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Monetary and non-monetary inputs on turmeric growth, nutrient uptake, yield and economics under irrigated condition

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ABSTRACT

Field experiment with split plot design was conducted to study the effect of monetary and non-monetary inputs on growth, nutrient uptake, yield and economics of turmeric. Non-monetary inputs *viz.,* two varieties (BSR 1 and BSR 2) and three planting time (15 May, 15 June and 15 July); monetary inputs *viz.,* three spacing (30 cm x 15 cm, 45 cm x 15 cm, 60 cm x 15 cm) and three N levels (125, 150 and 175 kg/ha) formed the treatment combination. Turmeric variety BSR 2 out yielded BSR 1 in terms of growth, nutrient uptake and yield. Planting the turmeric during middle of May (15 May) was superior compared to 15 June and 15 July plantings. Among spacing, 30cm x 15cm recorded significantly higher growth, nutrient uptake and yield than 45 cm x 15 cm and 60 cm x 15 cm. The crop response was better for higher rate of nitrogen (175 kg/ha) than other levels. Economic evaluation indicated that combination of non-monetary inputs *viz.,* planting BSR 2 at 15 May with monetary inputs *viz.,* 30 x 15 cm spacing with 175 kg/ha N would increase the turmeric production and income of the farmers.

Key words: Turmeric, economics, input management, nutrient uptake, yield.

INTRODUCTION

Turmeric (*Curcuma domestica*) is an important export oriented commercial crop of India. It is cultivated in an area of 1.5 lakh ha with a production of 5.64 lakh tonnes having productivity of 3,754 kg/ha. It ranks fifth in area among spices next to chillies, cumin, coriander and black pepper, whereas it occupies third position in production next to chillies and garlic. In export of spices, it ranks second both in quantity and value next to chillies (Premaja and Manojkumar, 9).Owing to its medicinal properties, its demand is increasing both in domestic and international market for use in food industry, pharmaceuticals and preservatives in health and body care. Crop is raised as rain-fed in states like Kerala and north-east where quantum of rainfall is high and distributed for 5 to 7 months by south-west and north-east monsoons. In Tamil Nadu, Maharashtra, Andhra Pradesh where rainfall is less, it is grown as irrigated crop. Although, turmeric is cultivated in more than 200 districts in 20 states, Erode district in Tamil Nadu alone contributes more than 10 percent of the national production (Kandiannan *et al*., 4) and delineated as efficient turmeric producing zone. However, yield in the farmer's field is low due to non-adoption of appropriate production technologies (Nagarajan, 7). The right choice of non-monetary inputs like correct time of planting, selection of the best varieties for that location and monetary inputs like adoption of more seed rates (closer planting) and fertilizer application would augment the yield. The present investigation was therefore, undertaken to study the different inputs on turmeric growth, nutrient uptake, yield and its economics.

MATERIALS AND METHODS

The field experiments were conducted at Agricultural Research Station, Bhavanisagar of Tamil Nadu Agricultural University during 2000-01 and 2001-02. The normal weather conditions at Bhavanisagar are a mean annual rainfall of 659 mm received in 43 rainy days. The mean maximum and minimum temperatures are 33 and 22°C, respectively. The soil of the experimental fields was well drained sandy loam, low in available N and P, and high in available K with near neutral *p*H. The crop was raised with irrigation from the Lower Bhavani Reservoir. The test variety BSR 1 was a selection from the mutant population irradiated with X-ray and BSR 2 was an induced mutant from Erode Local type. The experiments were laid out in split plot design with three replications. The combinations of two varieties (BSR 1 and BSR 2) and three times of planting (May 15, June 15 and July 15) constituted the main plot treatments. The combinations of three spacings (30 x 15, 45 x 15 and 60 x 15 cm) and three nitrogen levels (125, 150 and 175 kg/ha) formed the sub-plot treatments. Plot size was - gross: 4.0 m x 3.6 m; net 3.0 m x 2.4 m. The land was prepared to a fine tilth and ridges and furrow were formed at 30, 45 and 60 cm apart. Primary rhizomes of uniform size (25 g) were planted on one side of the ridge at 5 cm depth with a spacing of 15 cm between each rhizome piece. A common dose of P and K was applied at 60 kg and 108 kg/ha respectively. The nitrogen was

