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## Influence of graded levels of inorganic with organics and biofertilizers on growth and yield of turmeric (*Curcuma longa* L.)

**Shailendra Kumar, Meinam Chanchan, AK Bijaya Devi, N Surbala Devi and N Gopimohan Singh**

### Abstract

A field investigation was conducted at experimental field, Department of Horticulture, College of Agriculture, CAU, Imphal, during 2021-22 to study the "Influence of graded levels of inorganic with organics and biofertilizers on growth and yield of turmeric". The experiment was laid out in RBD (Randomized Block Design) with three replications under 13 different treatments including recommended NPK 100%. Four organics (compost, vermicompost, mustard cake and neem cake), three biofertilizers (*Azotobacter chroococcum*, *Bacillus polymyxa* and *Fraturia aurantea*) and three levels (100%, 75% and 50%) of NPK were included in this experiment along with recommended dose of NPK (150:60:150 kg/ha). Maximum breadth of leaves (18.97 cm) was recorded at 120 days after planting from the treatment combination of Neem cake + NPK 100% + BF. Maximum number of leaves per clump (13.37) at 120 DAP was recorded in Vermicompost + NPK 75% + BF. Mustard cake + NPK 100% + BF recorded the maximum number of primary finger (7.60), clump length (18.76 cm) and clump breadth (13.97 cm). The maximum weight (161.33 g), length (9.22 cm) and breadth (2.43 cm) of primary finger were recorded from the treatment combination of Compost + NPK 100% + BF. The maximum plant height (142.87 cm), number of tillers per clump (2.32) and length of leaves (67.40 cm) at 120 days after planting were observed in Vermicompost + NPK 100% + BF. Similarly, maximum clump weight (327.52 g) and yield per hectare (38.50 t) were obtained from treatment combination of Vermicompost + NPK 100% + BF.

**Keywords:** Biofertilizers, compost, mustard cake, neem cake, turmeric and vermicompost

### 1. Introduction

Turmeric (*Curcuma longa* L.) is one of the ancient and sacred spice of India. It is a tropical herbaceous perennial plant belongs to the family Zingiberaceae. Due to its numerous uses in culinary colouring, cosmetics and medicines, particularly for the creation of anticancer medications, turmeric is in great demand. Turmeric is widely cultivated for its rhizomes. Curcuminoids, yellow pigments present in the rhizome is responsible for the colour as well as several medicinal properties (Joe *et al.* 2004 and Aggarwal *et al.* 2005) [12, 1]. It has anti-diabetic, anti-septic, anti-bacterial, anti-asthmatic, anti-ulcer, insect repellent, blood purifier, carminative and healing properties (Ammon and Wahl, 1991) [2].

India is the largest producer, consumer and exporter of turmeric in the world. Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra and Assam are some of the important states for cultivation of turmeric. Andhra Pradesh alone occupies 38.0 per cent of area and 58.5 per cent of production (Anon., 2016) [3].

Organic manures and biofertilizers offer an alternative to chemical fertilizers and increasingly used in spice crop production including turmeric (Srinivasan *et al.* 2000) [20]. Organic source of nutrients are recommended for retaining productivity of soil, reducing usage of chemical fertilizers, improving soil health and minimize environmental pollution (Hossain and Ishimine, 2007) [10]. Application of organic manures also quickly increases soil microbial biomass and their activity (Dinesh *et al.* 2010) [9]. The use of various organic manures such as FYM, neem cake and vermicompost influences the growth and yield of turmeric. Organic manures improve soil texture and structure, as well as water retention and drainage which can aid in the growth and development of rhizomatous crops such as turmeric (Kale *et al.* 1991) [13].

## 2. Materials and Methods

The experiment was carried out at experimental field, Department of Horticulture, College of Agriculture, CAU, Imphal, during 2021-22. The university is geographically situated at an altitude of 850 m above mean sea level at 24°45' N latitude and 93°56' longitude. The soil at the experimental plots was clayey with pH 5.24 (acidic) and 1.18% organic carbon. Available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in soil were 238.33 kg/ha, 31.79 kg/ha and 196.50 kg/ha, respectively. The experiment was laid out in RBD with three replications. Raised beds of 3.0 m × 1.0 m and 15 cm high were prepared. Turmeric was planted in a spacing of 25 cm × 25 cm.

