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Effect of different organic manures on growth and yield of Radish (*Raphanus sativus* L.)

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Abstract
An investigation was carried out during *rabi* season of 2017-18 at Horticulture farm, College of Agriculture, Sehore RVSKVV, Gwalior to study experiment "Effect of different organic manures on growth and yield of Radish (*Raphanus sativus* L.)" Experiment was carried out in randomized block design with three replications The experiment was comprised of eight treatments *viz*., T_1: V (Swathi) + FYM 20 t /ha, T_2: V (Swathi) + PM 2 t /ha, T_3: V (Swathi) VC 4 t /ha, T_4: V (Swathi) + PM + VC (1 t +4 t) ha^{-1}, T_5: V (Swathi) FYM + VC (10 t+2 t) ha^{-1}, T_6: V (Swathi) FYM + PM (10 t+1 t) ha-1, T_7:V (Swathi) FYM + VC + PM (6.66 t + 1.33 t + 6.66 t) ha^{-1}, T_8: V (Swathi) + FYM+ N+ P +K (20 t+100 kg.+50 kg+50 kg) ha^{-1}.
The maximum plant height, maximum number of leaves per plant, leaf area, leaf area index, root length, root diameter, root weight with top (g), root weight without tops, number of root cracking per plot, marketable root yield per plot, marketable root yield per hectare, total root yield per plot, total yield per hectare.
It is revealed from the study obtained that a significantly maximum marketable root yield of radish 70.28 t ha^{-1} was recorded in T_4 (PM 1 t + VC 4 t ha^{-1}) along with net return of Rs 52,659 ha^{-1} and cost benefit ratio 1:2.36 followed by T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) (65.03 t ha^{-1}, Rs. 42149 ha^{-1} and 1: 2.00 root yield, net return and cost benefit ratio, respectively).

Keywords: Radish, organic manure, poultry manure (PM), vermicompost (VC), FYM

Introduction
Radish (*Raphanus sativus* L.) is a root crop and belongs to the family Cruciferae or Brassicaceae having chromosome number 2n=2x=18. Radish is a cool season crop is widely acclaimed for its excellent nutritive and medicinal values. Among various factors responsible for low production of radish, nutrient management is of prime importance for maintaining higher yield and soil fertility. The increasing use of chemical fertilizers to increase vegetable production has been widely recognized but in long run it had detrimental effect on soil health, ecology, natural resources, living organisms including beneficial soil microorganism and human being. The escalating prices of chemical fertilizers and its detrimental impact on the soil, environment and human health urged the farmer to adopt organic manures and bio-fertilizers that offers the sustainable crop production and soil fertility. The application of organic manures such as FYM, vermicompost and poultry manure has a positive effect on crop production. Organic manures are extremely advantageous in enriching soil fertility and do not contain any chemicals which are harmful. Organic manures feed the soil and maintain sustainability in the agro-ecosystem. Growing of crops by the package of organic manures brings forth the organic farming which is in vogue today and organic farming could find a new market scope.

Materials and Methods
The investigation was carried out at research field, department of Horticulture, College of Agriculture, Sehore campus of RVSKVV, Gwalior during *rabi* season 2016-17. The experiment was comprised of eight treatments *viz*., T1: V1 (Swathi) FYM 20 t /ha, T2: V1 (Swathi) + PM 2 t /ha, T3: V1 (Swathi) VC 4 t /ha, T4: V1 (Swathi) + PM + VC (1 t +4 t) ha^{-1}, T5: V1 (Swathi) FYM + VC (10 t+2 t) ha-1, T6: V1 (Swathi) FYM + PM (10 t+1 t) ha^{-1}, T7: V1 (Swathi) FYM+ VC +PM (6.66 t+1.33 t+6.66 t) ha^{-1}, T8: V1 (Swathi) + FYM+ N+ P +K (20 t+100 kg.+50 kg+50 kg) ha^{-1}. Experiment was laid out in Randomized Completely Block Design with three replications.

Full dose of phosphorus, potash and ½ dose of nitrogen were applied respectively according to treatments. Full quantity of vermicompost, phosphorus and potash along with one third of nitrogen was applied as par treatment plot before transplanting the seedling. While, the rest of the nitrogen was applied in two equal splits doses at 25 and 50 days after transplanting. Well decomposed vermicompost was incorporated in soil thoroughly as per treatment as basal dose. Transplanting of healthy seedlings was done with spacing of 30 cm × 10 cm. All cultural operations were done as per recommendations. Observations were recorded from five random healthy plants of each treatment on growth, yield and its attributes. The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhtame (1984) [20].

