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Effect of soil moisture stress at various growth stages on growth and productivity of summer groundnut (*Arachis hypogaea* L.) genotypes

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ABSTRACT

The field experiment was conducted in summer season on clay soil at Main Oilseeds research Station, Junagadh Agricultural University, Junagadh to study the effect of soil moisture stress at various growth stages on yield of summer groundnut (*Arachis hypogaea* L.) with six genotypes. Pooled analysis of data indicated that imposing a transient moisture stress significantly reduced the pod per plants, shelling, 100-kernal weight, harvest index and oil content. While, moisture stress at flowering and pod development stages by withholding irrigation does not affect the productivity of the groundnut crop significantly and save about 33.33 % of irrigation water by reducing the number of irrigations during summer season, but stress at flowering stage (25-47 days after sowing) and pod development stage (50-72 days after sowing) gave 18.45 % and 30.63 % reduction in pod yield than no moisture stress treatment, respectively. Different groundnut genotypes do not exerted their significant effect. The highest water use (84.35 cm) and benefit: cost ratio (2.42) was obtained under no moisture stress. While, maximum water-use efficiency (WUE) was achieved under water stress imposed at flowering stage. Among the genotypes GG 6 recorded higher water-use efficiency (WUE) and benefit: cost ratio. Groundnut was the most tolerant of post flowering stress among the different legumes.

Key words : Summer groundnut, Moisture stress, Genotype, Clay soil

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a major cash crop in the semi-arid tropics, where it is mostly grown under rainfed conditions. This is characterized by intermittent and occasionally by prolonged drought stresses. This affects one or more critical phenol phases of growth resulting in poor yield of groundnut. Water stress not only adverse affects the pod yield but also quality of seed (Ruker *et al*., 1995). In Gujarat, *Kharif* and summer season are cultivated on an area of about 20 lac hectares with an average production of 18 lac tones. The major constraint limiting groundnut yield is water stress, which varies in timing, intensity and duration understanding the physiological mechanisms imparting resistance to drought may provide some insight into identifying selection criteria for drought. The irrigations are the key factors in summer season for production technology, which need to be judiciously utilized for efficient and economic crop production. The development of high yielding and input responsive genotypes necessitated the study of their response to stimulated drought conditions. When water is scarce in summer season and information available on stimulated water stress of groundnut is scanty; hence, this investigation was carried out.

MATERIALS AND METHODS

A field experiment was conducted at Main Oilseeds research station, Junagadh Agricultural University, Junagadh during summer season of 2006 to 2008. The soil of the experimental plot was clayey in texture and slightly alkaline in reaction. The soil has an organic carbon content of 0.54 per cent and was medium in available nitrogen and potash and sulphur, low in phosphorus. The moisture content of the experimental plot at field capacity and permanent wilting point were 28.4 and 12.8 per cent, respectively, while the bulk density was 1.42 g cm^{-3}. The experiment was laid out in a split plot design keeping moisture stress, *viz.*, M_1:No moisture stress which follows regular irrigation; M_2:Moisture stress imposed at flowering stage(25-47 DAS) followed by regular irrigation; and M_3:Moisture stress imposed at pod development stage(50-72 DAS) followed by regular irrigation in Main plots and genotypes *viz.*, G_1:JBDR-5; G_2:JBDR-7; G_3:JBDR-64; G_4:ICGV-92121; G_5:GG-2; and G_6:GG-6 in sub - plots with three replications. Two common irrigation were given in (One before sowing and one after sowing) all the treatments for proper germination of the crop. A uniform depth of 6 cm irrigation was applied in all treatments, which was measured with Parshall flume. The different genotypes of groundnut were sown in the 1st week of February in all the three years at a spacing of 30 cm x 10 cm. The entire dose of fertilizers 25 $kgNha^{-1}$ and 50kg $P_2O_5ha^{-1}$ was applied basal as per recommendations. Normal cultural practices were followed during the growing season. Pod yield(kg/ha), haulm yield(kg/ha), numbers of pod/plant, shelling(%), 100-kernal weight(g), harvest index(%), dry matter(g) at 80 and 100 DAS and oil(%) were measured. Water use efficiency was calculated on the basis of pod yield/cm water used by the

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groundnut crop.

RESULTS AND DISCUSSION

The results obtained from the present investigation are summarized under following heads :

Yield attributes and yield :

Moisture stress at different growth stages of crop had a significant influence on yield attributes and oil component. Moisture stress at flowering stage recorded significantly higher yield attributes and oil content than at pod development stage; however, this treatment was at par with no- moisture stress treatment. While significant difference was not recorded in pod, haulm and biological yield. Differences were not found in yield might be due to groundnut plants compensate for an earlier drought period by initiating a flush of reproductive after the relief of the stress and water stress led to pods, shelling, 100-kernal weight and harvest index (Dutta and Mondal, 2006; Kumaga *et al*., 2003; Nageswara Rao *et al*., 1988). Between two stress treatment, stress given at flowering stage 18.45 % reduction in pod yield while, 30.63 % reduction due to stress imposed at pod development stage than no stress (normally irrigated) crop in pooled results. A temporarily soil moisture stress at flowering and pod development stages by withholding irrigation did not affect the pod, haulm and biological yield significantly, but it was detrimental in respect to pod yield (Table 1). Nageswara Rao *et al*. (1985) confirmed that irrigations could be withhold during much of the vegetative period without any apparent effect on pod yield, involving that water stress during vegetative stage has no effect on pod yield, implying that water stress during vegetative stage no effect no yield. Nautiyal *et al*. (1999) proved that soil moisture deficit for 25 days during vegetative phase was beneficial for growth and pod yield of groundnut, while Stirling *et al*. (1989) observed insensitivity of pod yield to early moisture deficit. Sivakumar and Sharma (1986) imposed drought stress or soil moisture deficit at all the growth phases of groundnut during three growing seasons observed that stress from emergence to pegging gave increased yield over control in all the three years while stress in other stages decreased the yield. Oil content of kernels was significantly decreased with increased the moisture stress. Dutta and Mondal (2006) reported that water stress due to withholding of irrigation at different stages of crop growth affects the oil content of groundnut; Shahid *et al*. (1997) also found that water stress affects the oil content of groundnut.

