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Corona Discharge Plasma Technology to Accelerate the Growth of Black Soybean Plants

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Abstract
Corona glow discharge plasma has been used to accelerate the growth of soybean black seed plants. This system consists a corona reactor with configuration of electrodes of multi points to plane. Multi points to plane electrodes system are designed with the distance between the electrodes 2 cm and number of points electrode was 64 of needles. Seeds were grouped to 5 groups of samples. Grouping was based on treatment time of plasma that were 6 minutes, 12 minutes, 18 minutes, 24 minutes and 30 minutes. The growth of the soybean seed black's crop has been carried out by analyzing the amount of percentage germination, measuring the length of the stem, the width of the leaves. Measurement have been taken each five days until 30 days. The research results showed that 5 groups of samples irradiated by glow discharge corona plasma (IGDCP) more progressive growth comparing with seeds without irradiated by corona plasma (control). Moreover, we found that the effectiveness of growth increases with increase of treatment irradiation time. For treatment irradiation time of 30 minutes after planted for 30 days, and compared with control samples, we found that escalates in length of 71.38%, number of leaves increases of 3.27%, wide leaves augment of 16.47%. Percentage germination of samples with 30 minutes' treatment time was 314.28% compare with control. We suppose that the increasing growth parameter of soybean black seed is cause of increasing nitrogen in seed by intrusion of nitrogen ion when irradiation corona discharge plasma.
Keywords: electrodes, irradiation, plasma, soybean black seed, nitrogen ions

1. Introduction

Soy (glcine max L) is plant legumes or crops of nuts are often used as the raw material manufacture of soy sauce, tofu, tempeh has a high nutritional value (Li, et.al., 2011; Minh, et.al.,2014). Black soybean production in Indonesia is extremely low compared to plant corn, rice, and sugar cane as well as soybean. Based on the Data of the Central Bureau of statistics of local soybean production in 2011 only 851,289 tons or 29% of the total needs so that Indonesia had to import soybean 2,087,986 tons to meet the 71% of the needs of domestic soybean and domestic soybean needs an estimated increase of approximately 24% of an annual. The current state of the world's production is controlled by the United States and absorbed by china 61.5%, Mexico 8,74% 5.24%, Japan and Indonesia 5.11%. There are two kinds of soybeans grown in Indonesia namely soybean yellow and black soybeans. Black soybeans contain higher than yellow soybean (normally soybeans in Indonesia) that is polyunsaturated fats content 5-6 grams, 3,4 grams of protein, 2 grams of soluble fiber and insoluble fiber is 5 grams (Muchlish, 2012).

The increase in soybean crops productivity has done a variety of methods, namely the method of fertilization with organic or inorganic. To increase plant productivity higher and efficiently scientist do planting black soybeans using the method of utilization of plasma as has been done in rice by (Lee,et.al.2007; Chung, et.al.2015), for accelerating growth of mangrove (Nur,et.al.2013) for radish seeds (Mihai et.al., 2014. By utilizing the plasma technology to accelerate the germination of maize seeds BISI-2, it was obtained the value of the sample group of maize seeds germination previously irradiated with the plasma reaches 100%. Comparing with of the group of maize without radiation plasma reaches 90%. Then the percentage of germination for seeds with plasma radiation reaching 178.9% compared to the sample group not given plasma radiation (Muhlisin, 2005).

In the needs of plants, nitrogen is a compound that is urgently needed for the growth and development of plant structures. In plants, nitrogen can be obtained by electrical discharges such as lightning in the form of oxides of nitrogen (Nur, 2011). Plasma technology is used as a generator of N^+ ions from the air. Intrusion of nitrogen ions into a material will change the microstructure of materials, so that the nature of the physical and chemical properties – such materials will undergo changes (Giller, 1991). In this regard, the role of plasma

technology serves to increase the plant's nitrogen needs directly through the ionization and recombination of nitrogen element on the State atmosphere or free air.

