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Lestari RW · Kusumiyati · Mubarok S · Maulana YE

Growth and yield response of Tanjung II and Unpad CB2 red chili varieties grown in the medium land

Abstract. Red chili is an important commodity that is daily needed by the community. Non-central chili areas often experience deficits due to the high consumption volume and low productivity of chili peppers. To increase the productivity of chili in non-central areas, expand it in the medium land. This study aims to determine the productivity of two introduced chili varieties in the medium land whose adaptation areas came from lowland and highland areas. This study was analyzed using an independent sample T-test at a significant level of 5%. The results of the data analysis showed that the Tanjung II variety significantly influenced the parameters of stem diameter and weight of the fruit. Meanwhile, the Unpad CB2 variety significantly influences the parameters of plant height, number of leaves, number of flowers, number of fruits, and fruit set. However, both varieties have no noticeable effect on the weight parameters of the cropping fruit and potential yield in hectares. The Tanjung II variety experienced a decrease in yield by 54.58%, while the Unpad CB2 variety was 53.56%.

Keywords: Expand · Medium land · Productivity · Red Chili · Variety

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Lestari RW[1] · Kusumiyati[1]* · Mubarok S[1] · Maulana YE[2]
[1]Faculty of Agriculture, Universitas Padjadjaran, Jalan Raya Bandung Sumedang km. 21 Jatinangor, Sumedang 45363 Indonesia
[2]Horticulture Laboratory, Faculty of Agriculture, Universitas Padjadjaran, Jalan Raya Bandung Sumedang km. 21 Jatinangor, Sumedang 45363 Indonesia
*Correspondence: kusumiyati@unpad.ac.id

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Introduction

Red chili (*Capsicum annuum* L.) is one of the most strategic horticultural commodities used as agricultural products. Red chili has an important role in meeting the needs of the community. Fluctuating chili prices have an impact on the formation of inflation. One of the reasons for the fluctuation in chili prices is the season and the availability of products in the market (Romeida et al., 2020).

In Indonesia, red chili domestic production in 2019 reached 1.21 million tons (Statistics Indonesia, 2020), with consumption needs of 368.160 tons in 2014, while the development of export volume during the period 2006-2014 averaged 936.090 tons (Yanuarti & Afsari, 2016). These data indicate that chili production is still in deficit or shortage, causing trade between regions (Statistics Indonesia, 2020). In areas of non-production centers, of course, they will buy from areas of production centers so that a distribution chain is formed.

Efforts to increase chili productivity in non-central areas can be made using intensification, namely increasing production by genetic engineering and cultivation patterns on the same land area. In addition, it can also carry out extensification by expanding the chili cultivation area. Highland areas are no longer a consideration because they are more suitable for conservation land than cultivated land (Juarsah, 2017), so agricultural cultivation practices need to optimize land in low to medium-land areas.

Chili is a horticultural product that is perishable and consumed fresh. Due to high temperatures, it is very risky if chili is planted in lowland areas. High temperatures cause plants to wilt quickly and lose water in the field and during the post-harvest process. Therefore, the medium land can be a solution for expanding the red chili plantation area because of the chili's adaptive characteristic to the plantation area on medium land that is not frosty such highland and not very warm such lowland areas. Chili can grow well at an altitude of 0-1400 meters above sea level, although not wide varieties can grow well in these areas.

The Tanjung II variety belongs to the segregated red chili, with an adaptation area in the lowlands, with an earlier age, almost simultaneous maturity time, resistance to trips and aphids, low seed prices, easy to sell in the local market, and good fruit color. Interesting if used as a paste (Basuki et al., 2014). Meanwhile, the Unpad CB2 chili variety is a red chili that was previously crossed with cayenne pepper, so the spiciness level is higher than red chili in general. The Unpad CB2 variety has an adaptation area in the highlands, with its fruit shape resembling a curly chili and a high yield of 23.6 tons/ha. This study aims to determine the productivity of two introduced chili varieties in the medium land whose adaptation areas came from lowland and highland areas.

Materials and Methods

This research was conducted in a plastic house in Sindanggalih Village, Cimanggung District, Sumedang Regency, West Java, from March to August 2021. The location of this research is at an altitude of 746 meters above sea level with Latosol and Alluvial soil types with a temperature range of 26 – 30 ^{o}C (Guswita et al., 2020). According to Istiawan & Kastono (2019), in general the altitude of the place is divided into 3 regions, namely the lowland (<400 m above sea level/masl), the medium land (400-700 masl) and the highlands (>700 masl). Almost the same as the height classification contained in Permentan No. 47/Permentan/OT.140/10/2006 that mountainous land based on elevation is distinguished from medium land (350-700 masl) and highlands (>700 m asl). The height of the place is closely related to the type of plant that is suitable for maintaining environmental sustainability.

