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Nitrogen and Potassium Based Fertigation Response on Plant Growth, Yield and Quality of Sweet Orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi.

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Research Article

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ABSTRACT

Sweet orange (*Citrus sinensis* Linn. Osbeck) is the major fruit crop in the state grown in nearly 2.5 lakh ha with a production of 3.25 lakh MT. Sweet orange respond very well to the application of nutrients either through soil or through fertigation. Though 70 % of area is under drip irrigation farmers are applying fertilizers through soil only. Hence the present study is taken up to find out the optimum doses of N & K that can be applied through fertigation which will increase the nutrient use efficiency and reduce the cost on labour. The treatments in the experiment included T_1 -100% of the recommended dose Nitrogen and Potassium applied through fertigation system, T_2-75% of recommended dose N and K applied through fertigation system, T_3-50% of recommended dose N and K applied through fertigation system and T_4-recommended dose of N and K are applied directly to the soil. The recommended dose of nutrients were 1500g N, 350g P_2O_5 & 400g K_2O per plant per year applied to soil in two split doses during July and January months. Urea and Muriate of Potash were used as source of N and K in the fertigation treatments. Fertigation treatments were given at 15 days interval and fruit yield and quality were measured at harvest. Results have indicated that highest growth parameters *i.e.,* plant height (3.09 m) canopy volume (20.9 m^3) were recorded when 50 % recommended dose of N &K were applied. However, the number of fruits per tree (345.69) and fruit yield (61.69 kg/tree) were found significantly highest in plants supplied with N &K at 75% recommended dose through fertigation. The same treatment has also given the highest C: B ratio of 1:2.29.

INTRODUCTION

Sweet orange (*Citrus sinensis* Linn. Osbeck) cv. Sathgudi is an important citrus fruit grown in South Indian states like Andra Pradesh, Tamil Nadu and Karnataka. Sweet orange respond very well to the application of nutrients either through soil or through fertigation. The application of fertilizer to the field along with irrigation water through drip is called fertigation [7].The efficient use of water and fertilizers to increase the crop yield and fruit quality is important concern in today's citricultural system [15].

Among the various factors responsible for higher yield and quality fruits of Sweet orange, use of proper quantity of potassium fertilizers along with N and P fertilizers at appropriate time of the fruit growth stages plays important role. As these fertilizers are applied in bulk, lot of fertilizer go waste due to the leaching, evaporation and fixation in the soil. Moreover these applied fertilizers get transmitted to areas beyond the active root zone and are no longer useful to plants. Drip irrigation and fertigation are the most

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efficient methods of modern irrigation systems which has a potential advantage of water and fertilizer saving [16].

Fertigation offers the best and sometimes the only way for ensuring the nutrients enters the root zone especially in areas with inadequate rainfall. Nitrogen fertigation was studied on Shamouti sweet orange [1], Valencia orange [4], Nagpur mandarin [10, 13, 14] and acid lime [8, 11]. The suitable fertilizers, water soluble fertilizers, ready to mix water soluble fertilizers (20-20-20) are more being used by growers. However, they are generally more expensive compared to urea and MOP [3]. The application of nitrogen (N) and potassium (K) fertilizers through fertigation system during flower initiation to fruit growth and development is latest technology and no literature as well as work is available on Sweet orange under South Indian agro-climatic conditions. Therefore, a field study was carried out to develop conventional nitrogen and potassium fertigation schedule and its response on plant vegetative growth, leaf nutrients up-take, yield and fruit quality of Sweet orange.

MATERIALS AND METHODS

The investigations were conducted at AICRP on Tropical fruits (Citrus), Citrus Research Station, Dr. YSR Horticultural University, Tirupati, Andhra Pradesh to study the effect of N & K fertigation on growth, yield and fruit quality of Sweet orange cv. Sathgudi during 2006 to 2013. The experiment was carried out with four treatments and five replications in randomized block design. The treatments consisted of fertigation with 100% of the recommended dose of N and K (T_1), 75% of recommended dose of N and K (T_2), 50% of recommended dose N and K (T3) and a control with direct soil application of N and K (T4). The recommended dose of nutrients for sweet orange *i.e.,* 1500g N, 350g P_2O_5 & 400g K_2O per plant per year applied to directly to soil in two split doses (July and January). Nitrogen and Potassium fertigation was done using Urea and Muriate of Potash (MOP) as source of N and K respectively. Fertigation treatments were given at 15 days interval and the irrigation water requirement was estimated based on daily pan evaporation rate.

