Genotype × Environment Interaction for Pod Yield in Groundnut

Iramma V. Goudar, U. Roopa, Guruprasad Hiremath, B.S. Yenagi and H.L. Nadaf*

AICRP on Groundnut, Oilseed scheme, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka, India

*Corresponding author

Abstract

Identification of stable performing genotypes in the changing environmental scenario is of prime importance in any breeding material of the present days. Eleven genotypes of Groundnut were evaluated for its stable performance over different dated of sowing at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka. The genotypes were evaluated in randomized block design with three replications. Substantial variation in mean performance of genotypes over different dates of sowing was observed. The mean squares due to genotype × environment (G×E) interactions were significant for dry pod yield indicating the environmental influence on the performance of genotypes. The regression coefficients (b_i) of the genotypes ranged from 0.61 to 1.19 and the deviation from regression (S^2_d) ranged from -0.02 to 0.15. All the genotypes except ICGV-0724, Dh-245 and TMV-2 deviated non-significantly from zero (S^2_d=0) hence they are stable. Among these genotypes, Dh-230, Dh-241, Dh-246 and Dh-247 shown average responsive as they deviated non-significantly from unity (b_i=1) and zero (S^2_d=0) with above average performance and are more suited to all three dates of sowing. Among the stable genotypes which shown average stable performance across the dates of sowing, Dh-230 (3749.22 kg/ha) followed by Dh-246 (3660.78 kg/ha) and Dh-247 (3598.56 kg/ha) showed higher mean dry pod yield compared to overall mean dry pod yield (3541.08 kg/ha). However the genotype ICGV-0724 is more suitable only for early sowing (4261.33 kg/ha) and G2-52 is more suited for early as well as mid late sowing (4069.78 kg/ha).

Keywords

Genotype, G×E interaction, Stability and Regression.

Article Info

Accepted: 12 September 2017
Available Online: 10 November 2017

Introduction

Groundnut (Arachis hypogaea. L) is one among the nine important crops of the world which is native to Brazil in South America and presently cultivated throughout tropical, subtropical and warm temperate regions of the world. It is mainly grown by resource-poor farmers in Africa and Asia to produce edible oil (48–50%) and for human consumption. It belongs to Leguminosae or Fabaceae family, a self-pollinating crop with basic chromosome number ten (2n = 4x = 40) (Stebbins 1957; Stalker and Dalmacio 1986) and genome size 2800 Mb (Guo et al., 2009).

In India, the crop is grown in about 4.60 million hectares with a production of 6.73 million tonnes with a productivity of 1460 kg per hectare (Anon., 2015). Karnataka is one of the five important states growing groundnut in India. It is grown in an area of about 0.65 million hectares with a production of 0.50 million tonnes and productivity of 769
kg per ha (Anon., 2015). Low productivity of
groundnut in the country is attributed to
several constraints and one among those is
poor adoption of improved varieties and their
inconsistent performance over range of
environments, as the crop is largely cultivated
as rainfed crop (Gadgil et al., 2012).
Therefore, it has become necessary to develop
varieties with attributes such as wide
adaptability.

The consistent performance of a genotype
over a range of environments is essential for a
wide stability of a variety. Stability of
genotypes depends upon maintaining
expression of certain morphological and
physiological attributes and allowing others to
vary, resulting in GxE interactions. GxE
interaction has a masking effect on the
performance of a genotype and hence the
relative ranking of the genotype do not remain
the same over number of environments.
Dixon et al., (1994) stated that GxE
interaction is the change in a cultivar’s
relative performance over environments,
which results from differential response of the
cultivar, to various edaphic, climatic and
biotic factors. GxE interaction occurs in two
ways. Firstly the difference between
 genotypes vary without alteration in their rank
i.e. GxE interaction is present because one
cultivar yields more than another cultivar in
all the environments, and secondly the
ranking between cultivars changes across
environments i.e. one cultivar will be more
productive in one environment, while the
other cultivar is more productive in another
environment. GxE is a phenomenon that is
very important and is of significance to plant
breeders, agronomist and farmers all over the
world. Breeding materials can be selected and
assessed on the basis of their different
responses to the environments. Studying of
gxe interaction is very important to plant
breeders because this interaction it can limit
the progress in the selection process and since
it is a basic cause of differences between
genotypes for yield stability. Understanding
the cause of GxE interaction is important to
help in selecting varieties with the best
adaptation and that can give stable yields.
Linnemann et al., (1995) stated that it is
important to understand crop development in
relation to biophysical conditions and changes
in season when selecting well-adapted
genotypes and correct planting date.

