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RESEARCH PAPER

Genetic correlation and path analysis of productive traits in confectionery groundnut (*Arachis hypogaea* L.) genotypes

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Abstract: The objective of this study was to look at the genetic correlation and path analysis of productive traits in 31 advanced breeding lines in confectionery groundnut, four parents (TG-76, GPBD-5, ICGV 86699, and TGLPS-3) and one check (ICGV-06189).The trait hundred seed weight showed a significant positive correlation with pod length, sound mature kernels, mature pods per plant, plant height, pod yield per plant and pod yield according to the correlation coefficient estimates.Sound mature kernels had a significant relationship with shelling percentage and pod yield per plant had a positive relationship with kernel yield and haulm yield. These characteristics are used as selection criteria for higher yield. The highest positive and direct effect on pod yield was found in kernel yield, hundred seed weight, days to 50 per cent flowering and sound mature kernel. Hence, direct selection for this trait would be successful.

Key words: Correlation coefficient, Kernel yield, Path analysis, Pod yield, Seed weight

Introduction

Arachis hypogaea L., the cultivated groundnut or peanut, is an allotetraploid (2n = 4x = 40). It is most likely to have originated in the Andes' eastern foothills (Southern Bolivia and Northern Argentina). Peanut is grown as an oil seed or food crop in over 144 countries around the world (including tropical and warm temperate regions). The commercial production is mostly limited to the latitudes 400 N and 400 S. Groundnut is an important oil seed crop that is also used for a variety of purposes, such as eating the seed (kernel) raw, roasted and boiled, or processed into confections and peanut flour for flavor enhancement, or crushing for oil for edible and industrial uses; source of high quality edible oil (44-56%), protein (22-30 %) on a dry seed basis, carbohydrates (10-25 %), vitamins (E, K, and B complex), minerals (Ca, P, Mg, Zn) and fiber.

Groundnut pod yield is complex in nature and is influenced by a number of different traits. The study of correlation and path analysis concept reveals different ways in which component attributes influence complex traits, revealing clear information of contribution of each trait to the final expression of the character.Understanding the relationships between yield and yield components is critical to making the most of these relationships during selection. Correlation is a biometrical method for determining the strength of an association between two pairs of characters and providing information on the components that could be used as selection criteria in a breeding programme. Positively correlated yield traits are thought to be effective because selecting for them would result in a simultaneous increase in yield (Mahalakshmi *et al.,* 2005). Due to common association in trait interrelationships, the correlation coefficient may be confounded with indirect effect.

Path coefficient analysis separates correlation coefficients into components of direct and indirect effects and measures the direct influence of one variable on another (Dewey and Lu, 1959). Information derived from correlation coefficients can be supplemented by path coefficient analysis, which partitions correlations into direct and indirect effects. The purpose of this study was to look into the relationship between pod yield and its component traits in confectionery groundnut.

Material and methods

The experiment was conducted during summer 2021at AICRP on Sesame & Niger the Main Agricultural Research Station, UAS, Dharwad, with the 31 advanced breeding lines (F_{10} generation) along with four parents (TG-76, GPBD-5, ICGV 86699 and TGLPS-3) and one check (ICGV-06189) (Table 1) were evaluated in randomized complete block design with two replications. Each breeding lines were sown in 3 meter length bed in six rows by providing 45 x 15 cm spacing. Recommended agronomic and plant protection measures were adopted for the conduct of experiment. Five random plants per replication were sampled for recording observations from each genotype per replication and their mean values were used. The data were recorded for yield and yield attributing traits *viz.* Days to 50 per cent flowering, hundred seed weight, pod length, sound mature kernel, number of pods per plant, mature pods per plant, days to maturity, plant height, primary branches per plant, secondary branches per plant, shelling percentage, oil content, pod yield per plant, kernel yield, haulm yield and pod yield. Genotypic and phenotypic correlation coefficients were calculated among the genotypes using the formulae suggested by Al-Jibouri *et al.,* (1958). Path coefficient analysis was carried out by using phenotypic and genotypic correlation coefficients as per the method suggested by Dewey and Lu (1959).

