SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Yield; yield Components for some Chickpea (*Cicer arietinum* L.) Genotypes as affected by Water Stress and Sowing Date

Abdellatif Mohmed Alamin[1] and Abdalwahab Hassan Abdalla[2]

1. Agric. Reseach Corporation, Shambat Res. Station, Sudan.
2. Faculty of Agric. Univ. of Khartoum, Sudan.
*Corresponding author:

Received: January 2019 **Accepted: February 2019**

Abstract

The study was carried out to assess the percentage of reduction and susceptibility index to water stress in seed yield and its components in chickpea. Twelve chickpea genotypes were evaluated in two sowing dates (mid Nov. and mid Dec.) under two levels of water treatments at two locations (Shambat and Shendi) during the period 2004-2008. A split-plot experiment in a randomized complete block design (RCBD) with four replications was applied. The main-plots were allocated for water treatment and sub-plots for the genotypes. The water levels adopted were normal irrigation (10-12 days interval) and water stress (withholding irrigation water for three weeks during the flowering stage). Generally early sowing during November gave a higher seed yield and better yield components. The genotype Rubatab and Wad-Hamid (checks) scored the highest seed yield at the four environments and under normal irrigation, while Rubatab and ILC6023 scored the highest seed yield under water stress conditions. A high percentage of reduction for genotypes means was detected at the four environments in seed yield and its components due to water stress. Plant height showed a small reduction percentage and relatively a narrow range of susceptibility index, while days to maturity were enhanced by water stress and had a wide range of susceptibility index. Moreover, Seed yield/ha, number of pods per plant, biomass yield/ha and harvest index recorded the highest percentage reduction values and a narrow range of susceptibility indices indicating that, chickpea is highly susceptible to water stress during flowering, however, some genotypes (Rubatab, ILC 6023, ILC3105 and ILC1792) showed relatively smaller reduction values and narrower susceptibility indices; therefore, we recommend them for testing in more seasons under water stress conditions to verify their tolerance to drought. Furthermore, the result showed that, the susceptibility indices for seed size was higher in larger seeds than the smaller ones. ILC4291 proved to be highly susceptible for all variables. Also the study showed and recommended the early sowing of chickpea during November for obtaining higher seed yield and better yield components.

Keywords: Chickpea, susceptibility, water stress, biomass yield; environment

Introduction

Chickpea, (*Cicer arietinum* L.) is one of the most important food legume in the world, it is the second most important among pulses after dry beans and is being cultivated in more than 14 million hectares with annual production of about 13 million tons (FAO, 2013).

In most parts of the world chickpea is predominantly grown on poor lands under limited moisture conditions of the rain-fed system and probably this practice is the main reason for low global productivity worldwide (Singh and Saxena, 1995). In the Sudan, chickpea is traditionally cultivated under residual moisture system on the banks of the Nile in the Northern Sudan and after flood recession in the Eastern Sudan (particularly in Hawata area) and Jabel Marra in western Sudan (Ahmed, 2009). Due to its growing economic importance as a cash crop, chickpea

cultivation has been extended to the irrigated sector and is grown now in nearly 22000 ha in the Gezira Scheme (Hamid and Hamad, 2017). FAO, 2013, estimated the area grown by chickpea in the Sudan by 8000 ha and the average seed yield by 1365 kg/ha, however, recent estimations mentioned 60000 ha for the area grown and 0.8-2.8 t/ha for the average yield (Sudan country report, 2018). The husbandry research at the Agricultural Research Corporation, Sudan determined the mid of November for optimum sowing date, 33.3 plants/ square metre or a seed rate of 60 kg/ha for optimum population density and a starter dose of 20 kg nitrogen per hectare for fertilization (Ibrahim, 1996). The National Variety Release Committee released more than 12 chickpea varieties for the different parts of the Sudan.

However, a yield of 4000 kg per hectare of chickpea has been recorded in a farm in Syria (Singh and Saxena, 1999), the global productivity worldwide is low (786 kg/ha, Anon. 2009). This gap in yield could be due to susceptibility of this crop to the abiotic constraints. Drought is one of the most serious problems versus yield of crops all over the world. Supplemental irrigation only one time at pod filling stage minimizes the effect of water stress and maximizes seed yield (Shamsi *et al*., 2010). The susceptibility index for a character reflects the response of the genotype to water stress in terms of percentage loss in the genotype mean. Saxena (1993), reported that yield losses due to drought in chickpea range between 20 to 50% in the semi arid tropic areas; and it may rise to more than 75% (Malhotra and Saxina, 2002). Behboudian *et al*. (2001) stated that, water stress imposed after podding reduced plant dry mass and seed yield by 23% and 30%, respectively. This was attributed to the deleterious effect of water stress on yield and to the increased of pod abortion and the decreased of pod formation. Ahmed (1988) mentioned that, irrigation interval of 20 days during the reproductive stage reduced seed yield by 53% compared to irrigation every 8 days. He concluded that, seed size and number of seeds per pod were the most affected yield components.

This research was started at Shambat and Shendi Research Stations with following objectives:-

1-To study the effect of water stress during the flowering stage on yield and yield components of 12 chickpea genotypes.

2-To estimate reduction in yield, its components and the susceptibility indices due to water stress among the tested genotypes and recommend tolerant ones for drought prone areas.

3- To study the effects of two sowing dates (mid of November and mid of December) on yield and yield components of some chickpea genotypes.

Materials and Methods

A field experiment was carried out during mid December 2004/05, mid Nov., 2005/06 and mid Dec.2005/06 at Shambat Research Farm (15º 40/ N Lat., 32º 32/ E Long. and 380 metres above sea level). In addition, the same experiment was conducted in mid Nov. 2005/06 at Shendi Research Farm (Lat. 16º N, and Long. 32º E).