This research was conducted on the testing System of incandescent plasma reactor discharge corona is to accelerate the growth of soybean plants seeds black by analyzing the optimal time area irradiation black soybeans. This research was conducted to analyze the growth of black soybeans that are affected by time period-given plasma irradiation seeds black soybeans.

2. Method

Corona discharge plasma Reactor incandescent the reactor is a comprised of two electrodes in the form of points and fields. Plasma being raised on the space between two electrodes using a DC voltage source (Tseng, 1999, Nehra,et.al.,2008). The form of needle point electrodes made from carbon steel materials have a distance between needles 3 cm, diameter of 0.7 cm and 3 cm in length and amounted to 64 points (8 points x 8 points) mounted on a metal plate as a place for needle fixed. The metal plate has an area of 30 cm x 30 cm. Glow discharge corona was generated by using high voltage DC source with maximum voltage of 10 kV.

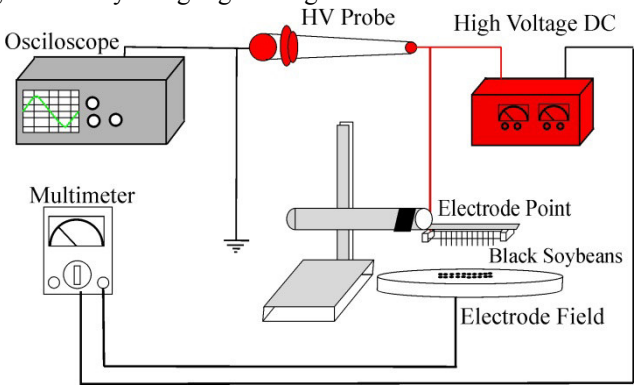


Figure 1. Scheme of experimental set up

The signal in the form of the output voltage is detected using the Oscilloscope with a frequency of 60-70 kHz (GOS 6050). Measurement of electrical current by using an Ammeter (Sanwa). The current of glow discharge treatment of 0.5 mA. Applied voltage of corona discharge was measured by the using of a voltage divider (divide 1000 times) or HV Probe (PD-28). The needles electrodes mutually perpendicular to plane electrode with distance of 2 cm. The distance between the electrodes was judged as effective distance in irradiation glow discharge corona plasma treatment.

The object of irradiation in this research are the seeds of black soybean (Glycine max (L) Merrini). There are 6 groups soybean seeds, five groups with irradiation glow discharge corona plasma treatment (IGDCP) or one group soybean seed control. Plasma radiation treatment is divided in 5 samples based on the length of irradiation i.e. 6 hours, 12 minutes, 18 minutes, 24 minutes and 30 minutes. Each sample contained 100 seeds black soybeans at each time of irradiation. All samples will be planted in the same soil media in the pots and the same watering treatment. At the time of planting to land and start growing there are several observation parameters i.e. high number of stems, leaves, and stem diameter.

3. Result and Discussion

The irradiation process of black soybean seeds was made on applied voltage of 6 kV. In this condition corona glow discharge marked by the sound of the sizzle on the tips of the electrode needles. Corona discharge plasma process accompanied by glowing colored purple between electrodes. The measurement of growth parameters was done after 5 days planted. We found the difference between a soybean seed irradiation treatment plasma with non-irradiation treatment plasma. Figure 2 shows research results in third graph both of the above the relationship of height of stem the number of leaves and width of leaves black soybean against the time of growth. Based on the graphs, we can see that sample with irradiation plasma treatment are growing more quickly than without treatment. The effect of plasma irradiation with 3 parameters of observations of each sample from start the day planting until day of 30^{th}.

