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# Evaluation of groundnut (*Arachir hypodaea* L.) lines for their yield potential and adaptability under rainfed conditions

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## Abstract

Evaluation of high yielding and newly developed groundnut lines is important to boost its yield in the country particularly in barani areas. As groundnut is mainly cultivated in barani or rainfed tract of the country therefore, it is necessary to evolve new genotypes to cope with changing environment. The objective of this research was to evaluate and access the yield and yield parameters of eight groundnut lines (six entries and two check varieties i.e. BARI-2011 and Golden) and their genetic advance and heritability and correlation among different traits during crop growing seasons of 2014 and 2015 at Groundnut Research Station Attock. Crop was grown under rainfed conditions and was harvested at physiological maturity. Data were collected for different yield and agronomic characters. A high variation was observed among the lines for agronomic traits. Groundnut advance line 10AK016 showed maximum pod yield (4.0 tonnes ha$^{-1}$), grain weight (63 g) maximum shelling percentage (70) and number of seeds per pod (2.5).Values of heritability and genetic advance were 0.87 and 10.3 for pod yield, respectively. Different yield attributes such as maturity %, grain weight, shelling percentage and pod length has strong positive correlations 0.84, 0.73, 0.59 and 0.6 respectively with pod yield. Groundnut advance line 10AK016 can be approved as groundnut variety for general sowing in rain fed areas of Pakistan.

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## Introduction

Groundnut is a part of the genus *Arachis* and it is also known as earthnut, peanut, manilanut, monkeynut and ground bean. *A. hypogaea L.* is the only species in the genus that have significant economic importance and is an annual herb that forms underground fruits. Groundnut is a cash crop grown in kharif season on well drained sandy loam soils in marginal lands of Pakistan. It is an important oil seed as well as food and feed crop. Its kernel is rich in both protein (25- 28%) and oil (43-55%). In Pakistan, it is utilized as roasted nuts, crop seed, salting and in confectionery. It is not only grown for grain yield but its haulm is also important for livestock feed. Groundnut is 13th most important food crop, 4th most important source of edible oil and 3rd most important source of vegetable protein in the world (Nigam, 2014).

In Punjab, Pothohar region mainly Chakwal, Attock, Jhelum and Rawalpindi are major groundnut growing areas in the country where, uncertain rainfalls, unpredictable environmental conditions and water shortage are limiting factors due to which per hectare yield of this crop is very low at field level. There is a wide gap between its average yield (1.3 t $ha^{-1}$) and potential yield (4.0 t $ha^{-1}$). Other limiting factors include unavailability of high yielding adapted varieties having characters like more number of seeds per pod (3-4), more pod length, larger seed size and high shelling percentage. For these areas there is dire need to develop such high yielding varieties having resistance to biotic and abiotic stresses, which limit the crop productivity.

Development of new variety in field crops has significant role to enhance the yield of different field crops (Naeem *et al.*, 2005; Naeem *et al.*, 2009). Groundnut production in barani areas has been limited by drought stress because pod yield and other growth parameters have been severely affected (Nigam *et al.*, 2005; Pimratch *et al.*, 2014). The groundnut is mostly self-pollinated crop, however, somewhat out crossing occurs. The natural out crossing in groundnut has been reported onepercent. Although, in groundnut it is very difficult to hybridize, but hybridization method is main procedure in plant breeding to create genetic variability. The major objective of development of present study was to evaluate different genetic material for yield potential and to develop a variety alternate to existing line of groundnut No. 334, which have less yield potential and are unable to meet the needs of farmers of the Punjab.

## Materials and methods

### *Experimental material, site and design*

Eight groundnut lines including six entries (10AK002, 10AK003, 10AK004, 10AK005, 10AK015 & 10AK016) and two check varieties i-e. BARI-2011 and Golden, were evaluated in this study during crop growing kharif season 2014 and 2015 at Groundnut Research Station Attock, Pakistan. These advance lines were developed through hybridization by using different parental combinations. In filial generations these lines were selected through pedigree method.

