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RESEARCH PAPER

Influence of organic nutrient sources on growth and seed quality of garden pea

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Abstract

In the post-era of the green revolution, the productivity of crops has been increased by massive application of agro-chemicals that has disturbed harmony existing in the ecosystem. As a legume crop, garden pea is gaining attention towards organic farming systems. Seeds produced organically are better adaptable to organic growing conditions. A field experiment was laid out with three replications, comprising of twelve treatment combinations of different levels of FYM and jeevamrit during *Rabi* season of 2020-21. Seeds of cv. 'Punjab-89' were sown at a spacing of 60 cm × 7.5 cm after inoculation with *Rhizobium* and PSB. FYM was applied at the time of sowing. Jeevamrit was applied treatment-wise as soil drenching at an interval of 15 days starting from 30 days after sowing. Combined application of FYM @ 15 t ha^{-1} and jeevamrit @ 10% drenching resulted in maximum plant height (80.63 cm), pod length (8.84 cm), number of pods per plant (21.33), number of seeds per pod (8.07), gross seed yield (12.56 q ha^{-1}), graded seed yield (11.31 q ha^{-1}), speed of germination (8.68 days), 100 seed weight (17.51 g), seed germination (88.33%), minimum powdery mildew severity (25.33%) and lowest EC of seed (15.26 µS cm^{-1}) along with highest net returns (₹ 195567.5 ha^{-1}).

Keywords: Economics, FYM, Jeevamrit, *Pisum sativum* L., *Rhizobium.*

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Introduction

Garden pea (*Pisum sativum* L.) is the most important vegetable crop among legumes with a rich history of domestication and are grown globally as a valuable export-oriented cash crop (Sharma *et al*., 2023; Devi *et al*., 2023). It is a diploid (2n=14), short-duration and cleistogamous crop belonging to the family Fabaceae. To meet the demand of vegetables by the rising population, increased application of synthetic chemicals has disturbed the harmony among ecosystems along with contamination of ground and surface water (Bahadur *et al.,* 2006). Applications of insecticides have a negative effect on the survival, growth, and working of symbiotic rhizobial association with roots of plants that ultimately decrease atmospheric N-fixation (Meena *et al*., 2020). Increased uses of chemical fertilizers cause many environmental problems due to the presence of heavy metals (chromium and cadmium) and high concentrations of radionuclides. There has been public concern about the ill effects of these fertilizers on the environment and food quality. Therefore, organic practices should be adopted to reduce the use of chemical inputs. Being a legume crop, garden pea is gaining attention in organic production due to its properties of atmospheric N fixation, market potential and good economic return (Fernandez *et al*., 2012). Organic manures are prepared from human and animal waste, vegetable compost, agricultural residues etc. that provide essential plant nutrients, and improves the fertility of soil and organic carbon (Brar *et al*., 2019). These manures supply N, P, K and convert unavailable forms of bound phosphates, elemental nitrogen, micronutrients and decomposed plant residues into an available form so that plants can absorb these nutrients. Jeevamrit is a cheaper and eco-friendly liquid manure prepared by fermentation of a mixture of cow dung, cow urine, legume flour, jaggery and live soil (Palekar, 2006). It enhances the uptake and availability of nutrients by crop, promotes biological activity in soil and helps in mineralization. Biofertilizers are cost-effective and renewable sources of plant nutrients to supplement the parts of chemical fertilizers.

In 1999, there were only 11 mha of land under organic agriculture worldwide, which has increased by six-fold till 2019. Moreover, India has reported the highest increase of 18.6% over 0.36 mha under organic agriculture among other countries (Willer *et al*., 2021). Whoever tries to write history about organic farming, will have to refer to India. This increase in organic production is attributed to raising awareness and mania for a healthy lifestyle among consumers for superior and agro-chemical-free food. Nowadays, the majority of consumers are expecting organic food for good nutritional value without any chemical residues (Ditlevsen *et al*., 2019). As seed production through an organic system will yield plants that are more adapted to thrive under organically growing conditions, the production of organic seeds in abundance is crucial. The use of organic practices offers a valuable alternative over commercial fertilizers due to their positive effect on aeration, water holding capacity and enhancing nutrient content of soil without any ill effects. Therefore, the present study was designed to evaluate the effect of organic nutrient sources on the growth and seed quality of garden pea.

