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Exploring the role of organic amendments on growth, yield and seed quality of knol-khol (*Brassica oleracea* var. *gongylodes*) in northern hills of India

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ABSTRACT

To find out the effect of different organic bulk and liquid manures on the growth, yield and seed quality of knol-khol, a field-experiment was conducted at CONF, Chatha during the Rabi season of 2022- 23. To increase yield, high amount of inorganic fertilizers and pesticides are used which not only pollute the vegetables but also affect soil chemical properties. As pesticides and inorganic fertilizers can penetrate vegetable tissues, they have a negative impact on the natural food chain when utilised extensively in areas where leafy vegetable production occurs therefore an experiment was conducted in RCBD with 02 factors viz., organic bulk and liquid manures. There were 20 treatments, with three replications. During the vegetative stage, liquid manures (Panchagavya, Jeevamrut, Compost tea) were applied at 20 and 30 DAT and after 20 days of replanting the knobs for seed production. Liquid manures were sprayed at 3% concentration whereas bulk manures were applied at various dosages like FYM 20 t/ ha, vermicompost 3 t/ ha poultry manure 2 t/ ha and mustard cake 2 t/ha, as basal dose to the crop. Results depicted that during the vegetative stage, foliar applications of Compost tea + FYM recorded significantly higher growth and yield contributing parameters as compared to other treatments. This treatment was statistically at par with the treatment having Jeevamrut + FYM for knob diameter (8.12 cm) and days to 50% marketable maturity (40 days). At the reproductive stage of the crop, Jeevamrut + FYM showed superiority concerning days to 50% flowering (91 days), number of siliqua per plant (945), siliqua weight per plant (75.67g), seed weight per plant (50g) and seed yield per hectare (610kg). Studies further revealed that organic amendments could not influence soil chemical properties like pH, EC and OC except available nitrogen. Its primary components, such as organic manures, offer a means of lowering the indiscriminate use of synthetic fertilizers, which promote soil health and have a good effect on soil organic matter.

Keywords: *Knol-khol, liquid manures, bulk manures, FYM, poultry manure, vermicompost compost tea, jeevamrut, panchagavya, mustard cake.*

Introduction

The Knol-khol or kohlrabi, 2n=2x=18 (*Brassica oleracea* var. *gongylodes* L.) belongs to family Brassicaceae is winter season crop and liked by people of J&K. It is recognized that kohlrabi has significant nutritional and therapeutic benefits due to its high potassium, vitamin C, and antioxidant content, which works to halt the development of cancer-causing chemicals. Vegetables are low in calories and fats and are a great source of vitamins proteins, dietary fiber and minerals and are rich in phyto-chemicals. It is a significant cole crop of the Jammu region and covers an area of 2712 ha with a production of 55,118 MT with a productivity of 20.32 MT/ha [3]. So far as national statistics of this crop are concerned, no data is available. Eaten as raw, boiled, cooked or pickled, knol-khol can prepared using knobs or leaves. Conventionally it is being grown using indiscriminate use of high inorganic fertilizers to the tune of 10:50:50 Kg/ha chemical insecticides and pesticides as recommended in the Package of Practices [3] by the State Agriculture University.

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To increase yield, high amount of inorganic fertilizers and pesticides are used which not only pollute the vegetables but also affect soil chemical properties. As pesticides and inorganic fertilizers can penetrate vegetable tissues, they have a negative impact on the natural food chain when utilized extensively in areas where leafy vegetable production occurs. They can cause illnesses like nausea, allergies, and headaches to serious conditions like cancer, neurological abnormalities, and reproductive problems [1] and [13].

In Jammu, knol-khol is a major vegetable crop and is being grown (3-4) times in a year due to its high demand in the market. During its cultivation, the majority of the farmers broadcast its seeds directly in the fields without the proper establishment of a nursery and other recommended practices. High nitrogen doses, in the form of urea, is applied for rapid growth without any control of time between last pesticide or fertilizer application and harvest, leading to high amount of residues in this crop [12], [17], and [2].