Soil of experimental site was non saline, non sodic, deficient in both phosphorus and potassium while adequate in organic matter having neutral pH. Experiment was laid according to RCBD in triplicate. Plant to plant and row to row distance was 10 cm and 45 cm, respectively. Four rows of four-meter length were planted for each line. Fertilizer was applied at the rate of 30-80-50 kg NPK $ha^{-1}$at the time of sowing. Gypsum was also applied at the rate of 500 kg $ha^{-1}$ at the time of peg formation for better seed development. Normal cultural operations of hoeing, weeding pest control were carried out. Crop was regularly monitored and harvested at physiological maturity.

### *Data recording*

Data were collected for different traits such as pod length, 100 pod weight, maturity percentage, number of seed per pod, shelling percentage and pod yield ($tha^{-1}$).

Maturity percentage was calculated by using the following formula.

Maturity percentage= (number of mature pods/total number of pods) × 100.

Shelling percentage was determined by applying the following formula.

Shelling percentage = (kernel weight/ pod weight) × 100.

Pod yield was taken by harvesting all four rows by leaving half meter on both sides. The dried samples were threshed, sun dried and weighed.

*Statistical analysis*

The data was statistically analyzed by using MSTAC-C software and means were separated by using least significant difference (LSD) test at a level of 0.05 percent (Steel *et al.,* 1997). Genotypic and phenotypic coefficient of variation was calculated by the method devised by Kwon and Torrie (1964). Heritability was calculated by the procedure described by to Singh and Chaudhry (1979). The genetic advance was calculated by the method of Falconer (1989).

Genetic Variance (vg) = (Genotype Mean Square-Error mean Square)/ Number of Replications

Environmental variance = Error mean square

Phenotypic variance (vp) = Vg+ Ve/r

Genotypic Coefficient of Variation= (vg/x) × 100

Phenotypic Coefficient of Variation= (vp/x) × 100

Environmental Coefficient of Variation= (ve/x) × 100

Heritability ($H^2$) on entry mean basis was calculated as:

$H^2 = vg/vp$

The expected genetic advance for each trait was calculated as:

$GA = K \times (VpH^2)^{1/2}$

where K= 1.4 at 20 % selection intensity for trait

GA % = GA/X × 100.

**Results and discussion**

Yield is being a complex trait which is the final product of many contributing factor like pod length, grains per pod and shelling percentage. To understand the final product i.e., yield we should understand the yield contributing factors their inter-relation and their ability to transmit heritable variation into off springs. Here in case of groundnut some of yield contributing parameters were studied. Overall GCV (%) are higher than PCV (%) which is in contrast with findings of Mahesh *et al.*, (2018), who reported more environmental influence than genetic. High heritability does not always rise to higher genetic advance (Johnson *et al.*, 1955 and Yadav *et al.*, 2014).

**Table 1.** Performance of groundnut entries for yield and yield related traits under rainfed conditions in Attock (average of two years).

| Treatments | Maturity %age | pod length (mm) | 100Kernel (g) | Shelling %age | Number of seed per pod | Pod yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|
| 10AK002 | 82 bc | 57 b | 56 b | 64 ab | 2.4 a | 3.5 b |
| 10AK003 | 83 b | 59 b | 57 b | 63 ab | 2.2 b | 3.4 bc |
| 10AK004 | 81 c | 58 b | 57 b | 64 ab | 2.0 b | 3.5 b |
| 10AK005 | 81c | 58 b | 50 c | 52 b | 2.1b | 3.3 c |
| 10AK015 | 81 c | 53 c | 49 c | 50 b | 2.0 b | 3.1 c |
| 10AK016 | 87 a | 72a | 63 a | 70 a | 2.5 a | 4.0 a |
| BARI- 2011 | 82 bc | 65 b | 59 b | 63 ab | 2.4 a | 3.7 b |
| Golden | 81 c | 62 b | 51 c | 53 b | 2.1 b | 3.6 b |

Means sharing common letters are non-significant at 5% level of significance.

