



The Impact of Road Light on Growth and Result of Soybean Plant

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ARTICLE INFO

e-ISSN: 2548-5148
p-ISSN: 2548-5121
Vol. 5 No. 2, December 2020
URL : <http://dx.doi.org/10.31327/atj.v5i2.1399>

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Abstract

Until now, soybean is still one of the priority food commodities in Indonesia. In the agricultural revitalization program launched by the government in 2005, due to the high price volatility that did not rule out the possibility of shaking the Indonesian economy. Soybean plants can provide positive and negative responses to environmental changes growing above and in the soil. This response can be known from phenotypic and physiological changes in plants. The environment on land which influences the growth of soybean plants mainly is the duration and intensity of irradiation, air temperature, CO₂ content in the atmosphere. The study aims to determine the impact of street lighting on the growth and yield of soybean plants. The study used a Randomized Block Design Method with 3 treatments, and each treatment was repeated 9 times, so that it takes 27 treatment plots. J₀ = Distance of street lighting to soybean land (meters), J₁ : 50 meters, J₂ : 60 meters, and J₃ : 70 meters. Observations were made one week after planting at 7-day intervals for growth parameters (plant height and number of leaves), while for the production parameters (Number of Content Pods/Plants, Dry Weight (DW) 100 Seeds, DW Seeds/Plots, and DW Seeds/Ha) are carried out after harvest. From the results of the study it can be concluded that there are real differences in the parameters of growth and production (number of filled pods, DW 100 seeds, DW seeds/plot, and DW seeds/ha), where the J₃ treatment is capable of producing 2.89 tons/ha (an increase in dry weight of seeds/ha by 28.4%), compared to J₁ 2.24 tonnes/ha, although not significantly different from Treatment J₂.

Keywords: lighting, lamp, growth, yield, soy

A. Introduction

Soybean is one of the priority commodities in the agricultural revitalization program launched by the government in 2005, as an effort to increase soybean production. This is indicated, among others, from the high turmoil arising from the soaring price of soybeans some time ago, which shook the economy. The government has tried to increase soybean production through the Soy Rise Program in 2004, the goal is to meet the needs of the community as food, industry and others. Food crop cultivation is inseparable from problems and requires careful maintenance.

Soybean plants can provide positive and negative responses to changes in the growing environment, above and in the ground. This response can be known from phenotypic and physiological changes in plants. The environment on land which influences the growth of soybean plants mainly is the duration and intensity of irradiation, air temperature, and CO₂ content in the atmosphere. air temperature, and CO₂ content in the atmosphere (Taufiq & Titi, 2012).

The results of this study are expected to get information about the impact of street lighting on the growth and yield of soybean plants as a food crop. This study aims to determine the effect of street lighting on the growth and yield of soybean plants. While the research hypothesis: is 1) It is suspected that street lighting has an impact on the growth of soybean plants, 2) It is suspected that street lighting has an impact on soybean yield, 3) It is suspected that the farther the soybean farm land with the lighting of the street lamp the better the growth and yield of soybean plants.

B. Literature Review

1. Overview of Soybean

The economic growth of developing countries like Indonesia, has changed the consumption patterns of its population towards more diverse and balanced nutritional patterns. This implies that the foodstuffs produced need to adjust to market demands, so that it can provide a variety of food ingredients to meet population consumption (Rachman, Handewi, & Ariani, 2008). Related to the pattern of changes in consumption, then the need for vegetable protein will continue to increase along with population growth, urbanization and increased income.

Human needs for vegetable protein can be obtained from soybeans which have a high protein content that is 40-50%. Soybean (*Glycine max* L.) is one of the food crops that plays an important role in Indonesia and has great potential to be developed. Soybean is annual major crops in the world and important legumes in food security. Increased soybean production can achieve through increased in the intensity of soybean cultivation and expansion of soybean cultivation to marginal lands such as dry land (Hasanah, Tengku, Hapsoh, & Hamidah, 2014).

