effects showed 'T_3V_3', 'T_2V_3' as the outstanding variety and treatment combinations with the number of seeds pod^{-1} (9.00) followed by 'T_2V_5' (8.00). Once again, in almost all cases, the varietal interaction with 'T_3' showed maximum seeds pod^{-1} as compared to other treatments.

Among the varieties, 'V_5' performed best in terms of yield (19.55 t ha^{-1}) followed by 'V_6' (18.39 t ha^{-1}) and 'V_1' (17.86 t ha^{-1}) but 'V_7' exhibited lower yield potential (15.16 t ha^{-1}) (Table 2). The findings also revealed 'T_3' as the best treatment in the expression of yield (18.39 t ha^{-1}) followed by 'T_1' (16.72 t ha^{-1}), The varietal interaction with different treatments showed 'T_3V_6' (23.10 t ha^{-1}) as the best, followed by 'T_2V_5' (22.93 t ha^{-1}). The findings of the present investigation regarding yield and associated attributes of garden pea supported well with the previous findings of Negi *et al.* (2006), Susheela *et al.* (2007), Jaipaul *et al.* (2011) and Dutta *et al.* (2018).

Quality attributes: The TSS content of seven garden pea varieties under the influences of four treatments showed 'V_3' as the best performer with TSS (14.21 ^{o}Brix) followed by 'V_4' (13.47 ^{o}Brix) and 'V_2' (12.88 ^{o}Brix) as contrast to the 'V_7' variety with the lowest TSS content of 11.54 ^{o}Brix. 'T_2' recorded the highest TSS content (12.99 ^{o}Brix) [Table 3]. The TSS content in almost all cases recorded higher under the influence of 'T_2'. The interaction effects showed 'T_2V_3' as the outstanding variety and treatment combination with the highest TSS content of 15.60 ^{o}Brix followed by 'T_1V_3' (14.27 ^{o}Brix).

Among the seven varieties, 'V_1' recorded the maximum amount of starch (17.89 %), followed by 'V_5' (16.60 %) [Table 3]. Among treatments, 'T_3' performed best in the case of starch content (17.73 %), followed by T_2 (17.72 %). Among the all varietal interaction with the treatments, 'T_3V_1' performed best in the case of starch content (23.17 %).

The findings on protein content showed 'V_4' as the best performer with higher protein content (5.48 %), followed by 'V_2' (5.39 %) and 'V_6' (5.30 %), whereas, 'V_7' was the poor performing variety with the lowest protein content of 3.57% (Table 3). Among treatments, 'T_3' recorded the highest protein content (5.89 %), which was at par with 'T_1', and 'T_2'. 'T_4' recorded minimum amount of protein content (2.86 %). The protein content in almost all cases recorded higher under the influence of 'T_1'. Such findings may probably be due to more amount of plant nutrients, especially nitrogen in 'T_1'. The interaction effects showed 'T_1V_6' as the outstanding variety and treatment interaction with the highest protein content of 7.88 % followed by 'T_2V_5' (7.84 %). The finding corroborated well with the earlier observation of Kanaujia *et al.* (1997).

Highest ascorbic acid content (39.50 mg 100 g^{-1}) was recorded in 'V_3' variety followed by 'V_1' (39.33 mg 100 g^{-1}) and 'V_4' (39.25 mg 100 g^{-1}), however, 'V_7' performed poorly with low ascorbic acid content of 38.58 mg 100 g^{-1} (Table 3). Among treatments, 'T_3' recorded the highest ascorbic acid (40.14 mg 100 g^{-1}) but at par effect was observed in 'T_1' and 'T_2'. The interaction effects showed 'T_2V_4' as the best variety and treatment combination with the highest ascorbic acid content of 43.00 mg 100 g^{-1} followed by 'T_1V_1' (42.33 mg 100 g^{-1}). However, in almost all cases, the varietal interaction with 'T_4' revealed poor ascorbic acid content as compared to other treatments (Table 3). The level of ascorbic acid as recorded in the present investigation closely matched with the earlier findings of Bahadur *et al.* (2006) but different to the previous findings of Dutta *et al.* (2018).

The observation emphasized that 'Swarna Amar' and 'Azad Pea-3' were highly responsive to organic farming under the condition of the south Chhotanagpur plateau of eastern India. On the other hand, when quality attributes of the crop were taken into account, it was observed that quality parameters performed independently under the influence of organically designed diverse treatment conditions.

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