



Plant Growth Analysis of Jack Bean (*Canavalia ensiformis* L.) at Different Spacing to Determine the Application Time of Cutback Technology

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Abstract

The growth of jack bean (*Canavalia ensiformis* L.) is affected by genetic and environmental factors. One of the environmental factors involved is growing space. Growing space related to each plant of areas occupied is stated by the distance between plants. A Research has been conducted as long three months in dry season with average daily temperature of 25 to 31°C on altitude of 25 to 500 meter, to determine the timing of the application of cutback technology based on an analysis of growth of jack bean plants (*Canavalia ensiformis* L.) in different growth spaces. The research was conducted in the trial form using a randomized block design. Variables of plants growth analysis observed is leaf area index (LAI), leaf area is computed by gravimetric method; net assimilation rate (NAR), and relative growth rate (RGR) is determined based on the dry weight of plants; in all three rooms grew, namely 75 cm x 100 cm (control), 75 cm x 75 cm and 75 cm x 50 cm, each repeated three times. The result shows that the trend of leaf area index increased at net assimilation rate (g-1.cm-2.week-1) and relative growth rate (g-1.g-1.minggu-1) decreasing at the time the plant to the age 8 weeks after planting. The best time for the application of reduction technology to jack bean plants (*Canavalia ensiformis* L.) in all tested growing spaces, is recommended when plants are between 7 and 8 weeks after planting

Keywords : Jack bean, LAI, NAR, RGR

A. Introduction

The growth of jack bean (*Canavalia ensiformis*) is affected by genetic and environmental factors. One of the environmental factors involved is growing space. Growing space related to each plant of areas occupied is stated by the plant between distances. The closer a plant between distances, the higher density at leaves between and the less light reaching the leaf below layer (Sitompul & Guritno, 1995). The shade can decrease the number of stomata and wide porous stomata on the leaf surface, but not to the length of stomata porous top surface and the bottom and width of the surface porous bottom of plant leaves *zephyranthes rosea* Lind (Haryanti, 2010). The ginseng plants not experienced shade has leaves that are thicker and the number and bigger of stomata density the underside of leaves compared to that experienced shade (Afa & Wahyu, 2014).

Plants growing in low light intensity environments has deeper roots are small, few and composed of thin-walled cells. It happens due to the translocation inhibition of photosynthesis from the root. Internode is longer composed of thin-walled cells, a bigger space between cells, the less a carrier and barrier tissue. The leaves are larger, thinner and larger size of the stomata epidermal cells is thin but the number of leaves less space between cells more (Haryanti, 2010). The results of his research that planting distance between rows of sweet corns in a cropping system effect on plant height, diameter base of the stem, long cob, and weight cob. The growth and the best result obtained at the use of plant spacing 100 cm x 30 cm (Ainun. M., Jumini & Jamilah, 2010), also concluded that the real effect on the spacing of higher plants, the highest obtained at the use of a spacing of 20 cm x 30 cm. Similarly, the results a spacing of 40 x 25 cm is significantly higher than the spacing of 40 cm x 40 cm (Pakaya, M.S., Pembengo, W. & Zakaria, F., 2013).

In the early phases of plant growth, leaf area increased will happen to continue with increasing age of the plant until a specific time. Leaf area is not with respect to time but decreased by increasing the age of plant (Gardner. F.P., Pearce, R.B. & Mitchell. R.L., 1991). The effectiveness of a plant leaf area can be detected by calculating the value of leaf area index.

Leaf area index (LAI) is a variable that shows the relationship between leaf area and areas extensive covered (Risdiyanto & Setiawan, 2007). The value of the leaf area index (LAI), which increased the growth of early phase still give net results increased assimilate.

The increase in the net assimilation rate (NAR) will result in an increase in the speed of plant growth. The net assimilation rate had a positive correlation and large direct effect on yield. Net assimilation rate among of rice genotypes ranged between 0, 40 to 0, 86 g-1.m-2.hari-1. Another character that has a close relationship with the result is a dry grain weight per hill amount of grain per panicle (Ratnasari, D., Hidayat, P., Sunarto. & Agung D. H. T., 2010). The resulting research indicated that the plant buncis highest net assimilation rate obtained in the age range 35 to 42 days after planting and the lowest obtained in the age range 28 to 35 days after planting (Duaja, M. D., Mukhsin. & Sijabat, R., 2013).