Results and discussion

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of India. In India, oil is the ultimate product of the groundnut therefore oil content is an important aspect for increased yield potential. All the breeding efforts so far have been targeted towards enhancing oil production, either by increasing the oil

Table 1.Pedigree of the studied confectionery groundnut genotypes

Names	Pedigree
CG-1	TG – 76 × ICGV 86699
CG-2	TG – 76 × ICGV 86699
CG-3	TG – 76 × ICGV 86699
CG-4	TG – 76 × ICGV 86699
CG-5	TG – 76 × ICGV 86699
CG-6	TG – 76 × ICGV 86699
CG-7	TG – 76 × ICGV 86699
CG-8	TG – 76 × ICGV 86699
CG-9	TG – 76 × ICGV 86699
CG-10	TG – 76 × ICGV 86699
CG-11	TG – 76 × ICGV 86699
CG-12	TG – 76 × ICGV 86699
CG-13	TG – 76 × ICGV 86699
CG-14	TGLPS 3 x GPBD-5
CG-15	TGLPS 3 x GPBD-5
CG-16	TGLPS 3 x GPBD-5
CG-17	TGLPS 3 x GPBD-5
CG-18	TGLPS 3 x ICGV 86699
CG-19	TGLPS 3 x ICGV 86699
CG-20	TGLPS 3 x ICGV 86699
CG-21	TG – 76 × GPBD-5
CG-22	TG – 76 × ICGV 86699
CG-23	TG – 76 × ICGV 86699
CG-24	TG – 76 × ICGV 86699
CG-28	ICGV 06189X DH 245-10
CG-29	ICGV 06189X AGL 2766-8
CG-30	ICGV 06189X ICGV 08025-1
CG-31	JSP-39 X GM6-1SSD-5
CG-32	JSP-39 X GM6-1- SSD-25
CG-33	ICGV 06189 X GM 6000-24-5
CG-34	ICGV 06189 X 6000-65-3
ICGV 86699	Parental lines
TG 76	Parental lines
GPBD-5	Parental lines
TGLPS 3	Parental lines
ICGV 06189	Check

content or by increasing the production. But during the past three decades, the pattern of groundnut utilization has gradually changed. Both food and confectionery uses of groundnuts are on the rise. The results revealed that for all the traits studied, genotypic correlations were higher than their corresponding phenotypic correlations. This may be due to the relative stability of genetic resources as majority of them were subjected to certain amount of selection and are furnished in Table 2.

Correlation evaluates the relationship between different characteristics, helping to identify effective strategies for indirect selection using associated traits and simultaneous selection of multiple traits. In the present study the results indicated significant and positive correlation between hundred seed weight and pod yield. Which shows that greater the seed yield higher the pod yield, which was consistent with the previous studies of Mukri *et al.* (2014), Mahalakshmi *et al.* (2018) and Tirkey *et al.* (2018). Therefore breeding for high pod yield can be fitted without compromising the more seed weight is preferred character for confectionery groundnut.

Pod yield per plant of the study was similar as reported by previous studies of Ramakrishna *et al.* (2017). The shelling percentage had a non significant but positive association with pod yield. There was highly significant and positive association between pod yield with kernel yield and haulm yield showing that greater the pod yield there is an increase in the kernel yield and haulm yield. Similar results were reported by Lakshmidevamma *et al.* (2004), Mahalakshmi *et al.* (2018), Nagaveni and Khan (2019), Tirkey *et al.* (2018). Correlation between pod length and hundred seed weight was significant and positive which was supported by study of Jahanzaib*et al.* (2021).Both genotypic and phenotypic correlation of shelling percentage had significant and positive correlation with the kernel yield which was consistent with the study of Roy *et al.* (2021) and Jahanzaib *et al.* (2021).

By considering pod yield as a dependent character, the correlation coefficient was further partitioned into direct and indirect effects to determine the direct and indirect effects of pod yield and yield related traits. Only the mutual association between the characters was revealed by the information derived from correlation studies. The path coefficient analysis, on the other hand, aids in understanding the magnitude of each character's direct and indirect contribution to the dependent character, such as pod yield (Table 3).

