

Increasing of “Keprok” Citrus Production in the Andisols of Karo by a Local Compound Fertilizers

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ABSTRACT

Increasing of “Keprok” Citrus Production in the Andisols of Karo by a Local Compound Fertilizers (E Tuherkih and Sukristiyonubowo): The improvement of “keprok” citrus production in term of quantity and quality depends on soil properties and fertilization. Many factors affected effectiveness and efficiency of fertilizers *i.e.* soil, climate, plant species, growth period of plant, plant productivity, and type and rate of fertilizers. Study on the effect of SUMUT-1 and SUMUT-2 compound fertilizers on keprok citrus production was carried out in Sukadame Village, Tanah Karo District from January to December 2008. The purpose of the research were to evaluate the effectiveness of new compound fertilizer SUMUT-1 and SUMUT-2 on leaf nutrient content, quality and quantity production of “keprok” citrus as well as to determine the optimum rate of SUMUT-1 dan SUMUT-2. Ten treatments were tested and arranged into a randomized completely block design with three replications. The fertilizer application rates of SUMUT 1 and SUMUT 2 were 400, 550, 700, dan 850 kg⁻¹ha⁻¹year⁻¹, meanwhile dosages of fertilizer recommended application of NPK originated from single fertiliser namely urea, SP-36, and KCl and farmer practice were used as control. The results indicated that application of SUMUT-1 and SUMUT-2 were more effective than fertilizers coming from single NPK fertilizer with RAE value >100%. Furthermore, SUMUT-1 was better than SUMUT-2 in improving N, P, K contents in citrus leaf. The optimum application rate of SUMUT-1 was 700 kg⁻¹ha⁻¹year⁻¹ reaching the citrus production of 36,29 Mg⁻¹ ha⁻¹ year⁻¹ with fruit grade of about 51% AB and 49% CD. These matched with the SPO (Standard Procedure Operation) for citrus of about 20 Mg⁻¹ ha⁻¹ year⁻¹.

Keywords: Andisols, compound fertilizer, keprok citrus, SUMUT-1, SUMUT-2.

INTRODUCTION

The citrus demand in Indonesia is getting increase in line with increasing life standard and the need of healthy foods. Meanwhile, national citrus production is not concomitant with the growing of citrus demand, and it shall be imported from other countries (Winarno 1987; Suryana 2005). The imported data indicated that is increasing by year, from 67,117 Mg in 1997 to 76,595 Mg in 2003 (Anonymous 2005). To fulfill citrus needed, since 1999, Tanah Karo District, North Sumatera, one of the citrus growing areas, has been enhancing the citrus plantation areas. In average, the plantation areas growth is about 39-50% (Anonymous 2006).

The local citrus production is considered low due to improper fertilizers application rates. Usually, the farmers give fertilizers based on their experiences, do not take in to account the inherent soil fertility and the plant needs. On the other hand, recommended fertilizers application rate for citrus are too general and mainly based on the agronomic regardless the soil type, variety of citrus being planted and other external factors (Setyorini *et al.* 2003; Suryana 2005 and Davtian *et al.* 2003).

High nitrogen fertilizer application rate does not only reduce the fruit size, but also reduce the taste quality and fruit performance as well. In order to improve growth, production and yield quality of citrus, a balanced fertilization has to be applied.

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Theoretically, balanced fertilizers application rates are developed according to the original soil fertility status, variety, cultural practices, climate, and expected production. Supriyanto (2006) reported that combination between macro and micro nutrients given at proper time, rate and application way enhance citrus production in term of quantity and quality of yield. Furthermore, Palmarum (2007) reported that to produce 1 Mg qualified citrus fruit about 1,773 g N, 506 g P₂O₅, 3,194 g K₂O, 367 g MgO, 1,009 g CaO, and 142 g S are required. Specifically, Supriyanto *et al.* (2003) provided confirmation that application of proper K fertilizer increases fruit size and the skin thickness.

