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Nutrient uptake pattern of radish under various sources of organic amendments: An pot experiment

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Abstract
The highest N uptake by radish shoot was 6.84 g pot^{-1} by the application of 100% RDF + FYM@ 25t ha^{-1} (T_5). The highest phosphorus uptake of 1.82 g pot^{-1} by shoot was observed in T_5 treatment due to the application of 100% RDF + FYM@ 25t ha^{-1}. Application of organic sources and industrial by – products on the uptake of potassium by radish root was found to be significant. The highest uptake of potassium 4.91 g pot^{-1} was recorded in T_5 treatment which received 100% RDF + FYM@ 25t ha^{-1}. Similarly, the highest N uptake by radish shoot was 6.84 g pot^{-1} by the application off 100% RDF + FYM@ 25t ha^{-1} (T_5). The highest phosphorus uptake of 1.82 g pot^{-1} by shoot was observed in T_5 treatment due to the application of 100% RDF + FYM@ 25t ha^{-1}. The maximum potassium uptake by shoot was 3.99 g pot^{-1} due to application of 100% RDF + FYM @ 25t ha^{-1} (T_5) treatment.

Keywords: Radish, nitrogen, phosphorus, potassium, recommended dose of fertilizer (RDF)

Introduction
Radish (*Raphanus sativus* L.) is one of the important root vegetables cultivated in India, mainly for its tender roots which are used as salad or cooked vegetable. Being a short duration crop it has the ability to fit well into multiple cropping under intensive agriculture production system. Radish recorded a production of 2093.28 metric tones in our country (Agri exchange 2015) [1].

Choice of soil management practices to improve or maintain soil fertility is utmost importance in increasing productivity of vegetable crops. The application of composts and organic amendments influence soil organic matter and nutrients cycling and increase soil nutrients levels.

Organic matter plays an important role in the improvement of soil physical properties such as the promotion of soil aggregation, improved permeability and moisture holding capacity, the most valued part in organic matter, well decomposed FYM or compost is humus as a chemically identifiable and stable product, outcome of microbial metabolites, laboratory studies have shown that low molecular weight substance from humus are also taken by the plants (Schnitzer and Khan, 1972) [11]

Review of Literature
Organic sources are traditionally important inputs for maintaining soil fertility and ensuring yield stability. These organic sources supply macronutrients and improve the physical and chemical properties of soil. There is a need for utilizing manures / wastes for supplementing the chemical fertilizer. Application of municipal solid waste compost with recommended N fertilizer increased N uptake in maize (Richard Wolkowski, 2003) [10]. The highest uptake of and straw yield were observed with application of 5 t ha^{-1} municipal solid waste compost in combination with 25 per cent N through inorganic fertilizer (Kavitha and Subramani, 2007) [6]. Youssef Ouni *et al.* (2014) [19] suggested that overall root and shoot dry weights increased with the municipal solid waste compost additions for Hordeum sp. The uptake of showed a broad optimum in the plants amended with 100 t ha^{-1} of municipal solid waste compost. They also revealed that application of municipal solid waste compost @ 100 t ha^{-1} used as saline soil amendment, improved plant biomass production and enhanced mineral contents. Panwar and Munda (2007) [7] noticed that nitrogen, phosphorus and potassium uptake by groundnut in the treatment received FYM@ 10 t ha^{-1} + 75 per cent recommended dose of inorganic fertilizer was significantly higher than that of 100 per cent recommended dose of inorganic fertilizer.

