Journal of Biotechnology
and Crop Science
4(5): 35-38, 2015

Effect of drought stress on carbohydrate content in drought tolerant and susceptible chickpea genotypes

Sarita Devi Gupta, Pratibha Singh, RN Kewat, Manjri, Akanksha Singh

Received: 06 October 2015 Revised Accepted: 04 November 2015

ABSTRACT

Drought stress is one of the major abiotic stresses in agriculture worldwide. The study was carried out to investigate the effect of drought stress on carbohydrate content in drought tolerant and susceptible chickpea genotypes. A field experiment was carried out at Student's Instructional Farm in a randomized block design with three replications and in the laboratory of Department of Biochemistry during *Rabi* season of 2013-14 and 2014-15. The tolerant variety accumulated more carbohydrate content than the sensitive one. Results showed that carbohydrate content ranged between 61.51 to 66.64 per cent in the year 2013-14 and 61.44 to 66.53 per cent in the year 2014-15. First year experiment recorded highest carbohydrate content in tolerant genotype K 850 (66.64%) and the lowest value were recorded in susceptible genotype PUSA 372 (61.51 %). In the second year experiment maximum carbohydrate content was recorded in K 850 (66.53%) whereas, the lowest value was noticed in PUSA 372 (61.44 %). Analysis of the data indicates that genotypes diferred significant with regard to carbohydrate content in both of the years. So, carbohydrate in stress condition can be used as markers for selection of drought tolerant genotypes.

Key Words: *Chickpea, Carbohydrate, Drought stress, Genotype, Tolerant*

INTRODUCTION

Chickpea (*Cicer arietinum* L.), also called Bengal gram, is an old world pulse crop and is one of the seven Neolithic founder crops in the fertile crescent of the Near East. Currently, chickpea is grown in over 50 countries across the Indian sub continent, North Africa, Middle East, southern Europe, America and Australia. Globally, chickpea is the third most important pulse crop in production, next to dry beans and field pea. Drought is the most severe abiotic stress factor limiting plant growth and crop production. When plants are subjected to various abiotic stresses, some reactive oxygen species (ROS) such as superoxide (O-), hydrogen peroxide (H_2O_2), hydroxyl radicals (·OH) and singlet oxygen ($1O_2$) are produced. However, under various abiotic stresses the extent of ROS production exceeds the antioxidant defense capability of the cell, resulting in cellular damages (Almeselmani *et al* 2006). Drought stress increased water soluble carbohydrate (WSC) concentration at flowering stage. Plants usually had the highest carbohydrate levels when grown under drought during vegetative phase and during anthesis. Owing to their solubility they may help plants to survive periods of osmotic stress induced by drought. The tolerant variety accumulated more soluble carbohydrate than the sensitive variety. Drought stress at vegetative stage did not increase WSC, but severe drought stress during vegetative and flowering phases increased WSC in drought resistance chickpea cultivars (Mafakheri *et al* 2011). Water soluble carbohydrate roles as a compatible solute under drought stress and might be a useful marker for

Sarita Devi Gupta (✉), Pratibha Singh, RN Kewat
Department of Agriculture Biochemistry, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad-224229
Email: sarita.nduat@gmail.com

Manjri
Department of Crop Physiology, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad-224229

Akanksha Singh
Department of PMB & GE, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad-224229

selecting more drought tolerant varieties. Changes in carbohydrate, in addition to depending on severity and duration of water deficit, might also reflect genotypic differences in the regulation of carbon metabolism and partitioning at the whole plant level (Praxedes *et al* 2005).

The total carbohydrate includes monosaccharides and oligosaccharides, starch and other polysaccharides. Starch is the most abundant pulse carbohydrate and varies from 31.5 to 53.6 per cent (Shad *et al* 2009). In drought tolerant plants the accumulation of higher amounts of soluble carbohydrates, glucose, sucrose and fructose demonstrated as markers for selection of drought tolerant genotypes (Kerepesi and Galiba 2000).

