Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [2] 2017: 428-432

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Estimation Of Drought Tolerance In Groundnut Based On Physiological And Yield Traits

Anusha Hugar, A.[1, 2] and D. L. Savithramma[1]
[1]University of agricultural sciences, Bengaluru, Karnataka- 560065, India
[2]*Current address:* University of Agriculture Science, Raichur, Karnataka-584101, India
e-mail: annu555anush@gmail.com

ABSTRACT
Groundnut is severly affected by water deficit due to drought hit situations and global warming thus holding Indian agriculture at distress. For effectiveness in any crop improvement programme Genetic variability and association studies are pre-requisite. Since in field conditions destructive method becomes cumbersome surrogate traits linked to WUE i.e., SLA and SCMR can be utilised which are easy to measure and highly correlated with TE, WUE and also to yield.
Key words: *Groundnut, Water use efficiency (WUE), Soil Plant Analysis Development (SPAD) Chlorophyll Meter Reading (SCMR), Specific Leaf Area (SLA), Transpiration efficiency (TE).*

Received 02.07.2017 Revised 19.08.2017 Accepted 29.08.2017

INTRODUCTION

Groundnut is an important oil seed crop grown in India, largely cultivated as rainfed crop in dry land. Drought is the most important factor limiting the yield of rainfed groundnut. As per India's Ministry of Agriculture; during the Rabi season farmers rely largely on the residual moisture from the Southwest (summer) Monsoon, which occurs from June through September. The Southwest Monsoon was characterized as normal for most of the country. In contrast, the southern region receives 30 *per cent* of its rainfall from the later Northeast Monsoon, which occurs from October through December (Anon, 2017).

According to the Ministry as of January 19, 2017; planting was behind the normal pace throughout the major peanut-producing states in southern India: by 42 *per cent* in Andhra Pradesh, 15 *per cent* in Telangana, 16 *per cent* in Karnataka, and 62 *per cent* in Tamil Nadu due to deficit in soil moisture level.

The scarcity of water especially at the time of flowering and pegging stages affects the yield components to the maximum extent. Hence it also becomes very important to study both quantitative and qualitative characters related to drought resistance and also yield attributing characters. High yielding genotypes with greater adaptability could be bred more efficiently and effectively if attributes that confer drought tolerance could be identified and used as selection criteria.

II. Variability, heritability and genetic advance

The basic key to bring about the genetic upgrading to a crop is to utilize the available or created genetic variability. If the variability in population is largely due to genetic cause with least environmental effect, the probability of isolating superior genotype is a prerequisite for obtaining higher yield, which is the ultimate expression of various yield contributing characters. Therefore direct selection could be misleading. It is also difficult to judge what proportion of the observed variability is heritable and what proportion of variability is not. The process of breeding in such population is primarily conditioned by the magnitude and nature of interactions of genotypic and environmental variations in plant characters. Partitioning the observed variability into heritable and non-heritable components and to understand parameters such as genetic coefficient of variation, heritability, genetic advance and so on becomes a critical issue.

Variability exists in different proportions from high, moderate to low in the peanut genotypes studied in different experiments by various scientific communities. Reddi *et al.*, (1991) had reported high magnitude of variability, heritability and genetic advance for number of secondary branches, 100-pod weight, test weight, sound mature kernel *per cent* and pod yield per plant in 32 diverse groundnut genotypes grown at three environments. Senapathi and Roy, (1991) in an experiment with 51 bunch groundnut genotypes studied during four seasons reported a wide range of variability for pod yield and days to maturity and also significant genotype x environment interactions.

In general, a high coefficient of variability indicates that there is a scope of selection and improvement of these traits. A low value indicates the need for creation of variability either by hybridization or mutation followed by selection. Gowda *et al.,* (1996) reported higher variability for pod yield; moderate variability for pod number and test weight as well as low variability for shelling per cent and mature kernel per cent for two crosses of groundnut in a study involving the segregating F_4 generation also Singh and Singh, (1998) experimented on 15 cultivars of groundnut and reported that moderate variability was observed for days to 50 per cent flowering, days to maturity, plant height and number of pods per plant. However, wide range of variation was also observed for pod yield per plant, 100 seed weight and shelling per cent.