It is reported that applying proper compound fertilizers enhance the growth, increase yield and improve quality of citrus (Yu 2000; Wen and Cai 2001). According to Djoemai'jah *et al.* (1991) proper potassium application rates does not only increase weight of fruits, but also improve ratio sugar-acid, sugar concentration and C vitamine contents. The optimum K fertilisers for Valencia varieties vary between 150 and 225 kg K₂O ha⁻¹, with the average rate of 187.5 kg K₂O ha⁻¹ and the K concentration in the citrus leaf about 1.93 – 1.95 %. Especially, addition of 40 g KCl per plant of one year age of citrus plant improved K sorption. Application rate of 250 g urea , 30 g TSP, 125 g KCl 20 kg organic fertiliser plant⁻¹ showed the best prodction of Siem citrus grown in slty clay texture in Sidrap and became an optimum fertiliser rate (Asaad *et al.* 1993). Moreover, application rate of 3,000 g petroganic, 250 g urea, 600 g ZA, 650 g SP-36, and 400 g KCl plant⁻¹ improved citrus production in term of quantity and quality of yield (Anonymous 2009).

Practically, compound fertilizers is better than single fertilizer in term of packaging, transportation, storage, and field application because of their nutrient contens. Normally, coumpound fertilizer contain more than one nutrient required by plant, for example SUMUT-1 and SUMUT-2. They are formulatted based on citrus plant needs, soil fertility status, and nutrient content in citrus leaves (Tuherkih *et al.* 2007). Principally, the nutrient content of SUMUT-1 and SUMUT-2 are 18-20% N, 8-10% P₂O₅, 12-14% K₂O, 1-2 % Mg, 1-3 %, for SUMUT-1 is completed with micro nutrient like B, Cu and Zn. The form of SUMUT-1 and SUMUT-2 is like stick with 50 g per stick in weight.

The objectives of the research were to study the effectiveness of SUMUT-1 and SUMUT-2 on the growth and production of Keprok citrus, to evaluate

the influence of SUMUT-1 and SUMUT-2 on leaf nutrient content and yield quality as well as to determine optimum rate of SUMUT-1 and SUMUT-2.

MATERIALS AND METHODS

Study Sites

Experiment was carried out at Andisols in Sukadame Village, Tiga Panah sub District, Tanah Karo District from January to December 2008. The land and Keprok citrus plant used for the experiment belong to the farmer. The Keprok citrus plants age was five year and they have been producing fruits.

Experimental Setup

The treatments were arranged into a Randomized Completely Block Design (RCBD) with three replications. Four uniform growth performance citrus trees were used for every treatment. Plant spacing was 4m x 4m. The number of treatments was ten (Table 1). As the treatment were the different rates of SUMUT 1 and SUMUT 2, namely 400, 550, 700, dan 850 kg ha⁻¹ year⁻¹ or equal to 1,200; 1,650; 2,100, and 2,550 g plant⁻¹ year⁻¹. Farmer application rate (200 kg Urea, 200 kg SP-36, and 200 kg KCl ha⁻¹ or equal to 550 g Urea, 550 g SP-36, and 550 g KCl plant⁻¹ year⁻¹) and recommended fertilizers application rate (300 kg Urea, 200 kg SP-36, dan 200 kg KCl ha⁻¹ (600 g Urea, 400 g SP-36, and 400 g KCl crop⁻¹ year⁻¹) were used as control and standard rates to measure RAE (Relative Agronomic Effectiveness). Fertilizers were applied three times per year, thus

Table 1. Kind and rate of fertilizers in every treatment.

Treatment	Coumpound Fertilizers	Urea	SP-36	KCl
	----- kg ha ⁻¹ year ⁻¹ -----			
Farmer practices	0	200	200	200
Recommendation rate	0	300	200	200
SUMUT-1 (400)	400	0	0	0
SUMUT-1 (550)	550	0	0	0
SUMUT-1 (700)	700	0	0	0
SUMUT-1 (850)	850	0	0	0
SUMUT-2 (400)	400	0	0	0
SUMUT-2 (550)	550	0	0	0
SUMUT-2 (700)	700	0	0	0
SUMUT-2 (850)	850	0	0	0

Table 2. Nutrient composition of SUMUT-1 and SUMUT-2.