The organic inputs namely compost, vermicompost, mustard cake and neem cake were applied basally during final land preparation @ 10 t, 5t, 3t and 3t per hectare respectively. The recommended dose of inorganic fertilizers was 150:60:150 kg NPK per hectare (Medda, 2000) [14]. The total amount of fertilizers was applied in three split doses. 1/3<sup>rd</sup> of N and full dose of P was applied after 15 days of planting whereas each split of 1/3<sup>rd</sup> N and 1/2<sup>nd</sup> K were applied after 45 and 90 days after the first application. Urea, SSP and MOP were used as inorganic source of N, P and K respectively. Straw was used as mulching material.

Biofertilizers (*Azotobacter*, phosphorus solubilizing bacteria and potassic mobilizer) were applied @ 20 kg/ha directly to the soil along with the organic manures. Healthy seed rhizome (30-35 g) along with *Trichoderma viride* @ 5 g/kg and Acacia gum (1 tablespoon) as sticker were taken in water in a plastic tray and mixed thoroughly. After soaking the rhizomes bits were dried under shade in airy place.

Treated rhizomes of turmeric were planted to a depth of 4-5 cm, in the last week of May, 2021. Plots were mulched immediately with paddy straw after planting. 3-4 hand weeding were done. Irrigation was given as per requirement. The crop was harvested 8 months after planting, observations on different growth (at 60 and 120 DAP) parameters, yield parameters were recorded from five randomly selected plants per replications. Rhizome yield was taken on net plot basis at harvest and yield per hectare was calculated on the basis of yield per plot, considering the 75% area occupied by the crop (Chanchan *et al.* 2017) [18].

## 3. Results and Discussion

### 3.1 Growth parameters

The growth parameters were presented in Table 1. The effect of different treatments on growth characteristics namely plant height (cm), number of tillers per clump, number of leaves per clump, length of leaves (cm) and breadth of leaves (cm) were recorded at 60 and 120 days after planting (DAP).

**3.1.1 Plant height (cm):** At 60 DAP, the maximum plant height (88.90 cm) was recorded in plants treated with Mustard cake + NPK 75% + BF followed by combined application of Vermicompost + NPK 100% + BF (86.10 cm). While, the minimum plant height (76.23 cm) was found in Vermicompost + NPK 50% + BF followed by Neem cake + NPK 100% + BF (78.10 cm). At 120 DAP, the maximum plant height (142.87 cm) was recorded in plants treated with Vermicompost + NPK 100% + BF followed by combined application of Mustard cake + NPK 75% + BF (141.87 cm). While, the minimum plant height (112.03cm) was obtained in Mustard cake + NPK 50% + BF followed by Vermicompost +

NPK 50% + BF (115.67 cm).

**3.1.2 Number of tillers per clump:** At 60 DAP, the maximum number of tillers per clump (1.32) was recorded in Neem cake + NPK 75% + BF followed by combined application of Vermicompost + NPK 75% + BF (1.31). While, the minimum number of tillers per clump (0.30) was found in Mustard cake + NPK 50% + BF followed by recommended NPK 100% (31). At 120 DAP, the maximum number of tillers per clump (2.32) was recorded in Vermicompost + NPK 100% + BF followed by combined application of Neem cake + NPK 75% + BF (2.20). While, the minimum number of tillers per clump (0.90) was obtained in Neem cake + NPK 50% + BF followed by Mustard cake + NPK 50% + BF (.92).

**3.1.3 Number of leaves per clump:** At 60 DAP, the maximum number of leaves per clump (6.40) was recorded in Vermicompost + NPK 100% + BF followed by combined application of Vermicompost + NPK 50% + BF (6.24). While, the minimum number of leaves per clump (5.35) was observed in recommended NPK 100% followed by Mustard cake + NPK 50% + BF (5.61). At 120 DAP, the maximum number of leaves per clump (13.37) was obtained in Vermicompost + NPK 75% + BF followed by combined application of Compost + NPK 100% + BF (13.31). While, the minimum number of leaves per clump (10.02) was observed in Vermicompost + NPK 50% + BF followed by Neem cake + NPK 50% + BF (10.10).

