JOURNAL OF PURE AND APPLIED MICROBIOLOGY, June 2016. Vol. **10**(2), p. 1311-1317

Effect of Variety, Planting Material and Plant Growth Bio-regulant on Turmeric Performance (*Curcuma longa* l.) under Middle Gujarat Condition

A.S. Thounaojam*, A.D. Patel, A.Y. Makani, N.N. Chaudhary and D.B. Nakarani

Department of Plant Physiology, Anand Agricultural University, Anand - 388 110, India.
*Assistant Research Scientist, Medicinal and Aromatic Plants Research Station, ICAR Unit, Anand Agricultural University, Anand, Gujarat, India.

(Received: 11 February 2016; accepted: 12 March 2016)

Turmeric (*Curcuma longa* L.) is one of the important spice crops currently receiving research attention to increase production and quality. A field experiment was therefore conducted at the Medicinal and Aromatic Plants Project, Anand Agricultural University, Anandin 2012-13 and 2013-14 to determine the effect of variety, planting material, plant growth bio-regulant on growth, yield and quality performance of turmeric. Under the main plot treatment consists of two varieties of turmeric, Gujarat navsari Turmeric-1 (V_1) and Sughandhum (V_2) along with two planting materials like mother (M_1) and finger (M_2) rhizome of each variety. In sub plot treatments consists of foliar spray of plant growth bio-regulant at 90 days after planting, which included of IBA at two levels (100 and 200 mg l^{-1}), NAA (50 and 100 mg l^{-1}) and KNO_3 (2000 and 4000 mg l^{-1}) with control (without spray). The growth, yield and quality contributing parameters were significantly differed during the individual years. The results revealed that mother rhizomes used as a planting material of variety Gujarat Navsari Turmeric-1 with NAA @ 100 mg l^{-1} had significant effect for plant height, leaf length, leaf width, number of leaves and tillers per plant; yield (t ha^{-1}) as well as higher curcumin content (%) were also observed.

Keywords: Turmeric, variety, planting material, IBA, NAA, KNO_3, growth, yield, curcumin.

Turmeric, the dried underground rhizomes of *Curcuma longa* L. is one of the horticultural and commercial spice crops produced in India as well as in other tropical and sub-tropical regions of the world. India is the single largest producer of turmeric and it contributes 94% of the world's demand (Anon. 2005).Indian turmeric is considered as the best in the world because of its high curcumin content. Curcumin is basically colouring compound present in turmeric underground rhizome which is commonly used as natural colouring agent for food, cosmetics and dyes. The active principles present in turmeric is curcuminoids, a sequisterpenecompound is known to have lots of medicinal properties like in the treatment of circulatory problems, liver disorders, dermatological disorders as well as menstrual disorders (Ishimine *et al*., 2003). The other constituents are carbohydrate (69.43%), protein (6.30%) and minerals (3.50%) on dry weight basis (Olojede *et al*., 2005). Turmeric requires a hot and moist climate, fairly heavy rainfall for the first 2 months after planting is essential for sprouting, root and shoot emergence with a soil pH range of 4.3 to 7.5.

Turmeric is vegetatively propagated through its fingers or rhizomes. Therefore, large amount of planting materials is required for planting per unit area. Planting material plays a very important role in production cost. Various opinions

* To whom all correspondence should be addressed.
E-mail: amarjeetsinghaau@gmail.com

are found regarding the use of planting material. The mother rhizomes used as planting materials observed higher yield over the finger rhizomes (Singh *et al.*, 2013; Padmadevi *et al.*, 2012; Manhas *et al.*, 2010; Balwinder and Gill, 2010). Plant growth hormones and other inorganic nutrients are required adequately at right stages of plant growth and its play a very important role on the vegetative and reproductive phages to complete their life cycle. Now a day, many synthetics hormones are available in market and employed by the farmers to accelerate the growth and development of any plant. Various process are incorporate with PGRs including cell division, cell elongation, enhance the source-sink relationship and stimulate the translocation of photo-assimilates thereby helping in effective flower formation, fruit and seed development and ultimately enhance the productivity of crops. On these backgrounds the present investigation was carried out to study the use of different planting materials and foliar application of IBA, NAA and KNO_3 on growth, yield and quality of turmeric crop under middle Gujarat agro climatic condition.

