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Physiological Parameters in Relation to Drought Tolerance in Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Field experiment was conducted with nine chickpea genotypes during three successive *Rabi* seasons of 2007, 2008 and 2009 at Regional Agricultural Research Station, Nandyal to identify high yielding chickpea genotypes with tolerance to drought. Pooled analysis of variance indicated that highly significant differences was observed among the genotypes for yield and drought tolerant parameters. The highest mean seed yield was recorded in Vijay (1011 kg/ha) followed by JAKI-9218 (977 kg/ha) and JG-11(968 kg/ha). Genotype JAKI-9218 (63%) and JG-11 (62%) also recorded higher relative water content. Higher proline content was recorded at filling stage in all genotypes. Apart from high prolne content (3.13 µ mol per g tissue) , the genotype JAKI-9218 has high RWC and SCMR . JG-11 also recorded high RWC Where as Vihar, a kabuli genotype exhibited higher SCMR .Higher SPAD chlorophyll Meter values at 60 DAS were recorded in JAKI-9218 (45) and Vihar (45). JAKI-9218 also recorded higher value of SPAD chlorophyll Meter reading at 30 DAS and comparatively higher proline content (3.13 µ mol per g tissue). Thus these promising genotypes identified for various drought tolerance and yield attributes can be exploited further in breeding programmes in order to develop high yielding drought tolerant chickpea genotypes.

Key words : Chickpea, R.W. C, Proline, Seed yield, SPAD chlorophyll meter readings.

India is one of the major pulse growing countries in the world , accounting for roughly one third of the total area under pulses and one fourth of the total world production (Anonymous 1999.) Among the pulses , chickpea (*Cicer arietinum*) is the most important crop representing about 27 % of the land area under pulses, which contributes 33percent of the pulse production in India. (Anonymous 2000) .Chickpea is cultivated as post rainy season crop in Andhra Pradesh. The crop is grown either on receeding soil moisture conditions or with irrigation. Productivity of chickpea is directly associated with avaivalable moisture in the soil. Since the crop is sown on stored soil moisture , there is every likely hood that it may be asffected by drought during the growing season .There is a great variability among genotypes for yield performance under drought conditions. (Upreti and sirohi 1985). Hence, an attempt was made to evaluate the performance of chickpea determine the indices of drought tolerance and its relationship with yield. Moisture stress increase total sugar, soluble protein and free amino acid content in chickpea cultivars and was positively correlated with tolerance to moisture stress(Yadav *et al.,* 1996). Proline is the one of the important osmolights which accumulates during moisture stress condition. It helps to maintain turgor and promotes continued growth in low water potential soils (Yadav and Khare 1995, Mullet and Whitsitt 1996).

MATERIAL AND METHODS

An experiment was conducted in Randomized Block Design with three replications during rabi 2007-08, 2008-09 and 2009-10. During 2007-08, 67.7 mm of rainfall was received in 8 rainy days , 14 mm of rainfall in 1 rainy day in 2008-09 and 53.7 mm of rainfall in 1.9 rainy days in 2009-10. The genotypes were sown with a spacing of 30x10 cm and a fertilizer dose of 20 kg N and 50 kg P_2O_5 /ha was applied as basal . Leaf samples at flowering and pod filling stages for estimation of Relative Water Content (RWC) ,proline content and SPAD chlorophyll meter reading were collected . The RWC was calculated by the following formulae.

$$RWC\ \% = \frac{FW - DW}{TW - DW} \times 100$$

Where FW = Fresh weight ,
TW= Turgid weight, Dw =Dry weight.

The leaf proline content was estimated by using the fully expanded leaf from top to fifth as per the method described by Bates et al (1973) .The data was analysed (Panse and sukhatme,1978)

RESULTS AND DISCUSSION

There was significant difference in yield (Table 1). Highest mean seed yield was recorded in Vijay (1011 kg/ha) followed by JAKI-9218 (977 kg/ha) and JG-11(968 kg/ha).Haulm yield was significantly influenced by the different varieties.

Table 1. Yield parameters in relation to drought tolerance in chickpea during Rabi – 2007-09 (Polled analysis).

