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Effect of Mid and End Season Moisture Stress on Growth Analysis and Seed Yield of Greengram Genotypes

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ABSTRACT

A field experiment was conducted during *rabi* 2010-11 to study the effect of mid and end moisture stress on growth analysis and seed yield of greengram genotypes .The results revealed that moisture stress at pod formation and maturity stage was more acute compared to mid stress at flowering in reduction of leaf area index, crop growth rate, net assimilation rate, leaf area duration, specific leaf area , harvest index and seed yield and yield components in greengram genotypes. Among the greengram genotypes tested, WGG37 and MGG357 recorded superior growth parameters and yield compared to other genotypes.

Key words : End moisture stress, Greengram, Growth analysis, Mid moisture stress, Net assimilation rate

Drought is complex phenomenon and always coupled with moisture and high temperature stress. Plants responded to drought by initiating a number of developmental, physiological biochemical and molecular changes. Plants have developed a number of strategies to cope with the physiological (Nageswarao *et al* 1994) and water use efficiency (Latha 2004) traits contributing to drought tolerance were reported. However, such traits in greengram genotypes were less explored. Moisture stress at flowering and podding stages is most common in southern zone of Andhra Pradesh and reported to reduce the yield and harvest index significantly. Under such situations , identification of genotypes with higher water use efficiency and seed yield is necessary for growing under rainfed conditions. Net assimilation rate is an index of photosynthetic efficiency which shows positive association with photosynthetic rate and grain yield. A significant positive correlation was obtained between the leaf area duration (LAD) during post flowering and yield which was earlier reported by Niljhwan and Chandra (1980) .Hence ,the present investigation was planned to study the effect of mid and end season moisture stress on growth and seed yield in greengram genotypes.

MATERIAL AND METHODS

A field experiment was conducted in wet land farm of S.V.Agricultural College Tirupathi in factorial randomized block design replicated thrice during late *rabi* 2010-11. There are three main treatments ,T_0 –adequately irrigated (control) ,T_1 – stress imposed at flowering (30-45DAS) ,T_2 – stress imposed at pod formation and maturity stage (45-60 DAS) and seven sub treatments consists of greengram genotypes (LGG 460, TM 96-2,WGG 37,MGG 347,MGG 348,MGG 357,MGG 360).The crop was sown with a spacing of 30x10cm on 7^{th} of January 2011. Recommended dose of fertilizers were applied .The water stress was imposed at flowering stage (30-45 DAS) and pod formation and maturity stage (45-60DAS). Prophylactic measures were taken for protection of crop from diseases and pests. Destructive analysis of plant samples was done at 10 days interval. For this purpose three plants from each treatment or each plot were dug out along with roots and separated into leaf, stem, root and pod and dried in hot air oven at 80^{0c} for 48hours.Leaf area was measured by LICOR3000 leaf area meter and leaf area index was computed on the basis of leaf area per unit ground area .The growth parameters were computed from leaf area and dry matter as per the formulae given by Radford(1967).The data on seed yield and yield components were recorded at the time of harvest.

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Table 1 Effect of mid and end season moisture stress on Leaf area index, crop growth rate and net assimilation rate of greengram genotypes (At maturity)

Genotypes	Leaf area index				Crop growth rate (g m^{-2} day^{-1})				Net assimilation rate(g dm^{-2} day^{-1})			
	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean
LGG 460	0.90	0.74	0.70	0.78	2.90	2.90	1.45	2.41	0.261	0.241	0.164	0.177
LGG 96-2	0.86	0.86	0.58	0.76	2.40	2.14	2.73	2.42	0.954	0.148	0.166	0.154
LGG 37	1.27	0.98	0.66	0.97	3.63	3.82	4.25	3.90	0.254	0.429	0.228	0.303
MGG 347	0.89	0.70	0.53	0.70	3.92	3.03	2.11	3.02	0.347	0.179	0.379	0.240
MGG 348	0.92	0.67	0.63	0.74	4.98	2.11	7.29	4.79	0.408	0.287	0.154	0.228
MGG 357	1.15	1.00	0.90	1.01	4.81	6.66	4.25	5.24	0.330	0.645	0.222	0.412
MGG 360	1.06	0.93	0.61	0.86	7.62	4.68	2.60	4.96	0.612	0.327	0.207	0.338
Mean	1.00	0.84	0.65	-	4.32	3.62	3.52	-	0.452	0.322	0.217	-
CD at 5%	T	G	TXG		T	G	TXG		T	G	TXG	
	0.010	0.016	0.028		0.238	0.364	0.631		0.051	0.61	0.045	

