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Effect of planting material and plant growth regulators on growth of turmeric

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Abstract
A field experiment was conducted on Effect of planting material and plant growth regulators on growth of turmeric at Department of Horticulture, Dr. PDKV. Akola. Maharashtra during 2017-18 and 2018-19. There were 18 treatments laid in FRBD with 2 replications *viz*., M_1-Mother rhizome M_2-Primary finger and P_1- GA_3 – 100 ppm, P_2- GA_3 – 200 ppm, P_3- Ethrel – 50 ppm, P_4- Ethrel - 100 ppm, P_5- Kinetin - 50 ppm, P_6- Kinetin - 100 ppm, P_7 - Cycocel – 250 ppm, P_8- Cycocel - 500 ppm, P_9- Control – Water. The results revealed that the growth parameters were significantly influenced by the planting material and plant growth regulators. Among the planting material, M_1 i.e. Mother rhizome was found significantly superior in respect of days foe emergence, emergence count (%),plant height, leaf area (Cm^2) and plant survival (%) and M_2 i.e. Primary finger was found significantly superior in terms of no. of tillers/plant and no. of leaves/plant. Regarding the PGR's P_5-Kinetin 50 ppm was found significantly superior for days for emergence and emergence count (%) and the treatment P_6-Kinetin 100 ppm was found maximum plant survival (%). The treatment P_2-GA_3-200 ppm was found significantly superior in plant height at 60,120 and 180 DAP and leaf area. The treatment P_8-CCC 500 ppm was found maximum no. of tillers and maximum no. of leaves/plant. An interaction effect of planting material and PGR's in respect of growth parameters i.e. days for emergence and emergence count (%) was found significant with treatment combination M_1P_5-Mother rhizome + Kinetin 50 ppm. In plant survival (%) was found significant in M_1P_6-Mother rhizome + Kinetin 100 ppm and no. of tillers/plant, no. of leaves /plant was found significantly superior in treatment combination of M_2P_8-Primary finger + CCC 500 ppm. Plant height and leaf area was found superior in treatment combination M_1P_2-Mother rhizome + GA_3 200 ppm.

Keywords: Planting material, emergence, plant height, plant growth regulators

Introduction
Turmeric (*Curcuma longa* L.) is one of the most important cash crop and ancient spice of the world. It is appears to be native of southern Asia and is cultivated in India since very ancient times. It is grown on large scale in India, Indochina and Sri Lanka. (Vaidya *et al*. 1972) [15]. India is the leading producer and exporter of the turmeric in the world. Turmeric play an important role in earning foreign exchange for the country. It is grown in different states of India and thus improves the economic status of farmers. It is the most widely and commonly used material in daily cooking and hence is commercially important spice. This is a rhizomiferous seasonal crop. The cost of planting material amounts to 50% of crop production in turmeric. Turmeric takes long time for germination and has slow initial growth. The application of growth regulators like GA_3, NAA or Kinetin may enhance the growth, yield and quality of the turmeric raised from primary and secondary rhizomes. Studies on the use of planting material in combination with different plant growth regulators are scanty. Hence there is a need to study the effect of different growth regulators to know the best suited growth regulator for getting higher yields under field conditions.

Material and Methods
A field trial was conducted at Department of Horticuture, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2017-18 and 2018-19 in factorial randomized block design (FRBD) with 2 replication and 18 treatment combinations with different planting materials In factor A i.e. Mother rhizome (M_1), Primary finger (M_2) and factor B different plant growth regulators *viz*. P_1- GA_3 – 100 ppm, P_2- GA_3 – 200 ppm, P_3- Ethrel – 50 ppm, P_4- Ethrel - 100 ppm, P_5- Kinetin - 50 ppm,P_6- Kinetin - 100 ppm P_7 - Cycocel – 250 ppm,P_8- Cycocel - 500 ppm,P_9- Control – Water. (Soaking and foliar application at 60 and 90 DAP).