Soybean demand is currently increasing, but domestic procurement has not been able to meet the demand, so it must be imported from abroad. Soybean commodity in Indonesia until now tends to decrease, both from production and productivity. An imbalance between the ability to produce soybeans in the country with an increase in demand, actually has happened in a long period of time. Starting in 2000 the need for imports of seeds and soybean meal has exceeded 2.0 million tons.

This is due to the reduction or decrease in the planting area and tend to be stagnant. Increased soybean deficit causes imports to increase and drain foreign exchange, thus keeping Indonesia away from soybean self-sufficiency. This is one of the reasons why Indonesia became a Net Importer of soybeans on the world soybean market. Handewi, Saliem & Sri (2012), in his writing concluded that the current condition of achieving self-sufficiency in soybean is still far from the target. The consumption and production gap is so large, this requires a breakthrough effort to achieve self-sufficiency targets.

Various efforts can be made to increase production. Soybean cultivation with liquid hyacinth organic fertilizer with a concentration of 7.1% - 14.3%, can increase the number of root nodules (Herawati, Indarwati, & Ernawati, 2017). Water hyacinth liquid organic fertilizer substituted with banana weevil and eggshell waste can also increase the number of effective root nodules, this is expected to increase soybean production (Herawati, Indarwati, Ernawati, Tunik & Noerhartati, 2019a). From the research results of Herawati, Indarwati, Tatuk, & Ristani (2019b), it is said that the application of liquid organic pupp made from fish waste, egg shell waste, or a mixture of both can increase soybean crop yields to reach 3.43 - 3.7 tons/ha. While from the results of other studies Herawati, Indarwati, & Ernawati (2020a), it is stated that the application of water hyacinth liquid fertilizer with banana weevil substitution, fish waste, and egg shells, as well as a combination of two of them or a substitution of a mixture of the three types of waste,

can increase yields of Dering varieties soybean reaches 3.5 - 3.99 tons/ha, while in Anjasmoro variety, the substitution of three kinds of waste with various compositions can reach 2.09 - 3.16 tons/ha (Herawati, Indarwati, Pratiwi, Ristani & Talib, 2020b).

The phenomenon of low import prices is mainly due to various efforts by exporting countries to protect soybean farmers, especially the United States. In a period of several years there has been a large price difference between the price of imported soybeans and domestic soybean prices. This condition makes farmers reluctant to plant, because they feel they do not get the right price and tend to harm farmers.

Soybean productivity in Indonesia is currently achieved around 1.3 tons / ha or still about 50% of the potential yield of the recommended superior soybean varieties, which is around 2-3.5 tons/ha. Besides being caused by the still low level of soybean productivity in each crop, which is around 0.5-2.5 tons/ha, also caused by differences in several factors including planting time, level of crop maintenance, availability of irrigation water, soil fertility and other environmental factors (Adisarwanto, 2008). Globally, the factors causing low soybean productivity in agricultural land are categorized into three major groups, namely: biotic, environmental and socio-economic factors.

2. Growing Environment

Like other plants, soybean requires specific environmental / agroecological conditions of the land to grow optimally. Land / land agroecology and climate are two components of the growing environment that affect the growth of soybean plants. These two components must support each other, so that the growth of soybeans can be optimal.

2.1. Land / Land Agroecology

Soybean plants can actually grow in all types of soil, but to achieve optimal growth and productivity, soybeans must be planted on sandy clay or sandy clay soil types. This is not only related to the availability of water to support growth, but also related to other growing environmental factors. Starch plant growth is very sensitive to changes in growing environmental conditions.

Another factor that influences the success of soybean planting is depth of tillage which is a supporting medium for root growth. This means that the deeper the tillage, the more space will be available for the growth of freer roots so that the taproots that are formed become more sturdy and deeper. In soil types with crumb structure with a depth of more than 50 cm, the roots of soybean plants can grow to a depth of 5 m. While in soil types with clay content, root growth only reaches a depth of about 3 m.

