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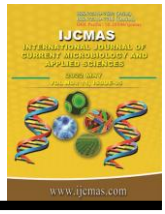

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Influence of Different Doses of Nutrients on Fruit Quality of Khasi Mandarin Grown Under Mid Hills of Arunachal Pradesh

Narendra Kumar* and Abhimanyu Chaturvedi

Krishi VIgyan Kendra- Tirap, Arunachal Pradesh, India

**Corresponding author*

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A B S T R A C T

Arunachal Pradesh having 4th rank in area but far below in productivity concern of Khasi mandarin orange in the India. The supply of Nutrient management is the serious problem in the major problem. To keeping facts an experiment was conducted in 2016 in Tirap district to study the influence of different doses of nutrients on fruit quality parameters of mandarin orange. In total seven treatments, the T4 (Integrated nutrient) reported greater fruit diameter: 5.12 cm, fruit weight: 81.66 g, total soluble solid: 14.24 brix % and lower titratable acidity: 0.846%. Meanwhile the T7 reported maximum peel percentage (25.87%). These results shown that integrated nutrient management system governs the quality of fresh mandarin orange.

Introduction

Arunachal Pradesh is the 4th rank reg. area of mandarin orange in the India. But productivity concern its ranking is far below. Nutrient management is the serious problem in most of the orchard along the state. The experiment was conducted in 2016 in Tirap district of the state to study the influence of different doses of nutrients on fruit quality parameters of mandarin orange. The total seven groups of treatment were applied with tree replications in randomized block design for experiment. The fruits of T4 (Integrated nutrient) reported greater fruit diameter: 5.12 cm, weight: 81.66 g total soluble solid: 14.24 brix % and lower titratable acidity: 0.846%. Fruits of T7 reported maximum peel percentage (25.87%). These results shown that integrated nutrient management system governs the quality of fresh mandarin orange. Citrus occupies third place after mango and banana, grown in 0.92 million ha area to the production tune of 8.62 MT per annum in India. The most commercial citrus cultivars in India are mandarin, sweet orange and acid lime sharing 41, 23 and 21 % of the total

cultivated area, respectively (NHB, 2011). It is the second important fruit crop in the world trade for fresh fruits and more than 50 countries are growing citrus commercially in different agro-climatic conditions for its diversified use and increasing demand world over. India is the sixth largest producer of citrus contributing 4.8% of the world's total citrus production. The north eastern Himalayan region is endowed with favourable agro-climatic conditions for the growth of different citrus species and is considered as the natural home of several citrus species (Gogoi *et al.*, 2004).

Among the all citrus species, *Khasi* mandarin is the premier crop being grown in all subtropical belts of Arunachal Pradesh comprising around 60% of the total geographical area, in an extent of over 32,730 ha with the production of 69,740 tons with the modest productivity of 2.13 t ha-1 whereas the national average productivity of citrus is 11.08 t ha-1 (NHB Bata base, 2018).

Very poor productivity in this region is mainly attributed to unscientific cultivation of crop and injudicious use of land resources (Suresh Kumar *et al.*, 2010). Generally, over concentration of nutrient in the soil does not affect the yield of citrus trees but may have negative or positive effects on quality of fruits (Ritenour *et al.*, 2003).

Quality production and high productivity of citrus mainly depends on the soil available pool of nutrients. Continuous exploitation and depletion of soil resources, in long run, tremendously influence the yield and quality of fruits and overall longevity and productivity of fruit trees. Long term field experiments have clearly indicated the negative impact of continuous use of chemical fertilizers on soil health (Yadav, 2003).

Here, urgent need to adopt good practices, which can improve the soil health and increase crop yield. Nonetheless, slow breakdown and release rate of nutrients from organic sources helps the plant to uptake nutrient for longer time (Choudhary and Suresh Kumar, 2013). The eminent target of Integrated Nutrient Management (INM) is proper combination of all aspects of plant nutrition like: manures, biofertlizers, fertilizers, micronutrients etc. The proper ratio and combination of all these factors are the key factors for regular production and better productivity for future generations. Mandarin plants received 60% of their required nutrients from chemical fertilizer and 40% from Farm Yard Manure (FYM), and found best with yield and qualitative parameters (Bhuyan *et al.*, 2016).

Keeping this in view, the present investigation was carried out to study the effect of Integrated Plant Nutrients Managements (IPNMs) on quality of Khasi mandarin orange fruits.

Materials and Methods

The experiment was carried in the 10 hectare mandarin orange block of in Tirap district, Arunachal Pradesh at altitude of 1215 masl during 2016/2017. All the Soil analysis were conducted in the Laboratory of Krishi Vigyan Kendra. Fruits were packed in a wooden box to transport from farm to laboratory. Soil application of nutrients and foliar spray were done as per the standards.

Integrated Plant Nutrients Management (IPNMs) Applied Method

Farm Yard Manure was applied in each treatment at the rate of 55 kg except in control (farmer practice treatment). FYM was applied during January (25, 26, 27) after corrective pruning.