The tools used were scissors, a ruler, a marker, a meter, a sprayer, and a digital caliper. The materials used were warm water, soil, husk charcoal, chicken manure, Tanjung II and Unpad CB2 chili seeds, seed tray, polybag (40 cm x 50 cm), stakes, UV plastic, labels, plastic rope, Gandasil D fertilizer and B, NPK Mutiara, urea, KCl fertilizers. Pesticides in form of Curacron, Sidamethrin, Demolish, and Antracol were also used.

Seedling is done by sowing chili seeds soaked in warm water (50 ^{o}C) for 1 hour. The planting media used during seeding and planting were 40% soil, 30% chicken manure, and 30% husk charcoal. Transfer of seedlings to polybags is carried out 21 - 28 days after sowing or when the seedlings have 4 - 5 true leaves. The maintenance includes fertilizing once every ten days, watering once a day, replanting if the

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plants are withered, installing stakes to support the chili plants so they do not fall over easily approximately two weeks after planting (WAP), loosening the soil, pinching in two WAP, and controlling plant-disturbing organisms such as plants' weed, pests, and diseases. Red chilies are harvested by computational methods, namely counting from the time of planting/flowering and visually when the chili is red from the base to the tip of the fruit. Computationally harvested chilies calculated from 50 - 60 days after flowering.

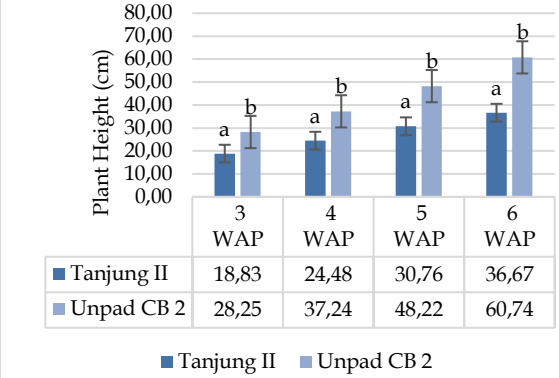
The parameters observed consisted of growth parameters namely plant height (cm), number of leaves (strands), and stem diameter (mm) measured at 3, 4, 5, and 6 WAP. The yield parameters consist of the number of flowers, number of fruits, fruit set (%), fruit weight (g), fruit weight of one plant (g), and potential yield per hectare (tons/ha). Each variety consists of 15 replicates, each replication containing three samples, so the total number of plants is 90 samples. Data were analyzed by independent sample T-test using Statistical Program for Social Science (SPSS) version 20 software at a 5% level.

Results and Discussion

Plant Height (cm). Figure 1 shows Unpad CB chili varieties have a higher average plant height at 3-6 WAP than Tanjung II. The increase in plant height of the Tanjung II variety was 30.04% at 4 WAP, 25.61% at 5 WAP, and 19.22% at 6 WAP. The Tanjung II variety experienced an increase in plant height by at least 6 WAP because the plant had entered the generative phase. The vegetative growth began to decline. In addition, plants are also attacked by aphids which attack the growing point in the form of shoots, causing stunted plant growth.

Meanwhile, Unpad CB2 red chili, according to the description, was able to grow to a height of 73.4 – 87.5 cm. However, at 6 WAP, the height of the chili plant was only 60.74 cm. Unpad CB2 chili can still experience high growth due to the increase experienced when 6 WAP was still quite large, namely 25.97%. Chili can still grow taller at 7 or 8 WAP until it reaches its optimal height.

Figure 1 shows that the difference in varieties significantly affected the height of chili plants from 3 WAP to 6 WAP. The Unpad CB2 variety produced higher plant height than the Tanjung II variety.