2.2. Climate

To achieve optimal plant growth, soybean plants need optimal growing environmental conditions as well. Soybean plants are very sensitive to changes in environmental factors, especially growing soil and climate. Water demand is highly dependent on rainfall patterns that fall during growth, crop management, and the age of the varieties planted. Some important components included in climate factors include: temperature, day length, humidity, and rainfall. These components, both separately and integrated greatly determine the success rate of soybean plant growth (Herwati, et al., 2019a).

a. Temperature

Fluctuations in air temperature that occur during the growth process greatly affect the survival of soybean plants, although soybean plants can grow in various temperature conditions. The optimal soil temperature in the germination process is 30°C. When seeds grow at low soil temperatures (<15°C), the germination process is inhibited, this is due to stress with high humidity conditions. While at high soil temperatures (> 30°C), many seeds die from respiration that is too fast.

In addition to soil temperature, environmental temperature also influences the development of soybean plants. When compared with the rainy season, soybean growth in the dry season with air temperature conditions ranging from 20-30°C is considered more optimal with better seed quality. But with temperatures that are too high during the dry season (> 30°C) can also suppress / inhibit the process of germination of soybean seeds, so that soybean pods become more rapid cooking and decay (abortion). This will certainly make the formation of the number of pods and the process of filling the seeds not optimal.

In addition, temperature fluctuations that are too high, especially between day and night, can trigger the development of certain disease pests, such as *thrips* and *embun upas* which cause dwarf soybean plants. Therefore, to avoid losses due to pest attacks, many farmers do not plant soybeans in periods of temperature difference that are too striking.

b. Humidity

Air humidity directly affects the process of cooking soybeans, because the higher the humidity the pod cooking process will be faster, so that the process of forming seeds becomes less optimal. On the other hand, high humidity for some time will encourage the development of pests and diseases, so attacks will increase. Optimal humidity for soybean plant growth ranges from 75-90%.

In addition to air humidity, a very influential growth environment factor is soil moisture. Reducing soil moisture from 90% of available water to 50% of available water, can reduce the yield of soy beans between 30-40%. This is especially true if the decrease in soil moisture occurs during the pod formation period. Efforts that can be made to reduce high soil moisture are by making draenase channels every 3-4 m distance (depending on plot width). This draenase channel is dual function, namely as an excess water drain when there is a lot of rain and as an irrigation channel during the dry season. Thus the water quickly spread evenly in the map. The depth of this channel ranges from 25-30 cm with a width of 20-25 cm.

c. Rainfall

The amount of water used by soybean plants depends on climate conditions, crop management systems, and the length of the growing period. However, in general, water requirements for soybean plants during the growing period range from 350-550 mm. Therefore to reduce the negative effects of excess water, it is recommended to make draenase channels so that the amount of water can be regulated and can be divided evenly. The availability of water can come from irrigation channels or from rainfall that falls.

Soybean growth levels that require a lot of water flow or high soil moisture are in the vegetative initial stage (germination), flowering stage, and the stage of formation/filling of pods. The need for water increases with age. To prevent drought, especially in flowering stages and the formation of pods, carried out with the right planting time, ie when soil moisture is sufficient for germination. But it also needs to be aware that high rainfall can also cause pod rot and the quality of the resulting seeds decreases. During the period of seed ripening, soybean plants need dry environmental conditions in order to obtain good quality seeds. Dry environmental conditions will encourage the process of cooking the seeds faster and uniform shape of the seeds. Therefore it must also be based on the distribution pattern of rainfall occurring in the area.

Another thing that must be considered when planting soybeans during periods of high rainfall is the use of soil types. The type of soil suitable for use in this period is sandy loam, where the water holding capacity is low, so that absorbed water is easily lost and does not cause high soil moisture. Soybean plants are actually quite tolerant of drought stress because it can survive and produce when drought stress conditions are maximum 50% of the field capacity or optimal soil conditions.

d. Day length

The length of the day is the length of the sun shining on the surface of the earth. In the tropics, the irradiation length generally ranges between 11-12 hours/day, while the subtropical regions have longer days, which is 14-16 hours/day. The length of the day is one of the factors causing the low level of productivity of tropical soybeans. This is related to the nature of soybean plants that are sensitive to changes in day length or length of sun exposure, because soybeans are included in the plants of "short days". This means that soybean plants will not bloom if the length of the day exceeds the critical limit, which is 15 hours/day.

