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The Effect of Silicon on Chlorophyll and Abscisis Acid Contect on Several Cultivar of Soybean Under Drought Stress

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Abstract

Silicon is the second most abundant in the soil and Silicon could be considered as an essential element in many crops to enhancing growth and alleviating biotic and abiotic stresses. Silicon present exclusively in the form of silicic acid (H4SiO4). It is absorbed by plants in the form of silicic acid. The aim of research is knowing the content of Chlorophyll and Abscisic Acid of soybean under drought stress by silicon application. The different levels of Silicon were tested in a pot experiment to assess their effects on chlorophyll content and Abscisic acyd on several cultivar of soybeans under drought stress. The results show that there is no interaction between each treatment cultivar and silicon. The absorbance value of chlorophyll leaf using spectrophotometer shows that chlorophyll content differs significantly on each cultivar of soybeans. The increasing application of silicon concentration tends to increase chlorophyll content but decreases the levels of Abscisic Acid (ABA) in leaves.

Keywords: Silicon, chlorophyll, drought stress

INTRODUCTION

Drought stress affects all aspects of plant growth and metabolism including membrane integrity, pigment content, osmotic balance, photosynthetic activity (Anjum et al., 2011; Naji and Rangaiah, 2009), decreased potential of protoplasmic water (Mundre, 2002). Prolonged drought stress conditions in plants can be a serious cause of decreased ability of plants to perform the process of photosynthesis this is due to the occurrence of dehydration in protoplasm.

Water loss that occurs in the cells of the plant because of the experience the drought stress will greatly effect on metabolic processes in the cells of plants. Several methods have been much done to overcome the dryness stress and end-end Silicon utilization method for increasing the durability of the plants have been brought to the attention of researchers. Silicon (Si) is the second largest element after the oxygen contained in the earth's crust, its existence is a universal element of Si has not been much attention, some form of Si is an inert element that is (very insoluble) so long as this Si is not considered to have significance for the processes of biochemistry.

Silicon is considered not essential nutrients but there are abundant in number in the ground. Silicon is a chemical element of Metalloids and has a beneficial influence on some kinds of plants. (Miyake and Takahashi, 2012; Ahmad et al., 2013). Silicon has the ability in controlling the damage from biotic stress caused by the attack of fungi and bacteria, and also described Silicon allegedly had an important role in reducing decreasing in growth due to

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abiotic stress and silicon involved in fortification of plants that have an effect on the oxidation of cell membranes, and resulted in the protection of various plant organs function that is experiencing drought conditions (Bray, 1998; Liu, 2004).

In plants silicon involved in the fortification of plants that have an effect on the oxidation of cell membranes, and resulted in the protection of various plant organs function that is experiencing drought conditions. Silicone also seems to be part of the regulation on the conditions in the cells osmolit experience dryness stress (Janislampi, 2012).

High levels plants, chlorophyll a and chlorophyll b is the primary photosynthetic pigment, which act to absorb violet, light blue, red and green reflected light. On conditions of stress continuous drought can reduce photosynthetic activity so that it also affects chlorophyll formation mechanism due to the result of the process of the closure of the stomata as the mechanism of plant drought-coping stress. (Maghsoudi et al, 2015).

Drought stress that occurred in all phases of the reproductive rate causing a decrease in photosynthesis, chlorophyll content, broad leaves, stomata are holes wide, biomass and seed yield, but the frequency of the closure of the stomata and the rate of respiration increases and reduce potassium uptake by roots (Xia, 1994; Sheikhpour et.al., 2014). High levels of intensity of drought and longer period of drought stress that plant suffered, ABA accumulation and result in the flow of potassium gets into the body of the plant is disturbed because the ABA inhibits the proton pump, whose potassium (cations flow K +) into the guard cells, this condition affects regulatory system opening of the stomata (Sreenivasulu et al., 2014; Liu et al. 2014). The occurence of the process increased the biosynthesis of Absisik Acid (ABA) on the plant, which suffered a drought caused by the process of oxidation in protoplast occurs continuously in conditions of water shortage (Bray, 1998). The objectives of this research is to determines content of chlorophyll and abcisics acid of soybean under stress by application of various concentration of silicon.

METHODS

This research was conducted in Screenhouse at University of Pembangunan Nasional Veteran East Java in June – August 2017 and designed using Randomized Block Design (RBD) in two Factors, Factor I: Varieties consisting of varieties of Dering 1 (V1), (V2) Wilis varieties, varieties of Grobogan (V3). Factor II Silicon Concentrations : 0 cc/l (K0), 5 cc/l (K1), 10 cc/l (K2) and 15 cc/l (K3). The condition of the drought stress simulated using Poly Ethylene Glycol (PEG) 6000 at concentrations 15 % equivalent to -0.41 MPa (Mexal et al., 1975). Application of PEG 6000 was given every 3 days until the plant was 70 days after planting.

