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Effect of different levels of N and K and their interactions on yield and yield contributing characters of acid lime *cv.* Phule Sharbati (*Citrus aurantifolia* Swingle)

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Abstract
The present investigation entitled, "Fertilizer requirement of acid lime cv. Phule Sharbati (*Citrus aurantifolia* Swingle)" was conducted during 2018 at the Research Farm of Horticulture, College of Agriculture, Dhule. The field experiment was laid out with nine treatments replicated thrice in Factorial Randomized Block Design. The main treatment includes three levels of nitrogen as 600, 700, 800 g N plant^{-1} and the sub treatments includes three levels of potassium as 600, 700, 800 g K_2O plant^{-1} and P_2O_5 @ 300 g plant^{-1} along with FYM @ 20 kg plant^{-1} were commonly used for all the treatment combinations. Application of 800 g N and 800 g K_2O and the treatment combination 800:300:700 g N: P_2O_5: K_2O plant^{-1} along with 20 kg FYM plant^{-1} showed a superior performance regarding yield and yield contributing characters i.e. fruit yield in terms of number of fruits harvested per plant, Weight of fruit (g), fruit yield (kg plant^{-1}), Fruit yield (t ha^{-1}) in acid lime.

Keywords: Acid lime, FYM, NPK, potassium

Introduction
Acid lime (*Citrus aurantifolia* Swingle) is commonly known as Kagzi lime or Neebu belongs to the family Rutaceae. The word Kagzi being derived from the word Kagzi meaning paper, as the rind of the fruit is very thin. It is a profusely branched thorny shrub. Some thornless types are known but they are not grown commercially. The 'Bearss' or 'Sersian' is very important types in Florida produces fruits larger than the conventional lime, totally seedless, smaller and less thorny tree, easier to harvest. The leaves are small with narrowly winged petioles. The flowers are small, pure white and are borne in clusters. Flowering occurs throughout the year. The fruits are more or less round or oval, smooth having thin rind (papery) attached tightly, with abundant juice content (45%) and acidity (7-8%). The immature fruits are dark green in colour which changes to light yellow when ripe. The colour of the pulp is light greenish-yellow taste is acid, aromatic cells fine and shiny. The numbers of segments and seeds per fruit are 9-11 and 9-10, respectively. Fruit of acid lime possess great medicinal and nutritional value. It is a rich source of vitamin "C", contains 6.3 to 6.% citric acid (Bhandari *et al*., 2017) [6].

Citrus fruits are popular in subtropical regions of North India and tropical regions of South India mainly due to their hardy nature and good nutritional values. India produced 3717 MT of lime/lemon fruits annually from 3.17 lakh hectare areas with an annual productivity of 11.72 tonnes/hectare (NHB database 2019-20). Rajasthan produce about 994.38 MT of fruits production from an area of 61.58 thousand hectare (NHB, 2019-20).

There are several factors responsible for low yield, poor quality fruits and even dieback. In Acid lime, among these factors, one of the factor is inadequate supplies of organic manures and inorganic fertilizers. Therefore, nutrient deficiencies is a widespread problem in citrus fruits. Being a high yielding perennial crop, application of adequate nutrients is important (Bankar *et al*., 2009) [4]. Integrated application of nutrient sources *viz*., organic, inorganic and microbial in consortium holds a good potential to overcome some of adverse soil physical constraints (Bellakki and Badanur, 1997) [5]. Farmyard manure has potential role on growth, yield and quality of plants and help in improving soil texture, soil aeration, soil structure, humus content, water holding capacity and microbial activities of the soil. (Priyanka katara *et al.* 2021) [14]. Integrated use of organic manures, and chemical fertilizers could help in

achieving the goal of obtaining safer food and environment for the people. Nutrient refers to all those compounds, which are required by the plant as a source of body building material and for the energy, without which, it will not be able to complete its life cycle.