Chikkaramappa *et al.* (2011) [3] revealed that significant increase in N, P, K, Ca, Mg and S content and uptake of groundnut haulm and kernel in FYM 5 t ha^{-1} + 100% recommended dose of NPK + *Azospirillum* treated plots. Pathak *et al.* (2007) [8] stated that NPK @ 30:60:60 kg ha^{-1} gave the highest uptake values of NPK in groundnut during the first year and FYM (6.0 t ha^{-1}) during the second year. Sharma and Sharma (2011) [12] reported that application of 50: 22: 25 kg of NPK along with FYM @ 15 t ha^{-1} to crop registered higher NPK uptake of 172.4, 15.7, 159.5 kg ha^{-1} respectively was found in potato – radish rotation. Ramesh *et al.* (2013) [9] observed that application of FYM @ 5 t ha^{-1} recorded significantly the highest uptake of N (65.1 kg ha^{-1}), P (10.63 kg ha^{-1}) and K (33.2 kg ha^{-1}) compared to NPK alone (50.2, 7.73 and 22.8 kg NPK ha^{-1}) respectively in castor. Babbu Singh Brar *et al.* (2015) [2] revealed that maximum uptake for N (186.5 kg ha^{-1}) P (23.5 kg ha^{-1}) and K (119.3 kg ha^{-1}) in maize and N (150.8 kg ha^{-1}) P (18.5 kg ha^{-1}) and K (92.4 kg ha^{-1}) in wheat crops were recorded.

Materials and Methods

The pot experiment was conducted with different organic resources application on radish crop and the uptake of individual nutrients (Nitrogen, Phosphorus and Potassium) by the root and shoot was calculated by multiplying the nutrient content of root and shoot by their dry weight and expressed in g pot^{-1} and the details of N, P and K analysis were given in Table 1.

Table 1: Method of analysis of soil sample

S. No.	Parameter	Methodology	References
Chemical analysis			
1	Available nitrogen ($KMnO_4$ - N)	Alkaline permanganate method	Subbiah and Asija (1956)
2	Available phosphorus (Olsen's - P)	Ascorbic acid modification of the molybdate blue method	Watanabe and Olsen (1965)
3	Available potassium (NH_4OAc-K)	Flame photometry (Neutral 1N NH_4OAc extract)	Stanford and English (1949)

Results

Nitrogen uptake by radish root

The nitrogen uptake by the radish root increased due to application of various organic sources and industrial by – products are presented in Table 2.

The effect of application of organic sources on nitrogen uptake by radish roots were found to be significant. The highest nitrogen uptake of 2.28g pot^{-1} was recorded in (T_5) treatment which received 100% RDF + FYM@ 25t ha^{-1}. This was followed by the application of 100% RDF + FYM@ 12.5t ha^{-1} (T_4) treatments which recorded nitrogen uptake of 2.10g pot^{-1}. The treatments T_3 and T_2 resulted in 1.88 and 1.52g pot^{-1}. The treatments T_7, T_9, T_8 and T_6 resulted in 1.25, 1.18, 1.17 and 1.17g pot^{-1} of N uptake by root on by par with each other. The lowest root uptake of 1.18g pot^{-1} was recorded in (T_1) control treatment.

Phosphorus uptake by radish root

The phosphorus uptake by radish roots improved due to the application of various organic sources and industrial by – products are presented in Table 2.

The effect of application organic sources on phosphorus uptake by radish root were found to be significant. The highest phosphorus root uptake of 1.86 g pot^{-1} was observed in (T_5) treatment due to the application of 100% RDF + FYM @ 25t ha^{-1}. This was followed by treatments T_4 and T_3 were on par with each other registered 1.52, 1.23g pot^{-1}. The treatments T_2, T_7, T_9, T_8 and T_6 were on par with each other registered 1.23, 1.00, 0.97, 0.96 and 0.96g pot^{-1} respectively. The lowest phosphorus uptake of 0.95g pot^{-1} was recorded in (T_1) control treatment.

Potassium uptake by radish root

The uptake of potassium by radish root was highest due to application of various organic sources and industrial by – products are presented in Table 2.

