Effect of Planting Dates and NPK (15:15:15) Fertilizer on the Growth and Yield of Turmeric (Curcumalonga Linn).

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Abstract

Climatic conditions prevailing during crop growth, the period to which crops are planted and varying fertility rates are great determinants of yield of crops. The study was carried out to evaluate the effect of planting dates and NPK (15:15:15) fertilizer on the growth and yield of Turmeric. The experiment was laid out in a randomized complete block design (RCBD) in split plot arrangement. Treatments consisted of four planting dates and four fertilizer rates replicated three times. Spacing used was 30cm x 20cm. The planting dates were April 15th, May 15th, June 15th, and July 15th. The fertilizer rates were O, 150, 300 and 450 (kg NPK ha^{-1}) giving a total of 16 treatment combinations. The result obtained showed that planting dates and NPK fertilizer rates significantly affected the growth and yield of Turmeric. Turmeric planted in May with NPK applied at the rate of 150 and 300 kg NPK ha^{-1} produced highest plant height, highest number of primary and secondary rhizome, highest rhizome weight and highest rhizome yield.

Key words: *Planting dates, NPK (15:15:15) fertilizer, turmeric (Curcuma longa) and Curcumin*

I. INTRODUCTION

Turmeric (*Curcumalonga Linn.*)a spice crop, is a rhizomatous herbaceous perennial plant of the family Zingiberaceaeand sub-family Zinigeradeae.It is cultivated extensively in India, Sri Lanka, parts of China, Indo-China and Pakistan. Turmeric is widely used as a spice, cosmetic and medicine in Bangladesh, India, Pakistan, Myanmar, Sri Lanka and Thailand. (Hermanand and Martin, 1991), Uechi et al.,2001).Use of turmeric can be traced back nearly 4000 years to the Vedic culture in India, when turmeric was the principal spice and also had religious significanceHossain et al., 2005).It is one of the principal ingredients of curry powder, which is a blend of many spices. Turmeric is valued for its underground orange colored rhizome which is used as natural coloring agent for food, cosmetics and dye. It is an ancient, most valuable, sacred spice that contains appreciable quantities of proteins (6.3%), lipids (5.1%), carbohydrates (69.4%) and fiber (2.6%).

It is also used as a natural dye of cloth, leather, silk, fibre, wool and cotton. It is extensively used as stimulant, blood purifier, tonic as a carminative and remedy against the skin diseases, pain and anthelminticSrimal, 1997). Turmeric oil is believed to have anti-arthritic and anti-inflammatory properties. The oil has antimicrobial properties, and is very effective against pathogenic bacteria and fungi. Curcumin, volatile oil and essential oil of turmeric prevents tumour formation, improve kidney and liver functions and they could be used to alleviate diabetic and hepatic disorders [1] (Hermann and Martins, 1991).The average composition of turmeric is; moisture (6.0%), protein (6.5%), ash (6.0%), crude fibre (3.0%), starch (5.0%), fixed oil (3.5%), volatile oil (4.5%) and curcumin (3.1%). (Manjunath et al.,1991).Several studies reported that turmeric is a nutrient exhaustive crop; especially it is a heavy feeder of N, (Singh et al., 2001; Soorianathasundaram et al., 2007; Agere and Shiferaw, 2015). The high nutrient requirement of turmeric is due to their shallow rooting and potential to produce large amount of dry matter per unit area(Singh et al., 2001). In addition, the crop has a prolonged growing period (up to 9 months), therefore, the nutrient requirement period also become prolonged. Nitrogen is commonly the most limiting nutrient for crop production. N is involved in chlorophyll formation, and influences stomatal conductance and photosynthetic efficiency and is responsible for 26-41% of crop yields (Ivonyi et al., 1997). Several studies reported that nitrogen application had significant effect on growth, yield and yield components of turmeric (Shashidhar and Sulikeri, 1996; Hikaru et al.,2007; Agere and Shiferaw, 2015). It has been also reported that application of nitrogen not only increases the yield of turmeric, but also enhances the quality attributes (Hikaru et al., 2007). Application of nitrogen also enhances the efficacy of other nutrients (P and K) that improve the yield of turmeric (Pandey, 1992).

