APPLICATION OF MINERAL PLUS FERTILIZER TO INCREASE TOMATO PRODUCTION AND QUALITY IN BATURITI DISTRICT, TABANAN REGENCY, BALI PROVINCE, INDONESIA

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ABSTRACT

Environmentally friendly agriculture and food health are needed to support tourism in Bali. Meanwhile, it is alleged that agricultural products do not meet the requirements, especially the quality that does not meet consumer requirements. This research refers to the Udayana University Research Master Plan, a leading field of food security. Food Security Research Roadmap, with the aim of producing appropriate technology. The research products can be implemented in activities to increase production, quality of horticultural crops and food health to support tourism. The research method was through testing the productivity and quality of tomato plants through the addition of organic fertilizers, mineral fertilizers, chemical fertilizers, and their combination. The highest production was obtained from the treatment of P6 = mineral plus fertilizer (5 tons of hill lime + 5 tons of organic fertilizer products organic fertilizer product simantri + 100 kg urea + 100 kg phonska) per ha, can increase production (34.46%). Treatment of mineral fertilization (P2) =mineral fertilizer 5 tons of hill limestone, contains the highest vitamin C (286.14 mg/kg), P2 is also able to neutralize heavy metals Cu and Mo, increase calcium content, increase shelf life, thicken tomato skin walls which Calcium sticks to tomato skin.

Keywords: *Mineral fertilizer, productivity and quality, tomato fruit*

INTRODUCTION

This research refers to the Unud Research Master Plan, Food Security Excellence. Food Security Research Roadmap, with the aim of producing appropriate technology and products that will be implemented in vegetable crop production activities in the production center (Baturiti District, Tabanan Regency, Bali, Indonesia). Increasing land productivity and quality of agricultural products supporting tourism is carried out through land resource management, environmentally friendly agricultural systems. Horticultural products in the form of vegetables, fruits and flowers are needed both for the consumption of the Balinese people, the need for ceremonial facilities. and fulfilling tourism needs, especially for hotels, restaurants and restaurants. For that we need quality products, environmentally friendly and healthy for consumption. The production and quality of organic fertilizers is allegedly lower than chemical fertilizers, it is also suspected that it contains coli bacteria due to animal and human manure.

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However, chemical fertilizers are also starting to be reduced due to the scarcity of fertilizers and reduce negative impacts. For this reason, fertilizer formulas are needed that do not pollute the environment and can increase production, as well as the quality of agricultural products and can neutralize heavy metals. This research was conducted at the location of sustainable food agricultural land according to the results of Lanya, et al. (2015), especially in the center of highland vegetable production. This article is limited to tomatoes, although the research also tested mineral fertilization for carrots, mustard greens, potatoes, broccoli, cauliflower, and gumitir fruit.

Research on the application of mineral fertilizers has been carried out by the research team, generally to improve the quality of local fruits such as oranges, salak, melons, papayas from 2000-2013, 2014 on lowland vegetable crops (spinach, mustard greens and kale. The results show that mineral plus fertilizer can increase the production and quality of fruits and vegetables. Therefore, in this study, the role of mineral fertilizer plus in increasing production, quality, food health and the environment for upland horticultural crops, especially tomatoes, will be tested. Research problems include: the tourism sector requires agricultural products of high quality and competitiveness, through environmentally friendly agricultural systems

Research on increasing the production and quality of horticultural commodities, especially fruits and vegetables is very urgent, to fulfill healthy food consumption. The use of organic fertilizers is being intensively recommended by the central and local governments. However, from the aspect of production, quality, food health. and the benefits of farming results using organic fertilizers still need to be reviewed, considering the low yields and the impact on the environment. This is due to the very low content of nutrients needed by plants in organic fertilizers. So it is needed in large quantities and has the potential to damage the environment, especially COD and BOD, as well as the coli bacteria they contain derived from animal and human waste.

