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Effect of chemical fertilizer on leaf nutrient concentration and fruit quality of rose apple (*Syzygium jambos* L.) cv. Tabtimjan

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Abstract

The effect of chemical fertilizer on leaf nutrient concentration and fruit quality of rose apple (*Syzygium jambos* L.) cv. Tabtimjan was studied in Ratchaburi Province, Thailand. The different chemical fertilizer doses applied to the rose apple tree by soil application was used as treatment, 2 kg/tree and 0.5 kg/tree of 17-17-17 chemical fertilizer formula. Both of chemical fertilizer doses were based on the farmer used in on and off season. The results showed that the different chemical fertilizer doses did not statistically affect ($t > 0.05$) to leaf nutrient concentration of rose apple. The leaf nitrogen (N) concentration was 1.51-1.79% and 1.47- 1.77% for 2 kg/tree and 0.5 kg/tree, respectively. The leaf phosphorus (P) concentration was 0.11-0.17% and 0.13-0.17% for 2 kg/tree and 0.5 kg/tree, respectively. The leaf potassium (K) concentration was 1.06-1.98% and 1.04-1.52% for 2 kg/tree and 0.5 kg/tree, respectively. While, there was significant difference in soil N, P and K concentration in some period of the study which 2 kg/tree gave the higher soil N, P and K concentration than those in 0.5 kg/tree ($t < 0.05$). For fruit quality, there was no significant difference in fruit quality but using 2 kg/tree gave the lower TSS:TA in December and February than those in 0.5 kg/tree ($t < 0.05$). From the results, it was concluded that the higher chemical fertilizer dose (2 kg/tree) applied to the rose apple trees did not significantly increase the leaf nutrient concentration as the optimum leaf nutrient concentration had met by the low chemical fertilizer dose (0.5 kg/tree) applied to the rose apple tree. Therefore, the 0.5 kg/tree chemical fertilizer dose should be optimum for the rose apple production.

Keywords: chemical fertilizer, leaf nutrient concentration, fruit quality, rose apple, *Syzygium jambos* L.

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1. Introduction

Rose apple (*Syzygium jambos*L.) is one of the economic fruit crops in Thailand that can be exported to many countries and has generated good income for farmers especially the cultivar Tabtimjan. However, chemical fertilizer has been extremely used for rose apple production which it was unsuitable dose of chemical fertilizer applied to the rose apple trees. This situation occurred because farmers lacked the farmers' knowledge about the appropriate amount of chemical fertilizers. Those may result in the residual effect to the soil and make soil deterioration. [1] reported that the over-use of chemical fertilizer decreased soil microbial population and imbalance soil nutrient occurred due to salt stress which according to [2] reported that the long-term use of inorganic fertilizers without organic supplements damages the physical, chemical and biological properties of soil and causes environmental pollution. Moreover, unsuitable chemical fertilizer used would make the high cost in rose apple production resulted in the decreasing income. The change of farmer behavior in using chemical fertilizer would be successful if the suitable chemical fertilizer dose was established and distributed to the farmer. Therefore, the objective of this study was to investigate effect of chemical fertilizer on leaf nutrient concentration and fruit quality of rose apple (*Syzygium jambos* L.) cv. Tabtimjan.

2. Materials and Methods

Ten rose apple cultivar Tubtimjan orchards in Damnoen Saduak District, Ratchaburi Province, Thailand were selected for this study during August 2017 to February 2018. The sites were located in north latitude N 13 3105.515800 and east longitude E 99 57017.592600. The tropical climate is characterized by average annual temperature of 27 C and average annual rainfall of 1000-1250 mm. Ten orchards were separated into 2 groups (five orchards each group) with the different chemical fertilizer dose used. Thus, the treatment of this study was as followed:

Treatment 1 low dose of chemical fertilizer (0.5 kg/tree)

Treatment 2 high dose of chemical fertilizer (2.0 kg/tree)

Both treatments were the chemical fertilizer dose used by the farmer. All treatment used 17-17-17 chemical fertilizer formula applied to the soil. In each

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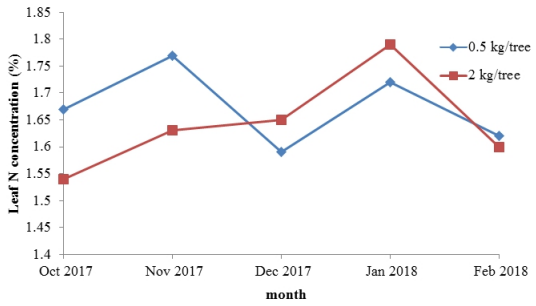

Figure 1: Effect of chemical fertilizer on leaf N concentration (%) in rose apple.