Analysis of chlorophyll and Absicic Acid (ABA)

The equipment used for the analysis of chlorophyll levels include mortar cold Muller each, the balance of analytic, a beaker glass tube 50 mL, ependorf, spectrophotometer (wavelength 649 and 665 nm), micropipet, yellow tip, sentrifuge, vortex, cuvet 5 mL, refrigerator, plastic bags, a ruler, bolpoint. The materials used include soybean leaves from 3 varieties tested, absolute Ethanol 96% aquades. Analysis of the levels of chlorophyll is done twice, namely on plants aged 50 and 75 days after planting. Analysis of *Abcisic Acid*, made through extraction of sample plants and continued with the analysis of the content of the ABA using Gas Chromatography. The observation is done at the age of 45 days. A method of analysis that will is a method of Monteiro. Leaf samples of the plants used are leaves to 2 and 3 of the top and from plants aged 50 days after planting.

RESULT AND DISCUSSION

The results of laboratory analysis gained further in the analysis of Anova. Based on statistical analysis of the results showed a difference of chlorophyll b and total chlorophyll in each treatment age 50 days after planting. (Table 1).

Table-1. Chlorophyll a, Chlorophyll b and Total Chlorophyll some Cultivars of Soybeans on Silicon Application (50 DAP)

Treatment	Chlorophyll a	Chlorophyll b	Chlorophyll total
Cultivar			
V1 (Dering 1)	14,32	12,13 b	26,31 a
V2 (Wilis)	17,48	14,35 b	31,88 b
V3 (Grobogan)	16,99	11,26 a	25,93 a
HSD 5 %	ns	1,80	3,33
Silicon (Si)			
S0 (0 cc/l)	16,54	10,43 a	26,39 a
S1 (5 cc/l)	16,90	13,09 bc	29,96 ab
S2 (10 cc/l)	17,02	12,22 ab	28,03 ab
S3 (15 cc/l)	17,27	14,59 c	31,64 b
HSD 5 %	ns	2,18	4,03

DAP: Days After Plant ; ns : non significant The same letter shows no significant using of HSD at 5% probability level

Absorbance values of Leaf chlorophyll by using a spectrofotometer showed that chlorophyll on all the treatments tend to be not significantly different, except with chlorophyll and chlorophyll b total shows happen significant differences both in some soybean cultivar and silicone applications tested. Cultivar Wilis had the highest chlorophyll compared to Dering 1 and Grobogan.

The levels of chlorophyll in plants age 75 days after planting showed that cultivars Grobogan has the highest chlorophyll levels compared with other cultivars though not significant cultivar Wilis. Application of silicon improves the content of chlorophyll b and total chlorophyll concentration at which 15 cc/l generates the highest average chlorophyll concentrations when compared to other silicone. (Table 2, Fig 1).

Table-2. Chlorophyll a, Chlorophyll b and Total Chlorophyll (mg/l) some Cultivars of Soybeans on Silicon Application (75 DAP)

Treatment	Chlorophyll a	Chlorophyll b	Chlorophyll total
Cultivar			
V1 (Dering 1)	15,65	24,54	40,15 a
V2 (Wilis)	16,89	26,36	43,21 ab
V3 (Grobogan)	19,07	27,27	46,30 b
HSD 5 %	ns	ns	3,45
Silicon (Si)			
S0 (0 cc/l)	16,38	24,39	40,73 a
S1 (5 cc/l)	16,17	24,97	41,10 ab
S2 (10 cc/l)	17,03	28,23	45,23 bc
S3 (15 cc/l)	19,23	28,63	47,82 c
HSD 5 %	ns	ns	4,11