MATERIALS AND METHODS

The field experiment was conducted during the Summer-*Kharif*2012-13 and 2013-14at Medicinal and Aromatics Plants Project, Anand Agricultural University, Anand. The area is characterized by low and erratic rainfall with mean annual rainfall of 864 to 870 mm with peaks in July to August and soil type is typical sandy loam locally known as "Goradu".

The experiment was laid out in SPD with three replications which consists of main plot treatments *viz.*, varieties [(Gujarat Navsari Turmeric-1 (V_1) and Sughanghum (V_2)] and planting materials [mother rhizome (M_1) and finger rhizome (M_2)] along with seven sub-plot treatments (T) *viz.*, T_1- IBA@ 100 mg l^{-1}, T_2-IBA@ 40mg l^{-1}, T_3- NAA @ 50 mg l^{-1}, T_4- NAA @ 100 mg l^{-1}, T_5- KNO_3@ 2000 mg l^{-1}, T_6- KNO_3@ 4000 mg l^{-1}, T_7-control (without spray) were applied at 90 days after planting (DAP) as a foliar application. The seedlings were planted on 14th and 3rd June 2012-13 and 2013-14, respectively and required agronomic practices were followed.

The plant height, leaf length, leaf width, number of leaves and tillers per plant were recorded at 90, 120, 150 and 180 DAS from the randomly selected five tagged plants from each plot and average was worked out and presented in graphical format (pooled value of the two individual years). As well as the yield (tonnes ha^{-1}) and curcumin content (%) were also analysed with the help of FT-NIR instrument available at Department of Soil Sciences, Navsari Agricultural University, Navsari, Gujarat (Table 1).The statistical analysis of the data generated during the course of investigation was carried out through software following the procedure described by Walter and Freedom 2007.

RESULTS AND DISCUSSION

Effect of varieties

The growth parameters like leaf length (29.76, 48.29, 52.54 and 51.33 cm), number of leaves $plant^{-1}$ (5.09, 6.75, 9.10 and 10.33) were recorded higher under the variety Gujarat Navsari Turmeric-1 (V_1) at 90, 120, 150 and 180 days after planting, respectively in pooled analysis. Similarly, higher plant height (97.55, 106.49 and 107.50 cm), leaf width (13.81, 15.21 and 15.67 cm) and number of tillers $plant^{-1}$(2.73, 3.34 and3.45) were also noted in Gujarat Navsari Turmeric-1 at 120, 150 and 180 DAP, respectively in pooled analysis. While, at initial growth stages the variety Sughandhum (V_2) recorded higher plant height (51.96 cm), leaf width (12.90 cm) and number of tillers $plant^{-1}$ (2.15) at 90 days after planting in pooled analysis.The differences among varieties were attributed to their genetic make-up. The findings were similar with the results reported by the Hazra *et al*., 2000, Rao, 2000 and Chandra *et al.*, 1999 in turmeric crop.

The results indicated that significant differences among the varieties in both the individual years for yield of turmeric (tonnes ha^{-1}). However, it was not significant in pooled analysis. Significantly higheryield (37.36 and 31.31 t ha^{-1}) was recorded under the variety Gujarat Navsari Turmeric-1 (V_1) compared to variety Sughandhum (36.14 and 30.25 t ha^{-1}) during the year 2012-13 and 2013-14, respectively. In pooled analysis numerically higher yield was registered with Gujarat Navsari Turmeric-1 (34.34 t ha^{-1}).The differences inrhizome yield observed between varieties in the present study may be attributed to their differences in growth habit and inherent potential yield. Similar results were obtained by Narayanpur and

Hanamashetti, 2003, Hazra *et al*., 2000 and Rao, 2000 in turmeric crop.