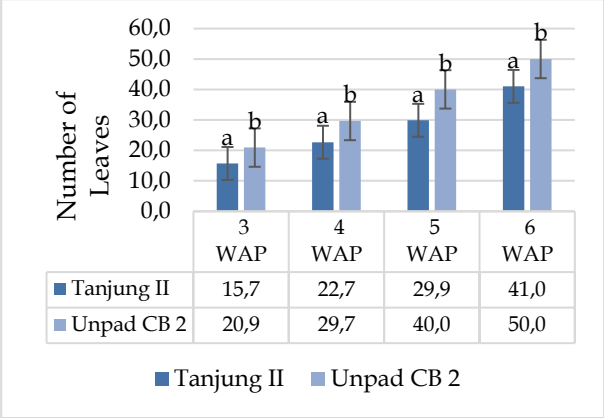


Note: The average value followed by the same letter in each row shows that it is not significantly different based on the unpaired T-test.

Figure 1. Average Plant Height of Tanjung II and Unpad CB2 Varieties Grown in Medium land

Different genetic characteristics and phenotypes caused the difference in plant height. As stated by Kusuma et al. (2009) in Naibaho et al. (2021), different parental crosses influenced different plant heights in each variety. Each variety's adaptability is different in terms of environmental factors and growing media (Dermawan et al., 2019). The Tanjung II chili variety adapts well to lowland environments, and the Unpad CB2 variety adapts to the highlands. The experiments carried out on both chili peppers were in the medium highland. So environmental changes affect plant height growth (Fauzi & Subositi, 2019).

Number of Leaves. Figure 2 shows that Unpad CB chili varieties have an average number of leaves at 3-6 WAP than Tanjung II. The number of chili leaves of the Tanjung II variety was 44.41% at 4 WAP, 31.73% at 5 WAP, and 37.25% at 6 WAP. The Tanjung II variety experienced an increase in the number at least 5 and 6 WAP. Meanwhile, Unpad CB2 red chilies increased the number of leaves at 4, 5, and 6 WAP, which were 41.72%, 34.98%, and 24.92%. The percentage increase in the number of leaves in both varieties tends to decrease as the plant approaches the generative phase. The vegetative growth begins to decline. In addition, the environment in which it grows can also affect plant leaf growth (Fauzi & Subositi, 2019).



Note: The average value followed by the same letter in each row shows that it is not significantly different based on the unpaired T-test.

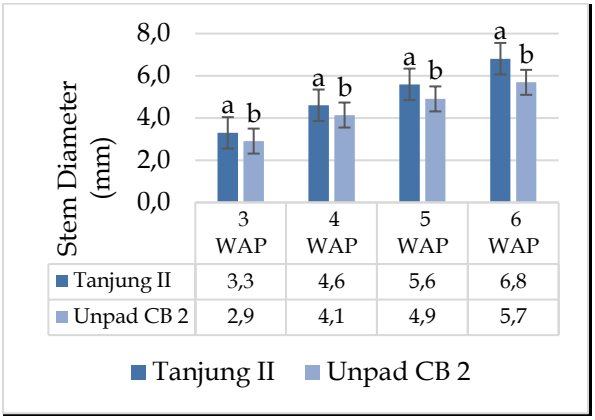
Figure 2. Average Number of Leaves of Tanjung II and Unpad CB2 Varieties Grown in Medium Highland

Figure 2 shows that the difference in varieties significantly affected the number of chili leaves from 3 WAP to 6 WAP. The Unpad CB2 variety produced more leaves than the Tanjung II variety.

The tolerance of Tanjung II chili varieties to aphids did not apply if the plants were planted in the medium highland. Aphids can grow optimally in the dry season with a temperature range of 25-30 °C (Utama et al., 2017). Pest attacks in the form of aphids and trips caused leaf growth to become stunted, and the number of leaves formed was small. Pest trips and aphids cause plant leaves to curl, shrivel, and cause leaf growth to be stunted (Meilin, 2014). The difference from the trip's pest attack is that the plant leaves will curl up, while the aphids will curve down. Both can appear when environmental conditions enter the dry season and actively attack at the beginning of plant growth until they enter the generative phase (Meilin, 2014).

Stem Diameter (mm). In Figure 3, it shows that the chili varieties of Tanjung II have a larger average stem diameter at 3-6 WAP than those of the Unpad CB2 variety. The increase in stem diameter of the Tanjung II variety was 39.70% at 4 WAP, 21.53% at 5 WAP, and 21.71% at 6 WAP. The Tanjung II variety experienced an increase in the number of at least at 5 and 6 WAP. Meanwhile, Unpad CB2 red chilies increased stem diameter at 4, 5, and 6 WAP, which were 42.48%, 18.45%, and 15.99%.

