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RESEARCH ARTICLE

Impact of vermicompost on growth and yield attributes of pea (*Pisum sativum* L.) based intercropping system

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Abstract

Intercropping systems are most utilized by small farmers as they maximize the production of the unit. The experiment was conducted at the vegetable farm, Department of Vegetable Science, College of Horticulture and Forestry, Jhalrapatan City, Jhalawar, during the *Rabi* season 2022-23. The varieties used in the experiment were Azad Pea 1(Pea) and G282 (Garlic). The experiment consisted of fifteen treatment combinations having three levels each of vermicompost (0, 2.5, and 5 ton/ha) and five levels of different intercropping systems (Sole Pea, Sole Garlic, Pea + Garlic 1:1, 2:1, 2:2) in Factorial Randomized Block Design with three replications. The result revealed that the interaction effect of vermicompost and intercropping V_2I_1 (Vermicompost@5ton/ha + Sole Pea) system on pea was found significant on maximum plant height at 90 DAS (51.19 cm), plant height at harvest (74.37 cm), number of leaves per plant (47.88), number of pods per plant (10.02), weight of pod per plant (37.27 g), weight of pods per plot (9.70 kg), estimated yield (123.00 q/ha). In case of garlic, the maximum number of leaves per plant (9.56), plant height (60.45 cm), fresh weight of bulb (28.79 g), number of cloves per bulb (19.35), bulb yield per plot (10.36 kg), estimated yield (80.60 q/ha) was recorded under the interaction impact of vermicompost and intercropping system V_2I_2 (Vermicompost@5ton/ha + Sole Garlic).

Keywords: Bulb, Garlic, Intercropping, Pea, Pod, Vermicompost.

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Introduction

Intercropping is the most suitable measure to stabilize crop production, especially in the case of vegetable production. Intercropping is a popular choice among farmers because it helps increase overall crop production per unit area, provides insurance against complete crop failure, and reduces the occurrence of pests and diseases (Lyocks et al., 2013). Vermicompost is an amazing natural fertilizer that contains hormones and growth regulators to enhance plant growth and productivity. Additionally, it plays a crucial role in improving soil structure and contains a rich supply of essential nutrients such as nitrogen, phosphorus, and potassium, which are vital for plant development (Mona et al., 2011). Pea (*Pisum sativum* L.) and garlic (*Allium sativum* L.) are two of the most important vegetable crops in Rajasthan. They are grown for local and export markets as pea green pods or/and dry seeds and garlic bulbs. Small farmers mostly utilize intercropping systems as they maximize the production of the unit and these systems are spread in third world countries. Besides, intercropping with legume crops is an excellent practice for controlling soil erosion and sustaining crop productivity. In view of the above facts and realizing the importance of vermicompost and intercropping systems, the present study was carried out.

Materials and Methods

A field experiment was conducted vegetable farm at the Department of Vegetable Science, College of Horticulture and Forestry, Jhalrapatan, Jhalawar, Rajasthan, from November to April 2023. Geographically, Jhalawar falls in Zone-V, i.e., humid southeastern plains, which extends over 6.32 lac hectares from 23°4′ to 24°52′ N (latitude) and 75°29′ to 76°56′ E (longitude). The variety used in the experiment was Pea- AP 1 (Azad Pea 1) and Garlic G282. Treatments were arranged in a Factorial Randomized Block Design with three replications. The experiment consisted of two factors and with 3 levels of vermicompost (0, 2.5, 5 t/ha) and 5 levels or types of intercropping system (Sole Pea, Sole Garlic, Pea + Garlic in the ratio of 1:1, 2:1 and 2:2). The experiment was carried out in a total of 45 plots and area of each plot was 12 m^2 (3 × 4 m). A uniform recommended dose of 15k g N, 30 kg P2O5 and 20 kg K_2O for sole pea, 100 kg N, 50 kg P_2O_5 and 50 kg K_2O_5 for sole garlic was applied. In intercropping, 100% and 50% of the recommended RDF of intercrops were applied along with the RDF of the base crop. The Physico-chemical properties of the soil of the experimental field are presented in Table 1.

