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VARIATION AND ASSOCIATION STUDIES AMONG YIELD TRAITS AND RESPONSE OF GENOTYPES FOR SOME OF THE BIOTIC STRESSES IN GROUNDNUT

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ABSTRACT

Sixteen diverse spanish bunch groundnut (*Arachis hypogaea* L.) genotypes were evaluated during two crop seasons for genetic variability, biotic stresses and their inter-relationship with yield and its component traits. Highly significant differences among genotypes were recorded for most of the traits studied indicating presence of significant variability in the material. The higher magnitude of GCV and PCV was recorded for 100- kernel weight, late leaf spot, dry pod yield, kernel yield and jassid incidence depicting the presence of ample variability for these traits. On the basis of pooled data, high heritability coupled with high to moderate genetic gain was observed for dry pod yield, kernel yield, 100-kernel weight, incidence of jassids and late leaf spot indicating the preponderance of additive gene effects. Correlation and path coefficient analysis revealed that the kernel yield, 100-kernel weight and shelling per cent were the most important characters for realizing improvement in pod yield. Six genotypes showed higher yield combined with less incidence of late leaf spot and jassids over checks under natural field conditions indicating concomitant improvement for yield and tolerance to insect-pest/disease.

Key words: Biotic stresses, Correlation, Groundnut, Path analysis, Variability.

Groundnut (*Arachis hypogaea* L.) is one of the most important oilseed crops of India. Although it has a wide range of adaptability under varying agro-climatic conditions, most of the groundnut is cultivated in *rainfed* conditions. Pod yield is a complex character which is largely influenced by the interaction of various component traits, each controlled by a different set of hereditary factors. Since the effectiveness of the selection depends on the extent of genetic variability, an attempt has been made to evaluate groundnut genotypes for various characters. Plant breeders are rarely interested in one character and therefore, there is an inevitable requirement to examine the relationship among various characters which are especially contributing to pod yield and other attributes consecutively for more than two crop seasons to reach a conclusion.

It is well documented that low productivity in groundnut is attributed largely to the wide occurrence of biotic stresses like late leaf spot and jassid incidence in addition to abiotic stresses. There has been a severe occurrence of the late leaf spot and incidence of jassids damaging the crop and causing severe losses in the groundnut growing areas. Yield losses due to late leaf spot ranges from 15-59 %, but vary from place to place and with seasons (McDonald *et al*., 1985). The sucking insect especially jassids cause considerable damage to groundnut throughout crop growth during rainy and post-rainy seasons by decreasing the photosynthetically active leaf area. Patel and Vora (1981) reported jassids as serious pests of groundnut in India that cause 9 per cent reduction in pod yield and 18 per cent in haulm weight. With this in view, 16 diverse genotypes were also screened for tolerance to these biotic stresses under natural condition as well as their correlation with yield and its component characters was analyzed.

MATERIALS AND METHODS

The experimental materials comprised 16 diverse genotypes grown in randomized block design with three replications during two crop seasons viz., *kharif* 2007 and

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kharif 2008 at the Instructional Farm, College of Technology & Engineering, Maharana Pratap University of Agriculture & Technology, Udaipur. In each replication, genotypes were sown in a plot of 7.5 m^2 accommodating 5 rows of 5m length spaced 30 cm apart with an intra-row spacing of 10 cm.

The observations were recorded on five randomly selected plants in each genotypes for plant height (cm), pods per plant, 100-kernel weight (g), oil content (%), while for days to 50 % flowering, days to maturity, dry pod yield, kernel yield and shelling (%) the data was recorded on whole plot basis.

The occurrence of severity of late leaf spot (1-9 scale) and jassids incidence (%) under natural field condition was monitored during the growth period. For late leaf spot, the modified 9 point scale (1-9) was used (James, 1974). Disease assessment was made at the maturity of the crop.

The incidence of adult and nymph population of groundnut jassids on a per leaf basis was recorded early in the morning at weekly intervals under natural field condition. Fifteen leaves were selected from 15 randomly chosen plants from each plot in such a sequence that 1st leaf from upper portion of the 1st plant, 2nd leaf from middle portion of the 2nd plant, 3rd leaf from lower portion of the 3rd plant and so on, were taken for recording the population data of jassids.