In Nigeria, turmeric is still a relatively new crop to farmers especially in the southern parts of the

country.The demand for turmeric in the past decade has been on the increase while its production technology has not been fully developed. The production of turmeric per unit area is still very low because of the poor knowledge on proper cultivation technology by the farmers (Ishimine, 2003). Turmeric growers are faced with a lot of barriers mitigating the production and yield of the crop; ranging from difficulties in agronomic practices such as best planting time and fertilizer requirement vis a vis paucity of information on the nutritional requirements, growth patterns and yield of the crop in relation to appropriate planting dates and fertilizer requirements. Therefore, the present study was undertaken to evaluate the effects of planting date and NPK (15:15:15) Fertilizer on the growth, yield and curcumin content of turmeric plants in Obubra, Nigeria.

II. MATERIALS AND METHODS

A field experiment was conductedin 2015 and repeated in 2016 cropping seasons atthe Teaching and Research farm, Cross River University of Technology (CRUTECH), Obubra, in the southern rainforest of Nigeria. The site characterized by a sandy loam tropical ultisol soil is situated on longitude 08^{o} 16′E and latitude 05^{o} 59′N with an altitude of 184 m above sea level. Obubra has a mean annual rainfall of 1500mm – 2500 mm with an annual temperature of (25 – 27) ^{o}C.Soil samples of the experimental site were collected with soil Auger prior to planting. The soil samples were air dried and sieved with wire mesh of 0.02 mm sieve. The particle size was determined by using the(Bouyoucos, 1962) hydrometer method. Treatments consisted of four planting dates; April 15th, May 15th, June 15th and July 15th and four fertilizer rates; 0; 150; 300 and 450 (Kg NPK ha^{-1}). These formed a total of 16 treatment combinations. These were assigned into a factorial experiment and fitted into a randomized complete block design (RCBD) and replicated thrice. The parameters taken were plant height, dry matter production, number of primary rhizomes, number of secondary rhizomes, fresh yield, dry yield, dry yield recovery and curcumin content.Harvesting was done when the leaves began to change colour from green to yellow while the rhizomes were separated from the turmeric plant. Data collection started immediately sprouting occurred and continued at 2 weeklyintervals for 16 weeks. The moisture content was determined using drying to the constant loss of the weight. Other proximate analysis of turmeric was done chemically according to the official methods of analysis described by(AOIC, 1990; AOIC, 1998). All data collected were subjected to ANOVA and significant means were separated by the Least Significant Differences (LSD) at 5% probability level.

III. RESULTS AND DISCUSSION

The chemical and physical properties of the soil used for the experiment before planting are presented on Table 1.The result of soil analysis show that the soil was acid sandy loam containing high amounts of organic carbon and available phosphorus, but was low in total nitrogen and effective cation exchange capacity (ECEC). The high sand fraction of the soil may be attributed to the nature of their parent material, and its low pH and ECEC to excessive rainfall that caused the leaching of basic cations beyond the rooting zone, leaving behind the acid-forming H^{+} and Al^{3+} ions. The organic carbon content of the soil was low, similar to reports by Oku et. al (2012) while the high base saturation indicates that it may be suitable for the cultivation of arable crops if measures are taken to alleviate soil acidity.

TABLE 1. PRE-PLANTING PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

AT THE STUDY SITE SOIL PROPERTY	2015	2016
pH (H_2O)	5.48	5.45
Organic matter (%)	2.10	1.66
Total nitrogen (%)	0.11	0.15
Available phosphorus (mg kg^{-1})	16.0	15.46
Exchangeable bases (cmolkg^{-1}):		
Ca	4.4	5.06
Mg	2.0	1.09
Na	0.08	0.09
K	0.19	0.22
Exchangeable acidity (cmolkg^{-1}):		
Al^{3+}	0.31	0.35
H^{+}	0.56	0.51
ECEC	8.9	8.55
Base saturation (%)	78.0	76.0
Particle size (%):		
Sand	78.3	78.1
Silt	15.0	13.4
Clay	6.7	8.5

Textural Class	Sandy loam	
Sandy loam		

Planting date and NPK (15:15:15) fertilizer had significant (P<0.05) effect on plant height and dry matter production, during both the years (Table 2).

