International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 10, 2018, pp.-6126-6127.
Available online at https://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

LEAF WATER POTENTIAL AS SCREENING TECHNIQUE FOR DROUGHT RESISTANCE IN PIGEONPEA [*Cajanus cajan* L Millsp.]

SAKHARE PRASANNA*[1], FAKRUDIN B.[2] and LOKESHA R.[3]
[1]Wheat scheme, MARS, University of Agricultural Sciences, Dharwad, 580005, India
[2]Department of Biotechnology and Crop Improvement, Post Graduate centre, Bengaluru, 560065, India
[3]Department of Genetics and Plant Breeding, College of Agriculture, University of Agricultural Sciences, Raichur, 584101, India
*Corresponding Author: Email - jprasannavs@gmail.com

Received: May 17, 2018; Revised: May 26, 2018; Accepted: May 27, 2018; Published: May 30, 2018

Abstract: Leaf water potential (LWP) represents a good indicator of the water status of plants, and continuous monitoring of it can be useful in research and field applications such as scheduling irrigation. Assessment of Leaf water potential, a physiological trait indication of drought tolerance among 20 genotypes of Pigeonpea chosen from core collection was done. Drought was induced by withholding irrigation at 30 days after sowing and following which alternate days LWP was monitored. LWP of stressed plants decreased rapidly compared to control plants. After 33 days of drought period a reduction of 71 % in LWP was recorded compared to control. At the end of stress period maximum LWP was recorded by ICP-8863 (-12.79 bars). Whereas control was at -4.10 bars. Upon re-watering, the genotypes CORG-9701, GRG-206, Gullyal white, ICP-8863, ICP-87119, ICP-96058, TS-3 and UPAS-120 had shown the recovery while rest died.

Keywords: Pigeonpea, Leaf water potential (LWP)¸ Drought, *Cajanus cajan*

Citation: Sakhare Prasanna, *et al*., (2018) Leaf Water Potential as Screening Technique for Drought Resistance in Pigeonpea [*Cajanus cajan* L Millsp.]. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 10, pp.- 6126-6127.

Academic Editor / Reviewer: Abdelsalam Mohammed Ibrahim, Dr Abhijit Borah

Introduction

Drought tolerance character of pigeonpea makes it as a successful crop in areas of low and uncertain rainfall. Considerable yield improvement can be made in pigeonpea with the selective utilization of germplasm, comprising excellent sources of resistance to diseases and pests and other important agronomic characteristics. Plants have evolved several mechanisms such as *viz*., drought escape, drought avoidance or dehydration postponement and drought tolerance to combat drought stress [1]. Mechanisms that confer avoidance or postponement of drought maintain higher water potential under conditions of decreased soil water content by the virtue of root system. Maintaining an adequate cell water content and/or water potential despite a low water content of soil and/or atmosphere is important. However, drought tolerance essentially refers to an ability of plant's cell to survive and metabolically function markedly desiccated and reduced water potentials situations [2]. Osmotic adjustment (OA) helps to maintain higher leaf relative water content (RWC) at low leaf water potential (LWP). Evidences indicate that OA helps to sustain growth while the plant is meeting transpirational demand by reducing its LWP. OA is considered as a major cellular adaptive response of crop plants that yield under stress [3]. Leaf water potential at wilting or turgor loss point is a determinant of the tolerance of leaves to drought stress and contributes to plant-level physiological drought tolerance [4]. Water potential index (WPI) is considered as an expression of the sensitivity of the trait to water stress and this WPI is derived from the integral of the course of leaf water potential [5]. Dehydration tolerance and levels of OA in certain genotypes of pigeonpea has been reported [6]. An understanding of LWP among genotypes in a moisture stress regime helps to pin down the genotype which could potentially useful in breeding crop drought tolerance in pigeonpea. Withholding water from potted 6-week-old pigeonpea plants caused a gradual decrease of leaf water potential and RWC. Upon rewatering, the leaf water relations recovered rapidly to their initial values [7]. Such a response is typical for a dehydration tolerant plant [8] and is like that observed in earlier studies with pigeonpea [9]. Leaf water potential estimation is considering one of the important quantitative measurements of drought tolerance of crop [10, 11]. It has been reported that LWP is an important physiological trait for drought tolerance under water deficit [12]. This technique provides an easy method to screen for drought-resistant barley [13]. Leaf water potential represents a good indicator of the water status of plants, and continuous monitoring of it can be useful in research and field applications such as scheduling irrigation. This study was undertaken to determine the relative drought tolerance of twenty genotypes of pigeonpea by measuring LWP as a tool.

