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Response of Lowland Passion Fruit (Passiflora edulis) Growth to the Application of KCl Fertilizer at Different Doses

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ABSTRACT: Passion fruit (Passiflora edulis) is one of Indonesia's fresh fruits highly favored by both domestic and international consumers. Its production can be increased by applying KCl fertilizer. This study aims to determine the response of KCl fertilizer on the growth of passion fruit in lowland areas. The research was conducted at the Bosowa University Experimental Garden located in Bontoramba Village, Pallangga District, Gowa Regency. The study was designed as an experiment using a Randomized Block Design. The treatments applied were different doses of fertilizer: K1 (control), K2 (1.5 g/plant), K3 (3.5 g/plant), and K4 (4.5 g/plant). The results indicated that the application of KCl fertilizer at a dose of 1.5 g/plant tended to have a better effect on the growth of the main stem length, stem diameter, number of leaves, and number of branches in the plants.

KEYWORDS: Fertilizer doses, KCL fertilizer, lowland cultivation, passiflora edulis, passion fruit growth

I. INTRODUCTION

Indonesia has agroecological conditions that can produce almost all types of fruit, including those originating from subtropical regions. Indonesia has the opportunity to develop passion fruit agribusiness and agroindustry centers. The global market demand for fresh and processed passion fruit is wide open, making passion fruit farming a viable and lucrative source of income. Currently, the production centers of passion fruit in Indonesia are in Karo and Simalungun (North Sumatra) as well as Gowa, Tana Toraja, Sinjai, and Enrekang (South Sulawesi). In North Sumatra, particularly in Tanah Karo, the area under passion fruit cultivation has decreased because farmers are more interested in growing citrus crops (Barus and Syukri, 2018).

However, there is a common belief that passion fruit is only suitable for highland cultivation. This notion is challenged by the existence of a passion fruit variety (Passiflora edulis f.) that is suitable for lowland cultivation. This variety is relatively easy to grow, as it can be propagated using cuttings and seeds, and the plant will bear fruit at six months of age. There are two types of passion fruit: purple passion fruit (Passiflora edulis) and yellow passion fruit (Passiflora flavicarva). The purple passion fruit is native to Brazil, while the yellow passion fruit is believed to have originated in Australia through mutation from tropical America. The introduction of passion fruit to the Philippines is not well-documented. Both types grow well in both lowland and highland areas, but their distribution is limited (Coronel, 2020).

The development of lowland passion fruit cultivation has not yet been widely pursued. Besides the volume of media, the type of growing media is an important factor for achieving optimal growth of passion fruit. The choice of growing media is crucial for potted plants as it affects root movement. The growing media used for planting passion fruit in pots must have good porosity to allow free root movement. Using media that retains too much water can cause the roots and lower stems of red betel to rot, while media with low water retention can dry out quickly, leading to plant death (Gavrilescu, 2021; Gebre & Earl, 2020). Passion fruit is rich in vitamins. The nutritional content of passion fruit per 100g (USDA National Nutrient Database) includes: energy 97 kcal, carbohydrates 23.38g, protein 2.20g, fat 0.70g, dietary fiber 10.40g, niacin 1.500mg, riboflavin 0.130mg, vitamin A 1274 IU, vitamin C 30mg, vitamin E 0.02mg, vitamin K 0.7mg, potassium 348 mg, calcium 12 mg, copper 0.86 mg, iron 1.60mg, magnesium 29mg, phosphorus 68mg, selenium 0.6 µg, and zinc 0.10µg (Biswas et al., 2021; Fonseca et al., 2022)

Indonesia's passion fruit production in 2010, 2011, and 2012 was 132,001 tons, 140,895 tons, and 134,582 tons, respectively. Although the plant can flower year-round, the main flowering season is from August to January, with the main harvest season from November to January. The yield ranges from 10-30 tons/ha/year. Passion fruit is primarily processed domestically, with only a small quantity sold fresh. However, international markets like Japan and Europe are open to fresh passion fruit. Ripe fruit stored at 5-10°C with 85-90% humidity can last for 20 days (Central Bureau of Statistics, 2020). Efforts to increase productivity involve ensuring the availability of nutrients for the plants. Generally, soil productivity can be defined as the soil's ability to produce a specific crop species or a cropping system under certain management practices. Management aspects include planting distance, fertilization, irrigation, pest and disease control, etc. For soil to be productive, it must be fertile, though fertile soil is not always productive. Soil productivity encompasses factors beyond soil fertility, including climate, topography, and slope conditions (Kumar et al., 2020; Wawire et al., 2021)