**3.1.4 Length of leaves (cm):** At 60 DAP, the maximum length of leaves (42.97 cm) was observed in Vermicompost + NPK 100% + BF followed by combined application of Compost + NPK 100% + BF (42.73 cm). While, the minimum length of leaves (38.20 cm) was recorded in Neem cake + NPK 75% + BF followed by recommended NPK 100% (38.43 cm). At 120 DAP, the maximum length of leaves (67.40 cm) was recorded in Vermicompost + NPK 100% + BF followed by combined application of Mustard cake + NPK 100% + BF (65.67 cm). While, the minimum length of leaves (60.10 cm) was found in recommended NPK 100% followed by Compost + NPK 100% + BF (60.33).

**3.1.5 Breadth of leaves (cm):** At 60 DAP, the maximum breadth of leaves (15.63 cm) was observed in Compost + NPK 50% + BF followed by Mustard cake + NPK 75% + BF (15.13 cm). While, the minimum breadth of leaves (12.91 cm) was obtained in recommended NPK 100% followed by Neem cake + NPK 100% + BF (13.50 cm). At 120 DAP, the maximum breadth of leaves (18.97 cm) was observed in Neem cake + NPK 100% + BF followed by Neem cake + NPK 75% + BF (17.95 cm). While, the minimum breadth of leaves (16.17 cm) was found in recommended NPK 100% followed by Mustard cake + NPK 100% + BF (16.20 cm). Turmeric responds to heavy dressing of organic matter and many experimental evidences are available on the beneficial effects of organic matter alone or with inorganic fertilizers on growth (Rethinam *et al.* 1994) [17]. Compared to the availability of nutrients for most of the bulky organic manures, the release of nutrients from vermicompost is more and could be the reason for higher plant heights (Bhende *et al.* 2013) [7]. These results showed that the improvement in plant growth parameters could probably be due to increase in enzymatic activity, increase in microbial population and

activity, increase in soil moisture holding capacity, accelerating the population and activity of earthworm and easy availability of macro and micronutrients by application of vermicompost. (Arancon *et al.* 2006, Prabha *et al.* 2008 and Azarmi *et al.* 2008) [4, 16, 5].

The turmeric rhizome treated with *Trichoderma* produces plant hormones and enzymes and thereby promotes plant growth (Sivaprasad, 2002) [19].

The higher values in plant height, leaf length and leaf breadth

in the vermicompost with biofertilizers might be due to supply of all the essential mineral nutrients in a balanced amount which results better growth and development. Combine application of biofertilizers significantly improved plant's vegetative growth due to production of different growth promoting hormones by microbial activities and as availability of essential plant nutrients for plant development. The result of the present investigation is in agreement with findings of Nongmaithem *et al.* (2013) [5].

**Table 1:** Influence of graded levels of inorganic with organics and biofertilizers on plant height (cm), number of tillers per clump, number of leaves per clump, length of leaves (cm) and breadth of leaves (cm) of turmeric

Treatment combination	Plant height (cm)		Number of tillers per clump		Number of leaves per clump		Length of leaves (cm)		Breadth of leaves (cm)	
	60 DAP	120 DAP	60 DAP	120 DAP	60 DAP	120 DAP	60 DAP	120 DAP	60 DAP	120 DAP
Compost + NPK 100% + BF	83.97	130.17	0.96	2.00	6.23	13.31	42.73	62.60	14.83	17.33
Compost + NPK 75% + BF	80.30	128.00	0.87	1.85	5.97	12.12	42.67	60.33	14.45	17.63
Compost + NPK 50% + BF	79.57	120.64	0.52	1.13	5.81	10.45	42.33	64.00	15.63	16.82
Vermicompost + NPK 100% + BF	86.10	142.87	1.07	2.32	6.40	12.44	42.97	67.40	14.90	16.35
Vermicompost + NPK 75% + BF	78.57	134.37	1.31	2.15	6.16	13.37	41.87	62.20	15.10	16.83
Vermicompost + NPK 50% + BF	76.23	115.67	0.73	1.15	6.24	10.02	40.00	62.93	14.43	16.63
Mustard Cake + NPK 100% + BF	84.66	140.53	1.02	1.93	5.96	12.13	42.37	65.67	14.83	16.20
Mustard Cake + NPK 75% + BF	88.90	141.87	1.24	1.70	6.20	11.82	42.07	63.47	15.13	16.91
Mustard Cake + NPK 50% + BF	81.30	112.03	0.30	0.92	5.61	10.25	40.07	63.13	14.50	16.62
Neem Cake + NPK 100% + BF	78.10	132.35	1.11	1.56	6.16	11.53	39.83	65.27	13.50	18.97
Neem Cake + NPK 75% + BF	79.50	134.33	1.32	2.20	5.79	11.40	38.20	61.73	14.90	17.95
Neem Cake + NPK 50% + BF	81.67	126.50	0.42	0.90	6.15	10.10	39.70	61.57	14.10	17.03
Recommended NPK 100% (150:60:150 kg/ha)	80.07	116.73	0.31	1.23	5.35	11.24	38.43	60.10	12.91	16.17
S.Em (±)	2.45	3.93	0.05	0.10	0.17	0.43	1.05	2.65	0.43	0.52
CD 5%	7.14	11.47	0.15	0.30	0.50	1.27	3.07	NS	1.25	1.52

