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EFFECT OF SUPPLEMENTATION OF NUTRIENTS FROM INORGANIC SOURCE, WITH BIOFERTILIZERS ON GROWTH, YIELD OF TURMERIC

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ABSTRACT

The experiment was carried out at HRS, Mondouri , BCKV, Nadia, West Bengal during 2012-2014. The experiment was laid out in RBD with three replications. Two manures (compost and vermicompost), two biofertilizers (*Azospirillum lipoferum* and *Glomus fasiculatum*) and three levels (100%, 75% and 50%) of inorganic NP were included in this experiment along with recommended dose of NPK (150:60:150 kg/ha). Compost/ vermicompost was applied with three levels of inorganic NP with or without nitrogenous and phosphatic biofertilizers. There are altogether 13 treatments including recommended NPK (inorganic). The uniform dose of potash was applied to all treatments. Among different treatments, maximum tiller number (3.40), leaf number (18.49), clump weight (378.38 g), weight of secondary finger (148.80 g), plot yield (13.94 kg/3 m^2) and projected yield (34.85 t/ha) were noticed in vermicompost + NP (75%) + *Azospirillum* + AMF. Application of compost + NP (100%) + *Azospirillum* + AMF recorded maximum plant height (171.52 cm). The best treatment was vermicompost + NP (75%) + *Azospirillum* + AMF. Application of recommended dose of inorganic NPK recorded yield of 27.63 t/ha which clearly indicates there is a chance of reduction of inorganic nitrogen and phosphorus by 25%.

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INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the ancient and sacred spices of India. The demand of turmeric is increasing due to its wide utility as spice; dye in textile industries, cosmetics and also by the drug industries particularly for the preparation of anti-cancer medicines (Shah, 1997). Consistent and indiscriminate use of chemical fertilizers has caused serious damage to the soil and ecology. Moreover, presently there is an increasing consciousness among people regarding health, hygine and environmental pollution. In the present day agriculture, supplementary and complementary role of organics is being increasingly felt for sustainable productivity and keeping the soil health in order (Modgal and Singh, 1990). Turmeric is a nutrient exhausting crop and responds well to organic manures and fertilizers (Mohan *et al*., 2004). To maintain long term soil health and productivity there is a need for integrated nutrient management through manures and bio fertilizers apart from costly chemical fertilizers for better yield of the crop(Mondal *et al*., 2003) However information on the use of organic manures and microbial inoculants on yield and quality is meagre. Hence the present investigation was designed with the objective to supplement the use of ever increasing costly chemical fertilizers with the incorporation of bio fertilizers that could ensure eco friendly environment and economically sustainable cropping.

MATERIALS AND METHODS

The experiment was carried out at Horticultural Research station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during last week of May, 2012 to January, 2014. The soil at the experimental plot was sandy clay loam with pH 6.8 and 0.58% organic carbon. Available N, P and K in soil were 223.45kg/ha, 18.07 kg/ha and 194.49 kg/ha respectively. The experiment was laid out in RBD with three replications. Raised beds of 3.0 × 1.0 m and 15 cm high were prepared.

The organic inputs namely compost and vermicompost were applied basally during final land preparation @ 20.0 t and 5.0 t per hectare respectively. Among biofertilizers, arbuscular mycorrhizal fungi (*Glomus fasiculatum*) was applied @ 65 kg/ha directly to the soil along with compost / vermicompost. *Azospirillum lipoferum* was incorporated through seed treatment @ 5g/kg seed. The biofertilizers along with *Tricoderma viridae* @ 5 g/kg seed rhizome and Acacia gum (1 tablespoon) as sticker were taken in water in a plastic tray and mixed thoroughly. Healthy seed rhizome (30-35 g) were soaked in biofertilizer mixtures and stirred thoroughly 4-5 times. Recommended dose of inorganic fertilizers was 150:60:150 kg NPK per hectare. The total amount of fertilizers was applied in three split doses. 1/3rd of N and full dose of P was applied after 15 days of planting whereas each split of 1/3rd N and ½ K will be applied 45 and 90 days after planting. Urea, SSP and MOP were used as inorganic source of N, P and K respectively.

Treated rhizomes of turmeric were planted to a depth of 3-4 cm, in the last week of April. The beds were mulched with paddy straw at the rate of 10 t/ha immediately after planting and 5t/ha at 45 and 90 days after planting. Earthing up was done before second and third mulching. Three to four hand weedings were done.