To have check on the use of these inorganic chemicals, a sustainable strategy which involves organic farming primarily bulk organic manures, biofertilizers, biopesticides, and other biological techniques. Its primary components, such as organic manures, offer a means of lowering the indiscriminate use of synthetic fertilizers, which promote soil health and have a good effect on soil organic matter. FYM promotes soil structure and adds humus and slowly-releasing nutrients to the soil.

[9].Vermicompost improves the physical, chemical and biological properties of soil and promotes growth of the plant[4] Poultry manure on the other hand feeds soil microbes allowing organic nutrients to breakdown faster, which in turn make them available to plant [32]. Where as mustard cake offers all the essential elements for plant growth and enhance root development[9].

Experiments conducted on different vegetables at Centre for Organic and Natural Farming (CONF), SKUAST Jammu, Chatha have shown that organic cultivation of knol-khol is possible and preferable however, it is encountered with its delay of 10-15 days to reach its marketable maturity. This much of delay was noticed in particularly short duration vegetables like spinach beet, coriander, fenugreek, radish, knol-khol etc. To supply essential nutrients rapidly particularly at crucial stages of growth and development of the crop under organic management, liquid organic manures finds their role.

Their foliar application provides availability of macronutrients, micronutrients, growth regulators and other beneficial substances to the plants rapidly in real time basis, in addition to enhanced tolerance to biotic and abiotic stresses. They also increase the beneficial microflora of the soil and their activity to a large extent upon soil application. These liquid manures can be easily prepared from naturally and locally available materials by the farmers [19].

Jeevamrut, Panchagavya, and Compost Tea are a few of the organic products that are used commonly as liquid manures.Their role is specific and improves soil and plant health. Jeevamrut enhance microbial population, soil fertility and productivity of soil [7]. Panchagavya and Compost Tea enhance yield and yield attributes like growth of roots, stems, branches, number of leaves, leaf area index, chlorophyll content, oil content, protein content and other quality parameters[30].

Material and Methods

Location and Climate

The experimental site was situated at a height of 293 metres above mean sea level, at 32°40′ N latitude and 74°82′ E longitude. The area lies in the Jammu district of the J&K UT, in the Shivalik foothills. The summers of Chatha, Jammu are hot and dry, followed by the warm and humid monsoon season and the chilly winters. The area receives 900 to 1200 mm of rainfall annually, of which 70 to 75 percent falls in June to September months while the remaining 25 percent fall as isolated showers during the winter as a result of western disturbances from October to April. The climate of Chatha is subtropical with hot dry summer and cold winter. The maximum temperature rose to 34.3ºC during winter (October - April) and minimum temperature occasionally falls to 3.9ºC during the winter of 2022-23. The mean rainfall during growing season was 8.9 mm most of which was received from south west monsoon during October to second fortnight of January the conditions that prevailed during the crop season was recorded at the Meteorological observatory, located at, Division of Agronomy, SKUAST-Jammu, Chatha. During the crop period from 14th October to 13th April 2020, the mean maximum and minimum temperature showed a fluctuation throughout the crop growth period. The mean relative humidity varied from 96 percent (maximum) and 38.3 percent (minimum).

Treatment combinations

The various combinations of organic bulk and liquid manures used were T_1- Control (No application), T_2- FYM (20T/ha), T_3- Vermicompost (3T/ha), T_4- Poultry Manure(2T/ha), T_5- Mustard Cake (2T/ha, T_6- Panchagavya (3%), T_7- Panchagavya (3%)+ FYM(20T/ha), T_8- Panchagavya(3%) + Vermicompost(3T/ha), T_9- Panchagavya(3%) + Poultry Manure(2T/ha), T_{10}- Panchagavya(3%) + Mustard Cake(2T/ha), T_{11}- Jeevamrut (3%), T_{12}- Jeevamrut (3%) +FYM(20T/ha), T_{13}- Jeevamrut (3%) +Vermicompost(3T/ha), T_{14}- Jeevamrut (3%) + Poultry Manure (2T/ha), T_{15}- Jeevamrut (3%) + Mustard Cake(2T/ha), T_{16}- Compost Tea (3%), T_{17}- Compost Tea (3%) + FYM(20T/ha), T_{18}- Compost Tea (3%) + Vermicompost(3T/ha), T_{19}- Compost Tea (3%)+Poultry Manure(2T/ha), T_{-20}- Compost Tea (3%) +Mustard Cake(2T/ha).