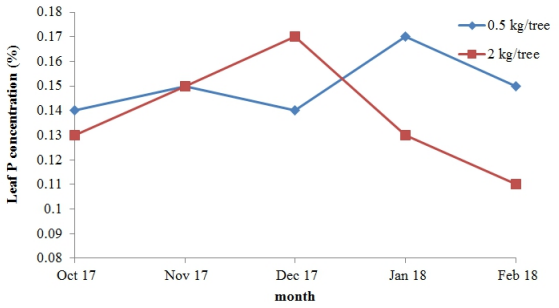

Figure 2: Effect of chemical fertilizer on leaf P concentration (%) in rose apple.

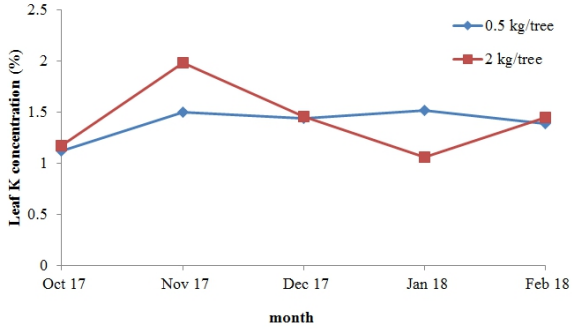

Figure 3: Effect of chemical fertilizer on leaf K concentration (%) in rose apple

orchard, 5 uniform sizes and ages (approximately 5 year old trees) of rose apple trees were chosen for leaf sampling. The 2nd, and 3rd leaf position from the growing tip of the first flush after harvest from around the canopy (four directions, North,East, West, and South) were sampled at one month intervals [3]. Four exposed leaves of each leaf position from around canopy in each tree were collected to make composite samples nutrient analysis. The rose apple trees were watered every 23 days. The leaf N, P and K concentrations were determined in rose apple leaves following the method mentioned below. Soil and plant samples were taken to laboratory for soil physical property analysis, soil pH analysis, soil nutrient analysis and plant nutrient analysis by methods as describe below.

2.1 Plant nutrient concentration analysis

The sampled leaves were washed with distill water and dried at 70 C for 72 hr. The dried leaves were ground to pass a 0.40 mm diameter (40 mesh) screen before taking for plant nutrient analysis. From this dried material the N, P and K concentration were determined. The subsample of leaves was digested with sulfuric acid (H_2SO_4)-hydrogen peroxide (H_2O_2). Levels of N were determined using the MicroKjeldahl Method. P and K were extracted by nitric acid (HNO_3)-perchloric acid ($HClO_4$) (5:1) then the solution was left to cool down. Phosphorus in solution was determined calorimetrically by the Molybdate-vanadate yellow color method. Potassium was determined using an atomic absorption spectrophotometer. All plant nutrient analysis was done at the Soil Plant and Agricultural Material Testing and Research Unit, Central Laboratory, Kasetsart University, Kamphaeng Saen Campus.

2.2 Soil property analysis

Composite soil samples were collected at 0 - 15 cm depth below the surface near fruit trees using auger at the edge of canopy. The soil samples were collected avoiding the applied fertilizer site. The samples were collected and taken to the laboratory for soil chemical property testing included pH, soil ECe, N, P and K concentrations. The methods used for soil chemical property analysis and soil nutrient analysis were identified in Table 1.

2.3 Fruit quality measurement

5 fruits from each tree were collected for fruit quality measurement totally 125 fruits per treatment (25 fruits each orchard). Total soluble solid (TSS), Total acidity (TA), fruit texture and fruit color were measured at fruit harvest in December 2017, January 2018 and February 2018.

2.4 Statistical analysis

Statistical analysis of the data was performed by t-test at 0.05 significant levels.

3. Results and Discussion

Effect of chemical fertilizer on leaf N, P and K concentration was studied and found that using 2 kg/tree chemical fertilizer gave no significant difference in leaf N, P and K concentration compared to using 0.5 kg/tree chemical fertilizer ($t > 0.05$). The leaf nitrogen (N) concentration was 1.51-1.79% and 1.47-1.77% for 2 kg/tree and 0.5 kg/tree, respectively. The leaf phosphorus (P) concentration was 0.11-0.17% and 0.13-0.17% for 2 kg/tree and 0.5 kg/tree, respectively. The leaf potassium (K) concentration was 1.06-1.98% and 1.04-1.52% for 2 kg/tree and 0.5 kg/tree, respectively (Fig. 1 - Fig. 3).

Table 1. Effect of chemical fertilizer on soil N concentration (mg.kg^{-1}) in rose apple orchard.

Treatment	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
0.5 kg/tree	71.05	53.29	71.05	52.10	84.07	122.50	132.53
2.0 kg/tree	80.52	97.10	142.10	74.60	138.55	165.78	184.73
t-test	ns	*	*	ns	ns	ns	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

Table 2. Effect of chemical fertilizer on soil P concentration (mg.kg^{-1}) in rose apple orchard.