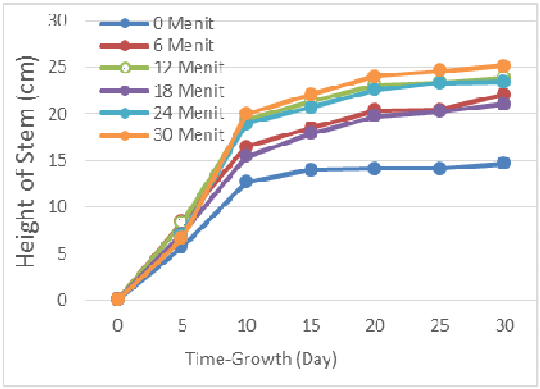
In Figure 2 (a), the height of the trunk is affected by the time of the treatment. Each sample has a different growth rate until the end of measurement day. We found that sample with IGDCP has the fastest growth rate i.e. 25.16 cm whereas without IGDCP (control) has a growth rate too late i.e. 14.68 cm, there is much difference between the two views of the pattern graph. Stem height growth the fastest or the maximum indicated by the sample of 30 minutes i.e. 25.16 cm, has the effectiveness of height growth of the stem of 71.38% compared with non-treatment.

In Figure 2 (b), the number of leaves affected the time of treatment. This data is taken based on the

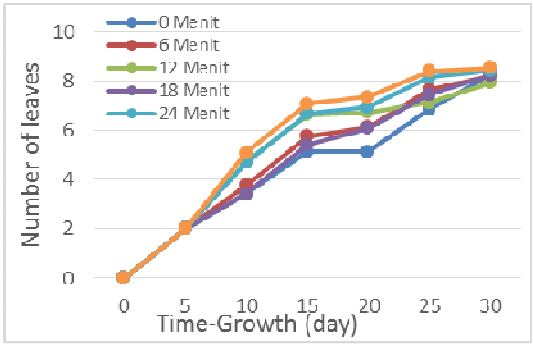
average growth of the leaves so that the result that is displayed is not an integer. Based on the quantity of leaf growth on day of 30th, most are present in a sample of 30 minutes i.e. 8.55 fruit and there is at least on a sample of 12 minutes i.e. 7.29 cm. The number of most leaves are present in a sample of 30 minutes i.e. 8.55 fruit, has a number of leaf growth of effectiveness of 3.27 % compared with treatment without IGDCP.

In Figure 2 (c), the diameter of the leaf influenced by the time of the treatment. When observations do not there is a difference of vision of the eye but after done measurement on day 30, 30-minute sample has a maximum diameter magnification i.e. 5.09 cm while the sample of 24 hours has the minimum diameter i.e. enlarge 4.06 cm. Maximum shaft diameter Magnification occur in 30-minute sample i.e. 5.09 cm, has a diameter growth of effectiveness 16.47% compared to treatment without plasma.

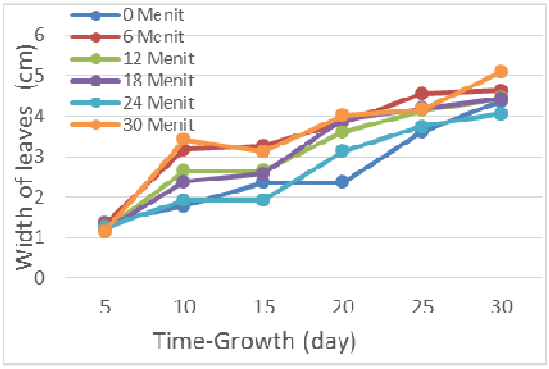
Based on the third graph above (Figure 3) from both the high number of stems, leaves and stem diameter, there is compelling data pattern when compared with data on other days i.e. data on day 20. Where further if seen will be seen in Figure 3 (a, b and c). Can be seen in Figure 3 (a) high stem is affected by time of treatment takes part time affects the acceleration of high growth of the stem, which means that each sample has a growing spurt. Stem height growth the fastest or the maximum indicated by the sample of 30 minutes i.e. 24.05 cm, has the effectiveness of stem height growth 70.8% compared with no treatment.