Significantly higher curcumin content recorded with Gujarat Navsari Turmeric-1 (3.03 and 2.77 %) compared to Sughandhum (2.65 and 2.37 %) in the year 2012-13 and 2013-14, respectively. It was not significant in case of pooled analysis and numerically higher curcumin content was observed in the variety Gujarat Navsari Turmeric-1(2.90 %).The varietal differences in turmeric quality were also reportedby the Pino *et al*., 2003 and Poduval *et al*., 2001in turmeric crop.

Effect of planting material

Looking to the results of various planting material used as seedling materials showed significant differences in growth parameters of turmeric. The higher plant height (53.17, 98.09, 106.95 and 107.98 cm), leaf length (30.55, 45.71, 47.36 and 48.92 cm), leaf width (12.38, 13.95, 14.95 and 15.42 cm), number of leaves plant^{-1} (5.28, 6.91, 9.22 and 10.43) and number of tillers plant^{-1} (2.29, 2.87, 3.41 and 3.54) recorded under the mother rhizome (M_1) used as planting material at 90, 120, 150 and 180 DAP, in pooled analysis respectively.This could be explained in terms of sufficient availability of food reserves in mother rhizome as compared to the finger rhizome, which probably facilitated thedevelopment of various physiological forms and functions. This is in agreement of the finding of Singh *et al.*, 2013, Padmadevi *et al.*, 2012 and

Table 2. Quality parameters of turmeric as influenced by varieties, planting materials and plant growth bio-regulant treatments

Treatments		Yield (tonnes ha^{-1})			Curcumin content (%)		
		2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Varieties(V)							
V_1 (Gujarat Navsari Turmeric-1)		37.36*	31.31*	34.34	3.03*	2.77*	2.90
V_2 (Sughandhum)		36.14	30.25	33.20	2.65	2.37	2.52
S.Em±		0.17	0.08	0.17	0.02	0.03	0.02
C. D. (P=0.05)		0.59	0.61	NS	0.08	0.10	NS
Planting materials (M)							
M_1(Mother rhizome)		38.15*	32.01*	35.08	2.86	2.71*	2.78
M_2 (Finger rhizome)		35.35	29.56	32.46	2.83	2.43	2.64
S.Em±		0.17	0.08	0.17	0.02	0.03	0.02
C. D. (P=0.05)		0.60	0.61	NS	NS	0.10	0.07
C. V. %		6.59	3.69	2.42	5.49	7.55	7.45
Chemical treatments (T)							
T_1 (IBA @ 100 mg l^{-1})		37.17	31.09	34.13	2.91	2.61	2.76
T_2 (IBA @ 200 mg l^{-1})		36.66	30.67	33.67	2.87	2.54	2.72
T_3 (NAA @ 50 mg l^{-1})		38.85*	32.56*	35.71	2.97*	2.63	2.80
T_4 (NAA @ 100 mg l^{-1})		37.83	31.68	34.76	2.86	2.64	2.75
T_5 (KNO_3 @ 2000 mg l^{-1})		36.49	30.68	33.59	2.84	2.56	2.70
T_6 (KNO_3 @ 4000 mg l^{-1})		36.92	30.84	33.88	2.80	2.53	2.66
T_7 Control (without spray)		33.34	27.96	30.65	2.63	2.51	2.57
C. D. (P=0.05)		0.90	0.93	NS	0.13	NS	NS
Interactions							
V x M	S.Em±	0.24	0.25	0.25	0.03	0.04	0.04
	C. D. (P=0.05)	NS	NS	NS	0.12	0.15	NS
V x T	S.Em±	0.45	0.46	0.46	0.06	0.07	0.07
	C. D. (P=0.05)	NS	NS	NS	NS	NS	NS
M x T	S.Em±	0.45	0.46	0.46	0.06	0.07	0.07
	C. D. (P=0.05)	NS	NS	NS	NS	NS	NS
V x M x T	S.Em±	0.63	0.66	0.65	0.09	0.10	0.09
	C. D. (P=0.05)	NS	NS	NS	NS	0.27	NS
C. V. %		2.97	3.69	3.33	3.33	6.44	5.84

