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Agronomic Characteristics of Various Soybean Varieties (*Glycine max* L.) Can Grow and Produce Due to Shade Stress

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Abstract

Soybeans are the main food crop commodity in Indonesia which is ranked third after rice and corn. The aim of this research is to determine the characteristics of soybean varieties that are able to grow and produce due to shade stress. The research was carried out from November 2023 to February 2024. The research used a Factorial Randomized Group Design (RAK). with the first 2 treatment factors Shading Stress, including P0 = No shade, P1 = TBM and P2 = TM. The second factor is the variation in soybean varieties consisting of six levels including (V1) Mutiara 1, (V2) Agromulyo, (V3) Dena 1, (V4) Dena 2, (V5) Edamame and (V6) Devon 1. Observed parameters include plant height, leaf area index, number of pithy pods and harvest age. Research data was analyzed using the ANOVA variance analysis procedure to determine whether there was an effect of each treatment. The results showed that the effect of TBM shading (P1) could increase plant height (48.18 cm), and treatment without shading (P0) increased the number of pithy pods (45.66 pods). The effect of varietal variations shows that the best performance is the Edamame (V5) variety on plant height (49.64 cm), Dena 2 (V4) produces the highest number of pods (40.62 pods), and Agromulyo (V2) produces the highest harvest age (83 days). Analysis of shade and various varieties that were carefully assessed on the growth and yield of soybean production showed that it had no real influence on all the parameters observed.

Keywords: *Growth and Production; Shade Stress ; Soybeans; Various Varieties*

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INTRODUCTION

Soybean (*Glycine max* L. Merrill) in Indonesia, is a food crop that has quite an important role after rice and corn. This makes soybeans one of the national strategic food commodities by the government through the special rice corn soybean program (UPSUS – PAJALE). This effort is based on domestic demand for soybeans which has increased from year to year, where national soybean consumption in 2021 will reach 2.8 million tons. Kementerian Pertanian (2021) shows that national soybean production is 200,000 tonnes with a harvest area of 362,612 ha with a productivity of 15.69 ku/ha. Direktorat Pengolahan Dan Pemasaran Hasil Hortikultura (2022) states that national production is only able to meet 10% of national needs of 2.8 million tons.

Factors that influence soybean production in Indonesia are lack of planting area, pest and disease attacks, and low seed quality (Sutrisno & Kuswantoro, 2016). One way that can be done to increase soybean production is to develop new superior varieties. This new superior variety of seed can play a role in determining the potential yield and quality of the product produced as well as the efficiency of production costs (Rusono, 2013). (Adisarwanto, 2010) suggests developing ideal type varieties with potential seed yields > 2.5 t/ha to increase soybean production.

One of the problems in increasing soybean production in Indonesia is the lack of arable land. Not to mention competition with land use for plantations, housing and even industrial areas. Increasing national production must take advantage of potential untapped land, including land under plantation and forestry plantations. Several studies in the last decade suggest the monocropping system should be revised and may no longer be the best system, taking into account sustainability, income security and nutritional diversity in rural areas. Therefore, intercropping systems offer an alternative for more sustainable agriculture with minimal input and stable yields (Gliessman, 2016; Knoerzer et al., 2019).

The presence of shade affects plant height, number of branches, branch diameter, flowering age, harvest age, number of pods, seed weight, plant dry weight, leaf area index, net assimilation rate, and plant growth rate (Fikriati et al., 2019; Handriawan et al., 2016). Handriawan et al., (2016) showed that a shade intensity of 25% reduced seed yield 17.41% in Dena 1 soybeans, 22.87% in Anjasmoro, and 12.33% in Grobogan. Meanwhile, shade intensity of 50% reduced the yield of Dena 1, Anjasmoro, and Grobogan soybean seeds by 34.38%, 45.74%, and 23.79%, respectively. Therefore, to overcome these obstacles, varieties are needed that are adaptive and shade tolerant.

Research results Sopandie & Trikoesoemaningtyas (2011) show that increasing the productivity of intercrops on land under stands of annual crops with low light intensity can be achieved through improving yield potential to produce high-yielding varieties and improving plant adaptation to produce tolerant varieties. An integrative approach between physiology, molecular and plant breeding is absolutely necessary in order to improve plants and cultivation techniques on land under stands. Based on the description above, the author is interested in conducting research on the agronomic characteristics of various soybean varieties (*Glycine max* L.) that can grow and produce due to shade stress.