Contribution to science is to improve his skills and professionalism in the fields of soil fertility, crop production and sustainable land resource management. It is expected to find fertilizer formulas that are able to increase production and quality of crop yields, food health and are friendly to the environment which are indispensable for supporting tourism.

Previous research has shown that mineral fertilizers containing high Ca and

Mg can increase rice production, reduce void levels (Subadiyasa et al., 2015). Mineral fertilizers can also increase the productivity and quality of melons and oranges (Lanya, 2001), papaya fruit (Subadiyasa et al., 2016). Papaya plants have been tested with organic fertilizers, NPK fertilizers/chemical fertilizers (600 kg ponska/ha), mineral fertilizers of 4 tons/ha and 8 tons/ha and a combination of chemical and mineral fertilizers (4 tons+300 kg NPK)/ha. This study found that: NPK fertilizer gave the highest yield (fruit per tree, number of fruit per tree) when compared to plants that were given organic fertilizer alone or without fertilizer as shown in Figure 1. The best quality, such as Vitamin C content and total sugar, was obtained from mineral fertilizer treatment.

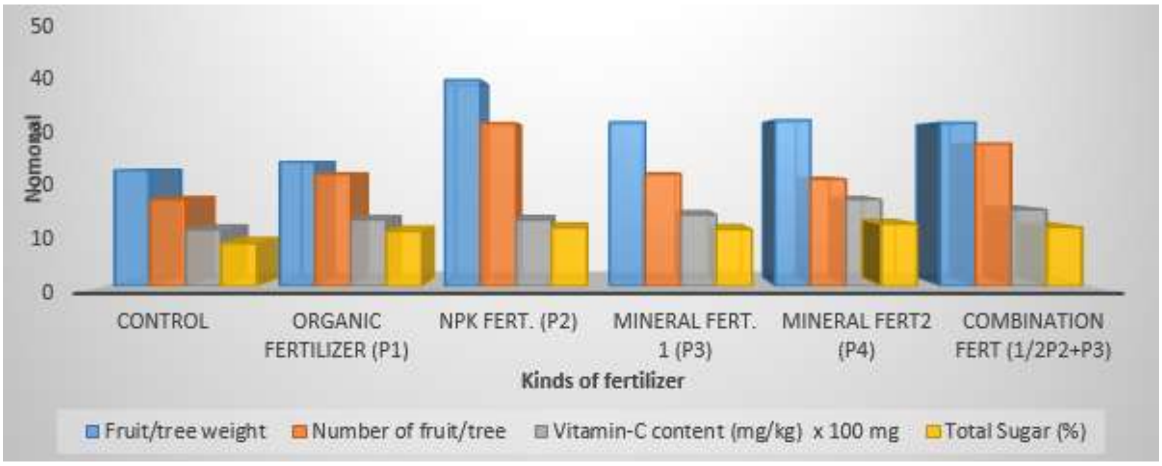

Figure 1. Effect of fertilization on the production and nutritional content of papaya fruit

Tests of mineral fertilization for horticultural commodities (beans) have been carried out at the same location, the results show that mineral fertilization can increase production, total sugar content and shelf life (Lanya and Subadiyasa, 2018). The same study tested mineral fertilization in the village of Wisesa, Baturiri, Tabanan Bali on horticultural commodity (broccoli, round salad, cauliflower, spinat, round salad, mustard tope) was also carried out in Baturiti. The result is that mineral fertilization greatly affects the increase in production, chlorophyll content, vitamin C content, anti-oxidants and storage time (Subadiyasa et al., 2019).

MATERIALS AND METHODS

Research on increasing the productivity and quality of tomato plants was carried out in Baturiti District, Tabanan Regency. The location selection was based

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on: the area is a center for highland vegetable production. This area is designated as a sustainable food cropland (Lanya et al., 2015). Besearch materials: tomato plant seeds, organic fertilizer (simantri product), mineral fertilizer (lime hill + kitchen salt), NPK (pearl), chemicals for analysis of visamin C and total sugar.

