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Application of Potassium Fertilizer at Various Doses on the Growth and Yield of Some Genotypes Local Red Chili (*Capsicum annuum* L.) West Sumatra

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ABSTRACT

In Indonesia, chili is a valuable horticultural commodity. On the other hand, chili productivity in West Sumatra shifted from time to time. One of the factors causing unstable chili production is pests. Genotype, environment, and the interaction of genotype and environment all impact plant productivity. Plant productivity increases as the environmental conditions surrounding the plant are favorable, and nutrient availability is sufficient to meet the needs of plant life. Environmental factors such as nutrient availability and genetic factors such as plant genotypes significantly impact crop production. The aim of the study was to determine the best growth and yield of several genotypes of local West Sumatra chili fertilized with potassium at various doses. The study employed a completely randomized design (CRD), 2 factor, replicated three times. The first factor was the chili genotype consisting of 6 local red chilies ie. Pesisir Selatan, Ateng Pasaman Barat, Dhamasraya 2, Ateng Maninjau, Tanah Datar and Kampung Manangah Solok Selatan. The second factor was the dose of potassium fertilizer (K2O) consisted of 180 kg/ha, 240 kg/ha and 300 kg/ha. The native chili genotype Ateng Pasaman Barat produced the highest crop yield when fertilized with potassium at a dosage of 300 kg/ha. A potassium fertilizer dose of 300 kg/ha generated the best growth and yield, as shown by higher plant height, number of fruits per plant, and fruit weight per plant.

INTRODUCTION

Red chili (*Capsicum annum* L.) is a horticultural plant in the Solanaceae family with a significant economic value (Kementrian Pertanian., 2012). In addition to being consumed as fresh fruit and vegetables, chili can also be consumed dry as a cooking spice and as a raw material for many industries, medicines, and cosmetics (Setiadi, 2008). Chili productivity fluctuates from year to year in West Sumatra. Chili productivity reached 8.12 tons/ha in 2015, according to data from the Central Bureau of Statistics and the Directorate General of Horticulture (2021), and decreased by 7.93 tons/ha in 2016. Chili productivity increased considerably in 2017 and 2018, reaching 9.78 tons/ha and 11,006 tons/ha, respectively. However, chili

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productivity decreased again in 2019, to 10.58 tons/ha, before rising more in 2020 and 2021, to 11.16 tons/ha and 15.69 tons/ha, respectively.

The demand for red chilies in West Sumatra grows yearly since the people of West Sumatra utilize chilies as a spice for foods such as Rendang Padang, Satay Padang, Tamarind Padeh, and other delicacies. Chili has become a commodity frequently discussed by all levels of society because the price can rise very high at times (Andoko, 2004). Because the economic prospects for red chili are promising, chili needs to be cultivated intensively to get high productivity. Using high grade seeds is one way to improve red chili's production. Syukur (2013) states that the use of superior quality seeds is absolutely necessary to increase chili productivity. Furthermore, according to Adisarwanto (2006), local varieties are varieties that have advantages, including resistance to pests and diseases.

Several factors influence plant productivity, including genotype, environment, and pest. If the environmental conditions are favorable for plant growth and nutrients are available for plant growth and development, a plant's productivity will increase. In addition to nitrogen (N) and phosphorus (P), potassium (K) is the most important essential element for plant growth. Potassium is an essential nutrient for plant development and growth. Several biochemical processes related to protein synthesis, carbohydrate metabolism, and enzyme activation involve K. According to Marschner (2012), K can promote root growth and is essential for fruit development. The study aimed to determine the best growth and yield of several local West Sumatra chili genotypes fertilized with potassium at various doses

MATERIALS AND METHOD

The research was conducted from May to November 2022 in Kenagarian Gurun Panjang, Bayang District, Pesisir Selatan, West Sumatra, Indonesia at an altitude of 20 m asl. Plant growth and yield variables were measured at the Plant Physiology Laboratory, Faculty of Agriculture, Andalas University.

The study used a completely randomized design (CRD), 2 factors. The first factor was 6 local red chili genotypes of West Sumatra, namely Pesisir Selatan, Ateng Pasaman Barat, Dharmasraya 2, Ateng Maninjau, Tanah Datar and Kampung Manangah Solok Selatan. The second factor was the dose of potassium fertilizer (K_2O) consisting of 180 kg/ha, 240 kg/ha and 300 kg/ha. Data were analyzed using the F test of variance (5%). Data showing significant differences were tested further with Duncan's Multiple Range Test (DMRT) at the 5% level.

