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Impact of integrated nutrient management on tuberous root of radish (*Raphanus sativas* L.) in Sandy Regosol

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Abstract

The present study was conducted to assess the influence of integrated nutrient management on tuberous root of radish (Raphanus sativas L.) in sandy regosol. This trial was designed in a Randomized Complete Block Design (RCBD) having seven treatments replicated four times. The treatments were recommended inorganic fertilizers (T1), 10t/ha cow dung as a basal with ½ dose of top dressing (T2), 8t/ha cow dung +2 t/ha compost as a basal +½ dose of top dressing (T3), 6t/ha cow dung +4 t/ha compost as a basal +½ dose of top dressing (T4), 4t/ha cow dung + 6 t/ha compost as a basal +½ dose of top dressing (T5), 2t/ha cow dung + 8 t/ha compost as a basal +½ dose of top dressing (T6), 10t/ha compost as a basal +½ dose of top dressing (T7). This study revealed that tuberous root diameter were significantly (P<0.01) varied at 7th week after planting. However, there were no significant change (P>0.05) in tuberous root length, fresh weights of plant and tuberous root and number of cracked roots per plot at 7th week after planting. Total yield and total marketable yield per plot showed significant difference (P<0.05) at 7th week after planting and it was high in T5 and no significant variation between T5 and T1. Further, pH and total soluble solid were same in al tested treatments. This study conclude that application of 4t/ha cow dung with 6 t/ha compost as a basal and ½ dose of recommended fertilizer as a top dressing (T5) would be more suitable for tuberous root of radish in sandy regosol.

Keywords: Compost, cowdung, nutrient management, radish, yield.

Introduction

The radish (*Raphanus sativus* L.) is an edible root plant of the family Brassicaceae which is one of the most common root crops in the tropical and temperate regions. Radish is a common choice for home garden, as they are easy to grow, quickly maturing crop within two months and providing income within two months. Radish is used in the treatment of several diseases due to its nutritional composition. Tuberous roots contain a tonic and laxative effect upon the intestines, stimulate the appetite and digestion and indirectly stimulating the movement of bile. Radish growth and yield depends on soil nutrient conditions. Soils improved with nitrogen, phosphorus and potassium through the addition of organic and inorganic fertilizers influence the growth and harvest of the crop. But due to an increase in demand of the vegetables, it is very common that excessive doses of inorganic fertilizers are applied to vegetable fields to accomplish maximum production[1]. This has dramatic effect on the enhancement of production and productivity.

Excessive inorganic fertilizers deteriorate environmental, ecological sustainability and affect the human health. Most inorganic fertilizers are water soluble and can wash away and runoff shortly after they are applied. Inorganic fertilizers that leach into the soil below the root systems reach ground water and chronic kidney diseases may cause.

Due to, the high economic and ecological costs associated with the practice of inorganic fertilizers make them unattractive to those conscious of ecological sustainability. Therefore substitution of chemical fertilizers by the organic manures or reduced inorganic fertilizers usage is very important for sustainability of agriculture production and maintain of soil fertility. Application of organic manures provides nutrients which enhance soil water holding capacity and enhance the nutrients in the soil. Cow dung accepted as the most desirable manures due to its high nutrient content[2]. Application of compost is an effective method for the get economically profitable yield while uplifting soil fertility. However, availability of quantity of animal excreta and crop residuals cannot meet country requirements. Also direct application of organic manure is bulky and taking longer time to decompose in the soil. Therefore maximizing the usage of organic manures with chemical fertilizers in the form of integrated approach appears to be the best alternative.

The integrated nutrient management system approach utilizes a judicious combination of inorganic fertilizer and organic wastes in building soil fertility and to the increase the production potential of crop[3]. Integrated use of organic and inorganic fertilizers is useful in improving production, organic carbon and available nutrients in sandy loam soil[4]. Combine use of organic and inorganic fertilizers can increase crop yield and maintain soil fertility[5]. Using organic fertilizers help to lowering the

amounts of chemical fertilizers added to the environment and improve crop production under sandy soil conditions[5].