Analysis of variance was computed as per the method suggested by Panse and Sukhatme (1985). The genetic parameters and correlations were calculated as per the standard methodology. The path coefficient was calculated following the methodology described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The pooled analysis of variance over two crop seasons revealed significant differences among the genotypes for all the characters studied indicating a great variability in the materials. The data on yield and its component traits, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance are presented in Table 1. A wide range of variation was observed for plant height, hundred kernel weight, dry pod yield, kernel yield, late leaf spot and jassids incidence. The estimates of variability revealed that the PCV was higher than GCV for all the traits studied, which is an indicator of additive effect of the environment on the expression of the traits. The higher magnitude of GCV and PCV was recorded for jassids incidence, kernel yield, dry pod yield, 100- kernel weight and late leaf spot. High PCV and GCV estimates for dry pod yield and kernel yield were in accordance with Khurram *et al*., 1998 and Kadam *et al*., 2007; for dry pod yield, late leaf spot and jassids incidence with John *et al*., 2006.

Table 1. Analysis of variance over the environments

Characters	Environment [1]	Rep/Env [4]	Genotype [15]	G x E [15]	Pool Err [60]
Days to 50 % flowering	24.00**	0.6458	4.1306**	2.4889**	1.035
Days to maturity	3.7604	1.1042	11.6660**	4.8715**	1.471
Plant height	408.3750**	5.3646	202.9972**	129.7972**	18.99
Branches per plant	3.0104**	0.1354	0.9215**	0.4993	0.3354
Pods per plant	570.3750**	6.4062	19.3306**	17.7750**	3.284
Shelling per cent	29.2604**	0.7604	31.3271**	15.5493**	1.238
100-kernel weight	2035.0417**	3.6667	204.9778**	21.3083**	5.156
Late Leaf Spot	3.7604*	0.3542	3.1549**	0.6049	0.5653
Oil content	75.2604**	0.8542	9.0326**	3.5938**	0.9986
Dry pod yield	0.5266	4.4805	69.8976**	24.8405**	3.518
Kernel yield	0.4803	1.7849	35.3888**	11.8512**	1.643
Jassid incidence	3.0104	2.8542	341.2326**	7.0771	5.399

The estimates of PCV & GCV have been found low for days to 50 % flowering, days to maturity, shelling and oil content, which were reported earlier for the traits shelling per cent and days to 50 % flowering by Yogendra *et al*. (2002).

Heritability estimates offer an idea of efficiency of selection on the basis of phenotypic performance but to assess selection effect more accurately predicting the resultant effect of selection on phenotypic expression genetic advance was also computed because high heritability has not been found to be associated with higher genetic gain.

Table 2. Estimates of range, mean, phenotypic and genotypic coefficient of variability, heritability and genetic advance as % of mean for sixteen genotypes in groundnut

Characters	Environment	Range	Mean ± SE	Coefficient of Variation (%)		Heritability in Broad Sense (%)	Genetic advance as % of mean
				GCV	PCV		
Days to 50% flowering	E1	23.00-26.67	24.48 ± 0.68	3.54	5.97	35.22	4.33
	E2	24.00-27.67	25.48 ± 0.48	3.43	4.72	52.73	5.13
	Pooled	23.83-26.33	24.98 ± 0.42	2.09	5.36	15.26	1.69
Days to Maturity	E1	97.67-103.67	99.94 ± 0.88	1.57	2.19	51.29	2.31
	E2	97.33-102.67	25.48 ± 0.45	1.45	1.65	77.30	2.62
	Pooled	97.83-102.67	99.74 ± 0.50	1.07	1.94	30.30	1.21
Plant Height (cm)	E1	31.67-58.00	44.33 ± 1.96	15.75	17.50	80.92	29.18
	E2	36.00-60.33	48.46 ± 2.97	14.52	17.99	65.16	24.15
	Pooled	35.33-59.17	46.40 ± 1.78	7.53	17.79	17.91	6.56
Branches per plant	E1	4.33-6.33	5.50 ± 0.34	6.78	12.57	29.07	7.53
	E2	4.33-6.00	5.15 ± 0.33	6.48	12.94	25.08	6.68
	Pooled	4.33-6.00	5.52 ± 0.24	4.98	12.75	15.28	4.01
Pods per plant	E1	11.00-23.00	15.50± 1.26	18.63	23.32	63.80	30.65
	E2	8.00-14.00	10.62 ± 0.78	12.78	18.06	50.08	18.63
	Pooled	11.00-17.00	13.06 ± 0.74	3.90	22.15	3.10	1.41
Shelling (%)	E1	60.00-70.67	66.00 ± 0.80	4.54	5.00	82.38	8.48
	E2	60.33-69.67	67.10 ± 0.43	3.60	3.77	91.25	7.09
	Pooled	62.50-70.17	66.55 ± 0.45	2.44	4.42	30.44	2.77
100-kernel Weight (g)	E1	32.33-55.33	43.52 ± 1.31	15.87	16.70	90.29	31.07
	E2	28.00-47.00	34.31 ± 1.31	14.36	15.82	82.42	26.86
	Pooled	30.83-50.33	38.92 ± 0.93	14.22	16.48	74.39	25.26