METHOD

This research was carried out on Jalan Horas Desa Pasiran Kec. Sei Dadap Asahan Regency, North Sumatera Province with flat topography located at an altitude of ± 20 m above sea level with temperatures around 20°C - 30°C research was carried out from November 2023 to February 2024. The materials used in this research are five varieties of kedelai seeds, varieties Mutiara 1, Agromulyo, Dena 1, Dena 2, edamame, nets (to avoid plants being eaten by young), label paper, insecticides, manure and other materials. support the research process. The tools used in this research are hoes, machetes, tools, tools, planks, hammers, plastic ropes, scales, bamboo (stakes), digital rod diameter measuring instruments, digital scales, kamiera, tools, saws, brushes, pliers. and other tools that can help during research.

Trial Design

This research uses a Factorial Randomized Group Design (RAK) with 2 treatment factors: the first factor, namely: Shade Stress consists of three levels, including P_0 = No Shade, P_1 = TBM (Plant that has not yet produced) and P_2 = TM (Produce Plant). The second factor is various soybean varieties consisting of six treatment levels including (V_1) Mutiara 1, (V_2) Agromulyo, (V_3) Dena 1, (V_4) Dena 2, (V_5) Edamame and (V_6) Devon 1. The observed variables consist of plant height, leaf area index, number of pithy pods and harvest age. Research data was analyzed using the ANOVA variance analysis procedure to determine whether there was an effect of each treatment. If it is known that there is a real difference in the effect of the treatment, continue with the DMRT test at the 5% level.

Research Implementation

We provide land structures without shade, land with TBM and TM coconut shade which can produce the desired light intensity. Land for planting kedelai must be prepared well in order to create environmental conditions that are suitable for plant growth, especially environmental and soil conditions. Before tilling the soil, the weeds in the agricultural area are cleaned first. If the land is in a very clean condition, then tillage is carried out. Soil processing is carried out twice, namely the first processing by hoeing the soil to a depth of 20-30 cm and then leaving the soil for several days. The second way of cultivating the soil is by crushing large lumps of soil, so that loose soil is obtained. The creation of research plots was carried out after processing the second soil, with a length of 200 cm and a width of 100 cm with a total of 36 plots. The number of repetitions was 2 repetitions, the distance between plots was 1 m.

Before the seeds are planted, it is best to first soak the tier seeds in water for about 4 hours. Soak the seeds first, then make a hole in the plot 4-5 cm deep. Add 1-2 kedelai seeds into the hole. Then cover it with thin soil without compacting it. Seed seeding must be done so that it can be used when the plants in the plot do not grow or die and can use tiered seedlings to replace plants. Provides a shading structure that can produce the desired light intensity. By using kielapa plants that have already produced fruit (TM) and kielapa plants that have not yet produced fruit (TBM). The varieties used are Mutiara 1, Agromulyo, Dena 1, Dena 2, Edamame and Devon.

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Treatment and Maintenance

The care and maintenance activities in the implementation of kedelai plant research are as follows. Watering is done routinely every day except when it rains. Watering is carried out in the morning and evening at the beginning of the growth phase or when the kedelai plant needs a lot of water, namely during the beginning of the germination 0-5 day after planting (DAP), the early vegetative stage (15-20 DAP), the flowering period and seed formation (35-65 DAP). Watering is stopped in the plant phase that does not require a lot of water, namely when the kedelai plant enters seed maturity..

Embroidery is done in the afternoon so that the plants do not wilt. Embroidery is carried out when the kedelai is 7 days after planting, namely by replacing the plant if there are seeds that do not grow. The plants used during embroidery are plants that have had their siebielum inserted and the age of the plants is the same as those studied. At the time of embroidery, a struggle is carried out, namely by maintaining one plant in the planting hole. Weeding is done manually, namely by pulling out weeds that grow using your hands, while weeds around the area are cleaned using a sickle. The weeding is done when the kedelai bieer is 15 DAP and 30 DAP. If there are still a lot of weeds, weeding is done again at 55 DAP. After weeding, then weeding is carried out, namely the soil around the stems of the weeds is raised to make the plants stronger so that the kedelai plants do not easily break down.