Results and Discussion

Growth parameters

The data (Table 1 and Table 2) recorded for Growth parameters *viz*., plant height (cm), number of leaves, leaf area (cm^2), leaf area index at 15, 30, 45 DAT, at maturity and yield and yield parameter *viz*., root length, root diameter, root weight with top, root weight without tops, number of root cracking per plot, marketable root yield (kg/plot), marketable root yield per hectare, total yield per plot and total yield per hectare recorded at maturity stage.

Treatment T_4 (PM 1 t + VC 4 t ha^{-1}) which was at par with T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) produced significantly the highest plant height (11.14 cm to 38.37 cm), while the treatment T_2 attained lowest plant height at (8.75 to 31.96 cm). Increased plant height may be due to application of major and minor nutrients, through different organic manures in various levels, increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the plant height. The findings is also in agreement with the findings of Bhaktavathsalam and Geetha (2004) [7], Zhou-Dongmei *et al*. (2005) [30], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kumar *et al*. (2007) [18], Vijayakumari *et al*. (2009) [27], Kirad *et al*. (2010) [17], Uddain *et al*. (2010) [24], Yanthan *et al*. (2012) [29], Jeptoo *et al*. (2013) [14], Kumar *et al*. (2014) [19], Ali *et al*. (2014) [2], Imthiyas and Seran (2015) [10] and Eric Randy (2016) [9].

Treatment T_4 (PM 1 t + VC 4 t ha^{-1}) which was at par with T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) produced significantly the highest number of leaves per plant (6.11 to 15.95). Probable reasons for enhanced more number of leaves, may be due to effects of macro and micronutrients on vegetative growth which ultimately lead to more photosynthetic activities. The findings are in agreement with the result of Bhaktavathsalam and Geetha (2004) [7], Zhou-Dongmei *et al*. (2005) [30], Vijayakumari *et al*. (2009) [27], Kirad *et al*. (2010) [17], Kanaujia *et al*. (2010) [15], Uddain *et al*. (2010) [24], Yanthan *et al*. (2012) [29], Jeptoo *et al*. (2013) [14], Ali *et al*. (2014) [2] and Eric Randy (2016) [9] whereas treatment T_2 attained minimum leaves 4.13 to 13.37

Treatment T_4 (PM 1 t + VC 4 t ha^{-1}) which was at par with T8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) significantly maximum leaf area (467.52 cm^2 to 1243.13 cm^2), The whereas treatment T_2 attained leaf area at (257.77 cm^2 to 824.94 cm^2), Leaf area was significantly increased by macro and micronutrients, possibly because nitrogen helps in greater assimilation of food material by the plant which resulted in greater meristmatic activities of cells and consequently the number of leaves, length and width of leaves of plant. These findings are in agreement with the results reported by Asghar *et al*. (2006) [5], Imthiyas and Seran (2015) [10] and Verma and Pandey (2016) [26].

From the study it is clearly seen that the Treatment T_4 (PM 1 t + VC 4 t ha^{-1}) which was at par with T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) showed maximum leaf area index (1.62 to 4.18) while the treatment T_2 attained lowest leaf area index (0.91 to 2.76). This might be due to the higher uptake of nutrients especially iron and magnesium from the soil resulting in greater photosynthetic activity and humic acid contributed to the increased leaf area index.

Yield parameters

The Data (Table 3 and Table 4) related to Yield attributing characters *viz*, root length, root diameter, root weight with top (g), root weight without tops, number of root cracking per plot, marketable root yield per plot, marketable root yield per hectare, total root yield per plot, total yield per hectare varied significantly due to treatments.

Treatment T_4 [PM 1 t + VC 4 t ha^{-}] produced maximum root length (31.04 cm), root diameter (6.86 cm), root weight with top (306.93), root weight without top (254.66 g) minimum root cracking per plot (8.09), percentage of root cracking per plot (9.63 %), marketable root yield per plot (16.39 kg), marketable root yield per hectare (70.28 kg) total root yield per plot (19.85 kg), total root yield per hectare. Decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic manures might have contributed in increasing the root length and root diameter of the plants. The increase in root length and root diameter may be attributed to solubilization of plant nutrients by addition of poultry manures and vermicompost leading to increase uptake of NPK. Similar results have been reported by Ahmad *et al*. (2005) [1], Asghar *et al*. (2006) [5], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kumar *et al*. (2007) [18], Vijayakumari *et al*. (2009) [27], Kirad *et al*. (2010) [17], Kanaujia *et al*. (2010) [15], Uddain *et al*. (2010) [24], Jeptoo *et al*. (2013) [14], Eric Randy (2016) [9] and Verma and Pandey (2016) [26].