In the present investigation path analysis was carried out to find out the direct and indirect effect of the character contributed to dependent character pod yield. The Path analysis using genotypic and phenotypic path coefficient between pod yield and various characters indicated that the kernel yield exhibited the highest direct effect on pod yield suggesting, the prime importance to be given for selection of these character for improving pod yield. Similar results were reported by Kushwah *et al.* (2016), Hampannavar *et al.* (2018), Nagaveni and Khan (2019), Tirkey *et al.* (2018), Kumari and Sashidharan (2020). Genotypic path coefficient between the pod yield, the hundred seed weight and sound mature kernel had direct effect on pod yield, which was inconsistent with the reports of Hampannavar *et al.* (2018), Tirkey *et al.* (2018) and Meta and Monpara (2010). Sound mature kernel and oil content showed the highest positive direct effect to pod yield at genotypic level and haulm yield. The results of John *et al.* (2019) showed the negligible direct effect at phenotypic level. Pod yield per plant and kernel yield had highest direct effect on pod yield which was also reported by the Barad *et al.* (2021). Pod yield showed positive significant association with the traits *viz.,* hundred seed weight and oil content at genotypic level. Sound mature kernel, primary branches per plant, kernel yield at both genotypic and phenotypic level. The pod yield per plant and haulm yield exhibited significant positive direct effect on pod yield. These characters can be considered as criteria for selection for higher yield, as these were mutually and directly associated with pod yield. Kernel yield had a highest positive direct effect on pod yield followed by hundred seed weight, oil content and sound mature kernel. Hence, a direct selection for these traits would be effective.

Table 2. Phenotypic and genotypic correlation for yield and yield attributing traits of confectionery groundnut genotypes

Traits		HSW	PL	SMK	NPP	MPP	DTM	PH	PBPP	SCBP	SP	OC	PYPP	KY	HY	PY
DFF	P	-0.437**	-0.13	-0.304**	0.048	-0.184	0.562**	-0.245*	0.215	0.314**	-0.063	0.116	-0.355**	-0.352**	-0.082	-0.326**
	G	-0.502**	0.043	-0.385**	0.126	-0.202	0.853**	-0.327**	0.582**	0.429**	-0.152	0.169	-0.448**	-0.480**	-0.114	-0.443**
HSW	P		0.349**	0.465**	0.197	0.419**	-0.148	0.257*	-0.339**	-0.191	0.197	-0.302**	0.395**	0.279*	-0.149	0.180
	G		0.518**	0.618**	0.192	0.530**	-0.160	0.324**	-0.573**	-0.201	0.232	-0.374**	0.452**	0.336**	-0.220	0.232*
PL	P			0.361**	0.192	0.200	0.120	-0.024	-0.238*	-0.087	-0.026	-0.312**	-0.09	-0.195	-0.114	-0.185
	G			0.450**	0.155	0.349**	0.095	0.003	-0.843**	-0.188	0.007	-0.471**	-0.156	-0.246*	-0.169	-0.242*
SMK	P				0.126	0.130	-0.114	0.119	-0.289*	-0.039	0.260*	-0.228	0.255*	0.230	-0.083	0.127
	G				0.095	0.090	-0.152	0.045	-0.520**	-0.051	0.328**	-0.362**	0.316**	0.294*	-0.166	0.186
NPP	P					0.519**	0.104	0.145	0.035	0.064	0.206	0.043	0.001	-0.392**	-0.533**	-0.558**
	G					0.541**	0.142	0.125	0.035	0.098	0.183	0.069	0.064	-0.354**	-0.523**	-0.526**
MPP	P						-0.134	0.423**	-0.186	-0.310**	0.285*	0.066	-0.009	-0.181	-0.494**	-0.333**
	G						-0.219	0.480**	-0.319**	-0.368**	0.378**	0.138	-0.014	-0.164	-0.544**	-0.357**
DTM	P							-0.243*	0.203	0.265*	0.144	-0.154	-0.088	-0.081	-0.041	-0.13
	G							-0.267*	0.143	0.364**	0.070	-0.155	-0.077	-0.084	-0.090	-0.122
PH	P								-0.294*	-0.315**	0.204	-0.051	0.281*	0.179	-0.338**	0.123
	G								-0.501**	-0.308**	0.199	-0.094	0.347**	0.227	-0.372**	0.191
PBPP	P									0.415**	-0.313**	0.187	-0.069	-0.193	0.004	-0.065
	G									0.666**	-0.703**	0.300*	-0.015	-0.305**	0.039	-0.036
SCBP	P										-0.272*	0.021	-0.200	-0.281*	0.020	-0.185
	G										-0.299*	0.027	-0.275*	-0.376**	-0.014	-0.271*
SP	P											-0.191	0.070	0.354**	-0.123	-0.076
	G											-0.298*	0.159	0.447**	-0.124	0.005
OC	P												-0.175	-0.229	-0.103	-0.193
	G												-0.249*	-0.144	-0.192	-0.344**
PYPP	P													0.800**	-0.004	0.800**
	G													0.806**	-0.032	0.797**
KY	P														0.282*	0.873**
	G														0.267*	0.872**
HY	P															0.372**
	G															0.362**

