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Research Paper

Effect of land configuration and soil conditioners on growth and yield of turmeric (*Curcuma longa*)

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ABSTRACT

A field experiment was carried out for two consecutive years (2007-08 and 2008-09) to study the effect of land configuration and soil conditioners on growth and yield of turmeric (*Curcuma longa* L.) on clayey soil of Navsari (Gujarat). Four land configurations *viz*., ridge and furrow method, raised bed (50 cm width) with 2 rows, raised bed (75 cm width) with 3 rows and raised bed (120 cm width) with 4 rows and three soil conditioners *viz*., bio-compost @ 12.5 t/ha, bio-compost @ 25 t/ha and biocompost @ 12.5 t/ha + gypsum @ 2 t/ha were evaluated. Raised bed planting had favourable effect on growth and yield of turmeric as compared to ridge and furrow planting. Raised bed with either 3 or 4 rows were equally effective in improving plant growth of turmeric. However, raised bed with 3 rows land configuration recorded significantly higher fresh rhizome yield (21.78 t/ha), the yield advantage being 26.6, 16.4 and 13.9% over ridge and furrow method, raised bed with 4 rows and raised bed with 2 rows, respectively. Application of biocompost @ 25 t/ha recorded significantly the highest rhizome yield (20.90 t/ha) and the magnitude of response was to the tune of 17.8 and 10.2% as compared to bio-compost @ 12.5 t/ha and bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha, respectively. Interaction effect between land configuration and soil conditioner was found significant and the combination involving raised bed with 3 rows and biocompost @ 25 t/ha recorded the maximum fresh rhizome yield (25.38 t/ha). These treatments also accrued the maximum net realization and B:C ratio.

Key words **:** Bio-compost, Gypsum, Land configuration, Soil conditioner, Turmeric

Turmeric is grown for its aromatic rhizomes since antiquity in India. It is traditionally used for medicinal, religious, culinary purposes and also as a cosmetic and dye (Shah, 1997). The spice is sometimes also called the 'Indian saffron' due to its brilliant yellow colour. Currently, India is the largest producer, consumer and exporter of turmeric in the world. The country consumes 80% of its production and exports the surplus. It is attaining a status of high value crop in Gujarat and has better scope in south Gujarat due to assured water availability and better rail and road connectivity. However, its productivity is constrained by soil physical and hydrological properties due to high proportion of clay content (40-60%). Majority of the soils of south Gujarat falls under Vertic Ustochrepts characterized by low infiltration, poor internal drainage, narrow workable moisture range, variable moisture availability, loss of soil structure, low organic matter, high cation exchange capacity and alkaline reaction. Besides, high rainfall (1500-2500 mm) as well as ample and cheap availability of canal water have favoured the cultivation of high water consuming crops like paddy and sugarcane in this region resulting in deterioration in soil conditions.

Producers and researchers alike are interested in improving the physical conditions of soil to enhance crop production. This can partly be accomplished through land management system involving different methods of seed bed preparation and use of soil conditioners. They play a crucial role in enhancing crop production through improving soil-water-plant relationship. Hence, this experiment was framed to assess the individual and combined effects of land configuration and soil conditioners on growth and yield of turmeric.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* and *rabi* seasons of 2007-08 and 2008-09 at soil and water management research farm, Navsari Agricultural University, Navsari. The soil was clayey in texture having 7.9 pH, 0.45% organic carbon, 228 kg/ha available N, 46 kg/ha available P_2O_5 and 456 kg/ha available K_2O. Twelve treatment combinations comprising of four land configurations *viz*., ridge and furrow method (L_1), raised bed (50 cm width) with 2 rows (L_2), raised bed (75 cm width) with 3 rows (L_3) and raised bed (120 cm width) with 4 rows (L_4)