T_0: Control (Irrigated)
T_1: Moisture stress at flowering
T_2: Moisture stress at pod formation and maturity stage

Table 2. Effect of mid and end season moisture stress on Leaf area duration, specific leaf area and harvest index of greengram genotypes (At maturity)

Genotypes	Leaf area duration ($Cm^2 day^{-1}$)				Specific leaf area (cm^2g^{-1})				Harvest index (%)			
	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean
LGG 460	11.64	10.41	9.22	10.42	100.1	101.2	94.0	98.43	36.40	35.40	35.30	35.70
LGG 96-2	9.58	9.34	6.98	8.63	75.0	81.0	68.9	74.96	35.90	33.40	34.10	34.46
LGG 37	14.40	11.94	10.13	12.15	86.6	85.0	86.6	86.06	40.40	36.50	36.30	37.73
MGG 347	11.60	10.26	8.52	10.12	86.0	95.8	87.2	89.66	37.10	35.40	33.40	35.30
MGG 348	12.38	10.23	8.37	11.40	92.2	86.7	73.9	84.26	36.40	36.20	35.70	36.10
MGG 357	13.93	11.92	10.81	12.22	91.7	84.0	81.6	85.76	42.10	40.60	40.50	41.06
MGG 360	12.67	11.39	9.02	11.02	86.0	89.2	86.1	87.10	38.20	35.40	34.50	36.03
Mean	12.31	10.78	9.00	-	88.2	88.9	82.6	-	38.07	36.12	35.68	-
CD at 5%	T	G	TXG		T	G	TXG		T	G	TXG	
	0.30	0.18	0.31		0.300	0.458	0.794		0.098	0.150	0.260	

T_0: Control (Irrigated)
T_1: Moisture stress at flowering
T_2: Moisture stress at pod formation and maturity stage

Table 3. Effect of mid and end season moisture stress on yield and yield components of greengram genotypes (At maturity)

Genotypes	Pods plant^{-1}				No.of seeds pod^{-1}				Pod length (Cm)				Seed yield (Kg ha^{-1})			
	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean	T_0	T_1	T_2	Mean
LGG 460	13.00	11.80	12.70	12.50	10.90	10.60	10.50	10.60	7.80	6.80	6.80	7.13	839	642	516	665
TM 96-2	12.40	10.10	11.10	11.20	10.40	8.40	10.20	9.66	7.10	6.70	5.50	6.43	350	538	308	399
WGG 37	18.10	16.00	14.40	16.16	13.00	11.10	10.50	11.53	8.70	7.20	7.40	7.76	1435	1138	1016	1202
MGG 347	14.20	11.20	11.30	12.23	10.60	9.60	8.00	9.40	7.30	5.70	5.50	6.16	758	728	668	718
MGG 348	16.20	14.60	13.90	14.90	11.40	11.10	10.20	10.90	7.90	7.10	7.10	7.36	872	796	893	854
MGG 357	17.40	15.20	14.90	15.83	12.10	12.00	11.00	11.70	8.10	7.40	7.30	7.60	1290	1196	1218	1235
MGG 360	15.00	14.00	13.00	14.00	11.00	10.60	10.00	10.53	7.60	6.90	6.90	7.13	868	739	876	828
Mean	15.18	13.27	13.04	-	11.34	10.61	10.05	-	7.78	6.82	6.64	-	916	825	785	-
CD at 5%	T	G	TXG	-	T	G	TXG	-	T	G	TXG	-	T	G	TXG	-
	0.130	0.360	0.208	-	0.036	0.096	0.0550	-	0.213	0.326	0.570		11.98	18.30	31.70	-

