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Efficacy of Paper Mill Sludge Along with Organic and Inorganic Nutrients on Growth and Yield of Turmeric (*Curcuma longa* L.)

Bibhuti Bhusan Dalei[1], Bibhuti Bhusan Sahoo[2], Lalatendu Nayak[2], Manoj Kumar Meena[1], Amit Phonglosa[3], Pravamayee Acharya[2] & Niranjan Senapati[2]

[1] AICRP on Niger, Regional Research & Technology Transfer Station (OUAT), Semiliguda, Koraput, Odisha, India

[2] Regional Research & Technology Transfer Station (OUAT), Semiliguda, Koraput, Odisha, India

[3] Regional Research & Technology Transfer Sub-Station (OUAT), Umarkot, Nabarangapur, Odisha, India

Correspondence: Bibhuti Bhusan Sahoo, Regional Research & Technology Transfer Station (OUAT), Semiliguda, Post Box No. 10, Sunabeda, Koraput 763002, Odisha, India. Tel: 91-943-818-3461. E-mail: bibhutihort@rediffmail.com

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Abstract

Red soils are strongly to moderately acidic with low to medium organic matter and poor water retentive capacity. These soils are deficient in macro as well as micronutrients like boron and molybdenum. Being a commercially cultivated crop turmeric production was drastically affected in such type of soil. To defence against the above said crisis an experiment was conducted with seven treatments and replicated thrice, at Regional Research & Technology Transfer Station (OUAT), during *kharif*-2012, under Eastern Ghat High Land zone of Odisha, to assess the efficacy of paper mill sludge (PMS) with a mixture of organic and inorganic fertilizers on turmeric cv. Roma. Results revealed that application of 100% Recommended Dose of Fertilizer with PMS i.e. (T_3) recorded highest fresh rhizome yield of 285.30 q per ha followed by 100% RDF i.e. T_2 with 261.83 q per ha which is at par with T_3. Maximum plant height of 136.97 cm along with highest weight of 73.25 g and 98.27 g of primary and secondary fingers per clump respectively were obtained from T_3.

Keywords: turmeric, paper mill sludge, yield

1. Introduction

Turmeric (*Curcuma longa* L.), one of the Indian customary medicinal plant used in Ayurveda, Unani and Siddha medicine as home remedy for various diseases, botanically it belongs to the family *Zingiberaceae*. It is a perennial plant having a short stem with large oblong leaves and bears ovate, pyriform or oblong rhizomes, which are often branched and brownish-yellow in colour. Turmeric is used as a food additive (spice), preservative and colouring agent in Asian countries, including China and South East Asia. It is also considered as auspicious and is a part of religious rituals. In old Hindu medicine, it is extensively used for the treatment of sprains and swelling caused by injury. In recent times, it is extensively used as digestive aid and treatment for fever, inflammation, wounds, infections, dysentery, arthritis, injuries, trauma, jaundice and other liver problems. It is considered to be safest herb of choice for all blood disorders since it purifies, stimulates and builds blood.

India is projected to have a population of 1.7 billion by 2050 and there is no possibility of increase in cultivable land (Anonymous, 2014). Consecutively India produces 11.9 lakh MT of turmeric from an area of 2.3 lakh ha with an average productivity of 5.1 MT per ha (Saxena et al., 2014). Odisha produces around 0.3 lakh MT of turmeric from an area of 0.025 lakh ha with an average productivity of 12.10 tonne per ha. However, the productivity of turmeric remains constant since 2012 to till date (Anonymous, 2015). On the other hand the consumption pattern of turmeric is increased frequently due to its high therapeutic and nutritional value. To cater the requirement of the increasing population and per capita consumption, there will be required for higher production from a precise unit of land. This demands an increase in average productivity from the same piece of land. But inadequate plant nutrition causes serious disorders in turmeric as well as enormous loss in yield. Higher productivity is possible through quality planting material, balanced nutrition and optimum plant health

management. Integrated approach of nutrient management is found beneficial for maintenance of soil fertility and sustaining crop productivity through all possible sources of plant nutrients.