Compound Fertilizer	Nutrient content (%)							
	N	P ₂ O ₅	K ₂ O	Mg	S	B	Cu	Zn
SUMUT 1 (M-1)	18	10	14	-	2	0,2	0,1	0,1
SUMUT 2 (M-2)	20	8	14	-	2	-	-	-

Source: Tuherkih *et al.* (2007).

every four month fertilizers was given. Composition of macro and micro nutrients in each compound fertilizers being tested were presented in Table 2. The compound fertilizers used in this experiment have passed the quality test according to SNI 02-2803-2003.

Soil and Plant Analysis

Monitorings were conducted for initial soil fertility, nutrient contents in citrus leaves, citrus production according to their grade (A, B and C). Citrus quality were determined by measuring the acid sugar based on brix value, and effectivity of fertilizers calculated with RAE formula. Parameters to be measured for initial soil fertility included pH, organic matter content (Walkley and Black methods), total nitrogen (Kjeldhal methods), available P were determined by Bray I extractable and HCl 25%, K were determined by HCl 25%, cation exchange capacity (CEC) and exchangeable cation were determined by NH₄OAc extraction, and soil texture (pipette methods). Soils were samples before experiment started. Nutrient content in citrus leaves covered was N, P, and K.

Data Analysis

Means were compared by analysis of variance (ANOVA) for significance difference ($P < 0.05$). When ANOVA results indicated a significant treatment effect, least significant differences (LSD) at $P < 0.05$ were used to separate treatment means for all properties.

RESULTS AND DISCUSSION

Soil Fertility Properties

The characteristic of soil according to sample taken from 0-10 cm and 10 – 30 cm depth indicated that soil has acid soil pH (5.4 – 5.5) with loamy sand texture, in which the sand content was about 45 –

Table 3. Texture and chemical soil properties at 0-10 cm dan 10-30 cm soil layer depth in Tiga Panah, Tanah Karo District.

Parameter	Soil depth	
	0 - 10 cm	10-30 cm
Texture		
Sand (%)	48	45
Silt (%)	38	37
Clay (%)	14	18
pH		
H ₂ O	5.5	5.4
KCl	4.7	4.7
Organic Matter		
C-org (%)	4.49	4.10
N-total (%)	0.36	0.27
C/N (%)	12	15
P ₂ O ₅ (HCl 25%) (mg 100 g ⁻¹)	236	106
K ₂ O(HCl 25%) (mg 100 g ⁻¹)	66	50
P ₂ O ₅ (Bray-1) (mg kg ⁻¹)	19.8	6.3
Exchangeable Cation		
Ca-dd (cmol (+) kg ⁻¹)	5.03	3.26
Mg-dd (cmol (+) kg ⁻¹)	1.08	0.70
K-dd (cmol (+) kg ⁻¹)	0.79	0.62
Na-dd (cmol (+) kg ⁻¹)	0.21	0.25
CEC (cmol (+) kg ⁻¹)	28.99	27.33
Base Saturation (%)	25	18

48% (Table 3). Organic matter content was considered high and N total content was medium.

High content organic matter may be due to long term use of organic fertilizer and litter with high active carbon making it more resistance to be decomposed and leached. Total content of phosphorus and potassium measured with HC 25% method as well as available P measured with Bray 1 method was considered high. In contrast, exchangeable Ca, Mg, and K varied from low to medium, causing the base saturation was considered low. So far, the CEC was high.

Table 4. The effect of treatments on Keprok citrus steam diameter measured six months after treatment in Andisol, Karo.

Treatment	Steam Diameter (cm)	
	Before Treatment	After Treatment
Farmer Practices	7.2 a ^{*)}	9.8 ab
Recommendation Rate	6.8 a	10.1 ab
SUMUT-1 (400)	7.6 a	9.6 ab
SUMUT-1 (550)	7.4 a	10.2 ab
SUMUT-1 (700)	7.1 a	11.2 a
SUMUT-1 (850)	8.0 a	10.1 ab
SUMUT-2 (400)	7.9 a	9.5 b
SUMUT-2 (550)	8.3 a	9.8 ab
SUMUT-2 (700)	8.0 a	10.9 ab
SUMUT-2 (850)	7.3 a	9.9 ab

Note: ^{*)} The mean values in the same column followed by the same letter are not statistically different by LSD test (P < 0.05).