Data analysis

In pea, the parameters that were recorded during the experiment are plant height (at harvest) (cm), number of leaves per plant, number of pods per plant, weight of pods per plant (g), weight of pods per plot (kg) and green pod yield (t/ha). In garlic, the number of leaves per plant, plant height (at harvest) (cm), fresh weight of bulb (g), number of cloves per bulb, and bulb yield per plot (kg). Estimated bulb yield (t/ha) was calculated on the basis of yield obtained per plot. Estimated yield was calculated using yield per plot.

Statistical analysis

The collected data was carefully analyzed using a randomized block design (RBD) in the MS Excel software, allowing for statistical analysis through ANOVA. In order to test the significance of treatment differences, the "F" test was utilized (Panse and Sukhatme, 1967).

Results and Discussion

Pea

Vermicompost

It is evident from the data in Table 2 that vermicompost and Intercropping systems had significant effects on pea-based intercropping systems individually as well as combined on growth and yield attributes of pea and garlic. The results revealed that treatment V_2 (Vermicompost @ 5t/ha) on peas exhibited maximum plant height at harvest (14.77%), number of leaves per plant (26.27%), number of pods per plant (27.07%), weight of pods per plant (62.08%), weight of pods per plot (18.49%) and green pod yield (18.70%) while minimum plant height at harvest, number of leaves per plant, number of pods per plant, weight of pods per plant, weight of pods per plot and green pod yield were recorded in treatment V_0 (Vermicompost @ 0t/ha). These results are in conformity with findings obtained by Rajiv *et al.* (2021) in peas and Singh *et al.* (2011) in French beans. These findings clearly indicated that the application of vermicompost @ 5t/ha played a significant role in enhancing the vegetative

Table 1: Physico-chemical properties of the soil of the experimental field

Properties		*Value*	*Method employed*
(A) Mechanical compositions			
1.	Sand (%)	25.66	Hydrometer method (Bouyoucos, 1927)
2.	Silt (%)	38.57	
3.	Clay (%)	32.28	
(B) Physical properties			
1.	Bulk density (mg m^{-3})	1.39	Core sampler method (Piper, 1950)
2.	Particle density (mg m^{-3})	2.65	Black (1965)
3.	Porosity (%)	43.28	Black (1965)
(C) Chemical properties			
1.	Organic carbon (%)	0.58	Walkley and Black (1934)
2.	Available nitrogen (kg ha^{-1})	337.53	Alkali Permanganate method (Subbiah and Asija, 1956)
3.	Available phosphorus(P_2O_5 kg ha^{-1})	16.61	Olsen's method (Olsen *et al.,* 1954)
4.	Available Potassium(K_2O kg ha^{-1})	216	Flame photometer method(Metson, 1956)
5.	EC (dSm^{-1} at 25°C)	0.90	Using solubridge (Jackson, 1973)
6.	pH (1:2: Soil: water suspension)	7.67	Potentiometric method usingpH meter (Jackson, 1973)

Table 2: Effect of vermicompost and intercropping system on growth and yield of pea