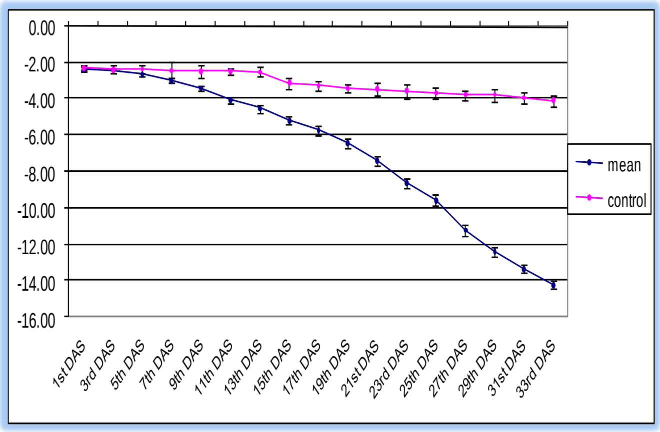
Materials and Methods

Twenty genotypes of pigeonpea *viz*., Black tur, BSMR-736, CORG-9701, GC-11-39, GRG-206, GRG-263, GRG-264, GS-1, Gullyal red, Gullyal white, ICP-8863, ICP-84060, ICP-87119, ICP-96058, ICP-96053, PG-12, PT-221, TS-3, UPAS-120 and WRP-1 were selected from the core collection at Agricultural Research Station, Gulbarga for present investigation. These genotypes comprised of advanced breeding lines, popular varieties, and land races. The experiment was laid out in RCBD design with 12 replications in which genotypes were raised in the plastic bags of size 30 cm X 18 cm. Among these, six replications were kept as control and remaining six replications are subjected to drought. Initially 2-3 seeds were sown in each pot and finally single plant per poly bag was retained. Drought was induced by withholding irrigation when plants attained 30 days from sowing; irrigation was restricted from 31st day after sowing. From the day of withholding irrigation the Leaf Water Potential (LWP) was measured by pressure chamber method [14] using the instrument Aramid-3000 every alternative day.

The fresh leaf was immediately excised with a single cut using sharp razor and placed in the chamber of Aramid-3000 with the cut end of the petiole protruding out from the rubber bung. The chamber was locked and then the pressure was applied on the leaf from the nitrogen gas cylinder till a drop of sap oozed out from the cut surface. Further rise of pressure was stopped and the water potential was recorded directly from electronic gauge and expressed in negative bars.

Results and Discussion

Response of pigeonpea genotypes to the drought stress was observed by taking leaf water potential after inducing drought. Genotypes showed marked variability with respect to leaf water potential (LWP). Leaf water potential of stressed plants was decreased rapidly compared to rate of decline in case of control plants [Fig-1] which is like the findings of [3,9,15]. After thirty-three days, non-irrigated plants exhibited a leaf water potential 71 % lower compared to control plants (irrigated daily) which is evident [16]. Normally pigeonpea is drought tolerant, have mechanisms of osmotic adjustment that reduce the use of water during the drought. This mechanism causes an increase on the concentration of the cell solution that may also increase tolerance to drought. It is also reported that values of leaf water potential reduced close to 25 % and transpiration decreased approximately 50 %, while the water use efficiency increased to 60 % [16]. This opens a new perspective for plant breeders that could try to associate these characteristics and develop new pigeonpea cultivars more tolerant to water stress [9]. The variance of leaf water potential among genotypes was very less at early days of stress (up to 15 days after imposition of water stress). It increased as days after stress increased. Maximum variance was observed on 25th day after suspension of irrigation and after again it reduced. Symptoms of leaf rolling were only visible below -9 bars, and severe wilting was observed in the plants with leaf water potentials lower than -13 bars. At the end of stress period, that is at severe stress, maximum LWP was shown by the genotype ICP-8863 (-12.79) and minimum was shown by the genotype GRG-264 (-15.83) whereas the control now was -4.10.