Citrus Trees Growth

The effect of treatments on Keprok citrus growth and development is presented in Table 4. For the perennial crops like keprok citrus, steam diameter is one of the criterias to monitor their growth and development in response to external factor like

fertilisation. It was measured about 20 cm above the surface soil. The initial steam diameter before the treatments were given varied from 6.8 to 8.3 cm. Furthermore, six months having treated with different rate of fertilisers showed that the biggest improvement of steam of about 11.2 cm indicated by SUMUT 1 at the rate of 700 kg ha⁻¹ year⁻¹, although it was not significantly different. The only significantly different when it was compared to SUMUT-2 at the rate of 400 kg ha⁻¹ year⁻¹ (Table 4). These data demonstrated that this rates could supply enough nutrient required by Keprok citrus to develop vegetative parts. Similar result was observed by Supriyanto *et al.* (2003).

Leaf Nutrient Content

Nutrient content in leaf is also good indicator to monitor the response of crop to external factor like fertilizer application. Furthermore, leaf analysis is proper method to determine fertilizer application rate for perennials crop (Al Jabri 2005). Leaf is a storage place in which nutrient content in leaf represent the nutrient status in the soil (Pushparajah 1994; Sutopo *et al.* 2004). Vissually. the deficiency symptom was not detected, meaning that the N, P and K contents in leaf were above the critical values (Figures 1a, b, and c). According to Dierolf *et al.* (2001) the critical values of N, P and K in the leaf were about 2.20 - 2.50% N, 0.09 - 0.12% P, and 0.70 – 1.20% K, respectively.

Compared to NPK compound originated from single fertilizers of urea, SP-36 and KCl, SUMUT-1

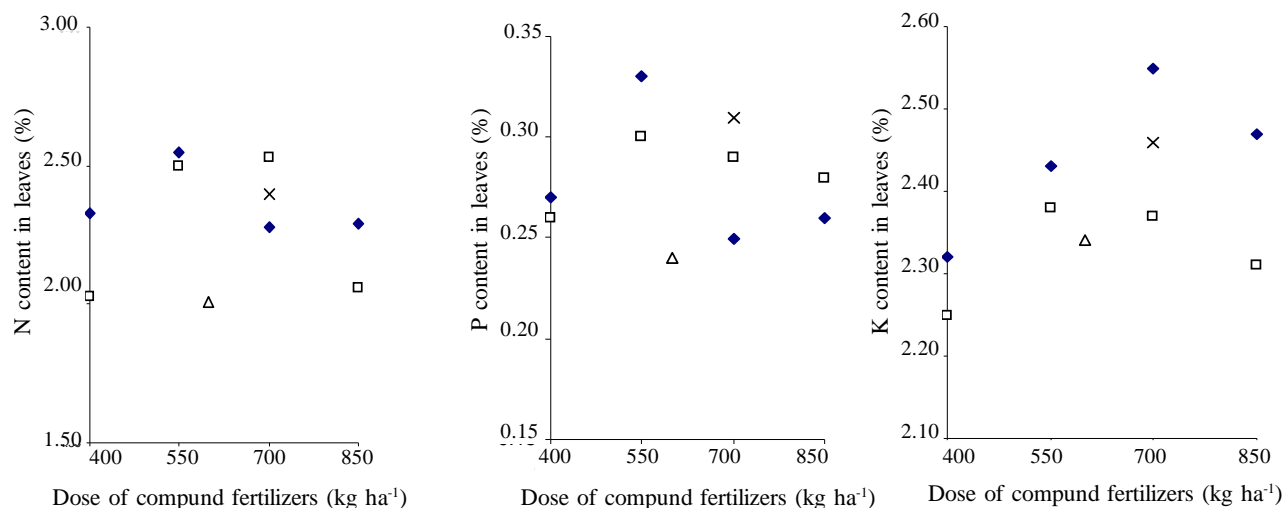


Figure 1. The relationship between rate of compound fertilizer (♦ = SUMUT-1 and □ = SUMUT-2), Δ = farmer dosage, and × = recommendation rate with N, P, and K content in leaves of citrus in Andisol, Karo.

