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Genetic Variability and Path Analysis of Groundnut (*Arachis hypogaea* L.)

M. A. Zaman[1]*, M. Tuhina-Khatun[2], M. Z. Ullah[3], M. Moniruzzamn[1] and K. H. Alam[4]

[1]*Regional Agricultural Research Station (RARS), BARI, Hathazari, Chittagong, Bangladesh*
[2]*Plant Pathology Division, Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh*
[3]*R & D Centre, Energy pack Agro. Ltd, Gazipur, Bangladesh*
[4]*PRC, Ishurdi, Pabna, Bangladesh*

**Corresponding author and Email: akzaman118@yahoo.com*

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Abstract

An experiment was conducted at the Research farm of Regional Agricultural Research Station, BARI, Hathazari, Chittagong during Rabi season (December to April), 2009-2010 for estimation of genetic variability, genetic parameters and correlation coefficient among different yield components in a randomized block design with three replications. Thirty four groundnut genotypes were tested in the experiment. Highly significant variations were observed among the genotypes for all the characters studied. The highest genetic coefficient of variation was observed for karnel yield per hectare, followed by karnel yield per plant, branches per plant, immature and mature nuts per plant, 100 kernal weight and plant height. The highest heritability was observed in karnel yield per pant (95.08%), followed by karnel yield per hectare (94.38%), 100 kernal weight (87.01%), immature and mature nuts per plant (82.24%, 80.32%), branches per plant (79.54%) and 100 nut weight (78.98%), while high values of genetic advance were obtained in all the characters except days to maturity and days to 50% flowering. The seed yield per plant showed the highly significant and positive association with nut size, number of nuts per plant, karnel size and days to 50% flowering. The number of mature nuts per plant had high positive direct effect on seed yield per hectare followed by nut size, shelling percentage, days to 50% flowering and days to maturity. Therefore, branches per plant, plant height, nuts per plant, nut size, karnel size, days to 50% flowering, shelling percentage and days to maturity were identified to be the important characters which could be used in selection for yield.

Keywords: **Genetic variability, heritability, genetic advance, groundnut**

1. Introduction

The annual production of groundnut *(Arachis hypogaea* L.*)* in our country is 46533 thousand metric tons from 77336 thousand acres of land during 2008-09 (BBS 2010). Groundnut is mainly used as a bakery food in our country. Therefore, it can also be used as a source of edible oil, fodder and green manuring crop for improvement of soil health. Groundnut oil contains 46 and 32 percent of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), respectively (USDA, 2009). Groundnut oil is also used in many preparations like soap making, fuels, cosmetics, shaving cream, leather dressings, furniture cream, lubricants etc.

Groundnut is an unpredictable crop due to its underground pods development. Nut yield is not only polygenically controlled, but also

influenced by its component characters (Alam *et al*. 1985). For improvement of yield in groundnut direct selection is often misleading. The knowledge of existing variability and degree of association between yield contributing characters and their relative contribution in yield is essential for developing high yielding genotypes in groundnut. The observed variability is a combined measure of genetic and environmental causes (Patel *et al*. 2009). The genetic variability is heritable from generation to generation. Heritability and genetic advance is a useful tool for breeders in determining the direction and magnitude of selection. Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. Path coefficient is essential to accumulate optimum combination of yield contributing characters and to know the implication of the interrelationships of various characters in a single genotype. Considering the above points, the present study was undertaken to evaluate the genotypes for yield and its components and to estimate the inter-relationship among the agronomic traits in groundnut.

2. Materials and Methods

An experiment comprising 34 groundnut genotypes was conducted in a randomized block design with three replications at the Research farm of Regional Agricultural Research Station, BARI, Hathazari, Chittagong during Rabi season (December to April), 2009-2010. The unit plot size was two rows of 4 m length. Row to row and plant to plant spacing were maintained at 40 cm and 10 cm, respectively. Recommended fertilizer doges, cultural practices and all plant protection measures were followed to ensure a good crop. The data on 11 morphological characters namely days to 50% flowering, days to nut maturity, plant height, final plant population, number of branches/ plant, number of mature nuts/plant, number of immature nuts/plant, 100 nuts weight (g), 100 karnel weight (g), shelling percentage, karnel yield/plant and karnel yield/ ha were recorded.