* Significant at 0.05 probability level NS-Non-significant

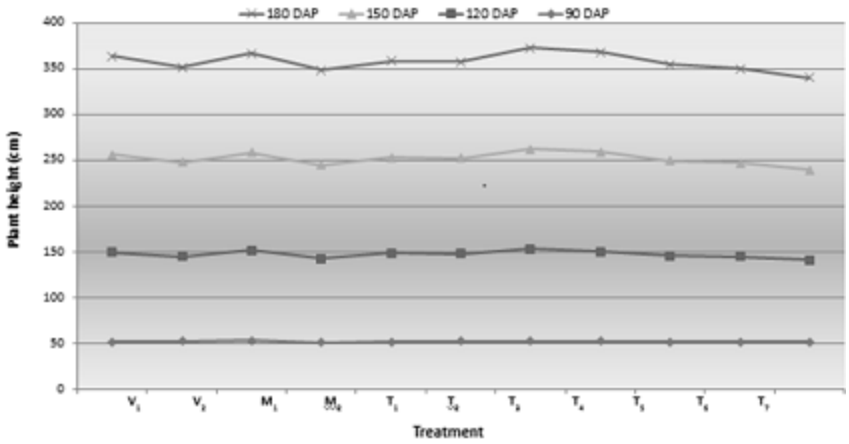

Fig. 1. Mean plant height (cm) as influenced by variety, planting material and plant growth bio-regulant treatments at 90, 120, 150 and 180 DAP

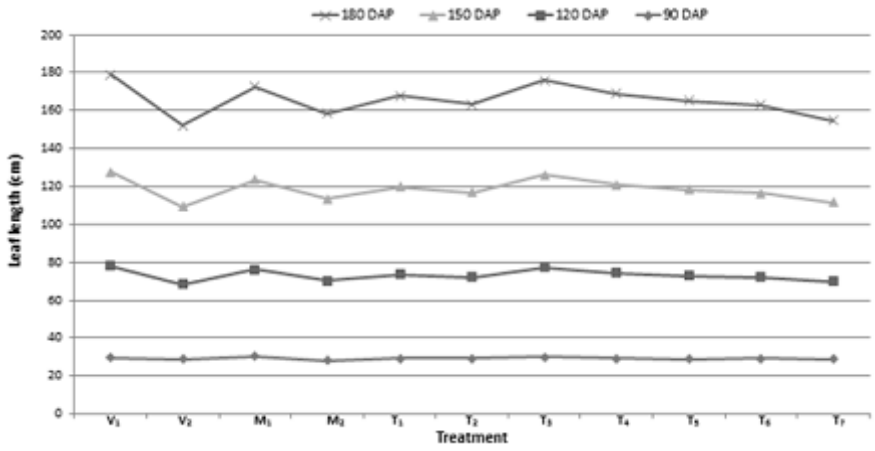

Fig. 2. Mean leaf length (cm) as influenced by variety, planting material and plant growth bio-regulant treatments at 90, 120, 150 and 180 DAP

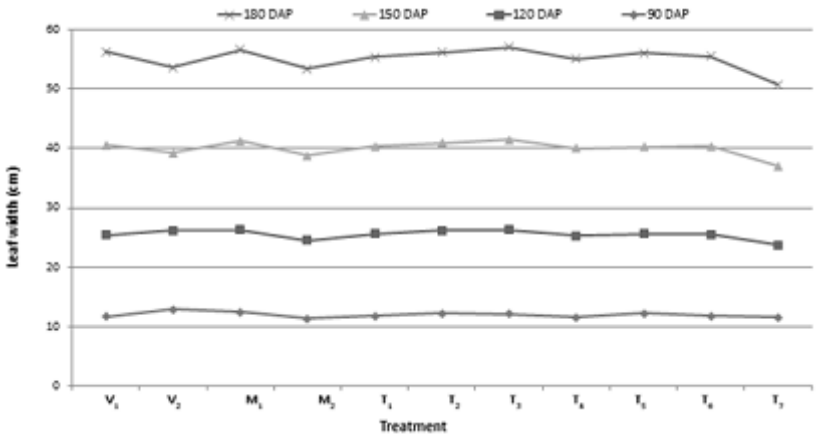

Fig. 3. Mean leaf width (cm) as influenced by variety, planting material and plant growth bio-regulant treatments at 90, 120, 150 and 180 DAP

Balwinder and Gill, 2010 in turmeric crop.