However, the leaves of growth will cover each other which is the upper leaves will cover the below it leaf thus reducing the net result assimilates (Susanto, 1994). The net assimilation rate (NAR) soybeans plant increase until the 43 days after planting (DAP) and decline after that age (Hartawan, 2013). LAB decline in value caused soybean leaves cover each other until the lower leaves only a little sunlight and the leaves are as parasites. Fotosintat amount produced is not balanced with the leaf area growth ultimately decreased LAB, indicates that the shade of reducing the weight of dry Stover per soybean plant (Chairudin, Efendi & Sabaruddin., 2015).

Based on this information it needed a time of application of technology research cutback based on based on the analysis of growth in order to jack bean (*Canavalia ensiformis*) be able to grow and produce optimally.

B. Methodology

The experiment was arranged by a randomized block design (RBD) with three treatments growing space of 75 cm x 100 cm (control), 75 cm x 75 cm and 75 cm x 50 cm were applied respectively in three groups in order to obtain 9 experimental units. Jack Bean of seeds used is a local seed derived from farmers in Enrekang district. The seed is planted using a dibble stick

and stuffed of one to two seeds each planting hole after soaked seeds, then after seeds grow the reduction to sustain one crop. Plant growth analysis observed variable is leaf area index (LAI), leaf area is computed by the gravimetric method; net assimilation rate (NAR) and relative growth rate (RGR) is determined based on the dry weight of plants. Observation is made of 7-day interval until the plant to concern generative phase.

Analysis of variance conducted at each growth analysis variable, if the treatment gives the effect of significant then it will continue Duncan test to see between treatments differences (Akib, 2013).

C. Result and Discussion

Leaf Area Index (LAI): Leaf area reflects the widest part of the photosynthesis, while LAI reflects the light interception by plants. Although part of the stem also light intercept but more happens effectively on the leaves. LAI increases with increasing intensity light until the optimum limit the plant light intercept (Duaja *et al.*, 2012).

That leaf area index (LAI) has an important role determining the speed of photosynthesis/degree of assimilation net and production, which value depends on the light conditions and forms of the canopy plant (Indonesian center for agricultural library and technology dissemination, 2013). LAI in the optimal range also the maximum production obtained. Management pruning or shade is one attempt to maintain the planting conditions in order to be at optimal LAI that is if more than 95 % of the leaf area receives sunlight.

Leaf area index of a plant community is not only determined by the morphology of plants related to the distribution of light, and the leaves nature but also by the leaves of density, so that that leaf area (LD) or leaf area ratio (NDL) parameters will not be sufficient to explain the differences between plant communities leaves unit price (HSD). The leaves of density are closely related to the plant population or growing space (plant spacing). The closer the plant between distances, the higher the leaves of density and the fewer quanta of radiation (light) that reached lower leaf layer (Suggu., A. G., Ahmed, E., Himayatullah, H., Ayaz, M., Ahmad, H. K. & Hannan, A., 2010).

LAI value in figure 1, show that the treatment to grow space the narrow resulted plants more reach quickly LAI > 1, this case give an information that in this condition happen the leaves between shade to affect the decreasing of productivity in the photosynthesis process to produce assimilates. The higher plant density the number of plants per unit area more and more, so that the plant inter canopy cover each other in the effort to get light (Suryadi., Setyobudi. L. & Soelistyono, R., 2013). A similar result was obtained in sorghum plant (*Sorghum bicolor* (L.)) (Puspitasari., N. G., Kastono, D. & Waluyo, S., 2012) and caisim plant (*Brassica juncea* L) (Abas, M. Z., Zakaria, F. & Pembengo, W., 2014).

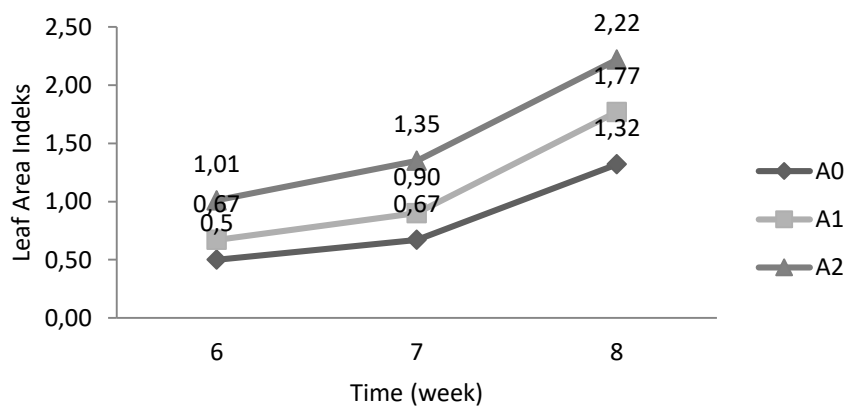


Figure 1. The average LAI of Jack Bean (*Canavalia ensiformis*) at treatment spaces growth different (A0, 75 cm x 100 cm; A1, 75 cm x 75 cm; A2, 75 cm x 50 cm)

The price $LAI > 1$ describes the existence of mutual the leaves among shading which resulted in leaves in shade on the bottom layer canopy received light to be less and can, therefore, behave a lower rate of photosynthesis from the leaves that are not shaded. When the leaf area exceeds that area the growing space, then there protected leaves. Protected leaves ineffective because as it cannot perform photosynthesis (Herlina, 2011).

