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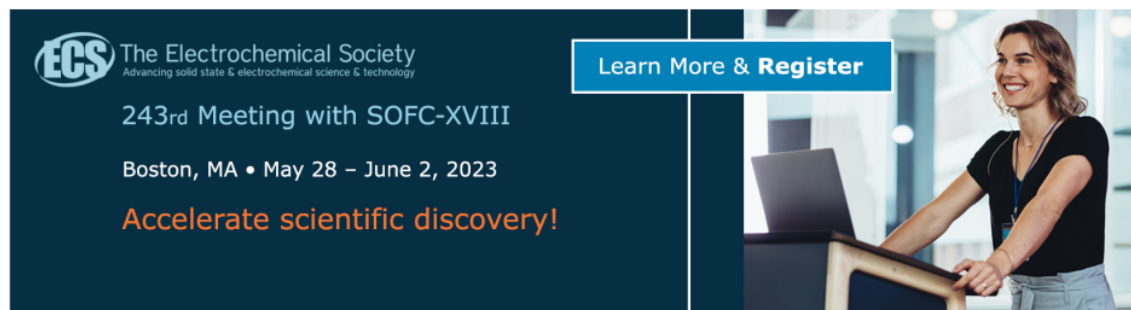
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Drought levels of several soybean's variety (*Glycine Max L. Merrill*)

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Abstract. Demand for soybeans in Indonesia is very high however, the domestic production is not sufficient enough for the community's needs for soybeans so it must be fulfilled through imports. The slow rate of soybean's production improvement in Indonesia caused by national low productivity that only reaches 1.30 tons/ha. While the potential increase in national soybeans can reach 2.2 million tons/ha. This research aims to find out some soybean varieties that are tolerant and sensitive to drought stress. This research was carried out at the Green House Cereals Plant Hall in Maros Regency, which began in July to October 2018. This research used factorial Randomized Group Design (RGD), Factor I is a soybean variety (V), consists of 4 varieties, namely : V1 = Tanggamus (tolerant to drought stress), V2 = Wilis variety (tolerant to drought stress), V3 = Anjasmoro variety (sensitive to drought stress), V4 = Argomulyo variety (sensitive to drought stress). The second factor is drought stress level (K) consists of 3 levels, namely: K1 = 80% field capacity, K2 = 60% field capacity, K3 = 40% field capacity. The results obtained that there is a decrease in all characters of the seed yield up to 50% along with the decrease in availability of groundwater in all tested varieties. The Tanggamus variety as a tolerant variety is still able to maintain several characters better than the other three varieties at 40% water availability, namely the number of pods, root length and stomata density. There are interactions between several soybean varieties and the level of drought stress on observations of plant growth and observation.

1. Introduction

Soybean (*Glycine max* L. Merrill) is a commodity that has commercial value and a good prospect to be developed because it is very much needed as a source of vegetable protein because it contains the most important oil because it contains the cheapest and most important source of protein produced worldwide [1]. Besides protein, soybeans also contain carbohydrates, fat, phosphorus, iron, calcium, vitamin B with a complete amino acid composition, so that the potential for the growth of the human body.

Demand for soybeans in Indonesia is very high, but domestic production is not sufficient for people's needs for soybeans so that it is met through imports. The slow rate of increase in soybean production in Indonesia is one reason for the low national productivity which only reaches 1.30 tons/ha. While the potential for national soybean increase can reach 2.2 million tons/ha [2]. One of the contributing factors is terrain and environmental degradation, both human activity and increasing natural disturbances. Much of the fertile land for agriculture switches to non-agricultural land. As a



result, agricultural cultivation activities shift to critical land (dry land) which requires high input and is expensive to produce food products per unit area [2].

Efforts to increase soybean crop productivity have been pursued through intensification and extensification. Increasing production through intensification is to increase seed yield per hectare, among others by improving crop cultivation systems, regulating the provision of appropriate water according to plants. Extensive increase in soybean production is through the addition of planting area by utilizing dry land.