Twelve chickpea (*Cicer arietinum* L.) genotypes were used in this study. Ten of them (ILC6023, ILC6119, ILC4291, ILC1792, ILC3210, ILC3843, ILC3105, Flip88-42C, Flip87-58C and Flip87-85C) are promising genotypes selected from a drought tolerance nursery received from the International Centre for Agriculture Research in the Dry Areas (ICARDA), and the other two were, Rubatab and Wad-Hamid, standard commercial released cultivars. These genotypes were grown under two watering regimes. Prior to the application of irrigation treatments all the plots were irrigated at 10-12 days intervals till 50% flowering. Then the stress environment was subjected to water stress by withholding the irrigation water for three weeks, after which watering was resumed up to physiological maturity. A split-plot design with four replications was used for laying out the experiment in the field. The water treatments, stress and non-stress, were assigned to the main plots. Each main plot consisted of 12 sub-plots to which genotypes were assigned randomly. Each genotype was grown in two 60 cm ridges; 5 metres long. Seeds were sown in holes along the eastern side of the ridge at a rate of three seeds per hole and then thinned to two plants per hole, three weeks after sowing. Spacing was 25 cm between plants. Weeding was done twice (after the third and the fifth irrigations) and spraying against pests (pod borer and termites) was carried out at flowering.

Data collection

Except for days to maturity, harvest index, biomass and grain yield (kg/ha), a random sample of 5 plants in each plot was used to record the data on plant height (cm), number of pods per plant, number of seeds per pod and 100-seed weight (g),

Statistical analysis

The collected data were subjected to individual analysis of variance described by Gomez and Gomez (1984). Then means were compared using the LSD.

In addition, the response of each genotype to water stress conditions was determined in the form of a susceptibility index (S1) as follows:-

a) Computation of the reduction percentages in performance of each genotype for the different characters following the formula:

$$R=1/\mu_n [(\mu_n-\mu_s)] x100$$

Where:

R= the reduction percentage.

μ_n= the mean of the genotype under normal irrigation.

μ_s= the mean of the genotype under water stress condition.

b) Estimation of S1 for each genotype, the computed R value was then multiplied by the correlation coefficient between seed yield/ plant and the character under consideration, under water stress. For each genotype, the products of the different characters were added together, using the following equation:

$S1=r_1.R_1+r_2.R_2+....+r_mR_m$

Where:

$r_{1.}r_2\ldots, r_m$= the correlation coefficients of the characters number 1, 2,….., m, respectively, with seed yield/plant under water stress condition.

$R_{1,}.R_2,\ldots., R_m$= the reduction percentage of characters 1,2,…,m, respectively.

Results and Discussion

Reduction due to water stress

Water stress reduced plant height by (10.60%) as a mean for all genotypes in the four environments (Table 1). The highest reduction (16.47%) was shown by Rubatab, while the lowest one (6.58%) was exhibited by Flip 88-42C (Table 3). Both cultivars showed the same trend at Shendi (Table 2); however, at Shambat (Table 2), only Rubatab recorded the highest reduction value in Dec. 2004 (11.32%) and Dec. 2005 (19.79%).

Water stress during flowering enhanced days to maturity as a mean for all genotypes in the four environments by 2.15 % (Table 1). Kumar *et al*. (2004), found water stress enhanced maturity by 10 days. In the current study, the highest reduction days to maturity (6.12%) was for ILC 1792, while the highest increase (-4.35%) was for ILC 6119 (Table 3). At Shendi (Table 2), the range varied between -2.00% (Rubatab) and 5.00% (ILC 3843). At Shambat, (Table 2), the range was between -15.31% (ILC 4291) in Nov.2005 and 13.04% (ILC 3210) in Dec. 2005.

Averaged over all genotypes, in the four environments, water stress during flowering reduced number of pods/ plant by 39.55% (Table 1). Our result was in accordance with the result of Alla Jabow *et al*. (2015) who obtained 37.2% reduction for this variable due to water stress in chickpea. The respective reductions in lentil was 41.2% (Alla Jabow and Mahgoub 2017) and 50.5% in fababean (Alla Jabow *et al*., 2016). Most studies show high reduction values for this variable under stress conditions, since it is usually highly co-related with seed yield. Other reason is that, water stress was imposed here during flowering and pod formation follows flowering, so the pods were highly affected. The highest reduction in this study (49.90%) was for ILC4291 while the lowest one (15.90%) was for ILC 3105 (Table 3). At Shendi (Table 2), the range was between -39.29% (ILC 3105) and 60.60% (Wad-Hamid). At Shambat (Table 2), Dec.2004 recorded the highest range in the three seasons (-35.00% for ILC 3210 and 74.19% for ILC 6119).

Water stress during the flowering stage reduced number of seeds per pod by 7.39% as a mean for all genotypes in the four environments (Table 1). Alla Jabow *et al*. (2015) and Ahmed (1988) reported higher reduction values for this variable in chickpea due to water stress. The variation in the reduction values between us and the other studies may be attributed to the timing of the stress, in our study the stress period coincided with flowering and the pod formation stages; therefore, the new formed seeds (upper and lateral branched pods) might not be subjected to the water stress, while in the other two studies their imposing of water stress by elongating water intervals to 20 days till maturity subjected seed formation to severe water stress that resulted in high reduction values. The respective reduction in lentil reported by Alla Jabow and Mahgoub (2017) was 29.6% and in fababean (Alla Jabow *et al*., 2016) was 23.1%. In this study, the highest reduction (19.80%) was observed for Rubatab while the lowest one (1.61%) was recorded for Flip 87-58C (Table 3). At Shendi (Table 2), the range was between -43.66% (ILC 3105) and 19.98% (Wad-Hamid). At Shambat (Table 2), the highest increase (-5.36%) and the highest reduction (25.47%) were recorded, respectively, for ILC3843 and ILC 3210 in Dec.2004.