The variables observed were plant height (cm), stem diameter (mm), leaf stomata density (cells/mm^2), harvesting time (days), fruit length (cm), fruit diameter (mm), number of fruit/plant (fruit) and fruit weight/ plant (g).

RESULTS AND DISCUSSION

Plant height

There was no interaction between the chili genotype and K dose, but each single factor had a significant effect on chili plant height (Table 1). K at a dose of 300 kg/ha was most effective in increasing plant height for all genotypes of local chili. The genotype with the highest plant height was the Pesisir Selatan genotype of 67.56 cm, and the lowest was the Kampung Manangah Solok Selatan genotype, with an average plant height of 54 cm. In

Table 1. Plant height at 7 WAP of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kg K_2O/ha)			Average
	180	240	300	
		...cm...		
Pesisir Selatan	65.33	67.00	70.33	67.56 a
Ateng Pasaman Barat	66.00	66.67	69.00	67.22 a
Dharmasraya 2	63.67	67.00	69.67	66.78 a
Ateng Maninjau	62.67	64.33	66.67	64.56 a
Tanah Datar	54.00	57.33	59.00	56.78 b
Kampung Manangah Solok Selatan	52.67	53.67	55.67	54.00 b
Average	60.72 B	62.67 B	65.06 A	

Note: The numbers followed by the same lowercase letter in the same column and the same uppercase letter in the same row show no significant difference at DMRT test 5%. CV= 2.56%

general, there was an increase in plant height as the K dose increased. Plant height has increased because K is available to plants. The primary function of K is to activate enzymes involved in the synthesis of the structure of organic molecules and building compounds such as starch or protein, as well as to play a role in cell division and the growth of young meristematic tissue (Arquero et al., 2006). The development of meristem tissue affects the growth of plant height and roots.

Potassium is also involved in plant metabolic activities, which promotes vegetative plant growth (Widyanti and Susila, 2015). According to Wang and Shen (2013), K is an essential nutrient in plant biochemical and physiological processes that regulate plant metabolic processes and growth. Wijayanti and Raden (2019) stated that K fertilization intends to increase the rate of photosynthesis in plants. Increasing the rate of photosynthesis will result in the production of photosynthate, which is used in forming plant cells. The formation of new cells due to photosynthetic activity will increase the height of the plant (Manurung, 2019).

Stem diameter

There was no statistically significant difference between genotype treatments and K doses (Table 2). Plant genetic and environmental factors influence the diameter of a plant's stem. According to Sunyoto et al. (2015), genetic and environmental variables influence the development of stem diameter. Growing variables such as altitude, plant media, rainfall, and sunlight intensity significantly impact the growth and production of chili (Bastian, 2016), the large diameter of the stem benefits vegetative and generative growth (Sunyoto et al., 2015).

Table 2. Stem diameter at 19 WAP of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kg K_2O/ha)			Average
	180	240	300	
	...mm...			
Pesisir Selatan	12.15	12.55	12.09	12.26
Ateng Pasaman Barat	12.03	12.12	12.25	12.13
Dharmasraya 2	13.18	12.70	11.87	12.59
Ateng Maninjau	11.37	12.42	12.22	11.88
Tanah Datar	11.39	12.74	11.86	12.00
Kampung Manangah Solok Selatan	11.16	11.50	10.25	10.97
Average	11.88	12.33	11.76	

Note: The numbers followed by the same lowercase letter in the same column were not significantly difference based on the DMRT at the 5% level. CV = 19.32%

Leaf stomata density

There was no significant difference in stomata density between treatments (Table 3). A plant's stomata density varies according to its genetic material. The stomata density of chili leaves is still relatively low. According to Rofiah (2010), stomata density categories are low (<300/mm2), medium (300-500/mm2), and high (>500/mm2). Changes also follow changes in stomata size in stomata density. The relationship between stomatal density and their essential function in photosynthesis and transpiration is close. The size of a plant's stomata varies depending on internal factors such as genetic components and external factors such as the growing environment. Light intensity, air temperature, and soil pH are all factors in the environment that can influence the size, number, and type of distribution of stomata (Sun et al., 2018). Similarly, gene variations determine the number of stomata, epidermis, and density of stomata. The phenotypic is also controlled by environmental factors such as levels of pollutants and water availability. Guard cell thickening influences stomatal size variation in response to light, CO2, and water conservation (Jaya et al., 2015).