Lack of water can inhibit the rate of photosynthesis because the turgidity of stomata guard cells will decrease. This causes the stomata to close. The closure of the stomata in most species due to lack of water in the leaves will reduce the rate of absorption of CO₂ at the same time and will ultimately reduce the rate of photosynthesis. Besides that stomata closure is a very important factor in protecting plants from severe drought stress [3]. One that also determines the nutrient absorption process for sub-optimal land (dry land) is the root system, where a good root system can increase nutrient absorption and penetrate solid soil (hardpan) so that it can increase soybean productivity (*Glycine max* L.) [4].

Soybean production is largely influenced by several abiotic pressures, and one of them is a drought factor which is the main environmental factor that limits soybean yields throughout the world as well as in the United States [5, 6].

One obstacle that can limit plant growth and production on dry land is the low availability of water because it requires more planting media that can hold water [7]. Another problem faced in using dry land is the low capacity of holding groundwater. In saturated soil conditions, when water precipitation exceeds the holding capacity of groundwater, water will occupy the pores of the soil, while water in drainage pores will mostly disappear as drainage water before it can be used by plants as a result of the very small holding power groundwater. So certain treatments are needed that can increase the holding power of the groundwater zone during rain and minimize or even prevent water loss from surface soil by evaporation. This study aims to find out some soybean varieties that are tolerant and sensitive to drought stress.

3 Research Methods

This research was conducted at the Green House of the Maros Cereal Crops Research Institute in June to October 2018. The research was arranged using a Randomized Group Design in factorial form. The first factor is soybean varieties (V), consisting of 4 types, namely:

V1 = Tanggamus variety (tolerant to drought stress)

V2 = Wilis variety (tolerant to drought stress)

V3 = Anjasmoro variety (sensitive to drought stress)

2 V4 = Argomulyo variety (drought sensitive)

The second factor is the level of drought stress (K) consisting of 3 levels, namely:

K1 = 80% of field capacity (1394 ml)

K2 = 60% field capacity (1046 ml)

K3 = 40% field capacity (697 ml)

(The amount of water available in the field capacity is 1743 ml).

Observations were conducted at various growing stages of soybean such as plant height, number of leaves, plant maturity, yield components and additional information. Statistical analysis was performed by using Tukey's HSD (honestly significant difference) test, a single-step multiple comparison procedure and statistical test. Analysis of data parameters were executed in SAS and SPSS software.

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3. Results and Discussion

The results showed that the variety and drought stress significantly affected all observed characters, the difference in response to the observed character was caused by the variety and level of water availability. The Tanggamus variety as a tolerant variety is still able to maintain several characters better than the other three varieties at 40% water availability, namely the number of pods, root length, stomata density.

Table 1. Average of soybean plant's height is 28 DAP at some varieties and Drought stress level

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1 (Tanggamus)	41,58	40,08	37,83	39,83 ^c	6,05
V2 (Wilis)	49,91	55,5	37,16	47,52 ^b	
V3 (Anjasmoro)	53,83	49,83	38	47,22 ^b	
V4 (Argomulyo)	76,16	70,5	56,66	67,77 ^a	
Average	55,37 ^a	53,97 ^a	42,41 ^b		

Value with the same letters and the same column were not significantly different from each other within treatments (one-way Anova Tukey's HSD test, $p=0.05$). DAP = day after planting

Table 2. The average number of Soybean Leaves is 28 DAP at some variety and drought stress level

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1 (Tanggamus)	32,50	33,50	32,00	32,67 ^{ab}	3,09
V2 (Wilis)	32,50	33,66	24,00	30,05 ^b	
V3 (Anjasmoro)	35,50	37,00	27,00	33,17 ^a	
V4 (Argomulyo)	29,00	30,00	24,00	27,67 ^c	
Average	32,37 ^b	33,54 ^a	26,75 ^c		

Value with the same letters and the same column were not significantly different from each other within treatments (one-way Anova Tukey's HSD test, $p=0.05$).

The results showed that the provision of 80% of available water could spur the increase in plant height, while 40% water stress showed the lowest plant height due to lack of water supply in the root area and the rate of evapotranspiration that exceeded the rate of water absorption by plants, according to [8]. Stating the provision of water under the optimum conditions for plants will result in stunted plant growth, ie plants will become stunted or late to enter the next vegetative phase and reduce the number of pods, number of seeds, seed weight, the weight of 100 seeds and multiple empty pods. The same is found by [9] that drought stress conditions at the vegetative stage can reduce plant height and leaf area.