Treatment notation	*Treatment combination*	*Plant height (cm) (at harvest)*	*Number of leaves per plant*	*Number of pods per plant*	*Weight of pods per plant (g)*	*Weight of pods per plot (kg)*	*Green pod yield (t/ha)*	*B:C ratio*
V_0	Vermicompost @ 0t/ha	60.67	34.11	7.13	17.33	5.14	4.28	-
V_1	Vermicompost @ 2.5t/ha	68.23	40.19	8.54	24.92	5.58	4.65	-
V_2	Vermicompost @ 5t/ha	69.63	43.07	9.06	28.09	6.09	5.08	-
	S.Em ±	0.43	0.29	0.06	0.18	0.05	0.34	-
	C.D at 5%	1.26	0.86	0.20	0.53	0.14	1.01	-
I_1	Intercropping (Sole Pea)	68.66	42.15	8.72	27.21	8.91	7.43	-
I_2	Intercropping (Sole Garlic)	-	-	-	-	-	-	-
I_3	Intercropping + [Pea +Garlic (1:1)]	66.79	39.18	8.44	23.84	4.91	4.09	-
I_4	Intercropping+ [Pea +Garlic (2:1)]	63.13	36.59	7.59	20.43	4.15	3.46	-
I_5	Intercropping+ [Pea +Garlic (2:2)]	66.11	38.57	8.21	22.32	4.45	3.71	-
	S.Em ±	0.49	0.33	0.07	0.20	0.05	0.39	-
	C.D at 5%	1.46	0.99	0.23	0.61	0.17	1.16	-
V_0I_1	Vermicompost @ 0t/ha+ Sole Pea	59.82	33.27	6.68	11.22	7.79	6.49	1.67
V_0I_2	Vermicompost @ 0t/ha+ Sole Garlic	-	-	-	-	-	-	1.19
V_0I_3	Vermicompost @ 0t/ha + [Pea + Garlic (1:1)]	61.91	35.30	7.47	20.51	4.54	3.78	3.24
V_0I_4	Vermicompost @ 0t/ha +[Pea +Garlic (2:1)]	60.14	33.59	7.07	18.45	3.83	3.19	3.22
V_0I_5	Vermicompost @ 0t/ha+ [Pea + Garlic (2:2)]	60.83	34.28	7.29	19.17	4.04	3.37	3.39
V_1I_1	Vermicompost @ 2.5t/ha + Sole Pea	71.80	45.32	9.47	33.14	9.24	7.70	1.70
$V1I_2$	Vermicompost @ 2.5t/ha+ Sole Garlic	-	-	-	-	-	-	1.23
V_1I_3	Vermicompost @ 2.5t/ha + [Pea + Garlic (1:1)]	68.71	39.13	8.66	23.29	4.91	4.09	3.50
V_1I_4	Vermicompost @ 2.5t/ha +[Pea +Garlic (2:1)]	63.90	37.35	7.71	20.66	4.12	3.43	3.40
V_1I_5	Vermicompost @ 2.5t/ha+ [Pea + Garlic (2:2)]	68.50	38.97	8.34	22.60	4.44	3.70	3.53
V_2I_1	Vermicompost @ 5t/ha + Sole Pea	74.37	47.88	10.02	37.27	9.70	8.08	1.72
V_2I_2	Vermicompost @ 5t/ha+ Sole Garlic	-	-	-	-	-	-	1.53
V_2I_3	Vermicompost @ 5t/ha +[Pea+ Garlic (1:1)]	69.76	43.11	9.21	27.72	5.28	4.40	3.80
V_2I_4	Vermicompost @ 5t/ha +[Pea +Garlic (2:1)]	65.37	38.82	8.01	22.19	4.51	3.76	3.72
V_2I_5	Vermicompost @ 5t/ha+ [Pea + Garlic (2:2)]	69.01	42.46	9.00	25.20	4.88	4.07	4.06
	S.Em ±	0.86	0.58	0.13	0.36	0.10	0.68	-
	C.D at 5%	2.53	1.73	0.39	1.07	0.29	2.01	-

Table 3: Effect of vermicompost and intercropping system on growth and yield of garlic

