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Effect of organic and inorganic manures on growth and yield of acid lime

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ABSTRACT

A field experiment was conducted in the year 2010-11 and 2011-12 to find out the effect of organic and inorganic manures on growth and yield in acid lime. The plant growth parameters in respect of plant height in both season was found maximum in the plants treated with 75% RDF (450:225:225 g NPK) + 50 kg FYM+ 500 g AM/plant + 100g PSB /plant + 200g $ZnSO_4$/plant, (T8) While mean plant spread and plant volume was maximum with T10 75% RDF (450:225:225g NPK) + 50 kg FYM + 100g Azospirillum + 100g PSB /plant + 200g $ZnSO_4$/plant during both season. Yield attributing characters viz., maximum fruit set with minimum fruit drop and highest fruit yield (number of fruits per plant, kg/plant and tons/ha) were observed with the application of 75% RDF 450:225:225g NPK + 50kg FYM+100g Azospirillum + 100g PSB /Plant+200g $ZnSO_4$/plant. (T10).

Keywords : *Acid lime, INM, Growth, Yield*

Introduction

Citrus fruits have important position among other popular fruit of the world. Since they possess a greater adaptability to different climatic conditions, are mainly grown in tropical and subtropical regions. In India, common citrus fruits grown are mandarins, sweet orange, limes and lemons comprising 45, 25, 15 and 10 % area respectively. Citrus fruits occupied 13.3% area out of the total area under fruit crops in India. It stands third position after banana and mango and about 10 per cent and annual fruit production of the country (Anon., 2011). Amongst the various citrus fruit grown in country, acid lime occupies 3.4 per cent area. In Maharashtra area under acid lime is 43000 ha. With 258 thousand MT production (Anon., 2011). Acid lime is grown in almost every districts of Maharashtra, Ahmednagar, Solapur, Dhule, Jalgaon, Pune, and Nasik, Akola, Amravati, Buldhana, Nagpur and Wardha district are the major producer. Acid lime (*Citrus aurentifolia* Swingle) belongs to family Rutaceae. It is originated in India and its chromosome number is 2n=18 plant is medium in vigour and size, spreading and bushy with numerous, slender, willowy fine stemmed branchlets densely armed with small, slender spines.

Nutrition management is one of the important aspect for improving the productivity and quality of fruit crops. A lot of systematic work has been done on various aspects on nutrient management in fruit crops based on time, doses, methods and forms of

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fertilizer to be applied. However, it is varied with region soil conditions, variety, rootstock and crop load. There is not a single recommendation, which can be universally followed all over the world. Deficiency of essential nutrient element especially micro nutrients is wide spread and sometime lead to huge crop losses. These deficiencies are associated with poor fruit set, heavy fruit drop, and poor quality of produce and make the trees vulnerable to disease and other disorders Integrated nutrient management (INM) improve crop growth and quality of agricultural products, help in sustainable crop production and through maintenance maintain of soil productivity. Present investigation was undertaken to find out the effect of INM on yield and quality of acid lime (Citrus aurantifolia (Christm) Swingle).

Material and Methods

The field experiment was conducted at Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the year 2010-11 and 2011-12. It was laid out in Randomized Block design with eleven treatment combinations viz., T1 : RDF (600 g N + 300 g P_2O_5 + 300 g K_2O) + 50 kg FYM/plant), T2 : T1 + 200 g $ZnSO_4$/plant, T3 : 75 % RDF (450:225:225 g NPK) + 50 kg FYM + 500 g AM/plant, T4 :T3 + 200 g $ZnSO_4$/plant.), T5 : 75% RDF (450:225:225 g NPK) + 50 kg FYM + 100 g Azospirillum, T6 :T5 + 200 g $ZnSO_4$/plant, T7 : 75% RDF (450:225:225 g NPK) + 50 kg FYM+ 500 g AM/plant + 100g PSB /plant, T8: T7 + 200g $ZnSO_4$/plant, T9 : 75% RDF (450:225:225g NPK) + 50 kg FYM + 100g Azospirillum + 100g PSB /plant), T10 : T9 + 200 g $ZnSO_4$/plant, and T11 : Control. Each treatment was replicated three times.Half dose of nitrogen and full dose of potassium and phosphorus were applied in October and remaining half dose of nitrogen at fruit set stage. Fertilizers were applied at a radical distances of 160 cm away from trunk. The growth observations viz., Plant height and plant spread were recorded. as per standard procedures given by and plant volume was calculated as using formula suggested by Westood, 1963.