Seed sowing and Transplanting

Seeds of variety G-40 of knol-khol, developed by SKUAST-J were sown in raised nursery beds of about 2.0 meter long, 1.0 meter width and 15 cm above ground level on 15th September 2020. The seed beds were covered with local mulching material (Sarkanda) to faster seed germination. Seedlings were ready for transplanting after 30 days sowing. These healthy seedling of uniform shape and size were transplanted in well prepared experimental plots of size 2 m × 2 m on ridges at a spacing of 30cm x 25 cm accommodating 30 plants per plot. Standard cultural and management practices were adopted to raise a healthy knol-khol crop.

Spray schedule

The spraying of liquid manures like Panchagavya, Jeevamrut and compost tea was done at 3% formulation. First spray was done at the knob initiation stage (20 days after transplanting) and second spray was applied at knob maturity stage (30 days after transplanting). For seed production third spray of liquid manures was applied at the flowering stage (20 days after replanting) of the knobs.

Results and Discussion

Results depicted that during vegetative stage, two foliar applications of Compost tea in presence of FYM recorded significantly higher yield (282quintal per hectare) viz., leaf area index (8.31), knob weight with leaves (390 g per plant), days to 50 % marketable maturity (39.67 days), plant height (50.13 cm), knob diameter (8.38 cm) as compared to other treatments. This treatment was statistically at par with the treatments having Jeevamrut + FYM for knob diameter (8.12 cm) and 50 % marketable maturity (40 days). Hence, it can be concluded that Compost tea (3 percent concentration) in the presence of FYM (20 tonnes per hectare) was applied twice at 20 and 30 days after transplanting and FYM as basal dose, recorded significantly higher growth and yield parameters. The use of compost tea have been found to increase plant height, crop production and nutritional quality [28]. It contains live micro-organisms that may boost nutrient absorption and plant development. It is reported to increase micronutrients which include a variety of plant growth stimulants, enzymes, useful bacteria and mycorrhizae as a result it enhanced nutrient availability, improved soil physical characterstics and increased activity of micro-organisms with greater amount of organics may have aided in raising plant height, number of leaves, 50% marketable maturity and leaf area index [31]. Similar results were found in the findings of [11], [21], [22], [34], [24], [25], and [14],

At reproductive stage of the crop, Jeevamrut (3 percent) + FYM (20 tonnes per hectare) showed superiority among all the

treatments with respect to days to 50% flowering (91 days), number of siliqua per plant (945), siliqua weight per plant (75.67g per plant), seed weight per plant (50g) and seed yield (610kg per hectare). This treatment was found statistically at par with the treatment having Panchagavya + FYM for seed weight per plant (47.33 g per plant) and seed yield (606 kg per hectare) as compared to other combinations. Whereas for seed production purpose, application of Jeevamrut (3percent concentration) at 20, 30 days after transplanting and 20 days after replanting along with FYM (20 tonnes per hectare) as basal dose, resulted in maximum seed contributing parameters in knol-khol. The earliness in flowering might be due to the net assimilation rate on account of better growth leading to the production of endogenous metabolites earlier in optimum level enabling early flower production [35] and [39]. Jeevamrut is a rich source of carbon, nitrogen, phosphorus, potassium and many micronutrients [10] and [36].

The application of Jeevamrut leads to the better translocation of nutrients, photo assimilates and finally better plant development [40]. The similar findings were also reported in [20] in snake gourd. The significance increase in and yield attributes were due to adequate supply of nutrients at different growth stages[7]. This result are in accordance with the findings of [16] and [10].

Studies further revealed that organic amendments could not influence soil chemical properties like pH, EC, OC except available Nitrogen. This might be partially due to application of organic matter releasing nitrogen from mineralization and partially due to the positive interaction effect between organic bulk FYM and liquid manures Jeevamrut [8]. In the case of organic manures maximum available N in the soil was recorded in FYM which may be due to an increase in soil available nutrients due to its application which might also be attributed to greater multiplication of microbes. Jeevamrut contains bioinoculants and rich in N, P, K and micronutrients like Ca, Mn and Na content rich in nitrogen fixing bacteria and phosphate solubilizing bacteria .The presence of these microbes increase the fertility ratio of the soil [29] and [36]. The similar findings were also reported in [5], [33] and [6] In case of pest and disease incidence, no major incidence was observed during the entire crop cycle, however incidence of aphid population was 20 percent in the treatment having Jeevamrut + FYM and maximum in case of control with 38 percent were observed in all the treatments during bolting and seed setting stage.