Result and discussion

Planting materials and plant growth regulators showed significant influence on growth parameters of turmeric. Data regarding growth parameters is presented in table 1 and 2 in the year 2016-17, 2017-18 and pooled. As regards planting materials M_1-Mother rhizome recorded significantly maximum emergence count (92.56%, 93.39% and 92.97%), Maximum emergence count in mother rhizome might be due to the fact that mother rhizome have more stored food material, which might have resulted in quick emergence and maximum emergence count. As regards minimum days for emergence (22.94, 19.44 and 21.19),significantly maximum plant height (85.07cm, 87.29 and 86.18cm) at 180 DAP, in planting material M_1-Mother rhizomes showed significantly more plant height over primary finger, This might be due to the mother rhizomes have more stored food material, which might have resulted in quick emergence and more vigorous plants, thus the plants from mother rhizomes had attend more height. Mother rhizome as planting material had produced taller plant has been reported by different workers (Naramnaidu and Yuvraj 2006, Deshmukh *et al.* 2005, Padmadevi *et al.* 2012, Meenakshi *et al.* 2001a, Singh *et al.* 1988, Singh *et al.* 2013, Singh *et al.* 2000 and Dhatt *et al.* 2008) [5, 1, 7, 4, 10, 12, 13, 2]. In respect of leaf area mother rhizomes (283.60cm^2, 315.80cm^2 and 300.20cm^2) gave significantly better leaf area at 180 DAP than primary finger. This might be due to the early emergence and more plant height, when mother rhizomes were used as planting material than primary finger. The planting material M_1-Mother rhizome recorded maximum plant survival (96.56%, 97.06% and 96.81%) over the primary finger. As regards planting material M_2-primary finger recorded significantly maximum number of tillers/plant (2.85, 3.59 and 3.22) than the mother rhizome. This might be due to horizontal growth of primary finger and more number of buds was observed in the primary finger and maximum number of leaves/plant (21.26, 22.66 and 21.96 at 180 DAP) recorded significant results when primary finger used as a planting material.

Amongst different plant growth regulators, treatment P_5 (Kinetin 50 ppm) was found superior in recording minimum number of days (21.75, 18.50 and 20.13) for emergence. This might be due to kinetin has ability to induce cell division resulting in early emergence. As regards emergence count P_5-Kinetin 50 ppm recorded significantly better emergence count (94.13%, 95.00% and 94.56%). Among different growth regulator treatments P_8-CCC 500 ppm produced maximum number of tillers per plant (3.95, 4.85 and 4.40) than all of the treatment. This might be due to CCC has decisive role in the suppression of apical dominance and diverting the polar transport of auxin towards the basal buds leading to increased tiller production. This is an accordance with the findings of Maruthi *et al*., (2003a) [3]; Sengupta *et al*., (2008) [14]; and Velayutham *et al*., (2013) [16]., Ravishankar (1983) [9] in ginger. Vijayakumar and Abdhul Khader (1986) [17] in cassava, Phogat and Singh (1987) [8] in ginger. In plant growth regulator, treatments P_2-GA_3 200 ppm recorded maximum plant height (98.64cm, 103.4cm and 101.00cm at 180 DAP). Increased plant height due to GA_3 treatment might be because of its effect on stem elongation. Similar findings were also reported by Singh *et al*. (1993) [11] and Nath and Medhi (2003) [6].

In respect of plant growth regulators the treatment P_8-CCC 500 ppm observed maximum number of leaves per plant 27.60, 29.68 and 28.64cm at 180 DAP. This might be due to CCC has decisive role in inducing the apical growth of plant and accelerating the formation of highest number of leaves per plant and also due to maximum tiller production in the treatment P_8 due to suppression of apical dominance and diverting the polar transport of auxin towards basal buds that increased leaves per plant.(Ravishankar,1983 and Maruthi *et al*. 2003a) [9] .When growth regulators treatments were evaluated, leaf area per plant at 180 DAP was recorded maximum in the treatment P_6-Kinetin 100 ppm (352.30cm^2, 395.80cm^2 and 368.30cm^2). As regards maximum plant survival (97.00%, 97.50% and 97.25%) was found in the treatment P_6-kinetin 100 ppm.