MATERIALS AND METHODS

Plant materials: The experiment was carried out with thirteen chickpea (*Cicer arietinum* L.) genotypes in which seven genotypes (K 850, KWR 108, RSG 888, BG256, BG 362, JG 11 and SAKI 9516) were drought tolerant and rest of the six (DCP 92-3, JG 315, GCP 105, NDG 54, PUSA 372 and Pant G 186) were susceptible type. Seeds of these genotypes were obtained from the department of Genetics and Plant Breeding of the university (NDUA & T) Kumarganj, Faizabad.

Experimental site: The field experiment was conducted at Students Instructional Farm of Narendra Deva University of Agriculture and Technology Kumarganj, Faizabad (U.P.). The site of field experiment laid under the humid and sub-tropical climate and is located between 24.47^0 and 26.56^0 North latitude and 82.12^0 and 83.98^0 longitude and elevation of about 113 m from the sea level in the gangetic alluvium of eastern U.P. The climate of area is semi arid with hot summer and cold winter. In order to determine the physico-chemical properties of soil and its fertility status, soil samples were collected from different places of field with the help of soil auger from a depth of 0.15 cm before applying the treatments. The soil sample taken from each spot was mixed together and composite samples was prepared and analyzed for different properties of soil. The result of soil analysis indicates that the soil of experimental field was silty loam in texture with slightly alkaline in reaction. Besides this the soil was low in nitrogen, phosphorus and medium in available potassium while deficient in sulphur. The experiment was of a randomized block design with three replications.

Methods of analysis: Total carbohydrate content was determined as described by Yemme and Wills (1954). Accordingly, one g of dried sample was transferred to 100 ml glass stoppard measuring cylinder. It was added with 10 ml of distilled water and stirred with a long glass rod to disperse the sample thorough it. Further, 13 ml of 52 per cent perchloric acid was added and frequently stirred for 20 minutes. The volume was made up to 100 ml with water. It was then mixed properly and filtered. It was diluted to the mark with water and mixed properly. Ten ml of the sample extract was diluted to 100 ml and preceded as follows:

i- One ml of diluted filtrate in duplicate was pipetted in to the test tubes.
ii- Duplicate blank was prepared using 1 ml of distilled water into another test tube.
iii- Duplicate standard using 1 ml of standard glucose (100 mg/ml) was pipetted into separate test tube.
iv- Five ml of anthrone reagent (0.1% in concentrated H_2SO_4 was added into all the test tubes.

The test tubes were kept in a water bath for 12 minutes for development of colour and it was measured at 630 nm on spectronic- 20.

RESULTS AND DISCUSSION

Drought stress increased the carbohydrate concentration in all drought tolerant chickpea genotypes in comparison to drought susceptible chickpea genotypes. It was estimated that carbohydrate content ranges between 61.51 to 66.64 per cent in the year 2013-14 and 61.44 to 66.53 per cent in the year 2014-15. First year and second year experiment recorded highest carbohydrate content in same genotype in K 850 (66.64%) and K 850 (66.53%), respectively. Analysis of the data indicates that genotypes diferred significant with regard to carbohydrate content in both the years. The result was closely supported by Benu and Srivastav (2006), Shad *et al* (2009) and Salem and Arab (2011) who reported that carbohydrate content varied from 53.75 to 65.44 per cent. Starch is the principal carbohydrate of chickpea seed. The amylose constitutes 31.86-45.8 per cent of starch whereas, remainder is amylopectin. The sugar and crude fibre constitute most of other carbohydrate together with protein influenced the functional properties of chickpea flours and their food products. The availability of carbohydrate is important in terms of calorific value (Ali *et al* 2003).

Generally plants had the maximum carbohydrate content when grown under drought stress condition. Owing to their solubility they may help plants to survive periods of osmotic stress induced by drought.

