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Differences in Drought Tolerance in Ten Chickpea Genotypes I-some Studies on Yield and Yield Components

Y. Ali, M.A. Haq*, N. Ahmad and S.S. Alam
Nuclear Institute for Agriculture and Biology, P.O. Box No. 128, Faisalabad,
**Department of Crop Physiology, University of Agriculture, Faisalabad-38040, Pakistan.*

Abstract

Ten genotypes of chickpeas viz. CM-1, CM-2, CM-72, CM-88, CM-1918, C-44, K-850, C-727, Thal White and 86135, were compared for their relative drought tolerance in terms of yield and yield components in field experiment. The genotype CM-2 proved superior to other varieties in almost all the characters studied. It produced maximum number of pods per plant (87.20), gave the highest yield per plant (18.97 g), and more elliptic index of leaf (71.81) under stress conditions. Based on these characters this genotype may be advanced further.

Key words: Chickpea, drought, yield, tolerance.

Introduction

Chickpea (*Cicer arietinum* L.) is the third most important pulse crop after dry beans (*Phasealus vulgaris* L.) and dry peas (*Pisum sativum* L.) on a global basis. Although predominantly consumed as a pulse, dry chickpea is also used in preparing a variety of snack foods, sweets and condiments. Green fresh chickpea are commonly consumed as a vegetable for a short period before the crop is mature. Nutritionally, chickpea is relatively free from various antinutritional factors, has a high protein digestibility and high phosphorus and calcium than other pulses.

In Pakistan chickpea is grown on about 0.98 million hectares with an annual production of about 0.46 million tones (Annonymous, 1989); thus the average yield of 0.466 tones/ha is very low as compared to some other chickpea producing countries. It is mostly grown as a rainfed crop on light textured soils with low water holding capacity and therefore is most likely to be affected by drought.

An effective way of increasing yield in drought affected environment is to alleviate the water deficit through irrigation. Only 14% of the world's arable (including Pakistan) is irrigated at present (Simpson, 1981) and further prospects for substantial increase in irrigable area are limited, especially in semi-arid regions. It is thus important to explore other alternatives for increasing and stabilizing crop yields in drought-affected environments. One such possibility is selection and breeding for genotypes better adapted to drought. Such programmes can be greatly aided by the identification of potential plant characters/traits responsible for drought tolerance and their incorporation in to high yielding agronomically acceptable cultivars.

The present studies were therefore conducted to see the effect of drought stress on yield and some yield components of 10 chickpea varieties/strains for selecting more productive genotypes of chickpea for drought affected environments and if possible for identifying some morphological/physiological markers related to drought tolerance.

Materials and Methods

The experiment was carried out under semi-controlled moisture conditions in the research area of the Department of Crop Physiology at Post-graduate Agricultural Research. Station (PARS) University of Agriculture, Faisalabad, Pakistan.

A split plot design was employed, keeping moisture levels in main plots and varieties (see Table 1) in sub-plots. The sub-plot size was 1.5 x 0.3 m (0.45 m^2) with three replications. Recommended cultural practices were followed for seed bed preparation. Before sowing Urea at 20 kg N ha^{-1} and single super phosphate at 22 kg P ha^{-1} were thoroughly mixed in the soil. Seed were dibbled in soil at a depth of 2.5 cm on November 21,1991. The area around the experiment was also sown to non-experimental chickpea. Thinning was done two weeks after seeding and twenty uniform seedlings were retained in each sub-plot.

The irrigation was applied uniformly to all plots 45 days after sowing for crop establishment. Thereafter non-stressed control was given two more irrigations i.e. first 90 days after sowing and second 135 days after sowing. No irrigation was given to stressed chickpea after the first irrigation and plants were protected from rain by plastic covers. The plants were individually harvested on May,7,1992 at the ground level and data on pods per plant (on the average of three plants per plot), Yield per plant (on counter scale balance), harvest index: (economic yield/biological yield x 100).

100 grains weight (on analytical balance), Ellpitic index of leaf are (EIL): LLW x LLL (leaflet width (LLW), Leaflet .length (LLL), using Haq (1990) method. The data were subjected to appropriate statistical analysis (Steel and

Table 1: Response of chickpea genotypes to water stress

Variety	No. of pods plant^{-1}		Plant yield (g)		Harvest index (%)	
	Non-stress	Stress	Non-stress	Stress	Non-stress	Stress
CM 1	89.87 cd	81.87 b	16.20 e	13.'57 cde	24.29 b	23.11 b
CM 2	127.0 a	87.20 a	28.80 a	18.97 a	17.77d	15.76 a
CM 88	64.23 a	52.60 f	16.67 e	12.67 de	25.65 b	22.98 b
CM 72	68.30 a	58.43 e	17.37 e	13.33 cde	19.26 d	17.73 f
CM 1918	68.37 e	46.17 g	16.63 e	12.20 ef	18.75d	20.37 c
CM 44	85.07 d	48.63 fg	25.83 b	14.70c	21.89c	21.61 bc
K 850	93.83 c	80.03 bc	23.53 c	16.53 b	32.96 a	28.07 a
C 727	67.90 e	53.80 ef	15.97 e	10.67 e	18.63 d	17.70 d
T.W.	101.10 b	72.57 d	25.57 b	14.53 cd	19.32 d	15.62 e
86135	94.50 c	75.17 cd	21.47 d	14.67c	25.12b	21.72 bc