Table 3. Leaf stomata density of several chili genotypes and K fertilizer at various doses

Genotypes	K-doses (kg K_2O/ha)			Average
	180	240	300	
Pesisir Selatan	209	207	213	210
Ateng Pasaman Barat	209	211	208	209
Dharmasraya 2	208	211	212	210
Ateng Maninjau	209	209	211	209
Tanah Datar	208	209	211	209
Kampung Manangah Solok Selatan	206	221	221	219
Average	208	211	213	

Note: The numbers followed by the same lowercase letter in the same column were not significantly difference based on the DMRT at the 5% level. CV= 6.53%.

Harvesting time

There was no significant difference between the treatments for the chili harvesting age (Table 4). It is suspected that the harvest time is related to the genetic characteristics of the plant. According to Masdar et al. (2006), plants will show ripe harvest if the total energy adopted has reached a particular level limit, which varies for each plant and is mainly determined by genotype traits. The appearance of a plant in a specific environment results from the interaction of environmental and genetic factors. In this case, hereditary factors dominate flower emergence and harvest age more than environmental factors (Mangoendidjo, 2003).

Fruit length

Fruit length was significantly different between local chili genotypes (Table 5). Genetic factors cause the difference in fruit length for each genotype. Genetic factors have more influence on fruit length compared to environmental factors. Zahrah (2011) stated that each variety has different genetic characteristics, which can be seen from the appearance and character of each variety. Differences in genetic traits can indicate differences in response to the environment and production factors. Each plant variety shows different genotypic responses to various growing environmental conditions. Genotypic factors affect the phenotypic appearance of each variety when it interacts with the environment where it grows. Differences in appearance will characterize or differentiate between varieties (Gardner et al, 1991).

Table 4. Harvesting time of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kg K_2O/ha)			Average
	180	240	300	
	..days after planting..			
Pesisir Selatan	89	90	89	89
Ateng Pasaman Barat	88	88	89	89
Dharmasraya 2	86	86	87	86
Ateng Maninjau	88	89	88	88
Tanah Datar	88	88	87	87
Kampung Manangah Solok Selatan	87	88	89	88
Average	88	88	88	

Note: The numbers followed by the same lowercase letter in the same column were not significantly difference based on the DMRT at the 5% level. CV = 2.14%

Fruit diameter

The treatment of local chili genotypes significantly affected fruit diameter (Table 6). Genetic differences between varieties can affect growth and yield. Furthermore, the adaptability of a variety to the growing environment varies. The advantageous characteristics of local genotypes are represented in features like high-yielding fruit, responsiveness to fertilization, and resistance to pests and diseases. The appropriate varieties planted in the right environment are expected to grow well and produce high yields

Table 5. Fruit length of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kg K_2O/ha)			Average
	180	240	300	
	...cm...			
Pesisir Selatan	18.77	18.23	19.03	18.68 a
Ateng Pasaman Barat	15.20	15.33	15.23	15.26 b
Dharmasraya 2	16.90	17.43	17.37	17.23 b
Ateng Maninjau	18.67	18.77	18.70	18.71 a
Tanah Datar	16.53	16.43	17.03	16.67 b
Kampung Manangah Solok Selatan	16.63	18.27	17.93	17.61 b
Average	18.77	18.23	19.03	

Note: The numbers followed by the same lowercase letter in the same column were not significantly difference based on the DMRT at the 5% level. CV = 5.98%

Table 6. Fruit diameter of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kgK_2O/ha)			Average
	180	240	300	
	...mm...			
Pesisir Selatan	4.30	4.32	4.50	4.38 c
Ateng Pasaman Barat	7.18	7.19	7.25	7.21 a
Dharmasraya 2	5.77	6.05	5.93	5.92 b
Ateng Maninjau	5.94	6.57	6.18	6.23 b
Tanah Datar	6.13	6.08	6.11	6.13 b
Kampung Manangah Solok Selatan	6.10	6.05	5.86	6.00 b

Note: The numbers followed by the same lowercase letter in the same column were not significantly difference based on the DMRT at the 5% level. CV = 10.89%

(Prajnanta, 2004).

According to Sa'diyah et al. (2013), genetic and environmental variety substantially impact the phenotypic diversity of all traits. Characters with a high genetic variety imply that genetic influences significantly affect a plant's visual appearance. According to the findings of this study, conditions in the environment have little effect on the visual characteristics observed in the plants evaluated (Romadhoni et al., 2011). The KCl fertilizer dose treatment also resulted in fruit diameters that were not statistically different. Mardanluo et al. (2018) discovered that applying KCl fertilizer concentrations ranging from 200 to 600 kg/ha did not influence chili fruit diameter.