The research method used was fertilization testing in the field using eight fertilizer treatments, namely: (1) P0 = control, (2) P1 = organic fertilizer/Simantri productsld 10 tons/ha, (3) P2 = mineral fertilizer 5 tons/ha (lime+salt), (4) P3 = chemical (NPK) fertilizer (200 kg ponska + 200 kg urea) per ha/ farmer dose, (5) P4 = combination fertilizer (P1+P3) per ha, (6) P5 = combination fertilizer (P2 + P3) per ha, (7) P6 = mineral fertilizer plus = ½ (P1 + P2 + P3), and (8) P7 = mineral fertilizer plus (½ P1 +½ P2). The plot size is 1 x 10 m = 10 m2, three replications, each type of plant has 24 plots. Parameters tested for production: height, weight and number per plot or per ha. Quality observed: water content, total sugar content, vitamin C and calcium mineral content.

Statistical analysis used a Randomized Block Design (RAK), analysis of variance (ANOVA) to determine the effect of fertilization treatment on the observed parameters. The smallest significant difference test (Duncan's Multiple Range Test) at the 5% level was used to determine the difference in the mean of each parameter observed. ANOVA test and BNT test using the COSTAT program. SEM (Scanning Electron Microscope) analysis with 250x and 1500x magnification was used to determine the morphology and pore space contained in tomatoes. EDS (Energy Dispensive Spectroscope)) analysis using ZAF standardless method of Quantitative analysis. Fitting coefficient 0.4658 to determine the elemental content in tomatoes.

RESULTS AND DISCUSSION

The results of the analysis of the variance of the effect of fertilization on tomato production and quality are presented in Table 1 and Figure 2. Table 1 shows that fertilization has a very significant effect on tomato production and the number of fruits harvested. Fertilization has a significant effect on the number of fruits. In contrast to the number of green fruits, stem weight and moisture content were not affected by fertilization. This means that fertilization only affects the production of tomatoes. To determine the nutritional content, an analysis of the content of vitamin C, calcium levels and total sugar was carried out as shown in Figure 3.

Table 1, Figure 2 and Figure 3 show that the fertilization treatment (P6) is a mixture of mineral fertilizer (5 tons/ha) + organic fertilizer (5 tons/ha) + urea fertilizer (200 kg urea/ha) + ponska (200 kg/ha)) obtained the highest production, number of fruits, and water content harvested, namely: tomato weight (44.04 tons/ha), number of fruit 228 grains/10 plants, fruit harvested 180 grains/10 plants), moisture content (93.5%), and shelf life (14 days). The more the number of fruits and berries harvested, the higher the production of tomatoes, as well as the higher the water content, the longer the shelf life. These data indicate that the water content affects the length of shelf life (P6).

Table 1. Effect of fertilization on production parameters and quality of tomato fruit

No	Parameters	P
Duncan's Test		
1	Tomato fruit production (tonnes ha^{-1})	0,0031**
2	Total number of fruits on 10 plants	0,249 *
3	Number of fruits harvested 1,2,3 in 10 plants $plot^{-1}$	0,0063 **
4	The number of green fruit remaining 10 plants	0,3334 ns
5	Tomato stem weight (kg $plot^{-1}$)	0,9544 ns
6	Water content (%)	0,3220 ns

LSD 0,05; Description: * significant effect; ** very real effect

BNT test

No	Fertilization Treatment	Fruit weight (tons ha^{-1})	Number of Fruits 10 Plants	Number of Harvested Fruits	Number of Green Fruit	Rod Weight	Water content (%)
1	2	3	4	5	6	7	8
1	P0 (control)	29,36 c	179,00 b	129,67 bc	38,67 a	2,87 a	87,25 b
2	P1(organic fertilizer)	36,49 b	178,67 b	104,67 c	57 a	2,5 a	89,82 ab
3	P2 (mineral fertilizer)	36,93 ab	188,67 b	143,67 abc	51,33 a	2,4 a	90,14 ab
4	P3(NPK fertilizer	38,93 ab	205,67ab	172,67 a	57 a	2,93 a	90,00 ab
5	P4 (P1+P3)	35.75 b	207,33ab	176,33 a	28 a	2,87 a	88,03 ab
6	P5 (P2+ P3)	39,35 ab	205,67ab	143,67 abc	37,67 a	2,6 a	90,32 ab
7	P6 (½P1 +½ P2 + ½ P3)	44,04 a	228 a	180,67 a	40 a	2,97 a	93,50 a
8	P7 (plus (½ P1 +½ P2).	35.55 b	178,67 b	104,67 c	33 a	2,5 a	88,61 ab