The nutrients in KCl fertilizer are potassium compounds that plants can readily absorb. Before absorption, KCl fertilizer decomposes into K2O and Cl++ ions in the soil. K2O has various benefits for plant growth and strengthens plant resistance to diseases. However, excessive application of Cl++ ions can be harmful to plants (Chy Ana, 2018; Tallapragada & Matthew, 2021; Wakeel & Ishfaq, 2022). Morton (2019) recommends fertilizing P. edulis passion fruit with NPK (10:5:20) at a dose of 1.36 kg/plant/year, applied four times a year. The best single applications of N and P fertilizers in India are 132 kg N and 31.6 kg P2O5 per ha/year, while in Ivory Coast, 220 g Urea and 210 g KSO4 per plant/year are recommended. According to Silalahi (2021), the best growth and yield of passion fruit are achieved with a fertilization dose of 360 kg N/ha, 180 kg P2O5/ha, and 180 kg K2O/ha, which also increases the number and size of passion fruits. Almadiy et al. (2023) and BPTP Sulsel (2018) suggest applying NPK 15:15:15 at a dose of 1000 g/tree/year, given three times a year at planting, 4, and 8 months after planting (BST). KPTB Berastagi recommends applying 60 g of urea at planting, 3, 6, and 9 months, and 20 g of SP-36 at planting, 100 g at 3 and 6 BST, and 20 g at 9 BST (Karsinah et al., 2019). Karsinah (2019) recommends fertilizing passion fruit with urea, SP-36, and KCl at 50, 100, and 100 g/tree, respectively, and NPK (15:15:15) at 50 g/tree every three months.

II. RESEARCH METHODOLOGY

This study was conducted at the Experimental Garden of the Faculty of Agriculture, Bosowa University, located in Bontoramba Village, Pallangga District, Gowa Regency. The materials used in this research included lowland passion fruit plants, KCl fertilizer, and organic manure. The tools used in the study were writing instruments, a measuring tape, a camera, bamboo sticks, labels, lamsoro plant stems, and a caliper.

Experimental Method

This research was conducted as an experiment using a Randomized Block Design with 4 treatments and 3 replications. Each experiment required 4 plants, resulting in a total of 48 plants needed. The treatments consisted of the following fertilizer applications:

K1 = No treatment (Control)
K2 = KCl fertilizer at a dose of 1.5 g/tree
K3 = KCl fertilizer at a dose of 3.5 g/tree
K4 = KCl fertilizer at a dose of 4.5 g/tree

Experiment Implementation

The land used was first cleared of weeds and plant residues, followed by soil tillage to a depth of 20 cm. Clods were broken up to level the soil, and then 12 plots were created. Each plot measured 1 m in width, 4 m in length, and 25 cm in height, with a 1 m distance between plots forming drainage channels. The planting distance used was 1 m x 2 m, resulting in 4 plants per plot, requiring a total of 48 plants. Seedlings were planted in small holes with a spacing of 1 x 2 meters. Before planting, each plot was fertilized with 20 kg of organic manure. Maintenance included replanting, watering, and fertilization. Replanting was done for dead plants, with seedlings taken from a reserve outside the plots, and was conducted one week after planting. Watering was done whenever the soil began to dry out. Fertilization was carried out three times with different doses as described in the experimental method. Passion fruit plants require regular watering and soil loosening, as well as fertilization at specific times. The application of organic fertilizer is crucial for supporting plant growth and development and is applied at 1.5 months and 3 months of age. Organic fertilizer should be applied the day after soil loosening. The method of applying organic fertilizer is by spreading it at the base of the plant, directly above the roots and stems. This method periodically provides the necessary nutrients to the passion fruit plants.

Observations

- Main Stem Length (cm): Measured from the base of the stem to the topmost leaf (30, 60, and 90 days after planting).
- Stem Diameter (mm): Measured at the lowest part of the stem using a caliper (30, 60, and 90 days after planting).
- Number of Leaves: Counted for all leaves on the sample plants (30, 60, and 90 days after planting).
- Number of Branches: Counted for all secondary branches on each plant (30, 60, and 90 days after planting).