Net Assimilation Rate (NAR): Net Assimilation Rate (NAR) is a plant's ability produce the dry ingredients of assimilation result per unit of leaf area per unit time ($\text{g}/\text{dm}^2/\text{minggu}$) (Gardner *et al.* 1991). The rate of net assimilation is affected by the amount of solar radiation, the leaves ability to photosynthesis, leaf area index, light distribution and the number of plant respiration (Kiswanto, D., Indradewa, E. T. & Susila. P., 2012). Value highest NAR at the time of plants is still small and most of the leaves are exposed to direct sunlight. NAR likely to decrease during accretion leaf area, so it is not capable of doing photosynthesis optimally (Nasaruddin, 2010).

Figure 2 shows that the highest NAR acquired during the seven-week-old plants and declined at the age of eight weeks, where the value of LAI increase to continues. LAI value on the treatment to grow wider space has reached a value greater than 1 n 7 days old plant but has not led to LAI impairment. It indicated that the need leaves shaded assimilates still afford to supply the leaf that light gets. There is a correlation between LAI value and dry matter production, which the asimotik curves follow, the curves are seen that during the plant production dry matter are not declining at a rate of greater LAI than the need for full interception radiation, then the bottom leaf canopy that protected not a parasite for the productive part (Sumarsono, 2008).

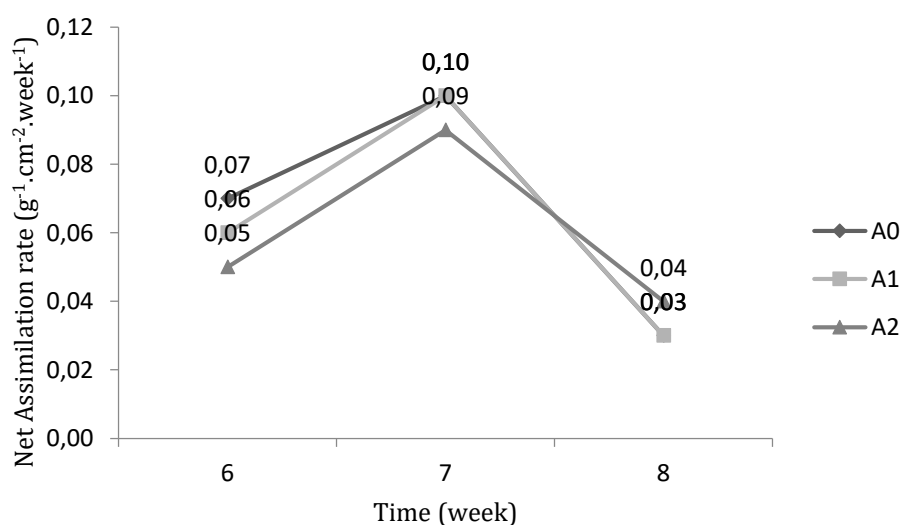


Figure 2. The average NAR of jack bean (*Canavalia ensiformis*) at treatment spaces growth different (A0, 75 cm x 100 cm; A1, 75 cm x 75 cm; A2, 75 cm x 50 cm)

The more and distantly the plant distances hence more and more captured solar energy by plants for use photosynthesis process, but in his study found to decrease on soybean dry weight with decreasing plant spacing (Pangli, 2014). The plant distance of dense affects the formation of chlorophyll and enzymes, the photosynthesis process will be disturbed when chlorophyll formed is not perfect, and so if the light deficiency, then enzyme formation is also disturbed (Herlina, 2011). Enzymes that are disturbed will disturb the photosynthesis process and eventually diminished photosynthesis is formed.

Relative Growth Rate (RGR): Relative growth rate indicates dry weight an increase in time intervals, in relation to the origin weight⁶. The relative growth rate (RGR) is the dry weight increase per unit dry weight that has been assimilating into the plant (Nasaruddin, 2010). The growing analytical variables that are closely related to the production of seed and 1000 grain

weight of seed is the relative growth rate (Hartawan, 2013). The protein content of seeds is the main variables that affect the quality of seed viability and vigor in storage.