*DAS = Days after stress

Fig-1 Leaf water potential (LWP) in successive days after stress among pigeonpea accessions. Bars represent S.Em.

Conclusion

The results suggest that 'ICP-8863' is more drought tolerant than 'GRG-264', because it avoided the loss of water via transpiration and maintained the leaf water content under stress. At end of the stressed period of 34 days, the plants were rewatered to know the recoverability. The genotypes CORG-9701, GRG-206, Gullyal white, ICP-8863, ICP-87119, ICP-96058, TS-3 and UPAS-120 would recover with drying of few leaves.

Application of Research

The identified genotypes *viz*., CORG-9701, GRG-206, Gullyal white, ICP-8863, ICP-87119, ICP-96058, TS-3 and UPAS-120 can be utilized in drought tolerance breeding program. These can be helpful in developing new elite lines which might be having drought tolerance character with the background of good agronomic characters.

Abbreviations:

% : Percentage, SEm : Standard error of mean, OA : Osmotic adjustment
RWC : Relative water content, LWP : Leaf water potential

Acknowledgement / Funding: Author thankful to University of Agricultural Sciences, Dharwad, 580005, India

***Research Guide or Chairperson of research: Dr B. Fakrudin**
University: University of Agricultural Sciences, Dharwad, 580005
Research project name or number: M.Sc Thesis

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Jones M.M., Osmond C.B. and Turner N.C. (1982) *Australian Journal of Plant Physiology*, 7,193-205.
[2] Sullivan C.Y., Yoshikawa F., Eastin J.D., Ross W.M., Clegg M. D., Maranville J.W. and Hallister A.L. (1971) *Annual Report No. 5. University of Bebraska coop. Res. Div. of ARS/USDA, RockfetLer Foundation*, 9-23.
[3] Blum A. (2005) *Australian Journal of Agriculture Research*, 56, 1159-1168.
[4] Isabelle Maréchaux, Megan K. Bartlett, Lawren Sack, Christopher Baraloto, Julien Engel, Emilie Joetzjer and Jérôme Chave (2015) *Functional Ecology*, 29, 10.
[5] Ioannis G. Argyrokastritisa, Papastylianoub P.T. and Alexandrisa S. (2015) *Agriculture and Agricultural Science Procedia*, 4, 463-470.
[6] Scholander P. F., Hammel H.T., Hemmingsen E.A. and Bradstreet E.D. (1964) *Proceeds of National Academy of Science of the USA*, 52, 119-25.
[7] Keller F. and Ludlow M.M. (1993) *Journal of Experimental Botany*, 44(265), 1351-1359
[8] Ludlow M.M., Muchow R.C.(1990) *Advances in Agronomy*, 43, 107–153.
[9] Flower D.J. and Ludlow M.M. (1986) *Leaves, Plant, Cell and Environment*, 9(1), 33-40.
[10] Ekanayake I., O'Toole, J.C., Garrity D. P. and Masajo T. M. (1985) *Crop Science*, 25, 927-933.
[11] Bashar M.K., Das R.K., Islam M.A., Miah N.M. and Ahmed S. (1990) *IRRN*, 15, 12-13.
[12] Jongdee B., Fukai S., Cooper M.(2002) *Field Crops Research*, 76(2–3), 153-163.
[13] Matin M.A., Jarvis H. Brown and Hayden Ferguson (1987) *Agronomy Journal*, 81,100-105.
[14] Scholander P.F., Hammel H.T., Hemmingsen E.A. and Bradstreet E.D. (1964) *Proceeds of National Academy of Science of the USA*, 52, 119-25.
[15] Jain M., Nandwal A. S., Kundu B.S., Kumar B., Sheoran I.S., Kumar N., Mann A. and Kukreja S. (2006) *Biologia plantarum*, 50, 303-306.
[16] Liberato M.A.R., Gonçalves J.F.C., Chevreuil L.R., Junior A.R.N., Fernandes A.V. and Junior U.M. S. (2006) *Brazalian Journal Plant Physiology*, 18(2), 315-323.