In Odisha turmeric is extensively cultivated in the districts like Kandhamal, Gajapati, Koraput, Rayagada, Nawarangapur and Malkangiri. Red soil covers about 7.14 m ha of lands and being the highest coverage of all soil groups of the state, extend to the above said districts. The soils are strongly to moderately acidic with low to medium organic matter and poor water retentive capacity. These soils are deficient in nitrogen and phosphorus. Micronutrients like boron and molybdenum are highly deficient in these soils. These soils have low cation exchange capacity with high phosphate and sulphur absorption property and deficient in calcium and magnesium. Water soluble phosphates get fixed and become unavailable to crop plants. Applications of in-soluble phosphates two weeks before sowing seeds or mixed application of insoluble rock phosphates and single super phosphate at equal proportion (1:1) makes the best utilization of phosphate. Soil acidity is corrected by application of lime. Application of 1 to 2 ton per ha of paper mill sludge corrects soil acidity as described by Sahu and Mishra (2005).

Keeping these in view, the present experiment was conducted to find out the effect of paper mill sludge (PMS) on turmeric along with various organic and inorganic fertilizers *viz*. Farm Yard Manure (FYM) Vermicompost (VC) and chemical fertilizers as recommended dose of fertilizer (125:100:100 NPK Kg per ha).

2. Materials and Methods

2.1 Experimental Site

The experiment was conducted at Regional Research & Technology Transfer Station (OUAT) Semiliguda under Eastern Ghat High Land zone (18°42′N, 82°30′E, elevation of 884 m.a.s.l.) of Odisha during *kharif* 2012. The soil of experimental field was red and laterite with sandy to clay loam in texture. The pH of the soil was 5.8 with low in organic carbon (0.03-0.05%), available N (150-170Kg per ha), available P (16-18 kg per ha) and available K (152-160 kg per ha).

2.2 Climatic Situation of the Experimental Site

The climatic situation of the experimental site was hot and humid with an annual mean rainfall of 1567 mm, most of which (90%) was received during the month of June to September, mean summer and winter temperature were 34 °C and 12 °C respectively.

2.3 Design of the Experiment

The experiment was laid out in randomized block design (RBD) with seven treatments and replicated thrice. The treatments are T_1-Farmers practice, T_2-100% RDF (125:100:100 NPK Kg per ha), T_3-100%RDF+PMS, T_4-FYM+VC, T_5-FYM+VC+PMS, T_6-50% RDF+FYM+VC, T_7-50% RDF+FYM+PMS.

2.4 Experimental Management

Turmeric *cv*. Roma was planted on 11th June 2012 with a seed rate of 20 q per ha, spacing of 30 cm × 20 cm in a plot size of 10 m × 9 m. The PMS was applied 30 days before planting. FYM, VC and fertilizer was applied as basal dose as per the treatment schedule. Immediate after planting mulching was done by using dry niger stalk and silver oak leaves. All other scheduled cultural operations until the harvest of the crop were followed uniformly to obtain a healthy crop production. At matured stage the above ground dried portion (shoot) was removed carefully before harvesting to obtain good and healthy rhizomes. The rhizomes were harvested subsequently the yield and yield attributes of fresh rhizomes were recorded.

2.5 Statistical Analysis

The data recorded on vegetative growth, yield and yield attributing parameters were subjected to statistical analysis and treatment mean were compared at 5% level of probability as derived by K. A. Gomez and A. A. Gomez (1984).

3. Results and Discussion

3.1 Effect on Growth and Yield Attributes

Effect of paper mill sludge on plant height, number of tillers per plant, number of leaves per tiller, leaf length, leaf breadth, number of primary fingers per clump, number of secondary fingers per clump, weight of primary fingers per clump and weight of secondary fingers per clump are presented in Table 1. All the growth parameters and yield attributes achieved higher values for PMS along with 100% recommended dose of fertilizer. Highest plant height (136.97 cm), number of tillers per plant (4.13), number of leaves per tiller (8.30), leaf length (50.70), and leaf breadth (17.17 cm) were recorded with application of PMS along with 100% RDF(T3). This is due to

improvement in soil fertility/nutrient availability to the crop and more plant-available water by application of PMS to the soil.

