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INTEGRATED EFFECT OF ORGANIC MANURE COMBINED WITH DIFFERENT BIOFERTILIZERS ON GROWTH, YIELD AND YIELD ATTRIBUTES OF TURMERIC (CURCUMA LONGA .L) CV. ROMA UNDER RAIN FED UP LANDS OF VISAKHAPATNAM DISTRICT

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ABSTRACT

A three years study was conducted during the year 2012-2013, 2013-2014 and 2014-2015 to find out the integrated effect of organic manure combined with different biofertilizers on turmeric (*Curcuma longa .L*) cv. Roma with reference to growth, rhizome yield and yield attributes in rain fed up lands of Visakhapatnam district. The combined application of compost along with Azospirillum +VAM recorded the maximum values for plant height 134.24 cm, number of tillers 4.24, number of leaves 8.26, leaf area 425.34M^2 , leaf area index 0.413, fresh weight of haulm 240.98g and dry weight of haulm 19.62g, where minimum values (124.52 cm, 1.81,5.42,275.62 m^2, 156.43g and 13.56g) were observed with control. Similarly, the same treatment expressed in terms of number of mother rhizomes per plant (1.64), number of primary rhizomes (5.62), secondary rhizomes (16.54), length of mother rhizome (5.36 cm), primary rhizome (10.57 cm) and secondary rhizomes (4.12 cm). Higher girth of mother rhizome (4.96 cm), weight of rhizomes (220.37 g) was excelled by the same treatment combinations. The treatment compost + azospirillum + VAM recorded highest fresh yield 24.91t/ha,cured rhizome yield 5.06 t/ha and curing percent 20.32 respectively. The study revealed that, combination of organic manure with biofertilizers shown better results yield and yield attributes of rainfed turmeric.

INTRODUCTION

Turmeric (*Curcuma longa* .L) an herbaceous, perennial belonging to the family zingiberaceae grows with tufted leaves. India is the largest, monopoly producer and traditional exporter of turmeric in the world. It is a sacred, auspicious, dual purpose spice for Asian countries valued for its food adjunct property and also a source of safe natural colouring agent required by pharmaceutical, confectionary and cosmetic industry. Andhra Pradesh, Tamil Nadu, Odisha, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra and Assam are important states cultivating turmeric. Andhra Pradesh alone occupies 35.0% of area and 47.0% of production. (Naresh Babu *et al.,* 2015).Organic manures and biofertilizers offer an alternative to chemical inputs and are being increasingly used in spice crop production including turmeric (Srinivasan *et al*. 2000). Organic farming assumes significant globally towards sustainable production and quality upgradation of turmeric (Sadaanadan, 1998). Application of biofertilizers along with the compost increase the yield of turmeric (Roy and Hore, 2011). There is great demand for the organically grown produce in Western countries. There is a scope to increase productivity by using biofertilizers where turmeric is cultivating organically (Jayanthi and Videka, 2015). Bio fertilizers have come to be known as low cost inputs in agriculture which gives high returns under favourable conditions and so far a limited work has been standardized for organic farming practice more especially in spice like turmeric and ginger (Neeraja Rana and Borla, 2010). Therefore, by keeping view in above facts the study was aimed in improving the growth, yield, curing percentage and quality of turmeric by application of compost along with different biofertilizers.

MATERIALS AND METHODS

The field experiment was conducted during the year 2012-2013, 2013-2014 and 2014-2015 to study the integrated effect of organic manure combined with different biofertilizers on growth, yield and yield attributes of turmeric CV. Roma in Araku vally of Visakhapatnam district, Andhra Pradesh. Soil analysis was done following of standard methods in BCT-KVK soil laboratory. The experiment was laid out in a Randomized Block Design (RBD) with three replications having seven treatments. Compost 5t/ha, and liquid bio fertilizers (2.5 litre/ha) are diluted in water (1 litre of biofertilizer mixed in 4 litres of water) and sprinkled on100 kg of compost, mixed well and kept for one week under shade for incubation (Himachal Motghare and Rashmi Gauraha, 2013). After that the fertilizer incorporated into the field during seed bed preparation five days before sowing of turmeric. All other agricultural practices were done as for recommendations. The crop was harvested after complete maturity, as indicated by the leaf drying and falling down of plants. To evaluate vegetative growth parameters like plant height, no. of tillers, no. of leaves, leaf