T_0: Control (Irrigated)
T_1: Moisture stress at flowering
T_2: Moisture stress at pod formation and maturity stage

RESULTS AND DISCUSSION

Production and maintenance of leaf area is important for drymatter production and yield. Significant differences were observed between genotypes and moisture stress treatments and their interaction regarding the leaf area index (Table1). Imposed moisture stress at pod formation and maturity stage reduced the LAI to the extent of 35% and followed by flowering stage (16%) compared to control. Leaf area index was more sensitive for moisture stress at post flowering phase compared to flowering stage .Among the genotypes tested, WGG 37 and MGG 357 maintained the maximum leaf area index. These genotypes also recorded higher leaf area and drymatter accumulation under irrigated control. MGG 347 ,MGG 348,LGG 460 and MGG 360 recorded moderate LAI where as TM 96-2 recorded lowest LAI .Similar significant differences among genotypes under irrigated as well as moisture stress was reported in chickpea (Mate *et al* 2003) and in greengram (Gosami *et al* 2003).

Crop growth rate (CGR) is the product of leaf area index and net assimilation rate .Significant differences were observed between moisture stress treatments, genotypes and interactions regarding crop growth rate (Table1). Imposition of moisture stress at flowering stage (30-45 DAS) caused significantly reduction in CGR to the extent of 6.2% where as 18.5%was recorded at pod formation and maturity stage compared to control. These results revealed that moisture stress at pod filling and maturity stages were more sensitive in greengram as in the case of LAI.Among the genotypes, MGG 357 and WGG 37 also recorded highest CGR compared to other genotypes.TM 96-2 recorded lowest CGR where as MGG 348, MGG 360, MGG347 and LGG 460 recorded moderate crop growth rate. Similar significant differences between genotypes under irrigated as well as under moisture stress treatments were reported in greengram (Gosami *et al* 2003) and in chickpea (Tejpal Singh *et al* 2003). Further, Premachandra *et al.,* (1987) attributed such cultivar differences under stress conditions to their ability to maintain photosynthesis and osmotic adjustment.

Significant differences were observed between moisture stress treatments, genotypes and interaction regarding net assimilation rate (NAR) (Table 1). Moisture stress at pod formation and maturity stage significantly reduced the NAR compared to moisture stress at flowering stage. Net assimilation rate is an indirect measurement of photosynthetic activity was also affected in end stress compared to imposition of moisture stress at flowering similar to CGR. Decreased crop growth rate and NAR can be attributed to poor drymatter accumulation and partitioning in moisture stress conditions, especially at post flowering stage. The genotypes MGG 357 and WGG 37 recorded higher NAR where as MGG 347 ,LGG 460 and MGG 360 recorded moderate NAR and TM 96-2 recorded low NAR values similar to CGR values .These results ,further establishes superiority of MGG 357 and WGG 37 maintained higher photosynthetic activity under irrigated as well as moisture stress conditions compared to other genotypes which shows their capabilities in maintaining chloroplast integrity at moisture stress conditions .Similar differences between genotypes under irrigated as well as moisture stress was reported in Faba bean (Zarghami,1994).

Leaf area duration (LAD) denotes leafiness of crop till harvest .Significant differences were observed between genotypes, moistures stress treatments and their interactions regarding LAD (Table 2). Moisture stress at flowering stage significantly decreased LAD to the extent of 12.42% where as at pod formation and maturity stage it was 26.8% compared to control. Current photosynthesis reported to be important in pulses thus leafiness at pod filling is important. However, moisture stress at pod filling affecting the LAD in green gram genotypes .Among the genotypes, WGG 37 and MGG 357 recorded highest LAD than other genotypes .TM96-2 recorded lowest LAD .MGG 360, MGG 347, LGG 460 and MGG 348 recorded moderate leaf area duration .The superior genotypes WGG 37 and MGG 357 also possess higher leafiness compared to other genotypes and thus proved efficient in current photosynthesis and higher seed filling characters. Similar significant differences between genotypes under irrigated as well as moisture stress were reported in greengram (Gosami *et al* 2003) and in chickpea (Mate et al 2003).