Methodology

The field study was conducted at the crop farm, EUSL to study the impact of integrated plant nutrient management on tuberous root of radish (*Raphanus sativas* L.) in sandy regosol. For this study, radish variety *Beeralu* was used. The study was carried out in Randomized Complete Block Design (RCBD) having seven treatments and four replicates. Treatments were recommended inorganic fertilizer as a basal + full dose of recommend top dressing (T1), 10t/ha cow dung as a basal +½ dose of recommended fertilizer as a top dressing (T2), 8t/ha cow dung as a basal +2t/ha compost +½ dose of recommended fertilizer as a top dressing (T3), 6t/ha cow dung as a basal +4 t/ha compost +½ dose of recommended fertilizer as a top dressing (T4), 4t/ha cow dung as a basal +6t/ha compost +½ dose of recommended fertilizer as a top dressing (T5), 2t/ha cow dung as a basal +8 t/ha compost +½ dose of recommended fertilizer as a top dressing (T6) and 10t/ha compost as a basal + ½ dose of recommended fertilizer as a top dressing (T7). Parameters such as tuberous root length and diameter, fresh weights of plant and fresh and dry weights of tuberous root, numbers of cracked roots (kg/plot), total yield per plot (kg/plot) and marketable yield (tons/ha) were recorded. Further, to test the quality of radish tubers, pH and Total Soluble Solids (TSS) were recorded. Recorded data were studied using statistical soft wares.

Results and discussion

Tuberous root length: Root yield is associated with root length of radish. There was significant variation ($P<0.01$) in tuberous root length at 2nd week after planting. Highest tuberous root length was recorded in T2 (10.30cm) at 2nd weeks after planting followed by T3 (8.25cm) and T7 (8.25cm). However no significant change ($P>0.05$) was noted in tuberous root length at 4th, 6th and 7th week after planting. It is agreeable with[7] noted that no variation in root length of radish among the various level of EM bokashi. Highest root length of radish was observed where compost was applied in incorporation of 75% recommended nitrogen fertilizer[8] is disagreeable with this present study. This is in accordance with Suthamathy and Seran[8] who stated that no significant difference was noted in tuber length of radish among the different level of manure EM bokashi.

Tuberous root diameter: Root diameter plays vital part in root growth and function[9]. Root diameter is an important to explain root physiological function and thicker roots showed larger cortical thickness and more cortical cell layers than thinner roots[10]. There was no substantial change ($P>0.05$) in root diameter at 4th week after planting is shown in Table-2. However, significant difference was obtained ($P<0.01$) at 2nd, 6th and 7th week after planting. Root diameter varies from 3.87cm (T1) to 2.89cm (T3) and 4.92cm (T2) to 3.81cm (T1) at 6th and 7th weeks after planting respectively. Root diameter was increased when increase the compost from 4t/ha to 8t/ha in 6th week after planting. However statistically similar diameters were recorded after increase compost amount further up from 4 t/ha to 10t/ha at 6th and 7th weeks after planting. Cow dung at the rate of 10t/ha and compost at the rate of 10t/ha offered similar root diameters at 6th week after planting. Cow dung at the highest rate (10t/ha) gave the highest root diameter (4.92 cm) at 7th weeks after planting. However, there was no substantial differences ($P>0.05$) between T2 and T4, T5 and T6.

Fresh weight of plant: Fresh weight of plant is shown in Table-3. There was significant differences ($P<0.05$) at 2nd, 4th and 6th week after planting. Highest seedling fresh weight was recorded in T1 (24.38g) followed by T5 (19.73g) at 4th week after planting and no significant differences ($P>0.05$) between T1 and T5. At 6th week after planting, highest weight was noted in T5 (194.34g) while minimum weight was observed in T3 (145.49 g). However, T5 is not significantly differed with other tested treatments except T3 at 6th week after planting. There was no significant differences ($P>0.05$) in total fresh weight at 7th week after planting suggest that similar fresh weight of plant compared to recommended inorganic fertilizer was not affected by tested treatments. Contrast finding was stated by Suge J.K. et al[11] that there was a high interaction ($P<0.001$) between the rate of inorganic fertilizers and the organic manures on fresh weight of eggplant and the farm yard manure gave higher fresh weight.

Table-1: Tuberous root length (cm) of radish at different weeks.

Treatments	2nd week after planting	4th week after planting	6th week after planting	7th week after planting
T_1	2.70± 0.07f	15.59± 1.17	22.44± 1.7	21.73± 1.72
T_2	10.30± 0.07a	12.83± 1.60	22.38± 1.60	22.79± 1.38
T_3	8.25± 0.04b	11.75± 0.68	21.07± 1.40	25.23± 2.00
T_4	7.80± 0.21c	11.56± 0.78	20.84± 2.10	20.70± 1.41
T_5	6.60± 0.42d	14.16± 1.00	24.58± 1.55	21.38± 1.19
T_6	5.70± 0.14e	11.83± 0.71	22.02± 0.82	23.78± 0.89
T_7	8.25± 0.11b	12.70± 2.65	22.60± 0.69	23.50± 1.95
F test	**	ns	ns	ns

Value represent mean ∓ standard error of four replicates. F test: -**: $P<0.01$; ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Table-2: Tuberous root diameter (cm) of radish at different weeks.