Pest control is carried out when kedelai plants show signs of infection due to pest attacks. Control is carried out technically and biologically. Technical control is carried out by killing or destroying pests manually using hands on plants that are attacked by pests. Pemanenan kedelai varieties pearl 1, agromulyo, dena 1, dena 2, edamame, and devon 1, carried out at 83-93 DAP, with the characteristics of the pods on the main stem being brown and 95% of the leaves having turned yellow. Harvesting is done in the morning by picking up the soil and then pulling out the kedelai plant, watering until the soil is wet so that when you pull out the roots of the kedelai plant, all of them are removed. So, the roots are cleaned from the existing soil using water and then the harvesting process is carried out.

Observation Variable

Plant height (cm), observations were made by measuring the main stem of the sample plant from the soil fertilizer to the highest shoot point using a ruler or tape measure. Observations were carried out at intervals of 1 week, starting when the plants matured at 14 DAP until the plants flowered (42 DAP). The leaf area index (Lieaf Ariea Indiex / LAI) is carried out using leaf samples or by using a special LAI measuring tool using the Pietiolie Pro application. These observations can provide information about the efficiency of sunlight use by plants, the level of photosynthesis, and yield potential. Number of biernas pods, observations were made at harvest time by counting the number of viable pods on each sample plant. Age of harvest, observations are made by calculating the age of the sample plants until the plants are harvested, expressed in DAP.

RESULTS AND DISCUSSION

Plant Height (cm)

The results of the analysis of variance showed that the influence of shade recording showed no significant influence on the height of kedelai plants aged 2 and 4 weeks after planting, but there was a very significant influence at the age of 6 weeks, the influence of various types of varieties showed a very significant difference at the ages of 2, 4, and 6 weeks after planting. The interaction of shade and various varieties of kedelai showed a very significant effect at the age of 2 and 4 weeks after planting, but there was no significant difference at the age of 6 weeks after planting.

Table 1. Average Bieda Test Results Influence Shade and Various Varieties on the Height of Kedelai Plants 6 Weeks Old

Treatment	Average (2 WAP)	Average (4 WAP)	Average (6 WAP)
P_0	14,47 a	23,61 a	30,20 c
P_1	15,17 a	22,73 a	48,18 a
P_2	14,62 a	23,51 a	42,49 b
V_1	14,34 bc	21,56 c	37,99 cd
V_2	12,63 c	21,17 c	41,81 c
V_3	15,90 a	23,05 bc	41,90 c
V_4	15,28 a	25,13 a	42,57 bc
V_5	15,45 a	24,11 b	49,64 a
V_6	14,95 b	24,67 b	43,85 b

Description : The same letter in the same column indicates there is no significant difference at 5% DMRT

Table 1 showed that in the TBM shading treatment (P_1) the highest tier plant height was 48.18 cm, a significant difference between the TM shade shading treatment (P_2) with a height of 42.49 cm and the treatment without shading (P_0) with a height of 42.49 cm. 30.20 cm, treatment P_2 is significantly different from treatment P0. In the treatment of various varieties, it can be seen that in the edamame (V_5) treatment the highest tier plant height was 49.64 cm, a significant difference compared to the Devon 1 (V_6) treatment with plant height of 43.85 cm, the Dena 2 (V_4) treatment with the height 42.57 cm, Dena 1 (V_3) treatment with a plant height of 41.90 cm, Agromulyo (V_2) treatment with a plant height of 41.81 cm, Mutiara 1 (V_1) treatment with a plant height of 37.99 cm. The V_6 treatment is not significantly different from the V_4 treatment, nor is the V_3 and V_2 treatment significantly different. The interaction between shading and various types of varieties shows that the results do not differ significantly in plant height parameters.

This is due to the response of the tiered kedelai plants to shading which varies simultaneously with their growth. In the early stages of growth, plants are more able to adapt themselves to varying shading conditions, but the differences are very significant at the age of 6 weeks, as with increasing age, plants need more energy and light for optimal growth, so that shade can have a greater influence on plant height at an older age. Another factor that may occur is the accumulation of effects from shade exposure that occurs over time, which can ultimately cause significant differences at 6 weeks of age. This is also supported by research by Hanafiah et al., (2011) which shows that the reduction in sunlight received by plants results in disruption of plant photosynthesis, which results in a lack of photosynthesis allocated for plant development and is caused by underdeveloped xylem, conditions This results in a reduction in the diameter of the plant stem

Other results obtained from observing plant height showed that shade had an effect on plant height in various varieties. Based on the average plant height at each shade intensity, it is known that the higher the shade intensity results in lower light stress on the plants. Low sunlight conditions can stimulate increased auxin activity and as a result cells grow elongated (Afandi et al., 2013).