III. RESULTS

Main Stem Length

The average plant height observed 30 – 60 days after fertilization and the statistical analysis results showed that the different doses of KCl fertilizer had an effect on plant height. However, 60 days after fertilization, the K2 treatment showed the best growth compared to the other treatments, as can be seen in the histogram below.

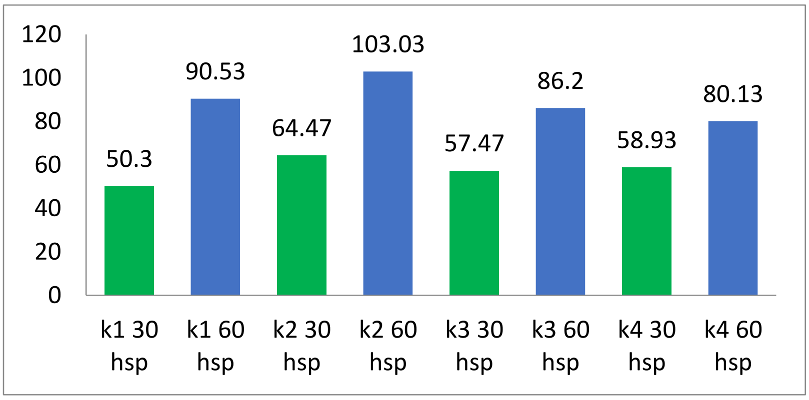

Figure 1. Histogram of average plant height of passion fruit plants at 30 and 60 days after fertilization.

Main Stem Length

The average plant height of passion fruit observed 90 days after fertilization and the statistical analysis results showed that the different doses of fertilizer had a significant effect on the height of passion fruit plants.

Table 1. Main Stem Length (cm) of Passion Fruit at 90 Days After Planting (DAP)

TREATMENT	Average	NP	BNT 0.05
K4	103.13 a		
K2	91.53 b		0.74
K3	86.20 c		
K1	80.13 d		

Note: Average values followed by the same letter are not significantly different according to the SNK test at the 0.05 level.

The SNK test results in Table 1 show that the K4 treatment with a fertilization dose of 4.5 grams per plant significantly affected the main stem length compared to K2, K3, and K1 treatments. Similarly, the K2, K3, and K1 treatments also showed significant differences among themselves.

Stem Diameter

The average stem diameter of passion fruit plants observed 30 days after fertilization and the statistical analysis results showed that the different doses of fertilizer did not have a significant effect on plant height. However, 30 days after fertilization, the K3 treatment tended to have a better effect compared to K1, K2, and K4. Meanwhile, 90 days after fertilization, the K2 treatment tended to perform better than K1, K3, and K4.

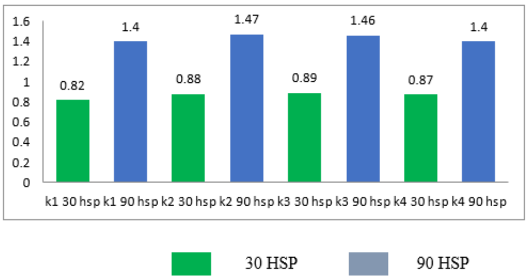

Figure 2. Histogram of stem diameter of passion fruit plants at 30 – 90 days after fertilization.

Stem Diameter

The average stem diameter of passion fruit plants observed 60 days after fertilization and the statistical analysis results showed that the different doses of fertilizer had a significant effect on the stem diameter of passion fruit plants.

Table 2. Stem Diameter (mm) at 60 Days After Planting (DAP)

TREATMENT	Average	NP	BNT 0.05
K2	1.26 a		
K3	1.13 ab		0.15
K1	1.06 bc		
K4	0.94 c		

Note: Average values followed by the same letter are not significantly different according to the SNK test at the 0.05 level.

The SNK test results in Table 2 show that the K2 treatment with a fertilization dose of 0.5 grams per plant had a significantly different effect compared to the K4 treatment with a fertilization dose of 4.5 grams per plant. However, it did not have a significant effect compared to the K3 treatment with a fertilization dose of 3.5 grams per plant and the K1 treatment with a fertilization dose of 0 grams per plant.