The data were subjected to statistical analysis using Genstat Diccovery Edition 3 software. Components of genetic parameters like genotypic and phenotypic variance, genotypic and phenotypic coefficient of variation, heritability, genetic advance, genotypic and phenotypic correlation coefficient and path analysis were estimated using excel based computer software program following Singh and Choudhury (1979).

3. Results and Discussion

The analysis of variance revealed significant differences among the genotypes for all the characters indicating the prevalence of genetic variability. The mean, range, coefficients of genotypic and phenotypic variation, heritability and genetic advance of various characters are given in the Table 1. Coefficient of variation at phenotypic and genotypic levels was relatively high in karnel yield/ha, karnel yield/plant, branches/plant, immature and mature pods/plant, 100 kernal weight and plant height. Similar findings were reported by Alam *et al*. 1985. On the other hand, days to 50% flowering and days to maturity showed were very low differences between genotypic and phenotypic coefficient of variation, suggesting less environmental influence on the expression of traits. These findings are in good agreement with those reported by Chandra (1968) and Joshi (1972) in case of chickpea. The magnitude of PVC was higher than GVC for all the characters indicating the influence of environment upon these traits.

Table 1. Estimation of statistical and genetical parameters of 11 characters for different genotypes of groundnut

Parameters	Mean	Range	MS_G	MS_e	Grand mean	$\delta^2 g$	$\delta^2 p$	$\delta^2 e$	GCV	PCV	h^2_b	GA	CV %
Days to 50% flowering	37.83	33-41	5.58	1.04	37.83	1.51	2.55	1.04	3.25	4.22	59.25	5.16	2.70
Days to maturity	167.04	141-171	42.16	17.55	167.04	8.20	25.75	17.55	1.72	3.04	31.85	1.99	2.51
Plant height	26.92	17-38	38.14	4.67	26.92	11.16	15.83	4.67	12.41	14.78	70.48	21.46	8.03
Branch/plant	8.00	8-15	16.05	1.27	8.20	4.93	6.20	1.27	27.06	30.34	79.54	49.71	13.72
Matured nut/plant	20.00	8-28	44.91	3.39	19.68	13.84	17.23	3.39	18.91	21.20	80.32	34.90	9.36
Immature nut/plant	7.00	4-12.2	10.18	0.684	7.46	3.17	3.85	0.68	23.84	26.29	82.24	44.54	11.08
100 nut weight (g)	88.90	58.6-126.4	526.88	42.94	88.91	161.31	204.25	42.94	14.29	16.07	78.98	26.15	7.37
100karnel weight	49.30	34.9-71	165.33	7.84	49.29	52.50	60.34	7.84	14.70	15.76	87.01	28.25	5.68
Shelling percentage	55.90	38.5-84.2	134.10	16.76	55.94	39.11	55.87	16.76	11.18	13.36	70.00	19.27	7.32
Yield/plant	11.70	2.6-23.4	56.37	0.96	11.65	18.47	19.43	0.96	36.89	37.83	95.08	75.00	8.39
Yield/hectare	1467	375-3150	1460463.32	28451.78	1467.47	477337.18	505788.96	28450.78	47.08	48.46	94.38	94.22	11.49

MS_G = Mean sum of squares due to genotypes, MSe = Mean sum of squares due to error, σ^2_p=Phenotypic variance, σ^2_g=Genotypic variance, σ^2_e=Environmental variance, PCV=Phenotypic coefficient of variation, GCV=Genotypic coefficient of variation, h^2_b =Heritability in broad sense, GA=Genetic advance, CV = Coefficient of variation.

