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Behavior of Several Peanut Genotypes Under Sunlight and Water Deficit Condition

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Abstract: Drought and shade stress often occur together in peanut plants. Sunlight and water are the main factors that determine the growth of peanut plants. This study aimed to determine the behavior of several peanut genotypes under conditions of sunlight and water deficit. This research was conducted using a Completely Randomized Design-Split Plot Design with three replications. The treatments to be tested were double stresses (sun light and water deficit) and no stress (control) factors as the main plot and peanut genotype factors, namely Takar-1, Domba, Bison, G2T5, and G19-UI as subplots. The results showed that the peanut genotypes had different behaviors under double stresses (sunlight and water deficit). Peanut plants under double stress caused a reduction in pod dry weight, number of pods, root dry weight, and chlorophyll-a levels compared to those without stress. Peanut genotype G19-UI resulted in the lowest percentage reduction in pod dry weight and number of pods per plant, namely 58.79% and 43.75% under double stresses, respectively.

Keywords: Fotosynthesis; Proline; Stomata

Introduction

Peanut (*Arachis hypogaea* L.), a widely grown legume, food, and oilseed crop, is sensitive to drought and shade (Reddy *et al*., 2003; Prasad *et al*., 2003). More than twothirds of the peanut crop worldwide is rainfed, and drought stress often threatens crop productivity (Rao *et al*., 2001). It has been estimated that annually >30% of peanut yield losses worldwide are attributed to drought and shade (Subbarao *et al*., 1995). Peanut plants planting is usually carried out as an intercrop (intercropping) between plantation crops or other secondary crops (Hemon and Sumarjan, 2015). Dry land conditions and intercropping cultivation systems often cause problems in peanut farming, especially water deficit problems (drought stress) (Singh *et al*., 2014) and sunlight deficits (shade stress). This problem has a very negative effect on peanut productivity. One of negative effect of shade stress is reduction photosynthetic process. A reduction in the photosynthetic may disturb the whole metabolic process required for plant growth and reproduction. In case of soybeans, this disruption can be observed since the vegetative stage like etiolation. Intense shade stress may deteriorate some physiological traits like photosynthesis efficiency, chlorophyll content, and chlorophyll a/b ratio. Shade stress can also affect behavior of traits linked to overall bean yield and its components like the number of filled pods, dry pod weight, and vegetative traits (Liu *et al*., 2015).

Water shortages need to be considered when cultivating peanuts on dry land because water is the main limitation for crop production. Plants under water stress usually exhibit poor growth, reduced leaf water contents, low turgor pressure (Tahi *et al*., 2007), and low transpiration rate (Ozenç, 2008). Prolonged drought impairs many plant cellular functions like protein synthesis, nitrogen assimilation, and cell membrane activity (Saneoka et al., 2004). Drought stress can also affect plant growth, especially on the morphological appearance and development of plants, cell development, physiology and biochemistry (Yoshiba *et a*l., 1997). In conditions of water deficit, the leaf area decreases compared to optimum conditions. Water stress causes a reduction in dry leaf and pod biomass of peanuts (Collino *et al*., 2000) and a decrease in pod dry weight is thought to be caused by the process of inhibiting gynophore initiation and elongation (Chapman *et al*., 1993). Drought stress also inhibits gynophore penetration and pod development, thereby reducing plant yields and the magnitude of the yield

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reduction really depends on the peanut cultivar (Jogloy *et al*., 1996). Other research also showed that Dry pegging zone soil delayed pod and seed development. Soil water deficits in the pegging and root zone decreased pod and seed growth rates by approximately 30% and decreased weight per seed from 563 to 428 mg (Sexton *et al*., 1997; Reddy *et al*., 2003).

The development of peanuts as an intercrop (intercropping) faces many obstacles, because the light intensity received by the plants will be low. Sunlight plays an important role in plant physiological processes, especially photosynthesis, respiration and transpiration. The low light received causes the rate of photosynthesis to be low and other metabolism is disrupted so that the formation of carbohydrates decreases, which in turn results in low results (Niinemets and Valladares, 2006).

Drought and shade stress often occur together in peanut plants. Light and water are the main factors that determine growth. Several studies have reported that changes in morphology, physiology, and biochemistry are caused by the combined effects of drought and shade (Aranda *et al*., 2005; Yin *et al*., 2013). Shade can reduce the effect of drought on plant seeds by reducing air temperature (Dai *et al*., 2009) so that leaf transpiration is reduced. Another opinion is that shade worsens the growth of seedlings affected by drought, because shade reduces root growth so that they are unable to capture water from the soil (Valladares and Pearcy, 1997).