This can be seen from the flowering process of soybeans, if high-yielding varieties from subtropical areas are planted in the tropics, then these varieties will experience a decline in production. This is because the subtropical soybean will flower faster (the flowering period becomes shorter), ie from 50 - 60 days to 30 - 40 days after planting. In addition, vegetative growth of plants stops faster so that plants grow shorter and the number of pods becomes small.

This condition also causes the humidity around the pods to be high enough so that it attracts pods to attack the pods and lowers the productivity of the resulting beans. And vice versa, if

tropical soybeans are planted in subtropical areas will get a slow-flowering soybean plants that have higher / bigger posture. The difference above does not only occur in soybean planted in the tropics and subtropics, but also occurs in soybean plants planted in the lowlands (<20 m asl) and highlands (> 1,000 m asl). The flowering age of soybean plants planted in the highlands retreats around 2-3 days compared to soybean plants grown in the lowlands.

Soybeans grown under the auspices of annual crops (coconut, teak, and mango), will get less sunlight. The results showed that the shade that did not exceed 30% did not have much effect on the reception of sunlight by soybean plants.

3. Effect of Street Lights on Plants

Plants consist of two main parts, namely, the part above the ground in the form of stems and leaves, and the underground part in the form of a root system. Environmental factors of plant parts above ground consist of sunlight, air temperature, humidity, gas content in the air and rain. While the environmental factors of plant parts in the soil consist of soil temperature, soil water content, salinity, pH, nutrient content, toxic element content, texture and structure of the soil and soil aeration. The components of these environmental factors individually and their interactions affect directly or indirectly on plant growth.

Irradiation is very influential on plant growth, especially because of its role in physiological activities such as photosynthesis, respiration, opening and closing of stomata, germination and growth and flowering of plants. Irradiance affects the growth, reproduction and yield of plants through the process of photosynthesis. The absorption of light by the pigments will affect the division of photosynthates into other parts of the plant through the process of photomorphogenesis, that is, the growth and development of plants which are directly controlled by light/light and are not dependent on photosynthesis

Basically, leaves are stem accessories with thin and flat shapes arranged with certain rules. The rules of the sitting position of the leaves on the stem are called phylotaksi (phylotaxy), with this position allowing the leaf to absorb light energy/light freely.

Based on the response of plants to the long irradiation, the plants can be classified into three groups. *First*, the group of long day plants (long day plants) such as barlei, alfafa, wit and so on that require light/irradiation for 13 hours or more in order to flower. *Second*, short day plants or commonly called C3 plants, such as rice, soybeans.

The response of plants to the environment varies depending on the type and cultivar of the plant. Plants can provide positive or negative responses to changes in the growing environment. These diverse responses can lead to interactions between the environment and genotypes. The response can be seen from the physical changes in the form of changes in plant growth, and also changes in plant phenotypes. Plant responses can also be known from changes in physiological processes, for example the speed of photosynthesis and photosynthate translocation. Street lights are lights used for street lighting at night, so pedestrians, cyclists, and motorists can see more clearly the road that will be traversed at night, so as to improve traffic safety and security of road users.

From a study conducted by researchers at the University of Exeter, UK quoted from *Eurekalert* (Ngazis, 2015), shows that the light at night has an impact on the disruption of the growth of wild plants. Researchers found that artificial light pollution can have an impact on the unpredictable natural environment. With the increasing number of night lights, the ecological impact is expected to expand.

Street lighting at night directly affects the presence of plants, because it can result in an increase in ambient temperature so that it is not in accordance with plant growth requirements. The existence of street lighting at night changes the environment around the plant location to be higher than usual. Temperature is a limiting factor that determines whether a plant can grow optimally (Anonymous. 2016).