This might be due to the presence of naturally occurring beneficial microorganisms predominately bacteria, yeast, actinomycetes, photosynthetic bacteria and certain fungi detected in cow dung which protect the crop from pathogens [38]. In accordance with [23] who reported that bacteria present in Jeevamrut acted as bio control agent. Similar findings were also reported by [7] and [35].

Conclusion

Among the treatments, Compost tea 3% concentration applied twice at 20 and 30 days after transplanting and application of FYM@ 20 t/ha as basal dose respectively, recorded significantly higher growth and yield parameters of knol-khol. For seed production purposes, the application of Jeevamrut @3% formulation at 20, 30 days after transplanting and 20 days after replanting along with FYM @ 20 t/ha as basal dose, resulted in maximum seed contributing parameters in knol-khol. Studies further revealed that organic amendments could not influence soil physio - chemical properties like pH, EC and OC except available N. In case of pest infestation, application of Jeevamrut @3% formulation in presence of FYM resulted in minimum aphid population as compared to control and other treatments. So far as potential diseases of knol-khol were concerned, no significant results were recorded.

Thus in this study, organic bulk and liquid manures play a major role in mitigating the harmful effect of chemicals on soil by improving soil fertility and also reducing the effect of chemicals on human health by reducing the residual effect of chemicals on leafy vegetables.

Acknowledgments

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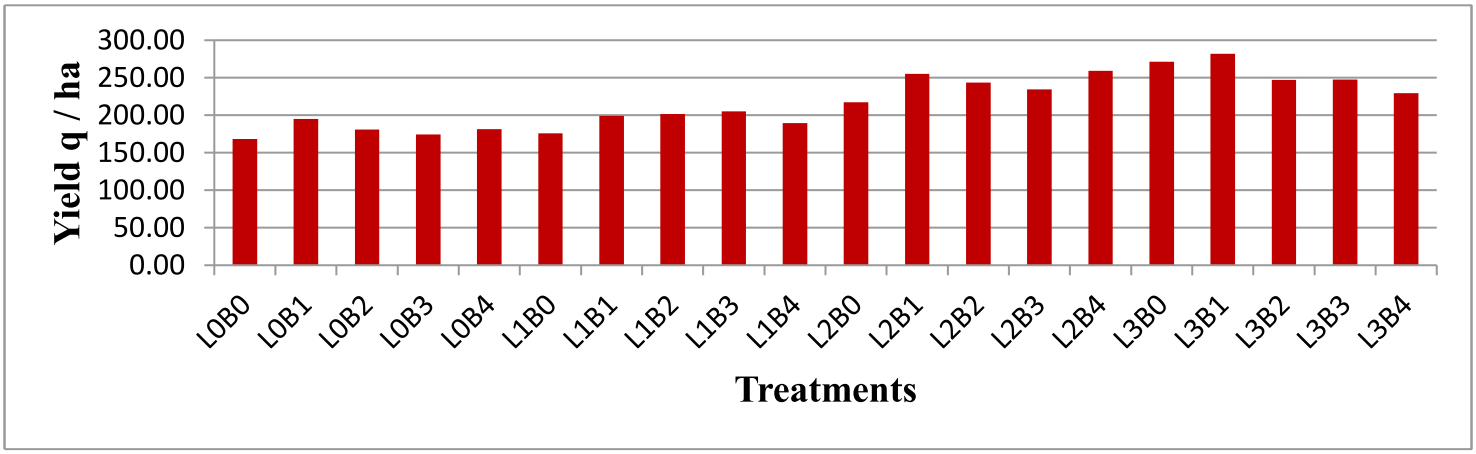