Highest values for yield attributes like number of primary fingers per clump (4.37), number of secondary fingers per clump (10.93), weight of primary fingers per clump (73.25 g) and weight of secondary fingers per clump (98.27 g) were recorded with application of PMS along with 100% RDF (T3). Lowest plant height (80.57 cm), number of tillers per plant (1.13), number of leaves per tiller (3.60), leaf length (22.67 cm) and leaf breadth (7.53 cm) were recorded with farmers practice. All the growth parameters and yield attributes achieved lower values for farmers practice. It might be due to inadequate supply of nutrients to the plants. Lowest values with respect to yield attributes like number of primary fingers per clump (1.49), number of secondary fingers per clump (4.63), weight of primary fingers per clump (25.36 g) and weight of secondary fingers per clump (41.07 g) were recorded with farmers practice.

Similarly, application of composted paper board mill solid sludge + fly ash + coir pith produced taller and stronger plant growth along with root length and nodules formation in cowpea was observed as described by Prasanthranjan et al. (2004).

Table 1. Effect of paper mill sludge along with organic and inorganic nutrients on growth and yield of turmeric

Treatments	Plant Height at harvest (cm)	Number of tillers per plant	Number of leaves per tiller	Leaf Length (cm)	Leaf Breadth (cm)	Number of primary fingers per clump	Number of Secondary fingers per clump	Weight of primary fingers per clump (g)	Weight of Secondary fingers per clump (g)	Fresh rhizome yield (qper ha)
T1: Farmers Practice	80.57	1.13	3.60	22.67	7.53	1.49	4.63	25.36	41.07	111.63
T2: 100% RDF	125.40	3.73	6.73	45.63	16.33	3.25	10.69	65.47	96.01	261.83
T3: 100% RDF+PMS	136.97	4.13	8.30	50.70	17.17	4.37	10.93	73.25	98.27	285.30
T4: FYM+VC	98.83	1.80	5.23	30.97	9.20	2.77	7.24	47.10	65.23	187.47
T5: FYM+VC+PMS	105.40	2.30	5.50	34.87	12.37	2.89	7.85	48.53	70.56	196.87
T6: 50% RDF+FYM+VC	121.73	2.87	6.37	36.83	13.23	3.19	9.27	54.35	82.91	227.87
T7: 50% RDF+FYM+PMS	122.73	3.50	6.40	43.57	15.30	3.72	9.93	63.27	89.57	253.43
SE m(±)	8.82	0.23	0.38	3.71	0.84	0.11	2.76	1.80	2.84	15.67
CD (P = 0.05)	27.17	0.72	1.17	11.44	2.60	0.32	8.21	5.35	8.42	48.28

Note. Recommended Dose of Fertilizer (RDF), Paper Mill Sludge (PMS), Farm Yard Manure (FYM), Vermicompost (VC).