Apart from the above studies moderate variability was also reported by Suneetha *et al.,* (2004) who delineated the presence of high heritability coupled with moderate genetic advance for days to 50 per cent flowering, height of main axis, total dry matter per plant, 100-pod weight, 100-kernel weight and pod yield in a study involving 23 genotypes of groundnut.

Broad sense heritability and significant differences in genetic advance as per cent mean indicates the role of additive gene action in the inheritance of the traits same was reported and observed by John *et al.,* (2007) that plant height, number of secondary branches per plant, number of mature pods per plant, pod yield per plant, kernel yield per plant, haulm yield per plant and harvest index showed high estimates of GCV and PCV, heritability (broad sense) and significant differences in genetic advance as per cent mean among F_2 population of six single crosses and parents for all characters. Same perspective was found by Nandini *et al.*, (2010) reporting moderate to high degree of heritability and genetic advance as *per cent* mean for pod yield per plant, kernel yield per plant, pods per plant, sound mature kernel percentage, plant height, number of branches per plant and SLA indicating the involvement of additive gene action in controlling these traits. Also higher PCV estimates compared to GCV for all the characters studied was observed indicating the influence of environment on the characters.

III. Character association and path coefficient analysis

Adequate knowledge on interrelationships of different traits is always a prime requirement for gaining optimum results in plant breeding. Correlation of morphological traits and physiological traits with yield has been reported by several workers. These estimates are helpful in determining the complex trait such as yield. The correlation between the characters may exist due to various reasons such as pleiotropy, genetic linkage and association of loci or block of loci governing variability for different characters located on same chromosome.

Dry pod yield per plant showed positive correlation with plant height, branches per plant, pods per plant and total pods per plant (Tekale *et al.*, 1988). Varman and Raveendran (1989) on 37 Spanish, two Valencia and 11 Virginia bunch genotypes reported that there was a significant and positive correlation for length of main stem, primary and secondary branches and haulm yield with pod yield.

Also in another study involving 42 bunch groundnut varieties were used and it was reported that kernel yield exhibited significant positive correlation with pods per plant, kernels per plant, 100-kernel weight and shelling per cent whereas; days to 50 per cent flowering showed significant negative correlation with sound mature kernel and shelling per cent (Abraham 1990). Similarly, Manoharan *et al.,* (1990) revealed a significant and positive genotypic correlation between kernel weight and pod weight, pod length and pod width in 23 genotypes of groundnut.

In an field experiment involving 80 varieties of groundnut Pushkaran and Gopinathan Nair, (1993) reported that pod yield was highly correlated with fresh weight of pods, number of mature pods, number of immature pods, shelling per cent and haulm yield whereas, pod yield was found to have significant negative correlation with duration of flowering and number of flowers.

Strong positive association of pod yield with number of mature pods per plant, 100-kernel weight and biomass per plant was revealed by Moinuddin (1997) besides reporting that pod yield was negatively correlated with haulm yield and shelling *per cent*.

Forty four groundnut genotypes were analysed by Singh and Singh (1999) which indicated that 100-kernel weight had high significant correlation with days to flowering, days to maturity, plant height, number of branches, and weight of pods per plant.

Furthermore association studies which acts as selection criteria for the improvement of pod yield per plant was justified by investigation on 57 groundnut genotypes which revealed that kernel yield per plant had significant and positive association with days to 50 per cent flowering, plant height, number of secondary branches, number of unproductive pegs, number of immature pods, number of mature pods, sound mature kernel (SMK) weight, SMK number, total number of pods, total number of gynophores,

shelling percentage, 100-kernel weight and pod yield but the association of kernel yield with other characters was found non-significant (Mahalakshmi *et al.*, 2005).
In an investigation conducted by Korat *et al.,* (2010) revealed that the estimates of genotypic correlation coefficients are higher than their corresponding phenotypic correlations indicating a strong inherent association among the traits. Yield contributing characters like biological yield per plant, 100 kernel weight and harvest index showed significant and positive association with pod yield per plant. Whereas, days to maturity and pod yield per plant was found to have a negative and significant correlation.
Apart from yield contributing characters association between kernel yield, protein content and oil content can also be realised. Such study was reported by Pavan Kumar *et al.,* (2014) in Sixty six genotypes of groundnut studied where results revealed that kernel yield was significantly and positively associated with pod yield per plant, number of mature pods per plant, shelling percentage, harvest index, sound mature kernel percentage, specific leaf weight at 60 DAS, protein content and oil content.