It is generally agreed that the more stable
genotypes adjust their phenotypic responses
to provide some measure of uniformity in
spite of environmental fluctuations.
Therefore, an attempt has been made in
present study to evaluate different groundnut
genotypes across the different date of sowing
to know the role of GxE interactions and also
to analyze the stability of genotypes for
different traits.

**Materials and Methods**

The present investigation comprising twelve
genotypes (Dh-230, Dh-232, Dh-241, ICGV-
0724, Dh-243, Dh-245, Dh-246, Dh-247,
GPBD-4, G2-52 and TMV-2) of groundnut
were evaluated for their stable performance
over three different environments created by
different dates of sowing (11th July(E1), 22nd
July(E2) and 4th August(E3) 2014) at MARS,
UAS, Dharwad during kharif 2014. The
genotypes were evaluated in randomized
block design (RBD) with three replications.
Each experimental unit of 4m×4m bed size
with 45×10 cm² inter and intra row spacing.
The recommended package of practices and
plant protection measures to raise a good crop
were timely and uniformly applied.

Combined analysis of variance over the dates
of sowing was estimated by assuming
replications effects as random and genotypes
effect as fixed effects. The phenotypic
stability parameters, linear regression
coefficient (b value), and deviation from regression ($S^2_d$) of genotype means over environment index were computed as suggested by Eberhart and Russell (1966). This model considered both linear ($b_i$) and non-linear ($S^2_{di}$) components of G×E interactions for the prediction of performance of the individual genotype.

**Results and Discussion**

The results of analysis of variation revealed that, the mean sum of squares due to varieties were significant for all the characters studied except dry pod yield (kg/net plot), Kernal yield (kg/net plot) and SMK(%) indicating the presence of substantial amount of variation in the material used for present investigation. The mean sum of squares due to environments was significant for all the characters indicating that the environments were quite variable. The significant mean squares due to genotypes × environment (G×E) interactions were observed for all the characters except SMK (%) and Oil content (%) (Table 1) indicating the influence of environment on the genotypes evaluated. The significant genotype × environment (G×E) interactions for various traits were also reported by Hariprasana et al., (2008), Pradhan et al., (2010) and Patil et al., (2014). The mean squares due to pooled deviation (Non-linear) were significant for dry pod yield (kg/net plot) and kernel yield (kg/ net plot) (Table 1). These results suggested that both linear and non-linear components played vital role in building up of total G×E interaction for various yield and yield attributing traits.

**Stability parameters for dry pod yield**

The regression coefficients ($b_i$) of the genotypes ranged from 0.61 to 1.19 and the deviation from regression ($S^2_d$) ranged from -0.02 to 0.15. The genotypes, Dh-232 and G2-52 expressed regression coefficient less than unity ($b_i<1$) with mean values higher than population mean, while the genotype GPBD-4 exhibited regression greater than unity ($b_i>1$) (Table 2). Genotypes with regression coefficient less than unity ($b_i<1$) and more than unity ($b_i>1$) are expected to show stability for dry pod yield in unfavourable and favourable environments, respectively. Similar finding were also reported by Habib et al., (1986), Senapati et al., (2004), Chuni Lal et al., (2006), Hariprasana et al., (2008), Pradhan et al., (2010) and Patil et al., (2014). The genotypes, Dh-230, ICGV-07214, Dh-246 and Dh-247 exhibited regression coefficient nearly equal to unity ($b_i \approx 1$) with higher mean than population mean (Table 2).
### Table 1: Analysis of variance for phenotypic stability in groundnut