and SUMUT-2 were more effective, meaning that the N, P and K contents in leaf were higher. So far, SUMUT-1 at the rate of 400 kg ha⁻¹ year⁻¹ gave higher N, P and K concentrations in leaf than SUMUT-2 at the same rate. This may be due to SUMUT-1 was composed both from macro nutrients (N, P, K and S) and micro nutrient likes B, Cu and Zn, whereas in SUMUT-2 was made up from macro nutrient only. Therefore, application of SUMUT-1 created a balanced nutrient on ratio between macro and micro nutrient. Purnomo *et al.* (2007) and Al-Jabri (2005) reported that B, Cu and Zn contents in citrus leaf planted in Andisol Karo were considered low indicated by chlorotical symptom in the middle of leaf.

Citrus Production

The effect of treatments on citrus production in term of quality (grade, total soluble solid) and quantity is presented in Table 5 and Figure 2. Imbalanced fertilization application rate could effect the production in term of quality (taste and fruit performance) and quality of citrus. Excessive of nitrogen and potassium bring about the bitter taste, in contrast, application of phosphate increase the sweet taste of fruits. Therefore, proper fertilizer application rates are very important to obtain good quality of citrus production (FFTC 2003).

The results indicated that the highest production of about 36.29 Mg ha⁻¹ with 59% grade AB and 41%

grade CD was obtained by treatment of 700 kg SUMUT-1 ha⁻¹ year⁻¹ and significantly different particularly with 400 kg SUMUT-1 and SUMUT-2 ha⁻¹ year⁻¹, farmer rate and recommended rate. Referring to Standard Operational Procedures (SOP) of Citrus Keprok in Karo District, citrus tress with 5 – 6 years old can produce citrus fruits higher than 20 Mg ha⁻¹ year⁻¹ or equal to 50 kg tree⁻¹ year⁻¹. The number of fruits with grade AB is 5 – 8 fruits kg⁻¹ and grade CD is 9 – 20 fruits kg⁻¹. It seems that the results matched with the SOP of Karo District as the ratio between grade AB and CD was 59/41.

Fertilizer Effectiveness

Fertility effectiveness was calculated according to relative agronomic effectiveness formula proposed by Machay *et al.* (1984). In this formula the fertilizers tested was compared with the recommended rate of NPK fertilizer originating from single fertilizer, namely urea, SP-36 and KCl. It is also called NPK standard. The formula is as follow:

$$RAE = \frac{\text{Yield of tested fertilizer} - \text{Yield of control}}{\text{Yield of NPK standard} - \text{Yield of control}} \times 100\%$$

In average, the RAE values of SUMUT-1 and SUMUT-2 were higher than NPK standard, meaning that the values were higher than 100. The highest RAE was 303% and indicated by the treatment of 700 kg ha⁻¹ year⁻¹ of SUMUT-1, followed by other treatments with the RAE values of 219 – 264% (Figure 3). So

Table 5. The effect of treatments on fruits production, citrus fruits grade and total soluble solid (TTS) in Andisol, Karo.

Treatment	Citrus Yield ----- Mg ha ⁻¹ -----	Fruits Grade		TTS
		AB	CD	
Farmer Practices	29.90 d ^{*)}	49.5 bc	50.5 ab	9.9 a
NPK Reccommended rate	32.00 cd	51.8 bc	48.2ab	10.2 a
M-1 (400)	32.70 bcd	53.4 ab	46.6 ab	10.3 a
M-1 (550)	34.50 abc	54.7 ab	45.3 ab	10.7 a
M-1 (700)	36.29 a	59.1 a	40.9 b	10.5 a
M-1 (850)	35.05 ab	57.8 ab	42.2 b	9.7 a
M- 2 (400)	32.28 bcd	50.9 bc	49.1 ab	9.6 a
M- 2 (550)	34.23 abc	56.9 ab	43.1 ab	9.4 a
M- 2 (700)	35.45 ab	57.7 ab	42.3 a	9.3 a
M- 2 (850)	34.80 ab	57.0 ab	43.0 a	9.6 a

Note: ^{*)} The mean values in the same column followed by the same letter are not statistically different by LSD test (P < 0.05).