Experimental findings revealed that drought tolerant chickpea genotype ‘K 850’ had the maximum carbohydrate content and genotype ‘PUSA 372’ the lowest carbohydrate content. The tolerant genotype accumulated maximum carbohydrate than the sensitive one. Results indicated that severe drought stress increased carbohydrate in drought resistance chickpea cultivars. The results indicate to close favour with Praxedes *et al* (2005) and MC Kersie and Leshem (1994) who reported that carbohydrate roles as a compatible solute under drought stress and might be a useful marker for selecting more drought tolerant genotypes. Changes in carbohydrate, in addition to depending on severity and duration of water deficit, might also reflect genotypic differences in the regulation of carbon metabolism and partitioning at the whole plant level.

Variation in carbohydrate content in different genotypes of tolerant and susceptible chickpea genotypes.

Genotype	2013-14	2014-15
K 850	66.64	66.53
KWR 108	66.47	66.40
DCP 92-3	62.87	62.57
RSG 888	66.54	66.43
BG 256	64.86	64.91
BG 362	63.34	63.22
JG 315	63.17	63.10
JG 11	64.80	64.40
SAKI 9516	63.88	63.83
GCP 105	63.21	63.12
NDG 54	61.91	61.86
PUSA 372	61.51	61.44
Pant G 186	62.29	62.31
SEm±	0.23	0.42
CD (at 5%)	0.69	1.24

Chickpea (*C. Arietinum* L.) is an agronomically significant plant which has an essential role in the economy and human diet especially in developing countries. Chickpea is successfully grown under conditions which limit growth of other plants. It is especially affected by drought which delays flowering and decreases yield in mediterranean and sub-tropical climates. The aim of this study was to determine the effect of drought on tolerant and susceptible chickpea genotypes which can be used to identify chickpea plant tolerance to drought stress. In the present study, the results show that the varietal differences were significant with regards carbohydrate content. It can be concluded that severe drought stress increased carbohydrate content in drought resistance chickpea genotypes.

ACKNOWLEDGEMENTS

We would like to thank DST- INSPIRE for the financial support for Ph. D programme and to the department of Genetics and Plant Breeding of the university (NDUAT) Kumarganj, Faizabad for kindly providing the seeds of chickpea genotypes.

REFERENCES

Ali M, Kumar S, Singh NB (2003) Nutritional quality and utilization of chickpea. Chickpea Research in India IIPR 303-316.

Almeselmani M, Deshmukh PS, Sairam RK, Kushwaha SR, Singh TP (2006) Protective role of antioxidant enzymes under high temperature stress. Plant Sci 171: 382–388.

Benu S, Srivastava SK (2006) Nutritive value of new chickpea (*Cicer arietinum*) varieties. J of Food Agriculture and Environment 4(1): 48-53.

Mafakheri A, Siosemardeh A, Bahramnejad B, Struik PC, Sohrabi Y (2011) Effect of drought stress and subsequent recovery on protein, carbohydrate contents, catalase and peroxidase activities in three chickpea (*Cicer arietinum*) cultivars. AJCS 5(10): 1255-1260.

McKersie BD, Leshem YY (1994) Stress and stress copping in cultivated plants. Kluwer Academic Publishers London.

Praxedes SC, DaMatta FM, Loureiro MEG, Ferrao MA, Cordeiro AT (2005) Effects of long term soil drought on photosynthesis and carbohydrate metabolism in mature robusta coffee (Coffea canephora Pierre var kouillou) leaves. The Biochemstry 6:94-99

Salem, Arab (2011) Properties Physico-chemical of tempeh produced from chickpea seeds. The Journal of American Science 7(7): 107-118.

Shad AM, Perrez H, Zafar Z, Haq UZM, Nawaz H (2009) Evaluation of biochemical compositio n and physico-chemicalparameters of oil from seeds of desi chickpea varieties cultivated in arid zone of Pakistan. Pak J Bot 41(2): 655-662.

Yemme EW Wills AJ (1954) The estimation of carbohydrate in the plant extracted by anthrone. Biochem J 87: 508-514.