This could be due to the application of poultry manures and vermicompost increase the root weight with top and root weight without. Decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic manures might have contributed in increasing the root weight with top and root weight without of the plants. The increase in root weight with top and root weight without may be attributed to solubilization of plant nutrients by addition of poultry manures and vermicompost leading to increase uptake of NPK.

Finding corroborates with their results obtained by Bhaktavathsalam and Geetha (2004) [7], Ahmad *et al*. (2005) [1], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kanaujia *et al*. (2010) [15] and Uddain *et al*. (2010) [24].

Probable region for increased marketable root yield $plot^{-1}$ and $hectare^{-1}$ due to humus substances could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes. These findings are in agreement with the findings of Ahmad *et al*. (2005) [1], Anjaiah and Padmaja (2006) [3], Asghar *et al*. (2006) [5], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kumar *et al*. (2007) [18], Kirad *et al*. (2010) [17], Kanaujia *et al*. (2010) [15], Bodkhe and Mahorkar (2010) [8], Uddain *et al*. (2010) [24], Islam *et al*. (2011) [11], Jatav *et al*. (2011) [13], Karkleliene *et al*. (2012) [16], Yanthan *et al*. (2012) [29],

Vithwel Kanaujia (2013) [28], Jeptoo *et al*. (2013) [14], Ali *et al*. (2014) [2] and Eric Randy (2016) [9].

The higher yield might be due to increase in plant height, number of leaves, and yield attributes *viz*., length and diameter of root, fresh weight of root with top and root weight without top. This might be due to the availability of the nutrients in readily available form and the C: N was high over control. These findings are in agreement with the findings of Uddin *et al*. (2004) [25], Anjaiah *et al*. (2005) [4], Ahmad *et al*. (2005) [1], Anjaiah and Padmaja (2006) [3], Asghar *et al*. (2006) [5], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kumar *et al*. (2007) [18], Kirad *et al*. (2010) [17], Kanaujia *et al*. (2010) [15], Bodkhe and Mahorkar (2010) [8], Uddain *et al*. (2010) [24], Islam *et al*. (2011) [11], Jatav *et al*. (2011) [13], Karkleliene *et al*. (2012) [16], Yanthan *et al*. (2012) [29], Vithwel Kanaujia (2013) [28], Jeptoo *et al*. (2013) [14], Ali *et al*. (2014) [2] and Eric Randy (2016) [9].

Treatment T_5 produced minimum root length (24.80 cm), root diameter (5.15 cm), root weight with top (205.62 g), root weight without top (177.37 g) maximum root cracking per plot (9.28), percentage of root cracking per plot (11.05 %), marketable root yield per plot (10.33 kg), marketable root yield per hectare (40.98 t), total root yield per plot (11.84 kg), total root yield per hectare (46.98 t/ha).

Economics

Higher money value and less cost of cultivation are desirable traits for getting higher returns. Hence, economics of the treatments was work out. The data (Table 5) pertaining to economics of different treatments are depicted in Table 5. It is revealed from the data obtained that a significantly maximum marketable root yield of radish 70.28 t ha^{-1} was recorded in T_4 (PM 1 t + VC 4 t ha^{-1}) along with net return of Rs 52659 ha^{-1} and cost benefit ratio 1:2.36 followed by T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) (65.03 t ha^{-1}, Rs. 42149 ha^{-1} and 1: 2.00 root yield, net return and cost benefit ratio, respectively). While, minimum cost benefit ratio 1: 1.19 was obtained in the T_5 (FYM 10 t + VC 2 t ha^{-1}) due to higher expenditure on the treatment which calculated root yield 58.12 t ha^{-1} and net return Rs 41150 ha^{-1} as compared to other treatments. These finding corroborates with their results obtained by Uddin *et al*. (2004) [25], Anjaiah and Padmaja (2006) [3], Rani *et al*. (2006) [22], Sunandarani and Mallareddy (2007) [23], Kanaujia *et al*. (2010) [15], Yanthan *et al*. (2012) [29] and Eric Randy (2016) [9].

