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Effect of Liquid Organic Manure on Growth and Yield of Field Pea (*Pisum sativum*, Fabaceae)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted during *Rabi* season of 2022 at the Crop Research Farm (CRF), Department of Agronomy, SHUATS, Prayagraj (UP) to examine the effect of liquid organic manure on growth and yield of Field Pea (*Pisum sativum* L.). The finding showed that field pea growth characteristics steadily improved with the maximum application of Dasagavya (250 l/ha) + spraying. This treatment resulted in significantly higher plant height (97.14 cm), Maximum number of nodules (28.13), plant dry weight (33.18 g), number of pods/plant (22.18), number of seeds/pod (4.16), seed yield (2.04 t/ha), and harvest index (40.16%), but in Stover yield the Dasagavya (250 l/ha) + seed inoculation and Spraying treatment (4.27 t/ha) was significantly greater. It is concluded with this data that spraying of Dasagavya is the most remunerative, profitable and economically efficient.

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1. INTRODUCTION

Field pea (*Pisum sativum* L.) holds significant popularity as a pulse crop in India, where it ranks as the second largest producer globally, just behind Russia. This nutritious leguminous crop boasts a wealth of protein, carbohydrates, vitamin A, vitamin C, calcium, and phosphorus. As a legume, it fulfills a major portion of its nitrogen requirements through biological nitrogen fixation. Consumers often express a preference for organic crops, citing the perceived transparency and sustainability of organic food production, which involves the use of organic fertilizers and crop rotations that include legumes, resulting in improved soil and plant health. Field pea belongs to the Fabaceae (Leguminosae) family and is characterized as a self-pollinating, annual cool-season leguminous crop, widely cultivated across the world. It plays a vital role as a pulse crop at the global level and ranks as the third most popular rabi pulse in India, following chickpea (*Cicer arietinum* L.) and lentil (*Lens culinaris Medik*.).

"Field pea (*Pisum sativum*) is a pulse crop grown and consumed globally. Approximately 7.5 million hectares of field pea were harvested in 2018, with the top producers consisting of Canada, Russia, China, India, and Ukraine, followed by the United States" [1]. "Currently, field pea is increasing in popularity within the organic and health food markets, as it is a nutrient-dense crop, naturally rich in iron, zinc, prebiotic carbohydrates, and protein, ideal for animal feed and as an alternative protein source to animal products" [2]. Field pea has the potential to fight "hidden hunger," which is the widespread occurrence of vitamin deficiencies caused by diets high in cereal. Therefore, expanding field pea production could boost organic agriculture and help reduce hidden hunger (F) by diversifying diets. At the global level, Canada ranks first in both area (21%) and output (35%) whereas China is second in area (13.70%) and is followed by Russia (12.94%). India occupy forth position in area (10.53%) and 5th position in production (5.36%). Highest productivity is recorded in Ireland (5000 kg/ha) followed by Netherland (4766 kg/ha), and Denmark (4048 kg/ha). While, India's productivity is only 955 kg/ha.

Field pea is primarily utilized for human consumption, and the market for field pea is characterized by high segmentation, with demand varying based on the end use. The sale of field pea occurs in primary or secondary wholesale markets, directly facilitated by the producers. Three main marketing segments have been identified: the direct food use market, the split (dal) market, and the feed substitute market for animals. Field pea is commonly consumed as whole seeds, either separately or incorporated into various dishes. Consumers typically prefer certain quality traits, such as creamish green and white seed color, as well as bold and heavy seeds.

"The global demand for organically produced crops has been steadily increasing, with retail sales reaching a substantial $81.6 billion in 2015. Organic farming, an age-old traditional practice passed down by our ancestors, solely relies on organic manures or natural inputs available on the farm, leading to reduced production costs compared to chemical inputs. This farming approach emphasizes balanced nutrition and takes care of soil health by enhancing its physical, chemical, and biological properties through nutrient cycling. Furthermore, organic farming guarantees the safety of the environment and the production of food free from harmful substances. The natural inputs used in organic farming are readily available, release nutrients slowly, provide a supply of macro and micro nutrients, and create a favorable soil environment for microbial populations" [2].