Materials and Methods

The investigation was carried out at Vegetable Research Farm, Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during *Rabi* season of 2020-21. The experimental site is located at an altitude of 1,270 meters above mean sea level lying between a latitude of 30˚5′ North and a longitude of 77˚11′ East. The experiment was laid out in Factorial Randomized Complete Block Design with three replications comprising of twelve treatment combinations of two factors – Factor I: Farm Yard Manure (M) with four levels *i.e.* 0, 5, 10, and 15 t ha^{-1} and Factor II: Jeevamrit (J) with three levels *i.e.* no drenching, 5% drenching and 10% drenching. The details of treatment combinations has been presented in Table 1. Seeds of garden pea cv. 'Punjab 89' was sown in the last fortnight of October 2020 at a spacing of 60 cm × 7.5 cm. Well rotten farm yard manure was applied as per the treatment details at the time of sowing. Jeevamrit was applied @500 litre ha^{-1} @ 5 and 10% as soil drenching (5 times) at an interval of 15 days starting from 30 days after sowing. Biofertilizers (*Rhizobium* + PSB *i.e.* Phosphate Solubilizing Bacteria) were applied @ 200 g per 10 kg as seed inoculation and 5 kg ha^{-1} as soil application uniformly to all the treatment combinations. Jeevamrit was prepared by mixing ingredients *i.e.* 10 kg of Indian cow dung, 10 liter of Indian cow urine, 2 kg of jaggery, 1 kg of pulse flour, and a hand of soil. All the ingredients were put in a plastic drum, and mixed thoroughly, and the final volume was made up to 200 litre by adding water. The drum was covered with jute bag and kept in the shade. The mixture was stirred in a clockwise direction twice a day till seven days. The nutrient contents present in each liter of jeevamrit prepared from dung and urine of Indian cows has been reported to be 0.04 g of nitrogen, 0.04 g of phosphorus and 0.28 g of potassium (Aulakh *et al*., 2013). Before the setup of this experiment, soil was high in available phosphorus (47.93 kg ha^{-1}), estimated as per Olsen *et al*., 1954; medium in organic carbon (0.98%), estimated as per Walkely and Black (1934); normal in available nitrogen (327.16 kg ha^{-1}), estimated as per Subbiah and Asija (1956); available potassium (309.19 kg ha^{-1}), estimated as per Merwin and Peech (1951); pH (6.95), estimated as per Jackson, 1967; electrical conductivity (0.41 dS m^{-1}), estimated as per Jackson, 1967; and viable microbial count (90.15 cfu g^{-1} of soil), estimated as per Subba Rao (1999). The height of ten randomly selected plants was measured and their average values were expressed in centimeters (cm), their number of pods was also counted and pooled. Similarly, ten pods were randomly selected to measure pod length and was expressed in centimeters, their number of seeds was also counted and pooled. The threshed seeds were weighed to record seed yield per plot. Seeds were cleaned manually and cleaned seed yield was recorded per plot and expressed as graded seed yield. From the seed yield per plot, seed yield per hectare was calculated. The speed of germination was calculated as per the procedure given by Maguire (1977).

Table 1: Details of treatments

Combination	*Treatment*
M_0J_0	No Manure (Control)
M_0J_1	No Manure + Jeevamrit @ 5 % drenching
M_0J_2	No Manure + Jeevamrit @ 10 % drenching
M_1J_0	FYM @ 5 t ha^{-1} + No Jeevamrit
M_1J_1	FYM @ 5 t ha^{-1} + Jeevamrit @ 5 % drenching
M_1J_2	FYM @ 5 t ha^{-1} + Jeevamrit @ 10 % drenching
M_2J_0	FYM @ 10 t ha^{-1} + No Jeevamrit
M_2J_1	FYM @ 10 t ha^{-1} + Jeevamrit @ 5 % drenching
M_2J_2	FYM @ 10 t ha^{-1} + Jeevamrit @ 10 % drenching
M_3J_0	FYM @ 15 t ha^{-1} + No jeevamrit
M_3J_1	FYM @ 15 t ha^{-1} + Jeevamrit @ 5 % drenching
M_3J_2	FYM @ 15 t ha^{-1} + Jeevamrit @ 10 % drenching