Treatment notation	*Treatment combination*	*Number of leaves per plant*	*Plant height (cm) (at harvest)*	*Fresh weight of bulb (g)*	*Number of cloves per bulb*	*Bulb yield per plot (kg)*	*Estimated bulb yield (t/ha)*
V_0	Vermicompost @ 0t/ha	7.81	42.94	24.12	15.37	4.57	3.81
V_1	Vermicompost @ 2.5t/ha	8.48	49.65	26.54	16.38	5.40	4.50
V_2	Vermicompost @ 5t/ha	8.90	55.38	27.96	17.55	5.54	4.62
	S.Em ±	0.05	0.44	0.17	0.10	0.13	0.29
	C.D at 5%	0.16	1.30	0.50	0.31	0.13	0.87
I_1	Intercropping (Sole Pea)	-	-	-	-	-	-
I_2	Intercropping (Sole Garlic)	8.62	51.55	26.68	17.37	9.60	8.00
I_3	Intercropping +Pea +Garlic (1:1)	8.39	48.26	25.65	15.91	4.10	3.42
I_4	Intercropping+Pea +Garlic (2:1)	8.49	50.74	26.61	17.12	3.19	2.66
I_5	Intercropping+Pea +Garlic (2:2)	8.08	46.74	24.56	15.32	4.04	3.37
	S.Em ±	0.06	0.51	0.19	0.12	0.15	0.34
	C.D at 5%	0.18	1.51	0.58	0.35	0.15	1.00
V_0I_1	Vermicompost @ 0t/ha+ Sole Pea	-	-	-	-	-	-
V_0I_2	Vermicompost @ 0t/ha+ Sole Garlic	7.57	40.31	22.79	14.91	8.20	6.83
V_0I_3	Vermicompost @ 0t/ha + Pea + Garlic (1:1)	7.73	44.18	24.39	15.18	3.90	3.25
V_0I_4	Vermicompost @ 0t/ha +Pea +Garlic (2:1)	8.14	45.57	25.55	16.34	3.06	2.55
V_0I_5	Vermicompost @ 0t/ha+ Pea + Garlic (2:2)	7.83	41.72	23.77	14.92	3.80	3.17
V_1I_1	Vermicompost @ 2.5t/ha + Sole Pea	-	-	-	-	-	-
$V1I_2$	Vermicompost @ 2.5t/ha+ Sole Garlic	8.74	53.89	28.46	17.86	10.24	8.53
V_1I_3	Vermicompost @ 2.5t/ha + Pea + Garlic (1:1)	8.13	47.15	25.90	15.92	4.14	3.45
V_1I_4	Vermicompost @ 2.5t/ha +Pea +Garlic (2:1)	8.56	51.51	27.16	16.46	3.26	2.72
V_1I_5	Vermicompost @ 2.5t/ha+ Pea + Garlic (2:2)	8.49	46.06	24.67	15.37	3.94	3.28
V_2I_1	Vermicompost @ 5t/ha + Sole Pea	-	-	-	-	-	-
V_2I_2	Vermicompost @ 5t/ha+ Sole Garlic	9.56	60.45	28.79	19.35	10.36	8.63
V_2I_3	Vermicompost @ 5t/ha +Pea+ Garlic (1:1)	8.39	52.46	26.67	16.62	4.26	3.55
V_2I_4	Vermicompost @ 5t/ha +Pea +Garlic (2:1)	8.78	55.14	27.13	18.58	3.25	2.71
V_2I_5	Vermicompost @ 5t/ha+ Pea + Garlic (2:2)	8.86	52.46	25.26	15.67	4.04	3.37
	S.Em ±	0.10	0.88	0.34	0.21	0.90	0.59
	C.D at 5%	0.32	2.61	1.01	0.62	0.26	1.74