Treatment	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
0.5 kg/tree	856.58	776.39	1,128.76	1,378.23	1,380.84	672.26	2,501.01
2.0 kg/tree	1,668.22	1,364.75	3,770.12	1,246.78	1,285.28	2,508.51	1,504.13
t-test	ns	ns	ns	ns	ns	*	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

Table 3. Effect of chemical fertilizer on soil K concentration (mg.kg^{-1}) in rose apple orchard.

Treatment	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
0.5 kg/tree	603.20	517.72	736.97	665.91	668.14	395.65	883.35
2.0 kg/tree	825.02	781.38	700.47	670.76	704.85	1,074.53	901.32
t-test	ns	ns	ns	ns	ns	*	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

Table 4. Effect of chemical fertilizer on Soil pH in rose apple orchard.

Treatment	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
0.5 kg/tree	6.76	7.08	6.77	6.31	6.32	7.00	6.48
2.0 kg/tree	4.79	4.93	5.41	6.05	5.47	4.74	5.50
t-test	*	*	ns	ns	ns	*	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

Table 5. Effect of chemical fertilizer on Soil ECe in rose apple orchard.

Treatment	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
0.5 kg/tree	2.32	1.43	1.38	3.59	3.39	2.91	3.29
2.0 kg/tree	2.27	2.06	2.51	4.09	3.71	4.27	4.46
t-test	ns	ns	ns	ns	ns	*	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

Effect of chemical fertilizer on soil N, P and K concentration was also studied and found that different chemical fertilizer dose used had affected on soil N concentration (Table 1). Using 2.0 kg/tree had the higher soil N concentration than those in 0.5 kg/tree in September and October 2017 ($t < 0.05$). While, chemical fertilizer gave significant difference in soil P concentration in January 2018. As 2.0 kg/tree had the higher soil P concentration (2,508.51 mg.kg^{-1}) than those in 0.5 kg/tree (672.26 mg.kg^{-1})(Table 2). Also, chemical fertilizer gave significant difference in soil K concentration in January 2018. 2.0 kg/tree had the higher soil K concentration (1,074.53 mg.kg^{-1}) than those in 0.5 kg/tree (395.65 mg.kg^{-1}) (Table 3).

Moreover, effect of chemical fertilizer on soil pH and Ec was studied. The results indicated that using 2.0 kg/tree chemical fertilizers had effect on soil pH which gave the significantly lower soil pH than those in 0.5 kg/tree in Aug 2017 Sep 2017 and Jan 2018 (Table 4). While, using 2.0 kg/tree chemical fertilizers tended to give the higher soil Ec than those in 0.5 kg/tree but there was no significant difference ($t < 0.05$) except in January 2018 (Table 5).

For fruit quality, there were no significant difference in fruit color (a,b, L value), fruit texture, TSS and TA of rose apple harvested in December 2017, January 2018 and February 2018 (Table 6-8) but there was significant difference in TSS:TA. Using chemical fertilizer at 0.5 kg/tree gave the higher TSS:TA (16.57 and 13.84) than those in 2.0 kg/tree (8.29 and 11.20) in December 2017 and February 2018, respectively (Table 6 and 7).

The results from this study indicated that the different chemical fertilizer dose (2.0 kg/tree and 0.5

Table 6. Effect of chemical fertilizer on fruit quality of rose apple harvested in December 2017.

Treatment	a*	b*	L*	Texture (kg.)	TSS (°Brix)	TA (mole/L)	TSS:TA
0.5 kg/tree	21.15	8.76	27.12	2.03	8.45	0.51	16.57
2.0 kg/tree	20.42	8.83	28.09	1.96	7.96	0.96	8.29
t-test	ns	ns	ns	ns	ns	ns	*

ns indicated non -significant difference at the significant level of 0.05.

*indicated significant difference at the significant level of 0.05.

Table 7. Effect of chemical fertilizer on fruit quality of rose apple harvested in January 2018.

Treatment	a*	b*	L*	Texture (kg.)	TSS (°Brix)	TA (mole/L)	TSS:TA
0.5 kg/tree	22.45	9.27	27.62	2.51	8.57	0.55	15.58
2.0 kg/tree	23.14	8.93	25.95	2.24	8.06	0.53	15.20
t-test	ns	ns	ns	ns	ns	ns	ns

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

Table 8. Effect of chemical fertilizer on fruit quality of rose apple harvested in February 2018.

Treatment	a*	b*	L*	Texture (kg.)	TSS (°Brix)	TA (mole/L)	TSS:TA
0.5 kg/tree	23.30	9.83	26.83	1.90	7.89	0.57	13.84
2.0 kg/tree	23.88	9.99	29.75	2.08	7.28	0.65	11.20
t-test	ns	ns	ns	ns	ns	ns	*

ns indicated non -significant difference at 0.05 significant level as analyzed data by t-test.