IV. Studies on water use efficiency

Improvement in water use efficiency (WUE) of the cultivars is one such attribute that could potentially lead to high yield under limited water conditions. So, both for rainfed and irrigated situations, cultivars that are efficient in utilization of available water are very essential. Such a goal might be possible since several studies have indicated substantial genetic variation for seed yield determinants, namely water transpired, WUE and harvest index.
Physiologically, Water Use Efficiency (WUE) is defined at either single leaf level or at whole plant level and or at canopy level. Also the presence of genetic variability is a basic requirement for successful exploitation of WUE through breeding programmes. The yield model proposed by Passioura (1986) i.e., (Grain yield = Transpiration × Water Use Efficiency × Harvest Index) reveals that water use efficiency is an important parameter influencing the biomass production. It has often been examined from various points of view in different context by hydrologists, agronomists, and physiologists.
Chlorophyll (Chl) is the main pigment involved in light capture for photosynthesis and other photochemical and non-photochemical reactions; therefore the amount of light absorbed by a leaf is related to Chl content. Besides its importance in light capture, leaf Chl content may be used as an indicator of the light environment during plant growth. For example, the Chl *a*/*b* relationship is lower in shade than in sun leaves (Boardman 1977). Most common method for determining leaf Chl content involve leaf destruction, which precludes assessing leaf Chl content over time. As there is a close relationship between leaf nitrogen and leaf Chl content, the *SPAD-502* Chl meter has been used as a tool to assess leaf nitrogen content in crops (Gáborcik 2003, Fritschi and Ray 2007).
Specific Leaf Area (SLA) an indirect measure of leaf expansion is one of the physiological traits in plant analysis which is defined as the ratio of leaf area to leaf dry weight. Higher the values of SLA indicate higher leaf area per unit biomass and hence larger surface area for transpiration. At the same time, higher SLA denotes lesser leaf thickness and hence smaller photosynthesis capacity. Therefore, a negative relationship between SLA and Water Use Efficiency can be observed (Wright *et al.*, 1994).
Very initial report of Water Use efficiency in groundnut was given by Wright *et al.*, (1988) in container experiments and reviewed that the genetic variability in peanut plants with respect to WUE ranged from 2.46g dry matter per kg of water to 3.71g dry matter per kg of water. Existence of variability is very much necessary with respect to any trait for that matter for its utilisation in crop improvement. The variability in WUE was attributed to variation in total dry production than that of water use.
Hebbar *et al.*, (1994) at field capacity and 60 *per cent* capacity studied 14 Spanish bunch groundnut genotypes under two different moisture regimes reporting a significant variability in WUE between genotypes and moisture regimes. Roy Stephen (1995) reported the range of WUE between 2.92 to 4.07 g dry matter per kg of water under 100 per cent field capacity and between 3.19 to 5.46 g dry matter per kg of water under 50 per cent field capacity in a similar study conducted.
SCMR and SLA have been most widely used linked traits of WUE, for assessing the same Talwar *et al.,* (2004) in a study showed that SLA exhibited significant genotypic variations and was also negatively correlated with total chlorophyll content in seven Virginia genotypes of groundnut. In the same year Vasanthi *et al.* reported the significance of additive gene action for harvest index significance of non-additive gene action for SCMR and SLA in 30 crosses obtained by crossing six lines with five testers.
The extent of dependence of phenotype on environment can also be a function of the genes involved. Matters of heritability are complicated because genes may canalize a phenotype, making its expression almost inevitable in all occurring environments. Hari and Upadhyaya*.,* (2005) outlined that there was higher heritability and lower proportion of Genotype × Environment interaction variance to phenotypic variance in SCMR compared to SLA in 184 mini collections of groundnut. Also SCMR values were strongly correlated with pod yield and other economic traits than SLA with SCMR and SLA showing negative correlation. Songsri *et al.,* (2008) delineated the heritability of drought resistance traits and genotypic

and phenotypic correlations between drought resistance traits and agronomic traits further reporting that heritability for biomass, pod yield, HI, SLA, and SCMR were high and correlation between SLA and SCMR were strong and negative. SCMR was positively correlated with pod yield and seed size.

