Combination of NPK fertilization and Foliar Application for Increasing the Yield of Citrus Fruit

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Abstract. The research aimed to obtain the best combination of NPK fertilizer dose and foliar application frequency for increasing the yield of citrus. The research was conducted from June 2019 to April 2020 at the Ex-farm belongs to Faculty of Agriculture, Jenderal Soedirman University. The research used Randomized Completely Block Design (RCBD) with two factors. The first factor was the NPK fertilization doses: 0, 25, 50 and 75 g/tree, the second one was frequency of foliar application: 0, 2, 4 and 6 times. The results showed that the combination of NPK fertilizer 75 g/tree and frequency of foliar application 6 times gave the highest number of flowers, fruitset, number of fruits, and weight per fruit. NPK fertilization of 75 g/tree gave the highest fruit diameter, and the lowest fruit drop. Foliar application of six times increased the diameter of the fruit and reduced fruit drop compared to control.

Keywords: Citrus · Yield · NPK · Foliar Application

1 Introduction

Citrus is one of favorite fruits both as fresh and processed fruit. As a comodity that has high economic value and give high contribution for national economic development, citrus must get special attention for its development [1].

There are many varieties of citrus, one of them is *Citrus reticulata* [2]. There are many benefits if we consume citrus fruit, i.e. for protecting the human body from cancer, increasing the human imunity, and contributing in fighting to virus [3]. Due to the importance of citrus, so its production and quality must be increased. The increasing of citrus fruit is also important for increasing the society and national income [4]. There are some ways to increase the production of citrus, one of them is application of fertilizer. Fertilizer can apply to soil or leaves or both of them. There many studies about effect of soil fertilization on citrus yield [5, 6] but there is few research about the effect of combination between soil fertilization and foliar application. Foliar spray of micronutrients gives quicker results than the soil application [7]. Plants requires spesific amount of micronutrients in several metabolic activities responsible for protein, sugar, and enzyme synthesis [8]. So it is very important to combine soil fertilization with foliar application

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to get more yield of citrus. To get efective fertilization, it must notice the dose and frequency of application [9]. The appropriate fertilization will support optimally growth and plant development. So it will increase productivity and quality of citrus [10].

The research aimed 1) to get the best combination of dose of NPK fertilization and foliar application to increase yield of citrus, 2) to get the best dose of NPK fertilization to increase yield of citrus 3) to get the best foliar application frequency to increase yield of citrus.

2 Materi and Method

The research was conducted from June 2019 to April 2020 at the Ex-farm belongs to Faculty of Agriculture, Jenderal Soedirman University. We used three-years old citrus of *Citrus nobilis*. This factorial experiment was arranged in Randomized Completely Block Design (RCBD) with two factors. The first factor was the NPK fertilization doses: 0, 25, 50 and 75 g/tree, the second one was frequency of foliar application: 0, 2, 4 and 6 times. There were 16 treatment combinations, it was repeated by 4 times respectively. We used fertilizer of NPK (9 25 25) and foliar application of Growmore (10 55 10). The observed variables were number of flower, fruitset, number of fruit, weight per fruit, fruit diameter, and fruit drop. Data was analysed by Anova and DMRT at $p = 0.05$.

3 Result and Discussion

The highest number of flower was achieved by combination of NPK fertilization 75 g/tree and foliar application by six times (Table 1). This matter showed that high doses of NPK fertilization must be followed by high frequency of foliar application for suficiency the needs of nutrients. Nitrogen (N), phosporus (P) and potassium (K) were needed by citrus tree to increase the succesful flowering [11]. Foliar application at flowering phase and growth of young fruit were very important to increase the yield of mango [12].

Combination of application NPK 75 g/tree and foliar application frequency of six times gave the highest fruitset (77.33%) (Table 2). This fruitset was increased 123.11% compared to fruitset at control. For high fruitset of citrus, application of high doses of NPK must be followed by application of foliar application with high frequency. Application of NPK fertilizer is very important to increase fruitset [13]. The appropriate foliar application can supply nutrients for plant quickly and increase photosynthesis process [14].

Table 3 showed that combination of application of NPK 75 g/tree and foliar application six times gave the highest number of fruit. Phosphor is very needed by citrus especially at reproductive phase because this nutrient accelerate flowering and fruit maturing [15]. The similar yield was reported for avocado and mangosteen. The number of avocado fruit can be increased by N application [16]. Application of potassium increase fruitset mangosteen [17]. The yield of citrus was increased by foliar application that contain of Zn and Cu [18].

The highest weight per fruit was achieved by combination application of NPK fertilizer 75 g/tree and foliar application four times (Table 4). The increase of weight per fruit was related with the content of potassium in leaves [19]. The appropriate foliar application increased weight per fruit of melon [20].