Treatments	Total Biomass (Kg/ha)	Seed Yield (Kg/ha)	Haulm (kg/ha)	Harvest Index (%)	100 Seed Weight (g)
T1: Vihar	1787	845	924	47	24
T2: JG-11	1827	968	859	53	24
T3: PKV2	1484	748	702	52	32
T4: LBeG – 7	1514	779	629	57	29
T5: ICCV – 37	1378	708	680	51	19
T6: Annegiri	1626	826	781	52	18
T7: JGK2	1497	717	700	53	30
T8: Vijay	2068	1011	995	52	16
T9: Jaki 9218	1983	977	969	52	22
SEm±	82.67	52.2	66	1.4	0.4
CD at P£ 0.05	248	156	199	4.1	1.2
CV %	9.0	11.3	15.3	4.6	2.7

Table 2. Yield attributes and physiological parameters in relation to drought tolerance in chickpea during Rabi – 2007-09 (Polled analysis).

Treatments	Plant height (cm)	Number of branches	Number of lateral branches	Number of Pods per plant	SPAD at 30 DAYS	SPAD at 60 DAYS	RWC at pod filling stage	Proline content (µ mole per gram tissue)	
								At flowering	At pod filling
T1 : Vihar	32	3	10	25	55	45	64	0.87	2.39
T2: JG-11	31	3	12	27	50	40	62	1.65	1.22
T3: PKV2	35	3	8	18	52	40	65	1.11	2.32
T4: LBeG – 7	35	2	9	21	52	41	65	1.37	2.23
T5: ICCV –37	29	2	10	23	54	41	63	1.43	2.85
T6: Annegiri	30	3	15	33	47	38	55	1.98	3.29
T7: JGK2	36	3	11	28	53	44	64	0.80	4.13
T8: Vijay	30	3	12	35	44	36	52	1.17	2.24
T9: Jaki 9218	31	3	11	24	49	45	63	2.16	3.13
SEm±	0.8	0.2	1	2.0	1.0	2.5	0.6		
CD at P≤ 0.05		0.5	3.1	6	3	7.6	1.9		
CV %		11.3	16.6	13.7	3.3	10.7	1.8		

Highest haulm yield was recorded in Vijay (995 kg/ha)followed by JAKI-9218 (969 kg/ha) and Vihar (924 kg/ha) harvest index was significantly influenced by the treatments . Highest harvest index was recorded in LBeG-7 (57%)followd by JGK-2 (53%) and JG-11(53%).Reletive water content has been suggested as an important criterion for screening genotypes for drought tolerence. Genotype JAKI-9218 (63%) and JG-11 (62%) also recorded higher Relative Water Content in pod filling stage Kumar (2003) reported that significant positive association between reletive water content and drought tolerance. Higher SPAD chlorophyll Meter values at 60 DAS were recorded in JAKI-9218 (45) and Vihar (45).

At flowering stage highest proline content was observed in JAKI-9218 (2.16 µ mol per g tissue)followed by Annegiri (1.98 µ mol per g tissue). At pod filling stage the highest proline content was recorded in JGK-2 (4.13 µ mol per g tissue) followed by Annegiri (3.29 µ mol per g tissue) and JAKI-9218 (3.13 µ mol per g tissue). Gunes *et al.,* 2008 reported that proline accumulation can be used as criterion for drought resistance assessment of varities.Plants can partly protect themselves against mild drought stress by accumulating osmolights in drought stressed plants. The proline content increased under drought stress in pea.(Sanchez et al 1998 , Alexieva et al 2001) . Proline accumulation can also be observed with other other sterss such as high temperature and under starvation (Sairam et al ,2002) . Proline metabolism in plants however, has mainly been studied in response to osmotic sterss(Verbruggen and Hermans 2008). Proline does not interfear with normal biochemical reactions but allows the plants to survive under stress(Stewart,1981).The accumulation of proline in plant tissues is also a clear marker for environmental stress. Particularly in plants under drought stress(Routley1966) . Proline accumulation may also be part of the stress signal influencing adaptive responses. The purpose of the present study was to a better understanding of the physiology responses of chickpea plants to drought stress. Mufakheri et al 2010 reported in chickpea cultivars that drought stress at anthesis phase reduced seed yield more severe than that of on vegetative phase. Drought stress imposed during vegetative or anthesis significantly decreased chlorophyll – a, Chlorophyll - b and total chlorophyll content . proline content was higher in drought tolerant ' ILC 482' than in drought sensitive ' Pirouz,' both under control and drought stress conditions.

It can be concluded that,higher SPAD chlorophyll Meter values 60 DAS were recorded in JAKI-9218 (45) and Vihar (45). JAKI-9218 also recorded higher value of SPAD chlorophyll Meter reading at 30 DAS and comparatively higher proline content (3.13 µ mol per g tissue). Thus these promising genotypes identified for various drought tolerance and yield attributes can be further exploited in breeding programme to develop high yielding drought tolerant chickpea genotypes.

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