*Maturity percentage*

Maturity percentage in genotypes was in range of 81 to 87 percent (Table 1). Entries such as 10AK004, 10AK005 and 10AK015 exhibited maturity percentage of 81 percent while for10AK016, it was 87 percent. Similar findings about genetic variability in groundnut genotypes were also been described by Korat *et al.* (2009), Zamurrad, *et al.,*(2013) and

Jeyaramraja and Fantahun (2014). Maturity percentage had strong positive correlation with pod yield which means that early maturing material should be selected for breeding as it may result in increased yield and resource saving (Table 3).

**Table 2.** Genotypic, environmental and phenotypic coefficient of variation for different traits studied in groundnut genotypes.

| Trait | Maturity % | Shelling % | Pod Length (mm) | 100-Kernel Weight (g) | Number of Seed per Pod | Pod Yield (t $ha^{-1}$) |
|---|---|---|---|---|---|---|
| PCV | 22.0 | 487 | 55.0 | 62.5 | 10.2 | 3.8 |
| GCV | 21.1 | 449 | 49.1 | 60.5 | 10.0 | 3.5 |
| ECV | 11.1 | 328 | 42.9 | 27.4 | 3.8 | 2.4 |
| Heritability ($H^2$) | 0.91 | 0.85 | 0.80 | 0.94 | 0.95 | 0.87 |
| Genetic Advance (GA) | 2.56 | 8.61 | 4.77 | 6.08 | 0.26 | 0.36 |
| GAPM | 3.11 | 14.37 | 7.88 | 11.03 | 11.58 | 10.25 |

Genotypic and phenotypic coefficient of variation was around 21.1 and 22 % respectively (Table 2).

Small difference between genetic and phenotypic coefficient of variation show very minute environmental effect. The heritability estimates were calculated as 0.91 while genetic advance value was 2.56 %.Higher heritability value shows that variation among plants is genetic which can be transferred to next generation but with non-additive gene effects so phenotypic selection could not be more effective in this case Suneetha *et al.*, (2004).

**Table 3.** Correlation among yield attributes and pod yield of ground nut.

| Variables | pod length | grain weight | Maturity %age | Seed per pod | Shelling %age |
|---|---|---|---|---|---|
| grain weight | 0.72* | | | | |
| Maturity %age | 0.66* | 0.76* | | | |
| Seed per pod | 0.62* | 0.63* | 0.47* | | |
| Shelling %age | 0.56* | 0.83* | 0.58* | 0.61* | |
| Pod yield | 0.60* | 0.73* | 0.84* | 0.38 | 0.59* |

*Significant at 5 % level of probability.

*Shelling percentage*

Shelling percentage showed significant differences in groundnut genotypes due to genetic variability (Table 1) which was also reported by Jeyaramraja and Fantahun (2014), Maurya *et al.*, (2014) and Shukla and Rai (2014). Maximum shelling percentage was recorded in entry 10AK016 (70 %) while minimum shelling percentage (50%) was observed in entry 10AK015 (Table 1).

Phenotypic and genotypic coefficient of variation was 487 and 449 respectively (Table 2). Higher difference between genotypic and phenotypic variants shows the role of environmental factors in this yield attribute as compared to other parameters hence phenotypic selection would be fruitful Mahesh *et al.*, (2018).Shelling percentage had strong positive correlation with pod yield and grain weight which means that it should be one of the criterion while selecting material for breeding purpose (Table 3).

Higher amount of heritability (85%) along with higher amount of GAPM (14.37) indicated the presence of ample amount of heritable variation. That also confirms the involvement of additive gene action for this particular trait in this study.

*Pod length*

It was found from the results that pod length showed a significant behavior (Table 1). Entry 10AK016 showed a significantly higher pod length of 72 mm than rest of the entries including check variety, BARI 2011, which gave 65 mm pod length. These results are closely related to the findings of Zamurrad *et al.,* (2013) and Mudassir *et al.*, (2015).Values of genotypic and phenotypic coefficient of variation for pod length were 49.1 and 55 mm respectively (Table 2).These values indicated that environment influence on pod length was more significant. While studying table 2 we can also see that broad sense heritability value for this trait was 0.8%, means significant amount of heritable variation for next generation. Low amount of genetic advance as percentage of means (7.88) along high amount of heritability showed non additive gene action of this particular trait. Pod length was significantly and positively correlated with grain weight, seed per pod, shelling percentage and pod yield (Table 3). This significant genotypic correlation showed beneficial effects on yield and its related traits.