Figure 3 shows that the difference in varieties significantly affected stem diameter from 3 WAP to 6 WAP. The Tanjung II variety significantly affected stem diameter compared to the Unpad CB2 variety.



Note: The average value followed by the same letter in each row shows no significant difference based on the unpaired T test

Figure 3. Average Stem Diameter of Tanjung II and Unpad CB2 Varieties Grown in Medium Land

The percentage increase in stem diameter in both varieties tended to decrease as the plant approached the generative phase. The vegetative growth began to decline. In the vegetative phase, assimilate is stored in the plant stem. Plant diameter should be directly proportional to plant height, and a larger diameter tends to be able to store greater assimilate and produce higher production (Flowrenzhy & Harijati, 2017).

Yield Parameters. The results of the research on the effect of different varieties on yield parameters in the form of a number of flowers, number of fruits, fruit set, fruit weight, planting weight, and potential yield per hectare are presented in the table. Table 1 shows the results of the analysis using the T-test.

Tabel 1. Plant height data of Tanjung II and Unpad CB2 varieties grown in medium land

Parameter	Average	
	Tanjung II	Unpad CB2
Number of Flowers	33.53 a	50.47 b
Number of Fruits	26.93 a	41.60 b
Fruit Set (%)	76.10 a	82.38 b
Fruit Weight (g)	4.90 b	4.18 a
Weight of Harvested Fruit (g)	136.13 a	169.56 a
Yield Potential (tonnes/ha)	5.45 a	6.79 a

Note: The average value followed by the same letter in each row shows no significant difference based on the unpaired T-test

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Number of Flowers. The results showed that the differences in chili varieties significantly affected the number of flowers. The Unpad CB2 variety produced more flowers than the Tanjung II variety.

Table 4 shows the number of flowers that appear on the Tanjung II and Unpad CB2 varieties. The Tanjung II chili varieties produced fewer flowers, with an average of 33.53 flowers. Compared to the Unpad CB2 variety, with 50.47 flowers. The flowering time of the two chilies also gives rise to flowers at different times. Flowering on the Tanjung II variety began to appear at the age of 29 days after planting (DAP). Meanwhile, flowering on the Unpad CB2 variety appeared at 34 DAP, according to the description, which was between 34 - 45 DAP. Flowering time is necessary to know because it is a component that determines fruiting time and harvest time (Flowrenzhy & Harijati, 2017).

Flowering time and the number of flowers planted are related to the process of plant adaptation to climate change and the ability of plants to survive in a different environment than usual (Flowrenzhy & Harijati, 2017). Genetic factors affect the process of pollination and fertilization as well as the ability to grow the formed embryo (Mochtar *et al*., 2018). In addition, environmental factors such as temperature and humidity affect the transpiration that occurs in plants to maintain the flowers that have emerged (Suparwoto et al. 2021). The experimental results in the field showed that the number of flowers was small due to the attack of aphids that attacked the growing point. The shoots of plants attacked by these pests become unproductive and difficult to produce flowers.

Number of Fruits. Table 4 shows that the differences in chili varieties significantly affect the number of fruits. The Unpad CB2 variety produced more fruit than the Tanjung II variety.

The number of fruits planted is the number of fruits that appear and survive until the harvesting process is carried out. The number of fruits that appear is usually directly proportional to the number of flowers that bloom, by what happened to the chili varieties of Tanjung II and Unpad CB2. The Tanjung II variety produced fewer harvestable chilies, which was 26.93 compared to 41.60 Unpad CB2. Compared with the description, the Unpad CB variety has not yet reached the minimum number of fruits planted, which is around 47 fruits; however, the number of fruits at the time of the experiment is close to the description.

The two varieties have different harvest times. Tanjung II chili was harvested when it entered the age of 80 DAP or 51 DAP; however, this was not by the description, which stated that the Tanjung II variety could be harvested at 58 DAP. Harvest time occurs slower for 22 days. The delay in harvest time is due to agronomic differences, which are the adaptation area of the Tanjung II variety. The chili can grow well in the lowlands with higher temperatures. High temperatures cause faster metabolic processes so that crop production increases and harvest time will be faster (Fauzi & Subositi, 2019).

Meanwhile, in the Unpad CB2 variety, chilies can be harvested from the age of 97 DAP or 63 DAS. The description states that the harvest time ranges from 85 - 90 DAP or 51 - 56 DAS. The harvesting time of Unpad CB chili is also seven days slower if it refers to the time of flowering anthesis.