TABLE 2: PLANT HEIGHT OF TURMERIC AND DRY MATTER PRODUCTION AS INFLUENCED BY PLANTING DATES AND NPK (15:15:15) FERTILIZER IN OBUBRA.

Treatment	Plant height/plant (cm)		Dry matter/plant (g)	
Planting Date	2015	2016	2015	2016
April 15	60.0	59.8	22.02	22.52
May 15	66.1	65.0	26.70	28.10
June 15	60.8	62.2	22.22	22.60
July 15	48.3	46.8	16.30	18.32
LSD (P=0.05)	5.6	6.5	1.74	1.89
NPK (15:15:15) Kg ha^{-1}				
0	60.8	63.2	17.23	20.60
150	67.5	66.6	24.82	22.50
300	70.4	71.6	25.56	24.60
450	67.4	56.8	22.74	21.82
LSD (P = 0.05)	5.3	5.5	1.74	NS
Planting date x NPK	NS	NS	NS	NS

However, highest plant height of (66.1 cm) and (65.0 cm) was obtained in May planting in 2015 and 2016, respectively. This was followed by June and April plantings with plant heights of (60.8 cm) and (60.0 cm) for 2015 and 2016, respectively while the lowest was found in July (48.3 cm) and (46.8 cm) for 2015 and 2016, respectively. Similarly, dry matter production was highest (26.7 g) and (28.10 g) in May plantings in both the years. The lowest (16.3 g) and 18.32 g) dry matter production was recorded in July planting for 2015 and 2016, respectively.

NPK (15:15:15) fertilizer applied at the rate of 300 kg ha^{-1} gave the highest(70.4 cm) plant height and dry matter production (25.56 g) of turmeric in 2015 and 2016, respectively.

Planting date had significant (P<0.05) effect on number of secondary rhizomes during 2015 and 2016 (Table 3).

TABLE 3: NUMBER OF PRIMARY AND SECONDARY RHIZOMES AS INFLUENCED BY PLANTING DATES AND NPK (15:15:15) FERTILIZER.

Treatment	No. of I^{o} rhizomes		No. of II^{o} rhizomes	
Planting date	2015	2016	2015	2016
April 15	3.1	3.5	10.8	11.3
May 15	3.9	4.2	14.2	15.5
June 15	2.8	3.0	8.8	12.8
July 15	2.5	2.7	7.5	10.0
LSD	NS	NS	5.7	2.67
Fertilizer (kg ha^{-1})				
0	2.5	2.8	28.6	28.2
150	3.5	3.6	41.5	46.5
300	4.6	5.0	42.3	48.3
450	2.8	3.2	44.9	41.5
LSD	1.14	1.15	5.22	5.42
Planting date x Fertilizer				
LSD (0.05)	NS	NS	NS	NS

Number of primary rhizomes was not significantly (P>0.05) affected by planting date in both the years. While the number of primary and secondary rhizomes was significantly (P<0.05) affected by NPK (15:15:15) fertilizer. Application of fertilizer at the rate of 300 kg ha^{-1} produced the highest (3.4), (5.0) and (42.3), (48.3) number of primary and secondary rhizomes in 2016 and 2017, respectively. Increasing the level of fertilizer beyond 300 kg ha^{-1} did not result to a significant increase in the number of primary and secondary rhizomes. The least number of rhizomes was recorded in the control where no fertilizer was applied.Planting dates and NPK (15:15:15) fertilizer also significantly (P<0.05) affected the fresh yield, dry yield, dry recovery and curcumin content of turmeric in 2015 and 2016 (Tables 4a and 4b).

TABLE 4A: FRESH YIELD, DRY YIELD, DRY RECOVERY AND CURCUMIN CONTENT OF TURMERIC AS INFLUENCED BY PLANTING DATES AND NPK (15:15:15) FERTILIZER IN OBUBRA IN 2015.

