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Effects of Nitrogen (N) Fertilizer and Plant Spacing on the Growth and Rhizome Yield of Turmeric (*Curcuma Longa L.*) in Ibadan South-West Nigeria

Modupeola T. O.[1, *], Olaniyi J. O.[2]

[1]National Horticultural Research Institute, Ibadan, Oyo State, Nigeria
[2]Department of Agronomy, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria

Abstract

Field study were conducted in 2013 at the National Horticultural Research Institute, Ibadan to determine effects of Nitrogen (N) fertilizer and plant spacing on the growth and rhizome yield of Turmeric (*Curcuma longa L.*) in south-west Nigeria. The treatments consist of five nitrogen fertilizer rates: 0, 60, 90, 120 and 150kgNha^{-1} applied in the form of urea and three plant spacings: 25×20cm, 25×25cm and 25×30cm**,** with turmeric as the test crop. The 3x5 factorial was laid out in a Randomized Complete Block Design (RCBD), replicated thrice. The data collected were plant height (cm), number of leaves, stem girth (cm), weight of rhizome (g) and length of rhizome (cm). The results showed significant ($P \leq 0.05$) influenced of N fertilizer and plant spacing on turmeric growth and rhizome yield. Application of 120kgNha^{-1} with 25x25cm plant spacing produced the best rhizome yield of 70t ha^{-1} while the least yield of 28 t ha^{-1} was obtained from 0kgNha^{-1} with 25x30cm spacing (widest spacing). During the cropping period, turmeric produced total yield of 70t ha^{-1}. It was concluded that application of N fertilizer applied at 120kgha^{-1} with plant spacing at 25x25cm will enhance the growth and yield of turmeric.

Keywords

Nitrogen Fertilizer, Plant Spacing, Turmeric, Yield

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1. Introduction

Turmeric (*Curcuma longa L.*) is a genus of about 70 species of rhizomatous herbs distributed in India, Siam, Malay Archipelago and Northern Australia. About 30 species occur in India of which a few are of economic importance. Turmeric is originated in South-East Asia. India is the largest producer, consumer and exporter of turmeric in the world. It is grown in an area of 163,000 ha^{-1} with an average production of 552.3 thousand tonnes (Kandiannan *et al*., 2004). The quantity of fertilizers required by the crop depends on the soil and weather conditions prevailing during crop growth (Karthikeyan *et al.,* 2009). As an essential element, N is the most commonly used mineral nutrient. It is important for protein production. It plays a pivotal role in many critical functions in a plant. Singh *et al.* (1992) observed significant improvements in rhizome yield of turmeric with increased N levels up to 120 kg N ha^{-1} in India. Similarly Meerabai *et al*. (2000) recommended an application of 120 kg N and 120 kg K_2O ha^{-1} for turmeric planted in coconut gardens. Understanding the proper planting pattern and distance is very important to increase yield and to decrease interference with weeds (Baki *et al*., 1995; Murphy *et al*., 1996). Murphy *et al*. (1996) reported that plant spacing is one of the important agronomic practices for increasing yield of a crop and reducing the competition with weeds. Turmeric (*Curcuma longa L.*) is a genus of about 70 species

* Corresponding author
E-mail address: atopson@yahoo.com (Modupeola T. O.)

of rhizomatous herbs distributed in India, Siam, Malay Archipelago and Northern Australia. About 30 species occur

2. Materials and Methods

This study was conducted in 2013 at the National Horticultural Research Institute (NIHORT) Idi-Ishin, Ibadan. It is located in the forest savanna zone of south – west Nigeria (Latitude 7° 33' N and Longitude 3° 56' E). The treatments were five nitrogen fertilizer rates (0, 60, 90, 120 and 150kgN/ha) applied inform of urea and three different spacings; 25×20cm, 25×25cm and 25×30cm **,** with turmeric as the test crop. The experiment was a factorial experiment laid out in a randomized complete block Design (RCBD) with three replicates. Harvesting was carried out when the leaves begin to change colour from green to yellow by hand pulling. The rhizomes were separated from the turmeric plant with the use of sharp knife. The following data were taken from six tagged plants per bed and commenced at 9th WAP and were carried out every month till harvesting; plant height, number of leaves, stem girth (cm), length of rhizome and weight of rhizome. Data collected were subjected to Analysis of Variance (ANOVA) and significant means were separated using least significant difference (LSD) at 5% probability level.