"In modern farming, liquid manure plays a crucial role in significantly increasing yields while simultaneously reducing the need for fertilizers. Liquid organic preparations like Panchagavya, Jeevamruta, and Sanjivak, made from cow products such as cow dung, urine, milk, curd, ghee, legume flour, and jaggery, have demonstrated positive results in promoting higher growth, increased yield, and improved crop quality. These preparations contain essential macro and micro nutrients, vitamins, essential amino acids, growth-promoting factors like IAA (Indole-3-acetic acid) and GA (Gibberellic acid), and beneficial microorganisms. As the concern for environmental safety and the global demand for pesticide-free food continue to grow, eco-friendly products that are easily biodegradable and leave no harmful toxic residues have gained considerable interest in crop production, while also contributing to nature conservation" [2].

“In Sanskrit, "panchagavya" refers to a blend of five substances obtained from desi cows, with each individual product referred to as "Gavya," and when combined, it is known as "Panchagavya." This mixture comprises cow dung, cow urine, milk, ghee, and curd in a proper ratio (5:3:2:2:1). To this mixture, banana, jaggery, and coconut water are added to facilitate fermentation, resulting in the final product known as "panchagavya." This highly effective organic product is recommended for crop improvement in organic agriculture” [3]. “Panchagavya has proven to be instrumental in providing resistance to pests and diseases, leading to increased overall yields” [4]. “When sprayed on crops, Panchagavya induces early flowering and high seed setting percentage, while also enhancing growth and yield components through its growth-promoting activity, all of which come at a low cost. Additionally, it exhibits properties similar to fertilizers and biopesticides” [5], Panchagavya also plays a vital role in improving the quality of fruits and vegetables and is applied as a foliar spray, soil application, irrigation supplement, and seed treatment (Natarajan, 2002). “As an eco-friendly alternative to chemical fertilizers and pesticides, Panchagavya offers promising solutions to address environmental degradation concerns while acting as a growth promoter and immunity booster”, as reported by Panchal et al. [6].

Taking all these factors into consideration, the present investigation was carried out during the Rabi season of 2022-23 to explore the impact of various liquid organic manures on enhancing the growth and yield of field pea, with the ultimate goal of providing valuable insights to further advance sustainable agricultural practices.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, India. The soil of the field constituting a part of central Gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc (2.32 mg/kg). The experiment was laid out in Randomized Block Design along with nine treatment combinations and replicated thrice. Treatments were randomly arranged in each replication, divided into 27 plots. The treatment combinations were as follows: T_1-Panchagavya (3 %) + Seed Inoculation, T_2-Panchagavya (3%) + Spraying, T_3-Panchagavya (3%) + Seed Inoculation and Spraying, T_4-Jeevamrutha (300 l/ha) + Seed Inoculation, T_5-Jeevamrutha (300 l/ha) + Spraying, T_6-Jeevamrutha (300 l/ha) + Seed Inoculation and Spraying, T_7-Dasagavya (250 l/ha) + Seed Inoculation ,T_8-Dasagavya (250 l/ha) + Spraying, T_9-Dasagavya (250 l/ha) + Seed Inoculation and Spraying. The growth parameters and yield production were recorded at harvest from randomly selected plants in each plot. These data were computed and analysed by following statistical method of Gomez and Gomez [7].

3. RESULTS AND DISCUSSION

3.1 Growth Paramaters

3.1.1 Plant height (cm)

Atharvest the treatment with application of Dasagavya (250 l/ha) + Spraying (97.14 cm) recorded significantly maximum plant height. However treatment with application of Panchagavya (3%) + Spraying (95.50 cm), Dasagavya (250 l/ha) + Seed inoculation and spraying (95.98 cm) were statistically at par with the Dasagavya (250 l/ha) + Spraying (Table 1).

“The plant height of field pea increased significantly during all crop growth stages, this might be due to the application of Panchagavya at frequent intervals leads to better adaption of plants and also supplied the plant with required nutrients throughout the crop season, this allowed the plant to grow with lesser nutrient competition, because of which production of more number of branches and leaves per plant were observed and thus enhanced the plant height” [8].

3.1.2 Number of nodules/ plant

At 60 days after sowing (DAS), the treatment with application of Dasagavya (250 l/ha) + Spraying (28.13) recorded significantly maximum number of nodules per plant. However, treatment with application of Panchagavya (3%) + Spraying (27.81) and Dasagavya (250 l/ha) + Seed inoculation and spraying (27.53) were statistically at par with the Dasagavya (250 l/ha) + Spraying (Table 1).