The influence of varieties on increasing plant height is determined more by the genetic factors of the variety in adapting to the environment. In accordance with the opinion of Gong et al., (2015), that the increase in plant height due to light stress is caused by an etiolation process that occurs during the stem elongation process. The etiolation process that continues to occur in shaded plants is a way for plants to capture more light. efficient. Furthermore Chairudin et al., (2015) stated that increasing stem height is an attempt by plants to increase light absorption because plants are unable to raise their leaves above the canopy. Research Bakhshy et al., (2013) reports that shade causes an increase in soybean plant stem height.

According to Sutopo (2019), shade has a real effect on plant height. The higher the shade, the taller the plants will be. When plants are stressed by low light intensity, plant height increases light capture efficiency. Furthermore Fauziah & Idris (2022).When plants are in the vegetative period, cell division occurs at the tip of the stem. Growth in the vegetative stage of soybean plants and the quality and quantity of light can influence length, stem diameter and stem density. The effect of shade stress on the height of 6 week old soybean plants can be seen in Figure 1. The influence of variety type on the height of 6 week old soybean plants can be seen in Figure 2.

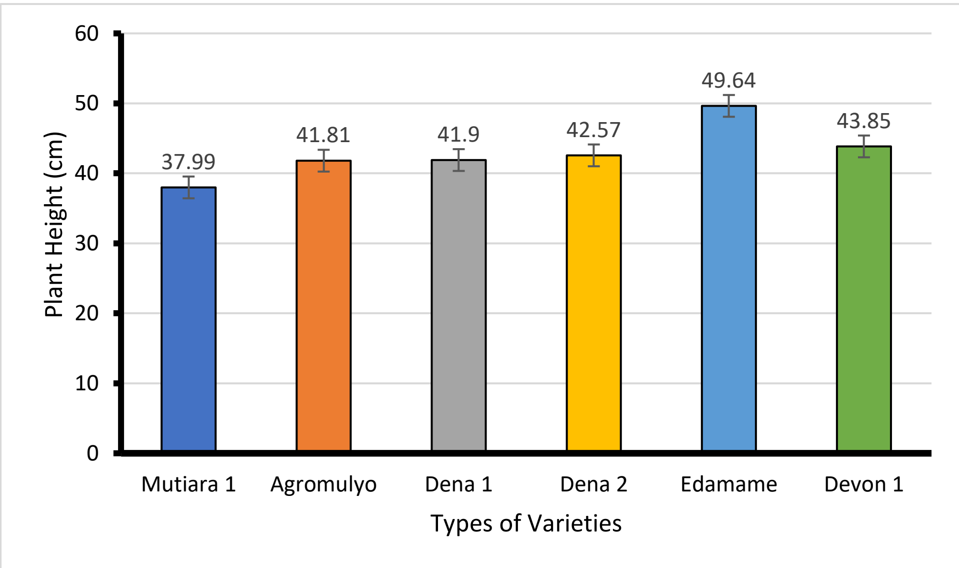

Figure 1 . The Effect of Shade Stress on the Height of 6 Week Old Soybean Plants

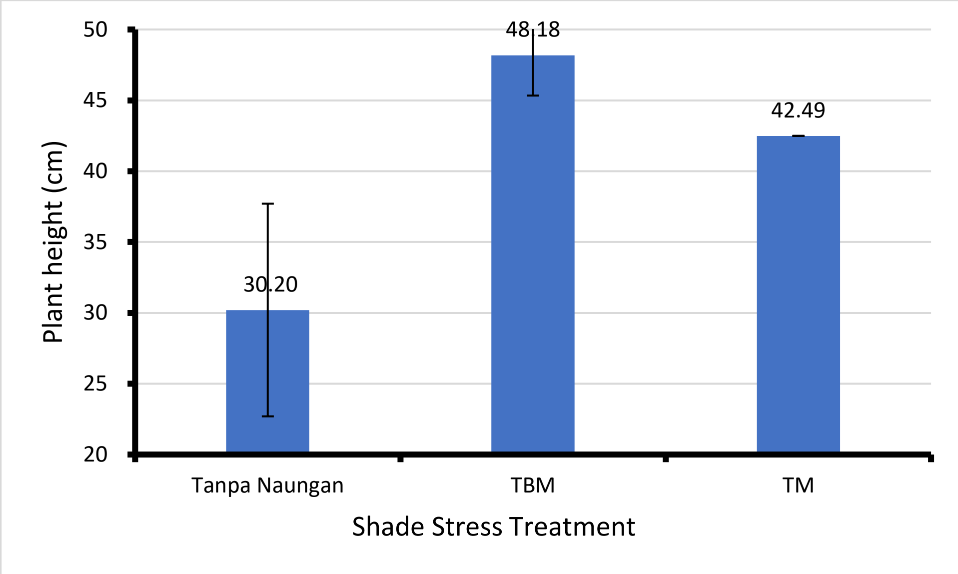

Figure 2. The Influence of Variety Type on the Height of 6 Week Old Soybean Plants

Leaf Area Index

From the results of the analysis of variance, it can be seen that the influence of shade exposure and various types of tier varieties on the leaf area index showed no significant difference. The interaction between shade and various varieties of kedelai showed no significant difference in the observed parameters.

Table 2. Average Test Results Influence Shade and Various Tier Varieties on the Leaf Area Index of Soybean Plants

Treatment	Average
P_0	26,33
P_1	23,90
P_2	27,29
V_1	18,30
V_2	28,10
V_3	22,68
V_4	23,99
V_5	31,50
V_6	30,47

Description : The same letter in the same column indicates there is no significant difference at 5% DMRT

From Table 2 above it can be seen that the TM shade treatment (P_0) has the largest leaf area index, namely 27.29 pods, there is no significant difference between the Unshaded shade treatment (P_0) with an area of 26.33 and the TBM treatment (P_1) with an area of 23 .90, treatment P_0 is not significantly different from treatment P_1. In the treatment of various varieties, it can be seen that in the edamame (V_5) treatment the broadest leaf area index is 31.50, there is no real difference compared to the Devon 1 (V_6)