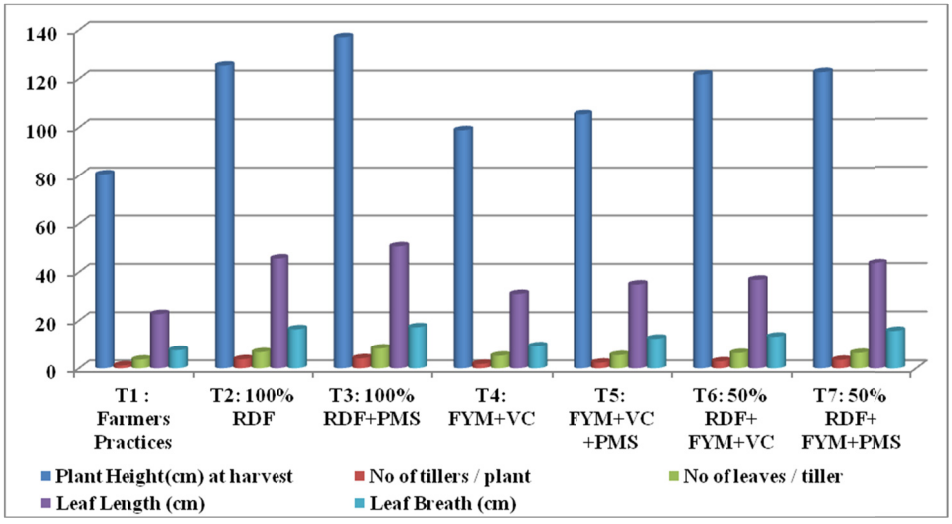

Figure 1. Effect of paper mill sludge along with organic and inorganic nutrients on vegetative growth of turmeric

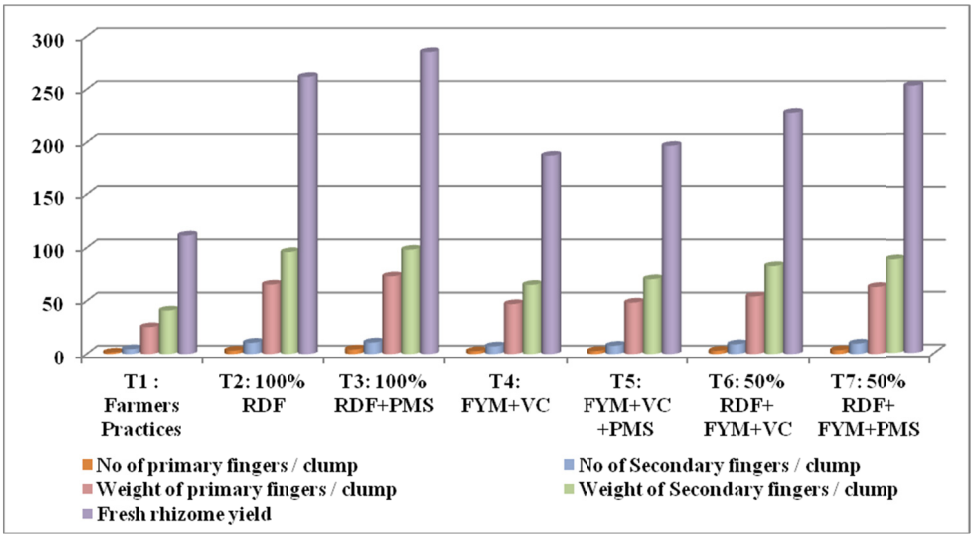

Figure 2. Effect of paper mill sludge along with organic and inorganic nutrients on growth, yield and yield attributes of turmeric

3.2 Effect on Yield

The yield of crop is generally governed by various yield attributing characters. Consequence upon superiority in yield attributes with treatment receiving PMS along with 100% RDF (T3) recorded highest rhizome yield (285.30 q per ha) followed by the treatment having only 100% RDF (261.83 q per ha). There was 9.0% increase in rhizome yield due to application of PMS along with RDF over application of RDF only.

Similarly, application of bio-compost (paper board mill solid sludge + fly ash + coir pith) with RDF recorded 27.45% increased in pod yield over 100 % fertilizer alone in cow pea (Prasanthranjan et al., 2004). Bowen et al. (1995) demonstrated that paper mill sludge amendments in potato could enhance crop yield relative to conventionally fertilized controls. Lowest rhizome yield was recorded with farmers practice.

Hence, Application of 100% RDF along with PMS shows highest extent of response in vegetative growth as well as in yield of turmeric dominating the sole application of 100% RDF and 50% RDF along with FYM, VC or PMS. 100% RDF enhance the better growth and yield of turmeric in comparison to 50% RDF where PMS balances the fertility status by neutralizing the acidity of the soil as described by Sahu and Mishra (2005).

4. Conclusion

Based on the results from the investigation it is concluded that the application of paper mill sludge along with N, P and K of 125:100:100 Kg per ha respectively could be able to produce higher yield in turmeric under Eastern Ghat High Land zone of Odisha.

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