Irrigation was given as per requirement.

The crop was harvested 8 months after planting, observations on different growth (at 180 days after planting) and yield attributing parameters were recorded from five randomly selected plants per replication. Rhizome yield was taken on net plot basis at harvest and projected yield was calculated on the basis of yield per plot, considering the 75% area occupied by the crop (Anon., 1995).

RESULTS AND DISCUSSION

Experimental results presented in Table 1 revealed number of interesting features on growth and yield of turmeric with various treatment combinations. At 180 DAP, application of compost + NP (75%) + *Azospirillum* + AMF recorded maximum plant height (171.52 cm) followed by vermicompost +NP (100%) + *Azospirillum* + AMF (169.63 cm) and compost + NP (75%) [168.44 cm] as compared to minimum plant height (150.63 cm) under NPK (100%) inorganic only. The favourable effects of organic manures were noticed through comparing the plant height as compared to NPK (100%) only. Irrespective of kind of organics, the efficacy of *Azospirillum* + AMF was also observed particularly at NP (100%) and NP (75%) levels.

At 180 DAP, the plants given with treatment combination vermicompost + NP (75%) + *Azospirillum* + AMF recorded maximum tiller (3.42) followed by compost + NP (100%) + *Azospirillum* + AMF (3.23) and vermicompost + NP (100%) + *Azospirillum* + AMF (2.87) as compared to minimum tiller (1.94) under vermicompost + NP (75%).Application of vermicompost + NP (75%) + *Azospirillum* + AMF again occupied the first position for production of highest number of leaves (18.49) followed by vermicompost + NP (100%) + *Azospirillum* + AMF (17.57) and compost NP (75%) + *Azospirillum* + AMF (17.40) as compared to lowest leaf number (15.62) in recommended NPK (inorganic).

The treatment combination of vermicompost + NP (75%) + *Azospirillum* + AMF was found superior for production of highest clump weight of 378.38 g . The next best treatment in this aspect was compost + NP (100%) + *Azospirillum* + AMF (345.20 g) followed by vermicompost + NP (100%) + *Azospirillum* + AMF (358.71 g). The lowest clump weight of 242.35g was noticed with compost + NP (50%) . The clump weight under recommended NPK (inorganic) was 296.52 g.

Application of compost + NP (75%) + *Azospirillum* + AMF was found best with respect of maximum weight of primary finger (173.64 g) followed by vermicompost + NP (75%) + *Azospirillum* + AMF (165.15 g) and compost + NP (100%) *Azospirillum* + AMF (161.21 g), as compared to the lowest weight (98.04 g) under compost + NP (50%). The weight of primary finger under recommended NPK (inorganic) was only 130.26 g.

Plants raised under combination of vermicompost + NP (75%) + *Azospirillum* + AMF recorded maximum weight of secondary finger (148.80 g) followed by vermicompost + NP (100%) [136.16 g). The treatment combination vermicompost + NP (50%) + *Azospirillum* + AMF recorded lowest weight of secondary finger (83.94 g). The weight of secondary finger under recommended NPK (inorganic) was 112.46 g .

Different combinations of nutrient resources had significant influence on fresh yield per plot (kg/3.0 m^2). The combination vermicompost + NP (75%) + *Azospirillum* + AMF recorded the maximum plot yield (13.94 kg). The next best treatment in this aspect was compost + NP (75%) + *Azospirillum* + AMF (13.47 kg) followed by vermicompost + NP (100%) + *Azospirillum* + AMF (13.08 kg). The lowest yield was recorded with compost + NP (50%) (8.68 kg). The plants grown under NPK (inorganic) recorded yield of 11.05 kg.

The highest projected yield was recorded with vermicompost + NP (75%) + *Azospirillum* + AMF (34.85 t/ha) followed by compost + NP (75%) + *Azospirillum* + AMF (33.68 t/ha) and vermicompost + NP (100%) + *Azospirillum* + AMF (32.71 t/ha). The lowest yield (21.70 t/ha) was observed in treatment combination compost + NP (50%).