area, leaf area index, fresh weight of haulm and dry weight of haulm, and yield parameters like no. of mother rhizomes, primary and secondary rhizomes per plant, length of mother and primary rhizome, girth of mother rhizome, weight of the rhizomes per plant, fresh weight of rhizomes(t/ha), cured rhizomes weight (t/ha) and curing percentage were recorded on five randomly selected plants in each of the treatment and mean was computed. Curing percentage was computed by deducting dry weight of rhizomes after curing from fresh weight of rhizomes and divided by fresh weight then multiplied by percentage. The data was analyzed using computer software programmed by the method of variance outlined by Panse and Sukhatme (1978). Statistical significance was tested by F value at 5 per cent level of significance.

RESULTS AND DISCUSSION

Vegetative growth of turmeric significantly influenced with all types of biofertilizers combination with organic manure as presented in Table 3. The treatment compost with azospirillum + VAM (T2) recorded the maximum plant height (134.24 cm) compared to that of other treatments. The treatment compost with azatobacter +VAM (T6) recorded plant height is 132.62 cm which is on par with compost with azatobactor + phospho bacteria(T5) (132.22 cm), fallowed by compost with azospirillum (T1) (128.60 cm), compost with azatobacter (T3) (122.8 cm) and comost with PSB (T4)(126.44 cm). Minmum plant height was recorded with control (124.52 cm). Similar results were found by Singh (2011), while investigating effect of organic, inorganic and biofertilizers on turmeric cv. Rajendra Sonia and Kamal and Yousuf (2012), while investigating on effect of organic manures on growth and yield of turmeric. Higher values of growth parameters like plant height, no. of branches were found with application of biofertilizers in chilli(Jadhav *et al.*,2014) Application of bio fertilizers with recomanded dose of NPK increased the plant height and pod yield in okra (Kirty Choudhary *et al.,* 2015). In case of number of tillers per plant, high tillering was found in T2 (4.24) fallowed by T6(3.82) and T5 (3.67). The treatment T1 recorded number of tillers per plant is 3.63 which is on par with T5 (3.67) and also T4 (3.46) on par with T3 (3.42) for the same parameter. The results are inconformity with findings of Padmapriya and chenzhiyan (2009) and Kamal and Yousuf (2012) while investigating the effect of organic manures and biofertilizers on turmeric. Maximum number of leaves per plant (8.26), leaf area (425.34 cm^2) and leaf area index (0.413) was found with compost with azospirillum +VAM (T2) fallowed by compost+ azotobacter + VAM (T6; 7.72, 392.5 cm^2, 0.381), compost + azatobacter+ PSB (T5; 7.12, 362.07 cm^2, 0.381), compost + azospirillum (T1; 16.86, 348.5 cm^2,0.339), compost + PSB (T4; 6.72, 341.73 cm^2, 0.332), T3 (6.12, 311.22 cm^2, 0.302), recorded respectively. The treatment T7 (control) recorded minimum values for number of leaves (5.42), leaf area (275.62 cm^2) and leaf area index (0.268). These results are in good agreement with the findings of several researchers which revealed that organic manures application combined with biofertilizers increased the vegetative growth and biomass production effectively (Roy and Hore., 2011; Singh 2010; Dinesh *et al.,* 2010; Mohapatra & Das, 2009). The treatment compost with azospirillum + VAM recorded highest values for fresh weight of haulm (240.98 g) and dry weight of haulm (19.62 g) when compared to other treatments. Fallowed by, compost+ azotobacter + VAM (T6; 232.16 g, 18.54 g), compost + azotobacter + PSB (T5; 212.82g, 17.86 g), compost + azospirillum (T1:188.36 g, 15.89 g), compost+ azotobacter (T4; 184.42 g, 15.32 g) and compost + PSB (T3;