Number of fruit/plant

Potassium fertilizer application at 300 kg/ha on the Ateng Pasaman Barat genotype produced the highest number of fruit (194.67) (Table 7). The lowest number of fruit was produced from the Pesisir Selatan Genotype chili, which was fertilized with potassium at a dose of 180 kg/ha with a total of 134.00 fruit. Each genotype has a different average number of fruits. Increased K dosages resulted in greater production of all chili genotypes tested. According to Zahrah (2011), the appearance and characteristics of each variety indicate various genetic traits. Differences in genetic attributes indicate that genotypes respond differently to the growing environment. According to Wang and Shen (2013), K is involved in protein synthesis, glucose metabolism, and enzyme activation. Plants are more vulnerable to pests and diseases if deficient in K.

Table 7. Number of fruit/plant of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kgK_2O/ha)		
	180	240	300
Pesisir Selatan	134 c C	146 e B	157 d A
Ateng Pasaman Barat	186 a B	194 a A	195 a A
Dharmasraya 2	155 b A	158 d A	161 d A
Ateng Maninjau	161 b B	183 b A	188 A
Tanah Datar	159 b C	167 c B	177 c A
Kampung Manangah Solok Selatan	158 b C	173 c B	185 b A

Note: The numbers followed by the same lowercase letter in the same column and the same uppercase letter in the row were not significantly difference based on the DMRT at the 5% level. CV = 2.30%

According to Jasmi (2016), K stimulates carbohydrate synthesis and translocation. Plants with sufficient K will have more carbohydrate reserves available for plant growth. Gardner et al. (1991) stated that the photosynthetic process can proceed effectively if enough K is available. K plays an essential role in the process of photosynthesis and increases CO2 assimilation and increases the translocation of photosynthetic products out of the leaves, including for the formation of seeds. Thus the production of plants with the addition of K is higher than without the addition of K.

Fruit weight/plant

The difference in K doses of the six local chili genotypes had a significant effect on fruit weight per plant. The most effective dose for the six Genotypes of local chili studied was 300 kg/ha, which improved the fruit weight of all Genotypes of local chili examined overall (Table 8).

Plant growth and harvest weight are related to the availability of K in the soil. Hassan et al. (1995) state by increasing K, plant growth and harvest weight will increase. Neliyati (2012),

Table 8. fruit weight/plant of several chili genotypes and K fertilizer at various doses.

Genotypes	K-doses (kg K_2O/ha)		
	180	240	300
		...g...	
Pesisir Selatan	522 e C	537 e B	564 e A
Ateng Pasaman Barat	670 a C	723 a B	788 a A
Dharmasraya 2	661a C	686 b B	712 b A
Ateng Maninjau	567 d C	686 b B	777 a A
Tanah Datar	611 c C	638 d B	654 d A
Kampung Manangah Solok Selatan	632 b C	665 c B	691c A

Note: The numbers followed by the same lowercase letter in the same column and the same uppercase letter in the row were not significantly difference based on the DMRT at the 5% level. CV = 1.24%

on the other hand, stated that photosynthate translocation to tomato fruit is significantly influenced by K, where potassium enhances photosynthate movement out of the leaves towards the roots. Photosynthate generated during the photosynthetic process provides more energy for root and plant growth, fruit development, and weight increase. The study's findings (Nugroho, 2011) revealed that K at a dosage of 350 kg/ha produced higher numbers of tomatoes per plant than K at 200 kg/ha or 275 kg/ha.

According to Suwanti et al. (2017), a lack of K can impair the rate of photosynthesis, as well as plant development and fruit weight. Potassium plays a role in the opening and closing of stomata, promoting translocation from source to sink and maintaining stems upright, allowing nutrients to move from soil to plants (Apriliani et al. 2016). Furthermore, potassium is involved in water transport in plants. According to the findings of this study, the lowest K dosage treatment, 180 kg/ha, resulting in the lowest fruit weight per plant. These findings suggest that the nutrients received by plants are insufficient, affecting photosynthesis and, as a result, crop production.

CONCLUSIONS

There was an interaction between several genotypes of local red chilies and doses of potassium fertilizer on fruit number and fruit weight per plant. The native chili genotype Ateng Pasaman Barat produced the highest crop yield when fertilized with potassium at a dosage of 300 kg/ha.

Potassium fertilizer at dose of 300 kg/ha produced the best growth and yield as indicated by higher plant height, number of fruits per plant and fruit weight per plant.

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