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Characters	Environment	Range	Mean ± SE	Coefficient of Variation (%)		Heritability in Broad Sense (%)	Genetic advance as % of mean
				GCV	PCV		
Late Leaf Spot (1-9 scale)	E1	3.33-5.67	4.38 ± 0.54	10.40	23.88	18.96	9.33
	E2	2.67-6.00	4.77 ± 0.29	17.15	20.05	73.14	30.21
	Pooled	3.00-5.67	4.57 ± 0.31	14.26	21.91	42.35	19.11
Oil content (%)	E1	43.33-48.00	46.40 ± 0.63	2.30	3.30	48.61	3.31
	E2	41.67-47.67	44.62 ± 0.51	3.47	4.00	75.24	6.21
	Pooled	43.50-47.83	45.51 ± 0.41	2.09	3.66	32.72	2.47
Dry Pod Yield (q/ha)	E1	6.11-22.28	13.88 ± 1.07	30.06	32.88	83.58	56.61
	E2	7.78-21.11	14.03 ± 1.10	24.52	28.02	76.59	44.20
	Pooled	7.32-20.86	13.95 ± 0.07	19.64	30.52	41.41	26.03
Kernel Yield (q/ha)	E1	4.06-15.53	9.25 ± 0.74	33.59	36.37	85.35	63.93
	E2	5.42-13.66	9.39 ± 0.74	23.81	27.41	75.43	42.60
	Pooled	4.91-14.30	9.32 ± 0.52	21.25	32.13	43.74	28.95
Jassid Incidence (%)	E1	10.33-42.67	21.83 ± 0.89	35.55	36.25	96.21	71.84
	E2	12.67-45.33	22.19 ± 1.68	32.58	35.10	86.12	62.28
	Pooled	11.50-44.00	22.01 ± 0.95	33.91	35.67	90.34	66.38

Table 3. Pooled estimates of phenotypic and genotypic correlation coefficient of sixteen different characters in groundnut

Character		Days to 50 % flowering	Days to maturity	Plant height	Pods per plant	Shelling Per cent	100-kernel weight	Oil Content	Kernel weight	Jassid Incidence	Dry pod yield
Days to 50% flowering	r_g	1.00	0.61*	0.21	0.63**	0.10	-0.05	-0.86**	-0.33	-0.02	-0.38
	r_p	1.00	0.29	0.03	0.06	0.11	-0.06	0.04	0.36	-0.07	0.36
Days to maturity	r_g		1.00	-1.04	-0.65**	0.07	-0.73**	-0.09	- 0.80**	0.47	-0.84**
	r_p		1.00	-0.01	-0.41	-0.15	-0.30	-0.05	-0.41	0.27	-0.41
Plant height	r_g			1.00	3.83	0.49	0.97**	0.52*	0.75**	-0.10	0.77**
	r_p			1.00	-0.14	0.13	0.37	0.27	0.14	-0.49	0.12
Pods per plant	r_g				1.00	0.21	0.03	1.36	1.24	-0.12	1.27
	r_p				1.00	0.14	0.07	0.34	0.36	-0.05	0.36
Shelling Per cent	r_g					1.00	0.46	-0.71**	0.52*	-0.08	0.43
	r_p					1.00	0.27	-0.05	0.43	-0.32	0.32
100-kernel weight	r_g						1.00	0.01	0.70**	-0.29	0.70**
	r_p						1.00	-0.01	0.39	0.09	0.37
Oil content	r_g							1.00	-0.21	-0.01	-0.14
	r_p							1.00	0.24	0.69**	0.27
Kernel weight	r_g								1.00	-0.55*	1.00**
	r_p								1.00	1.00	0.99**
Jassids incidence	r_g									1.00	-0.73**
	r_p										-0.56**
Dry pod yield	r_g										1.00
	r_p										1.00

* Significant at 5 % level; ** Significant at 1 % level

On the basis of pooled data over two crop seasons, high heritability coupled with high to moderate genetic gain was observed for 100-kernel weight and jassid incidence indicating the presence of additive gene action in the expression of these traits and phenotypic selection for the improvement of these traits will be effective. Similar finding in groundnut was reported for jassid incidence by John *et al*. (2009) and for 100-kernel weight by Uddin *et al.* (1995). Moderate heritability coupled with moderate genetic gain was observed for kernel yield, dry pod yield and late leaf spot indicating considerable influence of environment, so that simple selection will not be effective because of non-additive gene action. Similar results have also been reported earlier by Lakshmidevamma and Gowda, (2002) for kernel yield. A low heritability with low genetic gain was observed for days to flowering, plant height, branches per plant and pods per plant suggesting that environment had a major role in its expression.