Providing 80% of available water reduces the potential for empty pods, this is due to the water supply in plants is sufficient for metabolic processes and plant physiological processes. Lebi continued [10] explains that drought stress at flowering causes flower loss, drought stress at pod formation stage will cause the number of pods to fall in number and loss, and drought stress at pod filling stage causes decreased number of pods and seed size.

Table 3. Soybean maturity in several varieties and drought stress levels

Varieties	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1(Tanggamus)	84	83	89	85,33 ^a	4,5
V2 (Wilis)	82	78,33	86	82,11 ^{ab}	
V3 (Anjasmoro)	78,66	77,33	83	79,66 ^b	
V4 (Argomulyo)	76,66	76	80	77,55 ^{bc}	
Average	80,33 ^b	78,66 ^{bc}	84,5 ^a		

Value with the same letters and the same column were not significantly different from each other within treatments (one-way Anova Tukey's HSD test, $p=0.05$).

Furthermore [11] said that drought stress in the early stages of soybean plants causes a reduction in yields of up to 10%. In the early stages of flowering and the initial filling of pods, there will be a loss in the lower pods. In addition, soybean are very sensitive to drying soil and this can have a negative effect on grain yield.

Table 4. Average number of soy pods in some variety and drought stress level

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1	47,25	33,42	16,62	32,42 ^a	4,82
V2	19,08	32,62	16,12	22,66 ^{bc}	
V3	42,12	29,08	14,50	28,56 ^{ab}	
V4	24,83	16,50	13,75	18,36 ^c	
Average	33,32 ^a	27,90 ^b	15,24 ^c		

Value with the same letters and the same column were not significantly different from each other within treatments (one-way Anova Tukey's HSD test, $p=0.05$).

According to [12], drought stress encourages changes in ABA (abscisic acid) in plants so that it affects growth and development and encourages pod loss to reduce pod formation by 40% and reduce seed size. Further [13], states that lack of water in the period of pod formation and seed filling can inhibit pod formation, shed pods formed, reduce the number of seeds [14]. reported that the sufficient water during vegetative stage and the lower volume of water during generative stage (flowering and ripening of seed stages) increased the production of soybean.

Table 5. Average number of seeds per plant in several varieties and drought stress levels

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1(Tanggamus)	79	55,25	16,37	50,20 ^a	3,01
V2 (Wilis)	61,62	69,62	25,00	52,08 ^a	
V3 (Anjasmoro)	72,87	58,50	21,75	51,04 ^a	
V4 (Argomulyo)	45,75	33,87	17,75	32,45 ^b	
Average	64,81 ^a	54,31 ^b	20,21 ^c		

Value with the same letters and the same column were not significantly different from each other within treatments (one-way Anova Tukey's HSD test, $p=0.05$).

Table 6. Average seed weight per plant in several varieties and drought stress levels

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1(Tanggamus)	8,25	4,29	1,40	4,64 ^b	0,97
V2 (Wilis)	7,58	9,00	1,33	5,97 ^{ab}	
V3 (Anjasmoro)	10,08	6,83	3,12	6,67 ^a	
V4 (Argomulyo)	7,12	5,25	2,01	4,79 ^b	
Average	8,25 ^a	6,34 ^b	1,96 ^c		

Value with the same letters and the same column were not significantly different from each other withintreatments (one-wayAnovaTukey's HSD test, $p=0.05$).

Drought stress with the provision of 60% of water is available earlier than the provision of other available water, this occurs because the water needs of soybean plants in the seed maturity phase are less than 50% compared to the pod filling phase which is 85% so that the potential for this medium for seed maturity or earlier harvest time. Soybean plants are actually quite tolerant of drought stress because they survive and produce if drought stress conditions are a maximum of 50% of the field capacity or optimal soil conditions. During the cooking season, soybean plants require dry environmental conditions to obtain good quality seeds. Dry environmental conditions will encourage faster seed ripening and uniform seed shape [15]. Next [16], states that during drought stress there is a decrease in photosynthesis caused by stomatal closure and a decrease in electron transport and phosphorylation capacity in leaf chloroplast.