The interaction effect of planting material and plant growth regulators was found significant.M_1P_5 i.e M_1- mother rhizome and P_5-kinetin 50 ppm was found significant for producing maximum emergence count (99.25%,99.50% and 99.37%).As regards number of tillers/plant (4.50,5.30 and 4.90) and number of leaves/plant (27.35,29.05 and 28.20) was found significant results in treatment combination M_2P_8 i.e. Primary finger and CCC 500 PPM. In respect of plant height M_1P_2 i.e. Mother rhizome and GA_3 200 ppm (103.42cm,109.50cm and 106.46 cm at 180 DAP) was found significant results. As regards leaf area M_1P_6 i.e. mother rhizome and Kinetin 100 ppm (384.55cm^2, 446.50cm^2 and 410.77cm^2) was found significant results.

Table 1: Effect of of planting material and Plant growth regulators on growth of turmeric

Treatment	Days for Emergence			Emergence count (%)			No.of tillers/plant			Plant Height (180DAP)		
Planting Material	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean
M_1-Mother rhizome	22.94	19.44	21.19	92.56 (9.66)	93.39 (9.71)	92.97 (9.69)	2.55	3.33	2.94	91.07	94.05	92.56
M_2-Primary Finger	28.56	25.11	26.83	87.53 (9.40)	88.94 (9.48)	88.24 (9.44)	2.85	3.59	3.22	85.07	87.29	86.18
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.31	0.24	0.20	0.013	0.011	0.008	0.06	0.08	0.05	0.27	0.44	0.20
CD@5%	0.92	0.72	0.60	0.039	0.033	0.024	0.20	0.26	0.15	0.82	1.32	0.61
Factor B-Plant growth regulators												
P_1 -GA_3 100ppm	23.50	20.25	21.87	89.75 (9.52)	90.62 (9.57)	90.18 (9.54)	1.80	2.42	2.11	98.05	103.1	100.57
P_2 GA_3 200ppm	24.25	21.00	22.63	89.25 (9.50)	90.38 (9.55)	89.81 (9.52)	1.97	2.50	2.23	98.64	103.4	101.00
P_3 –Ethrel 100 ppm	25.25	22.25	23.75	91.00 (9.58)	92.13 (9.64)	91.56 (9.61)	3.32	4.22	3.77	85.40	86.58	85.99
P_4 –Ethrel 200 ppm	26.50	22.25	24.37	92.50 (9.66)	94.50 (9.77)	93.50 (9.72)	3.50	4.47	3.98	84.20	85.05	84.62
P_5 –Kinetin 50 ppm	21.75	18.50	20.13	94.13 (9.75)	95.00 (9.79)	94.56 (9.77)	2.30	4.00	2.60	95.28	99.18	97.23
P_6 -Kinetin 100 ppm	22.25	19.25	20.75	93.75 (9.73)	94.88 (9.79)	94.31 (9.76)	2.40	3.00	2.70	93.43	97.48	95.45
P_7 –CCC 250 ppm	27.25	24.25	23.75	89.50 (9.51)	90.50 (9.56)	90.00 (9.53)	3.70	4.70	4.20	82.13	83.00	82.56
P_8 –CCC 500 ppm	28.25	23.25	25.75	88.75 (9.47)	89.50 (9.51)	89.13 (9.49)	3.95	4.85	4.40	75.33	76.58	75.95
P_9 –Water	32.75	29.50	31.13	81.75 (9.09)	83.00 (9.16)	82.38 (9.13)	1.37	2.12	1.75	80.18	81.65	80.01
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.65	0.51	0.42	0.027	0.023	0.017	0.13	0.18	0.10	0.58	0.93	0.43
CD@5%	1.96	1.53	1.27	0.082	0.069	0.051	0.42	0.56	0.31	1.75	2.80	1.29
Interaction												