| Source of variation      | df  | DPY (kg/plot) | SH (%) | KY (kg/plot) | SMK (%) | 100 Seed wt (g) | Oil (%) | KY (kg/ha) | Oil yld (kg/ha) | DPY (kg/ha) |
|--------------------------|-----|---------------|--------|-------------|---------|-----------------|---------|------------|----------------|-------------|
| Rep within Env.          | 6   | 0.02          | 1.11*  | 0.01        | 3.93    | 2.44            | 0.35    | 66320.61   | 15024.38       | 125448.04   |
| Varieties                | 10  | 0.10          | 8.25** | 0.05        | 6.99    | 7.16*           | 3.39**  | 379570.46**| 95620.94*      | 675304.43*   |
| Env.+(Var.*Env.)         | 22  | 0.37**        | 2.30** | 0.21**      | 11.91   | 4.78*           | 0.22    | 357765.78*| 80159.17*      | 635028.11*   |
| Environments             | 2   | 3.82**        | 9.59** | 2.15**      | 72.61** | 15.28**         | 1.22*   | 2624697.71**| 605963.97**    | 4957246.55** |
| Var.* Env.               | 20  | 0.034         | 1.57** | 0.02        | 5.84    | 3.73            | 0.12    | 131072.59  | 27578.69       | 202806.27   |
| Environments(Lin.)       | 1   | 7.64**        | 19.19**| 4.30**      | 145.23**| 30.56**         | 2.44**  | 5249395.43**| 1211927.94**   | 9914493.11** |
| Var.*Env.(Lin.)          | 10  | 0.02          | 2.82** | 0.01        | 5.80    | 5.65*           | 0.08    | 119232.67  | 26301.38       | 181333.62   |
| Pooled Deviation         | 11  | 0.04*         | 0.30   | 0.02*       | 5.34    | 1.65            | 0.15    | 129920.47  | 26232.72       | 203889.92   |
| Pooled Error             | 60  | 0.01          | 0.88   | 0.01        | 2.88    | 1.40            | 0.08    | 69554.32   | 14987.15       | 112665.52   |

*and **, probability at 0.05 and 0.01
Dry pod yield (DPY), Shelling per cent (SH), Kernal yield (KY)
Table.2 Estimates of phenotypic stability parameters for dry pod yield in groundnut

| Sl.No | Genotype   | Mean DPY (kg/plot) | Mean DPY (kg/ha) | $\beta_i$ | $\sigma^2_{di}$ |
|-------|------------|--------------------|------------------|----------|-----------------|
| 1     | Dh-230     | 1.53               | 3749.22          | 1.19     | -0.01           |
| 2     | Dh-232     | 1.49               | 3774.56          | 0.83*    | -0.02           |
| 3     | Dh-241     | 1.29               | 3139.44          | 1.09     | -0.01           |
| 4     | ICGV-07214 | 1.71               | 4261.33          | 1.09     | 0.15*           |
| 5     | Dh-243     | 1.43               | 3527.67          | 1.06     | 0.00            |
| 6     | Dh-245     | 1.27               | 3106.67          | 1.04     | 0.10'           |
| 7     | Dh-246     | 1.47               | 3660.78          | 0.95     | -0.01           |
| 8     | Dh-247     | 1.47               | 3598.56          | 1.19     | -0.01           |
| 9     | GPBD-4 (C) | 1.43               | 3516.00          | 1.13*    | -0.02           |
| 10    | G2-52 (C)  | 1.60               | 4069.78          | 0.82*    | -0.02           |
| 11    | TMV-2 (C)  | 1.01               | 2547.89          | 0.61     | 0.09'           |
| Mean  |            | 1.43               | 3541.08          | 1.00     |                 |

C- Checks

Table.3 Mean performance for dry pod yield (kg/ha) over different dates of sowing

| Genotype   | Env1     | Env2     | Env3     | General Mean |
|------------|----------|----------|----------|--------------|
| 1 Dh-230   | 4407.3   | 4176     | 2664.3   | 3749.222     |
| 2 Dh-232   | 4014.7   | 3884.3   | 3424.7   | 3774.556     |
| 3 Dh-241   | 3548.3   | 3842.7   | 2027.3   | 3139.444     |
| 4 ICGV-07214 | 5252   | 3988.7   | 3543.3   | 4261.333     |
| 5 Dh-243   | 4148     | 3810.3   | 2624.7   | 3527.667     |
| 6 Dh-245   | 3037     | 4171.7   | 2111.3   | 3106.667     |
| 7 Dh-246   | 4133.3   | 3819.3   | 3029.7   | 3660.778     |
| 8 Dh-247   | 4251.7   | 4088.3   | 2455.7   | 3598.556     |
| 9 GPBD-4 (C) | 3940.7  | 4143.3   | 2464     | 3516         |
| 10 G2-52 (C) | 4088.7  | 4259     | 3861.7   | 4069.778     |
| 11 TMV-2 (C) | 2178   | 3243.7   | 2222     | 2547.889     |
| Environment Index | 367.98 | 406.86   | -774.8   |