(a)



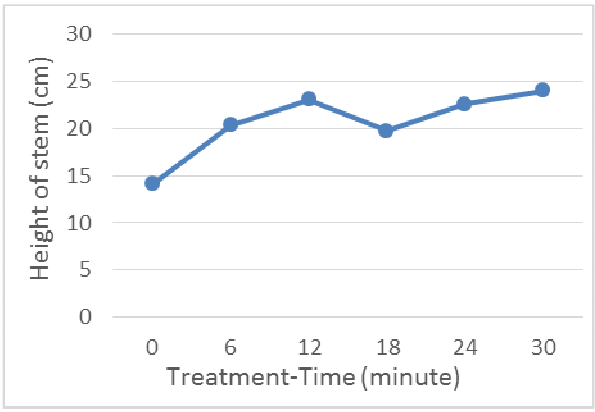
(b)



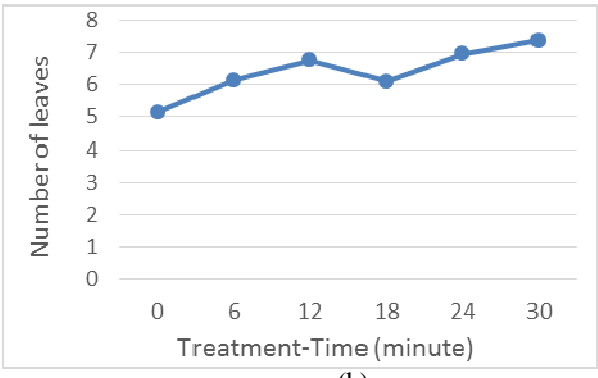
(c)

Figure 2 Growth parameters as function of times of planted (a) Length/height of stem, (b) the number of leaves, and (c) the width of the leaves ICGDP and control

To figure 3 (b) of the number of observations of the leaf which has average from a few sample that grows, the number of leaves is also influenced by the long treatment, where the longer the treatment the greater number of leaves that grow. The number of most leaves are present in a sample of 30 minutes i.e. 7.38 fruit, has a number of leaf growth of effectiveness of 43.5% in comparison with the treatment without plasma.



(a)



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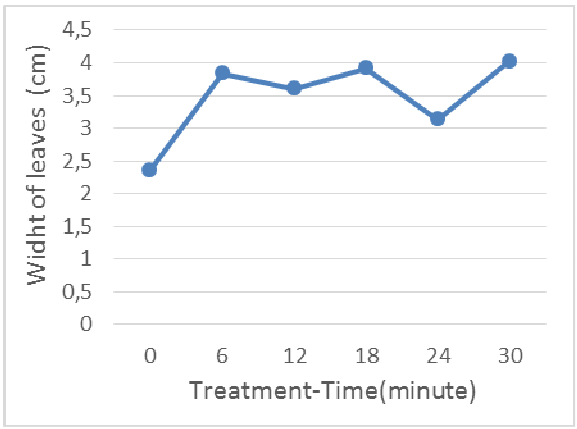

(c)

Figure 3 Growth parameters as function of treatment times at day of plated at 20th (a) Length of stem, (b) the number of leaves, and (c) the width of the leaves ICGDP and control

Observation of the leaf is only seen from the large number of leaves that appear or grow is not based on the width of the leaves. Furthermore, Figure 3 (c), the diameter of the stem is affected by the long time treatment. Maximum shaft diameter magnification occurs in 30-minutes sample i.e. 4.02 cm, has a diameter growth of effectiveness of 70.38% in comparison with the treatment and without treatment IGDCP.