Water stress during the flowering stage reduced 100- seed weight by 9.55% as a mean for all genotypes in the four environments (Table 1). The respective reduction values for this variable reported by Alla Jabow *et al*. (2015) were 22.5% in chickpea, 17.7% in lentil (Alla Jabow and Mahgoub, 2017) and it was 20.2% in fababean (Alla Jabow *et al*., 2016). Also; Ahmed (1988), reported a high reduction value for this trait. Here, the same justification under number of seeds per pod may be raised to clarify the variation in the values obtained in the studies. In this study, the highest reduction (16.71%) was observed for ILC 4291 that had the heaviest seed weight while the lowest one (2.22%) was for Rubatab that had the smallest seed weight (Table 3). These findings confirm those reported by Toker and Cagirgan (1998) in chickpea. At Shendi (Table 2), the highest reduction (10.48%) was shown by ILC 3210 while an increase (-4.85%) was observed for Flip 88-42C. At Shambat (Table 2), ILC 4291 showed the highest reduction in two seasons (36.02% and 16.21%, respectively, for Dec. 2004 and Nov. 2005).

A high percentage reduction of 31.95 as a mean for all genotypes in the four environments due to water stress during flowering was detected for biomass yield (Table 1). Behboudian *et al*. (2001) mentioned that, water stress imposed after podding reduced plant dry mass by 23%. In the present study, the highest reduction (41.44%) was observed for Wad-Hamid, while the lowest one (18.56%) was shown by ILC 6023 (Table 3). At Shendi (Table 2), the highest reduction (53.90%) was for Wad-Hamid while the highest increase (-5.17%) was for ILC 6023. At Shambat (Table 2), ILC 4291 recorded the highest reduction (38.04%) in Dec.2004 and 49.62% in Dec.2005, while ILC 3210, ILC 3843 and ILC6023 recorded 13.00, 25.35 and 16.73% in Dec. 2004, Dec. 2005 and Nov. 2005, as the lowest reduction values, respectively. Basu and Singh (2003) attributed the reduction in grain yield in chickpea under drought to the decrease in the above ground dry mater or vegetative biomass. However, Siddique (2000) stated that, drought stress during vegetative stage alone does not appear to cause a significant yield loss in chickpea.

Water stress during the flowering stage subjected seed yield in the four environments to the highest reduction (45.98%) among all variable. (Table 1). Our results were in accordance with the results of Alla Jabow *et al*. (2015) who obtained 56.4% reduction for this variable due to water stress in chickpea. Saxena (1993), reported yield losses up to 50% in chickpea due to drought. Malhotra and Saxina (2002) mentioned a yield loss of about 75% in chickpea in West Asia and North Africa due to severe drought. The present study showed Flip 87-58C as has had the highest reduction (57.42%), while ILC 3843 recorded the lowest one, 34.55% (Table 3). At Shendi (Table 2), Wad-Hamid showed an extreme reduction (83.76%). At Shambat (Table 2), both Decs. 2004 and 2005 showed high reduction values, the highest one (86,80%) was for ILC 6119 in Dec.2004, while the lowest one (51.14%) was for Flip

87-85C, in Dec.2004 too.. Behboudian *et al*. (2001) mentioned that, water stress imposed after podding in chickpea genotypes reduced seed yield by 30%.

Water stress during the flowering stage reduced harvest index by 28.28% as a mean for all genotypes in the four environments (Table 1). The highest reduction (43.20%) was recorded for ILC 4291 while the lowest one (14.25%) was observed for Flip 88-42C (Table 3). At Shendi (Table 2), the highest reduction (44.59%) was exhibited for ILC 3210. At Shambat (Table 2), the highest reduction (85.26% %) was recorded for ILC 6119 in Dec. 2004, while an increase of -17.99% was exhibited for the same genotype in Nov.2005.

Susceptibility index (%)

The response of the evaluated chickpea genotypes to the effect of water treatments in terms of susceptibility index for the different characters as a mean of the four environments is presented in Table 3.

In plant height, the susceptibility index ranged between 62.08% and 155.38%. Flip 88-42C was the least susceptible genotype and Rubatab was the most susceptible one. On the other hand, Wad-Hamid, Flip 87-85C, ILC 3843, ILC 1792 and ILC 6023 exhibited estimates of susceptibility index lower than 100% (Table 3).

A wide range of susceptibility index was obtained for number of days to maturity, (202.33% for ILC 6119 and 284.65% for ILC 1792). ILC 4291 and Flip 88-42C showed negative values for susceptibility index, while ILC 3843, ILC 6023 and Rubatab showed less than 100% susceptibility index values.

Number of pods/ plant showed relatively a narrow range of susceptibility index (between 40.30% and 126.14% (Table 3). The least susceptible genotype was ILC 3105 while the most susceptible one was ILC4291. On the other hand, seven genotypes showed less than 100% susceptibility index while five genotypes scored susceptibility index values higher than 100%.

A wide range of susceptibility index (between 21.79% and 267.93%) was recorded for number of seeds/ pod (Table 3), the lowest value was observed for Flip 87-58C while the highest was recorded for Rubatab. Other least susceptible genotypes in number of seeds/pod were ILC 6119 (25.58%) and ILC 3105 (37.08%), while higher susceptibility indices were reported for ILC 4291, 141.54% and Flip 88-42C, 191.07%.