The highest heritability in broad sense was observed in karnel yield/pant (95.08%) followed by karnel yield/ha (94.38%), 100 karnel weight (87.01%), immature and mature nuts/plant (82.24%, 80.32%), branches/plant (79.54%) and 100 nut weight (78.98%). Katiyar *et al*., (1974) mentioned that the only heritability value provides no indication of the amount of genetic progress that would result from selecting the best individuals. However, Johnson *et al*. (1955) suggested that heritability estimates along with genetic advance would be more useful in predicting yield under phenotypic selection than heritability estimate alone. In the present study the character karnel yield/ ha as well as per plant showed the highest heritability high genetic advance (94.38% and 75.00%) along with high heritability (94.38 and 95.08) indicating additive gene effect. These results are comparable to the results reported by Jain and Ramgiry (2000). Primary branches/plant (49.71), nuts/plants (44.54 and 34.90), 100 nut weight (26.15), 100 karnel weight (28.25), plant height (21.46) and shelling percentage also showed the high values of genetic advance which were also linked with acceptable values of heritability. The characters days to maturity (1.99) and days to 50% flowering (5.16) showed the lowest genetic advance along with lowest heritability. Therefore, selection should be made on the basis of karnel yield/plant. For breeding program of groundnut primary branches/plant, nuts/plant, 100 karnel weight, plant height and shelling percentage might be considered as a important selection criteria. The present study for high habitability for these characters was conformed to those observed by Chandra (1968), Joshi (1972) and Indu (1985) in different chickpea trials.

The genotypic and phenotypic correlations were calculated for all pairs of characters (Table 2). The genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficient means in general, all pairs of characters mean that environmental effect suppressed the association at phenotypic levels, indicating that both environmental and genotypic correlation in those cases act in same direction and finally maximize their expression at phenotypic level. Seed yield/plant exhibited highly significant and positive correlation with all the characters except plant height and shelling percentage. Plant height and shelling percentage showed the non significant and negative correlation with yield/plant. The karnel yield/plant showed the highly significant and positive association with nut size, number of nuts/plant, karnel size and days to 50% flowering. Similar trend of association in case of yield per plant with the above traits except days to 50% flowering and maturity was reported by Alam, *et al*. (1985) and Rajkumar *et al.* (2010) in case of soya bean. High positive associations were also obtained between nut yield and number of nuts/plant, number of secondary branches/plant and karnel size had been reported by Tripathi (1974) which supported the present findings. In the present study plant height was showed negative and significant correlation with primary branches/plant and shelling percentage. Primary branches showed the positive and significant association with days to 50% flowering, nuts/plant and shelling percentage but negative and significant correlation with plant height. Karnel size showed the positive and highly significant correlation with nuts size, primary branches/plant and shelling percentage respectively. Shelling percentage showed positive and highly significant correlations with days to 50% flowering, branches/plant and karnel size but significant negative correlation with nut size.

The results on genotypic correlation coefficients and path coefficients on seed yield per plant are given in Table 3. Number of mature nut/ plant had significant direct effect on karnel yield per hectare followed by nuts size, shelling percentage, days to 50% flowering and days to maturity. Similar finds were recorded by Mahmudul Hassan *et al.* (2005) in case chickpea. On the other hand, number of immature nuts/plant, karnel size, plant height and primary branches/plant exhibited direct negative effect on karnel yield/ha indicating that karnel yield could be increased in groundnut by selecting the plant with maximum number of nuts, larger nut size, higher shelling percentage, early days to 50% flowering and days to maturity. Similar findings were reported by Yadava, *et al.* (1981) and Makand Itai *et al*. (2009) in case of Bambara Gourndnut. Proper attention should therefore be given to the above traits for the improvement of groundnut yield.

Table 2. Genotypic (upper right) and phenotypic (lower left) correlation coefficient among eleven characters of Groundnut

Characters	DF	DM	PH	BP	NMN/P	NIMN/P	100 nwt	100 kwt	SP	KY/P	KY/H
DF	**1.000**	-0.408	-0.019	0.716**	0.338	0.531**	-0.065	0.233	0.4512**	0.4193*	-0.297
DM	-0.087	**1.000**	0.034	-0.200	0.364*	0.203	0.209	0.131	-0.079	0.157	0.217
PH	0.025	-0.043	**1.000**	-0.379*	-0.296	-0.518**	0.291	-0.005	-0.403*	-0.001	0.458**
BP	0.450**	-0.088	-0.283	**1.000**	0.422*	0.652**	-0.015	0.367*	0.532**	0.315	-0.384*
N.MN/P	0.283	0.167	-0.247	0.396*	**1.000**	0.777**	0.182	0.307	0.209	0.606**	0.055
N.IM/P	0.359*	0.119	-0.395*	0.538**	0.691**	**1.000**	-0.224	0.161	0.554**	0.225	-0.474**
100 nwt.	-0.098	0.075	0.245	-0.003	0.097	-0.146	**1.000**	0.751**	-0.349*	0.635**	0.629**
100 kwt.	0.169	0.064	-0.021	0.294	0.239	0.151	0.690**	**1.000**	0.350*	0.567**	0.317
SP	0.372*	0.004	-0.332	0.360*	0.188	0.400*	-0.428*	0.349*	**1.000**	-0.048	-0.406*
Y/P	0.359*	0.104	0.013	0.265	0.543**	0.198	0.548**	0.530**	-0.012	**1.000**	0.392*
Y/H	-0.219	0.130	0.389*	-0.331	0.040	-0.420*	0.548**	0.275	-0.351*	0.376*	**1.000**