CONCLUSION

Generally, the phenotype of a plant is realised by its genetic composition, the environment in which the plant is grown, and the interaction of genotype with the environment. This poses a tremendous challenge to plant breeders to identify and select those plants that have desirable phenotypes due to the genetic component, rather than favorable phenotypes due to environmental effects. In this perspective, the above article compiles the studies so far conducted by the scientific community in the context of variability, heritability and association components in the groundnut. Physiological traits associated with drought tolerance are complex as well as difficulties associated with their measurements envisages the use of non-destructive method *i.e.,* the surrogate traits as a selection criterion for better WUE in the genotypes which are encapsulated in this manuscript.

REFERENCES:

1. Anonymous, 2017, Commodity intelligence Report. USDA, Foreign Agricultural Service [online]. Available: https://www.fas.usda.gov/highlights/2017/01/India/index.htm
2. Abraham, M. J., 1990, Correlation, Path and discriminant function analysis in Groundnut grown on P deficient acidic soil. *Crop Improv*., **17**(1)**:** 34 –37.
3. Boardman, N. K. 1977, Comparative photosynthesis of sun and shade plants. *Annu. Rev. Plant Physiol.* **28:** 355–377.
4. Fritschi, F. B. and J. D, Ray., 2007, Soybean leaf nitrogen, chlorophyll content, and chlorophyll a/b ratio. *Photosynthetica*., **45**: 92-98.
5. Gaborcik, N., 2003, Relationship between contents of chlorophyll (a+b) (SPAD values) and nitrogen of some temperate grasses. *Photosynthetica* **41**(2):285-287.
6. Gowda, M. V. C., Prabhu, T. G. and Bhat, R. S., 1996, Variability and association of late leaf spot resistance and productivity in two crosses of groundnuts. *Crop Improv*, **23**(1): 44-48.
7. Hari, D and Upadhyaya., 2005, Variability for drought resistance related traits in the mini core collections of groundnut. *Crop sci*., **45**: 1432-1440.
8. Hebbar, K. B., Sashidhar, V. R., Udaya kumar, M., Devendra, R. and Nageswara Rao, R. C., 1994, A comparative assessment of water use efficiency in groundnut (*Arachis hypogaea*) grown in containers and in field under water limited conditions. *J. Agril. Sci*., **122:** 429- 434.
9. John, K., Vasanthi, R. P. and Venkateswarlu, O., 2007, Variability and correlation studies for pod yield and its attributes in F2 generation of six Virginia x Spanish crosses of groundnut (*Arachis hypogaea* L.). *Leg Res*. **30**(4): 292-296
10. Korat, V. P., Pithia, M. S., Savaliya. J. J., Pansuriya, A. G. and Sodavadiya, P. R., 2010, Studies on characters association and path analysis for seed yield and its components in groundnut (*Arachis hypogaea* L.) *Legume Res*., **33** (3): 211 – 216.
11. Mahalakshmi, P., Manivannan, N. and Muralidharan, V., 2005. Variability and correlation studies in groundnut (*Arachis hypogaea* L.). *Legume Research* **28**(3): 194-197.
12. Manoharan, V., Varman, P. V. and Ramalingam, R. S., 1990, Character association in groundnut *(Arachis hypogaea L.)* hybrids. *Madras Agric. J.* **77**(9 –12): 512 -514.
13. Moinuddin, H. H., 1997, Evaluation of Genotype x Environment interaction in Groundnut (*Arachis hypogaea L.)* genotypes*.* M.Sc.(Agri) thesis submitted to University of Agricultural Sciences, Bangalore.
14. Nandini, C, Savithramma, D. L. and Naresh Babu, N., 2010, Genetic variability for surrogate traits of water use efficiency in F8 recombinant inbred lines of the cross NRCG12568 x NRCG12326 in groundnut (*Arachis hypogaea* L.). *Electron. J. Plant Breed.,* **2**(4): 555-558.
15. Passioura, J. B., 1986, Resistance to drought and salinity: Avenues for improvement. *Australian J. Plant Physiol*., **13**: 191-201.
16. Pavan Kumar, C., Rekha, R., Venkateswarulu, O. and Vasanthi, R. P., 2014, Correlation and path coefficient analysis in Groundnut (*Arachis hypogaea* L.). *Inter. J. Applied. Bio. Phar.Tech.,* **5**(1): 8-11.
17. Pushkaran, K. and Gopinathan Nair, V., 1993, Correlation studies in groundnut. J. Trop. Agri., **31**: 155-160
18. Reddi, M. V., Reddy, K. R., Reddy, K. H. P. and Rao, J. A., 1991, Heritability, genetic advance and character association in groundnut over three environments. *J. Maharashtra Agril. Univ.,* **16**(3): 383 –385
19. Roy Stephen, 1995, Genotypic variation in Water Use Efficiency in groundnut (*Arachis hypogaea* L.) and its relationship to carbon isotope discrimination and specific leaf area. *M.Sc. (Agri)* thesis submitted to the University of Agricultural Sciences.
20. Senapathi, B. K. and Roy, K, 1991, Stability analysis for pod yield and maturity of groundnut. *Crop Res.,* **4**(2): 253-257.
21. Singh, S. B. and Singh, J. P., 1998, Variation in yield and agro morphological characters in groundnut cultivars. *Crop Res.,* **16**(2): 146-149.
22. Singh, S. B. and Singh, J. P., 1999, Correlation analysis of growth and yield components in groundnut. *J. Maharashtra Agric. Univ.,* **24**(1): 48- 49.