Results given significant differences for yield of turmeric as influenced by the planting materials during both the years. Mother rhizome (M_1) used as planting material recorded significantly higher yield (38.15 and 32.01 t ha^{-1}) over the finger rhizome (35.35 and 29.56 t ha^{-1}) during the year 2012-13 and 2013-14, respectively. In case of pooled analysis it was not significant and numerically higher yield was registered with mother rhizome (35.08 t ha^{-1}).The present comparative study of different planting materials used as seeding purposed noted the higher performance over the finger rhizomes. Translocation and mobilization of assimilates and nutrients from sources are more in mother rhizome from which these are further distributed in fingers thereby making the mother rhizomes qualitatively and quantitatively superior in nature than fingers. Thus, the plants resulting from mother rhizomes are vigorous in the take off stage and further in the growing season with better productivity as compared to the finger rhizomes. These findings were in accordance with the results reported by Singh *et al.*, 2013, Padmadevi *et al.*,2012, Balwinder and Gill, 2010 and Manhas *et al.*, 2010 in turmeric crop.

The planting material mother rhizome was registered significantly higher curucmin content (2.71 and 2.78 %) compared to finger rhizome (2.43 and 2.64 %) during the year 2013-14 and in pooled analysis, respectively. However, it was not

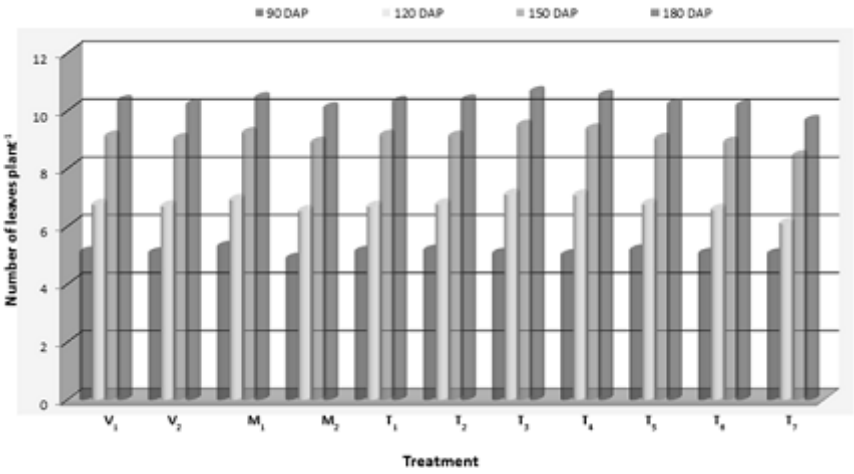

Fig. 4. Mean number of leaves $plant^{-1}$ as influenced by variety, planting material and plant growth bio-regulant treatments at 90, 120, 150 and 180 DAP

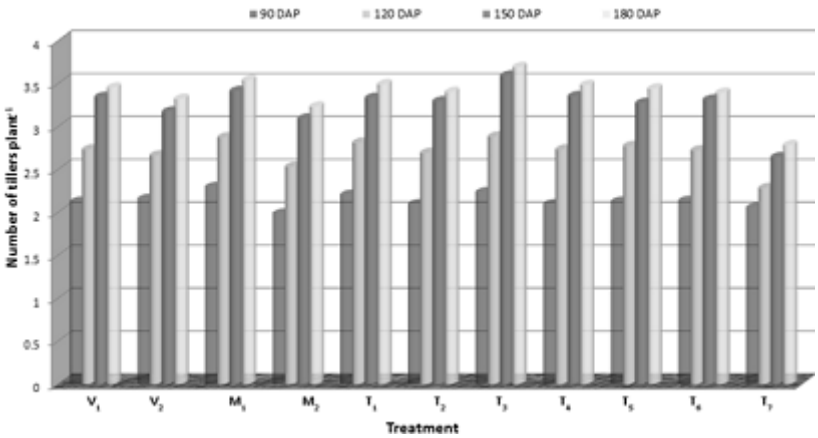

Fig. 5. Mean number of tillers $plant^{-1}$ as influenced by variety, planting material and plant growth bio-regulant treatments at 90, 120, 150 and 180 DAP

significant in the year 2012-13.These finding were in agreement with the results described for turmeric crop by Balwinder and Gill, 2010 and Manhas and Gill, 2010 in turmeric crop.