For 100-seed weight (Table 3), Rubatab and ILC 1792 (had the smallest seed size) obtained 23.25% and 29.22% as the least susceptible genotypes, while ILC 4291, ILC 6119 and ILC 3843 (had the largest seed size) were the most susceptible ones for this trait (174.87%, 117.0 and 117.70%, respectively). Our result for this variable confirms the findings of Toker and Cagirgan (1998) in that, the susceptibility indices for larger seed size was higher than the smallest ones.

Biomass yield showed relatively a narrow range of susceptibility index (between 58.11% and 129.74%, (Table 3). The least susceptible genotype for this trait was ILC 6023 while the most susceptible one was Wad-Hamid. Flip 88-42C was among the least susceptible genotypes for this trait (69.85%), while ILC4291was among the most susceptible genotypes (120.48%).

Seed yield showed relatively a narrow range of susceptibility index (Table 3). The least susceptible genotype in seed yield was Rubatab (61.20%), while the most susceptible one was Flip 87-58C (124.80%). The genotypes ILC 3843 and ILC 6023, were among the least susceptible genotypes (75.10 and 84.36 percent) respectively, while Wad-Hamid (120.40% susceptibility index) was among the most susceptible ones.

Harvest index percentage (Table 3), showed a range of susceptibility index between 50.43% (exhibited for Flip88-42C) and 152.98% (shown by ILC 4291). Wad-Hamid and ILC 3843 had relatively small estimates susceptibility indices for harvest index (51.91% and 68.41%), respectively), while ILC 3210 and Flip 87-58C had higher ones (149.68% and 123. 44%, respectively.

Conclusion and Recommendation

1- All the chickpea genotypes evaluated in this study were highly sensitive to water stress during the flowering stage.
2- The most contributing variables to seed yield in this study were plant height, pods/plant, 100-seed weight, biomass yield and harvest index showed highly reduction values and a narrow susceptibility indices indicating that the evaluated genotypes were highly sensitive to water stress.
3- Those genotypes that showed relatively small susceptibility indices for the above mentioned variables and seed yield should be evaluated for more seasons under water stress conditions to verify their tolerance to drought, e g Rubatab, ILC 3105, ILC 1792, ILC6023.
4- The study shows that; the large seeded type's, e g ILC4291 and ILC3843 as more susceptible to water stress for the same character compared to small seeded types , e g Rubatab and ILC1792.
5- The genotype ILC4291 was mostly susceptible to water stress for all variables.
6- Early sowing during November gives higher seed yield and better yield components than December sowing.

References

Ahmed, A. M. A. (2009). Yield Response to Water Stress in Some Chickpea (*Cicer arietinum* L.) Genotypes during Flowering Stage. Ph.D thesis, Sudan Academy of Sciences.

Ahmed, S. H. 1988. Effect of water-stress at different growth stages on yield of four promising chickpea genotypes. Agricultural Research Corporation, Hudeiba Research Station, Annual Report 1987/88, Ed-Damer, Sudan.

Alla Jabow, M. K. and Mahgoub, Z. B. 2017. The yield and yield response factors of lentil as affected by deficit irrigation at North Sudan. *Sudan Journal of Agricultural Research* vol. 27. (2) pp.9-22.

Alla Jabow, M. K., Ibrahim, O. H. and Adam, H. S. 2016. Yield and water productivity of faba bean (Vicia faba L.) as influenced by different irrigation regimes and varieties under semi desert climatic conditions. *Sudan Journal of Agricultural Research* vol. 26. (1) pp.17-26.

Alla Jabow, M. K., Ibrahim, O. H. and Adam, H. S. 2015. Yield and Water Productivity of Chickpea(*Cicer arietinum* L.) as Influenced by Different Irrigation Regimes and Varieties under Semi Desert Climatic Conditions of Sudan. Agricultural Sciences, 2015, 6, 1299-1308 Published Online November 2015 in SciRes.

Anonymous. 2009. http:// www. icrisat.org/ Chickpea/ Chickpea.htm. Aydın, N. 1988. Ankara koşullarında

Basu, P. S. and D. N. Singh. 2003. Physiology and abiotic Stresses in Chickpea. In "*Chickpea Research in India*" (Eds. Masood Ali, Shiv Kumar and N.B.Singh) pp 137-166 (PR, Kanpur,India).

Behboudian, M. H.; Q, Ma; N. C. Turner and Palta, J. A. 2001. Reaction of chickpea to water stress: yield and seed composition. *Journal of Science of Food and Agriculture*, vol.81, No.13, pp: 1288-129.

FAO, 2013. Chickpea production. *Food and Agriculture Organization*. Year book.

Gomez, K. A. and Gomez A. A. 1984. *Statistical Procedures for Agricultural Research*. 2nd. Ed. John Wiley and Sons, Inc. New York.

Hamid, S. M. and Hamad, A. A. 2017. Effect of sowing date and planting density on yield and yield components of irrigated chickpea (*Cicer arietinum* L.) in Gezira, Sudan. *The 61 Meeting of the National Crop Husbandry Committee, Wad Medani, Sudan*.

Ibrahim, O. H. 1996. Review of Chickpea Agronomic Studies. In *Production and Improvement of Cool-Season food Legumes in the Sudan* (eds.) Agricultural Research Corporation; ICARDA and (DGIS), The Netherlands pp: 87-95.

Kumar, J; N. Dhiman,; S. S. Yadav; J. Berger; N. C. Turner and Singh, D. 2004. Moisture in different chickpea types, 4th International Crops Science congress. *Proceeding of the 4th International Crop Science Brisbane*. Australia 26 Sep- 1Oct.2004//SBN/920842 209/ WWW.cropscience.org.a

Malhotra, R. S. and Saxena, M. C. 2002. Strategies for overcoming drought stress in chickpea.*ICARDA Caravan*. Issue No.17. http:// www.icarda. Cigar. Org/ publications/ Cravan 17/ Focus/ Strategies. htm

Saxena, M. C. 1993. The Challenge of Developing Biotic and Abiotic Stress Resistance in Cool-Season Food Legumes. In *Breeding for Stress Tolerance in Cool-Season Food Legumes*. Edited by K. B. Singh and M. C. Saxena. A Wiley-Sayce Publication.P:3-14.