Number of Leaves

The average number of leaves observed 30, 60, and 90 days after fertilization and the statistical analysis results showed that the different doses of fertilizer did not have a significant effect on the number of leaves in the plants. However, the K2 treatment at 30 days, the K4 treatment at 60 days, and the K2 treatment at 90 days after fertilization tended to be better.

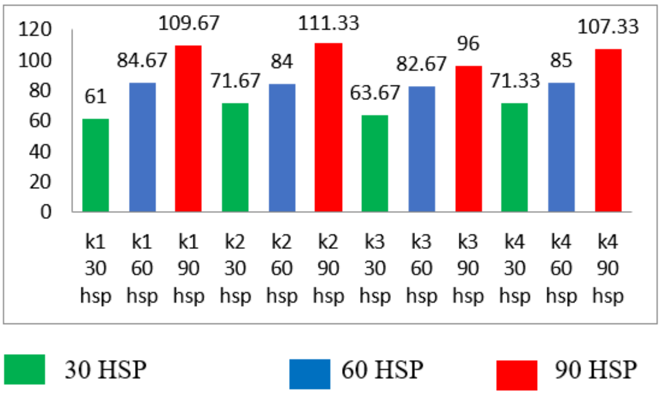

Figure 3. Histogram of the average number of leaves of passion fruit plants at 30, 60, and 90 days after fertilization.

Number of Branches (30 DAP)

The average number of branches of passion fruit plants observed 30 days after fertilization and the statistical analysis results showed that the different doses of fertilizer had a significant effect on the number of branches in passion fruit plants.

Table 3. Number of Branches of Passion Fruit at 30 Days After Planting (DAP)

TREATMENT	Average	NP	BNT 0.05
K2	4.67 a		
K4	4.34 a		0.58
K1	3.33 b		
K3	4.00 b		

Note: Average values followed by the same letter are not significantly different according to the SNK test at the 0.05 level.

The SNK test results in Table 3 show that the K2 treatment with a fertilization dose of 1.5 grams per plant had a significant effect compared to the K1 and K3 treatments. However, the K2 and K4 treatments did not have a significant effect on the number of branches formed.

Number of Branches (60 DAP)

The average number of branches observed 60 days after fertilization and the statistical analysis results showed that the different doses of fertilizer did not have a significant effect on the number of branches in the plants. However, the K2 treatment tended to produce more branches compared to the K1, K4, and K3 treatments.

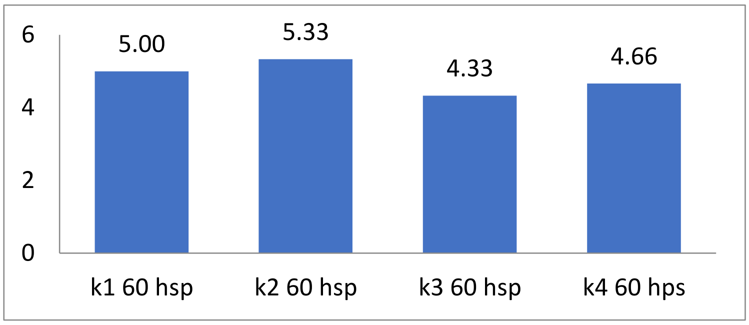

Figure 4. Histogram of the average number of branches of passion fruit plants 60 days after fertilization.

Number of Branches (90 DAP)

The average number of branches of passion fruit plants observed 90 days after fertilization and the statistical analysis results showed that the different doses of fertilizer had a significant effect on the number of branches in the passion fruit plants.

Table 4. Number of Branches of Passion Fruit at 90 Days After Planting (DAP)

TREATMENT	Average	NP	BNT 0.05
K2	6.00 a		
K4	6.67 b		0.15
K1	5.33 b		
K3	6.00 c		

Note: Average values followed by the same letter are not significantly different according to the SNK test at the 0.05 level.
The SNK test results in Table 4 show that the K2 treatment with a fertilization dose of 1.5 grams per plant had a significant effect on the number of branches compared to the K4, K1, and K3 treatments, while the K4 and K1 treatments did not have a significant effect on the number of branches.