The basal doses of NPK were also applied in January (25, 26,27). Similarly, the second doses of NPK and foliar spray of micronutrients were applied after fruit set (May 25, 26) before onset of monsoon.

The source of FYM was cow manure, Nitrogen-Urea and DAP, Phosphorous-DAP, Potassium-MOP respectively. Zinc, Copper, Magnesium, Iron were used in sulfate form and calcium was in commercial agricultural lime. FYM, Urea, DAP and MOP were applied as soil application but Zinc, Copper, Iron,

Magnesium and Lime were applied as foliar spray by making solution in 1.5 L of water by Knap sack spray.

Analysis Methods

Physical Parameters

Size of the Fruits

Data was recorded from single branch by tagging it, all over the period from eastern aspect. Fruit size data was recorded during harvesting time, from three fruits of each replication (30th November). The fruit size (diameter) was recorded by manual vernier caliper.

Fruits Weight

From the tagging branches single fruits were harvested from each treatment (plant) and final fruit weighs by digital weight balance in gram.

Peel Weight

Peel of fruits were separated and weighed by using digital weighing balance. The weight was expressed in gram.

Number of Seeds

Number of seeds from the harvested fruits accordingly from treatment and replication was counted in a numbers.

Numbers of Segments

The segment of the sampled fruit was counted and expressed in number.

Chemical Parameters

Total Soluble Solid

Total Soluble Solid (TSS) was measured by hand held refractometer at room temperature of 20 ºC and expressed in degree brix. To obtain accurate readings at temperature measurement was performed at day hours at 20 ºC. Each fruit were cut in to half crosswise and was squeezed to extract all the juice. An equal number of drops from the prepared fruit were placed onto the refractometer prism plate. The prism lid was closed.

To get proper readings, the instrument was turned towards the light position at which the demarcation line between the light and dark regions crosses the vertical scale gave the percentage soluble solids reading. The reading on the prism scale was noted to one decimal place. After each test the prism plate was cleaned with (distilled) water and wiped dry with a soft tissue.

Quality parameter of fruit

Titratable Acidity

Titratable acidity is a total amount of acid in the solution as determined by the titration using a standard solution of sodium hydroxide (titrant). By using colored indicator (phenolphthalein) titratable acidity was analyzed.

The fruit was cut, pressed with a hand and filter with muslin cloth to obtain at least 10 ml of juice and make it 50 ml by adding distilled water. The sampling process was done at room temperature. 0.1 N sodium hydroxide (NaOH) was filled in a burette with well labeled volume. 2-3 drops of phenolphthalein was added in juice volume and NaOH was added to the beaker until the pink color disappears.

TA% was calculated by following formula:

$$\frac{[\text{ml NaOH used}] \times [0.1\text{ N NaOH}] \times [\text{milliequivalent factor}]}{\text{Volume of sampel}} \times 100$$

Experimental Design

The experiment was conducted in 10 years aged plant by Randomized Complete Block Design in seven treatments replicated thrice. Data were

analyzed by computer software R Package and Excel. Treatments used in experiment were showed in Table 3.

Results and Discussion

Quality Parameters of Fruit

Table 4 showed the quality parameter of fruits. FMY, macro nutrients and micronutrients applied according to respective treatment showed the significant results in diameter or breadth of the fruit. Treatment-4 (T4) showed the significant results over treatment-1 (T1). The fruits from T4 have highest diameter with 5.12 cm followed by treatment-2 (T2) with diameter 5.08 cm at second position and treatment-5 (T5) and treatment-6 (T6) with diameter 4.74 cm at third highest diameter. The fruit belongs to control treatment have diameter 4.01 cm only. Comparatively, T4 has high dose of macro nutrients and micro nutrients which resulted in greater diameter of fruit as compare to other treatment fruits. The correct ratio of nitrogen and potassium gives significant fruit size (Embleton *et al.,* 1968). Potassium increase the fruit size (Zekri *et al.,* 2003). Similarly, deficiency of copper reduces the size of fruit (Zekri, 2011)

Nitrogen, potassium, magnesium and copper function in increasing total soluble solid up to a certain limits (Ram & Bose, 2000). T4 showed signifies result over treatment-7 (T7) which was control treatment during TSS measurement. Nitrogen, potassium, phosphorous and micronutrients (boron, copper and zinc) have important role to decrease the amount of acid in the fruits. T4 titratable acidity 0.792% which was very less concentration and highly significant over T7 that is control treatment (farmer practices).

Total soluble sugar showed significant correlation with nitrogen content of the in mandarin orange. High dose of nitrogen application increases total soluble solid up to a certain limit (Zerki, 2011). With increases in total soluble solid in mandarin fruit, it decreases titratable acidity of juice (Aular *et al.,* 2017). Application of excess nitrogen dose than requirement causes to reduce in total soluble sugar). Similarly, phosphorous enhances higher sugar to acid ratio in citrus fruit (Ritenour *et al.,* 2003). 0.3% zinc sulfate spray increases total soluble solid significantly and found titratable acidity of fruit decreases when single or more micronutrients are combinely applied as foliar spray (Monga & Josan, 2000).