The use of genotypes that are tolerant to the effects of drought stress and shade tolerant is an alternative for increasing peanut production. The use of tolerant genotypes in peanut cultivation in shade-drought stressed areas is more efficient and practical compared to other cultivation techniques. The research results of Hemon *et al*. (2018-2020) have obtained several F4 generation peanut lines resulting from crosses between shade-tolerant and drought-tolerant cultivars and the level of tolerance of these lines to multiple stresses at once (shade and drought) was not yet known. Hence this research aimed to determine the behavior of several peanut genotypes in conditions of sunlight and water deficit.

Method

Experimental Plan

The experimental design used was a Completely Randomized Split Plot Design. The treatment to be tested was the factor of double stress (sunlight deficit and water deficit) and no stress (control) as the main plot and the peanut genotype factor consisting of Takar-1, Domba, Bison, G2T5, and G19-UI. Each treatment was repeated 3 times.

Experimental Design

Polybags containing soil (10 kg) from the sieve are prepared in the greenhouse. The planting medium was fertilized with NPK Ponska compound fertilizer 3.2 g per polybag or 75 kg per hectare. Each polybag was planted with 2 seeds and the planting hole was sprinkled with Furadan 3G. The polybag placement was arranged so that the planting distance was 40x20 cm.

Peanut seeds were planted under double stress conditions (shade and drought stress) and others were planted under optimum conditions (control). Shading was provided from the start of planting the seeds using black paranet and the shade provided was 65% or the sunlight entering the planting was only 35%. Other peanut lines were treated with no shade or 100% sunlight shining on the peanut plants.

Drought stress treatment as follow: plants were watered to field capacity from the start of planting until 14 days of age. Field capacity was determined by pouring water into the planting medium until it was saturated. Water saturation was indicated by water dripping into the aeration holes at the bottom of the polybag. Drought stress treatment was given from 15 days after planting (DAP) to 85 DAP. When the plants were 15 DAP, some plants did not experience drought stress (plants in conditions of soil moisture and field capacity) and others were maintained in drought stress conditions as a result of reduced water supply.

Plants experiencing drought stress were watered to field capacity once every 4-7 days (the day after 70% of the leaves wilt and some of the leaves curl due to lack of water). Wilting symptoms begin to occur when the soil water content reaches (<60%) of field capacity, which is calculated based on the difference in weight of the amount of water poured to reach field capacity and when the plant begins to wilt. Drought stress treatment was given until the plants were 85 days old. The plants were then given field capacity conditions until the plants were harvested (Hemon, 2006).

Plant maintenance includes hilling, weed control, pest control, disease and watering. Plants at the age of 25 DAP were planted and while cleaning the weeds around the plants. Pest and disease control were carried out by spraying Bestfast 250 EC insecticide and Bestartop 250 SC fungicide. Water the plants according to treatment.

Result and Discussion

Peanut plants often experience problems due to a deficit of sunlight and water. Lack of sunlight and water occurs simultaneously at one time so that plants are unable to grow normally. Lack of light and water causes disruption of the processmetabolism, especially photosynthesis, so that plant growth is reduced (Min and Su, 2016).In Table 1, it can be seen that the double stress that occurred simultaneously (light and water deficit) caused a reduction in pod dry weight and pod number in all peanut genotypes. Lack of sunlight reaching the surface of plant leaves causes low photosynthesis rates so that the number and dry weight of pods becomes lower (Niinemets and Valladares, 2006). Lack of water causes a decrease in the transpiration process due to limited stomata opening so that the concentration of CO2 entering the cells is limited.

Table 1. Pod dry weight (g) per plant of several peanut genotypes under double stress

Genotype	Without stress	Double stress (sunlight + water deficit)	Percentage (%) reduction in pod weight due to double stress
Takar-1	19.3aA	6.5bA	66.32
Domba	21.0aA	8.3bA	60.48
Bison	18.7aA	6.5bA	65.24
G2T5	14.8bB	5.7bA	61.49
G19-UI	18.2aA	7.5bA	58.79

*) Numbers followed by the same small letter in the same row are not significantly different, and numbers followed by the same capital letter in the same column are not significantly different, on Duncan's test 5%

Lack of water and shade also inhibit gynophore penetration and pod development, thereby reducing plant yields (Jogloy *et al.*, 1996). Other research also shows that shade and lack of soil water reduce pod growth (Sexton *et al.*, 1997). Low light intensity during gynophore formation will reduce the number of gynophores. In addition, the low intensity of light during the pod filling period causes an increase in the number of empty pods.