IV. DISCUSSION

The growth and production of a plant are influenced by two important factors: genetic factors and environmental factors. Genetic factors include the inherited traits of the plant, which dictate its potential for growth, disease resistance, and overall productivity. Environmental factors encompass a wide range of external conditions such as soil quality, water availability, temperature, light, and nutrient supply. These factors interact to affect the plant's phenotype, the observable characteristics that result from the interaction of its genotype with the environment. Environmental factors impact the physiological processes within the plant, influencing aspects such as photosynthesis, nutrient uptake, and growth rates. In contrast, genetic factors determine the plant's response to these environmental conditions, shaping how effectively it can utilize available resources and adapt to changing conditions.

KCl fertilizer is highly beneficial for enhancing plant growth by suppressing the development of generative organs such as seeds, fruits, and flowers. This suppression allows the plant to direct more energy towards vegetative growth, promoting stronger stems and more extensive foliage. The beneficial effects of KCl fertilizer are primarily due to the K2O compound it contains, which provides a significant source of potassium. Potassium is essential for various plant functions, including enzyme activation, photosynthesis, protein synthesis, and the regulation of osmotic balance. The nutrient content in KCl fertilizer is 60% K2O of the total content, making it a potent source of this critical nutrient. Furthermore, KCl fertilizer comprises two substances: nutrients and carriers. The carrier material helps to distribute the nutrients evenly and ensures that they are available to the plant over time. Since KCl fertilizer comes in various types, the ratio of nutrients to carriers can vary. However, the most commonly used by consumers is the standard KCl fertilizer, which provides a reliable balance of nutrients and ease of application.

Based on the analysis of variance, the data presented in Tables 1, 2, 3, and 4, and Figures 1, 2, 3, and 4 show that the parameters of stem length, stem diameter, number of leaves, and number of branches indicate significant differences between treatments. Specifically, the K2 treatment with a fertilizer dose of 1.5 grams per plant resulted in better growth for stem diameter, number of leaves, and number of branches. In contrast, the K4 treatment with a fertilizer dose of 4.5 grams per plant showed better growth in stem length. These findings underscore the importance of optimizing fertilizer dosage for different growth parameters. The appropriate dose of KCl fertilizer is crucial for achieving optimal growth in stem length, stem diameter, number of leaves, and number of branches. This suggests that the potassium required for plant growth is adequately supplied at these doses, facilitating robust vegetative growth.

According to Johnson et al. (2022) potassium plays a significant role in vegetative growth, particularly in actively growing parts such as the apical meristem (shoots). Potassium is present in higher quantities in these actively growing tissues compared to older parts, highlighting its importance in new growth and development (Sardans & Peñuelas, 2021). Figure 3 shows that the application of KCl fertilizer did not significantly affect the number of leaves. This is likely because leaves are plant organs with limited growth. The short growth period of leaves may explain the lack of significant effect from different doses of KCl fertilizer, as Tang et al. (2023) noted that leaf growth is brief, aligning with the short development period of apical and marginal leaf tissues in most plants. Additionally, Sardans & Peñuelas (2021) state that potassium is not essential for forming key compounds necessary for plant growth, like nitrogen (N) and phosphorus (P). However, potassium is crucial for carbohydrate formation and translocation. It aids in the movement of sugars and starches, which are vital for energy and growth. This makes potassium an essential element for sustaining overall plant health and productivity, even if it does not directly contribute to the formation of key structural compounds.

V. CONCLUSION

This study aimed to evaluate the response of lowland passion fruit (Passiflora edulis) growth to the application of KCl fertilizer at different doses. The findings indicated that the application of KCl fertilizer at a dose of 4.5 grams per plant significantly enhanced stem length, demonstrating its effectiveness in promoting vertical growth. Conversely, the application of KCl fertilizer at a dose of 1.5 grams per plant resulted in superior stem diameter and a higher number of branches, indicating a positive impact on overall plant robustness and branching. Although different doses of KCl fertilizer did not significantly affect the number of leaves, trends suggested that certain doses might be more beneficial during specific growth periods. These results imply that tailored fertilizer dosing can optimize different growth aspects of passion fruit plants. Therefore, it is recommended that for promoting stem length, a higher dose of 4.5 grams per plant be used, while for enhancing stem diameter and branching, a lower dose of 1.5 grams per plant is more effective. Future research should explore the long-term effects of these fertilization strategies on fruit yield and quality.

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