Treatments	2 weeks after planting	4 weeks after planting	6 weeks after planting	7 weeks after planting
T1	0.25± 0.004d	0.99± 0.07	3.87± 0.08a	3.81± 0.07c
T2	0.29± 0.004b	0.94± 0.22	3.37± 0.23ab	4.92± 0.23a
T3	0.09± 0.007g	0.68± 0.04	2.89± 0.10b	4.23± 0.21bc
T4	0.26± 0.004c	2.08± 1.29	3.52± 0.21a	4.52± 0.21ab
T5	0.34± 0.004a	1.08± 0.10	3.63± 0.15a	4.43± 0.13ab
T6	0.15± 0.011f	0.62± 0.03	3.59± 0.24a	4.69± 0.08ab
T7	0.17± 0.007e	0.70± 0.12	3.30± 0.18ab	4.35± 0.16bc
F test	**	ns	*	**

Value represent mean ∓ standard error of four replicates. F test: -**: P<0.01; *: P<0.05; ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Table-3: Total fresh weight of radish at different weeks.

Treatments	2nd week after planting	4th week after planting	6th week after planting	7th week after planting
T_1	1.21± 0.004d	24.38± 4.05a	188.60± 22.48ab	203.50± 18.52
T_2	1.51± 0.021b	16.64± 3.55abc	177.62± 18.40ab	259.40± 26.42
T_3	0.85± 0.021g	8.98± 2.81c	145.49± 17.00b	213.26± 24.26
T_4	1.49± 0.018c	15.19± 2.52bc	177.90± 27.22ab	224.88± 18.61
T_5	1.63± 0.011a	19.73± 1.86ab	194.34± 21.68a	256.62± 22.34
T_6	1.20± 0.053e	8.87± 2.61c	190.48± 23.27ab	286.25± 15.07
T_7	0.93± 0.060f	8.36± 2.13c	163.32± 17.40ab	258.66± 23.40
F test	**	**	*	ns

Value represent mean ∓ standard error of four replicates. F test: -**: P<0.01; *: P<0.05; ns: not significant Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Fresh weight of tuberous root: Tuberous root is most vital one for food storage of crops with a highly efficient mechanism for reserving energy in form of food[12]. Fresh weight of root per plant was significantly affected by organic level[13]. The root weight was recorded and has been presented in Table-4. The data presented in Table-4, showed that, there was no significant differences (P>0.05) in fresh weight of root at 2nd and 7th week after planting. However, there were significant differences observed at 4th and 6th week after planting. Highest mean value was recorded in T1 (163.63g) at 6th week after planting, while no significant difference (P>0.05) was noted between T1 and other tested treatments except T3. Integration of organic manures into paddy soil distinctly enhanced root morphological features of rice. The root weight density for organic fertilization treatments improved, as compared with the sole chemical fertilization[14].

Table-4: Fresh weight of radish tuberous root at different weeks.

Treatments	2nd weeks after planting	4th weeks after planting	6th weeks after planting	7th weeks after planting
T1	0.03± 0.004	5.52± 1.97a	163.63± 16.43a	187.60± 14.32
T2	0.08± 0.004	3.44± 1.55abc	125.69± 12.05ab	210.53± 22.32
T3	0.04± 0.007	1.04± 0.15c	94.87± 10.62b	166.51± 16.72
T4	0.08± 0.004	2.13± 0.54bc	125.88± 29.06ab	171.26± 17.58
T5	0.08± 0.007	4.42± 0.75ab	142.66± 9.06ab	226.64± 29.26
T6	0.08± 0.007	0.84± 0.11c	138.00± 17.75ab	219.70± 14.94
T7	0.63± 0.40	1.71± 0.72bc	117.70± 11.49ab	198.95± 15.20
F test	ns	*	*	Ns

Value represent mean ∓ standard error of four replicates. F test: - *: P<0.05; ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Dry weight of root: There was significant variation (P<0.05) among root dry weight of radish at 2nd ,4th and 7th weeks after planting (Table-5) while there is no variation in dry weight of toot at 4th week after planting. At 7th week after planting T6 (14.86 g) gave higher dry weight followed by T5 (14.00 g).

Number of cracked roots per plot: Number of cracked roots per plot at 6th and 7th week after planting is shown in Table-6. Combination of organic manures and inorganic fertilizer which have not been significantly affected the cracked roots at 6th and 7th weeks after planting is confirmed with *P* value 0.122 and chi square value of 4.20.