Table 2: Effect of organic nutrient sources on growth attributes of garden pea

Treatments	*Plant height (cm)*	*Pod length (cm)*	*No. of pods per plant*	*No. of seeds/pod*	*Gross seed yield (q ha^{-1})*	*Graded seed yield (q ha^{-1})*
M_0J_0	64.66	6.46	14.53	5.33	7.12	6.41
M_0J_1	69.63	6.57	15.53	5.67	7.88	7.09
M_0J_2	69.80	7.54	16.33	5.87	8.07	7.26
M_1J_0	70.16	8.17	17.20	6.07	8.47	7.62
M_1J_1	71.86	8.24	17.30	6.13	9.08	8.17
M_1J_2	73.27	8.20	17.60	6.33	9.41	8.47
M_2J_0	74.96	8.26	17.93	6.40	10.33	9.30
M_2J_1	76.13	8.34	19.67	6.60	10.37	9.34
M_2J_2	76.89	8.38	20.27	6.80	10.97	9.88
M_3J_0	77.60	8.23	20.60	7.67	11.22	10.09
M_3J_1	79.13	8.55	20.28	7.80	11.05	9.95
M_3J_2	80.63	8.84	21.33	8.07	12.56	11.31
CD (0.05)	1.71	0.49	0.72	0.07	0.54	0.49
CV (%)	1.36	3.61	2.31	0.60	3.28	3.29
SEm	058	0.17	0.24	0.02	0.18	0.17

The electrical conductivity of seed was measured as per the method suggested by Matthews and Powell (1987). 100 seeds were drawn randomly from each treatment and were weighed by an electronic balance. The mean weight was expressed in grams as 100 seed weight. The germination percent was carried out as per ISTA (1985) procedure. Seed vigor index-I and seed vigor index-II was calculated from the formula as formulated by Abdul-Baki and Anderson (1973). Disease assessment was done as per Mckinney (1923). Net return and B: C ratio was calculated on the basis of total cost of cultivation and gross income. The data recorded was analyzed by using MS Excel & OPSTAT. The data was subjected to analysis of variance at 5% level of significance for Factorial Randomized Complete Block Design.

Results and Discussion

The data pertaining to different growth parameters have been presented in Table 2. A significant influence was found among the interaction effect of organic and liquid manures. Maximum plant height (80.63 cm), pod length (8.84 cm), number of pods per plant (21.33), number of seeds per pod (8.07), gross seed yield (12.56 q ha^{-1}) and graded seed yield (11.31 q ha^{-1}) was recorded in the treatment M_3J_2 and minimum value of all these parameters were recorded in control (M_0J_0). The increase in growth characters with the combined application of FYM and jeevamrit may be due to increased availability of nitrogen, potassium and phosphorus in organic and liquid manures that ultimately increased vegetative growth. These manures play a crucial role in enhancing root and shoot development, thus, responsible for better pod development. Higher levels of N and P ions of soil contributed to vigorous root development, better N fixation, and improved plant growth, which in turn led to higher photosynthetic activity and translocation of photosynthates from source to sink, resulting in improved plant development. This might be due to an adequate supply of nutrients by these manures to plants for completing different reproductive stages and production of growth-promoting substances *i.e.* GA_3 and IAA. These findings are in agreement with Singh *et al*., (2023) in French bean, Shalu and Rattan (2023) in pea, Birla *et al*., (2018) in cowpea, Makwana *et al*., (2020) in green gram and Akarsh *et al*., (2020) in garden pea.

The data pertaining to different seed characters have been presented in Table 3. Electrical conductivity (EC) of seed, 100 seed weight and seed germination (%) were significantly influenced, whereas, the non-significant influence was observed in the speed of germination, seed vigor index-I and seed vigor index-II. The interaction effect of organic and liquid manures produced a maximum 100 seed weight (15.26 g), seed germination (88.33%) along with the lowest EC of seed (15.26 µS cm^{-1}) in the treatment M_3J_2 and minimum values of all these parameters including maximum EC of seed were recorded in control (M_0J_0). It might be due to the fact that FYM and jeevamrit application maintain soil organic content along with improving nutrients and structure of soils, which influence the percentage of seed germination along with enhanced enzymatic activities required for germination of seeds and speed of germination. Bolder seeds were produced due to larger leaf area for photosynthetic activity and its translocation from source to sink leading to increased filling of seeds. The beneficial effect of FYM was exhibited only when it was applied in combination with jeevamrit, which could be due to the synergistic role of FYM in increasing the nutrient availability, thus, leading to superior-quality seeds. The higher the EC of the seed, the lower is the quality of the seed and vice versa. The seeds produced from the application of organic and liquid manures had high cell membranes and seed coat, thus, leaching small quantity of electrolytes resulting in low EC. The results are in conformation with Maheshbabu *et al*. (2008) in soybean, Hellal and Abdelhamid (2013) in soybean, Chinthapalli *et al*. (2015) in faba bean and Raihan *et al*. (2020) in the country bean.