The increase in number of nodules per plant might be due to the better availability of nutrients

that were supplied by regular application of panchagavya. The foliar application of panchagavya supplies micronutrients, which creates a stimulus in the plant system and enhancing the cell division increased number of nodule production in plants, ultimately promoting the required growth and development. Similar findings were reported by Kumaravelu and Kadamban [9].

3.1.3 Plant dry weight (g/plant)

At Harvest, significantly higher plant dry weight was obtained with application of Dasagavya (250 l/ha) + Spraying (33.18 g/plant). However, Panchagavya (3%) + Spraying (30.94 g/plant), Panchagavya (3%) + Seed inoculation (31.58 g/plant); Panchagavya + seed inoculation and spraying (31.45 g/plant), Jeevamrutha (300 l/ha) + Spraying (32.14 g/plant) and Dasagavya (250 l/ha) + Seed inoculation and spraying (31.26 g/plant) statically at par with Dasagavya (250 l/ha) + Spraying (Table 1).

Dry matter production in plant of Field pea was significantly influenced due to different interval and concentration of panchagavya. The inoculation of panchagavya supplied the plant with enough macronutrients (N, P & K) and micronutrient (Zn, Fe, Cu and Mn) that are required for overall plant growth and development thus the application of panchagavya increased the dry matter production in plants. Similar findings were reported by Kumar et al. [10].

3.1.4 Crop Growth Rate (g/m^2/day)

At 60 - 80 DAS, treatment Dasagavya (250 l/ha) + Seed inoculation (19.16 g/m^2/day) was significantly higher. However, treatment Panchgavya (3%) + Seed inoculation and spraying (18.83 g/m^2/day) and Dasagavya (250 l/ha) + Seed inoculation and spraying (17.61 g/m^2/day) were statically at par with treatment Dasagavya (250 l/ha) + Seed inoculation (Table 1).

3.1.5 Relative Growth Rate (g/g/day)

At 60-80 DAS, data was found non-significant, However maximum relative growth rate is observed in Panchagavya (3%) + Seed inoculation and spraying (0.036g/g/day) and lower was found in Dasagavya (250 l/ha) + Spraying (0.027 g/g/day) (Table 1).

3.2 Yield Paramaters

3.2.1 Number of pods per plant (No.)

The treatment with application of Dasagavya (250 l/ha) + Spraying (22.18) recorded significantly maximum number of pods per plant. However, Panchagavya (3%) + Seed inoculation (19.12), Jeevamrutha (300 l/ha) + Seed inoculation and spraying (21.65) and Dasagavya (250 l/ha) + Seed inoculation and spraying (21.33) were statistically at par with the Dasagavya (250 l/ha) + Spraying (Table 2).

Increase in number of pods/plant could be attributed to the fact that application of panchagavya concentrations at different intervals must have created a stimulus in the plant system that altered physiological process and biochemical activities which modify plant anatomy and morphology of the yield attributes in plants as reported by Latha and Sharanappa [11].

3.2.2 Number of seeds per pod (No.)

The treatment with application of Dasagavya (250 l/ha) + Spraying (4.16) recorded significantly maximum number of seeds per pod. However, treatment with application of Panchagavya (3%) + Spraying (4.05) and Panchagavya (3%) + Seed inoculation and spraying (3.65) were statistically at par with the Dasagavya (250 l/ha) + Spraying (Table 2).

The increases in number of seeds per pod might be due to more vigorous and luxuriant vegetative growth which in turn favoured a better partitioning of assimilates from source to sink. Similar findings were reported by Kumawat et al. [12].

3.2.3 Seed index (g)

Seed Index data was non-significant, However maximum seed index was found in Dasagavya (250 l/ha) + Seed inoculation (21.36 g) and lower in Panchagavya (3%) + Seed inoculation and spraying (20.83 g) (Table 2).

The balance supplement of major and minor nutrient might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency that help to produce a healthy seed. Similar findings were reported by Kumawat et al. [12].