Plant volume = $4/3 \times \pi \times 0.5 \times a2 \times 0.5$ b

where,

a = Mean spread

b = Plant height (m)

The yield and yield contributing characters viz., fruit set, fruit drop, fruits per plant, days required from flowering to harvesting, fruit size, fruit weight and fruit yield were recorded. The data were statistically analyzed as suggested by Panse and Sukhatme (1967).

Results

The data presented in Table 1 indicated that, maximum height of the plant was recorded as 3.53 and 3.58 m during first and second season respectively, with application of 75% RDF (450:225:225 g NPK) + 50 kg FYM+ 500 g AM + 100 g PSB + 200g $ZnSO_4$ per plant per year. Minimum height of the plant (2.95 m) was observed in first season and (3.03 m) in second season in control. (T11). Maximum plant spread (5.23 m and 5.25 m) was recorded with 75% RDF (450:225:225 g NPK) + 50 kg FYM + 100 g Azospirillum + 100 g PSB + 200 g $ZnSO_4$ per plant per year. Minimum plant spread (3.18 m) and (3.24 m) during first season and second season of experiment was observed in control. The leaf area was not significantly influenced due to integrated nutrient management, though, maximum leaf area was noted 22.54 cm^2 and 21.92 cm^2 during first and second season In the treatment T8. While, minimum19.04 cm^2 and 18.71 cm^2 in control (T11) during first and second season of experiment respectively. Maximum plant volume (46.35 m^3) and (48.23 m^3) was recorded with 75% RDF (450:225:225 g NPK) + 50 kg FYM + 100g Azospirillum + 100g PSB + 200 g $ZnSO_4$ per plant per year. While, Minimum plant volume (15.82 m^3) and (16.62 m^3) during first season and second season of experiment was observed in control. (T11).

The results are in close conformity with the findings of Ingle *et al.*, (2001); Musmade *et al.*, (2009) in acid lime, Goramnagar *et al.* (2000) and Taywade (2006) in Nagpur mandarin and Chokha Singh *et al.*, (2000) and Patel *et al.* (2009) in sweet orange.

The data presentated in Table 2 clearly indicated that, days required for flowering to harvesting were not significantly influenced by the different organic and inorganic manures. Maximum fruit set (46.98 %) was observed in (T10) with 75% RDF (450:225:225 g NPK) + 50 kg FYM + 100 g Azospirillum + 100 g PSB + 200 g $ZnSO_4$ per plant per year which was at par with treatments.T9 (45.32%), T8 (44.43%), T7 (44.08%), T5 (43.91%), T6 (42.79%), T2 (42.67%) and T3 (42.62%) in first season of experimentation while, during second season maximum fruit set (47.12%) was recorded in treatment (T8) 75% RDF (450:225:225 g NPK) + 50 kg FYM + 500 g AM/plant + 100 g PSB /plant + 200 g $ZnSO_4$/plant which, was at par with treatment T10 (46.90%), T9 (46.83%) while, Minimum fruit set (30.59%) and (27.62%) were was recorded in control during both the year of experiment. Minimum fruit drop (38.92%) was observed in treatment T10 (75% RDF (450:225:225g NPK) + 50kg FYM+100g Azospirillum + 100g PSB+200g $ZnSO_4$ per plant per year which was also found at par with T9 and T4 (39.85%) (39.83%). While, during second season of experiment minimum fruit drop (34.43%) was recorded in treatment T8 (75% RDF (450:225:225 g NPK) + 50 kg FYM + 500 g AM/plant + 100 g PSB / plant + 200 g $ZnSO_4$/plant per year which was at par with T10 (35.00%), T9 (35.34%) and T7 (37.89%).

However, Maximum fruit drop was recorded (48.12% and 45.44%) respectively, during first and second season in control.The results of fruit set and fruit drop are in accordance with the findings of Dheware and Waghmare (2009) Patel *et al.* (2009) in sweet orange, and Shukla *et al.* (2009) is guava.