BF (Biofertilizers): *Azotobacter*, Phosphorus solubilizing bacteria and KM (*Fraturia aurantea*).

NS: non-significant

### 3.2 Yield parameters

The yield parameters were presented in Table 1 and 2, respectively.

**3.2.1 Weight of clump (g):** The maximum weight of clump (327.52 g) was observed in Vermicompost + NPK 100% + BF followed by Mustard cake + NPK 50% + BF (303.19 g). While, the minimum weight of clump (205.82 g) was found in Neem cake + NPK 100% + BF followed by Compost + NPK 50% + BF (214.80 g).

**3.2.2 Length of clump (cm):** The maximum length of clump (18.67 cm) was observed in Mustard cake + NPK 100% + BF followed by Vermicompost + NPK 100% + BF (17.93 cm). While, the minimum length of clump (16.00 cm) was recorded in Vermicompost + NPK 50% + BF followed by Neem cake + NPK 75% + BF (16.23 cm).

**3.2.3 Breadth of clump (cm):** The maximum breadth of clump (13.57 cm) was observed in Mustard cake + NPK 100% + BF followed by Compost + NPK 100% + BF (13.77 cm). While, the minimum breadth of clump (11.07 cm) was recorded in Neem cake + NPK 50% + BF followed by Mustard cake + NPK 50% + BF (11.83 cm).

**3.2.4 Number of primary finger:** The maximum number of primary finger (7.60) was observed in Mustard cake + NPK 100% + BF followed by Mustard cake + NPK 75% + BF (7.22). While, the minimum number of primary finger (4.93) was recorded in Compost + NPK 50% + BF followed by

Vermicompost + NPK 50% + BF (5.33).

**3.2.5 Weight of primary finger (g):** The maximum weight of primary finger (161.33 g) was observed in Compost + NPK 100% + BF followed by Vermicompost + NPK 100% + BF (141.36 g). While, the minimum weight of primary finger (93.20 g) was recorded in Neem cake + NPK 75% + BF followed by Vermicompost + NPK 50% + BF (100.02 g).

**3.2.6 Length of primary finger (cm):** The maximum length of primary finger (9.22 cm) was observed in Compost + NPK 100% + BF followed by Vermicompost + NPK 100% + BF (8.83 cm). While, the minimum length of primary finger (6.40 cm) was recorded in Mustard cake + NPK 50% + BF followed by Neem cake + NPK 50% + BF (6.83 cm).

**3.2.7 Breadth of primary finger (cm):** The maximum breadth of primary finger (2.43 cm) was observed in Compost + NPK 100% + BF followed by Vermicompost + NPK 100% + BF (2.32 cm). While, the minimum breadth of primary finger (1.60 cm) was recorded in Mustard cake + NPK 50% + BF followed by Compost + NPK 50% + BF (1.65 cm).

**3.2.8 Yield per hectare (t):** The maximum yield per hectare (38.50 t) was recorded in Vermicompost + NPK 100% + BF followed by Compost + NPK 100% + BF (36.57 t). While, the minimum yield per hectare (24.55 t) was obtained in Compost + NPK 50% + BF followed by Mustard cake + NPK 50% + BF (24.77 t).

These results clearly indicated the integrated approach of

organic manure in combination with biofertilizer and inorganic fertilizer can improve both the yield and quality of the crop. These findings are in consonance with findings of Kumar *et al.* (2005) [1] who also reported the superiority of vermicompost as compared to other organic sources. The recommended dose of chemical fertilizer can be reduced by 25% with biofertilizer and organic manure.