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applied as per treatment. The fertilizer urea, superphosphate and muriate of potash were the sources for N, P and K, respectively. The entire P was applied as basal at the time of planting. Nitrogen and potash were applied in five equal splits at 30, 60, 90, 120 and 150 days after planting (DAP). First irrigation was given immediately after planting followed by the life irrigation three days after planting. Subsequent irrigations were given uniformly to all the treatments at an interval of seven to ten days. Yellowing and drying of leaves and subsequent lodging of plant at the end of the season are the symptoms of crop maturity. A week prior to the harvest, stem with leaves were cut close to the ground. The field was irrigated to facilitate the digging of the rhizomes with spade. The rhizome clumps were carefully lifted and cleaned and their fresh weights were recorded. The first and second year crops were harvested on 26.2.2001 and 4.3.2002, respectively irrespective of time of planting. The leaf area of the individual leaf was calculated as suggested by Balakrishnan *et al*. (1). Leaf Area = Leaf length x Leaf width x 0.6605 and leaf area index (LAI) on 180 days after planting (DAP) was calculated as per standard method and dry matter production (DMP) was recorded at harvest. The sample plant of five numbers were uprooted and sun dried for a week to ten days and later in hot air oven at 60°C till a constant weight was obtained and converted into kg/ha. The net plot yield was recorded as kg/plot and computed to t/ha. The economics were worked as per the prevailing market price and farm wages.

RESULTS AND DISCUSSION

The varieties BSR 1 and BSR 2 did not differ in their LAI in both the years but BSR 2 produced higher DMP than BSR 1 (Table 1) which was due to higher underground rhizome mass. The variety BSR 2 had higher dry turmeric yield than BSR 1. On an average, BSR 2 recorded 11.7 percent higher dry yield than BSR 1. Nutrient uptake was higher in BSR 2 than BSR 1. However, uptake of P and K of varieties was significant only during the second year. On an average, the uptake of N, P and K was 3.93, 12.39 and 3.30 percent higher in BSR 2, respectively than in BSR 1. The differential response of varieties for nutrients uptake and higher DMP were the reasons for higher uptake in BSR 2. Venkatesha (15), and Sadanandan and Hamza (11) also reported similar findings. The difference among varieties attributed to their genetic make up. The higher rhizome yield with BSR 2 might be due to more photosynthate translocation to underground rhizome by this variety. Similar growth and yield differences among turmeric varieties were also recorded by Rumi Kotoky *et al*. (10), and Dixit and Srivastava (2). The time of planting had a marked effect on growth, yield and nutrient uptake of turmeric (Table 1 and 2). Early planting of turmeric (May 15) recorded significantly higher LAI, DMP, nutrient uptake and yield during both

Table 1. Growth of turmeric as influenced by inputs.

Treatment	Leaf area index (LAI)		Dry matter production (DMP) (t/ha)		Dry turmeric yield (t/ha)	
	2000-01	2001-02	2000-01	2001-02	2000-01	2001-02
Variety						
BSR 1	6.39	6.78	11.45	10.42	5.0	5.3
BSR 2	6.11	7.02	12.05	11.04	5.6	5.9
CD (P = 0.05)	NS	NS	0.58	0.67	0.2	0.2
Planting time						
15 May	7.0	7.53	10.22	11.68	6.4	6.9
15 June	6.30	6.67	9.53	10.87	5.1	5.6
15 July	5.60	6.59	8.53	9.87	4.4	4.5
CD (P = 0.05)	0.75	0.80	0.74	0.89	0.4	0.4
Spacing						
30 x 15 cm	7.20	9.19	11.47	14.70	6.0	6.3
45 x 15 cm	6.00	6.34	9.64	9.98	5.5	5.6
60 x 15 cm	5.60	5.17	7.30	7.53	4.5	4.8
CD (P = 0.05)	0.46	0.49	0.50	0.52	0.4	1.0
Nitrogen						
125 kg/ha	6.08	5.96	9.43	9.79	4.7	4.9
150 kg/ha	6.50	6.97	10.45	10.62	5.4	5.6
175 kg/ha	7.06	7.69	11.47	11.79	5.7	6.3
CD (P = 0.05)	0.46	0.49	0.50	0.52	0.4	1.0

the years. Delayed planting (July 15) produced lower values than May 15 and June 15 planted crops. June 15 planted crop recorded medium values between May 15 and July 15 crops. The average dry rhizome yields were 6.7, 5.4, 4.5 t ha^{-1} for May 15, June 15 and July 15 plantings, respectively. Yield reduction due to delay in planting was also noted in Orissa by Mishra *et al*. (6). The nutrients (NPK) uptake in respect of time of planting indicated the same trend as that of DMP at harvest. May 15 planted crop recorded the higher uptake of N, P and K in both the years. The minimum uptake values of N, P and K were recorded in the late planted crop (July 15). The phosphorus uptake between June 15 and July 15 planted crops in both the years showed not much variation. The higher DMP recorded by early planting is the reason for higher nutrients uptake.