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treatment with an area of 30.47, Agromulyo (V_2) with an area of 28.10 , and the Dena 2 (V_4) treatment with an area of 23.99, Dena 1 (V_3) with an area of 22.68 and the Muiara 1 (V_1) treatment with an area of 18.30. These results are in accordance with (Purba et al., 2024). Apart from environmental factors, genotypic factors influence plant responses. Tolerant genotypes have relatively high photosynthetic activity capabilities in shaded conditions so that they can produce adequate photosynthate for plant growth and production (Sopandie, 2006). Soverda (2011) states that tolerant upland rice and soybean genotypes in 60% shade produce higher production. higher compared to the susceptible genotype

Hale et al., (1987) found that plants responded differently to different light exposures. Plants are able to adapt in 2 ways. First, increase leaf area to reduce metabolite consumption. Second, reduce respiratory density to maintain carbon balance and compensation points. There are two mechanisms by which plants adapt to low light intensity. One is to increase total light absorption by increasing leaf area and reducing the amount of reflected and transmitted light to increase the percentage of light used for photosynthesis.

Observation of leaf area showed that the shade treatment showed no effect on increasing leaf area statistically. The response to shade treatment which resulted in lower light intensity was wider and thinner leaves. The change in the character of wider and thinner leaves is an adaptation made by plants to enable them to capture more light and transmit it to the lower leaves quickly so that photosynthesis activities take place at a maximum. This change in character is thought to be a form of avoidance mechanism against low light (Chairudin et al., 2015).

Response of various soybean varieties to leaf area under shaded conditions between varieties. The difference in leaf area between various varieties is thought to be due to the genetic diversity of the varieties tested and the adaptive nature of the plants. In this study, the Anjasmoro variety had the highest leaf area compared to the Dena-1 and Gepak Kuning varieties. The same results were reported Pratiwi & Artari (2018) which stated that the character of leaf area in several soybean genotypes differed between genotypes where the results of the research showed that the leaf area of the Edamame and Devon 1 varieties had the highest leaf area compared to other varieties in response to the shade provided.