M_1P_1	20.50	17.00	18.75	91.00 (9.59)	91.75 (9.63)	91.37 (9.61)	1.95	2.50	2.22	100.95	106.20	103.57
M_1P_2	21.50	18.00	19.75	90.50 (9.56)	91.50 (9.61)	91.00 (9.59)	2.15	2.60	2.37	103.42	109.50	106.46
M_1P_3	22.50	19.00	20.75	96.50 (9.87)	97.50 (9.92)	97.00 (9.89)	2.85	3.70	3.27	88.70	90.00	89.35
M_1P_4	23.50	20.00	21.75	95.50 (9.82)	96.75 (9.88)	96.12 (9.85)	3.05	4.00	3.52	86.80	87.30	87.05
M_1P_5	18.50	15.50	17.00	99.25(10.01)	99.50 (10.02)	99.37 (10.01)	2.40	3.15	2.77	98.70	103.70	101.20
M_1P_6	19.00	16.00	17.50	97.50 (9.92)	98.26 (9.96)	97.87 (9.94)	2.50	3.25	2.87	96.75	101.80	99.27
M_1P_9	32.50	28.50	30.50	82.25 (9.12)	83.75 (9.20)	83.00 (9.16)	1.50	2.15	1.82	84.35	85.60	84.97
M_2P_1	26.50	23.50	25.00	88.50 (9.46)	89.50 (9.51)	89.00 (9.48)	1.65	2.35	2.00	76.85	77.75	77.30
M_2P_2	27.00	24.00	25.50	88.00 (9.43)	89.25 (9.50)	88.62 (9.46)	1.80	2.40	2.10	83.10	84.60	83.85
M_2P_3	28.00	25.50	26.75	85.50 (9.30)	86.75 (9.36)	86.12 (9.33)	3.80	4.75	4.27	95.15	100.0	97.57
M_2P_4	29.50	24.50	27.00	89.50 (9.51)	92.25 (9.65)	90.87 (9.58)	3.95	4.95	4.45	93.85	97.35	95.60
M_2P_5	25.00	21.50	23.25	89.00 (9.48)	90.50 (9.56)	89.75 (9.52)	2.20	2.65	2.42	82.10	83.15	82.62
M_2P_6	25.50	22.50	24.00	90.00 (9.53)	91.50 (9.61)	90.75 (9.57)	2.30	2.75	2.52	81.60	82.80	82.20
M_2P_7	30.50	28.00	29.25	88.50 (9.46)	90.00 (9.53)	89.25 (9.50)	4.20	5.10	4.65	91.85	94.65	93.25
M_2P_8	32.00	26.00	29.00	87.50 (9.40)	88.50 (9.46)	88.00 (9.43)	4.50	5.30	4.90	90.10	93.15	91.62
M_2P_9	33.00	30.5	31.75	81.25 (9.06)	82.25 (9.12)	81.75 (9.09)	1.25	2.10	1.67	79.90	80.40	80.15
F Test	NS	NS.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	73.80	75.40	74.60
SE(m)±	0.93	0.72	0.60	0.039	0.032	0.024	0.19	0.26	0.15	77.25	78.70	77.97
CD@5%	-	-	1.80	0.116	0.098	0.073	0.58	0.79	0.45	Sig.	Sig.	Sig.

Note: Figures in parenthesis are square root transformations.

Table 2: Effect of planting material and plant growth regulators on growth of turmeric