*100-Kernel weight*

The weight of kernels expresses the magnitude of kernel development which is an important determinant of kernel yield per hectare.100-kernel weight showed significant differences among the groundnut genotypes and maximum 100-kernel weight was recorded in entry 10AK016 (63 g) followed by BARI-2011 (59 g) (Table 1). Zamurrad *et al.*, (2013) and Patidar, *et al.*, (2014) also reported significant behavior. Minimum 100-kernel weight was recorded in entry 10AK015 (49g). PCV was 62.5 while GCV was 60.5 (Table 2). This least amount of difference among GCV and PCV proved to be less amount of environmental effects on kernel weight of theses genotypes. Higher values of GCV and PCV showed a greater scope of phenotypic selection of the trait (Mahesh *et al.*, 2018).Kernel weight proved to be among those traits that exhibited maximum amount of broad sense heritability i.e., 0.94 (Table 2). This indicated that ample amount of heritable variation of kernel weight to next generation. On the other hand, GAPM value of kernel weight also proven to be non-additive variation accompanied with high heritability. 100-kernel weight also exhibited positive and significant correlation among other traits like maturity percentage, seeds per pod, shelling percentage and pod yield (Table 3). This indicated that if we increase kernel weight of those groundnut genotypes then there would be a significant increase of pod yield which is the ultimate objective of every breeding program.

*Number of seed per pod*

Number of seed per pod expresses the magnitude of grain development and ultimately effect yield. Seed per pod also showed a significant behavior which ranged between 2.07 to 2.53 (Table 1). Maximum number of seeds per pod (2.53) was recorded for entry 10AK016 followed by BARI 2011and 10AK002 (2.4). Entry 10AK015 and 10AK004 showed minimum number of seeds per pod (2.0). Mostly 2-3 seed per pod was common. Shukla and Rai (2014) also reported similar results. Non-significant values of GCV and PCV showed that there was no effect of environment on this trait. Number of seeds per pod was the trait that showed highest amount of heritability values (0.95) along with medium to low amount of genetic advance. This indicated that there is non-additive gene action involved in this trait (Table 2). Seeds per showed significant positive correlation with pod length (0.62), kernel weight (0.63), maturity % (0.47) and shelling % (0.61) as mentioned in Table 3.

*Pod yield*

Pod yield is a result of function of collective behavior of all the yield parameters. Pod yield also showed significant difference among the entries. Similar results were reported by Taj Naseeb Khan *et al.* 2013 and Patidar, *et al.*, 2014. Pod yield ranged from 3.1 tons $ha^{-1}$ to 4.03 tons $ha^{-1}$. Entry 10AK016 had maximum pod yield (4.03 tons $ha^{-1}$) while minimum pod yield was recorded in entry 10AK015 (3.1 tons $ha^{-1}$) (Table 1). Values of genotypic and phenotypic coefficient of variation for pod yield were 3.5 and 3.8 respectively means less influence of environment. Pod yield was positively and significantly associated with pod length, grain weight, maturity %age, number of seeds per pod and shelling percentage Vange and Maga (2014) and Trivikrama *et al.*, 2017 (Table 3). Heritability value for pod yield was 0.87 which shows high amount of broad sense heritability among the genotypes and very less role of environmental factors. Genetic advance value of 10.25 indicate that pod yield can further be improves by selection of plants. But the participation of non-additive gene action hinders its direct selection towards improvement of that trait (Table 2).

**Conclusion**

Evaluation of groundnut genotypes for yield and other characters under rainfed conditions showed that entry 10AK016 produced maximum pod yield of 4.0tonnes ha$^{-1}$ due to higher number of seed per pod and maturity percentage. However high heritability values but low genetic advance showed that selection criteria should not only be on phenotypic basis rather genotypic. Yield can be improved by selection among this genotype as indicated by heritability and genetic advance values. It is due to its high yield potential and it can be approved as groundnut variety for general sowing in rain fed areas of Pakistan.

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