The biometric growth parameters of Sweet orange plants (plant height and tree spread) were recorded. The plant stock girth was taken at 15 cm above the soil surface. The canopy volume was calculated according to formula suggested by Castle [2]. Sweet orange fruit yield and quality analysis was also carried out as per procedures described by Ranganna [6]. The leaf samples were collected from the different treatments as per the technical programme. The standard leaf sampling method was adopted while collecting the samples. Leaf samples were collected as per procedures suggested by Srivastava *et al.* [17] and finally prepared samples were digested in diacid mixture of H_2SO_4: $HClO_4$ in 2.5:1 ratio. The leaf N was determined using alkaline permangate steam distillation method, P by vanadomolybdophosphoric acid method and K flame photo metrically. The data on fruit yield and quality attributing to the different levels of N & K fertigation was analysed by Analysis of variance method [5].

RESULTS AND DISCUSSION

Plant growth and canopy volume of Sweet orange

Data recorded has revealed that N and K fertigation levels have significant effect on different growth parameters (Table. 1). The growth parameters (plant height, stock girth, and canopy volume) were recorded during July and January months of every year (2006-13). The data of plant height and plant spread have been used in estimating the canopy volume of the tree with Castle [2] formula. The highest average plant height (3.09 m) and canopy volume (20.90 m^3) with medium stem girth (33.66 cm) were recorded in 50% of the recommended dose of N and K, followed by fertigation with 75% of the recommended dose of N and K(plant height, 3.04 m and canopy volume19.80 m^3). The lowest plant canopy (18.01 m^3) was observed in soil application of recommended dose of N and K.

Table.1: Effect of N and K fertigation on plant growth and canopy volume of sweet orange at Tirupati (2006-2013).

Treatments	Plant height (m)	Stem Girth (cm)	Canopy Volume (m^3)
T_1: 100% of the recommended dose of N and K	2.88	33.58	19.54
T_2: 75 % of the recommended dose of N and K	3.04	**35.43**	19.80
T_3: 50% of the recommended dose of N and K	**3.09**	33.66	**20.90**
T_4: Soil application of recommended dose of N and K	2.93	34.78	18.01
CD @ 5%	0.19	3.01	0.80

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The increase in plant growth parameters could be due to the application of N and K through fertigation at critical stages which ultimately could have favoured fruit growth and development also. Similar observations were also recorded in the earlier studies on fertigation scheduling in Nagpur mandarin [10] and in acid lime [12] under the central Indian conditions.

Leaf nutrient status with N & K fertigation

The effect of differential N and K fertigation with four different treatments on leaf nutrient status and nutrient up-take was monitored with leaf analysis. The final leaf samples were collected and analysed for N, P and K contents as well as Fe, Mn, Zn and Cu elements in 2013. In the final leaf nutrient analysis the 100% of the recommended dose of N and K fertigation with Urea and Muriate of Potash recorded the highest concentration of Nitrogen, Potassium and Iron (N, K and Fe) nutrient levels (Table 2). However, the fertigation treatment with 50% of the recommended dose of N and K recorded the highest concentration of micronutrients (Zn 181.96 ppm, Cu 100.13 ppm and Mn108.93 ppm) compared to rest of the other fertigation treatments. Leaf P (0.24 %) content was significantly higher with soil application. The lowest leaf nutrient levels (N: 3.42%, K: 1.52 %), Fe: 307.50 ppm and Zn 130.67 ppm) were observed with soil application.

