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Influence of water stress and cultivar on some characteristic of soy bean

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ABSTRACT: Plants are subjected to several rude environmental stresses that adversely affect their growth, metabolism, and yield. Drought is a meteorological term and defined as a stage without sufficient rainfall for crop growth and yield. The damage of yield under drought stress conditions depends on the soybean phonological phase, duration and intensity of drought. The field experiment was laid out split plot with randomized complete block design with three replications. Treatments included water stress (control, Water stress at flowering and grain filling) and Soybean Cultivars (PE, HT, V292, Sahar, M7, DPX, M9, Williams). Analysis of variance showed that the effect of cultivar on all characteristic was significant. Analysis of variance showed that the effect of water stress on biological yield and grain yield was significant.

Key words: Harvest Index, Biological yield, Grain yield

INTRODUCTION

Plants are subjected to several rude environmental stresses that adversely affect their growth, metabolism, and yield. Drought is a meteorological term and defined as a period without sufficient rainfall for crop growth and productivity. This limitation for water supply in agriculture is likely to increase in the future due to growth of population and economical sectors other than agriculture (Araus 2004). Soybean is considered a species sensitive to several abiotic stresses (Van Heerden and Krüger 2000), when compared with other tropical legumes, such as *Vigna unguiculata* and *Phaseolus vulgaris* (Roy-Macauley *et al.* 1992; Silveira *et al.* 2003), as well as others species as *Gossypium hirsutum*, *Sorghum bicolor* (Younis *et al.* 2000) and chickpea (Talebi *et al.* 2013). The worldwide importance of soybean and the main limitations to crop yields Because of its potential for large-scale production, soybean (*Glycine max* (L.) Merrill) has excelled in the world agricultural economy as a major oilseed crop. At present, soybeans are grown primarily for oil extraction and for use as a high protein meal for animal feed (Singh & Shivakumar, 2010). According to Li-Juan & Ru-Zhen (2010), soybean has a protein content of approximately 40% and an oil content of approximately 20%. In 2010, the area planted with soybeans worldwide was 102.4 million hectares, with total production of 261.6 million tons in the same year (Faoestat, 2012). This crop is currently being produced around the world, including in much of North America, South America and Asia. The U.S. and Brazil are the world's largest producers and exporters of soybean (Kumudini, 2010). The loss of productivity under water deficit conditions depends on the soybean phonological stage, duration and intensity of water shortages (Doss & Thurlow, 1974). Kron *et al.* (2008) evaluated the responses of soybean to water stress induced in different phases in the plants and concluded that plants subjected to water stress during the V4 stage showed an increased tolerance to water shortages in later stages. This stage was considered to represent a "developmental window" in soybean, characterized as a specific period during plant development when environmental disturbances can be embodied, thereby improving subsequent plant resistance to environmental changes (Kron *et al.,* 2008). The effects of water stress at various stages of development in soybean plants and found the average length of the internodes to be the most sensitive feature to drought imposed during the vegetative stages (V4) and flowering (R1-R3), and a reduction in plant height was associated with water stress induced in the V4 stage. The number of pods per unit of shoot dry matter was significantly affected by water deficits in the reproductive stages (R3-R5). When stress occurred during grain filling (R5), the characteristics of the plant that were most affected were the number of grains per pod and the grain weight. Rosolem (2005) notes that the water demand of soybean is highest at the initiation of flowering, but a water deficit from pod initiation (R3) until 50% yellow leaves (R7) is the most critical stage for productivity. In a study performed by the same author correlating rainfall with grain yields, it was found that when water restriction occurred between flowering and the emergence of pods, the grain yield of soybean was 1,275 kg ha^{-1}, but under no water limitation at this stage, there may be an increase in productivity of 3.8 kg ha^{-1} for each mm of rain.

Ground water level depth in paddy fields before planting may differ from year to year depending on rainfall in the latter part of the rainy season. Ground water depth has effects on the growth and yield of soybean after rice without irrigation. Photosynthetic rates, stomatal conductance, and yield were higher when ground water was at 60 cm depth below the surface as compared to depths lower than 60 cm (Sarwar, 2002). Ground water depth of 70 cm below the soil surface had higher grain yields and yield components as compared to depths of 40 cm (Shimada *et al.,* 1995).