Materials and Methods

The experiment was carried out in 2018 at Department of Horticulture, College of Agriculture, Dhule, Mahatma Phule Krishi Vidyapeeth, Rahuri, India. (20° 54' 11 N latitude, 74° 46' 29 E longitude and an altitude of 319 m amsl). It was laid out in Factorial Randomized Block Design with nine treatment combination and three replications. The main treatment (Factor A) includes three levels of nitrogen as 600, 700, 800 g N plant^{-1} and the sub treatments (Factor B) includes three levels of potassium as 600, 700, 800 g K_2O plant^{-1} and P_2O_5 @ 300 g plant^{-1} along with FYM @ 20 kg plant^{-1} were commonly used for all the treatment combinations. The treatment combinations were T_1 (A_1B_1) *i.e.* application of 600:300:600 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_2 (A_1B_2) *i.e.* application of 600:300:700 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_3 (A_1B_3) *i.e.* application of 600:300:800 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_4 (A_2B_1) *i.e.* application of 700:300:600 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_5 (A_2B_2) *i.e.* application of 700:300:700 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_6 (A_2B_3) *i.e.* application of 700:300:800 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_7 (A_3B_1) *i.e.* application of 800:300:600 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_8 (A_3B_2) *i.e.* application of 800:300:700 g NPK plant^{-1}+ 20 kg FYM plant^{-1}, T_9 (A_3B_3) *i.e.* application of 800:300:800 g NPK plant^{-1}+ 20 kg FYM plant^{-1}. The FYM was applied in the month of June. Fertilizers were applied to the selected plants as per treatment details the nitrogen was applied in two split doses, half dose of N, was applied in the month of June and remaining half dose was applied after one month. All phosphorus and potassium were applied in the month of June 2018. Application of fertilizers was done by ring method and observation were recorded such as the fruit yield attributes like, Number of fruits plant^{-1} were recorded by fruits of each tree in every treatment and replication were counted at each harvesting. After completion of harvesting, it was summed up and average number of fruits per tree was computed.

Weight of fruit (g) - The weight of fruit was recorded with the help of electronic balance. The values were summed up and average value calculated.

Fruit yield (kg plant^{-1}) - At each picking, the weight of the harvested fruits from each tree under a treatment was recorded. The sum total of each picking was worked out for each tree. The average for a tree was computed and presented. Yield per tree (kg) was calculated by the following formula.

$$\text{Yield per tree (kg)} = \frac{\text{Total number of fruits per tree x Average fruit weight (g)}}{1000}$$

Fruit yield (t ha^{-1}) - Total yield per hectare was calculated by multiplying by hectare factor to the yield per tree. Yield per hectare (tonnes) was calculated by the following formula.

$$\text{Yield per hectare (tonnes)} = \frac{\text{Yield per tree (kg) x 277}}{1000}$$

Results and Discussion

Weight of Fruit (g)

Data presented in table 1, the application of different levels of nitrogen significantly increased the fruit weight of Acid lime as compared to level A_1. Highest fruit weight (54.57g) were recorded at application of 800 g nitrogen plant^{-1} (A_3) and the lowest fruit weight (50.32 g) was found under application of 600 g nitrogen plant^{-1} (A_1). Nitrogen level A_3 was found to be statistically at par with nitrogen level A_2.

A significant effect was observed on the weight of fruit with the application of different levels of potassium. The application of 800 g potassium plant^{-1} (B_3) registered significant superiority increasing weight of fruit over rest of the levels of potassium. The significantly highest weight of fruit was obtained as 53.99 g under level B_3 (800g potassium plant^{-1}).

The interaction effect of nitrogen and potassium also showed non-significant influence on weight of fruit of acid lime. The result of present finding are in conformation with the finding of Musmade *et al*. (2010) [9], Rajendra *et al.* (2013) [15] and Lal and Dayal (2014) [8] in acid lime.

Number of Fruits Plant^{-1}

Number of fruits plant^{-1} of Acid lime is presented in table 1 was greatly influenced by application of different levels of nitrogen. Application of 800 g nitrogen plant^{-1} (A_3) produced significantly highest number of fruits (695.78) plant^{-1} as compared to (655.11) plant^{-1} under level A_1 (600 g nitrogen plant^{-1}). However the difference between A_1, A_2 and A_3 remained non-significant.

Also found the significant result with application of different levels of potassium. Significantly highest number of fruits (694.11) plant^{-1} recorded at application of 800 g potassium plant^{-1} followed by (B_2).

The interaction effect of different levels of nitrogen and potassium on number of fruits plant^{-1}, was observed as non-significant.