23. Songsri, P., Jogloy, S., Kesmala, N., Vorasoot, C., Akkasaeng, A., Patanothai. and Holbrook, C. C., 2008, Heritability of drought resistance traits and correlation of drought resistance and agronomic traits in peanut. *Crop Sci.,* **48:** 2245-2253.
24. Suneetha, K., Dasaradha, C., Rami Reddy and Ramana, J. V., 2004, Genetic variation and character association in groundnut (*Arachis hypogaea* L.). In: proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh.
25. Talwar, H. S., Nageshwar Rao, R. C., Nigam, S. N. and Wright, G. C., 2004, Leaf Anatomical characteristics Associated with Water Use Efficiency in groundnut. *In*: proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh, pp.128.
26. Tekale, G. R., Dahiphale, V. V., Shelke, V. B. and Sondge, V. D., 1988, correlation and regression studies in Groundnut. *J. Maharastra Agric. Univ.,* **13**: 215.
27. Varman, P. V. and Raveendran, T.S., 1989, Stability analysis in certain Virginia groundnut genotypes. *J. Oilseeds Res.*, **6**: 165-167.
28. Vasanthi, P., Babitha, M., Reddy, P. V., Sudhakar, P. and Venkateswarulu, O., 2004, Combining ability for Water Use Efficiency in groundnut (*Arachis hypogaea* L.). In: proceedings of National symposium on enhancing productivity for sustaining food and nutritional security, NRCG, Junagadh.
29. Wright, G. C., Hubick, K. T. and Farquhar, G. D., 1988, Discrimination in carbon isotopes of leaves correlates with water use efficiency of field grown peanut cultivars. *Aust. J. Plant Physiol*., **15:** 815–825.
30. Wright, G. C., Nageshwara Rao, R. C. and Farquhar, G. D., 1994, Water use efficiency and carbon isotope discrimination in peanut under water deficit conditions. *Crop Sci.,* **34:** 92–97.

CITATION OF THIS ARTICLE

Anusha Hugar, A. and D. L. Savithramma. Estimation Of Drought Tolerance In Groundnut Based On Physiological And Yield Traits. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 2, 2017: 428-432