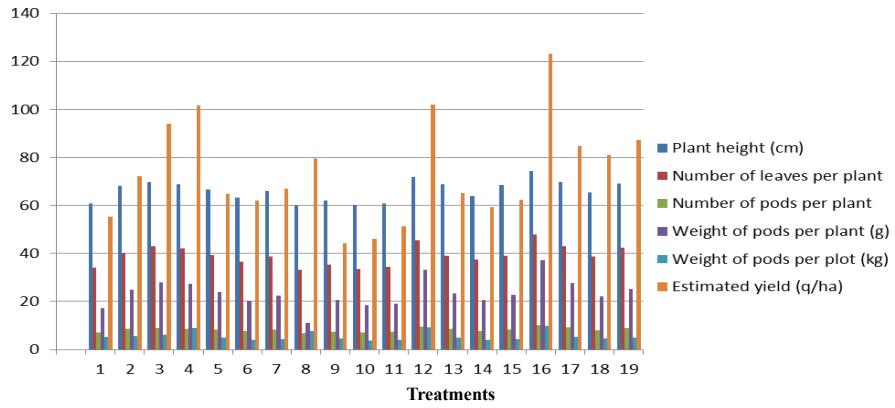

Figure 1: Effect of vermicompost and intercropping system on growth and yield of pea

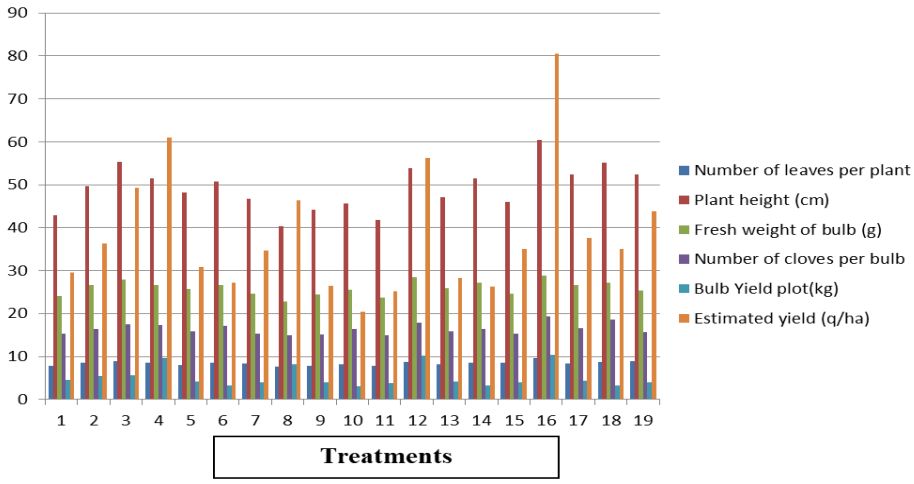

Figure 2: Effect of vermicompost and intercropping system on growth and yield of garlic

growth of peas. The compost produced by earthworms (vermicompost) is a rich source of macro and micronutrients. The earthworm dung contains nitrogen, which is easily accessible to plants, making it capable of supplying 30% of the total nitrogen required for crop growth (Sharma *et al*. 2010). Along with offering a range of nutrients, it also contains growth-promoting compounds, mycorrhizae, and nitrogen-fixing bacteria in the soil. The improvement in plant height number of leaves with the application of vermicompost may be due to better moisture holding capacity, supply of micronutrients and availability of major nutrients due to favorable soil conditions. The increased nitrogen nutrition may also have enhanced cell division and differentiation (Jamwal *et al*., 2024).

Intercropping

In intercropping system I_1 (Sole pea) pea exhibited maximum plant height at harvest (8.75 %), number of leaves per plant (15.19%), number of pods per plant (14.88%), the weight of pods per plant (33.18%), weight of pods per plot and green pod yield (114.70%) while the minimum value for plant height at harvest, number of leaves per plant, number of pods per plant, weight of pods per plant, weight of pods per plots and estimated bulb yield was recorded in treatment I_4 (Pea + Garlic 2:1).

These results are in conformity with the results obtained by Qassim *et al*., (2013) in pea. The significant increase in the growth of sole pea is primarily due to its efficient utilization of space and light, as well as its ability to uptake and utilize applied nutrients effectively. These factors contribute to a higher production of assimilates and faster biosynthesis of metabolic activities, resulting in greater plant growth, development, and yield. (Choudhary and Jana, 2012).