Treatment	No.of leaves (180DAP)			Leaf area (cm^2)			Plant Survival (%)		
Planting Material	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean	2017-18	2018-19	Pooled Mean
M_1-Mother rhizome	19.81	21.36	20.58	283.60	315.80	300.20	96.56 (9.87)	97.06 (9.90)	96.81 (9.88)
M_2-Primary Finger	21.26	22.66	21.96	273.10	289.30	284.30	92.94 (9.69)	93.44 (9.71)	93.19 (9.70)
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.24	0.25	0.15	1.78	4.79	0.89	0.40	0.40	0.40
CD@5%	0.73	0.74	0.44	5.32	14.31	2.66	1.20	1.20	1.20
Factor B-Plant growth regulators									
P_1 -GA_3 100ppm	15.60	17.05	16.32	324.97	359.50	342.23	95.50 (9.82)	96.00 (9.84)	95.75 (9.83)
P_2 GA_3 200ppm	16.40	17.53	16.96	314.00	347.00	337.00	96.00 (9.84)	96.50 (9.87)	96.25 (9.86)
P_3 –Ethrel 100 ppm	23.33	25.23	24.28	262.30	280.50	278.50	93.50 (9.72)	94.00 (9.74)	93.75 (9.73)
P_4 –Ethrel 200 ppm	24.10	26.50	25.30	248.08	263.55	264.11	94.00 (9.74)	94.50 (9.77)	94.25 (9.75)
P_5 –Kinetin 50 ppm	18.88	20.23	19.55	332.80	377.30	350.00	96.50 (9.87)	97.00 (9.89)	96.75 (9.88)
P_6 -Kinetin 100 ppm	19.38	20.63	20.00	352.30	395.80	368.30	97.00 (9.89)	97.50 (9.92)	97.25 (9.91)
P_7 –CCC 250 ppm	25.88	27.40	26.64	241.30	256.60	254.90	94.50 (9.77)	95.00 (9.79)	94.75 (9.78)
P_8 –CCC 500 ppm	27.60	29.68	28.64	237.70	244.10	242.20	95.00 (9.79)	95.50 (9.82)	95.25 (9.81)
P_9 –Water	13.63	13.85	13.74	192.20	198.60	193.10	90.75 (9.57)	91.25 (9.60)	91.00 (9.59)
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m)±	0.52	0.53	0.31	3.78	10.17	1.89	0.85	0.85	0.85
CD@5%	1.55	1.59	0.95	11.29	30.37	5.64	2.55	2.55	2.55
Interaction									
M_1P_1	16.20	17.50	16.85	349.55	403.65	383.67	97.50	98.00	97.75
M_1P_2	17.20	18.00	17.60	337.75	389.25	370.12	98.00	98.50	98.25
M_1P_3	21.25	23.20	22.22	245.67	257.05	254.73	95.50	96.00	95.75
M_1P_4	22.00	23.95	22.97	235.10	251.05	249.80	96.00	96.50	96.25
M_1P_5	19.50	21.70	20.60	358.05	422.35	373.52	98.50	99.00	98.75
M_1P_6	20.00	22.20	21.10	384.55	446.50	410.77	99.00	99.50	99.25
M_1P_7	23.00	24.55	23.77	225.15	239.75	237.87	96.50	97.00	96.75
M_1P_8	24.85	26.60	25.72	222.50	227.20	225.15	97.00	97.50	97.25
M_1P_9	14.25	14.50	14..37	194.36	205.50	196.48	91.00	91.50	91.25
M_2P_1	15.00	16.60	15.80	300.40	315.35	300.80	93.50	94.00	93.75
M_2P_2	15.60	17.05	16.32	290.20	304.65	303.90	94.00	94.50	94.25
M_2P_3	25.40	27.25	26.32	278.85	303.85	302.22	91.50	92.00	91.75
M_2P_4	26.20	29.05	27.62	261.05	276.05	278.42	92.00	92.50	92.25
M_2P_5	18.25	18.75	18.50	307.45	332.30	326.42	94.50	95.00	94.75
M_2P_6	18.75	19.05	18.90	320.00	345.05	325.75	95.00	95.50	95.25
M_2P_7	28.75	30.25	29.50	257.35	273.45	271.92	92.50	93.00	92.75
M_2P_8	30.35	32.75	31.55	252.80	260.90	259.30	93.00	93.50	93.25
M_2P_9	13.00	13.20	13.10	190.00	191.75	189.75	90.50	91.00	90.00
F Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	NS	NS	NS
SE(m)±	0.73	0.75	0.45	5.35	14.39	2.67	1.21	1.21	1.21
CD@5%	2.20	2.24	1.34	15.97	42.95	7.98	-	-	-

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