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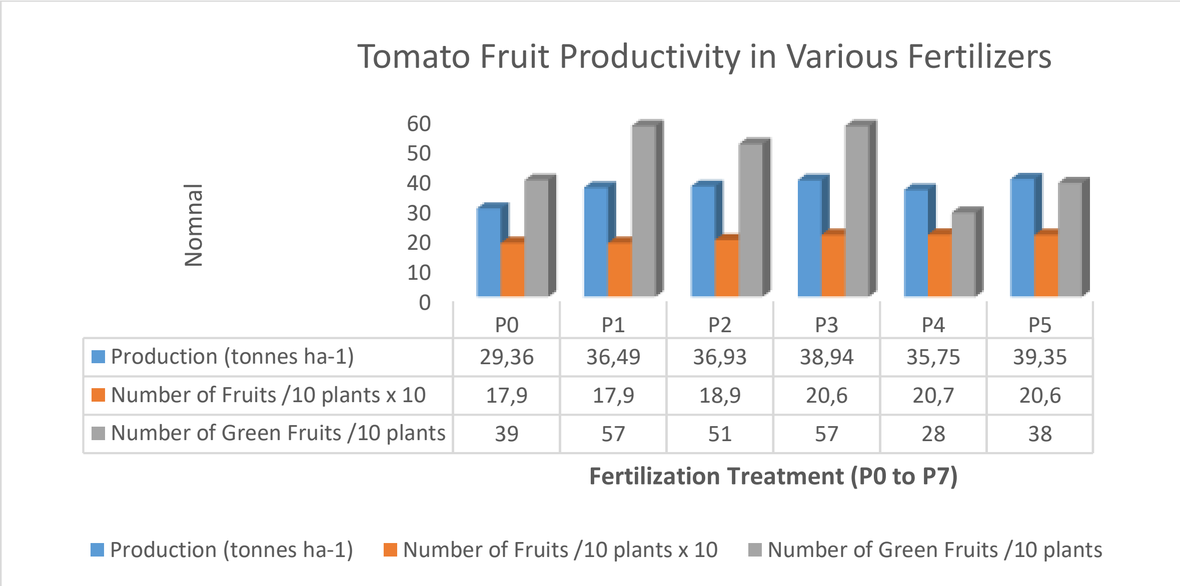


Figure 2. Graph of the relationship between production parameters and fertilization treatment