Treatment	Fresh yield (t/ha)	Dryyield (t/ha)	Dry Recovery (%)	Curcumin (%)
Planting Date	2015	2015	2015	2015
April 15	52.2	9.2	17.0	3.7
May 15	57.8	12.7	19.5	3.8
June 15	43.7	8.3	18.0	3.5
July 15	24.5	4.5	15.4	3.6
LSD(P=0.05)	3.5	2.6	0.5	NS
NPK (15:15:15) Kg ha^{-1}				
0	37.5	6.7	17.9	3.9
150	54.6	9.4	17.2	3.8
300	56.0	10.6	18.9	3.3
450	32.1	5.6	17.4	3.8
LSD (P 0.05)	4.5	2.6	0.5	NS
Planting date				

x NPK	NS	NS	NS	NS

TABLE 4B: FRESH YIELD, DRY YIELD, DRY RECOVERY AND CURCUMIN CONTENT OF TURMERIC AS INFLUENCED BY PLANTING DATES AND NPK (15:15:15) FERTILIZER IN OBUBRA IN 2016.

Treatment	Fresh yield (t/ha)	Dry yield (t/ha)	Dry Recovery (%)	Curcumin (%)
Planting Date	2016	2016	2016	2016
April 15	51.5	8.3	15.8	3.2
May 15	58.2	10.8	19.8	4.0
June 15	44.0	8.0	18.2	3.5
July 15	28.6	5.6	18.6	3.1
LSD(P=0.05)	5.6	1.8	2.8	0.5
NPK(15:15:15) Kgha^{-1}				
0	35.2	5.8	16.5	3.7
150	65.5	9.4	16.9	3.8
300	60.2	10.2	16.9	3.7
450	35.5	6.1	17.2	3.9
LSD (P = 0.05)	8.6	1.8	2.8	NS
Planting date x NPK	NS	NS	NS	NS

Planting date and NPK fertilizer significantly ($p<0.05$) affected the fresh yield, dry yield and dry recovery of turmeric. The highest fresh and dry rhizomes yield of 57.8 and12.7 tons ha^{-1}and 58.2 and 10.8 tons ha^{-1}was obtained in May planting in 2015 and 2016, respectively. while the least was obtained in Julyplanting with a fresh yield of24.5 and28.6 tons ha^{-1} and dry yield of 4.5 and 5.6 tons ha^{-1} for 2015 and 2016, respectively. Similarly, NPK (15:15:15) fertilizer also significantly ($p<0.05$) affected the fresh and dry weight of turmeric. The application of NPK (15:15:15) at the rate of 150 kg ha^{-1}gave the highest fresh and dry yield of turmeric with a yield of 65.5 and 54.6 tons ha^{-1} and 9.4 and 9.4 tons ha^{-1}for 2015 and 2016, respectively.

The plant growth and rhizome formation starts early and gets more time for development thus resulting in taller plants, more accumulation of dry matter, and higher number of primary and secondary rhizomes in early planted crop than late planted crops except in April planting. The reduction in yield due to delayed planting for fresh and dry rhizome yields were 24.4% and 57.6% and 34.6% and 64.5% for 15 June and 15 July plantings, respectively than 15 May planting. The dry recovery of 15 May planted crop was higher by 7.7 % and 2.0% during the first year and 8.3 % and 56.5% in the second year than 15 June, plantings respectively. Similarly, the curcumin content of 15 May planted crop was higher by 7.9 and 10.5% in the first year and 12.5 and 22.5% in the second year than 15 June planted crops, respectively. However, yield reduction due to earlier planting for fresh and dry rhizome yields were 9.7 % and 27.6% for 15 April plantings, respectively than 15 May planting. The dry recovery of 15 May planted crop was higher by 12.8 % and 20.2% during the first and second year than 15 June, plantings respectively. Similarly, the curcumin content of 15 May planted crop was higher by 2.6 and 20% in the first year and second year than 15 June planted crops, respectively.