Application of recommended dose of inorganic NPK (100%) only recorded yield of 27.63 t/ha which is higher than the

Table 1: Effect of manures, nitrogenous and phosphatic biofertilizers on turmeric(Pooled data of two years)

Treatments	Plant height (cm)	No.of tillers per clump	No. of leaves	Weight of clump (g)	Weight of primary finger (g)	Weight of secondary finger (g)	Yield per plot (kg/3.0m^2)	Projected yield (t/ha)
Compost + NP 100% + *Azospirillum* + AMF	165.84	3.23	16.98	345.20	161.21	128.52	12.33	30.82
Compost + NP 75% + *Azospirillum* + AMF	171.52	2.75	17.40	368.76	173.64	132.33	13.47	33.68
Compost + NP 50% + *Azospirillum* + AMF	160.32	2.46	16.93	264.23	113.55	103.62	9.34	23.35
VC + NP 100% + *Azospirillum* + AMF	169.63	2.87	17.57	358.71	158.76	134.05	13.08	32.71
VC + NP 75% + *Azospirillum* + AMF	166.53	3.42	18.49	378.38	165.15	148.80	13.94	34.85
VC + NP 50% + *Azospirilllum* + AMF	164.16	2.48	17.13	276.91	131.53	83.94	10.54	26.35
Compost + NP 100%	160.44	2.60	16.40	317.38	135.65	119.73	11.37	28.43
Compost + NP 75%	168.44	2.76	16.03	273.90	119.75	93.18	10.26	25.66
Compost + NP 50%	163.83	2.28	15.92	242.35	98.04	85.32	8.68	21.70
VC + NP 100%	166.51	2.36	16.68	324.82	140.25	136.16	11.75	29.38
VC + NP 75%	157.58	1.94	16.75	292.63	128.91	102.78	10.96	27.41
VC + NP 50%	155.55	2.15	15.68	248.65	98.53	93.65	9.13	22.83
Recommended NPK (Inorganic)	150.63	2.42	15.62	296.52	130.26	112.46	11.05	27.63
S.Em. (±)	2.145	0.119	0.135	5.218	3.472	3.846	0.477	0.945
C.D.(P=0.05)	6.096	0.339	0.383	14.834	9.870	10.934	1.355	2.685

AMF = Arbuscular mycorrhizal fungi, VC = Vermicompost

treatment combination of compost/vermicompost at 75% (NP) and 50% (NP) levels and compost/vermicompost + *Azospirillum* + AMF at NP (50%) but lower than compost/ vermicompost + *Azospirillum* + AMF at NP (100%)/ NP (75%) level which clearly indicates the favourable effect of compost/ vermicompost and bio-inoculants over recommended dose of inorganic fertilizer and also there is a chance of reduction of inorganic nitrogen and phosphorus by 25%. Better uptake by the plants might be the reason for the highest rhizome yield in this treatment (Shamrao *et al*., 2013). Kale *et al*. (1992) observed that vermicompost application enhanced the activity of beneficial microbes like N-fixers and colonization by mycorrhizal fungi and hence play a significantly role in N_2 fixation and phosphate mobilization leading to better uptake by the plant. Thus the increased availability of nutrients and uptake by the plants would have resulted in better growth and yield in plots treated with vermicompost.

The improvement in growth and yield due to application of bio-inoculants incombination of organic manure has been reported by Mohan *et al*. (2004) and Sreekala and Jayachandran (2006) in turmeric and ginger respectively. Bio fertilizers have now emerged as a promising component of nutrient supply. The role of bio fertilizers like *Azospirillum* and VAM in enhancing the availability of nitrogen and phosphorus has been well established by several workers (Reddy *et al*., 2003 and Mohan *et al*., 2004). The microorganism can build up organic matter of the soil which can increase the availability of other nutrients (Parthasarathy *et al.,* 2007) and synthesis of growth promoting substances like IAA and GA_3 (Jeon *et al.,* 2007). The application of 100% recommended dose of fertilizer alone adversely affects the soil health, it is not advisable to use synthetic fertilizers in higher quantities. The supplementation of inorganic with organics also reported in onion (Naik *et al*., 2014), garlic (Damse *et al*., 2014) and carrot (Patil *et al*., 2016). The combined usage of manures, bio-inoculants with inorganic fertilizers not only help to improve the yield of turmeric but also help in improving the soil health .

The most effective treatment combination is compost + NP (75%) + *Azospirillum* + AMF followed by vermicompost + NP (75%) + *Azospirillum* + AMF for turmeric production under new alluvial plains of West Bengal. The results also clearly indicate the chance of reduction of 25% nitrogenous and phosphatic fertilizer. The favourable effect of biofertilizers over recommended dose of NPK was observed.

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