Application of NPK fertilizer 75 g/tree increased fruit diameter 59% whereas application of NPK fertilizer 50g/tree increased 49% compared to control (Table 5). Application of P fertilizer increased fruit diameter of citrus. Foliar application by six times increased fruit diameter 31% and reduced fruit drop compared to without foliar application.

Generally, the lower fruit drop was achieved by fertilization at higher dose. The insufficient nutrient content at the soil lead to increase fruit drop [21, 22]. This study showed that combination of NPK fertilization 75 g/tree and foliar application six times gave the highest number of flowers and fruits, weight per fruit, and fruitset. This result was similar reported by Van Dang et al., combination of application P, K. Mg, and Zn enhanced the fruit quality and productivity of pomelo [23]. So it was recommended to apply the cobination of NPK fertilization 75 g/tree and foliar application six times to get high yield and quality of citrus at planter bag. But for cultivation at land, this combination needs to study further.

4 Figures and Tables

Table 1. Number of flower at some doses of NPK fertilization and frequencies of folar application

Doses of NPK fertilization (g/tree)	Frequencies of foliar application (times)			
	0	2	4	6
0	36.33 aA	37.33 aA	38.66 aA	42.66 aA
25	43.00 aA	44.00 aA	60.33 aBC	58.66 aAB
50	44.00 aA	47.00 aA	44.33 aAB	71.66 bBC
75	38.00 aA	42.33 aA	67.66 bC	83.00 bC

Notes: Values followed by different capital letters within a column are significantly different at p = 0.05; and values followed by different noncapital letters within a row are significantly different at p = 0.05

Table 2. Fruitset (%) at some doses of NPK fertilization and frequencies of folar application

Doses of NPK fertilization (g/tree)	Frequencies of foliar application (times)			
	0	2	4	6
0	85.80 aA	90.71 aA	91.48 bA	92.13 bA
25	93.17 aB	93.18 aAB	94.54 aB	94.59 aAB
50	94.64 aB	95.57 aB	95.49 aBC	96.56 aB
75	93.93 aB	95.40 aB	96.12 aC	99.11 bC

Notes: Values followed by different capital letters within a column are significantly different at p = 0.05; and values followed by different noncapital letters within a row are significantly different at p = 0.05

Table 3. Number of fruit at some doses of NPK fertilization and frequencies of folar application

Doses of NPK fertilization (g/tree)	Frequencies of foliar application (times)			
	0	2	4	6
0	31.66 aA	32.33 aA	33.33 aA	36.66 aA
25	37.33 aA	38.00 aA	54.00 bB	48.00 abAB
50	36.00 aA	36.33 aA	35.00 aA	60.33 bBC
75	34.66 aA	37.00 aA	60.00 bB	72.66 bC

Notes: Values followed by different capital letters within a column are significantly different at p = 0.05; and values followed by different noncapital letters within a row are significantly different at p = 0.05

Table 4. Weight per fruit (g) at some doses of NPK fertilization and frequencies of folar application

Doses of NPK fertilization (g/tree)	Frequencies of foliar application (times)			
	0	2	4	6
0	138.00 aA	166.33 bA	144.33 aA	147.33 aA
25	149.00 aA	180.00 bAB	166.00 bB	169.00 bB
50	153.33 aAB	177.00 bAB	157.33 aAB	189.00 bB
75	166.00 aB	183.66 bB	207.33 cC	226.00 dC

Notes: Values followed by different capital letters within a column are significantly different at p = 0.05; and values followed by different noncapital letters within a row are significantly different at p = 0.05

Table 5. Fruit diameter and fruit drop at some doses of NPK fertilization and frequencies of folar application

Treatments	Fruit diameter (mm)	Fruit drop (%)
Doses of NPK fertilization (g/tree)		
0	33.41 a	31.51 a
25	37.01 a	23.66 a
50	45.84 a	20.85 a
75	53.26 b	10.99 b
Frequencies of foliar application (times)		
0	37.84 a	30.74 a
2	40.70 a	25.64 a
4	42.21 a	21.94 a
6	50.88 b	11.69 b

Notes: Values followed by different letters within a column for each factor are significantly different at $p = 0.05$

5 Conclusion

Combination of NPK fertilizer 75 g/tree and frequency of foliar application 6 times gave the highest number of flowers, fruitset, number of fruits, and weight per fruit. NPK fertilization of 75 g/tree gave the highest fruit diameter, and the lowest fruit drop. Foliar application of six times increased the diameter of the fruit and reduced fruit drop compared to control.

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