Fig. 1: Effect of various organic amendments on yield of knol khol

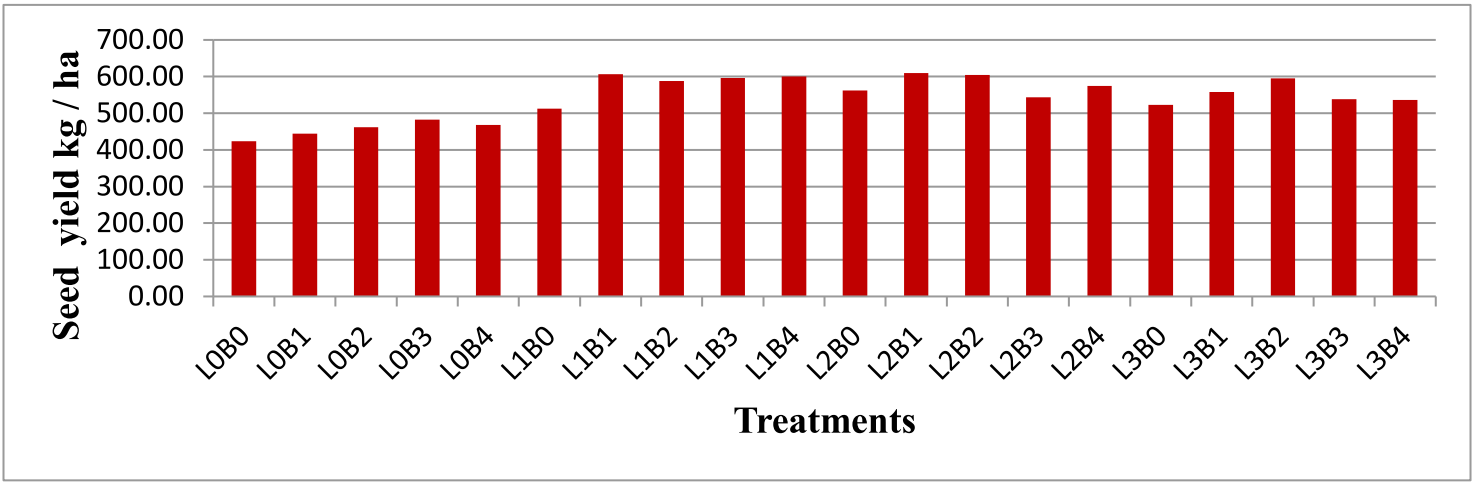

Fig. 2: Effect of various organic amendments on seed yield of knol khol

Table1: Effect of organic amendments on plant growth and yield parameters

Treatment No.	Treatment code	Plant height(cm)	Knob weight with leaves (g)	Knob diameter (cm)	Number of leaves per plant	Days to 50% marketable maturity	Leaf area index	Yield (q/ha)
T_1	L_0B_0	37.00	172.33	6.05	11.00	48.00	3.07	168.33
T_2	L_0B_1	46.13	186.33	6.67	13.60	44.02	5.58	195.00
T_3	L_0B_2	38	182.00	7.20	11.30	44.05	3.87	181.00
T_4	L_0B_3	37.47	181.00	6.48	13.20	43.10	4.23	174.60
T_5	L_0B_4	37.33	200.00	7.28	12.07	47.90	3.57	181.25
T_6	L_1B_0	37.67	222.33	7.57	11.67	46.00	3.48	175.80
T_7	L_1B_1	41.93	262.00	7.33	11.47	44.20	3.72	199.20
T_8	L_1B_2	41.13	266.00	8.03	12.33	43.00	3.89	201.60
T_9	L_1B_3	45.80	272.00	6.72	13.13	43.10	3.58	205.20
T_{10}	L_1B_4	47.80	291.00	7.47	12.20	40.34	6.29	189.60
T_{11}	L_2B_0	38.05	292.07	6.79	13.34	44.20	4.16	217.24
T_{12}	L_2B_1	49.33	384.00	8.12	14.97	40.00	7.18	255.00
T_{13}	L_2B_2	39.07	310.00	7.25	11.67	40.33	5.59	243.69
T_{14}	L_2B_3	43.80	311.00	6.24	12.47	44.67	4.73	234.60
T_{15}	L_2B_4	42.13	352.00	7.48	14.33	44.10	4.19	259.20
T_{16}	L_3B_0	44.13	372.27	6.78	11.10	40.67	7.03	271.36
T_{17}	L_3B_1	50.13	390.00	8.38	15.00	39.67	8.31	282.00
T_{18}	L_3B_2	41.67	332.00	6.83	11.73	46.67	5.07	247.20
T_{19}	L_3B_3	40.13	330.96	7.25	11.87	44.00	6.91	247.50
T_{20}	L_3B_4	42.00	302.00	7.22	13.00	43.20	5.13	229.20