The phenomenon of relative growth rate in figure 3 shows a decrease in dry weight addition plant of planting line with decrease value net of assimilation rate (NAR) at the time the plant reaches age 8 WAP where continue increase of LAI. This indicated that the shaded leaves organ has become parasitic to plants. The leaves a lack of sunlight receives will reduce photosynthesis and eventually reduce fotosintat which is useful for growth (Herlina, 2011).

The soybean plant is shaded at 50 %, increasing the leaf area index, the decrease net assimilation rate; decrease the Relative Growth Rate, lowering the total dry weight of the plant and pods weight (Merita & Qadir, 2011). Similarly, the results tomato plants that shade obtains 70 % (Baharuddin, R., Chozin, M. A. & Syukur, M., 2014). The diminished light on shade treatment caused leads to stacks of nitrate (NO_3). The nitrate increase caused to diminish of energy required by the enzyme nitrate reductase to reduce nitrate to nitrite (NO_2). The energy comes from the reaction of photosynthesis through the supply of carbohydrates. Inhibition of photosynthesis and nitrate pile, in turn, decreases the production of biomass plant is shaded (Sirait, 2008). The 75 % shade treatment nitrate reductase activity is also quite high. This is probably caused by the plant efficiently light capture by increasing the surface area of leaves (Latifa & Anggawulan, 2009). The increase in the rate of photosynthesis followed by increased respiration which will produce energy to reduce NO_3^- to NO_2^- .

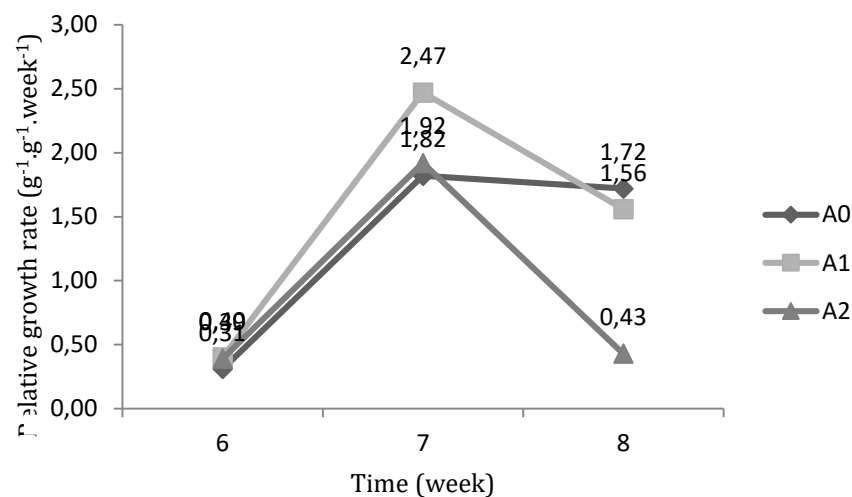


Figure 3. The average RGR of jack bean (*Canavalia ensiformis*) at treatment spaces growth different (A0, 75 cm x 100 cm; A1, 75 cm x 75 cm; A2, 75 cm x 50 cm)

In addition to the buildup of nitrate in the shaded plant, also an increase of proline and ascorbic acid compounds. The plant cells exposed to environmental conditions that are less suitable for example shade will produce a proline to maintain osmotic balance of cells. Setting the osmotic pressure on the stress condition or known as osmotic adjustment will produce a soluble compound that accumulated during the osmotic adjustment process such as sugar compounds and proline acid. Increased content of proline and the shaded chili is the mechanism of osmotic adjustment to the lack of light intensity due to the of shade treatment. Further, explain that the condition shade of acid ascorbic content continued to decline of the observation initial until the last day. This is according to the ascorbic acid function of the plant as a co-factor for violaxanthin deoxidase on xanthophyll cycle. This process plays a role in the protection of the release of light absorption in the form of temperature and can be measured as nonphotochemical quenching of fluorescence of chlorophyll. Ascorbic acid as antioxidant compounds can interact with the plasma membrane and electrons donated to the radical x-tocopheroxyl and activity-trans-plasma membrane oxidoreductase. Recycling x-tocopheroxyl can help protect the plasma membrane from peroxidation (Kloiri, 2010).

Information concerning the influence application of the catback technology on the growth and crop production sword koro bean plant will be written in another article.

D. Conclusion

A good time for technology cutback application on jack bean plant in all three growing space is recommended when the plants reach the age of 7 to 8 weeks after planting.

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