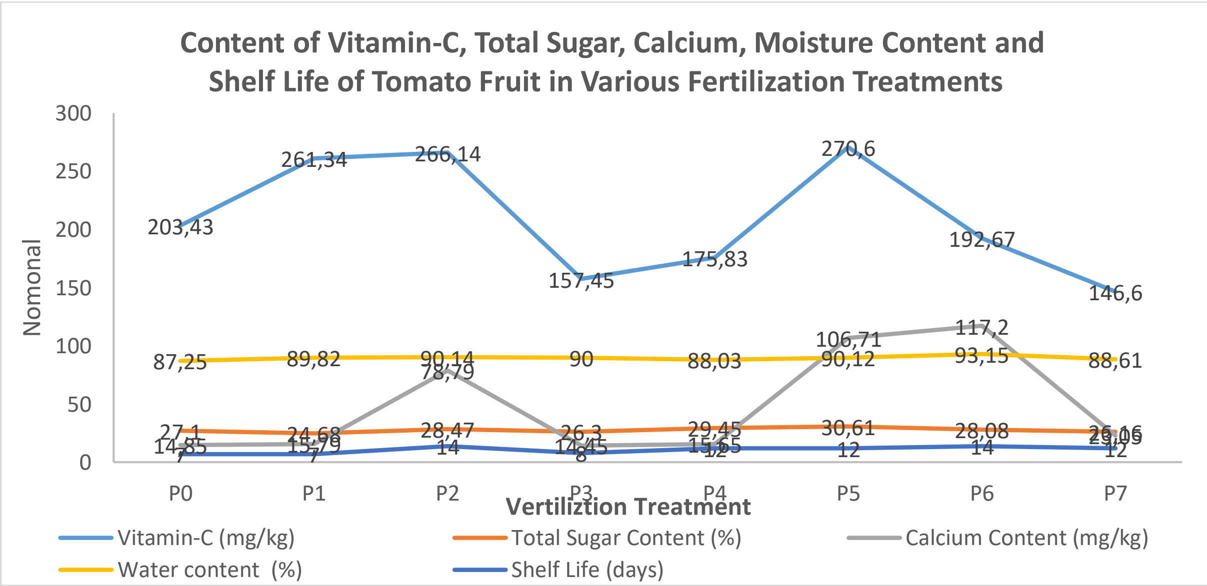
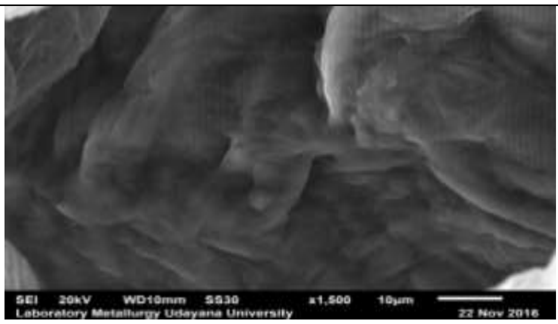
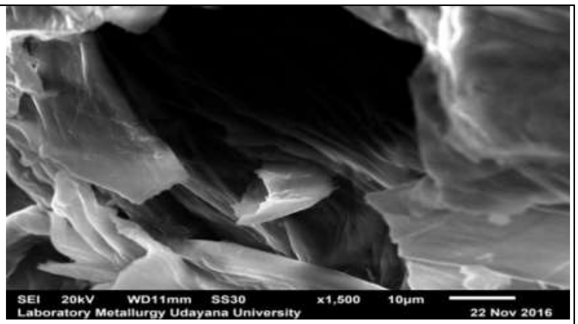


Figure 3. Vitamin C content, total sugar, calcium, water content and storage time of tomato in various fertilization treatments

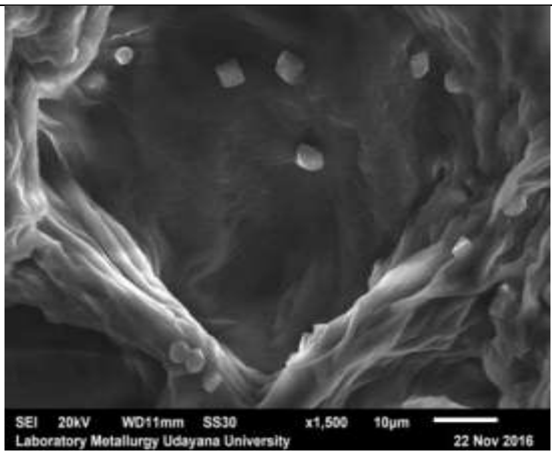
The length of shelf life is shown by the results of the SEM analysis listed in Figure 4. Data on the content of elements contained in tomatoes from various fertilization treatments are listed in Figure 5. Figure 4 shows that the largest cavities and the thickest skin were found in tomatoes that were treated with P6, respectively, getting narrower and thinner from treatments P2, P1, P3 and the narrowest and thinnest at P0. In addition, in the mineral fertilization treatment (P3) there was calcium attached to the tomato skin wall which was strengthened by Figure 5 where the highest calcium content in the P2 treatment was attached to the tomato skin.