Yield of a crop is the result of interaction of a number of inter-related characters; therefore, selection should be based on these component characters after assessing their correlation with yield. Character association revealed the mutual relationship between two characters, and its important parameters for taking a decision regarding the nature of selection to be followed for improvement in the crop under study.

Table 4. Path coefficient analysis indicating direct and indirect effects of sixteen component traits on dry pod yield in groundnut

Character	Days to 50 % flowering	Days to Maturity	Shelling	100-kernel weight	Oil content	Kernel yield	r
Days to 50 % flowering	0.04	0.00	-0.01	0.00	-0.06	-0.36	-0.38
Days to maturity	0.02	0.01	-0.01	0.01	-0.01	-0.86	-0.84**
Shelling percent	0.00	0.00	-0.08	-0.00	-0.05	0.56	0.43
100-kernel weight	-0.00	-0.00	-0.04	-0.01	0.00	0.75	0.70**
Oil content	-0.03	-0.00	0.05	-0.00	0.06	-0.22	-0.14
Kernel yield	-0.01	-0.00	-0.04	-0.01	-0.01	1.07	1.00**

Table 5. Genotypes having significantly higher yield along with higher biotic tolerance than checks in groundnut

Genotype	Dry pod yield (q/ha)	Late leaf spot severity * (1-9 scale)	Jassid incidence (%)
Entries			
UG 72	20.86	3.3	17.00
UG 76	18.80	4.2	17.67
UG 79	16.16	4.3	20.17
UG 81	15.64	4.3	19.67
UG 78	14.83	5.0	17.00
UG 77	13.84	4.3	11.83
Checks			
Pratap Mungphali 1	13.79	3.0	23.83
Pratap Mungphali 2	10.39	4.0	25.67
TG 37A	17.89	4.7	18.83
TAG 24	13.42	5.0	27.00
JL 24	07.31	5.3	44.00
CD (5%)	1.33	0.87	2.68
CD (1%)	1.77	1.16	3.57

*Score 1: no damage; Score 2: 1-5% leaves are affected; Score 3: 6-10% leaves are affected; Score 4: 11-20% leaves are affected; Score 5: 25-30% leaves are affected; Score 6: 31-40% leaves are affected; Score 7: 41-60% leaves are affected; Score 8: 61-80% leaves are affected; Score 9: 81-100% leaves are affected.

The correlation coefficients for yield and its component characters (Table 2) revealed that genotypic correlations were higher than their corresponding phenotypic ones, thereby, suggesting strong inherent association among the characters studied. On the basis of pooled data of two crop seasons, the dry pod yield exhibited significant positive association with kernel yield (at both phenotypic and genotypic levels), plant height and 100-kernel weight (genotypic level). These results are in accordance with John, *et al*. (2005). On the other hand it showed significant negative association with days to maturity at genotypic level. Since the incidence of jassids reduces the pod yield as well as kernel yield, it is important to know its association with pod yield. The dry pod yield exhibited significant negative association with jassid incidence.

Path coefficient analysis was carried out to estimate the direct & indirect contribution of individual traits on pod yield. On the basis of pooled data of path analysis as presented in Table 3, kernel yield had the highest positive direct effect on dry pod yield. Similar results were reported by Mathews *et al*. (2000). Correlation of 100-kernel weight and shelling per cent was mainly due to its indirect effect through kernel yield. The characters like kernel yield, 100-kernel weight and shelling per cent should be considered in selection programme for improving yield of groundnut.

Since the incidence of late leaf spot and jassids considerably affects the productivity of groundnut, one of the major aspects of groundnut breeding programme should include to screen the genotypes against major biotic stresses with the concomitant improvement in yield. These genotypes were also screened for the tolerance of late leaf spot and jassid incidence under natural field conditions.

Six genotypes *viz.*, UG 72, UG 76, UG 79, UG 81, UG 78, UG 77 showed higher yield combined with less incidence of late leaf spot and jassids over checks indicating concomitant improvement for yield and tolerance to insect-pest/disease (Table 4).

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