MATERIAL AND METHODS

Location of experiment. The experiment was conducted at the zahak which is situated between 31° North latitude and 61° East longitude.

Composite soil sampling. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment. The field experiment was laid out split plot with randomized complete block design with three replications.

Treatments. Treatments included water stress (control, Water stress at flowering and grain filling) and Soybean Cultivars (PE, HT, V292, Sahar, M7, DPX, M9, Williams).

Data collected. Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

RESULTS AND DISCUSSION

A. Harvest Index

Analysis of variance showed that the effect of water stress on harvest index was not significant (Table 1). The maximum of harvest index of treatments control was obtained (Table 2). The minimum of harvest index of treatments Water stress at flowering and grain filling was obtained (Table 2). Analysis of variance showed that the effect of cultivar on harvest index was significant (Table 1). The maximum of harvest index of treatments HT was obtained (Table 2). The minimum of harvest index of treatments M7 was obtained (Table 2).

Table 1: Anova analysis of the soy bean affected by water stress and cultivar.

S.O.V	df	Harvest Index	Biological yield	Grain yield	Number of seed per pod
R	2	15.14^{ns}	15221.34^{ns}	58001.37^{ns}	0.083^{ns}
Water stress	1	89.434^{ns}	10879361.12^{*}	2330637.54^{*}	1.021^{ns}
Error a	2	8.166	417132.41	39960.86	0.083
Cultivar	7	133.614^{**}	1235733.03^{*}	536425.21	0.426^{*}
Stress* cutivar	7	13.754^{ns}	1304955.81^{*}	234729.51^{*}	0.21^{ns}
Error b	28	9.669	535587.30	75733.04	0.131
CV (%)	-	9.20	16.08	17.70	11.06

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

B. Biological yield

Analysis of variance showed that the effect of water stress on biological yield was significant (Table 1). The maximum of biological yield of treatments control was obtained (Table 2). The minimum of biological yield of treatments Water stress at flowering and grain filling was obtained (Table 2). Analysis of variance showed that the effect of cultivar on biological yield was significant (Table 1). The maximum of biological yield of treatments sahar was obtained (Table 2). The minimum of harvest index of treatments M7 was obtained (Table 2).

C. Grain yield

Analysis of variance showed that the effect of water stress on grain yield was significant (Table 1). The maximum of grain yield of treatments control was obtained (Table 2). The minimum of grain yield of treatments Water stress at flowering and grain filling was obtained (Table 2). Analysis of variance showed that the effect of cultivar on grain yield was significant (Table 1). The maximum of grain yield of treatments HT was obtained (Table 2). The minimum of grain yield of treatments M7 was obtained (Table 2).

D. Number of seed per pod

Analysis of variance showed that the effect of water stress on number of seed per pod was not significant (Table 1). The maximum of number of seed per pod of treatments control was obtained (Table 2). The minimum of number of seed per pod of treatments Water stress at flowering and grain filling was obtained (Table 2). Analysis of variance showed that the effect of cultivar on number of seed per pod was significant (Table 1). The maximum of number of seed per pod of treatments sahar was obtained (Table 2). The minimum of number of seed per pod of treatments M7 was obtained (Table 2).

Table 2: Comparison of different traits affected by water stress and cultivar.

Treatment	Harvest Index (%)	Biological yield (kg/h)	Grain yield (kg/h)	Number of seed per pod
Water stress				
control	35.17a	502.2a	1775.37a	3.42a
Water stress at flowering and grain filling	32.44a	4075.1b	1334.66b	3.12a
cultivar				
PE	33.53b	4960.7ab	1704.6ab	3.50ab
HT	40.03b	4632.3bc	1849.9a	3c
V_292	34.23b	4550.1c	1555.9bc	3.5ab
Sahar	32.79b	5170a	1692.3b	3.67a
M_7	23.44c	3629d	856.6d	3.33abc
DPX	35.23b	4411.7ab	1555.2c	3.17bc
M_9	35.54b	4445.8ab	1572.8bc	3c
Williams	35.67b	4609.5bc	1652.8b	3c

Any two means not sharing a common letter differ significantly from each other at 5% probability

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