Table-5: Dry weight of radish tuberous root at different week.

Treatments	2 weeks after planting	4 weeks after planting	6 weeks after planting	7 weeks after planting
T1	0.009± 0.002ab	2.60± 1.42a	8.22± 1.15	9.98± 0.82b
T2	0.015± 0.003a	0.46± 0.19b	6.66± 1.25	13.94± 2.39ab
T3	0.008± 0.001ab	0.10± 0.02b	6.35± 0.47	11.26± 1.11ab
T4	0.011± 0.001ab	0.18± 0.05b	8.29± 1.88	11.67± 0.77ab
T5	0.090± 0.004ab	1.15± 0.33ab	7.25± 0.46	14.00± 1.50ab
T6	0.007± 0.002b	0.10± 0.02b	8.27± 0.91	14.86± 0.47a
T7	0.008± 0.002ab	0.17± 0.07b	7.32± 0.76	13.95± 1.73ab
F test	*	*	ns	*

Value represent mean ∓ standard error of four replicates. F test: -*: P<0.05; ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Table-6: Total number of cracked roots.

Treatments	6^{th} week after planting	7^{th} week after planting
T_1	3	3
T_2	1	1
T_3	1	1
T_4	1	1
T_5	1	1
T_6	1	1
T_7	2	2
P value	0.122	0.122
Chi- square	4.20	4.20

Yield of radish tuberous root: There was no significant variation (P>0.05) on radish yield at 6^{th} week after planting by different treatments is shown in Table-7. At 7^{th} week after planting radish yield per plot (kg) was high in T5, followed by T6. Average yield per plot ranged from 7.90 kg (T3) to 10.74 kg (T5). There was no significant differences (P>0.05) at 6^{th} week after planting. At 7^{th} week after planting there was a significant difference (P<0.05) in marketable root yield was noted. Average yield root yield per plot ranged from 7.69(kg) to 10.39 (kg). Highest marketable yield was recorded in T5 (10.39) followed by T6 (10.21).

Table-7: Yield of radish tuberous root.

Treatments	Total yield per plot (Kg)		Total marketable root yield per plot (Kg)	
	6^{th} week after planting	7^{th} week after planting	6^{th} week after planting	7^{th} week after planting
T1	7.76± 0.65	9.43± 0.65ab	7.11± 0.25	9.23± 0.12ab
T2	6.96± 0.54	9.98± 0.72ab	6.75± 0.32	9.75± 0.16ab
T3	6.50± 1.0	7.90± 0.69b	6.35± 0.24	7.69± 0.14b
T4	6.97± 0.89	8.12± 0.75ab	6.77± 0.11	7.99± 0.23ab
T5	6.77± 0.78	10.74± 0.78a	6.56± 0.16	10.39± 0.16a
T6	6.54± 0.69	10.42± 0.81a	6.32± 0.18	10.21± 0.18a
T7	6.58± 0.78	8.47± 0.79ab	6.23± 0.19	8.32± 0.15ab
F test	Ns	*	ns	*

Value represent mean ∓ standard error of four replicates. F test: - *: P<0.05; ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

pH and Total soluble solids of radish root: There was no significant differences (P>0.05) in quality parameters of pH, TSS is shown in Table-8.

Table-8: pH and TSS values in radish roots of different treatment.

Treatment	pH	TSS (^{0}Brix)
T1	6.44±0.001	4.0±0.037
T2	6.57±0.011	4.9±0.003
T3	6.37±0.012	3.9±0.076
T4	6.27±0.001	3.9±0.013
T5	6.39±0.024	4.3±0.068
T6	6.37±0.018	3.9±0.085
T7	6.45±0.069	3.4±0.025
F value	Ns	ns

Value represent mean ∓ standard error of four replicates. F test: - ns: not significant. Means followed by the same letter in each column are not significantly different according to the Duncan's Multiple Range Test at 5% level.

Conclusion

The study revealed that tuberous root diameter were significantly ($P<0.01$) varied at 7th week after planting. Highest root diameter was observed in T2 (4.92cm). However, there were no substantial variation ($P>0.05$) in tuberous root length, fresh weights of plant and tuberous root, number of cracked roots per plot at 7th week after planting. Total yield and total marketable yield per plot showed significant difference ($P<0.05$) at 7th week after planting and it was high in T5. Reduce the use of inorganic fertilizer without affecting the productivity as well as maintain good quality soil is vital for sustainable agriculture. This study conclude that application of 4t/ha cow dung with 6 t/ha compost as a basal and ½ dose of recommended fertilizer as a top dressing (T5) would be more suitable for sandy regosol.

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