

EFFECT OF INTEGRATED PLANT NUTRIENT MANAGEMENT SYSTEM IN QUALITY OF MANDARIN ORANGE (*Citrus reticulata* Blanco)

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ABSTRACT

Nepal is a major producer among top twenty producing country of mandarin orange in the world. The productivity of the mandarin orange is very low as compared to other developed countries. Nutrient management is the serious problem in most of the orchard along the country. The experiment was conducted in Baglung district of Gandaki Province, Nepal in 2017 to study the effect of Integrated Plant Nutrient Management System (IPNMs) in quality parameters of mandarin orange. Seven group of treatment were assigned for experiment. All treatments were replicated three times in randomized complete block design. The fruits of T4 (Integrated nutrient) have greater fruit diameter: 5.26 cm, weight: 83.32 g total soluble solid: 14.53 brix % and lower titratable acidity: 0.846%. Fruits of T7 have more peel percentage (26.07%). These all findings indicate, integrated plant nutrient management system governs the quality of fresh mandarin orange.

INTRODUCTION

Nepal is major producing country of Mandarin orange (*Citrus reticulata* var. Blanco) among top 20 countries of the world (FAO, 2013). Mandarin is a most promising fruit crop that stands in first position of the total fruit industry in Nepal (Rokaya, Baral, Gautam, Shrestha, & Paudyal, 2016). The national productivity of mandarin orange in Nepal is nearly 11 ton/ha, which is very low as compared to other citrus growing countries (NCDP, 2016). In some mandarin pocket areas of Nepal, more than 100 years old trees are still in fruiting condition, which indicates proper nutrient management longer the life of trees. Major cultivated varieties of mandarin orange in Nepal are Pokhara local, Dailekh local and Dhankuta local (NCDP, 2016).

The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and man-made soil nutrients to increase crop productivity and preserve soil 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, Sarker, Rahman, Fujita, & Hasanuzzaman, 2016). There is wide difference in productivity and quality from one type of soil to another type even under similar management (Baral, 2008). Plant nutrition is one of the major pre-harvest factors among climate/environment, rootstock/scion, planting design, pruning practices, pest management, irrigation, and plant growth regulators to affect the quality of mandarin orange fruits (Arpaia, 1994). The inconsistent manuring practice is the most serious problems in mandarin growing pockets in central and western development region of Nepal (Gurung, 1998). Soil fertility management is the top most ranked problems ranked by the farmers of Western mid hills farmers (Devkota, Regmi, & Subedi, 2002). The soils of Nepalese hills are particularly vulnerable to losses of organic matter and nutrients due to heavy monsoon rainfall (Baral, 2008). 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, Wardowski, & Tucker, 2003). This experiments were conducted to identified the effect of IPNMs on quality mandarin orange production.

MATERIALS AND METHODS

Materials

Urea (46%) obtained from Farmers Fertilizer Cooperative limited, India; DAP (18% N and 46% P) obtained from Gujarat State Fertilizer and Chemicals Limited, India; MOP (60% K) obtained from TRANS AGRO INDIA PVT. LTD; CuSO_4 obtained from Alpha Chemicals, India; ZnSO_4 obtained from FIZMERK India Chemicals; CuSO_4 obtained

from Fisher Scientific, India; and Ag lime obtained from local market.

Description of Experimental Site

The experiment was carried in the 100 hectare mandarin orange block of Prime Minister Agriculture Modernization Project in Baglung district, Nepal at altitude of 1250 masl during 2017/2018. Soil analysis was conducted in Agriculture Technology Center, Jawalakhel Lalitpur. Laboratory analysis for quality determination was performed in Agriculture technical school in Baglung districts and also in Postgraduate Campus Horticulture laboratory, Kritipur, Kathmandu. Fruits were packed in a wooden box to transport from farm to laboratory. Soil application and foliar spray were the methods of soil application.

Table 1. Treatments used in experiments

Treatment	N (g)	P (g)	K (g)	ZnSO_4 (g)	CuSO_4 (g)	MgSO_4 (g)	FeSO_4 (g)	Ag lime (g)
T1	513	253	510	-	-	-	-	-
T2	513	253	510	5	3	2	2	8
T3	513	253	510	3	2.5	1.5	1.5	4
T4	678	322	660	5	3	2	2	8
T5	348	184	360	5	3	2	2	8
T6	183	115	210	5	3	2	2	8
T7 (control)	-	-	-	-	-	-	-	-

IPNMs Applied Method

FYM was applied in each treatment at the rate of 50 kg except in control (farmer practice treatment). FYM was applied during January (29, 30, 31) after corrective pruning. The basal doses of NPK were also applied in January (29, 30, 31). Similarly, the second doses of NPK and foliar spray of micronutrients were applied after fruit set (May 26, 27) before onset of monsoon. The source of FYM was buffalo manure, Nitrogen-Urea and DAP, Phosphorous-DAP, Potassium-MOP respectively. Zinc, Copper, Magnesium, Iron were used in sulfate form and calcium was in commercial agriculture 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 (15th 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 °C and expressed in degree brix. To obtain accurate readings at temperature measurement was performed at day hours at 20 °C.

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.

Table 2. Quality parameter of fruit

Treatments	Fruit diameter (cm)	TSS (%)	TA (%)	Fruit weight (g)	Peel (%)	Seed No.	Segment No.
T1	4.76 b	11.5 cd	0.936 ab	66.16 ab	26.06	6.66	10.33
T2	5.06 ab	14.4 a	0.853 c	75.55 ab	23.95	6	11.33
T3	4.77 ab	12.86 bc	0.903 b	70.03 ab	24.44	6.33	9.66
T4	5.26 a	14.53 a	0.846 c	82.32 a	24.09	6	9.66
T5	4.86 ab	13.83 ab	0.850 c	72.45 ab	25.97	6.33	9.33
T6	4.86 ab	13.60 ab	0.853 c	68.90 ab	25.63	6.66	10.33
T7 (control)	4.2 b	10.7 d	0.966 a	57.05 b	26.06	6.66	9.33
Sig. 5%	0.049	0.00	0.00	0.030	NS	NS	NS

NS: Non Significant, TSS=Total soluble Solid, TA= Titratable acidity

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 investigation was conducted in 8 years age 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 1.

RESULT AND DISCUSSION

Quality Parameters of Fruit

Table 2 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 5.26 cm followed by treatment-2 (T2) with diameter 5.06 cm at second position and treatment-5 (T5) and treatment-6 (T6) with diameter 4.86 cm at third highest diameter. The fruit belongs to control treatment have diameter 4.2 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, Jones, & Platt, 1968). Potassium increase the fruit size (Zekri, Obreza, Koo, & Alferez, 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 significant 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 0.846% 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,

Casares, & Natale, 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 82.32 g. There was difference of 25.27 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).

Table 3. Grading of fruits

Treatments	Weight of single fruit	Size of fruit (Diameter)	TSS	Result (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

Fruit belongs to T7 (control) have highest peel percentage that is 26.07%. Fruit belongs to T2 have lowest peel percentage that is 23.95%. 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 3 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. 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 Nepal the government organization of citrus fruit named National Citrus Development Program (NCDP) develop ideas and criteria for grading of fruit in Nepalese context. Table 3 reflects the result as fruit belongs to T4 and T2 are B grade. The remaining other treatments fruits are of C grade.

Grading rules:

1. Weight of fruits: Large (A): more than 100 gm, medium (B): 75-100 g and small (C): less than 75 g.
2. 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.
3. TSS: High (A): More than 13 % Brix, medium (B): 11.5-13 Brix % and low (C): less than 11 Brix %

CONCLUSION

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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