Fruit Set (%). Table 4 shows that the differences in chili varieties significantly affect the fruit set. The Unpad CB2 variety produced a more extensive fruit set than the Tanjung II variety.

The fruit set is the ratio of the number of flowers to fruit. The higher the value of the fruit set, the better the plant is at retaining flowers until they become market-worthy fruit. According to Lawalatta et al. (2017), the fruit set on a good chili plant is 80%. Tanjung II chili varieties produced a fruit set of 76.10% and 82.38% for Unpad CB2 varieties. The percentage of fruit set formation in both varieties was optimal because it was close to 80%; even in the Unpad CB variety, it was more than 80%.

Fruit Weight (g). Fruit weight is the weight of chili that is harvested fresh in less than one day. The weight of chilies planted is the accumulation of the chilies harvested from the first to the last harvest. Based on table 4, it shows that differences in chili varieties have a significant effect on fruit weight. Tanjung II variety produces greater fruit weight compared to Unpad CB2 variety.

Fruit weight is the average weight produced in one chili. In chili, the Tanjung II variety produces a fruit weight of 4.90 grams, while in the Unpad CB2 variety it is 4.18 grams. Referring to the description for the Unpad CB variety, it can produce a fruit weight of 6.6 – 14.8 grams. This shows a decrease of 36.67% from the

supposed weight. The weight loss can be caused by genetic, environmental, growing media, and fertilization factors that affect metabolic processes in plants.

Weight of Harvested Fruit (g). Weight of harvested fruit is an important parameter that determines the amount of fruit produced and is suitable for harvesting in one plant. Based on the results of the study, it was shown that the differences in chili varieties did not significantly affect the weight of the crop.

Suparwoto et al. (2021) stated that the fruit produced by a plant would adapt to the genetic potential of each variety. The greater the weight of the fruit, the higher the potential yield. The Tanjung II variety yielded 136.13 grams of planting weight, while the Unpad CB2 variety yielded 169.56 grams. The weight has decreased from what is stated in the description that Unpad CB2 can produce 430.6 – 702.0 g/plant. The decrease that occurred was 60.62%. Meanwhile, the Tanjung II variety according to the description can reach an average weight of 600 g/plant, resulting in a decrease of 77.31%. The weight of the fruit planted can be influenced by two factors, namely the weight of the fruit and the number of fruits planted; if both of these factors have high yields, the weight of the fruit of the plant will also be high.

Yield Potential (tons/ha). Yield potential is the ability of plants to produce their main target organs optimally. Yield potential is the primary goal of a cultivation process to find the number of suitable products for harvesting. Based on the results of the study, it was shown that the differences in chili varieties did not significantly affect the yield potential.

Each chili variety has a different yield potential; the factors that affect the yield potential are the weight of the fruit planted (Suparwoto et al., 2021) and the number of plants in the unit area. The higher the weight of the plant, the greater the potential yield. According to the description, the Tanjung II variety can produce 12 tons/ha chilies, while Unpad CB2 is 14.6 – 23.6 tons/ha. The experiments resulted in yield potential for each variety of 5.45 tons/ha and 6.79 tons/ha. The yield decreased by 54.58% and 53.56%, respectively. A decrease in productivity due to an unsuitable location was also experienced by farmers in the Ciamis area who grow Tanjung II chili varieties in the medium highland (Basuki et al., 2014)

According to Suparwoto et al. (2021), differences in the growth and yield potential of each variety are influenced by the genotypic response to the environment in which it grows. The decrease in yield potential of the two varieties is because they are not adaptive varieties in the medium highland. Planting chilies outside their adaptation areas can provide information about plant tolerance to climate change and productivity (Flowrenzhy & Harijati, 2017). According to Gonzalez-Dugo et al. (2007) in Flowrenzhy and Harijati (2017), the modest decrease in productivity due to changes in metabolism is 20%.

Conclusion

The conclusions of this study include the following:

1. The Tanjung II variety that is grown in medium highland shows a higher growth and yield performance than Unpad CB2, especially in the form of stem diameter and fruit weight.
2. The Unpad CB2 variety significantly affects growth and yield parameters, especially in the form of plant height, number of leaves, number of flowers, number of fruit, and fruit set.
3. There were no significant differences between the two varieties in yield parameters such as plant weight and potential yield per hectare. The Tanjung II variety experienced a decrease in the yield of 54.58%, while the Unpad CB2 variety was 53.56%.

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