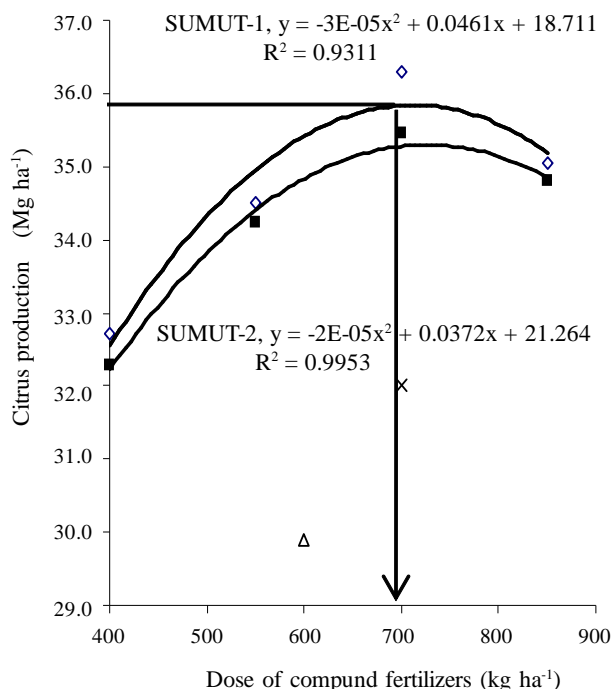


Figure 2. Relation between rate of dose of compound fertilizers on citrus production. \diamond = SUMUT-1 and \blacksquare = SUMUT-2, Δ = farmer dosage, and \times = recommendation rate.

far, at the rate of 400 kg ha⁻¹ year⁻¹ both SUMUT-1 and SUMUT-2, the RAE values were 113 – 133%. It can be concluded that application of SUMUT-1 was better than application of NPK compound originating from single fertilizer, namely urea, SP-36 and KCl.

CONCLUSIONS

It was concluded that compound fertilizer of SUMUT-1 composed of the macro nutrient of N, P, K and S (18:10:14:2) and micro nutrient of B, Cu and Zn (0.2:0.1:0.1) was better than SUMUT-2 made up with the nutrient composition of N, P, K, S (20:8:4:2) without micro nutrient content in increasing N, P and K concentration in citrus leaf.

The optimum rate of SUMUT-1 was reached at 700 kg ha⁻¹ year⁻¹ with the citrus production of 36.29 Mg ha⁻¹ year⁻¹ and fruits grade of AB 59% and CD 41% as well as met with the SOP (Standard Opretaional Procedure) of citrus of Karo District

SUMUT-1 and SUMUT-2 were more effective than NPK compound originating from single fertilizer namely urea, SP-36 and KCl, indicating with their RAE values higher than 100%.

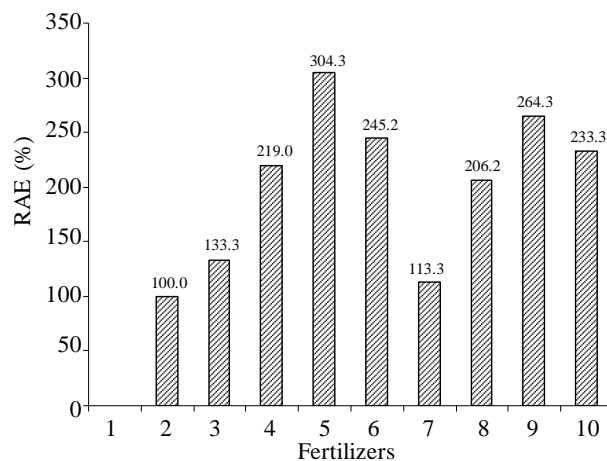


Figure 3. The effect of fertilizers treatment on RAE value (%) for Keprok citrus. 1 = Farmer Practices, 2 = NPK recommendation rate, 3 = SUMUT-1 (400), 4 = SUMUT-1 (550), 5 = SUMUT-1 (700), 6 = SUMUT-1 (850), 7 = SUMUT-2 (400), 8 = SUMUT-2 (550), 9 = SUMUT-2 (700), 10 = SUMUT-2 (850).

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