Number of Bernas Pods

From the results of observation and variety analysis, it can be seen that the influence of tier shade coverage on the number of bienas pods shows a very significant difference. The influence of various types of varieties shows very significant differences in the observed parameters. The interaction between shade and various varieties of kedelai showed no significant difference in the observed parameters.

From Table 3 above, it can be seen that the treatment without shade (P_0) has the highest number of green beans, namely 45.66 pods, a significant difference between the TM shade shade treatment (P_2) with a number of 25.00 and the TBM treatment (P_1) with a number of 23 .17 pods, treatment P_2 is not significantly different from treatment P_1. In the treatment of various varieties, it can be seen that the Dena 2 (V_4) treatment has the highest number of tiered fruit pods, namely 40.62 real seed pods compared to the Dena 1

(V_3) treatment with a total of 35.42 pods, Devon 1 (V_6) 33.20 pods, Agromulyo (V_2) 32.89 pods, Edamame 1 (V_5) 23.70 pods and Mutiara 1 (V1) 21.84 pods. The interaction between shade shade and various types of plant varieties showed that the results did not significantly differ in the parameters of the number of green beans.

Table 3. Test Results of Mean Differences on the Effect of Shade Stress and Various Tier Varieties on the Number of Fertile Pods in Kedelai Plants.

Treatment	Average
P_0	45,66 a
P_1	23,17 b
P_2	25,00 b
V_1	21,84 c
V_2	32,89 bc
V_3	35,42 b
V_4	40,62 a
V_5	23,70 c
V_6	33,20 b

Description: The same letter in the same column indicates there is no significant difference at 5% DMRT

The highest number of fruity pods was obtained from the Dena-2 variety (40.62 pods/stem). According to Adie (2013); Yardha & Adri (2019), the number of pithy pods is influenced by genetic factors. The high number of pithy pods in the Detap-1 variety is thought to be due to the high light during flowering so that carbohydrate formation is sufficient. According to Sumarno (2013), the increase in empty pods in soybean plants is largely determined by light.

The highest number of fruity pods was obtained in the Detap-1 and Dena-1 varieties, respectively 40.62 pods/stem and 35.42 pods per stem. The number of pods is one of the determinants of seed yield. According to Adie & Krisnawati (2013), the greater the number of pods on each plant, the greater the opportunity to contribute to higher yields. The number of pods is greatly influenced by the stage of pod formation. According to Suhartina et al., (2016), pod formation is a stage that is very sensitive to water shortages, especially for 30 days. Lack of water during the pod formation period will result in fewer filled pods. Sumarno & Manshuri (2013) stated that when the pods are filled, the pods will become a distribution area for assimilation. Most of the assimilation will be used to increase seed weight. Pod formation depends on high soil moisture levels and nutrient supply. The effect of shade stress on the number of pithy pods in soybean plants can be seen in Figure 3. And the influence of variety type on the number of pithy pods in soybean plants can be seen in Figure 4.