Shamsi, K. Kobraee, S. and Haghparas, R. 2010. Drought stress mitigation using supplemental irrigation in rainfed chickpea (*Cicer arietinum* L.) varieties in Kermanshah, Iran. *African Journal of Biotechnology* vol. 9(27), pp. 4197-4203, 5 July, 2010
African Journal of Biotechnology Vol. 9(27), pp. 4197-4203, 5 July, 2010.

Siddique, K. 2000. Abiotic stresses of cool season pluses in Australia. In: The1999-2000 Mallee and Wimmera *Crop and Pasture Production Manual (in press)*. http:// www.agric. Wa.gov. au/ agency/ pubns/cropupdate/ 2000/ pulses/ BUBLICATION 1, 11.8.2007.

Singh, K. B., & Saxena, M. C. 1999. Chickpeas. In R. Coste (Ed.), *The Tropical Agriculturist*. Macmillan, London.

Singh, K. B. and Saxena, M. C.1995. *Chickpeas, the Tropical Agriculturalist Series* (Ed.) Rene Coste. pp.134.

Sudan, country report (2018). Grain Legumes and Dry Lands Cereals Research Program. *Launch Meeting 14-16 February 2018, Harmony Hotel, Addis Abba, Ethiopia*, net.

Toker, C. and Cagirgan M. I. 1998. Assessment of Response to Drought Stress of Chickpea (*Cicer arietinum* L.) lines Under Rain-fed Conditions, *Turk.J. of Agriculture and Forestry* 22:615-621.

Table1. Means and percentage reduction due to water stress for yield, yield components and vegetative characters of 12 chickpea genotypes evaluated at four environments

Character	Non-stress	Stress	% Reduction #
Plant height (cm)	54.70	48.90	+10.60
Days to maturity	93.00	91.00	+2.15
Number of pods/ plant	48.80	29.50	+39.55
Number of seeds/ pod	1.055	0.977	+7.39
100-seed weigh (g)	31.40	28.40	+9.55
Biomass yield (kg/ha)	4251.4	2893.3	+31.95
Seed yield (kg/ha)	1372.7	741.6	+45.98
Harvest index (%)	32.44	23.28	+28.26

Percent reduction due to water stress = (1- stress mean/ non stress mean) x 100

Table 2.Percent reduction due to water stress in 12 chickpea genotypes evaluated at four environments.

Genotype	Plant height (cm)				Days to maturity (no)				Pods/ plant (no)			
	Shendi	Shambat			Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	12.72	3.56	7.78	14.96	1.02	9.20	-6.80	6.90	0.59	51.37	53.82	71.59
ILC 6119	10.92	8.76	17.52	13.04	0.00	-1.20	- 9.71	-3.70	31.72	74.19	20.15	70.42
ILC 4291	18.03	11.16	1.56	12.86	2.08	5.68	-15.31	6.90	44.99	55.91	49.24	53.90
ILC 1792	14.79	-0.46	3.04	19.50	0.000	10.11	1.77	12.50	40.57	55.09	1.34	65.00
ILC 3210	18.16	-3.50	8.63	14.98	2.94	11.96	-4.59	13.04	-16.39	-35.0	33.57	74.61
ILC 3843	16.89	9.15	3.83	7.29	5.00	8.99	-7.48	5.88	40.92	46.70	29.83	51.72
ILC 3105	12.00	8.89	13.95	12.41	1.02	8.14	- 5.31	11.36	-39.29	17.47	1.98	63.46
Flip 88-42C	3.72	3.82	10.27	7.60	-1.03	0.00	-7.77	3.80	6.58	34.87	56.25	54.23
Flip 87-58C	13.81	7.04	10.30	12.04	2.11	5.06	0.00	6.41	25.36	40.73	24.09	71.21
Flip 87-85C	16.01	1.15	14.33	0.85	3.06	6.17	-6.00	8.64	15.05	36.49	48.03	40.25
Rubatb	21.54	11.32	12.46	19.79	-2.00	12.64	-6.54	9.52	51.17	64.83	22.78	68.41
Wad-Hamid	12.08	9.00	8.14	4.55	2.11	6.33	-4.00	7.60	60.60	51.42	28.25	58.81

Table 2 continued.

Genotype	Seeds/pod (no)				100-seed weight (g)				Bimass yield (kg/ha)			
	Shendi	Shambat			Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	16.53	-0.93	1.23	6.13	7.38	6.69	8.75	5.81	-5.17	24.21	16.73	43.48
ILC 6119	2.92	2.19	4.68	-2.34	4.36	26.50	0.56	15.72	40.60	15.24	23.68	44.00
ILC 4291	0.69	11.05	19.02	9.38	3.09	36.02	16.21	15.97	35.82	38.04	33.16	49.62
ILC 1792	1.69	1.81	11.06	10.91	-2.52	8.00	-3.14	10.27	29.73	20.64	41.88	49.58
ILC 3210	-22.73	25.47	2.33	8.79	10.48	12.45	9.30	9.97	3.63	13.00	38.43	37.79
ILC 3843	9.48	-5.36	10.14	4.81	2.61	26.14	3.28	17.16	38.58	37.20	30.31	25.35
ILC 3105	-43.66	14.58	19.27	11.05	6.38	30.11	-1.81	2.93	21.66	19.77	43.58	42.34
Flip 88-42C	11.61	15.68	22.28	6.58	-4.85	23.66	11.52	8.08	-4.62	21.06	34.18	43.23
Flip 87-58C	17.95	-21.4	2.79	6.30	-1.43	27.04	4.63	6.97	30.92	33.42	46.61	44.01
Flip 87-85C	9.75	18.06	2.64	0.10	2.46	20.22	-1.08	6.20	21.03	19.51	31.73	43.17
Rubatb	15.75	16.12	15.21	24.73	-1.06	13.58	1.05	-3.35	20.43	29.60	25.64	35.67
Wad-Hamid	19.98	5.02	-2.94	2.37	-0.63	18.58	-0.33	28.53	53.90	16.00	27.61	44.15

Table 2 continued.