Application of organic sources and industrial by – products on the uptake of potassium by radish root was found to be significant. The highest uptake of potassium 4.91g pot^{-1} was recorded in T_5 treatment which received 100% RDF + FYM@ 25t ha^{-1}. This was followed by 100% RDF + FYM@ 12.5t ha^{-1} (T_4) recorded 4.5g pot^{-1}. The treatments T_3, T_9 and T_8 recorded 3.85, 2.76 and 2.74g pot^{-1} respectively were on par with each other. The treatments T_2, T_7 and T_6 recorded 2.48, 2.39 and 2.26g pot^{-1} were on par with each other. The lowest potassium uptake of 2.69g pot^{-1} was recorded in T_1 control treatment.

Table 2: Effect of organic sources and industrial by – products on NPK uptake by radish root.

Treatment	N	P	K
	Uptake root (g pot^{-1})		
T_1 – control – 100% RDF	1.18	0.95	2.69
T_2 – 100% RDF + Municipal solid waste compost @ 5 t ha^{-1}	1.52	1.23	2.48
T_3 – 100% RDF + Municipal solid waste compost @ 10 t ha^{-1}	1.88	1.52	3.55
T_4 – 100% RDF + Farm yard manure @ 12.5 t ha^{-1}	2.10	1.68	4.5
T_5 – 100% RDF + Farm yard manure @ 25 t ha^{-1}	2.28	1.86	4.91
T_6 – 100% RDF + Rice Husk Ash @ 5 t ha^{-1}	1.17	0.96	2.26
T_7 – 100% RDF + Rice Husk Ash @ 10 t ha^{-1}	1.25	1.00	2.39
T_8 – 100% RDF + Bagasse Ash @ 5 t ha^{-1}	1.17	0.96	2.74
T_9 – 100% RDF + Bagasse Ash @ 10 t ha^{-1}	1.18	0.97	2.76
Mean	1.52	1.24	3.10
S.Ed	0.20	0.16	0.42
CD (p=0.05)	0.43	0.35	0.88

Nitrogen uptake by radish shoot

The nitrogen uptake of radish shoot increased due to organic sources and industrial by – products are presented in Table 3.

The highest N uptake by radish shoot was 6.84g pot^{-1} by the application of 100% RDF + FYM@ 25t ha^{-1} (T_5). This was on par with the treatments T_4, T_3, and T_2 recorded 6.12, 6.20, 5.86 g pot^{-1} respectively. The treatments T_7, T_6, T_9 and T_8 recorded 5.21, 5.17, 4.89, 4.78g pot^{-1} recorded were on par with each other. The lowest nitrogen shoot uptake of 3.87g pot^{-1} was recorded in control treatments (T_1).

Phosphorus uptake by radish shoot

The phosphorus uptake by radish shoots increased due to application of various organic sources and industrial by – products are presented in Table 3.

The effect of application of organic sources and industrial by – products on phosphorus uptake by shoot was found to be significant. The highest phosphorus uptake of 1.82g pot^{-1} by shoot was observed in T_5 treatment due to the application of 100% RDF + FYM@ 25t ha^{-1}. This was followed by the treatments T_4, T_3 and T_2 were on par with each other registered 1.62, 1.63 and 1.53g pot^{-1} the treatments T_7, T_6, T_9 and T_8 recorded 1.31, 1.30, 1.28 and 1.22 g pot^{-1} were on par with each other. The lowest phosphorus shoot uptake of 0.95g pot^{-1} by shoot was recorded in T_1 control treatment.

Potassium uptake by radish shoot

The potassium uptake by radish shoots improved due to application of various organic sources and industrial by – products treatments are presented in Table 3.

Table 3: Effect of organic sources and industrial by – products on NPK uptake by radish shoot.