The growth of turmeric which showed tallest plants, higher dry matter production, number of primary and secondary rhizomes, fresh and dry rhizome yield in May, indicates that the most suitable planting date for turmeric in this location is middle of May. These date is in agreement with the findings byKandiannan andChandaragir. 2006, and differ from an earlier report byYukio, et al., 2004; Mishra, et al., 1997, Yadav, 2000 andNandi, 2000)whoall reported that most number of primary and secondary rhizomes were produced in June. The production of tallest plants in this study in the month of May agrees with the report of (Mins et al. 1996)who noted that the best planting dates for turmeric is May. April planting did not, however produce higher yield even though it was planted earlier than May. This could be attributed to the scanty rainfall within the period which hampered the initial crop establishment for better utilization of light and soil nutrients. NPK fertilizer applied at the rate of150 kg ha^{-1} produced taller plants, higher dry matter production,primary and secondary rhizomes, fresh and dry rhizome yields and dryrecovery. The growth and yield response of turmeric to NPK fertilizer is an indication of the plant's response to complete fertilizerNPK which are the three major nutrients which individually and/or together maintain growth, yield and quality of plants Mazid, 1993;Govid, et al., 1990;and Reddy, et al., 2003. Behura, 2001also reported that the application of NPK provides 4 to 6 times greater shoot biomass and 8 to 9 times higher yield.

IV. CONCLUSION

The experiment was laid out in a randomized complete block design (RCBD) in split plot arrangement with three replications. Treatments consisted of four fertilizer rates (O, 150, 300 and450 kg^{-1}NPK 15:15:15 fertilizer) and four planting dates (April 15, May 15, June 15, July, 15, respectively). Whole or split mother and finger rhizomes were used as planting materials.

The result showed that planting done in May and June will suffice to produce good yield but planting done in May will ensure optimum growth

and rhizome yield with the fertilizer rates of 150kg^{-1} and 300kg^{-1}. From the result, it can be concluded that planting dates and levels of fertilizer significantly affected the growth and yield of turmeric. Planting done in done in May will ensure optimum growth and rhizome yield. Fertilizer rates of 150kg^{-1} and 300kg^{-1} can ensure optimum growth and rhizome yield.Hence, turmeric planted in this locality, Obubra, should be done in May with fertilizer levels of 150kg^{-1} and 300kg^{-1} to ensure optimum growth and yield.

REFERENCES

[1] P.T.A. Hermanand A.W. Martin "Pharmacology of Curcuma longa". Planta Med. 1991. 57: 1-7

[2] S. Uechi, Y. Miyagi and Y. Ishimine. Antibacterial activity of essential oils from Curcumin sp. (Zingiberaceae) cultivated in Okinawa against foodborne pathogenic bacteria. Jap. J. 2001. 44(2): 138-40

[3] M.A.Hossain, Y. Ishimine, H. Akamine and K. Motomura. "Effect of seed rhizome size on growth and yield of turmeric (Curcuma longa L.)". Plant Prod. Science 2005. 8: 86-94

[4] R.C.Srimal, Turmeric: A brief review of medicinal properties. Fitoterapia. 1997. 68(6): 483-93.

[5] M.N.Manjunath, V. V. Sattigeri, and K. V. Nagarai. "Curcumin in turmeric". Spices of India, 1991. 12: 7-9.

[6] P.Singh, P. Srivastava, A. Sharma, D. Hore and B. Panwar, 2001. Genetic variability and correlation in turmeric (Curcuma longa L.). Indi. J. Hill Farm., 14:24-28.

[7] K.Soorianathasundaram, P. Selvaraj and M. Balusamy, 2007.Training manual onBalanced Fertilization for Turmeric. Agricultural Research Station, TNAU, Bhavanisagar-638451.

[8] AgereLupi and ShiferawTemteme, 2015. Determination of optimum rate of nitrogen and phosphorous fertilizers for the yield and yield components of turmeric (Curcuma longa L.) on Nitisols at YakiWoreda Southwestern Ethiopia. Acad. Res. J. Agri. Sci. Re.3(10):289-295

[9] Ivonyi, I., Izsoki, Z. and Van der, W., 1997. Influence of nitrogen supply and P and K levels of the soil on dry matter and nutrient accumulation of fiber helm (Cannabis sativa L.). J.Inter.Hel. Assoc., 4:82-87

[10] T.Shashidharand G. Sulikeri, 1996. Effect of plant density and N levels on growth and yield of turmeric (Curcuma Longa L.). Division of Horticulture, University of Agricultural Sciences, Dharwad. Karnat. J. Agri. sci.9(3):483-488.