From 100 black soybean seeds samples without IGDCP or treatment IGDCP on the respective not all the seeds grow into plants black soybeans. most do not experience the germination in influence by land area (in a land area of land in accordance with the comparative amount of seeds planted then percentage of plant growth would be more efficient), the received light plants, watering levels during the process of planting and soil nutrient elements are used. It can be seen in Figure 4, the percentage growth of each sample is affected by the

long treatment. Percentage growth of best or maximum found in the 18-minute samples of 100 seeds which only 30 seed who managed to grow on day 30 whereas the percentage growth was smallest at sample 0 minutes or without plasma treatment. It looks a clear difference between the percentage of growth without treatment with plasma treatment.

Based on observation and analysis that has been done, the fourth parameter that is a high number of stems, leaves and stem diameter as well as percentage growth for plasma radiation treatment affect plant growth black soybeans when compared with no treatment of plasma radiation. Of the 5 samples of plasma treatment, as seen from the four research parameters then it's best to sample this research sample is 30 minutes. Where effectiveness growth of 30-minute samples are compared without plasma treatment on day 30 is the height of the stem 71.38%, number of leaves, stem diameter 3.27% 3.90% and the percentage growth of 314.28%.

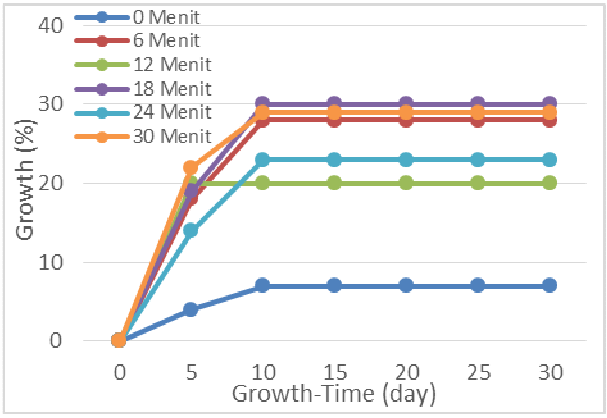

Figure 4 . Percentage of black soybean growth as functions of time of planted, for several time of IGDCP

With the results of the study showed an increase in growth black soybean plants by providing free air that hypothesis (in the form of nitrogen that almost 80% of the air composition) between electrode space of ionized plasma corona discharge.

Figure 5 . Photograph of black soybean planted, for several time of IGDCP

Corona glow discharge plasma can be able to produce nitrogen ions from air (Nur et.al.,2014), and these ions were inserted into seeds of black soybeans. and seeds causes an acceleration of the soybean plant. Ion nitrogen is the element most in free air, therefore an ionized nitrogen formed into the plasma so that the ion has the greatest nitrogen probability to infiltrate into the soy bean seed compared to other ions in air compotition. An increase in nitrogen in plants through the process of ionization of nitrogen by electric field followed the changes of physical and chemical changes in the microscopic plant soybeans suplied substance nitrogen so effectively by the plasma discharge reactor system Corona (Chen, et al., 2002, Nur et. al 2014). The possibility of nitrogen coming into soy beans supported by nitrogen properties as one of the constituent components of the cell that is important. It functions as a constituent of proteins, nucleic acids, chlorophyll (the substance of the green leaves) and as a regulator of growth (Tseng, 1999). Plasma corona discharge system is able to produce nitrogen ions then intruded into seed soybeans, this causes increased levels of nitrogen in soybean seed showed there is an increasing growth in black soybeans.

4. Conclusion

Of research results, its can be concluded that, corona glow discharge plasma with the configuration of the

electrode multi points to plane able to ionize air on gap between the electrodes, and it can produce plasma species for source irradiation corona glow discharge plasma (ICGDP) for bombardment black soybeans seed. The influence of ICGDP on black soybeans seeds black proved the existence of effective growth after treatment compared without ICGDP treatment

Of the whole experiment conducted in this study, we found that the longer the treatment ICGDP the better the quality of growth. In this study, the longest time of 30 minutes, and we found that the best results among the ICGDP longest time. Not to be optimized so that in subsequent research needs to be optimized. Based on the results of this study suggested that ICGDP can be used as a technique to improve the quality of black soybean seeding.

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