From Table 2 the fruit yield in terms of number of fruits harvested per plant, fruit yield kg/plant and tons/hector were significantly influenced by different treatments. comprised of integration of organic, inorganic sources of nutrients along with biofertilizers.Maximum number of fruits (866 fruit / plant) were recorded in T10 with 75% RDF (450:225:225 g NPK) + 50 kg FYM + 100 g Azospirillum + 100 g PSB + 200 g $ZnSO_4$ per plant per year. which was found at par with treatment T9 (835.6 fruits/plant and T8 (771fruits/plant) in first season. While, during second season maximum number of fruit (887 per plant) were recorded in T9 (75% RDF (450:225:225 g NPK) + 50 kg FYM + 100g Azospirillum + 100 g PSB /plant which was found at par with treatment T10 (875.33 fruit/plant).

However, pooled mean of two seasons show the maximum number of fruit harvested (870.66 fruits / plant) in treatment T10 which was found to be at par with treatment T9 (861.50 fruits/plant) and T8 (793.16 fruits/plant) while, minimum number of fruits (331.67, 320, 325.83 fruits /plants) during both the season and pooled mean respectively, were found associated with control.

Fruit Yield (kg/plant and tons/ha) the Highest fruit yield (31.38 kg/plant) and (8.69 tons/ha) was recorded with the treatment of T10 75% RDF (450:225:225g NPK) + 50 kg FYM+100g Azospirillum + 100g PSB+200g $ZnSO_4$ per plant per year, which was found at par with the treatments T9 30.45 kg/plant) and (8.43 tons/ha) and T8 (27.61 kg/plant) and (7.64 tons/ha) during first season of experimentation while, during second season of experimentation maximum fruit yield (29.82 kg/ plant) and (8.26 tons/ha) was noted in the treatment of T9 (75% RDF (450:225:225g NPK) + 50 Kg FYM+100 g Azospirillum + 100 g PSB /plant per year) which was found at par with treatment T10 (29.05 kg/plant) and (8.04 tons/ha) and T8 (26.84 kg/plant) and (7.43 tons/ha).

Table 1. Effect of integrated nutrient management on plant growth and days required from flowering to harvesting

Treatment	Plant height (m)		plant spread (m)		Leaf area (cm^2)		Plant volume (m^3)		Days required from flowering to harvesting	
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
T_1	3.15	3.18	3.36	3.38	21.41	21.42	18.97	19.33	180.08	180.89
T_2	3.17	3.22	4.16	4.20	20.40	20.47	29.11	30.03	179.37	179.55
T_3	3.25	3.32	3.96	3.99	20.57	20.81	26.92	27.94	178.27	177.42
T_4	3.21	3.29	4.46	4.49	20.29	20.21	33.89	35.14	178.68	179.27
T_5	3.15	3.18	3.85	3.91	20.21	21.12	25.39	26.37	180.10	178.78
T_6	3.18	3.22	4.51	4.57	20.64	20.77	34.06	35.46	179.57	177.64
T_7	3.28	3.38	4.61	4.67	21.24	21.21	36.98	39.14	178.32	177.57
T_8	3.53	3.58	4.72	4.74	22.54	21.92	41.78	42.74	178.02	177.61
T_9	3.22	3.27	4.62	4.66	21.88	21.24	36.96	38.13	178.04	178.58
T_{10}	3.19	3.30	5.23	5.25	22.27	21.89	46.35	48.23	177.25	178.89
T_{11}	2.95	3.03	3.18	3.24	19.04	18.71	15.82	16.62	178.42	179.58
'F' test	Sig.	Sig.	Sig.	Sig.	NS	NS	Sig.	Sig.	NS	NS
SE (m)±	0.09	0.09	0.32	0.32	0.95	0.87	4.72	4.79	0.84	1.30
CD at 5%	0.25	0.25	0.94	0.94	-	-	13.85	14.05	-	-

Table 2. Effect of integrated nutrient management on fruit set, fruit drop and fruit yield