The spacings influenced the growth, yield and nutrient uptake. Spacing treatments were found to influence the LAI remarkably in both the years. Closer spacing recorded higher LAI followed by medium spacing. The wider spacing produced lower values of LAI. On an average, closer spacing produced 32.8 and 52.2 percent higher LAI than medium and wider spacings respectively. At closer spacing, more plants per unit area can be achieved compared to medium and wider spacings as a result more leaf area per unit area of land. Turmeric planted at closer spacing produced higher DMP in both the years and the least was recorded under wider spacing (60 cm x 15 cm). The closer spacings on an average recorded 33.4 and 76.5 percent more DMP than medium and wider spacings respectively at harvest. This difference was due to variations in number of plants per unit area. The spacings significantly influenced the dry rhizome yields of turmeric. The closer spacing recorded high rhizome yield. This result is in agreement with the findings of Medhi and Bora (5). The uptake of N, P and K was higher under narrowly spaced (30 cm x 15 cm) crop followed by 45 cm x 15 cm spacing. The uptake was lower under widely spaced (60 cm x 15 cm) crop. The phosphorus uptake of turmeric planted at medium and wider spacings was on par with each other in both the years. Similarly, closer and medium spacings behaved similarly for P uptake in first year alone. The closer spacing recorded higher uptake of N, P and K in both the years at harvest. The two years average values for K uptake for the closer, medium and wider spacings were 306.6, 297.0 and 273.4 kg/ha, respectively. Higher DMP in closer spacing resulted in higher nutrients uptake compared to medium and wider spacings. Shashidhar and Sulikeri (12) found that N and K uptake were high in medium spacing (45 cm x 22.5 cm), whereas P uptake was more in closer spacing (45 x 15 cm).

In general, higher LAI observed at 175 kg N/ha followed by 150 and 125 kg N/ha (Table 1). The result is in agreement with the findings of Sivaraman (14). This was due to larger leaf area per plant under higher N levels. Enhanced level of N (175 kg/ha) produced higher DMP in both the years. The lower level (125 kg N/ha) recorded the least values. The taller plants and

Table 2. Nutrient uptake of turmeric in relation to input management practices.

Treatment	Nutrient uptake (kg ha^{-1})					
	2000-2001			2001-2002		
	N	P	K	N	P	K
V_1 - BSR 1	173.4	34.7	282.0	175.1	33.1	293.1
V_2 - BSR 2	178.9	37.1	288.8	183.3	39.1	305.3
CD (P = 0.05)	4.2	NS	NS	4.0	4.5	8.0
D_1 - 15 May	184.5	41.1	303.9	190.4	40.1	315.3
D_2 - 15 June	176.0	35.8	282.0	178.5	35.6	301.9
D_3 - 15 July	167.8	30.9	270.3	168.5	32.5	280.3
CD (P = 0.05)	5.4	5.6	10.5	4.9	5.6	9.8
S_1 - 30 x 15 cm	185.8	38.7	297.8	189.1	39.5	315.4
S_2 - 45 x 15 cm	176.3	35.8	286.8	178.9	35.6	307.1
S_3 - 60 x 15 cm	166.1	33.3	271.7	169.6	33.5	275.1
CD (P = 0.05)	4.6	3.0	3.0	2.6	3.0	4.0
N_1 - 125 kg ha^{-1}	165.7	33.1	260.3	167.8	33.8	280.0
N_2 - 150 kg ha^{-1}	175.9	35.9	292.1	179.3	35.7	302.4
N_3 - 175 kg ha^{-1}	186.6	38.6	303.9	190.4	38.7	315.3
CD (P = 0.05)	4.6	3.0	3.0	2.6	3.0	4.0

Note : Interactions not significant.

more leaf area recorded under 175 kg N/ha are the reasons for higher DMP than 125 and 150 kg N/ha. The significant difference in DMP for N levels also reported by other workers (Pal *et al*., 8; Shashidhar *et al*., 13). Application of 175 kg N/ha recorded higher rhizome yield than the other levels. The result is in agreement with Gopalakrishna *et al*. (3). The N, P and K uptake of crop were higher at higher rate of N application followed by medium level. The phosphorus uptake of crop supplied with 175 and 150 kg N/ha did not differ significantly in both the years. Similarly, medium and higher levels were comparable with each other for P uptake in both the years. N levels significantly influenced potassium uptake and the differences in K uptake were significant between N levels. The reason is due to higher DMP by the application of 175 kg N/ha that contributed for higher uptake. Shashidhar and Sulikeri (12) also observed similar differences in N, P, K uptake at Dharwad conditions.