Table 1: Effect of different treatments of organic manures on plant height (cm) and number of leaves in radish at 15, 30, 45 days after sowing and at maturity

Treat. Symb.	Treatments	Plant height (cm) at				Number of leaves per plant			
		15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
T1	FYM 20 t ha^{-1}	9.86	17.13	26.26	35.16	5.01	7.20	11.52	14.27
T2	Poultry Manures (PM) 2 t ha^{-1}	8.75	15.90	23.67	31.96	4.13	6.75	10.27	13.37
T3	Vermicompost (VC) 4 t ha^{-1}	9.98	17.25	26.51	35.44	5.14	7.27	11.64	14.60
T4	PM 1 t + VC 4 t ha^{-1}	11.70	19.14	29.61	38.47	6.11	8.40	13.16	15.95
T5	FYM 10 t + VC 2 t ha^{-1}	10.57	17.93	27.13	36.75	5.48	7.49	12.09	15.26
T6	FYM 10 t + PM 1 t ha^{-1}	9.07	16.37	24.15	32.20	4.43	6.97	10.98	13.80
T7	FYM 6.66 t+VC 1.33 t+PM 6.66 t ha^{-1}	9.47	16.70	25.13	33.84	4.81	7.15	11.31	14.06
T8	FYM 20 t+N 100 kg + P 50 kg + K 50 kg ha-1	11.14	18.45	28.51	37.43	5.81	7.83	12.55	15.64
	S.Em ±	0.20	0.34	0.39	0.33	0.19	0.18	0.10	0.20
	C.D. at 5% level	0.63	1.05	1.21	1.02	0.58	0.54	0.32	0.62

FYM= Farm Yard Manure, PM = Poultry Manure, VC= Vermicompost,

Table 2: Effect of different treatments of organic manures on Leaf area plant^{-1} (cm^2) and Leaf area index at 15, 30, 45 DAS and at maturity

Treat. Symb.	Treatments	Leaf area plant^{-1} (cm^2) at				Leaf Area Index			
		15 DAS	30 DAS	45 DAS	Maturity	15 DAS	30 DAS	45 DAS	Maturity
T1	FYM 20 t ha^{-1}	357.72	518.35	810.17	1011.58	1.20	1.70	2.70	3.34
T2	Poultry Manures (PM) 2 t ha^{-1}	257.77	425.07	643.28	824.94	0.91	1.46	2.16	2.76
T3	Vermicompost (VC) 4 t ha^{-1}	373.56	524.29	842.78	1056.28	1.28	1.76	2.82	3.49
T4	PM 1 t + VC 4 t ha^{-1}	467.52	658.91	1048.85	1243.13	1.62	2.20	3.52	4.18
T5	FYM 10 t + VC 2 t ha^{-1}	407.94	559.88	915.94	1127.58	1.37	1.88	3.06	3.75
T6	FYM 10 t + PM 1 t ha^{-1}	285.63	456.88	711.33	909.24	1.00	1.56	2.38	3.06
T7	FYM 6.66 t+VC 1.33 t+PM 6.66 t ha^{-1}	327.74	492.98	785.96	960.71	1.14	1.65	2.63	3.23
T8	FYM 20 t+N 100 kg + P 50 kg +K 50 kg ha^{-1}	449.11	593.75	990.39	1198.12	1.57	2.02	3.29	4.03
	S.Em ±	6.19	5.16	6.23	5.17	0.02	0.02	0.02	0.04
	C.D. at 5% level	18.80	15.65	18.89	15.69	0.08	0.07	0.08	0.14

FYM= Farm Yard Manure, PM = Poultry Manure, VC= Vermicompost,

Table 3: Effect of different treatments of organic manures on yield parameter of radish

Treat. Symb.	Treatments	Root Length (cm)	Root diameter (cm)	Root weight with top (g)	Root weight without top (g)	No. of root cracking plot^{-1}	Percentage of root cracking plot^{-1}
T1	FYM 20 t ha^{-1}	27.10	6.22	238.33	204.10	8.88	10.61
T2	Poultry Manures (PM) 2 t ha^{-1}	24.80	5.15	205.62	177.37	9.28	11.05
T3	Vermicompost (VC) 4 t ha^{-1}	27.67	6.31	247.62	212.85	8.83	10.53
T4	PM 1 t + VC 4 t ha^{-1}	31.04	6.86	306.93	254.66	8.09	9.63
T5	FYM 10 t + VC 2 t ha^{-1}	29.20	6.45	271.32	227.21	8.70	10.39
T6	FYM 10 t + PM 1 t ha^{-1}	25.93	5.69	215.20	186.65	9.08	10.85
T7	FYM 6.66 t+VC 1.33 t+PM 6.66 t ha^{-1}	26.67	6.10	230.70	195.30	8.95	10.66
T8	FYM 20 t+N 100 kg + P 50 kg +K 50	29.83	6.80	289.16	233.77	8.21	9.79