Table 1: Analytical data of experiment soil

Soil type	pH	EC (dsm^{-1})	N (Kg/ha)	P (Kg/ha)	K(Kg/ha)	O.C(%)
Red sandy loams	6.45	0.42	294.32	11.26	189.26	0.75

Table 2: Composition of Biofertilizer.

S.no.	Biofertilizer	Species	Source
1	Azospirillum	*Azospirillum brasilens*	ANGRAU Amaravathi
2	Azotobacter	*Azotobacter chroococcum*	ANGRAU Amaravathi
3	Phosphate Solubilizing Bacteria (PSB)	*Bacillus coagulans*	ANGRAU Amaravathi
4	Vesicular Arbuscular Mycorrhiza (VAM)	*Glomus fesciculatum*	ANGRAU Amaravathi

Table 3: Three years compiled data of combined effect of organic manures and biofertilizers on growth parameters of turmeric Cv. Roma .

Treatments	Plant height (cm)	No. of Tillers	No. of leaves	Leaf area (m^2)	Leaf area Index	Fresh weight of haulm (g/plant)	Dry weight of haulm (g/plant)
T1:Compost + Azospirillum	128.60	3.63	6.86	348.85	0.339	188.36	15.89
T2:Compost + Azospirillum +VAM	134.24	4.24	8.26	425.34	0.413	240.98	19.62
T3:Compost +PSB	126.44	3.42	6.12	311.22	0.302	176.48	14.78
T4:Compost +Azatobacter	128.32	3.46	6.72	341.73	0.332	184.42	15.32
T5:Compost+ Azato bacter + PSBia	132.22	3.67	7.12	362.07	0.352	212.82	17.86
T6:Compost+ Azatobacter +VAM	132.62	3.82	7.72	392.58	0.381	232.16	18.54
T7:Compost (control)	124.52	1.81	5.42	275.62	0.268	156.43	13.56

Table 4: Three years compiled data of combined effect of organic manures and biofertilizers on yield and yield attributes of turmeric CV. Roma

Treatments	No. of mother rhizomes /plant	No. of primary rhizomes /plant	No. of secondary rhizomes /plant	length of mother rhizome (cm)	length of primary rhizome (cm)	length of secondary rhizome (cm)	Girth of mother rhizome	Weight of rhizomes/ plant (g)	Fresh rhizome yield (t/ha)	cured rhizome yield (t/ha)	Curing percent
T1: Compost + Azospirillum	1.42	4.53	13.85	3.96	9.02	3.62	4.39	187.56	21.68	4.16	19.23
T2: Compost + Azospirillum + VAM	1.64	5.62	16.54	5.36	10.57	4.12	4.96	220.37	24.91	5.06	20.32
T3: Compost + PSB	1.43	4.26	12.26	3.53	8.76	3.42	3.98	182.92	20.39	3.90	19.13
T4: Compost + Azotobacter	1.51	4.34	13.26	3.82	8.92	3.56	4.10	183.68	20.94	4.01	19.19
T5: Compost + Azoto bacter + PSB	1.54	5.22	14.68	4.32	9.43	3.78	4.57	196.53	22.32	4.31	19.34
T6: Compost + Azotobacter + VAM	1.53	5.24	14.93	4.82	9.96	3.91	4.68	200.37	22.74	4.46	19.62
T7: Compost (control)	1.14	3.22	10.22	3.13	6.72	3.20	2.96	143.26	16.42	2.91	17.76