Table 2. Number of pods per plant for several peanut genotypes under double stress

Genotype	Without stress	Double stress (sunlight + water deficit)	Percentage (%) decrease in pod number due to double stress
Takar-1	10.7aA	5.0bA	53.27
Sheep	9.0aA	5.0bA	44.44
Bison	12.8aA	4.7bA	63.28
G2T5	8.5aA	3.7bA	56.47
G19-UI	8.0aA	4.5bA	43.75

*) Numbers followed by the same small letter in the same row are not significantly different, and numbers followed by the same capital letter in the same column are not significantly different, on Duncan's test 5%

In Table 3 it can be seen that double stress causes peanut stem segments to be longer than without stress. A reduction in solar intensity causes stem elongation. Franklin (2008) suggests that plants will experience increased height at low light intensity as a response to seeking light. Even though there is a water deficiency, it turns out that plant behavior is more dominant in stem elongation due to the influence of shade.

Table 3. Stem segment length (cm) of several peanut genotypes under double stress

Genotype	Without stress	Double grip (sunlight + water deficit)
Measure-1	4.42bA	5.04aA
Sheep	2.73bA	5.63aA
Bison	3.63bA	4.92aA
G2T5	2.54bA	5.33aA
G19-UI	3.33bA	5.63aA

*) Numbers followed by the same small letter in the same row are not significantly different, and numbers followed by the same capital letter in the same column are not significantly different, on Duncan's test 5%

In Table 4 it can be seen that several peanut genotypes have shorter root growth under double stress compared to without stress. The Lamb peanut genotype (18.87%) resulted in a smaller reduction in root weight than other genotypes. Dry weight and root length are indicators of a plant's ability to survive conditions of water shortage. Shade stress will also reduce root growth, so that ultimately the processes of water absorption and photosynthesis are disrupted. The large number of long roots will help absorb water for the plant growth process. According to Kusvuran (2011), drought stress can disrupt the permeability of root cell membranes, causing inhibition of plant growth, especially the root part of the plant, so that indirectly, water deficit can reduce root dry weight.

Table 4. Root dry weight (g) of several peanut genotypes under double stress

Genotype	Without stress	Double stress (sunlight + water deficit)	Percentage (%) reduction in root dry weight due to double stress
Measure-1	1.30aA	0.69bA	46.92
Sheep	1.06aA	0.86bA	18.87
Bison	0.98aA	0.52bA	46.94
G2T5	0.81aA	0.39bA	51.85
G19-UI	1.14aA	0.69bA	39.47

*) Numbers followed by the same small letter in the same row are not significantly different, and numbers followed by the same capital letter in the same column are not significantly different, on Duncan's test 5%

Peanut genotypes respond differently to multiple stresses to produce chlorophyll-a levels. Peanut genotypes that are tolerant to multiple stresses will produce higher levels of chlorophyll-a than sensitive genotypes. Chlorophyll formation is closely related to the availability of water and lightsun (Rezai *et al.*, 2018).

Table 5. Chlorophyll-a content (mg.L-1) of several peanut genotypes under double stress

Genotype	Without stress	Double stress (sunlight + water deficit)	Percentage (%) decrease in chlorophyll levels due to double stress
Measure-1	27.80aA	20.45bA	26.44
Sheep	26.48aA	21.34bA	19.41
Bison	26.57aA	22.63bA	14.83
G2T5	26.31aA	23.91bA	9,12
G19-UI	25.31aA	21.49bA	15.09

*) Numbers followed by the same small letter in the same row are not significantly different, and numbers followed by the same capital letter in the same column are not significantly different, on Duncan's test 5%

Conclusion

The results showed that peanut genotypes had different behavior under double stress (deficit of sunlight and water). Peanut plants that experienced double stress resulted in a reduction in pod dry weight, number of pods, root dry weight, and chlorophyll-a levels compared to those without stress. The peanut genotype G19-UI produced the lowest percentage reduction in pod dry weight and number of pods per plant, namely 58.79% and 43.75% respectively under double stress.

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Conflicts of Interest
The authors declare no conflict of interest

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