C- Checks

All the genotypes except ICGV-0724, Dh-245 and TMV-2 deviated non-significantly from zero ($S^2_{d}=0$) hence they are stable and indicating their predictable behaviour. Among the genotypes studied, Dh-230, Dh-241, Dh-246 and Dh-247 shown average responsive as they deviated non-significantly from unity ($b_i=1$) and zero ($S^2_{d}=0$) with above average performance and are more suited to all three dates of sowing (Table 3). Among the stable genotypes which shown average stable performance across the dates of sowing, Dh-230 (3749.22 kg/ha) followed by Dh-246 (3660.78 kg/ha) and Dh-247 (3598.56 kg/ha) showed higher mean dry pod yield compared to overall mean dry pod yield (3541.08 kg/ha).

However the genotype ICGV-0724 is more suitable only for early sowing (4261.33 kg/ha) and G2-52 is more suited for early as well as mid late sowing (4069.78 kg/ha). These genotypes could be used in further breeding improvement programme.
References

Anonymous, 2015, INDIASTAT, Ministry of Agriculture and Farmers Welfare, Govt. of India

Chuni Lal, R., Rathnakumar, A.L., Hariprasanna, K., Gor, H.K., Chikani, B.M., 2006. Early maturing groundnut advanced breeding lines with high day-1 productivity under rainfed situations. e-journal. icrisat.org 5(1): 4.

Dixon, A.G.O., R. Asiedu & S.K. Hahn, 1994. Genotypic stability and adaptability: analytic methods and implications for cassava breeding for low input agriculture. In: Tropical root crops in a developing economy. F. Ofori and S.K. Hahn (Eds.), pp.130-137. Proceedings of the 9th Symposium of the International Society for Tropical Root Crops, 20-26 October 1991, Accra, Ghana.

Eberhart, S.A., Russel, W.A., 1966. Stability parameters for comparing varieties. Crop Science, 6: 36-40.

Gadgil, S., Seshagiri Rao, P.R., Joshi, N.V., Sridhar, S., 1995. Forecasting rain for groundnut farmers-How good is good enough? Current Science, 68(3): 301-309.

Habib, A.F., Nadaf, H.L., Kulkarni, G.K., Nadiger, S.D., 1986. Stability analysis of pod yield in bunch groundnut. Journal of Oilseeds Research, 3: 46-50.

Joshi, H.J., Vekaria, G.B., Mehta, D.R., 2003. Stability analysis for morphophysiological traits in groundnut. Legume Research, 26(1): 20-23.

Linnemann, A.R., E. Westphal & M. Wessel, 1995. Photoperiod regulation of development and growth in bambara groundnut (Vigna subterranea). Field Crops Research 40(1):39-47.

Patil, A. S., Nandanwar, H. R., Punewar, A. A. and Shah, K. P., 2014. Stability for yield and its component traits in Groundnut (Arachis hypogaea L.). Intl. J. Bio-resource and Stress Management, 5(2):240-245.

Pradhan, K., Das, P.K., Patra, R.K., 2010. Genotype x environment interaction for pod yield and components of groundnut varieties in warm sub-humid climate and moderately acidic soil. Indian Journal of Genetics, 70(2): 201-203.

Senapati, B.K., Maity, D., Sarkar, G., 2004. Stability evaluation of summer groundnut (Arachis hypogaea L.) under coastal saline zone of west Bengal. Legume Research 27(2): 103-106.

Thaware, B.L., 2009. Stability analysis for dry pod yield in Spanish bunch groundnut. Agricultural Science Digest 29(3): 221-223.

How to cite this article:

Iramma V. Goudar, U. Roopa, Guruprasad Hiremath, B.S. Yenagi and Nadaf, H.L. 2017. Genotype × Environment Interaction for Pod Yield in Groundnut. Int.J.Curr.Microbiol.App.Sci. 6(11): 1566-1571. doi: https://doi.org/10.20546/ijcmas.2017.611.187