Interaction effect

The interaction effect of vermicompost and intercropping V_2I_1 (Vermicompost @ 5t/ha + Sole Pea) system on pea was found significant on maximum plant height at harvest (24.32%), number of leaves per plant (43.91%), number of pods per plant (50.00%), weight of pods per plant (232.17%), weight of pods per plot, green pod yield (24.51%). However, minimum plant height at the harvesting stage,

number of leaves per plant was recorded with treatment V_0I_1 (Vermicompost @ 0t/ha+ Sole Pea), number of pods per plant, weight of pods per plant under treatment (Vermicompost @ 0t/ha Pea+ Garlic 1:1), weight of pods per plot with treatment V_0I_4 (Vermicompost @ 0t/ha+ Pea+ Garlic 2:1) and green pod yield of pea with treatment V_0I_3 (Vermicompost @0t/ha +Pea+ Garlic 1:1). However, Maximum B:C ratio (4.06) was recorded under treatment V_2I_5 (Vermicompost @5ton/ha+ Pea+ Garlic 2:2) while minimum B:C ratio (1.67) was recorded under treatment V_0I_1 (Vermicompost @0t/ha+ Sole Pea). The higher plant height, number of leaves in different vegetable crops in respective sole crops and 1:1 ratio were due to less competition for sunlight, space, nutrients and water as compared to other ratios. These results are in conformity with the research of Chongloi *et al*. (2018) in pea as mentioned in data in Table 2.

Garlic

Vermicompost

The data on effect of vermicompost in presented in Table 3. The results revealed that the effects of vermicompost V_2 (Vermicompost @ 5t/ha) on garlic exhibited a maximum number of leaves per plant (13.96%), plant height (28.97%), fresh weight of bulb (15.92%), number of cloves per bulb (14.18%), bulb yield per plot and estimated bulb yield (21.22%) as compared to the minimum number of leaves per plant, plant height, fresh weight of the bulb, number of cloves per bulb, bulb yield per plot and estimated bulb yield of garlic were recorded under treatment V_0 (Vermicompost @ 0t/ha). Improvement in plant growth attributes with the application of vermicompost might be due to the fact that vermicompost not only improved nutrient availability to plants but also improved the physical state of soil in respect to granulation, friability and porosity, which in turn provided a balance of nutritional environment supporting both soil rhizosphere and plant system (Singh *et al.,* 2011; Singh et al., 2023).

Intercropping

The data presented in Table 3 revealed that effect of intercropping system I_2 (Sole Garlic) on garlic exhibited a maximum number of leaves per plant (6.68%), plant height (10.29%), fresh weight of bulb (8.63%), number of cloves per bulb (13.38%), bulb yield per plot, estimated bulb yield (137.62%) while minimum the number of leaves per plant, plant height was recorded under treatment I_5 (Pea + Garlic 2:2). The minimum fresh weight of bulb was noted in treatment I_5 (Pea + Garlic 2:2) and bulb yield per plot and estimated bulb yield of garlic under treatment I_4 (Pea + Garlic 2:1). These results are in conformity with the results obtained by Mehta et al. (2015) in fennel based intercropping system. In sole garlic, the higher growth and yield attributes were obtained due to no competition for food with any other crop except garlic, leading to better uptake of nutrients and water by garlic. The higher growth and qualitative attributes of garlic in 2:1 ratio with all intercropping systems might be due to the garlic crop was grown as an intercrop in between two rows of peas. As a result more nutrients were available to garlic as more amount of nitrogen was fixed by pea in both rows. But in the case of yield, maximum yield was obtained under the intercropping system Pea + garlic (1:1) compared to Pea + Garlic (2:1) as this is directly based on the plant population, which was higher in Pea + Garlic (1:1) as compared to Pea + Garlic (2:1).