	kg ha^{-1}						
	S.Em±	0.21	0.04	5.76	6.71	0.05	0.03
	C.D. at 5% level	0.66	0.14	17.49	20.37	0.16	0.10

FYM= Farm Yard Manure, PM = Poultry Manure, VC= Vermicompost,

Table 4: Effect of different treatments of organic manures on number and percentage of root cracking plot-1 as well as yield of Radish

Treat. Symb.	Treatments	No. of root cracking plot^{-1}	Percentage of root cracking plot^{-1}	Marketable root yield plot^{-1} (kg)	Marketable root yield hectare^{-1} (t)	Total root yield plot^{-1} (kg)	Total root yield hectare^{-1} (t)
T1	FYM 20 t ha^{-1}	8.88	10.61	12.93	51.30	14.68	58.25
T2	Poultry Manures (PM) 2 t ha^{-1}	9.28	11.05	10.33	40.98	11.84	46.98
T3	Vermicompost (VC) 4 t ha^{-1}	8.83	10.53	13.36	53.00	15.12	59.99
T4	PM 1 t + VC 4 t ha^{-1}	8.09	9.63	17.71	70.28	19.85	78.76
T5	FYM 10 t + VC 2 t ha^{-1}	8.70	10.39	14.65	58.12	16.78	66.59
T6	FYM 10 t + PM 1 t ha^{-1}	9.08	10.85	11.27	44.72	12.87	51.07
T7	FYM 6.66 t+VC 1.33 t+PM 6.66 t ha^{-1}	8.95	10.66	12.11	48.04	13.84	54.92
T8	FYM 20 t+N 100 kg + P 50 kg +K 50 kg ha^{-1}	8.21	9.79	16.39	65.03	18.27	72.50
	S.Em±	0.05	0.03	0.08	1.02	0.13	0.87
	C.D. at 5% level	0.16	0.10	0.25	3.11	0.40	2.64

FYM= Farm Yard Manure, PM = Poultry Manure, VC= Vermicompost,

Table 5: Economics of different treatments of organic manures of radish

Treat. Symb.	Treatments	Root yield (t ha^{-1})	Gross income (Rs ha^{-1})*	Expenditure (Rs ha^{-1})	Net income (Rs ha^{-1})	C:B ratio
T1	FYM 20 t ha^{-1}	51.30	66690	38150	28540	1: 1.33
T2	Poultry Manures (PM) 2 t ha^{-1}	40.98	53274	31350	21924	1: 1.42
T3	Vermicompost (VC) 4 t ha^{-1}	53.00	68900	44150	24750	1: 1.78
T4	PM 1 t + VC 4 t ha^{-1}	70.28	91364	38705	52659	1: 2.36
T5	FYM 10 t + VC 2 t ha^{-1}	58.12	75556	41150	34406	1: 1.19
T6	FYM 10 t + PM 1 t ha^{-1}	44.72	58136	34750	23386	1: 1.48
T7	FYM 6.66 t+VC 1.33 t+PM 6.66 t ha^{-1}	48.04	62452	35691	26761	1: 1.98
T8	FYM 20 t+N 100 kg + P 50 kg +K 50 kg ha^{-1}	65.03	84539	42705	42149	1:2.00

FYM= Farm Yard Manure, PM = Poultry Manure, VC= Vermicompost, t= Tonnes

Conclusion

From Present study it can be concluded that significantly maximum marketable root yield of radish 70.28 t ha^{-1} was recorded by application of (PM 1 t + VC 4 t ha^{-1}). Treatment T4 (PM 1 t + VC 4 t ha^{-1}) recorded highest net return of Rs 52,659 ha^{-1} and cost benefit ratio 1:2.36 followed by T_8 (FYM 20 t + N 100 kg + P 50 kg + K 50 kg ha^{-1}) (65.03 t ha^{-1}, Rs. 42149 ha^{-1} and 1: 2.00 root yield, net return and cost benefit ratio, respectively).

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