The higher gross returns (GR), net returns (NR) and BC ratio were recorded in the second year than in the first year. The gross and net returns and B:C ratio of BSR 2 were Rs. 1,25,000, Rs. 65,000 and 2.08 for the first year and Rs. 1,32,500, Rs. 74,100 and 2.26 for the second year (Table 3), respectively and it was higher than BSR 1. Planting at May 15 recorded higher gross and net returns, and B:C ratio followed by June 15 and July 15 plantings. Closer spacing produced higher gross and net returns, and B:C ratio than medium and wider spacings. The higher N level recorded higher gross and net returns, and B:C ratio than lower and medium levels. The economic returns, and B:C ratio were higher in the second year and it was due to higher yield compared to the first year. The variety BSR 2 performed better and produced more yield, in turn, higher economic returns. On an average, GR and NR and BC ratio were 11.7, 21.6 and 12.0 percent higher in BSR 2, respectively than BSR 1 variety. Planting early in the season (May 15) recorded higher gross and net returns and BC ratio than June 15 and July 15 plantings. The favourable growth and yield attributes and higher yield under early planting were attributed to higher returns in May 15 planting. Closer spacing (30 cm x 15 cm) recorded higher returns than other spacings. On an average, closer spacings gave, GR, NR and BC ratio of 11.0 and 32.3, 12.6 and 44.3 and 2.1 and 11.4 percent higher than (45 cm x 15 cm) and (60 cm x 15 cm) spacings, respectively. The closer spacing accommodated more plants per unit area resulting in higher yield and monetary returns. The economic returns were higher under higher N level (175 kg ha^{-1}) than lower levels. The growth and yield attributes and yield were higher under 175 kg N/ha and resulted in greater economic returns than lower N levels. Economic evaluation indicated that combination

Table 3. Influence of varieties, times of planting, spacings and nitrogen on economics (Rs./ha). ('000's)

Treatments	2000 - 2001			2001 - 2002		
	Gross returns	Net returns	B:C ratio	Gross returns	Net returns	B:C ratio
V_1 - BSR 1	125.0	65.0	2.08	132.5	74.1	2.26
V_2 - BSR 2	140.0	80.0	2.33	147.5	89.1	2.53
D_1 - 15 May	160.0	100.0	2.67	172.5	114.1	2.95
D_2 - 15 June	127.5	67.7	2.13	140.0	82.0	2.41
D_3 - 15 July	110.0	49.3	1.81	112.5	54.9	1.95
S_1 - 30 x 15 cm	150.0	85.0	2.31	157.5	94.1	2.48
S_2 - 45 x 15 cm	137.0	77.0	2.28	140.0	82.0	2.41
S_3 - 60 x 15 cm	112.5	57.5	2.05	120.0	66.6	2.25
N_1 - 125 kg N ha^{-1}	117.5	57.2	1.95	122.5	64.4	2.11
N_2 - 150 kg N ha^{-1}	135.0	75.0	2.25	140.0	81.6	2.40
N_3 - 175 kg N ha^{-1}	142.5	82.3	2.37	157.5	98.9	2.69

Data not statistically analysed. Details of cost and price: Cost of turmeric seed rhizome = Rs. 10 kg^{-1}; Price of cured turmeric = Rs. 2,500 $quintal^{-1}$; Cost of men day = Rs. 72; Cost of urea = Rs. 4.60 kg^{-1}; Seed rate = S_1 - 2000 kg ha^{-1}; S_2 = 1500 kg ha^{-1}; S_3 = 1000 kg ha^{-1}.

Number of irrigation		D_1	D_2	D_3
	1st crop	35	32	25
	2nd crop	40	35	30

of non-monetary inputs *viz.,* planting BSR 2 at 15 May with monetary inputs *viz.,* 30 x 15 cm spacing with 175 kg/ha N would increase the turmeric production and income of the farmers.

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