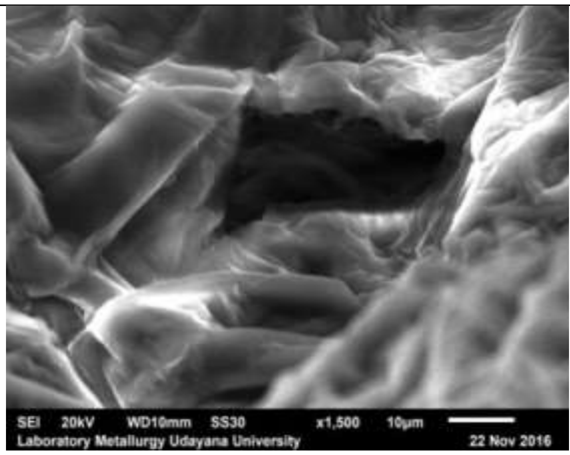
P0 treatment: 1500x . magnification



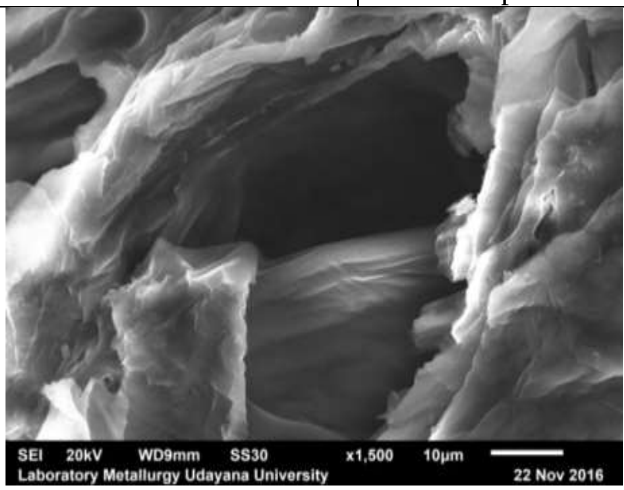
P1 organic fertilizer treatment: 1500x . magnification



Treatment P2= mineral fertilizer: magnification 1500x



Treatment P3= NPK fertilizer+ponska: magnification 1500x



Treatment P6= combination of organic fertilizer + mineral + urea + phonska: magnification 1500x

Figure 4. Pore space of tomato skin on various fertilization treatments (P0, P1, P2, P3, P6) (Source: SEM Analysis Results, 2018)

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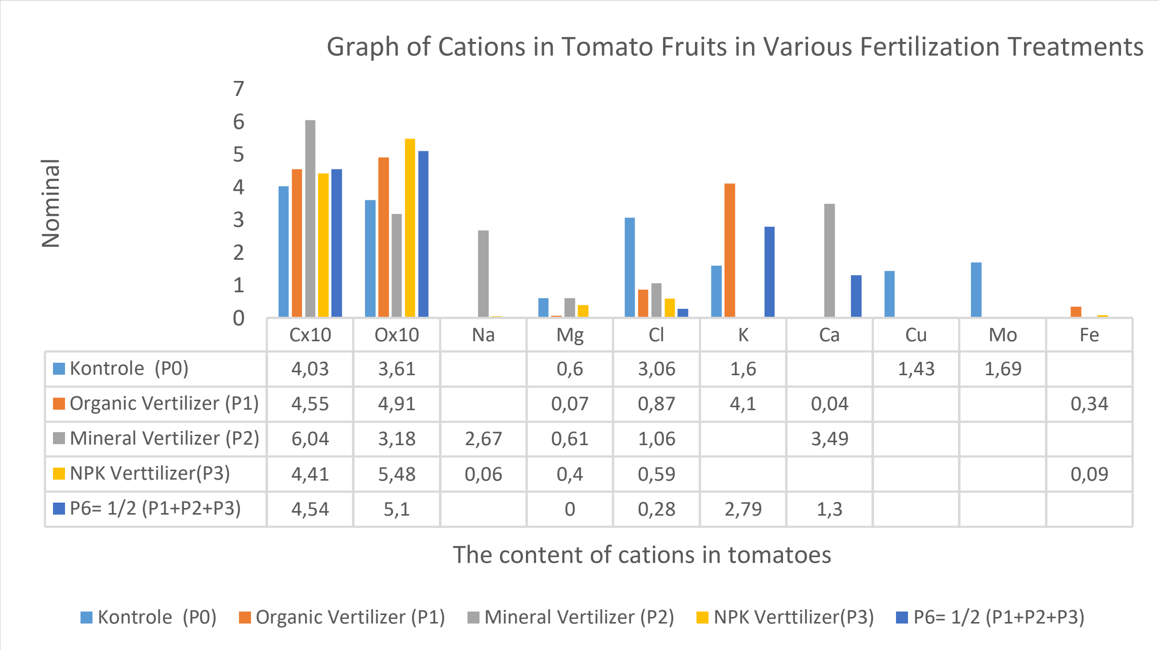