The fruits belong to T4 have highest average weight with 81.66 g. There was difference of 23.61 g in a single fruit belongs from T4 and control. Micronutrients (magnesium sulfate, zinc sulfate and manganese sulfate) each at 0.5% alone or in combinations gives the best in size and weight of ten years old Kinnow mandarin (Babu & Yadav, 2005).

Fruit belongs to T7 (control) have highest peel percentage that is 25.87%. Fruit belongs to T2 have lowest peel percentage that is 22.89%. There was no significant difference among seven treatments. High concentration of nitrogen than requirement caused the thicker peel of fruit peel in mandarin (Baral, 2008). Magnesium is also the fundamental element in chlorophyll formation and linked with photosynthesis process. Low or unavailability of magnesium causes thicker peel in mandarin fruits.

No effect was analyzed in seed number due to effect of nutrients when different types of nutrients and their concentration were applied seven different treatments replicated thrice. Seeds number varies from zero to twenty five. The average seeds numbers in all treatments was six to seven. There variation in gene or environmental factors may be the probable cause of such large variation in seeds numbers with in a replication. Segment number in fruit ranged from nine to twelve. Size of the segment and juice content inside the segment was greatly influenced by nutrient management system.

Grading of the Fruit

Table 4 showed the grading of citrus fruits. In all treatments the fruits size is smaller or "C" grade

fruit. The probable cause of smaller fruit may be the genetic factors. In five treatments, T2, T3, T4, T5 and T6 different doses of micro nutrients which were applied cause heavy flowering and caused small fruiting but more numbers of fruits in the tree (Tariq, Sharif, Shah, & Khan, 2007). To overcome this problem, fruit thinning operation can be practice, which increase the size and weight of the fruit without reduction in yield (Guardiola and Garcia-Luis, 1997).

But in T1 and T7, the reason of smaller fruit was very low dose of nitrogen, phosphorous, potassium applied and no application of micronutrients.

Table.1 Highest Orange producing states of India

State	Area (000 Ha)	Production (000 MT)	Productivity (Tonne/Ha)
Madhya Pradesh	121.11	2103.64	17.36
Pujnab	51.65	1208.42	23.39
Maharastra	107.32	797.95	7.43
Rajasthan	23.19	317.68	13.69
India	**428**	**5101**	**11.08**

Source: National Horticulture Board (2017-18)

Table.2 Orange production in North-eastern states of India

State	Area (000 Ha)	Production (000 MT)	Productivity (Tonne/Ha)
Assam	14.95	203.72	13.62
Arunachal Pradesh	32.73	69.74	2.13
Nagaland	6.52	47.33	7.25
Meghalaya	9.28	45.24	4.87
Mizoram	16.37	44.02	2.68
Manipur	4.46	39.89	8.94
Tripura	5.62	25.33	4.50
Sikkim	13.08	18.99	1.45

Source: National Horticulture Board (2017-18)

Table.3 Treatments used in experiments

Treatment	N (g)	P(g)	K(g)	ZnSO4	CuSO4	MgSO4	FeSO4	Ag lime
T1	498	238	470	-	-	-	-	-
T2	498	238	470	5	3	2	2	8
T3	498	238	470	3	2.5	1.5	1.5	4
T4	612	308	560	5	3	2	2	8
T5	334	172	301	5	3	2	2	8
T6	174	98	198	5	3	2	2	8
T7 (Control)	-	-	-	-	-	-	-	-

Table.4 Grading of fruits

Treatments	Singles fruit weight	Diameter of fruit	TSS	Grade
T1	C	C	B	C
T2	B	C	A	B
T3	C	C	B	C
T4	B	C	A	B
T5	C	C	A	C
T6	C	C	A	C
T7 (Control)	C	C	C	C

The weight of the fruit ranges from small to medium that is grade C to B. Fruit thinning operation possibly increased the weight of fruit. Similarly, total soluble solid ranges from grade A to C that is high, medium and low. Total soluble solid of the fruits was influenced by the nutrient management and slope of the orchard.

In our India, APEDA has develop ideas and criteria for grading of fruit in marketing context. Table 4 reflects the result as fruit belongs to T4 and T2 are B grade. The remaining other treatments fruits are of C grade.

Grading rules

Weight of fruits

Large (A): more than 100 gm, medium (B): 75-100 g and small (C): less than 75 g.

Size of fruits

Diameter: Large (A): more than 5.8 cm, medium (B): 5.3-5.8 cm and small (C): less than 5.3 cm. Length: Large (A): more than 5.3 cm, medium (B): 5-5.3 cm, small (C): less than 5 cm.

TSS

High (A): More than 13 % Brix, medium (B): 11.5-13 Brix % and low (C): less than 11 Brix %. Nitrogen, phosphorous and potassium along with micronutrients have great influence on fruit quality of mandarin orange. Total soluble solid, Titratable acidity, Fruit diameter and Fruit weight showed significant positive correlation with application of nutrients. Peel percentage, Seed number in fruit and Segment number of fruit does not showed significant result with application of different dose and types of nutrients when data were tested at 5% significant level.

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