Genotype	Seed yield (kg/ha)				Harvest index (%)			
	Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	-0.59	72.37	32.60	68.53	6.23	61.46	20.66	43.12
ILC 6119	36.82	86.8	12.17	75.00	-8.52	85.26	-17.99	52.89
ILC 4291	20.84	76.74	51.61	75.95	-7.00	66.11	39.27	50.60
ILC 1792	27.83	64.39	44.65	76.71	-3.64	56.91	5.05	54.35
ILC 3210	43.75	66.89	48.67	68.75	44.59	60.24	19.30	52.38
ILC 3843	22.49	67.40	20.31	54.72	-28.87	51.35	-1.25	38.82
ILC 3105	-3.55	65.19	55.00	70.42	-31.72	63.67	29.21	46.19
Flip 88-42C	12.18	67.57	55.38	58.18	25.69	60.65	31.80	23.10
Flip 87-58C	45.26	66.85	55.20	65.00	25.46	52.84	20.29	38.93
Flip 87-85C	33.97	51.14	36.37	63.08	17.86	43.92	13.64	35.09
Rubatb	-9.86	79.65	36.32	62.12	-35.54	71.08	15.34	41.09
Wad-Hamid	83.76	58.87	20.51	67.11	-63.20	51.86	-4.67	39.96

Table 3.. Percent reduction and susceptibility index due to water stress in the performance of 12 chickpea genotypes evaluated under normal and water stress condition at Shambat and Shendi in 2004 and 2005 seasons.

Genotype	Plant height(cm)		No. of days to maturity		Number of pos/ plant		Number of seeds/ pod	
	% Red	Susc.	% Red	Susc.	% Red	Susc.	% Red	Susc.
ILC 6023	9.96	93.96	2.13	99.07	47.80	120.96	6.11	82.68
ILC 6119	12.99	122.55	-4.35	-202.33	40.33	101.97	1.89	25.58
ILC 4291	11.09	104.62	-1.09	-50.23	49.90	126.14	10.50	141.54
ILC 1792	9.62	90.76	6.12	284.65	35.30	89.15	6.27	84.84
ILC 3210	10.73	101.23	5.05	234.88	34.00	85.97	5.15	69.55
ILC 3843	9.42	87.17	2.11	97.67	39.10	98.89	4.83	65.36
ILC 3105	12.06	113.77	3.13	145.12	15.90	40.30	2.74	37.08
Flip 88-42C	6.58	62.08	-1.12	-52.09	37.60	94.97	14.12	191.07
Flip 87-58C	10.90	102.83	3.41	158.61	39.50	99.82	1.61	21.79
Flip 87-85C	9.02	85.09	2.22	103.26	37.70	83.49	7.46	100.81
Rubatab	16.47	155.38	2.13	99.07	49.70	125.69	19.80	267.93
Wad-Hamid	8.41	79.34	2.27	105.58	47.30	119.47	6.16	83.36

Table 3. Continued.

Genotype	100-seed weight (g)		Biomass yield kg/ha		Seed yield (kg/ ha		Harvest index %	
	% Red	Susc.	% Red	Susc.	% Red	Susc.	% Red	Susc.
ILC 6023	7.32	76.65	18.56	58.11	38.76	84.36	30.98	109.70
ILc 6119	11.18	117.00	34.12	106.83	40.94	89.00	24.32	86.12
ILC 4291	16.71	174.87	38.49	120.48	55.64	121.00	43.20	152.98
ILC 1792	2.79	29.22	38.25	119.73	52.12	113.30	27.62	97.81
ILC 3210	10.48	109.74	24.58	76.96	54.99	119.50	42.27	149.68
ILC 3843	11.24	117.70	33.27	104.16	34.55	75.10	19.32	68.41
ILC 3105	9.03	94.56	34.48	107.92	49.59	107.80	32.79	116.11
Flip 88-42C	9.23	96.65	22.31	69.85	40.79	88.70	14.25	50.43
Flip 87-58C	8.21	85.97	38.17	119.51	57.42	124.80	34.87	123.44
Flip 87-85C	6.09	63.77	29.20	91.42	45.53	99.00	26.30	93.13
Rubatab	2.22	23.25	26.66	83.44	38.15	61.20	28.70	101.63
Wad Hamid	11.11	116.30	41.44	129.74	55.38	120.40	14.66	51.91

Table 2.Percent reduction due to water stress in 12 chickpea genotypes evaluated at four environments.