Effect of plant growth bio-regulant treatments

Differences in various growth parameters due to the plant growth bio-regulants treatments showed significant for growth parameters of turmeric. The higher value of growth parameters *i.e.* plant height (100.47, 109.14 and 110.12 cm), leaf width (14.20, 15.20 and 15.63 cm) and number of leaves plant^{-1} (7.10, 9.48 and 10.64) was recorded under the treatment of NAA @ 50 mg l^{-1} (T_3) at 120, 150 and 180 DAP, respectively in pooled analysis. Whereas, higher leaf length (29.96, 47.38, 48.80 and 49.97 cm) and number of tillers plant^{-1} (2.23, 2.88, 3.59 and 3.69) at 90, 120, 150 and 180 DAP were recorded under the treatment of NAA @ 50 mg l^{-1} (T_3) compared with other treatments in pooled analysis.

However, at 90 days after planting higher plant height (52.35 cm) and leaf width (12.24 cm) was observed in the treatment of IBA @ 200 mg l^{-1} in pooled analysis. While, at 90 DAP, higher number of leaves plant^{-1} was recorded under the treatment of KNO_3 @ 2000 mg l^{-1} (5.15).It was found that NAA showed a positive effect among the different treatments. The application of auxin in plant has a role in the stimulation of RNA and protein synthesis and greater enhancement in photosynthesis rate, increased in cell division, cell elongation as well as cell wall plasticity which ultimately showed the enhancement in various growth parameters. The above finding were in agreement with the Masroor *et al.,* 2006, Karmur *et al.,* 2005 and Birbal *et al.,* 2003 in turmeric crop.

The perusal of the data revealed that effect of different treatmentsfor yield of turmeric was significant differences in both the years. Whereas, in pooled analysis it was not significant and numerically higher yield recorded with NAA @ 50 mg l^{-1} (35.71 t ha^{-1}) and lower was observed in control(30.65 t ha^{-1}). The treatments of NAA @ 50 mg l^{-1}(T_3) recorded significantly higher yield (38.85 and 32.56 t ha^{-1}), and was statistically at par with NAA @ 100 mg l^{-1} (37.83 and 31.68 t ha^{-1}), while lower rhizome yield was registered under the control (33.34 and 27.96 t ha^{-1}) during the year 2012-13 and 2013-14, respectively.The possible reason for increased in yield may be due to higher photosynthetic activity and producing more photosynthates by the plant because of auxin enhanced leaf area and leaf number which would have resulted in a greater production of photosynthates and translocation of the same to rhizome (economic sink) which might have caused better source sink relationship. The above results are in agreement with those reported by Karmur *et al.,* 2005 and Birbal *et al.,* 2003 in turmeric crop.

Significantly higher curcumin content was recorded with NAA @ 50 mg l^{-1} (2.97 %) which was at par with T_1(2.91 %), T_2(2.87 %) and T_4(2.86 %) while, lower curcumin content was observed in control (2.63 %) in the year 2012-13. During the year 2013-14, treatments of NAA @ 100 mg l^{-1}(T_4) was registered numerically higher curcumin content (2.64 %) followed by T_3(2.63 %) and T_1 (2.61%). However, in pooled analysis it was higher with NAA @ 50 mg l^{-1} (2.80 %).The results were supported by the observation of Karmur *et al.,* 2005 and Lynrah *et al.,* 2002 with turmeric crop.