Table 7. Average soybean root length in several varieties and drought stress levels

Variety	Drought stress level			Average	HSD 0,05
	K1	K2	K3		
	80%	60%	40%		
V1(Tanggamus)	24,50	26,00	21,00	23,83 ^a	2,30
V2 (Wilis)	25,00	21,33	17,33	21,22 ^b	
V3 (Anjasmoro)	21,33	21,33	18,33	20,33 ^b	
V4 (Argomulyo)	21,00	18,33	17,00	18,77 ^c	
Average	22,95 ^a	21,74 ^a	18,41 ^b		

Value with the same letters and the same column were not significantly different from each other withintreatments (one-wayAnovaTukey's HSD test, $p=0.05$).

Table 8. Average of production per hectare on several varieties and drought stress levels

Variety	Drought stress Level			Average	NP BNT 0,05
	K1	K2	K3		
	80%	60%	40%		
V1	1,03	0,54	0,18	0,58 ^b	0,97
V2	1,13	0,95	0,12	0,73 ^{ab}	
V3	1,26	0,85	0,4	0,83 ^a	
V4	0,89	0,66	0,25	0,60 ^b	
Average	4,31 ^a	3,00 ^b	0,95 ^c		

Figure 1 shows that the highest density of leaf stomata of soybean plants was obtained by a combination of variety Wilis treatments with Drought stress level of 60% water available (V2K2). While the average density of leaf stomata from the lowest soybean plants was obtained by a

combination of the treatment of Anjasmoro variety with Drought stress level at giving 40% of available water (V3K3).

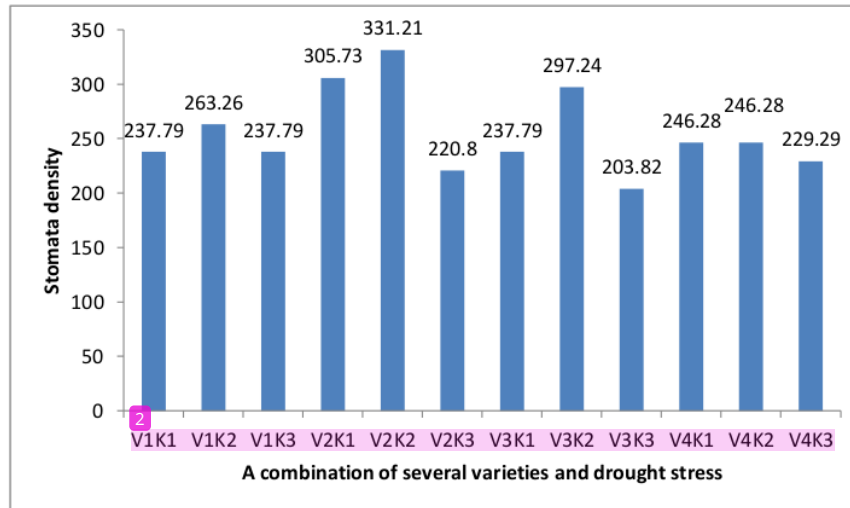


Figure 1. Average Soybean Stomata Density in Some Varieties and Drought stress level

4. Conclusion

1. There is a decrease in all the characteristics of the components of the seeds up to 50% along with the decrease in availability of water in the soil in all tested varieties, namely : Tanggamus 1.03 tons / ha 80% of field capacity, 0.54 tons / ha (60% of field capacity) and 0.18 tons / ha (40% of field capacity). Wilis 1.13 tons / ha (80% of field capacity), 0.95 tons / ha (60% of field capacity) and 0.12 tons / ha (40% of field capacity). Anjasmoro 1.26 tons / ha (80% of field capacity), 0.85 tons / ha (60% of field capacity) and 0.4 tons / ha (40% of field capacity). Argomulyo 0.89 tons / ha (80% of field capacity), 0.66 tons / ha (60% of field capacity) and 0.25 tons / ha (40% of field capacity).
2. The Tanggamus variety as a tolerant variety is still able to maintain several characters better than the other three varieties at 40% water availability, namely the number of pods 16,62 and root length, 21,0 cm.

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