The higher and easily available nutrient content in vermicompost and their uptake might be one of the reasons for the highest rhizome yield. Besides influencing the physiochemical properties of soil, vermicompost is also

known to contain growth promoting substances, enhance microbial activity and prevent nitrogen loss by leaching (Shinde *et al.*, 1992) [18].

The positive effect of biofertilizers on the various growth and yield parameters observed in the present study was due to enhanced uptake of nutrients by the plants (Barea, 1991) [6]. *Azotobacter* aided in increased plant growth due to their nitrogen fixing capacity and also they are known to help in the synthesis of growth promoting substances like IAA and GA. (Jackson and Brown, 1966) [11].

**Table 2:** Influence of graded levels of inorganic with organics and biofertilizers on clump weight (g), clump length (cm), clump breadth (cm) and Yield of turmeric

Treatment combination	Characters of clump			Yield (t/ha)
	Weight (g)	Length (cm)	Breadth (cm)	
Compost + NPK 100% + BF	285.21	17.83	13.77	36.57
Compost + NPK 75% + BF	262.34	16.43	13.07	30.70
Compost + NPK 50% + BF	214.80	16.60	12.67	24.55
Vermicompost + NPK 100% + BF	327.52	17.93	13.20	38.50
Vermicompost + NPK 75% + BF	278.33	16.53	13.07	33.40
Vermicompost + NPK 50% + BF	246.17	16.00	12.43	29.30
Mustard Cake + NPK 100% + BF	272.81	18.76	13.97	32.32
Mustard Cake + NPK 75% + BF	249.32	17.40	12.57	28.30
Mustard Cake + NPK 50% + BF	303.19	17.03	11.83	24.77
Neem Cake + NPK 100% + BF	205.82	17.07	13.03	35.05
Neem Cake + NPK 75% + BF	258.34	16.23	11.92	31.76
Neem Cake + NPK 50% + BF	228.31	16.67	11.07	26.55
Recommended NPK 100% (150:60:150 kg/ha)	242.41	16.33	12.44	24.98
S.Em (±)	2.41	0.54	0.53	2.22
CD 5%	7.03	1.56	1.55	6.47

**Table 3:** Influence of graded levels of inorganic with organics and biofertilizers on number, weight (g), length (cm) and breadth (cm) of primary finger of turmeric

Treatment combination	Characters of primary finger			
	Number	Weight (g)	Length (cm)	Breadth (cm)
Compost + NPK 100% + BF	6.50	161.33	9.22	2.43
Compost + NPK 75% + BF	6.32	124.56	8.66	1.90
Compost + NPK 50% + BF	4.93	133.03	6.84	1.65
Vermicompost + NPK 100% + BF	7.10	141.36	8.83	2.32
Vermicompost + NPK 75% + BF	6.22	117.10	8.72	2.12
Vermicompost + NPK 50% + BF	5.33	100.02	7.36	1.87
Mustard Cake + NPK 100% + BF	7.60	121.21	8.70	1.93
Mustard Cake + NPK 75% + BF	7.22	127.15	7.46	1.90
Mustard Cake + NPK 50% + BF	6.31	101.65	6.40	1.60
Neem Cake + NPK 100% + BF	6.80	127.40	8.60	2.06
Neem Cake + NPK 75% + BF	6.32	93.20	7.83	2.23
Neem Cake + NPK 50% + BF	5.40	101.67	6.83	1.80
Recommended NPK 100% (150:60:150 kg/ha)	6.22	121.43	7.30	1.81
S.Em (±)	0.51	1.68	0.43	0.16
CD 5%	1.50	4.92	1.25	0.46

#### 4. Conclusion

The growth and yield parameters of turmeric were influenced by the application of different combination of organics (compost, vermicompost, mustard cake and neem cake) and biofertilizers [*Azotobacter*, Phosphorus solubilizing bacteria and Potassic Mobilizer (*Fraturia aurantea*)]. From the results it was observed that the combined application of Vermicompost + NPK 100% + BF increased growth parameters (number of tillers per clump and length of leaves in centimeter) and yield parameters (clump weight in gram and yield t/ha).

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