Genotype	Plant height (cm)				Days to maturity (no)				Pods/ plant (no)			
	Shendi	Shambat			Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	12.72	3.56	7.78	14.96	1.02	9.20	-6.80	6.90	0.59	51.37	53.82	71.59
ILC 6119	10.92	8.76	17.52	13.04	0.00	-1.20	- 9.71	-3.70	31.72	74.19	20.15	70.42
ILC 4291	18.03	11.16	1.56	12.86	2.08	5.68	-15.31	6.90	44.99	55.91	49.24	53.90
ILC 1792	14.79	-0.46	3.04	19.50	0.000	10.11	1.77	12.50	40.57	55.09	1.34	65.00
ILC 3210	18.16	-3.50	8.63	14.98	2.94	11.96	-4.59	13.04	-16.39	-35.0	33.57	74.61
ILC 3843	16.89	9.15	3.83	7.29	5.00	8.99	-7.48	5.88	40.92	46.70	29.83	51.72
ILC 3105	12.00	8.89	13.95	12.41	1.02	8.14	- 5.31	11.36	-39.29	17.47	1.98	63.46
Flip 88-42C	3.72	3.82	10.27	7.60	-1.03	0.00	-7.77	3.80	6.58	34.87	56.25	54.23
Flip 87-58C	13.81	7.04	10.30	12.04	2.11	5.06	0.00	6.41	25.36	40.73	24.09	71.21
Flip 87-85C	16.01	1.15	14.33	0.85	3.06	6.17	-6.00	8.64	15.05	36.49	48.03	40.25
Rubatb	21.54	11.32	12.46	19.79	-2.00	12.64	-6.54	9.52	51.17	64.83	22.78	68.41
Wad-Hamid	12.08	9.00	8.14	4.55	2.11	6.33	-4.00	7.60	60.60	51.42	28.25	58.81

Table 2 continued.

Genotype	Seeds/pod (no)				100-seed weight (g)				Bimass yield (kg/ha)			
	Shendi	Shambat			Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	16.53	-0.93	1.23	6.13	7.38	6.69	8.75	5.81	-5.17	24.21	16.73	43.48
ILC 6119	2.92	2.19	4.68	-2.34	4.36	26.50	0.56	15.72	40.60	15.24	23.68	44.00
ILC 4291	0.69	11.05	19.02	9.38	3.09	36.02	16.21	15.97	35.82	38.04	33.16	49.62
ILC 1792	1.69	1.81	11.06	10.91	-2.52	8.00	-3.14	10.27	29.73	20.64	41.88	49.58
ILC 3210	-22.73	25.47	2.33	8.79	10.48	12.45	9.30	9.97	3.63	13.00	38.43	37.79
ILC 3843	9.48	-5.36	10.14	4.81	2.61	26.14	3.28	17.16	38.58	37.20	30.31	25.35
ILC 3105	-43.66	14.58	19.27	11.05	6.38	30.11	-1.81	2.93	21.66	19.77	43.58	42.34
Flip 88-42C	11.61	15.68	22.28	6.58	-4.85	23.66	11.52	8.08	-4.62	21.06	34.18	43.23
Flip 87-58C	17.95	-21.4	2.79	6.30	-1.43	27.04	4.63	6.97	30.92	33.42	46.61	44.01
Flip 87-85C	9.75	18.06	2.64	0.10	2.46	20.22	-1.08	6.20	21.03	19.51	31.73	43.17
Rubatb	15.75	16.12	15.21	24.73	-1.06	13.58	1.05	-3.35	20.43	29.60	25.64	35.67
Wad-Hamid	19.98	5.02	-2.94	2.37	-0.63	18.58	-0.33	28.53	53.90	16.00	27.61	44.15

Table 2 continued.

Genotype	Seed yield (kg/ha)				Harvest index (%)			
	Shendi	Shambat			Shendi	Shambat		
	Nov.05	Dec.04	Nov.05	Dec.05	Nov.05	Dec.04	Nov.05	Dec.05
ILC 6023	-0.59	72.37	32.60	68.53	6.23	61.46	20.66	43.12
ILC 6119	36.82	86.8	12.17	75.00	-8.52	85.26	-17.99	52.89
ILC 4291	20.84	76.74	51.61	75.95	-7.00	66.11	39.27	50.60
ILC 1792	27.83	64.39	44.65	76.71	-3.64	56.91	5.05	54.35
ILC 3210	43.75	66.89	48.67	68.75	44.59	60.24	19.30	52.38
ILC 3843	22.49	67.40	20.31	54.72	-28.87	51.35	-1.25	38.82
ILC 3105	-3.55	65.19	55.00	70.42	-31.72	63.67	29.21	46.19
Flip 88-42C	12.18	67.57	55.38	58.18	25.69	60.65	31.80	23.10
Flip 87-58C	45.26	66.85	55.20	65.00	25.46	52.84	20.29	38.93
Flip 87-85C	33.97	51.14	36.37	63.08	17.86	43.92	13.64	35.09
Rubatb	-9.86	79.65	36.32	62.12	-35.54	71.08	15.34	41.09
Wad-Hamid	83.76	58.87	20.51	67.11	-63.20	51.86	-4.67	39.96

Table 3.. Percent reduction and susceptibility index due to water stress in the performance of 12 chickpea genotypes evaluated under normal and water stress condition at Shambat and Shendi in 2004 and 2005 seasons.

Genotype	Plant height(cm)		No. of days to maturity		Number of pos/ plant		Number of seeds/ pod	
	% Red	Susc.	% Red	Susc.	% Red	Susc.	% Red	Susc.
ILC 6023	9.96	93.96	2.13	99.07	47.80	120.96	6.11	82.68
ILC 6119	12.99	122.55	-4.35	-202.33	40.33	101.97	1.89	25.58
ILC 4291	11.09	104.62	-1.09	-50.23	49.90	126.14	10.50	141.54
ILC 1792	9.62	90.76	6.12	284.65	35.30	89.15	6.27	84.84
ILC 3210	10.73	101.23	5.05	234.88	34.00	85.97	5.15	69.55
ILC 3843	9.42	87.17	2.11	97.67	39.10	98.89	4.83	65.36
ILC 3105	12.06	113.77	3.13	145.12	15.90	40.30	2.74	37.08
Flip 88-42C	6.58	62.08	-1.12	-52.09	37.60	94.97	14.12	191.07
Flip 87-58C	10.90	102.83	3.41	158.61	39.50	99.82	1.61	21.79
Flip 87-85C	9.02	85.09	2.22	103.26	37.70	83.49	7.46	100.81
Rubatab	16.47	155.38	2.13	99.07	49.70	125.69	19.80	267.93
Wad-Hamid	8.41	79.34	2.27	105.58	47.30	119.47	6.16	83.36