In visible light, the most absorbed by green plants are red and orange light (with wavelengths of 600- 700 nm) and blue violets (with wavelengths of 400-500 nm), green light (500 - 600 nm) absorbs only traces.

C. Methodology

The study was conducted at the Mojosari Experimental Garden in Mojokerto, starting in March 2019 and ending in July 2019. The materials used in this study were: ring varieties of soybean seeds, Urea, KCl, and TSP basic fertilizers, organic liquid fertilizer (POC) and others. While the equipment needed during the research are: hoes, rattles, pits, buckets, agricultural sprayers, rulers, cameras, analytical and digital scales, LED street lighting and others.

1. Research Design

The study was conducted using a randomized block design with 3 treatments, and each treatment was repeated 9 times, so that as many as 27 (9 x 3) treatment plots were needed. J = Distance of street lighting to soybean land (meters), J1 = 50 meters, J2 = 60 meters, and J3 = 70 meters.

2. Population and Sample

This study uses a spacing of 40 cm x 15 cm with a plot area of 15 m² (5 m x 3 m), so that there are around 250 plant populations per treatment. From 250 plant populations 10 plant samples were taken to be observed, because each treatment was repeated 3 times so 90 plant samples were needed for each treatment and 270 plant samples for 3 treatments.

3. Technique of Data Collection

Observation of growth is carried out non destructively one week after planting in the field with an observation interval of 7 days for one month. As for the production parameters carried out after harvesting. Characteristics of soybean plants that are ready to harvest, namely leaves and pods are already yellowing (not due to disease pests), the pods begin to change color from green to brownish yellow and cracks / pods look old.

4. Instrumens

Variables / parameters observed included: growth parameters (plant height and number of leaves) and production parameters (number of filled pods / plants, dry weight (DW) seeds / plot, DW seeds / ha, and DW 100 seeds).

5. Technique of Data Analysis

The observational data obtained were processed using Variance Analysis (Test F) Randomized Group Design patterns at the level of 5% and 1%, to find out if there were any real differences between treatments. If there is an influence that is a significant difference between treatments, then the test is continued with a comparison test between treatments using the Least Significant Difference Test (LSD) at the 5% level.

D. Result

1. Finding

Growth Parameters

Table 1. Average Plant Height (cm) due to Lighting Distance Treatment Street Lights Against Soybean Land (meters) at Various Ages Observations

Treatment	Days after planting (dap)			
	7	14	21	28
J1 (50 m)	5,93	12,88 a	15,21 a	21,36 a
J2 (60 m)	5,73	11,88 a	14,76 b	20,13 b
J3 (70 m)	5,76	11,24 a	14,29 c	19,02 b
LSD 5%	NS	0,60	0,42	1,17

Note : Numbers followed by the same letter in the same column, NS = Not Significant

Table 2. Average Number of Leaves (Stands) for The Treatment of the Distance of the lingting of the Street Lights Against Soybean Land (meters) at Different Age of Safekeeping

Treatment	Days after planting (dap)			
	7	14	21	28
J1 (50 m)	2	4,02	5,04 a	6,76 a
J2 (60 m)	2	3,96	4,84 a	6,63 a
J3 (70 m)	2	3,96	4,42 b	6,16 b
LSD 5%	NS	NS	0,21	0,3

Note : Numbers followed by the same letter in the same column, NS = Not Significant

Table 1. it can be seen that there is no real difference in the height parameters of the observational age of 7 dap in the treatment of street lighting distance to soybean land (meters), but at the age of observation 14-28 dap occur very significant differences. At the age of observation 14-21 dap J1 treatment gave significantly different plant height with treatments J2

and J3. At the age of 28 dap observations, J1 treatment gave the best plant height, which had an average plant height of 21.36 cm, which was significantly different from treatments J2 and J3, whereas treatment J2 was not significantly different from J3.