Fruit Yield (kg plant^{-1})

Results presented in Table 1 clearly indicated that the fruit yield of Acid lime showed differential response towards the application of different levels of nitrogen. Among the different levels of nitrogen significantly maximum fruit yield (36.56 kg plant^{-1}) was recorded with application of 800 g nitrogen plant^{-1} (A_3) and the lowest fruit yield (32.81 kg plant^{-1}) was found at application of 600 g nitrogen plant^{-1} (A_1). Level A_3 is statistically at par with A_2.

Fruit yield was influenced significantly by application of different levels of potassium. Significantly maximum fruit yield (36.33 kg plant^{-1}) was recorded at application of 800 g potassium plant^{-1} (B_3) followed by (B_2) *i.e.* application of 700 g potassium plant^{-1} and lowest fruit yield (33.85 kg plant^{-1}) was recorded at application of 600 g potassium plant^{-1} (B_1). The interaction effect of factor A and factor B were non-significant.

Fruit Yield (t ha^{-1})

Application of different levels of nitrogen exhibited a significant effect on fruit yield (t ha^{-1}) of Acid lime. Level A_3 *i.e.* application of 800 g nitrogen plant^{-1} gave maximum fruit yield (10.11 t ha^{-1}) and lowest fruit yield (9.15 t ha^{-1}) was found at application of 600 g nitrogen plant^{-1} (A_1). Level A_3 is statistically at par with A_2.

The fruit yield was increased significantly due to different potassium levels. Highest result of fruit yield (10.06 t ha^{-1}) was noted under application of 800 g potassium plant^{-1} (B_3)

followed by (B_2) *i.e.* application of 700 g potassium plant^{-1} (9.60 t ha^{-1}) and the lowest fruit yield (9.44 t ha^{-1}) was found at application of 600 g potassium plant^{-1} (B_1).

The interaction effect due to the factor A and factor B is presented in table revealed non-significant results were observed among different treatment combinations.

Inorganic fertilizers along with organic manures like farmyard manure which might have increased the activity of beneficial microbial population helped to initiate various growth promoting processes resulting in vigorous growth of plants. Besides promoting growth, and imparted beneficial effects on soil environment, specially on soil physical properties, thus making rhizosphere most congenial for growth and development resulting in increase availability of nutrient status of NPK in both soil and leaf of acid lime which lead to higher yield and yield attributing traits. The results of present investigations are elaborated by similar results in sweet orange by Singh et al. (2000) [16].

Table 1: Fruit yield and yield contributing characters in Acid lime as influenced by nutrient management

Treatments		Fruit weight (g)	No. of fruits (plant^{-1})	Fruit yield (kg plant^{-1})	Fruit yield (tones ha^{-1})
Main treatment					
Factor A	(N Levels)				
	A_1 (600)	50.32	655.11	32.81	9.15
	A_2 (700)	52.68	672.67	35.47	9.82
	A_3 (800)	54.57	695.78	36.56	10.11
S.E.(m) ±		0.673	8.019	0.514	0.142
C.D at 5%		2.018	24.041	1.542	0.426
Sub treatment					
Factor B	(K Levels)				
	B_1 (600)	51.01	659.00	33.85	9.44
	B_2 (700)	52.57	670.44	34.66	9.60
	B_3 (800)	53.99	694.11	36.33	10.06
S.E.(m) ±		0.243	2.896	0.186	0.051
C.D at 5%		0.729	8.683	0.577	0.154
Interaction					
T_1	A_1B_1	48.53	635.00	30.77	8.71
T_2	A_1B_2	50.07	641.33	32.20	8.92
T_3	A_1B_3	52.37	689.00	35.47	9.82
T_4	A_2B_1	51.87	658.00	34.85	9.65
T_5	A_2B_2	51.97	666.67	34.86	9.65
T_6	A_2B_3	54.20	693.33	36.70	10.17
T_7	A_3B_1	52.63	684.00	35.93	9.95
T_8	A_3B_2	55.67	703.33	36.92	10.22
T_9	A_3B_3	55.40	700.00	36.83	10.20
S.E.(m) ±		1.346	16.038	1.028	0.285
C.D at 5%		NS	NS	NS	NS

Conclusion

Considering overall result it can be concluded that the 800 g N and 800 g K_2O and the treatment combination 800:300:700 g N: P_2O_5: K_2O plant^{-1} along with 20 kg FYM plant^{-1} which positively influences the yield and yield contributing characters of Acid lime cv. Phule Sharbati.

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