and three soil conditioners *viz*., biocompost @ 12.5 t/ha (C_1), bio-compost @ 25 t/ha (C_2) and biocompost @ 12.5 t/ha + gypsum @ 2 t/ha (C_3) were evaluated in strip plot design with four replications. Ridge and furrow were prepared by ridger at 45 cm. Raised beds were prepared by opening 40 cm wide and 25 cm deep furrows at 90 cm in L_2, 60 cm wide and 30 cm deep furrows at 135 cm in L_3 and 60 cm wide and 30 cm deep furrows at 180 cm spacing in L_4 accommodating 2, 3 and 4 rows of turmeric at 30-35 cm inter-row spacing, respectively. After opening the furrows, finishing of the beds thus prepared was done manually to give them proper shape. The required quantity of sugarcane pressmud based bio-compost (33.5% OC) and gypsum were applied in the respective plot as per layout plan and thoroughly mixed in the soil before planting. Turmeric 'Sugandham' was planted on 3 and 4 June during 2007 and 2008, respectively keeping 20 cm intra-row spacing. The crop was fertilized with a common dose of fertilizer (60:60:60 N:P_2O_5:K_2O kg/ha). Nitrogen and potash were applied in 3 and 2 equal splits, respectively, while full amount of phosphorus was applied as basal. The mean maximum temperature ranged from 23.6 to 35.1ºC and 27.8 to 36.7ºC and mean minimum temperature from 9.6 to 28.0ºC and 12.4 to 27.9ºC during 200708 and 2008-09, respectively. During the corresponding years, mean morning relative humidity ranged from 57 to 97% and 43 to 95%, while the mean evening relative humidity ranged from 17 to 89% and 22 to 92%. The crop received total 1856 mm and 2069 mm rainfall during first and second year in 65 and 62 rainy days, respectively. The crop was given 9 irrigations each year, 2 before onset of monsoon and 7 after cessation of monsoon.

RESULTS AND DISCUSSION

Effect of land configuration

Raised bed planting resulted in remarkable improvement in plant growth, yield attributes and fresh rhizome yield of turmeric as compared to ridge and furrow method (Table 1 and 2). Among the raised bed treatments, plant height, tillers per plant, stem girth, leaf area index and plant dry matter were better under raised bed with 3 or 4 rows land configurations. However, raised bed accommodating 3 rows recorded significantly highest number and weight of mother and finger rhizomes per plant as well as yield per plant (238.6 g/plant) and yield per hectare (21.78 t/ha) and thus, emerged out as the best land configuration for turmeric. The mean yield advantage under raised bed with 3 rows land configuration was 26.6, 16.4 and 13.9% over ridge and furrow method, raised bed with 4 rows and raised bed with 2 rows, respectively. Better plant growth and yield under raised bed treatments can be attributed to improvement in nutrient availability due to adequate air and water movement under improved soil physical conditions. The results corroborate the earlier findings of Balashanmugam and Vedamuthu (1989) and Amzad *et al*. (2005), who recorded markedly higher yield of turmeric when planted on broad ridges. Lower yield in raised bed with 2 rows as compared to raised bed with 3 rows treatment may be due to comparatively smaller furrow and bed dimensions, while that in case of raised bed with 4 rows treatment can be ascribed to moisture stress faced by the two middle rows, during rhizome formation and development stage owing to inadequate horizontal movement of water from furrow to the centre of wider beds.

Effect of soil conditioners

Application of biocompost @ 25 t/ha recorded significantly higher values of all the growth parameters, yield attributes and yield of turmeric as compared to bio-compost @ 12.5 t/ha and bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha (Table 1 and 2). The increase in rhizome yield was to the tune of 17.8 and 10.2%, respectively. Supple-

Table 1. Effect of land configuration and soil conditioners on growth parameters of turmeric (Pooled data over two years)

Treatment	Plant height (cm)	No. of tillers/plant	Stem girth (cm)	Leaf area index	Plant dry matter (g/plant)
Land configuration					
Ridge and furrow	102.9	1.61	6.67	2.74	54.5
Raised bed with 2 rows	108.6	1.77	7.20	3.11	62.4
Raised bed with 3 rows	115.2	1.95	7.66	3.56	71.0
Raised bed with 4 rows	111.3	1.97	7.65	3.40	63.9
SEm±	1.9	0.07	0.89	0.07	1.2
CD (P=0.05)	5.6	0.20	0.26	0.21	3.6
Soil conditioners					
Bio-compost @ 12.5 t/ha	103.8	1.68	7.06	2.91	56.1
Bio-compost @ 25.0 t/ha	115.7	2.03	7.64	3.57	71.5
Bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha	109.0	1.76	7.19	3.14	61.3
SEm±	1.8	0.06	0.08	0.08	0.8
CD (P=0.05)	5.5	0.17	0.24	0.25	2.6

menting gypsum @ 2 t/ha to bio-compost @ 12.5 t/ha made little improvement in growth and yield of turmeric. Rajamani *et al*. (2007), Velmurugan *et al*. (2007), Sanwal *et al*. (2007) and Padmapriya and Chezhiyan (2009) have also reported positive and significant effect of various organic sources, applied alone or in conjunction with chemical fertilizers, on growth characters, yield attributes and yield of turmeric. The reasons for such favourable effect of bio-compost lie in the fact that it is a rich source of organic carbon, improves microbial/biological properties of the soil (Partha and Sivasubramanian, 2006) and supplement macro and micro nutrients (Patel and Das, 2009). The reason for little effect of gypsum is that it contributes only Ca and S, while bio-compost has multifarious beneficial effects.