		CD 0.05%	SEm±	CD 0.05%	SE±	CD 0.05%	SEm±	CD 0.05%	SEm±	CD 0.05%	SEm±	CD 0.05%	SEm±	CD 0.05%	SEm±
Factor	**B**	**1.87**	0.73	**1.16**	0.40	**0.31**	0.11	**0.37**	0.13	**1.32**	0.46	**0.10**	0.04	**6.86**	2.40
	L	**2.09**	0.65	**1.04**	0.36	**0.28**	0.10	**0.33**	0.12	**1.81**	0.41	**0.09**	0.03	**6.13**	2.14
Interaction	**B x L**	**4.18**	1.46	**2.32**	0.81	**0.63**	0.22	**0.74**	0.26	**2.63**	0.92	**0.21**	0.07	**13.72**	4.79

***Note – B denotes Bulk manures B0** = Control, **B1** = FYM, **B2** = Vermicompost, **B3** =Poultry Manure, **B4** = Mustard Cake*
***L denotes Liquid Manures - L0** = Control, **L1** = Panchagavya, **L2** = Jeevamrut, **L3 =** Compost Tea*

Table 2: Effect of organic amendments on seed parameters

Treatment No.	Treatment code	Days to 50% flowering (DAT)		Siliqua weight per plant (g)		Number of siliqua per plant		Seed weight per plant (g)		Seed yield (kg/ha)		Seed vigour index		Test weight (g)	
T_1	L_0B_0	105.00		48.00		702.00		30.17		423.33		400.00		3.52	
T_2	L_0B_1	104.00		50.17		710.00		31.00		444.67		442.13		3.88	
T_3	L_0B_2	103.33		51.00		711.67		31.33		462.00		483.00		3.68	
T_4	L_0B_3	102.67		53.67		724.67		32.67		482.67		505.21		3.90	
T_5	L_0B_4	103.00		53.33		723.33		33.33		468.00		526.17		3.98	
T_6	L_1B_0	101.67		54.00		730.67		33.67		512.00		426.19		4.22	
T_7	L_1B_1	93.33		72.00		928.00		47.33		606.00		562.12		3.82	
T_8	L_1B_2	98.00		64.67		889.67		39.67		588.00		509.13		3.62	
T_9	L_1B_3	97.00		67.00		906.67		42.00		596.33		477.25		3.76	
T_{10}	L_1B_4	96.00		67.33		912.00		42.67		600.00		517.23		3.56	
T_{11}	L_2B_0	98.67		60.00		810.00		36.00		562.00		537.20		4.42	
T_{12}	L_2B_1	91.00		75.67		945.00		50.00		610.00		590.17		4.29	
T_{13}	L_2B_2	95.67		68.00		914.00		44.00		604.00		565.27		4.28	
T_{14}	L_2B_3	99.33		56.00		787.00		34.67		543.67		540.17		3.68	
T_{15}	L_2B_4	98.33		62.00		830.67		39.67		574.00		463.00		4.31	
T_{16}	L_3B_0	101.00		54.33		742.00		34.00		523.00		501.67		4.04	
T_{17}	L_3B_1	99.00		59.67		809.00		35.00		557.67		492.00		4.03	
T_{18}	L_3B_2	98.00		65.00		889.67		40.00		594.67		529.25		4.07	
T_{19}	L_3B_3	99.67		59.67		755.33		34.20		538.00		578.67		4.28	
T_{20}	L_3B_4	100.33		55.00		753.67		34.33		536.67		574.00		3.57	
		CD 0.05%	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**
Factor	**B**	**1.30**	0.45	**1.45**	0.51	**4.20**	1.47	**1.84**	0.64	**2.65**	0.93	**0.68**	0.24		
	L	**1.61**	0.41	**1.29**	0.45	**3.76**	1.31	**1.64**	0.57	**2.37**	0.83	**0.61**	0.21	NS	NS
Interaction	**B x L**	**2.60**	0.91	**2.90**	1.01	**8.40**	2.93	**3.67**	1.28	**5.30**	1.85	**1.37**	0.48		