Treatment	N	P	K
	Uptake in shoot (g pot^{-1})		
T_1 – control – 100% RDF	3.87	0.95	2.23
T_2 – 100% RDF + Municipal solid waste compost @ 5 t ha^{-1}	5.86	1.53	3.39
T_3 – 100% RDF + Municipal solid waste compost @ 10 t ha^{-1}	6.20	1.63	3.61
T_4 – 100% RDF + Farm yard manure @ 12.5 t ha^{-1}	6.12	1.62	3.61
T_5 – 100% RDF + Farm yard manure @ 25 t ha^{-1}	6.84	1.82	3.99
T_6 – 100% RDF + Rice Husk Ash @ 5 t ha^{-1}	5.17	1.30	3.06
T_7 – 100% RDF + Rice Husk Ash @ 10 t ha^{-1}	5.21	1.31	3.07
T_8 – 100% RDF + Bagasse Ash @ 5 t ha^{-1}	4.78	1.22	2.86
T_9 – 100% RDF + Bagasse Ash @ 10 t ha^{-1}	4.89	1.28	2.92
Mean	5.44	1.41	3.12
S.Ed	0.71	0.18	0.36
CD (p=0.05)	1.50	0.38	0.77

The effect of application of organic sources and industrial by - products on potassium uptake by shoot was found to be significant. The maximum potassium uptake by shoot was 3.99g pot^{-1} due to application of 100% RDF + FYM @ 25t ha^{-1}(T_5) treatment. This was followed by treatments T_4, T_3 and T_2 registered 3.61, 3.61 and 3.39g pot^{-1} respectively which were on par with each other. The treatments T_7, T_6, T_9 and T_8 registered K uptake 3.07, 3.06, 2.92 and 2.86g pot^{-1} which were on par with each other. The lowest K uptake of 2.23g pot^{-1} was recorded in (T_1) control treatment.

Discussion

NPK uptake by radish crop

Nitrogen uptake

The highest nitrogen root uptake (2.28g pot^{-1}) and shoot uptake (6.84g pot^{-1}) was observed in T_5 (100% RDF + FYM @ 25t ha^{-1}). Increase in N uptake might be due to additional amount of nutrients supplied by organic sources improving physical and chemical properties of soil. This may be due to significant of the soil available nitrogen due to FYM resulting in higher accumulation of nitrogen in soil, besides additional supply of nitrogen through FYM. The application of FYM improved physico – chemical properties of soil along with increased mineralization of nitrogen which resulted in more nitrogen uptake. Similar were reported by Sharma and Singh 1991 [14]; Sharma and Raina (1994) [13].

Phosphorus uptake

The uptake of phosphorus was maximum in treatment T_5 100% RDF + FYM @ 25t ha^{-1} with root uptake of 1.86g pot^{-1} and shoot uptake of 1.82g pot^{-1}.

Further phosphorus status of soil increased due to lower utilization of phosphorus by crop from the applied sources. FYM additions resulted in the important of physiological and biological properties of the soil and reduced the activities of phosphorus complexing agents to make more phosphorus available to the crop which ultimately increase its uptake. Such results have also observed by Jaggi *et al*. (1995) [5].

Potassium uptake

The uptake of potassium was maximum in treatment T_9 100% RDF + Bagasse ash @ 10t ha^{-1} with root uptake of (2.76g pot^{-1}) and shoot uptake of (3.12g pot^{-1}). This could be ascribed to the accumulation of dry matter content in the plant in above treatment. This particular treatment could have increased the exchangeable and water soluble potassium. In Bagasse ash application along with 100% RDF, the K content of the shoot biomass was significantly greater than that of the other amendments. Similar observations were reported by Valerio Pita *et al*. (2012) [17].

Conclusion

The combined application of 100% RDF + FYM@ 25t ha^{-1}(T_5) registered the highest total N and P uptake by shoot and root in radish. The application of 100% RDF + Bagasse ash @ 10t ha^{-1}(T_9) recorded the highest total K uptake of shoot and root in radish. The combined application of 100% RDF + FYM @ 25t ha^{-1} (T_5) with inorganic fertilizer increased the organic carbon, available nitrogen and phosphorus content in soil. Application of 100% RDF with Bagasse ash @ 10t ha^{-1} (T_9) resulted in the highest potassium content in soil.

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