Effect of different genotypes/cultivars on shelling %, 100-kernal weight, and harvest index, dry matter at 80 and 100 DAS as well as oil content found significant. While pod per plant, Pod, haulm and biological yields were found non significant (Table 1).

Interaction between moisture stress and genotypes (MxG) remained un affected in regards to yield attributes and yield.

Water use and water-use efficiency :

Water use by the groundnut was highest under no moisture stress condition (84.35 mm) owing to supply of more irrigation water, but maximum water use efficiency (28.12 kg-ha/cm) was recorded with stress at flowering

Table 1 : Effect of moisture stress and genotypes on yield attributes and yield of groundnut (Pooled data of 3 years)

Treatments	Pods/plants	Shelling (%)	100-kernal weight (g)	Dry matter (g)		Pod yield (q/ha)	Haulm yield (q/ha)	Biological yield (q/ha)
				80 DAS	100 DAS			
Moisture stress								
M_1:No moisture stress	18.37	69.15	39.18	17.04	33.82	22.09	39.77	61.85
M_2:Stress at flowering stage	17.82	66.95	37.95	14.14	26.99	18.65	41.77	60.42
M_3:Stress at pod development stage	15.31	62.34	32.19	14.25	29.60	16.91	41.53	58.45
C.D. (P=0.05)	0.90	2.65	2.21	1.57	1.97	NS	NS	NS
Genotypes								
G_1:JBDR-5	18.05	68.21	36.22	14.62	25.17	18.76	39.27	58.03
G_2:JBDR-7	16.30	66.20	35.19	16.31	34.81	17.93	43.76	61.68
G_3:JBDR-64	18.00	69.70	36.15	14.56	28.11	19.49	40.34	59.83
G_4:ICGV-92121	17.32	68.35	35.37	16.84	35.21	18.53	46.44	64.97
G_5:GG-2	17.67	68.29	36.26	14.55	29.47	19.57	37.06	56.62
G_6:GG-6	18.24	68.63	38.20	13.98	28.04	21.02	39.27	60.29
C.D. (P=0.05)	NS	2.42	4.95	1.70	3.59	NS	NS	NS
Interaction(MxG)	NS	NS	NS	NS	NS	NS	NS	NS

NS = Non significant

Table 2 : Effect of moisture stress and genotypes on harvest index, oil content, economics and water use efficiency of groundnut (Pooled data of 3 years)

Treatments	Harvest index (%)	Oil content (%)	Net return (Rs/ha)	B:C ratio	No. of irrigation	Irrigation water (cm)	Total water use (cm)	Water use efficiency (kg-ha/cm)
Moisture stress								
M_1:No moisture stress	35.87	48.72	29940	2.42	12	72.00	84.35	26.19
M_2:Stress at flowering stage	30.91	47.53	25600	2.33	9	54.00	66.32	28.12
M_3:Stress at pod development stage	29.89	45.91	23630	2.37	9	54.00	66.21	25.53
C.D. (P=0.05)	5.27	1.46	-	-	-	-	-	-
Genotypes								
G_1:JBDR-5	32.02	46.20	21840	1.97	-	60.00	72.35	25.94
G_2:JBDR-7	29.33	47.24	20221	1.86	-	60.00	72.30	24.80
G_3:JBDR-64	33.01	48.50	23264	2.02	-	60.00	72.25	26.98
G_4:ICGV-92121	29.36	47.31	21510	1.90	-	60.00	72.24	25.65
G_5:GG-2	34.47	48.24	2300	2.05	-	60.00	72.32	27.06
G_6:GG-6	35.12	49.51	26247	2.16	-	60.00	72.12	29.15
C.D. (P=0.05)	2.08	1.27	-	-	-	-		-
Interaction(MxG)	NS	NS	-	-	-	-		-

NS = Non significant

stage (Table 2). Dutta and Mondal (2006) also reported increase in moisture supply leading to increase in water use and reduction in water-use efficiency of groundnut.

There was also variation found in water-use efficiency due to different genotypes (Table 2). Maximum water-use efficiency was recorded by genotype GG 6 (29.15 kg-ha/cm).

Economics :

No moisture treatment recorded maximum net return realized (29940 Rs/ha) and benefit: cost ratio (2.42) than both imposed stress treatments (Table 2). Genotype GG 6 gave more monetary return (26247 Rs./ha) and benefit: cost ratio (2.16) than other genotypes.

Present study indicates that imposing a transient moisture stress at flowering and pod development stages by withholding irrigation does not affect the productivity of the groundnut crop significantly and save about 33.33 % of irrigation water by reducing the number of irrigations during summer season. Groundnut is most tolerant of post-flowering water stress (Kumaga *et al.*, 2003). Thus, groundnut should recover from multiple drought conditions and still produce seeds as experienced in its large-scale cultivation in many semi-arid regions.

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