[11] A.Hikaru, H. Amzad, I. Yukio, Y. Kenichi, H. Kazuo, I. Yukikazu and A. Yoko, 2007. Effects of application of N, P and K alone or in combination on growth, yield and curcumin content of turmeric (Curcuma longaL.). Plan.Pro.Sci., 10(1):151-154

[12] A.Pandey. Response of turmeric to various levels of nitrogen under terrace conditions of mid altitude, Mizoram. Indi. Coc., Are. Spi. J.,1992. 16(1):14-16

[13] Y.Ishimine, M. A. Hossain, K. Motomura, H. Akamine and T. Hirayam. "Effects of planting date on emergence, growth and yield of turmeric (Curcuma longa L.) in Okinawa Prefecture, Southern Japan". Jpn. J. Trop. Agric. 2003. 48:10-16.

[14] G.J.Bouyoucos. "Hydrometer method improved for making particle size analyses of soils". Agronomy J. 1962. 54: 464-465.

[15] AOAC, "Official Methods of Analysis, Volume 2. 18th Edn." 1990. Association of Official Analytical Chemists, Washington DC. USA.

[16] AOAC, "Official Methods of Analysis, Volume 2. 18th Edn." 1998. Association of Official Analytical Chemists, Washington DC. USA.

[17] E.Oku,A. Iwara, and E. Etukinam. "Effects of age of rubber (HeveabrasiliensisMuellArg.) plantation on pH, organic carbon, organic matter, nitrogen and micronutrient status of ultisols in the humid forest zone". Kasetsart J. (Natural Science). 2012. 46(5): 648-693.

[18] K.Kandiannan and K.K. Chandaragir. 2006. Influence of varieties, planting dates, spacing and nitrogen levels on growth, yield and quality of turmeric (Curcuma longa). Indian J. of Agricultural sciences. 76 (7): 432-434

[19] S.Yukio, M. A. Hossain, K. Motomura, H. Akamine and T. Hirayama. "Effects of planting date on Emergence, Growth and Yield of Turmeric (Curcuma longa L.) in Okinawa Prefecture, Southern Japan". 2004

[20] M.Mishra, B.B. Mishra, and S. N. Mishra. 1997. Effects of planting dates and varieties on yield of turmeric (Curcuma longa). Indian J. Agron. 42(4): 713-716

[21] G.C. Yadav. Response of turmeric varieties to dates of planting and fertility levels, Ph.D Thesis, Department of Veg. Sci., Narendra Deva University of Agriculture and Technology, Kumargani, Faizabad (U.P).2000.

[22] A.Nandi. Evaluation of turmeric (Curcuma longa L.) varieties for north east Plateau Zone of Orissa under rain fed condition. 2000. Indian J. Agric. Sci. 60: 760-761.

[23] H.Min,S. Chiu and H. Liv. 1996. Effects of planting dates and density on the rhizome yield and turmeric content of turmeric (Curcuma aromatic). J. Agric. Res., China 45(2): 146-173

[24] M.A.Mazid. Exploring nitrogen remobilization for seed filling using natural variation in Arabidopsis thaliana. Ph.D dissertation, University of the Phillippines at Los Banos, 1993. 232p.

[25] S.Govid, P. N. Gupta and R. Chandra. Response of N and P levels on growth and yield of components of turmeric. 1990. Indian J. Hort. 47(1): 79-84

[26] Behura, S. 2001. Effect of Nitrogen and potassium on growth parameters and rhizomatic. Indian J. Agron. 46: 747-751

[27] L.Reddy, B. Odhav and K.D. Bhoola. Natural products for cancer prevention: a global perspective. 2003.

[28] Pharmacology and Therapeautics. Vol. 99(1): 1-13