3. Results and Discussion

3.1. Interaction Effect of N Fertilizer and Spacing

The interaction of N fertilizer and spacing significantly (P<0.05) influence the height of turmeric plant at all the sampling period. The plant grown in combined treatment of closest spacing with the optimum fertilizer rate of 120kg Nha^{-1} gave the best plant height of turmeric. Fertilizer rate at 120kgNha^{-1} with 25x20cm spacing produced the tallest plant(85.17cm) while the shortest plant height (60.33cm) was recorded at the widest spacing (25x30cm) with no fertilizer (Table 1). The highest plant height obtained in 25x20cm spacing (closest spacing) than the 25x30cm spacing (widest spacing) may be due to competion existing among plants for light, thereby causing stem elongation. When the planting density is too low, each individual plant may perform at its maximum capacity. Ameen *et al.* (1988) stated that the closest spacing recorded the highest plant height. The significantly higher plant height and number of leaves obtained at the application of 120kgNha^{-1} as compared with the value recorded to when the highest N fertilizer (150kg Nha^{-1}) was applied may be due to the effects of an excessive fertilizer on the growth of a plant. Hikaru *et al.* (2007) reported that an imbalance or excessive of nutrients prevent information which cause trouble in nutrient absorption for plant and could determine quality of turmeric. Fertilizer rate at 120kgNha^{-1} with 25x30cm spacing produced the thickest stem of 8.22cm while the thinnest stem diameter of 4.90cm was obtained from no fertilizer application at the closest spacing at 17WAP(Table 2). Rhizome length in the 25x30cm spacing had the highest value. The observation of highest rhizome length under widest spacing (25x30cm) is assumed as due to maximum space available which helps the rhizomes to extend at the fullest while the lowest rhizome length under close spacing might be due to the restriction to the growth length due to obstruction from another rhizome planted at comparatively closer spacing (25x20cm). Similar type of results was inaccordance with Sumarjit *et al.* (2013) while working on turmeric. Fertilizer rate at 150kgNha^{-1} in the widest spacing of 25x30cm gave the highest leaves number of 61.50 and the least leaves number (32.17) was obtained from no fertilizer application of the 25x20cm spacing at 17WAP(Table 3). The interaction effect of N Fertilizer with plant spacing significantly (P< 0.05) affected the rhizome length of turmeric. The longest rhizome of 8.27cm was recorded from 150kgNha^{-1} and the shortest rhizome of 4.17cm was obtained from the control at Ibadan. The combined effect of spacing and N fertilizer was significant on the rhizome yield. The best rhizome yield of 70t ha^{-1} was recorded at plant spacing of 25x25cm with 120kgNha^{-1} and this was followed by yield (68.60t ha^{-1}) obtained from 25x25cm spacing under 150kgNha $^{-1}$ while the lowest of 28t ha^{-1} was obtained from the control. The increase in yield of turmeric with increase in N application may be explained on the fact that nitrogen being active constituent of protoplasm enzyme and chlorophyll plays a role of catalytic agent in various physiological processes, accelerate cell division and speed up the photo assimilation which in turn boost the plant growth and improve the plant structures (Pandey 1992). Similar trend of increase in yield attributes with increase in nitrogen level was also reported by Pandey (1992). The higher yields at the higher nitrogen level may be due to better stem size and higher number of rhizomes per plant which may result from increase in number of leaf per plant with increase in nitrogen level with the result the net photosynthesis might be higher to supply adequate amount of photosynthates to the sinks. This trend was in line with Medhi and Bora (1993).

3.2. Main Effect of N Fertilizer and Spacing

The plant height of turmeric increased gradually as the plant aged. Spacing had significant increase on turmeric plant height with the closest spacing of 25x20cm recorded the tallest plant of 79.18cm while turmeric plants grown in 25x30cm spacing recorded the shortest plant of 69.68cm at 17WAP. At all the sampling occasions plant spacing