Significant differences were observed between moisture stress treatments, genotypes and interaction regarding specific leaf area (SLA) (Table 2). Due to imposition of moisture stress at flowering stage 30-45 DAS, SLA was significantly decreased. The extent of decrease was 5.8% at 45DAS .Imposition of moisture stress at pod formation and maturity stage (45-60DAS) significantly decreased the SLA by 6.34% at 60DAS.Such decrease in SLA values under water stress conditions was reported by Latha (2004) in groundnut and Sudhakar *et al* (2006) in blackgram . Water deficit may have influenced leaf thickness by increasing number of chlorenchyma cells and chloroplasts per unit leaf surface area (Nobel 1991). The genotype MGG 357 recorded lowest SLA values followed by WGG37 compared to all other genotypes .Wright *et al* (1994) reported if SLA is lower the leaf thickness would be more and hence the capacity of photosynthesis would be higher and thus these genotypes recorded high NAR values also. Wright *et al* (1994) reported an inverse relationship between SLA and WUE, thus indicating genotypes with thick leaves (low SLA) under moisture stress conditions may be water use efficient.

Harvest index is one of the major component for higher grain yield. Significant differences were noticed between moisture stress treatments ,genotypes and their interaction regarding harvest index (Table 2) .Due to the imposition of moisture stress at flowering stage (30-45DAS) and pod formation and maturity stage (45-60DAS) ,mean harvest index was significantly decreased .The extent of decrease was more pronounced at pod formation and maturity stage (6.27%) and less at flowering stage (5.12%) compared to control ,which indicated that moisture stress affected partitioning of photosynthates .These results are conformity with the reports in chickpea by Sharma (2007) and in guar by Anupam chakraborty (2007) .Among the genotypes ,MGG357 recorded highest harvest index (41.06%) followed by WGG 37 (37.73%) compared to other genotypes .MGG348, MGG360 and LGG460 recorded moderate harvest index ,where as MGG347 and TM96-2 recorded lowest harvest index. The higher harvest index of these genotypes represents an increased physiological capacity to mobilize photosynthates and translocate them efficiently to organs of economic value as opined by Wallace *et al* (1972).

Significant differences were noticed between moisture stress treatments, genotypes and their interaction with regard to number of pods per plant, pod length, number of seeds per pod and seed yield (Table 3) .The yield and yield components were significantly reduced due to the imposition of stress at both flowering and pod formation and maturity stages. Imposition of moisture stress at pod formation and maturity stage showed higher reduction of number of pods (14.1%) , number of seeds per pod(9.1%) ,pod length (14.65%) and seed yield (14.3%) compared to flowering stage (12.6,3.6,12.3,9.92%)respectively . These results were in conformity with reports in chickpea by Luftfor Rahman (2000) and Anupam Chakraborty (2007) in guar. These results clearly indicates that moisture stress during sensitive growth stages i.e flowering and pod fillings stage are detrimental to pod growth and effect was more pronounced at terminal stress.

The genotypes MGG 357 and WGG 37 maintained higher seed yield of 1235kg ha^{-1} and 1202 kg ha^{-1} respectively compared to other genotypes . MGG 348, MGG 360 and MGG 347 recorded moderate seed yield, where as LGG 460 and TM 96-2 recorded lowest seed yield similar to pod yield. The genotypes MGG 357 and WGG 37 recorded highest drymatter, leaf area ,number of pods per plant ,number of seeds per pod ,pod length and harvest index .Thus maintained higher seed yields under irrigated as well as moisture stress conditions . From these results it can be conclude that MGG357 and WGG37 recorded higher values of growth parameters and seed yield in greengram.

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