Table 2. it can be seen that there is no significant difference in the parameters of the number of leaves age of observation 7-14 dap in the treatment of the distance of street lighting to soybean land (meters), but at the age of observation 21-28 dap there is a very significant difference, treatment J1 gives a very different number of leaves significantly with J3 treatment although not significantly different from J2 treatment.

Production Parameters

Table 3. It can be seen that there is a very significant difference in the parameters of the number of filled pods, DW seeds/plot, DW seeds/ha, and DW 100 seeds in the treatment distance of street lighting to soybean fields. Based on observations, it is known that J3 gives the best number of filled pods and DW 100 seeds which are significantly different compared to other treatments of J1 and J2. While on the parameters of the number of seeds DW / plot and seeds BK / ha in the treatment of the distance of street lighting to soybean land, the observation results are known that J3 gives the best BK seeds / plot and DW seeds / ha that differ very significantly compared to J1 treatment although it is not different evidently by treatment J2.

Table 3. Average Number of Fill/Plant Pods, DW Seeds/Plots (kg), DW seeds/ha (Tons), and DW 100 seeds (g) due to the Treatment Distance of Street Lights for Soya Land (m).

Treatment	Number of Filled Pods	DW Seed/Plot (kg)	DW Seed/ha (ton)	DW 100 Seed (g)
J1 (50 m)	94,53 c	5,42 b	2,24 b	10,60 c
J2 (60 m)	165,02 b	6,38 a	2,66 a	10,85 b
J3 (70 m)	189,76 a	6,93 a	2,89 a	11,30 a
LSD 5%	7,44	0,73	0,30	0,21

Note : Numbers followed by the same letter in the same column

E. Discussion

From the results of observations on growth parameters it can be seen that the treatment distance of street lighting to soybean land on the parameters of plant height and number of leaves (Tables 1 and 2) at the age of 28 dap there is a significant difference where J1 gives the best plant height which is significantly different from J3 although it is no different from J2. From the research results of Setiasih, Sugeng, Ahmad, & Diding, (2016), it is said that environmental factors including the intensity of light/light can affect plant growth, which causes etiolation in plants where plant growth faster but become thin and not develop.

While on the parameters of the number of leaves, the distance of the lighting of the street lights to the soybean field produced the most number of leaves which were significantly different from the treatments of J2 and J3. Light has an important role in the physiological activities of plants, namely photosynthesis, respiration, opening and closing of stomata, germination and plant growth. According to Saifulloh (2017). From the results of research by Ristiana, Ramdan, & Sutini (2016), it was concluded that irradiation time affects the vegetative and generative growth of plants. In this study carried out on land adjacent to street lighting with a distance of about 50 m.

According to Ting (1982) in Saifulloh (2017), it is said that the growth and development of plants are directly controlled by light and are not dependent on photosynthesis. Soybeans are a subtropical native plant which requires a length of 14-16 hours while Indonesia with a tropical climate has a nearly constant day length of 12 hours. So that soybean plants do not experience photosynthesis perfectly because of the lack of sunlight. According to Afidah & Ika, (2018), one of the efforts that can be done to overcome the problem of day length is by manipulating sunlight. Sunlight can be manipulated using LED lights.

F. Conclusion

There was a significant difference in the parameters of plant growth where J1 had the highest average plants compared to J2 and J3, while on the number of leaves the J1 parameters had the most number which was significantly different from J3, although it was not significantly different from J2. There was a real difference in the parameters of the number of filled pods, where the J3 treatment produced \pm 190 filled pods/plants compared to the J1 treatment (the

closest land distance to street lighting) only produced ± 95 filled pods/plants. There was a real difference in the weight parameters of 100 seeds, where the J3 treatment had an average weight of 100 seeds 11.3 grams which was more than the 10.1 gram J1 treatment. There was a significant difference in the dry weight parameters of seeds/ha, where the J3 treatment was able to produce 2.89 tons/ha (an increase in dry weight of seeds/ha by 28.4%, compared with the treatment of 2.24 tons/ha, J1 although not significantly different from Treatment J2).

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