Interaction effect

Results indicated positive and significant interaction between land configuration and soil conditioners with respect to fresh rhizome yield of turmeric (Table 3). The treatment involving raised bed with 3 rows land configuration and application of bio-compost @ 25 t/ha with fresh rhizome yield of 25.38 t/ha turned out to be significantly superior combination as compared to other treatment combinations. The positive and significant interaction effect may be attributed to marked improvement in the soil-plant environment including the favourable physical, chemical and bio-chemical changes associated with land configuration and soil conditioner treatments.

Economics

Ridge and furrow system accrued the minimum net realization of ₹1,12,598/ha with benefit:cost ratio of 1.89 (Table 2). Raised bed treatments *viz.*, raised bed with 2 rows, 3 rows and 4 rows increased the net realization to ₹1,31,665/ha, ₹1,58,265/ha and ₹1,27,565/ha and benefit:cost ratio to 2.21, 2.66 and 2.14, respectively indicating that raised with 3 rows was the most profitable land configuration. Economics of soil conditioner treatments revealed that bio-compost @ 25 t/ha recorded the highest net realization of ₹1,47,543/ha and benefit:cost ratio of 2.40 followed by bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha (₹1,30,558/ha and 2.21, respectively). Thus, the former treatment (bio-compost @ 25 t/ha) emerged out to be most profitable soil conditioner treatment.

The present study indicated that higher production and

Table 2. Effect of land configuration and soil conditioners on yield attributes, yield and economics of turmeric (Pooled data over two years)

Treatment	No. of mother rhizomes/ plant	No. of finger rhizomes/ plant	Weight of mother rhizomes/ plant (g)	Weight of finger rhizomes/ plant (g)	Rhizome yield/plant (g)	Yield (t/ha)	Net realization ($\times 10^3$₹/ha)	B:C ratio
Land configuration								
Ridge and furrow	2.0	9.6	40.8	150.7	191.5	17.21	112.6	1.89
Raised bed with 2 rows	2.1	10.9	43.9	171.6	215.4	19.12	131.7	2.21
Raised bed with 3 rows	2.5	12.0	50.4	188.2	238.6	21.78	158.3	2.66
Raised bed with 4 rows	2.1	10.9	43.9	168.9	212.8	18.71	127.6	2.14
SEm±	0.55	0.29	0.9	4.5	5.2	0.45	-	-
CD (P=0.05)	0.16	0.86	2.7	13.5	15.4	1.34	-	-
Soil conditioners								
Bio-compost @ 12.5 t/ha	2.0	9.8	41.2	156.5	197.6	17.74	119.5	2.06
Bio-compost @ 25.0 t/ha	2.4	12.1	48.9	186.3	235.3	20.90	147.5	2.40
Bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha	2.1	10.7	44.1	166.7	210.8	18.97	130.6	2.21
SEm±	0.05	0.20	0.9	2.8	3.2	0.37	-	-
CD (P=0.05)	0.14	0.61	2.7	8.6	10.0	1.15	-	-

Table 3. Interaction effect of land configuration and soil conditioners on yield of turmeric (Pooled data over two years)

Land configuration	Yield (t/ha)		
	Bio-compost @ 12.5 t/ha	Bio-compost @ 25.0 t/ha	Bio-compost @ 12.5 t/ha + gypsum @ 2 t/ha
Ridge and furrow	16.67	17.47	17.50
Raised bed with 2 rows	16.46	21.01	19.89
Raised bed with 3 rows	19.98	25.38	19.98
Raised bed with 4 rows	17.86	19.75	18.52
SEm±		0.59	
CD (P=0.05)		1.41	

net profit from turmeric 'Sugandham' can be secured by planting 3 rows on raised beds, prepared by opening 60 cm wide and 30 cm deep furrows 135 cm apart and applying pressmud based bio-compost @ 25 t/ha as soil conditioner in heavy black (clay) soils.

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