Data presented regarding disease parameters in Table 3 depicts that incidence of *Fusarium* wilt was found to be

Table 3: Effect of organic nutrient sources on seed quality, *Fusarium* wilt incidence and powdery mildew severity

Treatments	*Speed of germination (days)*	*EC of seed (µS cm⁻¹)*	*100 seed weight (g)*	*Seed germination (%)*	*Seed Vigour Index-I*	*Seed Vigour Index-II*	*Fusarium wilt incidence (%)*	*Powdery mildew severity (%)*
M_0J_0	6.99	20.34	15.49	76.33	1898.61	2858.04	10.00	43.55
M_0J_1	7.04	19.23	16.39	83.67	2062.53	2957.72	6.67	40.11
M_0J_2	7.25	18.68	16.76	81.67	2087.69	3205.68	10.00	39.54
M_1J_0	7.34	18.23	16.78	86.67	2330.44	3508.49	6.67	42.66
M_1J_1	7.75	17.39	17.01	83.33	2079.87	3351.12	10.00	39.57
M_1J_2	7.62	18.13	17.19	79.67	2015.67	2764.14	10.00	38.21
M_2J_0	7.28	16.66	17.00	85.33	2302.58	3436.24	13.33	32.11
M_2J_1	7.74	16.16	17.30	85.67	2062.16	3046.77	13.33	33.22
M_2J_2	7.73	16.02	17.10	79.33	2095.87	3164.28	16.67	28.11
M_3J_0	7.88	15.68	17.25	80.33	1987.19	2970.85	10.00	29.33
M_3J_1	8.29	15.47	17.39	85.00	2330.94	3502.31	6.67	27.40
M_3J_2	8.68	15.26	17.51	88.33	2266.28	3478.96	3.33	25.33
CD (0.05)	NS	0.41	0.45	2.74	NS	NS	NS	2.41
CV (%)	8.71	1.40	1.55	1..95	11.10	11.54	82.86	4.07
SEm	0.38	0.14	0.15	0.94	136.23	212.38	4.65	0.82

Table 4: Effect of different organic nutrient sources on economics of pea seed production

Treatments	*Yield (q ha⁻¹)*	*Gross income (₹ ha⁻¹)*	*Cost of cultivation (₹ ha⁻¹)*	*Net return (₹ ha⁻¹)*	*B: C ratio*
M_0J_0	6.41	192200	77432.5	114767.5	1.48
M_0J_1	7.09	212600	78557.5	134042.5	1.71
M_0J_2	7.26	217800	94682.5	123117.5	1.30
M_1J_0	7.62	228600	94682.5	133917.5	1.41
M_1J_1	8.17	245000	107807.5	137192.5	1.27
M_1J_2	8.47	254000	111932.5	142067.5	1.27
M_2J_0	9.30	278900	110762.5	168137.5	1.52
M_2J_1	9.34	280000	123557.5	156442.5	1.27
M_2J_2	9.88	296200	128012.5	168187.5	1.31
M_3J_0	10.09	302700	126182.5	176517.5	1.40
M_3J_1	9.95	298300	139307.5	158992.5	1.14
M_3J_2	11.30	339000	143432.5	195567.5	1.36
CD (0.05)				14633.46	
CV (%)				5.70	
SEm				4957.42	