significantly (P<0.05) influenced the height of the turmeric plant (Table 5). The application of N fertilizer significantly (P<0.05) improved the height of turmeric plant at all sampling occasions. The plant height increased as the N rate increases from 0 up till 120 kg N ha^{-1} thereafter a declined at 150 kg N ha^{-1} of fertilizer application. The tallest plant of 82.08cm was obtained from turmeric plant that received optimum N application of 120 kg Nha^{-1} while the least height of turmeric plant was recorded at 0 kg N ha^{1} (Table 5). The stem diameter of turmeric increased gradually as the plant aged in both locations. Spacing had significant increase on the turmeric stem diameter with the widest spacing of 25x30cm produced the thickest stem of 7.33cm followed by stem in the closest spacing which recorded 6.62cm, while the stem diameter at 25x25cm spacing gave the least value of 6.54cm at 17WAP (Table 6). The stem diameter increased as the N rate increases from 0 up till 120kg N ha^{-1}, thereafter a declined at 150 kg N ha^{-1} of fertilizer application. The thickest stem of 7.76cm was obtained from turmeric plant that received optimum N application of 120kgNha^{-1} while the thinnest stem of 5.32cm was recorded at no fertilizer application at 17WAP (Table 6). The number of leaves of turmeric plant increased gradually with the increase in plant age in both locations. Spacing had significant effect on the number of leaves with the widest spacing of 25x30cm produced the highest number of leaves (54.07) while the least number of leaves (46.97) was recorded at the closest spacing at 17 WAP (Table 7). The application of N fertilizer increased the number of leaves from 0 to 120 kg Nha^{-1} thereafter decline at 150 Kg N ha^{-1} of fertilizer application. The highest number of leaves (56.11) was recorded from turmeric plant that received optimum N application of 120 kg N ha^{-1} while the least number of leaves of 33.78 was obtained from no fertilizer application at 17WAP (Table 7). The rhizome length of turmeric plant increased as the spacing increases from the closest spacing to the widest spacing. The longest rhizome of 6.38cm was obtained from the widest spacing of 25x30cm while the shortest rhizome of 5.42cm was obtained from the closest spacing (Table 8). The rhizome length increased as the N fertilizer rate applied increases. Application of 150 kg Nha^{-1} produced the longest rhizome of 6.73cm while the shortest rhizome of 4.38cm was obtained from 0 kg Nha^{-1} (control) (Table 8). Plant spacing had a significant (P≤ 0.05) influence on the rhizome yield. The highest rhizome yield (52.79 t ha^{-1}) was obtained from 25 x 25cm spacing followed by the closest (25x20cm) spacing which gave the rhizome yield of 44.7 t ha^{-1}, while the widest (30x25cm) spacing recorded the least rhizome yield of 42.5 t ha^{-1}(Table 8). The applied N fertilizer rates were also found to have significant effect on the rhizome yield. The rhizome yield increased as the N application rate increases from 0 up till 120 kg N ha^{-1}, then a declined at 150 kg N ha^{-1}. The highest rhizome yield of 61.33 t ha^{-1} was obtained from the plants supplied with 120kgNha^{-1} which was significantly higher than yield of 60.6 t ha^{-1} obtained from plants treated with 150kgNha^{-1} while the lowest rhizome yield of 28.22 t ha^{-1} was recorded from the plants in the plot with no fertilizer application (control) (Table 8).

It was concluded that application of 120KgNha^{-1} to turmeric plants spaced at 25x25cm enhanced the growth and rhizome yield of turmeric.

Table 1. Interaction effect of nitrogen fertilizer and plant spacing on Plant height (cm) of turmeric.

Spacing(cm)	Fertilizer(N.kg/ha)	9WAP	13WAP	17WAP
25×20	0	28.75	54.75	66.50
	60	39.83	66.43	79.58
	90	41.70	68.83	80.17
	120	43.92	69.33	85.17
	150	42.02	70.95	84.50
25×25	0	27.17	51.20	62.67
	60	31.42	65.55	73.72
	90	35.07	63.08	74.42
	120	41.57	69.33	82.50
	150	39.22	64.03	81
25×30	0	22.83	50.25	60.33
	60	34.35	56.16	67.42
	90	36.13	57.33	69.42
	120	36.31	68.58	78.58
	150	39.17	65.88	72.67
L.S.D.(5%)				
Spacing		0.84	0.34	0.92
Fertilizer		1.08	0.43	1.18
Spac × Fert.		1.88	2.17	2.05

Table 2. Interaction effect of nitrogen fertilizer and plant spacing on stem girth (cm) of turmeric.

Spacing(cm)	Fertilizer(N.kg/ha)	9WAP	13WAP	17WAP
25×20	0	2.58	3.40	4.90
	60	3.20	5.62	6.53
	90	3.17	6.10	6.76
	120	3.32	6.18	7.90
	150	3.38	5.52	7.00
25×25	0	1.95	3.92	5.22
	60	3.02	5.28	6.10
	90	3.17	5.82	6.35
	120	3.57	6.35	7.17
	150	2.97	5.83	7.85
25×30	0	2.33	4.22	5.85
	60	3.33	6.48	7.07
	90	3.38	6.52	7.65
	120	3.38	6.82	8.22
	150	3.15	6.43	7.88
L.S.D.(5%)				
Spacing		NS	0.50	0.61
Fertilizer		0.35	0.64	0.79
S × F		NS	NS	NS

ns= not significant.