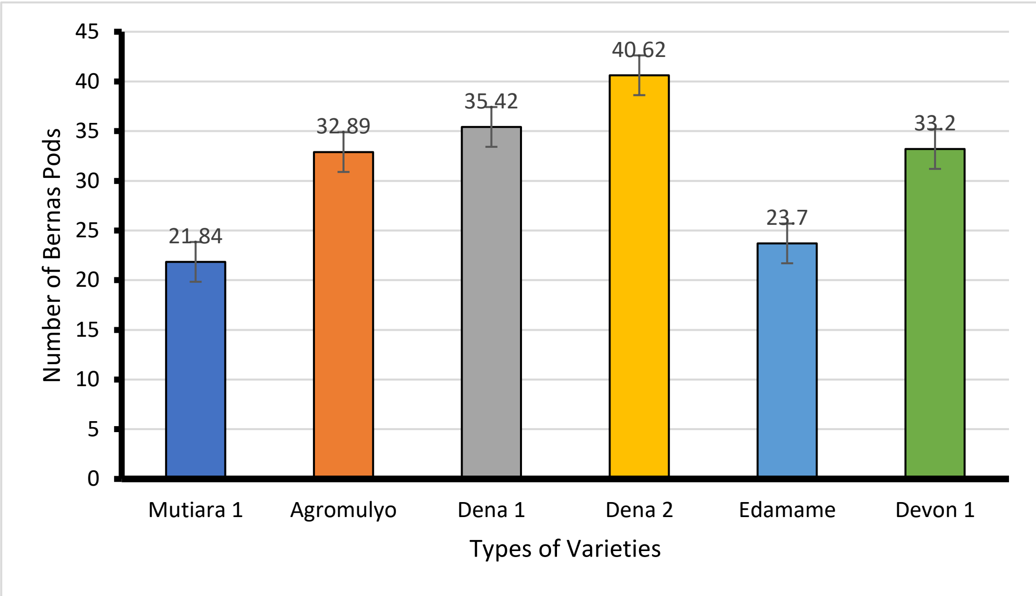

Figure 3. Effect of Shade Stress on the Number of Fertile Pods in Soybean Plants

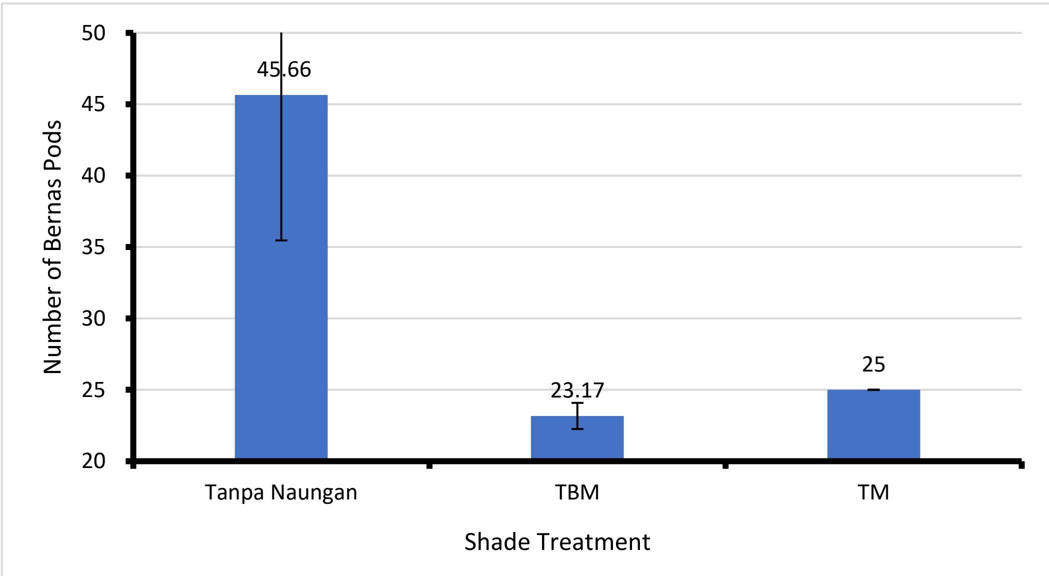

Figure 4. Effect of Variety Type on the Number of Fertile Pods in 6 Week Old Soybean Plants

Harvest Age

From the results of observation and variance analysis, it can be seen that the influence of shade recording shows an insignificant influence on the harvest age of kedelai plants. The influence of various varieties shows very significant differences in the observed parameters. The interaction of shade and various varieties of kedelai showed no significant in the observed parameters.

Table 4. Results of Mean Difference Test on the Effect of Shade Stress and Various Tier Varieties on Harvest Age of Soybean Plants.

Treatment	Average
P_0	86,91
P_1	84,92
P_2	86,00
V_1	88,50 d
V_2	83,00 a
V_3	84,00 a
V_4	87,17 c
V_5	85,50 b
V_6	87,50 c

Description : The same letter in the same column indicates no significant difference at 5% DMRT

Table 4 showed that in the TBM (P_1) shade harvesting treatment, the harvest age was 84.92 days, not significantly different from the TM (P_2) shade harvesting treatment of 86.00 days and (P_0) 86.92 days, P_2 treatment. there is no significant difference with P_0. In the treatment of various varieties, it can be seen that in the Agromulyo (V_2) treatment above, it can be seen that in the TBM (P_1) 84.92 day shade protection treatment, there is no significant difference between the TM (P_2) 86.00 day shade protection treatment and the no shade treatment. (P_0) for 86.92 days, the treatment of P_2 was not significantly different from P_0. In the treatment of various varieties, it can be seen that in the Agromulyo (V_2) treatment the harvest age was 83.00 days, which was not significant compared to the Dena 1 (V_3) treatment of 84.00 days, but a significant difference with the Edamame (V_5) treatment of 85.50 days. Devon (V_6) treatment took 87.17 days, Dena-2 (V_4) treatment 87.17 days, Mutiara 1 (V_1) treatment 88.50 days. The interaction between shade exposure and various types of varieties shows that the results do not differ significantly in terms of harvest age parameters.