Table 2: The leaf nutrient concentration under different N and K fertigation treatments in Sweet orange at Tirupati (2006-2013)

Treatments	Macronutrients (%)			Micronutrients (ppm)			
	N	P	K	Fe	Zn	Cu	Mn
T_1: 100% of the recommended dose of N and K	3.57	0.21	1.67	406.88	151.90	84.26	102.00
T_2: 75 % of the recommended dose of N and K	3.37	0.20	1.52	392.60	168.13	98.99	100.32
T_3: 50% of the recommended dose of N and K	3.41	0.19	1.52	380.98	181.96	100.13	108.93
T_4: Soil application of recommended dose of N and K	3.42	0.24	1.52	307.50	130.67	91.98	108.52
CD @ 5%	0.15	0.04	0.19				

Fruit yield and quality of Sweet orange under N and K fertigation

The nitrogen (N) potassium (K) fertigation had a positive effect on the yield as well as fruit quality of the sweet orange during 2006-2013. The sweet orange fruits were harvested during Aug – October and February- April months in the year. The average number of fruits per plant, yield, TSS, Juice content, and acidity was analysed for the study period and pooled data and mean values were presented. The study was revealed that fruit yield and quality were significantly influenced by the different N and K fertigation treatments (Table 3). The highest number of fruits per plants (345.69 fruits/plant) and fruit yield (16.67 t/ha) was in 75% of the recommended dose of N and K fertigation followed by fertigation with 100% recommended dose of N and K fertigation (314.38 fruits/plant and 15.75 t/ha). However, the average fruit weight was high in 50% of the recommended dose of N and K fertigation (173.75 g). The lowest number of fruits per plant was with soil application of N and K (296.68 fruits/ plant). This clearly indicated that the nitrogen (N) and potassium (K) fertigation is essential for high yields in sweet orange. The drip irrigation maintained higher as well as continuous soil moisture along with nitrogen and potassium availability influenced by the water and nutrient uptake resulting into high yields.

Table 3: Effect of N and K fertigation on yield and fruit quality parameters of Sweet orange at Tirupati (2006-2013).

Treatments	No. of fruits	Fruit yield kg/tree	Yield, t/ha	Average wt. of fruit, g	TSS, ^{0}Brix	Juice, %	Acidity, %	Benefit Cost Ratio
T_1	314.38	57.286	15.75	173.08	9.61	41.14	0.83	1.97
T_2	345.69	61.697	16.97	173.18	9.67	38.98	0.85	2.29
T_3	308.07	54.143	14.89	173.75	9.52	40.69	0.83	1.97
T_4	296.68	54.370	14.95	171.86	9.64	40.18	0.84	1.58
CD @ 5%	1.04	3.47	1.73	1.56	0.05	0.76	0.07	--

T_1: 100% of the recommended dose of N and K, T_2: 75 % of the recommended dose of N and K
T_3: 50% of the recommended dose of N and K, T_4: Soil application of recommended dose of N and K

However, the best quality fruits (Juice 41.14%, TSS 9.61^{0}Brix and acidity 0.83%) observed in 100% recommended dose of N and K followed by 50% of the recommended dose of N and K (Juice 40.69%, TSS 9.52^{0}Brix and acidity 0.83%). The medium quality parameters were recorded in 75% of the recommended dose of N and K (Juice 38.98%, TSS 9.67^0 Brix and acidity 0.85%). The similar results were observed in Nagpur mandarin [9, 18] and acid lime [11].

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The benefit cost ratio was higher under 75% N and K fertigation level (2.29) as compared to 100 % N and K fertigation level (1.97). This was particularly attributed to higher cost of fertilizers at higher doses. But 50% N and K fertigation level (1.97) has also recorded the low benefit cost ratio compared to 100% which is particularly attributed to low fruit yields. Sweet orange grower can get higher income per rupee invested by adopting drip fertigation system at 75% dose of recommended level (Urea + Muriate of Potash).

CONCLUSION

The quality fruit production of sweet orange can be increased with N (nitrogen) and K (potassium) fertigation. The highest plant growth parameters *i.e.,* plant height (3.09 m) and canopy volume (20.9 m^3) recorded when 50 % recommended dose of N &K were applied. However, the number of fruits per tree (345.69), fruit yield (61.69 kg/tree, 16.97 t/ha) were found significantly highest along with medium fruit quality (Juice 38.98%, TSS 9.67^{0}Brix and acidity 0.85%) in plants supplied with N &K at 75% recommended dose through fertigation. The same treatment has also given the highest C: B ratio of 1:2.29. Thus the use of 75% nitrogen (N) and potash (K) fertilizers through fertigation technique can be a sustainable solution for increasing the sweet orange production as well as fruit quality which also cuts down the cost of cultivation.

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