*indicated significant difference at 0.05 significant level as analyzed data by t-test.

kg/tree) gave no significant difference in leaf N, P and K concentrations. Using 2.0 kg/tree gave 1.511.79%, 0.11-0.17% and 1.061.98% for N, P and K respectively and using 0.5 kg/tree gave 1.47-1.77%, 0.13-0.17% and 1.04 1.52% for N, P and K respectively. However, leaf nutrient concentrations found in this study were in suitable range for rose apple except K which was very high level. [3] reported that standard leaf nutrient concentrations in rose apple were 1.45 1.85%, 0.08 - 0.18% and 0.41- 0.79% for N, P and K, respectively. From those results, it indicated that using the high dose of chemical fertilizer (2.0 kg/tree) did not result in higher nutrient absorption of rose apple than those in low dose (0.5 kg/tree). This is due to the concentration of nutrient absorbed from the soil occurred as much as it's necessary for plant growth. Therefore, the over use of chemical fertilizer would make the residual effect to the soil and make soil deterioration [7]. For fruit quality, using the high dose of chemical fertilizer did not effect to fruit quality compared to the low dose. Thus, the dose of 0.5 kg/tree should be suitable for plant growth and development in rose apple cv. Tabtimjan in this study.

For soil nutrient concentration, using 2.0 kg/tree trend to give the high soil nutrient concentration as there was significant difference in some months. These may be that using 2.0 kg/tree resulted in the residual effect of chemical fertilizer and soil deterioration could be occurred. The consideration of leaf nutrient concentration showed that there was no significant difference in leaf nutrient concentration between the different chemical fertilizer doses. These indicated that nutrient absorption for plant growth and development in both using dose was similar. The residual effect of chemical fertilizer could be occurred in the 2.0 kg/tree using dose. Moreover, the using 2.0 kg/tree dose gave the lower soil pH than those in 0.5 kg/tree with significantly different in August 2017 September 2017 and January 2018. These could be the effect of unsuitable used chemical fertilizer. While, using 2.0 kg/tree tend to give the higher soil ECe (2.01 5.51 dS/m) than those in 0.5 kg/tree (1.38-3.59 dS/m). [5] reported that the suitable soil ECe was < 2 dS/m which this level will not have any effect to plant growth. Therefore, using 2.0 kg /tree has an increased chance of increasing soil ECe which adversely affects plant growth and development of more than 0.5 kg / plant.

The results from this study according to [8] who reported that using chemical fertilizer decreased soil pH compared to using organic fertilizer in yellow poplar (*Liriodendron tulipifera* Lin.). [2] reported that using high dose of NPK fertilizer can decrease soil pH in soybean growing area and the chemical fertilizers at higher doses have deleterious effects on plant growth and development. In apple, it has been reported that using more chemical fertilizer increased soil acidity [9]. While, [10] revealed that the application of only organic manures maintained the good health of soil, they were slow to release adequate nutrients timely and only inorganic fertilizers application could affect the soil health, which in turn may affect flowering and fruiting. [11] determined that high doses of complex NPK fertilizers broadcast annually across the rows in pear, blackberry and strawberry plantings, induced disturbances in mineral nutrition, primarily due to the accumulation of higher amounts of K and increases in the soil acidity. While, the low dose of chemical fertilizer did not have any effect on fruit quality but in-

duced the high TSS:TA compared to those in the high dose of chemical fertilizer. These revealed that the 0.5 kg/tree was suitable dose for rose apple production in this study.

From all of the results, using high dose of chemical fertilizer (2.0 kg/tree) trended to give the residual effect to the soil and could make the soil deterioration in the long term. Soil pH from the orchard used the high dose of chemical fertilizer was lower than the suitable level and high soil acidity in many period of time. Moreover, using 0.5 kg/tree could give the suitable nutrient concentration for plant growth and fruit quality very similar to those from using 2.0 kg/tree. Thus, using low dose of chemical fertilizer (0.5 kg/tree) would be able to decrease the cost, to maintain soil fertility and to meet the nutrient need of rose apple.

4. Conclusions

From all results it can be concluded that using 0.5 kg/tree of chemical fertilizer should be the appropriate dose of chemical fertilizer used for rose apple production because it gave no significant difference in leaf and soil nutrient concentration compared to using 2.0 kg/tree. Whereas, using 2.0 kg/tree of chemical fertilizer showed the higher soil pH and lower soil ECe than those in using 0.5 kg/tree of chemical fertilizer. Moreover, using 0.5 kg/tree of chemical fertilizer also gave the higher TSS:TA than those in using 2.0 kg/tree. Finally, the optimum leaf nutrient concentration could be met by using 0.5 kg/tree.

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