176.38 g, 14.78 g) recorded respectively. Minimum values were found with control (T7) for fresh weight of haulm (156.43 g) and dry weight of haulm (13.56g). The mechanisms by which biofertilizers like azospirillum and VAM stimulate plant growth involve the availability of nutrients originating from genetic processes, such as biological nitrogen fixation and phosphate solubilisation and production of phytohormones like auxines (Rochelli De Souza *et al.*, 2015). Incorporation of organic manures with biofertilizers positively influence the biomass, C,N minerilization, soil respiration and enzyme activity increase availability of plant nutrients (Dinesh *et al.* 2010). Similar results were found by Kamal and Yousuf (2012), and Padmapriya and Chezhiyan (2009) and velumuragan *et. al.* (2008) while investigating effect of organic manures and biofertilizers on turmeric. Application of bio fertilizers, organic manure with 50% RDF recorded highest plant height, plant spread, fresh weight and dry weight of chrysanthemum (Mridubhashini Patanwar *et al.,* 2014). Application of azospirillum and VAM to the soil increase the root and shoot growth of the plant by plant growth promoting hormones like IAA and make availability of nutrients like nitrogen and phosphate to the plants (Yoav Bashan, 2010).

Significant differences were noticed for yield, yield attributes and quality of turmeric due to the application of compost along with various biofertilizers. Among the treatments, compost along with azospririllam + VAM followed by compost along with azotobacter + VAM was superior to other treatments with regard to yield and yield attributes (Table 4). The application of compost along with azospirillum and VAM produced superior yield attributes like more number of mother rhizomes per plant (1.64), more number of primary rhizomes per plant (5.62) and secondary rhizomes per plant (16.54). Similarly the same treatment expressed the best in terms of length and girth of mother rhizome (5.36 cm; 4.96 cm), length of primary rhizome (10.97 cm) and secondary rhizomes (4.12 cm). Fallowed by compost with azotobacter + VAM (T6), compost with azotobacter + PSB (T5), compost with azospirillum (T1), compost with azotobacter (T3), compost with PSB (T4) recorded for above treatments (Table 3) respectively. All these parameters in cumulative produced the highest weight of rhizome per plant (220.37 g), estimated fresh rhizomes yield (24.91 t ha^{-1}) and cured rhizomes yield (5.06 t ha-1) in application of compost with azospirillum + VAM. Green longer leaves and had higher plant height, number of tiller, larger leaf area and greater leaf biomass and total dry matter, which ultimately provided longer and higher photosynthesis process and resulted in a higher rhizome yield of turmeric (Kamal and Yousuf 2012). Previous studies reported that application of organic manures with biofertilizers improved the soil productivity and fertility, which improved yield and quality of such long duration crop like turmeric (Hossain & Ishimine, 2007; Velmurugan *et al.*, 2007; Mohapatra & Das 2009; Roy and Hore., 2011; Dinesh *et al.,* 2010). Moreover, Padmapriya and Chezhiyan (2009) found that application of organic manures with biofertilizers increased the growth, dry matter accumulation, rhizome yield and quality of turmeric. Chilli yield was increased significantly by application of N fixing biofertilizerslike Azotobacter and Azospirillum(Khan and Pariari 2012).

The highest curing percentage (20.32) was excelled by the treatment having compost along with azospirillum + VAM followed by compost + azotobacter + VAM (19.64) and compost + azotobacter + PSB (19.34) respectively. The treatments compost with azospirillum (19.23) and compost with azotobacter (19.19) are statistically on par with each other. Among the treatments lowest curing percent was found with control (17.76). Similer results were obtained by Kamal and Yousuf (2012), Singh (2010) and Velumuragan *et al.*, (2008) while investigating effect of organic manures and biofertilizers on turmeric. Application organic manures and biofertilizers significantly increased the growth and yield of groundnut (Zalate and Padmani, 2009). Application of azospirllam with VAM increase the seed yield and quality of Radish through biological 'N' fixation and make availability of phosphate (Shukla *et al.,* 2012).

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