The Agromulyo and Dena 1 varieties are harvested faster than other varieties. Plants that experience stress will speed up their life cycle to deal with the stress. In accordance with Mitra (2011) who explains that some plants speed up flowering and harvest time (shorten their life cycle) to be able to escape drought stress. The harvest age for mature plant treatments is significantly different from the harvest age for immature shade plants. This indicates that drought stress accelerates the process of plant maturation. In line with research results Saloka & Ariffin (2019), soybeans at 100% field capacity were harvested at 86.33 DAP, while plants that experienced stress at 60% of field capacity were harvested more quickly at 82.33 DAP.

Table 4 also shows that the Agromulyo variety gave the fastest results in the harvest age parameter, namely 83.00, which is significantly different from other treatments. If you look at the description of each variety, the Agromulyo variety has a faster harvest time than other varieties. Each soybean genotype has a different harvest age due to different genetics. Whether the harvest is fast or slow is thought to be influenced by flowering factors, varieties, environmental factors and weather factors. This agrees with Trihantoro (2010), that the long or short lifespan of a plant's harvest is also caused by several environmental factors, such as sunlight, rainfall, humidity and local weather. The influence of variety type on the number of harvest ages of soybean plants can be seen in Figure 5.

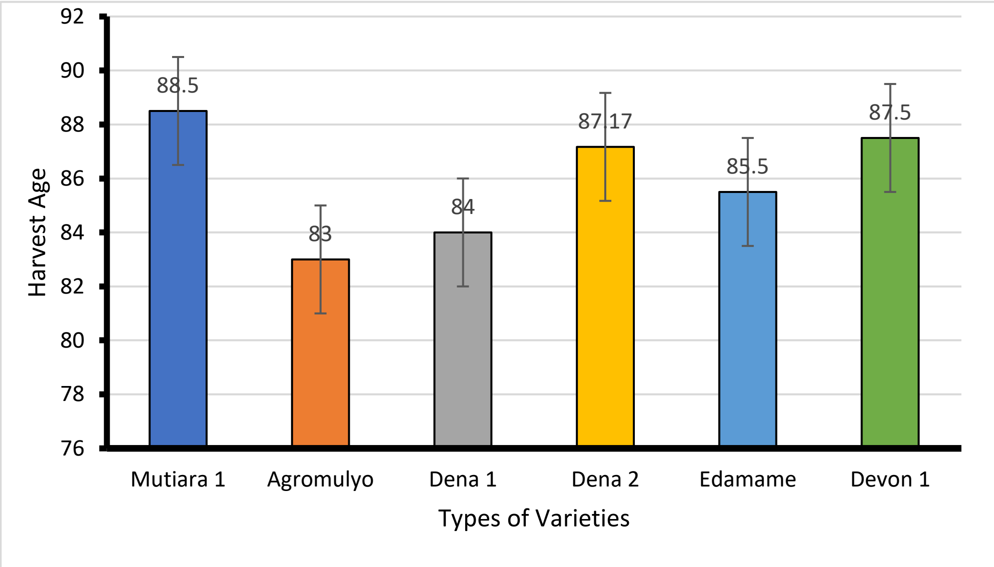

Figure 5. The Influence of Variety Type on Harvest Age of Soybean Plants.

CONCLUSION

The influence of TBM shade exposure (P_1) shows that the best treatment can increase plant height parameters (48.18 cm), and in the treatment without shade (P_0) it can increase parameters for the number of beetroot pods (45.66 pods). The influence of the growth of various soybean varieties shows the best performance in the Edamame (V_5) which produces the highest plant height (49.64 cm), Dena 2 (V_4) which produces the highest number of wildflower pods (40.62 pods), and Agromulyo (V_2) produces the highest crop maturity. (83 days). The analysis of the behavior of shading and various species varieties is assessed closely on the growth and production yields of the species shown to have an intangible influence on all the observed parameters.

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