Table 3. Interaction effect of nitrogen fertilizer and plant spacing on number of leaves of turmeric.

Spacing(cm)	Fertilizer (N.kg/ha)	9WAP	13WAP	17WAP
25×20	0	5.50	15.83	32.17
	60	6.50	20.38	49.50
	90	6.00	20.67	49.67
	120	7.50	22.55	53.83
	150	7.33	19.50	49.67
25×25	0	5.33	19.67	34.00
	60	6.83	21.00	50.17
	90	7.17	21.00	51.67
	120	7.50	22.17	54.00
	150	7.33	21.65	53.50
25×30	0	5.67	19.50	35.17
	60	7.33	22.50	55.33
	90	7.50	22.82	57.83
	120	7.67	25.83	60.50
	150	7.67	23.17	61.50
L.S.D.(5%)				
Spacing		NS	NS	0.98
Fertilizer		1.03	NS	1.26
S × F		NS	NS	2.19

ns= not significant.

Table 4. Interaction effect of nitrogen fertilizer and plant spacing on yield parameters of turmeric.

Spacing (cm)	Fertilizer (N.kg/ha)	Rhizome Length (cm)	Yield t/ha
25×20	0	4.17	28.0
	60	5.80	37.50
	90	5.60	42.00
	120	5.83	59.33
	150	5.70	56.67
25×25	0	4.33	28.66
	60	6.23	44.00
	90	6.23	52.67
	120	6.53	70.00
	150	6.23	68.60
25×30	0	4.63	28.00

Spacing (cm)	Fertilizer (N.kg/ha)	Rhizome Length (cm)	Yield t/ha
	60	5.33	35.33
	90	6.67	38.00
	120	7.00	54.67
	150	8.27	56.67
L.S.D.(5%)			
Spacing		0.40	0.47
Fertilizer		0.52	0.61
S × F		0.89	1.06

NS= not significant.

Table 5. Main effect of plant spacing and nitrogen fertilizer on Plant height (cm) of turmeric.

Treatments	9WAP	13WAP	17WAP
Spacing(cm)			
25x20	39.24	66.06	79.18
25x25	34.89	62.64	74.86
25x30	33.76	59.64	69.68
L.S.D. (5%)	0.84	0.34	0.92
N Fertilizer (kg ha^{-1})			
0	26.25	52.07	63.17
60	35.20	62.72	73.57
90	37.63	63.08	74.67
120	40.60	69.08	82.08
150	40.13	66.96	79.39
L.S.D. (5%)	1.08	0.43	1.18

Table 6. Main effect of nitrogen fertilizer and plant spacing on stem diameter (cm) of turmeric.

Treatments	9WAP	13WAP	17WAP
Spacing(cm)			
25x20	3.11	5.36	6.62
25x25	3.13	5.44	6.54
25x30	3.12	6.09	7.33
L.S.D. (5%)	0.27	0.50	0.61
N Fertilizer (kg ha-1)			
0	2.29	3.84	5.32 7.76 7.58
60	3.18	5.79	6.57
90	3.24	6.14	6.92
120	3.42	6.45	7.76
150	3.46	5.93	7.58
L.S.D. (5%)	0.35	0.64	0.79

Table 7. Main effect of nitrogen fertilizer and plant spacing on number of leaves of turmeric in Ibadan and Ogbomoso.

Treatments	9WAP	13WAP	17WAP
Spacing(cm)			
25x20	6.57	19.8	46.97
25x25	6.83	21.1	48.67
25x30	7.17	36.1	54.07
L.S.D. (5%)	0.80	22.44	0.98
N Fertilizer (kg ha^{-1})			
0	5.50	18.3	33.78
60	6.89	21.3	51.67
90	6.89	43.7	53.06
120	7.56	23.5	56.11
150	7.44	21.4	54.89
L.S.D. (5%)	1.03	28.97	1.26

Table 8. Main effect of nitrogen fertilizer and plant spacing on yield parameters of turmeric in Ibadan and Ogbomoso.

Spacing(cm)	Rhizome Length (cm)	Yield (t ha-1)
25x20	5.42	44.7
25x25	5.91	52.79
25x30	6.38	42.5
L.S.D. (5%)	0.40	0.47
N Fertilizer (kg/ha)		
0	4.38	28.22
60	5.79	38.94
90	6.17	44.2
120	6.46	61.3
150	6.73	60.6
L.S.D. (5%)	0.52	0.61

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