DF= Days to 50% flowering, DM= Days to maturity, PH= Plant height, BP=Branch per plant, NMN/P=No. of Mature Nuts per plant, NIM/P= No. of Immature nuts per plant, 100 nwt.=100 nuts weight, 100 kwt=100 karnel weight, SP=Shelling Percentage, KY/P= Karnel yield per plant and KY/H= Karnel yield per hectare

Table 3. Direct (bold) and indirect effect among ten characters of Groundnut

Characters	DF	DM	PH	B/Plant	MNP	IMNP	HSW	HKW	SP	KY/P
DF	**0.308**	-0.079	0.001	-0.052	0.384	-0.785	-0.070	-0.168	0.310	-0.145
DM	-0.126	**0.194**	-0.001	0.015	0.414	-0.300	0.226	-0.095	-0.055	-0.055
PH	-0.006	0.007	**-0.039**	0.027	-0.337	0.765	0.314	0.003	-0.277	0.001
B/Plant	0.221	-0.039	0.015	**-0.072**	0.480	-0.964	-0.016	-0.264	0.366	-0.109
MNP	0.104	0.071	0.012	-0.031	**1.137**	-1.148	0.197	-0.221	0.143	-0.210
IMNP	0.163	0.039	0.020	-0.047	0.883	**-1.478**	-0.242	-0.116	0.380	-0.078
HSW	-0.020	0.041	-0.011	0.001	0.207	0.331	**1.080**	-0.541	-0.239	-0.220
HKW	0.072	0.026	0.000	-0.027	0.349	-0.238	0.811	**-0.720**	0.241	-0.196
SP	0.139	-0.015	0.016	-0.039	0.237	-0.818	-0.377	-0.252	**0.687**	0.016
Y/P	0.129	0.031	0.000	-0.023	0.689	-0.332	0.686	-0.409	-0.033	**-0.346**

Residuals effect= 0.489
DF= Days to 50% flowering, DM= Days to maturity, PH= Plant height, BP=Branch per plant, MNP=Mature Nuts per plant, IMMP= Immature nuts per plant, HSW = Hundred seed weight, HKW=Hundred karnel weight, SP=Shelling Percentage and KY/P=Karnel yield per plant

The experiment revealed that karnel yield/ha, karnel yield/plant, branches per plant, immature and mature nuts/plant, 100kernals weight and plant height were more variable characters among these genotypes. Correlation and path co-efficient analysis showed that seed yield/plant exhibited highly significant and positive correlation with all the characters except plant height and shelling percentage. Plant height and shelling percentage showed insignificant and negative correlation with yield per plant. Number of mature nuts/plant had high positive direct effect on karnel yield/ha followed by nuts size, shelling percentage, days to 50% flowering and days to maturity. On the other hand, number of immature nuts/plant, karnel size, plant height and primary branches/plant exhibited direct negative effect on karnel yield/hectare.

4. Conclusions

The present study clearly showed that karnel yield/ha, karnel yield/plant, branches per plant, immature and mature nuts/plant, 100 kernal weight and plant height were more variable characters among these genotypes. All yield contributing characters except plant height and shelling percentage showed the highly significant positive correlation with karnel yield per hectare. Number of mature nuts/plant had high positive direct effect on karnel yield/ha where as number of immature nuts/plant, karnel size, plant height and primary branches/plant exhibited direct negative effect on karnel yield/ha. Therefore, maximum number of nuts, larger nut size, higher shelling percentage, early days to 50% flowering and days to maturity are the important characters which could be used in selection for higher yield of groundnut.

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