Interaction effect

The data in Table 3. Depicting the interaction impact of vermicompost and intercropping system V_2I_2 (Vermicompost @ 5t/ha + Sole Garlic) was found suitable for the growth and yield of garlic. The maximum number of leaves per plant (26.28%), plant height at harvest (49.97%), fresh weight of bulb (26.33%), number of cloves per bulb (29.77%), bulb yield per plot and estimated bulb yield (238.56%) was recorded under V_2I_2 and minimum number of leaves per plant and plant height, fresh weight of the bulb and number of cloves per bulb with treatment V_0I_2 (Vermicompost @ 0t/ha + Sole Garlic) and estimated yield of garlic under treatment V_0I_4 (Vermicompost @ 0t/ha + Pea+ Garlic 2:1). These results are conformity with the research of Mohammadii et al. (2019) in fennel intercropping with cauliflower and radish. The interaction of vermicompost and pea-based intercropping systems had several positive effects on plant growth and its production potential. The vermicompost improved the soil's physiochemical and biological condition, water holding capacity, and increased aggregation and microbial activity, resulting in increased moisture availability and nutrient mineralization, which increases N, P and K availability and uptake by the plant. The more nitrogen in plants increased cell division, cell elongation, carbohydrate, protein formation and photosynthesis, which ultimately increased plant height.

Conclusion

In pea, the interaction effect of vermicompost and intercropping (Vermicompost @5 t/ha + Sole Pea) system was found significant on maximum plant height at harvest (74.37 cm), number of leaves per plant (47.88), number of pods per plant (10.02), weight of pods per plant (37.27 g), weight of pods per plot (9.70 kg) and estimated yield (123.00 q/ha). In the case of garlic, the interaction effect of vermicompost and intercropping system (Vermicompost @5ton/ha + Sole Garlic) was found suitable for growth and yield attributes. The maximum number of leaves per plant (9.56), plant height (60.45 cm), fresh weight of bulb (28.79 g), bulb yield per plot (10.36 kg) and estimated yield (80.60 q/ha). The interaction effect of Vermicompost and Intercropping system significantly increased the B:C ratio (4.06) and was recorded as highest under treatment V_2I_5

(Vermicompost @5ton/ha+ Pea+ Garlic 2:2) as compared to other treatments. Hence, we can suggest farmers for pea and garlic intercropping as compared to sole cropping. However, this result serves as a reference for further investigation into the impact of vermicompost on pea-based intercropping systems.

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सारांश

मटर में, वर्मीकम्पोस्ट और अंतरफसल (वर्मीकम्पोस्ट @ 5t/हेक्टेयर + एकमात्र मटर) प्रणाली का परस्पर प्रभाव कटाई के समय अधिकतम पौधे की ऊंचाई (74.37 सेमी), प्रति पौधा पत्तियों की संख्या (47.88), प्रति पौधा फलियों की संख्या पर महत्वपूर्ण पाया गया। 10.02), प्रति पौधा फलियों का वजन (37.27 ग्राम), प्रति प्लॉट फलियों का वजन (9.70 किग्रा) और अनुमानित उपज (123.00 क्विंटल/हेक्टेयर)। लहसुन के मामले में, वर्मीकम्पोस्ट और अंतरफसल प्रणाली (वर्मीकम्पोस्ट @5टन/हेक्टेयर + एकमात्र लहसुन) का परस्पर प्रभाव विकास और उपज विशेषताओं के लिए उपयुक्त पाया गया। प्रति पौधा पत्तियों की अधिकतम संख्या (9.56), पौधे की ऊंचाई (60.45 सेमी), बल्ब का ताजा वजन (28.79 ग्राम), प्रति प्लॉट बल्ब की उपज (10.36 किलोग्राम) और अनुमानित उपज (80.60 क्विंटल/हेक्टेयर)। यह परिणाम एक के रूप में कार्य करता है। मटर आधारित अंतरफसल प्रणाली पर वर्मीकम्पोस्ट के प्रभाव की आगे की जांच के लिए संदर्भ।