Table 1. Influence of liquid organic manures and method of application on growth attributes of Field pea (*Pisum sativum)*

Sl. No	Treatments	AT Harvest		AT 60DAS	During 60-80 DAS	
		Plant Height (cm)	Dry weight (g/plant)	Number of Nodules/plant	CGR ($g/m^2/day$)	RGR (g/g/day)
1.	Panchagavya (3%)+ Seed inoculation	93.19	31.58	26.80	16.33	0.035
2.	Panchagavya (3%)+ Spraying	95.50	30.94	27.81	13.99	0.034
3.	Panchagavya (3%) + Seed inoculation and spraying	89.36	31.45	22.43	18.83	0.036
4.	Jeevamrutha (300l/ha)+ Seed inoculation	91.06	31.84	25.73	16.93	0.033
5.	Jeevamrutha (300l/ha)+ Spraying	92.42	32.14	26.86	14.77	0.032
6.	Jeevamrutha (3001/ ha)+ Seed inoculation and spraying	90.97	29.82	25.93	13.67	0.033
7.	Dasagavya (250l/ha)+ Seed inoculation	93.28	30.04	23.66	19.16	0.034
8.	Dasagavya (250l/ha)+ Spraying	97.14	33.18	28.13	15.04	0.027
9.	Dasagavya (250l/ha)+ Seed inoculation and spraying	95.98	31.26	27.53	17.61	0.030
	F-test	S	S	S	S	NS
	$\mathrm{SEm}(\pm)$	0.71	0.74	0.21	0.56	0.0002
	$\mathrm{CD}(\mathrm{P}=0.05)$	2.14	2.24	0.77	1.69	-

Table 2. Influence of Liquid organic manures and method of application on yield attributes of field pea

Sl. No	Treatment	Pods/Plant (No)	Seeds/Pod (No)	Seed Index (g)	Seed yield (t/ha)	Stover Yield (t/ha)	Harvest Index (\%)
1.	Panchagavya (3%)+ Seed inoculation	19.12	2.67	21.05	1.25	2.81	30.79
2.	Panchagavya (3%) + Spraying	15.25	4.05	20.93	1.47	2.56	36.48
3.	Panchagavya (3%)+ Seed inoculation and spraying	13.92	3.65	20.83	1.04	2.73	27.59
4.	Jeevamrutha (300 L/ha)+ Seed inoculation	15.25	3.30	21.13	1.37	2.92	31.93
5.	Jeevamrutha $(300\mathrm{l/ha})$ + Spraying	16.32	2.67	21.01	1.54	3.14	32.91
6.	Jeevamrutha (3001/ha)+ Seed inoculation and spraying	21.65	3.27	20.97	1.14	2.84	28.64
7.	Dasagavya (250l/ha)+ Seed inoculation	17.45	2.51	21.36	1.43	3.06	31.85
8.	Dasagavya $(250\mathrm{l/ha})$ + Spraying	22.18	4.16	21.25	2.04	3.04	40.16
9.	Dasagavya (250l/ha)+ Seed inoculation and spraying	21.33	3.11	21.17	1.84	4.27	30.11
	F-test	S	S	NS	S	S	S
	$\mathrm{SEm}(\pm)$	1.23	0.17	0.65	0.19	0.39	1.22
	$\mathrm{CD}(\mathrm{P}=0.05)$	3.61	0.51	-	0.57	1.17	3.68

Table 3. Influence of Liquid organic manures and method of application on economics of field pea

Sl. No	Treatment	Cost of Cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C
1.	Panchagavya (3%) + Seed inoculation	40,150	81,250	41,100	1.02
2.	Panchagavya (3%) + Spraying	47,650	95,550	47,850	1.00
3.	Panchagavya (3%)+ Seed inoculation and spraying	48,900	87,600	38,700	0.80
4.	Jeevamrutha (300l/ha) + Seed inoculation	39,525	89,050	49,525	1.25
5.	Jeevamrutha (300 1/ha) + Spraying	43,275	100,100	56,825	1.29
6.	Jeevamrutha (300l/ha)+ Seed inoculation and spraying	43,900	84,100	40,200	0.91
7.	Dasagavya (250 tha) + Seed inoculation	40,775	92,950	52,175	1.28
8.	Dasagavya (250 /ha) + Spraying	51,025	132,600	81,575	1.59
9.	Dasagavya (250 tha) Seed inoculation and spraying	53,900	119,600	65,700	1.21

3.3 Economics

In Table 3 are the result showing that maximum gross return (132,600 ₹/ha), net return (81,575₹/ha) and benefit cost ratio (1.59) were recorded in Dasagavya (250 l/ha) + Spraying [13,14].

4. CONCLUSION

The concluded experiment showed that spraying of Dasagavya was found to be remunerative, profitable and economically efficient. The conclusion drawn was based on one season data only which requires further confirmation for recommendation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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