DAP: Days After Plant ; ns : non significant

The same letter shows no significant using of HSD at 5% probability level

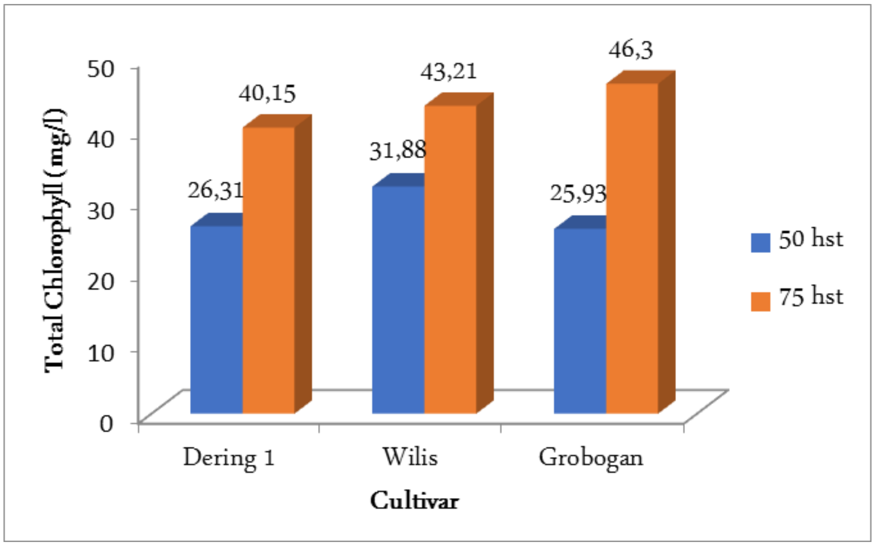

Figure 1. The development of chlorophyll levels of soybean cultivars

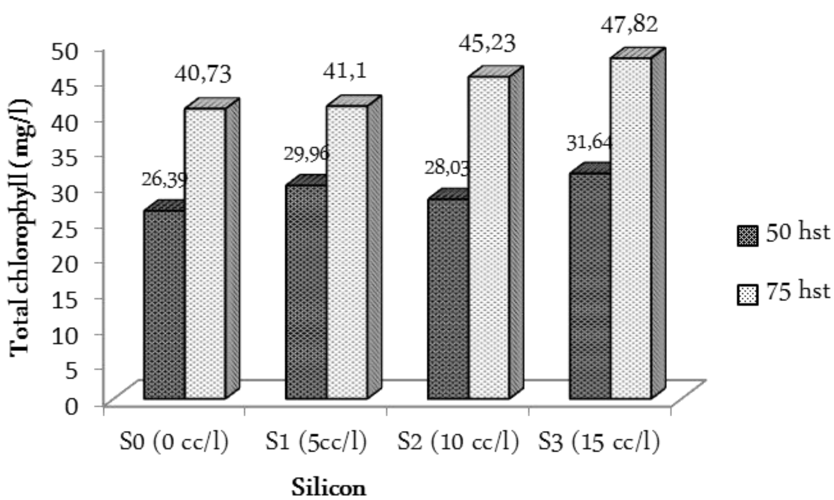

Figure 2. The influence of application of Silicon (Si) on the development levels of Chlorophyll

Physiologically plants that experienced a drought occurs the ABA biosynthesis process improvement (Abcisic Acid). The ABA is a hormone that is synthesized in the root, translocation to the leaves, and may also be synthesized by the cell guards itself (Assmann and Shimazaki, 1999). The ABA found on leaves, especially at the guard cells control the process of the closure of the stomata (Turner, 1986; Hartung, et al, 2002).

Based on the analysis Anova pointed out that the content of absisat acid (ABA) varies on each treatment cultivars and silicon applications although from both there is no significant interaction.

Soybean cultivars tested shows different response against drought stress, cultivars Dering 1 produce lowest Abcisic Acid than the Wilis and Grobogan, this indicates that Deri ng 1 more tolerant to drought stress (Table 3).

Table 3. Abscisic Acyd (ABA) leaf some Cultivars of Soybeans on Silicon Application (50 DAP)

Treatment	Content of ABA Leaf μg g^{-1}
Cultivar	
V1 (Dering 1)	0.31 a
V2 (Wilis)	0.34 ab
V3 (Grobogan)	0.38 b
HSD 5 %	0.04
Silicon (Si)	
S0 (0 cc/l)	0.44 c
S1 (5 cc/l)	0.42 c
S2 (10 cc/l)	0.35 b
S3 (15 cc/l)	0.17 a
HSD 5 %	0.05

DAP: Days After Plant; ns: non-significant
The same letter shows no significant using of HSD at 5% probability level

Liu (2004) explain that drought stress push changes to the ABA concentration in the plant so that the effect on growth and development of pea pods and loss while encouraging lower formation of legumes to 40 percent as well as lower the size of the seed. Table 3 above shows that fertilizer application of silicon is capable to pressing the increase of Absicic Acid.

CONCLUSION

1. Each of the soybean cultivars tested produce levels of chlorophyll a, chlorophyll b and total chlorophyll a varied, at 50 days after planting cultivar Wilis produces the highest chlorophyll at the age 75 days after planting the Grobogan cultivars highest. Cultivars Dering 1 produce ABA with lowest levels if compared with the Wilis and Grobogan.
2. The increasing application of Silicon fertilizer provided tend to increase levels of chlorophyll, 15 cc/l concentrations showed the highest levels of chlorophyll. Silicon (Si) are able to suppress the increased levels of ABA in plants that experienced drought stress.

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