Treatment	Fruit set (%)		Fruit drop (%)		No. of fruits per plant			Fruit yield (kg /plant)			Fruit yield (tons/ha)		
	2010-11	2011-12	2010-11	2011-12	2010-11	2011-12	Pooled mean	2010-11	2011-12	Pooled	2010-11	2011-12	Pooled mean
T_1	38.82 (38.52)	33.55 (35.39)	46.68 (43.09)	43.19 (41.08)	400.33	402.33	401.33	14.69	13.43	14.06	4.07	3.72	3.89
T_2	42.67 (40.78)	42.32 (40.57)	45.84 (42.61)	40.21 (39.32)	403.33	360.83	382.16	13.78	11.71	12.74	3.81	3.24	3.53
T_3	42.62 (40.75)	41.46 (40.07)	44.17 (41.65)	39.31 (38.79)	409.67	361.33	385.66	14.83	11.72	13.27	4.11	3.25	3.67
T_4	40.19 (39.33)	40.73 (39.65)	39.83 (39.13)	42.14 (40.48)	415.00	403.17	409.16	14.49	13.51	14.00	4.01	3.74	3.87
T_5	43.91 (41.49)	42.56 (40.71)	41.62 (40.18)	40.40 (39.45)	444.00	453.00	448.50	16.06	15.04	15.54	4.45	4.16	4.07
T_6	42.79 (40.85)	43.14 (41.05)	42.25 (40.54)	40.71 (39.64)	503.67	492.67	498.33	18.50	16.15	17.32	5.12	4.47	4.79
T_7	44.08 (41.59)	43.67 (41.35)	40.96 (39.79)	37.89 (37.97)	606.33	618.00	612.16	23.05	20.99	22.02	6.38	5.81	6.09
T_8	44.43 (41.79)	47.12 (43.34)	41.66 (40.20)	34.43 (35.92)	771.00	815.33	793.16	27.61	26.84	27.22	7.64	7.43	7.54
T_9	45.32 (42.31)	46.83 (43.18)	39.85 (39.15)	35.34 (36.46)	835.67	887.33	861.50	30.45	29.82	30.14	8.43	8.26	8.34
T_{10}	46.98 (43.26)	46.90 (43.21)	38.92 (38.60)	35.00 (36.26)	866.00	875.33	870.66	31.38	29.05	30.27	8.69	8.04	8.36
T_{11}	30.59 (33.57)	27.62 (31.69)	48.12 (43.92)	45.44 (42.38)	331.67	320.00	325.83	9.19	8.36	9.07	2.54	2.48	2.51
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m)±	0.98	0.66	0.40	0.92	44.00	20.28	31.36	1.39	1.39	1.26	0.38	0.38	0.35
CD at 5%	2.88	1.95	1.16	2.68	129.82	59.50	91.98	4.10	4.08	3.69	1.08	1.07	1.03

Figures in parentheses arc sin transformed values

However, pooled data of two season showed that, maximum fruit yield kg/plant and tons/ha was associated with the treatment T10 (30.27 kg/plant) and (8.36 tons/ha) which was found at par with treatment T9 (30.14 kg/plant) and (8.34 tons/ha) and T8 (27.22 kg/plant) and (7.54 tons/ha) while, minimum fruit yield was recorded in control during first season, second season and pooled mean was found (9.19 kg/plant) and (2.54 tons/ha),(8.36 kg/plant) and (2.48 tons/ha), (9.07 kg/plant) and (2.51 tons/ha) respectively.

These results are in agreement with those obtained by Goramnagar *et al.*, (2000), Taywade (2006) in Nagpur mandarin, Ingle *et al.*, (2001) and Musmade *et al.*, (2009) in acid lime, Dheware and Waghmare (2009), Patel *et al.*, (2009)

Discussion

The positive effect of integrated nutrient management on growth performance in respect of plant height, plant spread and plant volume could be attributed due to beneficial effect of microbe present in rhizosphere leading to higher mobilization of solute to the roots and hence the improvement in plant growth. (Balota *et al.*, 1995)

Increase in yield of fruits might be due fact that use of inorganic fertilizers along with FYM, Azospirillum on account of their direct role in nitrogen fixation, production of phytohormone like substances and increased uptake of nitrogen. The beneficial effect NPK in increasing fruit retention might be due to its direct role in improving the plant vigor thereby increasing food reserves, in addition to the foliage which is the seat of production of auxin required for many physiological activities of the plants including fruit retention. This enhance in fruit yield might be the ultimate result of increased flowering and fruit set with reduced fruit drop in respective treatment. (Dheware *et al.*, 2010).

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