[a-g]Any two means not sharing a letter in common differ significantly at 5% probability

Table 2: Response of chickpea genotypes to water stress

Variety	100-grain weight (g)		Elliptic index of leaf (EIL)	
	Non-stress	Stress	Non-stress	Stress
CM 1	20.40 d	19.10 c'	47.90 f	41.88 f
CM 2	20.17 d	18.63 d	97.94 a	71.81 b
CM 88	16.87 g	15.73 e	49.19 ef	40.77 f
CM 1918	21.47 c	17.27 d	72.10 b	52.52 cd
C44	28.10 a	24.97 a	90.50 a	78.97 a
K850	28.10 a	24.67 a	64.88 C	53.11 cd
T.W.	23.97 b	20.73 b	51.72 e	45.81 e
86135	16.70 g	13.97 f	58.20 d	49.94 d

[a-g]Any two means not sharing a letter in common differ significantly at 5% probability

Torrie, 1980), Comparisons among treatment means were made by Duncons Multiple Range (DMR) test (Duncan, 1955).

Results and Discussions

Pods per plant: Chickpea varieties differed significantly for number of pods per plant both under stress and non stress conditions (Table 1). Under non stress conditions variety CM-2 produced maximum number of pods per plant (127) followed by Thal White (101). Significantly higher number of pods in CM-2 were found as compared to CM-88 (64.23) which produced the lowest. Under water stress maximum number of pods were observed in CM-2 (87.20) followed by CM-1 (81.87). The differential behavior of various varieties to water stress may be attributed to their variable genetic make up and impaired physiological mechanism of plants carried out in the presence of water. These findings are in accordance with Turner and Begg (1981), Pandey *et al*. (1988), Pannue and Singh (1988), Didar *et al*. (1991) and Rathore *et al*. (1992).

Yield per plant: Water stress imposed from flowering to maturity affected grain yield per plant significantly (Table 1). The maximum yield (28.80 g) under non stress conditions variety CM-2 produced maximum grain yield per plant (18.97 g) followed by K-850 (16.53 g). Grain yield per plant was the lowest in C-727 (10.67 g) under stress conditions. The results similar to these were reported by Turner and Begg (1981), Day and Legg (1983), Saxena (1984) and Rathore *et al*. (1992).

Harvest index: Chickpea varieties differed significantly for harvest index both under stress and non stress conditions. Under non stress conditions variety K-850 produced maximum harvest index (32.96%) followed by CM-88 (25.65%) and CM-1 (24.29%) respectively (Table 2). Under stress conditions maximum harvest index (28.07%) was produced by K-850 while Thal White produced the least (15.62%).

100 grain weight: Grain weight, an important yield determining factor, reflects the extent of grain development. Results (Table-2) indicated that under non stress conditions varieties C-44 and K-850 produced heavier grain (28.10 g) followed by Thal White (23.97 g), while the lowest 100 grain weight (16.70 g), was noted in 86135. Under stress conditions varieties K-850 and C-44 produced heavier seeds (24.97 and 24.67 g), respectively. Variety 86135 was most affected and produced the lowest weight (13.97 g). Water stress imposed from following to maturity resulted in low 100 grain weight as compared to non stress chickpea plants. Decrease in 100 grin weight under stress conditions might be due to lower photosynthetic translocation in the developing seed. Similar observations have been reported by Kumar and Arora (1991).

Elliptic index of leaf (EIL): Water stress from flowering to maturity affected leaf development (Table 2). Under non stress conditions variety CM-2 gave maximum EIL (97.94) followed by C-44 (90.50). Variety CM-1 produced least EIL

(47.90). Under stress conditions C-44 produced highest EIL (78.97) followed by CM-2 (71.81). These results agree with findings of Harvey (1980), Sexena and Sheldrake (1980) and Aggrawal *et al*. (1984).

Conclusion

The superiority of CM-2 to other genotypes observed under drought conditions is due to the production of more number of pods per plant, yield per plant and leaf area per plant.

CM-2 is an induced mutant derived from mutagenic seed treatment of genotype 6153 with 15 kR exposure of gamma irradiation. The mutant was selected from M_2 segregating generation on the basis of resistance against ascochyta blight and was confirmed in subsequent generations. Based on its superiority under drought conditions and blight resistance, it may be used directly as a variety particularly in rainfed areas of Pakistan.

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