Note – B denotes Bulk manures B0 = Control, **B1** = FYM, **B2** = Vermicompost, **B3** =Poultry Manure, **B4** = Mustard Cake
L denotes Liquid Manures - L0 = Control, **L1** = Panchagavya, **L2** = Jeevamrut, **L3 =** Compost Tea

Table 3: Effect of organic amendments on soil parameters and disease and insect pest incidence

Treatment No.	Treatment code	pH	EC(dS/m)	OC (%)	Available Nitrogen (kg/ha)		Aphid population (%)		Diamond backmoth population (%)	Leaf spot incidence (%)	Downy mildew incidence (%)
T_1	L_0B_0	7.07	0.22	0.18	162.00		3.80		5.33	5.00	4.33
T_2	L_0B_1	7.18	0.23	0.62	165.33		3.00		4.90	3.57	2.67
T_3	L_0B_2	7.12	0.24	0.40	168.00		3.25		4.93	4.70	3.21
T_4	L_0B_3	7.17	0.26	0.44	176.00		3.50		3.30	4.70	3.10
T_5	L_0B_4	7.18	0.27	0.55	183.33		2.80		4.46	2.70	4.00
T_6	L_1B_0	7.37	0.22	0.29	184.00		2.60		3.22	2.10	2.33
T_7	L_1B_1	7.40	0.22	0.17	192.00		2.50		5.13	2.67	4.10
T_8	L_1B_2	7.25	0.24	0.21	195.67		3.60		4.25	3.40	4.15
T_9	L_1B_3	7.02	0.22	0.26	190.00		3.70		4.17	3.00	3.66
T_{10}	L_1B_4	7.32	0.24	0.31	191.33		2.50		3.22	3.17	3.67
T_{11}	L_2B_0	7.28	0.25	0.18	197.00		2.30		4.48	4.00	3.18
T_{12}	L_2B_1	7.42	0.29	0.65	214.67		2.00		1.67	1.30	1.00
T_{13}	L_2B_2	7.03	0.24	0.40	198.00		2.70		2.23	2.08	2.00
T_{14}	L_2B_3	7.20	0.26	0.44	193.00		3.00		2.40	3.50	4.10
T_{15}	L_2B_4	7.20	0.25	0.55	198.00		2.33		2.32	3.69	2.05
T_{16}	L_3B_0	7.32	0.25	0.19	203.00		3.30		4.67	3.97	3.33
T_{17}	L_3B_1	7.31	0.24	0.62	210.00		2.40		3.74	4.00	3.00
T_{18}	L_3B_2	7.28	0.26	0.50	211.00		2.90		3.46	4.81	4.00
T_{19}	L_3B_3	7.35	0.24	0.57	196.67		2.51		4.22	4.10	2.00
T_{20}	L_3B_4	7.10	0.28	0.18	184.67		2.45		3.00	4.17	4.00
		CD 0.05%	**CD 0.05%**	**CD 0.05%**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**SEm±**	**CD 0.05%**	**CD 0.05%**	**CD 0.05%**
Factor	**B**				**1.24**	0.43	**0.32**	0.10			
	L	NS	NS	NS	**1.11**	0.39	**0.27**	0.09	NS	NS	NS
Interaction	**B x L**				**2.47**	0.86	**0.61**	0.20			

Note – B denotes Bulk manures B0 = Control, **B1** = FYM, **B2** = Vermicompost, **B3** =Poultry Manure, **B4** = Mustard Cake
L denotes Liquid Manures - L0 = Control, **L1** = Panchagavya, **L2** = Jeevamrut, **L3 =** Compost Tea

Note - 0 = no disease incidence**, 1=**10-20%, **2** =21-30%, **3**=31- 40%, **4**=41-50%, **5**=51- 60%, **6**=61-70 %, **7**=71-80%, **8**=81-90%, **9**= 91-100 % total aerial part of the plant is infected

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