	Cx10	Ox10	Na	Mg	Cl	K	Ca	Cu	Mo	Fe
Kontrole (P0)	4,03	3,61		0,6	3,06	1,6		1,43	1,69	
Organic Vertilizer (P1)	4,55	4,91		0,07	0,87	4,1	0,04			0,34
Mineral Vertilizer (P2)	6,04	3,18	2,67	0,61	1,06		3,49			
NPK Verttilizer(P3)	4,41	5,48	0,06	0,4	0,59					0,09
P6= 1/2 (P1+P2+P3)	4,54	5,1		0	0,28	2,79	1,3			

Figure 5. Cation content in tomatoes (source: EDS analysis results)

The data in Figure 5 also shows that tomato fruit from the control treatment means that the unfertilized soil contains heavy metals Cu and Mo, as well as organic fertilizers containing Fe. In contrast to tomatoes that underwent mineral fertilization, they did not contain heavy metals Cu, Mo and Fe. Precisely mineral fertilizers can provide the highest nutritional content in the form of Na, Mg, Ca cations in tomatoes. In other words, mineral fertilization can neutralize heavy metal content and increase nutritional content in the form of Na, Mg and Ca cations and Cl anions.

The results of this study are in accordance with the results of previous research on lowland rice, which concluded that mineral fertilizers combined with chemical fertilizers obtained the highest production compared to chemical fertilizers alone (Lanya and Subadiyasa, 2017). In this research, mineral fertilization containing Ca and Mg can increase the productivity and quality of tomatoes. This is due to the role of Ca and Mg proposed by Stanier, et al. (1963) stating that Ca is a cofactor for several enzymes, such as proteinases and plays a role in the formation of protein compounds. The role of Ca ions is very important for amino acid transport and protein synthesis in Achliya cells (Singh and Le John, 1975 in Payne, 1980) reported that Ca ions act as binding energy in amino acid transport with a proton drive system. Meanwhile, Mg functions as a chlorophyll core, a cofactor for several enzymes that bind energy and stabilizer acids and bases in cells.

CONCLUSION

The highest tomato production was 44.04 tons/ha (an increase of 34.46%) in the P6 treatment = mineral fertilizer plus (5 tons organic fertilizer + 5 tons mineral fertilizer + 100 kg urea + 100 kg phonska) per ha. Mineral plus fertilizer produces tomatoes containing the highest vitamin C (286.14 mg/kg), the highest calcium (Ca) (111.12 mg/kg), and total sugar (28.08%), capable of neutralizing heavy metals Cu and Mo, increase Ca, and increase shelf life. Calcium attaches to the skin walls of tomatoes which can strengthen cell walls and increase the nutritional content of tomatoes, found in mineral fertilization treatment. "Mineral Bali Plus" fertilizer can be used as the superior product of this research which is able to increase the production, quality, and nutritional content of tomatoes, as well as neutralize heavy metals.

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