non-significant, whereas, powdery mildew severity was significantly affected. The minimum severity of powdery mildew (25.33 %) was recorded with the combined application of FYM @ 15 t ha^{-1} + jeevamrit @ 10 % drenching (M_3J_2). This might be due the beneficial effect of FYM and jeevamrit due to the presence of micronutrients and plant growth hormones that resulted in superior plant defense mechanisms against diseases. Further, inoculation of biofertilizers increases the number of soil microbes and reduces the population of pathogens. Similar results were reported by Pandia *et al*., (2019) in mung bean. Further, data depicted in Table 4 revealed that among different treatments, the highest cost of cultivation per hectare (₹ 1,43,432.5) was observed in the treatment M_3J_2, whereas the lowest (₹ 77,432.5 ha^{-1}) was observed in the control (M_0J_0). Similarly, the maximum gross income per hectare (₹ 3,39,000) was recorded in the treatment M_3J_2, while the lowest gross income per hectare (₹ 1,92,200) was observed in control (M_0J_0). The net returns were highest (₹ 1,95,567.5 ha^{-1}) in M_3J_2 followed by M_3J_0 (₹ 1,76,517.5 ha^{-1}), whereas lowest net returns (₹ 1,14,767.5 ha^{-1}) were recorded in M_0J_0, which was statistically at par with M_0J_2 (₹ 1,23,117.5 ha^{-1}). Organic module M_3J_2 resulted in the highest net returns (₹ 1,95,567.5 ha^{-1}) along with enhanced growth and seed quality characters. Higher net returns in M_3J_2 could be attributed to the higher seed yield of peas recorded under this treatment. Highest B:C ratio was recorded in M_0J_1 (1.71) followed by M_2J_0 (1.52). The low B: C ratio in M_3J_2 was because of the high cost of organic inputs. Akarsh *et al*., (2020) reported the highest net returns with the application of FYM @ 10 t ha^{-1} +*Rhizobium*+ jeevamrit at 21-day intervals in garden pea. Similar results were reported by Singh *et al*. (2023) in French beans.

Conclusion

It can be concluded that combined application of FYM @ 15 t ha^{-1} + jeevamrit @ 10% drenching at an interval of 15 days starting from 30 days after sowing + biofertilizers (*Rhizobium* and PSB) @ 200 g per 10 kg as seed and 5 kg ha^{-1} as soil application resulted in enhanced growth, seed yield, seed quality and highest net returns for organic seed production of garden pea.

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सारांश

हरित क्रांति के बाद के युग में, कृषि-रसायनों के बड़े पैमाने पर उपयोग से फसलों की उत्पादकता में वृद्धि हुई है, जिसने पारिस्थितिकी तंत्र में विद्यमान सामंजस्य को बिगाड़ दिया है। एक फलीदार फसल के रूप में, मटर जैविक कृषि प्रणालियों की ओर ध्यान आकर्षित कर रहा है। जैविक तरीके से उत्पादित बीज जैविक खेती की परिस्थितियों के लिए बेहतर अनुकूल होते हैं। 2020-21 के रबी सीज़न के दौरान एफवाईएम और जीवामृत के विभिन्न स्तरों के बारह उपचार संयोजनों सहित तीन प्रतिकृति के साथ एक क्षेत्रीय प्रयोग किया गया था। सीवी के बीज. 'पंजाब-89' को राइजोबियम और पीएसबी के टीकाकरण के बाद 60 सेमी × 7.5 सेमी की दूरी पर बोया गया। बुआई के समय एफवाईएम का प्रयोग किया गया। जीवामृत को उपचार के अनुसार बुआई के 30 दिन से शुरू करके 15 दिनों के अंतराल पर मिट्टी को गीला करने के रूप में प्रयोग किया गया। 15 टन हेक्टेयर की दर से गोबर की खाद और 10 प्रतिशत भीगने की दर से जीवामृत के संयुक्त प्रयोग से अधिकतम पौधे की ऊंचाई (80.63 सेमी), फली की लंबाई (8.84 सेमी), प्रति पौधा फलियों की संख्या (21.33), प्रति फली बीज की संख्या (8.07) प्राप्त हुई, सकल बीज उपज (12.56 क्विंटल हेक्टेयर$^{-1}$), श्रेणीबद्ध बीज उपज (11.31 क्विंटल हेक्टेयर$^{-1}$), अंकुरण की गति (8.68 दिन), 100 बीज वजन (17.51 ग्राम), बीज अंकुरण (88.33%), न्यूनतम ख़स्ता फफूंदी गंभीरता (25.33%) और बीज की न्यूनतम ईसी (15.26 µS सेमी$^{-1}$) के साथ-साथ उच्चतम शुद्ध रिटर्न (₹195567.5 हेक्टेयर$^{-1}$)।