Table 3. continued

Genotype	100-seed weight (g)		Biomass yield kg/ha		Seed yield (kg/ ha		Harvest index %	
	% Red	Susc.	% Red	Susc.	% Red	Susc.	% Red	Susc.
ILC 6023	7.32	76.65	18.56	58.11	38.76	84.36	30.98	109.70
ILc 6119	11.18	117.00	34.12	106.83	40.94	89.00	24.32	86.12
ILC 4291	16.71	174.87	38.49	120.48	55.64	121.00	43.20	152.98
ILC 1792	2.79	29.22	38.25	119.73	52.12	113.30	27.62	97.81
ILC 3210	10.48	109.74	24.58	76.96	54.99	119.50	42.27	149.68
ILC 3843	11.24	117.70	33.27	104.16	34.55	75.10	19.32	68.41
ILC 3105	9.03	94.56	34.48	107.92	49.59	107.80	32.79	116.11
Flip 88-42C	9.23	96.65	22.31	69.85	40.79	88.70	14.25	50.43
Flip 87-58C	8.21	85.97	38.17	119.51	57.42	124.80	34.87	123.44
Flip 87-85C	6.09	63.77	29.20	91.42	45.53	99.00	26.30	93.13
Rubatab	2.22	23.25	26.66	83.44	38.15	61.20	28.70	101.63
Wad Hamid	11.11	116.30	41.44	129.74	55.38	120.40	14.66	51.91

تاثير الاجهاد المائى ومواعيد الزراعة على محصول الغلة ومكوناتها لبعض طرز الحمص

عبداللطيف محمد الامين [1] وعبدالوهاب حسن عبدالله[2]

1.هيئة البحوث الزراعية, محطة ابحاث شمبات, الخرطوم بحرى– السودان
2.جامعة الخرطوم, كلية الزراعة, شمبات, الخرطوم بحرى – السودان

المستخلص

أجريت هذه الدراسة على محصول الحمص خلال الموسم 2004/05, 2005/06 بكل من محطة بحوث شمبات ومحطة بحوث شندى بهدف دراسة معدل الاصابة بالاجهاد المائى والنسبة المئوية للانخفاض فى محصول الغلة ومكوناتها لعدد 12 طرزا وراثية من الحمص تحت مستويين من المعاملات المائية وتاريخى زراعة (منتصف نوفمبر ومنتصف ديسمبر)، واستخدم تصميم القطاعات المنشقة بأربعة مكررات حيث استعملت في القطع الرئيسة اثنان من المعاملات المائية هما الري العادي (10 – 12 يوما بين الريات) والإجهاد المائي (إيقاف الري لمدة ثلاثة أسابيع خلال مرحلة الإزهار) بينما استخدمت الطرز الوراثية في القطع الفرعية. اظهرت نتائج الدراسة ان الزراعة المبكرة خلال نوفمبر اعطت اعلا انتاجية من محصول الغلة ومكوناتها. الصنفان Rubatab وWad-Hamid اعطيا أعلى إنتاجية من محصول الغلة فى الاربعة مواقع وتحت ظروف الري العادي فيما اعطى الصنفان Rubatab وILC 6023 اعلا انتاجية من الغلة تحت ظروف الاجهاد المائى.اوضحت الدراسة ايضا انه حدث نسبة انخفاض كبيرة فى انتاجية الغلة ومكوناتها فى الاربعة بيئات بسبب الاجهاد المائى. طول النبات حدثت به نسبة انخفاض طفيف ومدى ضيق لمعدل الاصابة بالاجهاد المائى بين الطرز, بينما ادى الاجهاد المائى للاسراع فى عدد ايام النضج للطرز الوراثية واظهار مدى واسع لمعدل الاصابة للعطش. اظهرت انتاجية الغلة (كجم/هكتار), عدد القرون للنبات , الوزن الحيوى للمحصول (كجم/هكتار) ومعدل الحصاد اعلا نسبة للانخفاض بين الصفات المدروسة ومدى ضيق فى معدل الاصابة بالاجهاد المائى مقارنة بالصفات الاخرى مما يدل على أن محصول الحمص شديد الحساسية للاجهاد المائى خلال مرحلة الازهار. بعض الطرز (Rubatab, ILC 6023, ILC3105 and ILC1792) اظهرت نسبة انخفاض ومعدل اصابة أقل لهذه الصفات علية أوصت الدراسة باختبارها لسنوات اكثر تحت ظروف الاجهاد المائى للتأكد من تحملها للجفاف ومن ثم اجازتها كاصناف لهذه المواقع. كذلك اوضحت الدراسة ان الطرز الاعلى فى وزن البذرة اكثر تاثرا بالانخفاض وبمعدل الاصابة عن الطرز الاقل وزنا للبذرة لنفس الصفة. الطرز ILC4291 هو الوحيد الذى ايصاب بمعدل اجهاد مائى عالى لكل الصفات المدروسة تقريبا بينما الطرز الاخرى تختلف شدة معدل الاصابة بالاجهاد المائى لها من صفة للاخرى. خلصت الدراسة ايضا الى أن الزراعة المبكرة خلال نوفمبر تعطى انتاجية عالية من الغلة ومكوناتها عن الزراعة المتأخرة خلال ديسمبر عليه توصى الدراسة بالزراعة المبكرة خلال نوفمبر.