CONCLUSION

From the result, it can conclude that variety Gujarat Navsari Turmeric-1 with mother rhizome used as planting material produce higher quantitative and qualitative yield. In addition to this among the growth regulators,NAA @ 50 mg l^{-1} as foliar application at 90 days after planting was found the most beneficial and efficient treatment for luxurious growth and development of turmeric and finally increased in yield and quality parameters.

REFERENCES

1. Anonymous. Turmeric Production and Trade. Plant cultures, www.plantcultures.org.uk/ Accessed 21/6/2005; 2005.
2. Balwinder, K. and Gill, B. S. Growth, yield and quality of turmeric (*Curcuma longa* L.) as influenced by planting method, plant density and planting material. *J. of Spices and Aromatic Crops*.2010; **19**(1 & 2): 42-49.
3. Birbal, Singh, R. K. and Kushwah, V. S. Effect of plant growth regulators on potato production. *Potato JournaL*. 2003; **30**(1 & 2): 195-196.
4. Chandra, R., Govind, S., Desai, A. R. Growth, yield, and quality performance of turmeric (*C. longa* L.) genotype in mid altitutes of Meghalaya.

J. of Applied Hort., 1999; **1**: 142-144.

5. Hazra, P. Roy, A. and Bandopadhyay, A. Growth characters as rhizome yield components of turmeric (*Curcuma longa* L.) *Crop Res.*,2000; **19**(2): 235-240.
6. Ishimine, Y., Hossain, M. A., Ishimine, Y., and Murayana, S. Optimal planting depth for turmeric (Curcuma longa L.) cultivation in dark red soil in Okinawa Island, Southern Japan. *Plant Production Sci*., 2003; **6**: 83-89.
7. Karmur, A. M., Pdhiar, B. V. and Mehta, M. D. Crop Quality and Quality Improvement through Physiological Intervention. *National Conference at Navsari*. 2005; 234-238.
8. Lynrah, P. G., Chakraboty, B. K. and Chandra, K. Effect of CCC, kinetin, NAA, and KNO_3 on growth, and curcumin content of turmeric. *Indian J. of Plant Physiology*. 2002; **7**(2): 94-95.
9. Manhas, S. S., Gill, B. S. and Sharma, S. Effect of different planting material, planting dates and harvesting dates on economy of turmeric crop. *J. of Agri. Phy.*, 2010; **10**: 50-52.
10. Masroor, M., Khan, A., Singh, M., Naeem, M. and Nasir, S. Preharvest combined application of triacontanol and kinetin could ameliorate the growth, yield and curcumin content of turmeric (*Curcuma longa* L.). *Planta Med.*,2006; **72**: 296-299.
11. Olojede, A. O., Ilubbey, P. and Dixon, A. G. O. IITA/NRCRI Collaborative Germplasm and data collection on root and tuber crops in Nigeria. NRCRI. Annual Report. 2005; 77-81.
12. Padmadevi, K., JeevaJothi, L., Ponnuswami, Durgavathi, V. and RijwanaParveen, I., Effect of different grades of rhizomes on growth and yield of turmeric (*Curcuma longa* L.). *Asian J. of Hort.* 2012; **7**(2): 465-467.
13. Pino, J., Marbat, R., Palau, E. and Roncal, E. Essential oil constituents from Cuban turmeric rhizomes. *Revista-Latinoamaricana-de-Quimica.* 2003; **31**: 16-19.
14. Poduval, M., Mathew, B., Hasan, M. A. and Chattopadhyay, P. K. Yield and curcumin content of different turmeric varieties and species. *Environmental and Ecology.* 2001; **19**: 744-746.
15. Rao, A. M. Genetic variability, yield and quality studies of turmeric (*Curcuma long* L.). Ph.D. thesis, ANGRAU, Rajendranagar, Hyderabad, 2000.
16. Singh, D. K., Aswal, S., Aswani, G., Shivhare, M. K. Performance of planting material on growth and yield of turmeric under guava orchard. *Hort. Flora Research Spectrum.*2013; **2**(2): 116-120.
17. Walter, T. F. and Freedom, K. Variations on Split Plot and Split Block Experiment Designs. Wiley-Interscience, A John Wiley & Sons, Inc., Publication. Chapter 1, 2007.