DFF-Days to 50% flowering; HSW: Hundred seed weight; PL: pod length; SMK: Sound mature kernels; NPP: Number of pods per plant; MPP: Mature pods per plant; DTM: Days to maturity; PH: Plant height (cm); PBPP: Primary branches per plant; SBPP: Secondary branches per plant; SP: Shelling percentage; OC: Oil content; KY: Kernel yield (kg/ha); HY: Haulm yield (kg/ha); PY: Pod yield (kg/ha); PYPP: Pod yield per plant.

Table 3. Path analysis of confectionery groundnut genotypes for yield attributing traits

Traits		DFF	HSW	PL	SMK	NPP	MPP	DTM	PH	PBPP	SCBP	SP	OC	PYPP	KY	HY	PY
DFF	G	0.504	-0.253	0.022	-0.194	0.063	-0.102	0.430	-0.165	0.293	0.217	-0.077	0.085	-0.226	-0.242	-0.116	-0.443**
	P	-0.023	0.010	0.003	0.007	-0.001	0.004	-0.013	0.006	-0.005	-0.007	0.001	-0.003	0.008	0.008	0.001	-0.326**
HSW	G	-0.678	1.350	0.699	0.835	0.260	0.716	-0.216	0.437	-0.774	-0.271	0.313	-0.505	0.610	0.454	0.506	0.232*
	P	0.028	-0.063	-0.022	-0.029	-0.012	-0.026	0.009	-0.016	0.021	0.001	-0.012	0.019	-0.025	-0.018	0.012	0.180
PL	G	-0.042	-0.501	-0.968	-0.436	-0.150	-0.338	-0.092	-0.003	0.816	0.182	-0.007	0.456	0.151	0.238	0.163	-0.166
	P	-0.002	0.006	0.017	0.006	0.003	0.003	0.002	0.000	-0.004	-0.002	0.000	-0.005	-0.002	-0.003	-0.003	0.003
SMK	G	-0.246	0.396	0.288	0.640	0.061	0.058	-0.097	0.029	-0.333	-0.033	0.210	0.456	0.202	0.188	-0.003	0.186
	P	-0.003	0.005	0.004	0.004	0.011	0.001	0.001	-0.001	0.001	0.000	0.003	-0.005	-0.002	-0.003	-0.003	-0.185
NPP	G	-0.240	-0.367	-0.295	-0.181	-1.908	-1.032	-0.270	-0.239	-0.067	-0.187	-0.350	-0.232	-0.122	0.676	-0.358	-0.526**
	P	-0.016	-0.064	-0.063	-0.063	-0.041	-0.326	-0.169	-0.034	-0.047	-0.021	-0.067	-0.002	0.003	0.003	-0.002	0.127
MPP	G	0.304	-0.795	-0.523	-0.136	-0.811	-1.500	0.329	-0.719	0.478	0.552	-0.566	-0.132	0.022	0.246	-0.786	-0.357**
	P	-0.001	0.003	0.001	0.001	0.001	0.004	0.007	-0.001	0.003	-0.002	0.002	-0.014	0.000	0.128	0.170	-0.558**
DTM	G	-0.266	0.050	-0.030	0.047	-0.044	0.068	-0.312	0.083	-0.045	-0.113	-0.022	-0.207	0.024	0.026	-0.001	-0.122
	P	0.010	0.003	0.002	0.002	-0.002	0.002	-0.002	0.018	-0.004	0.005	0.003	0.000	0.000	-0.001	-0.003	-0.333**
PH	G	0.113	-0.112	-0.001	-0.016	-0.043	-0.166	0.092	-0.346	0.173	0.107	-0.069	0.048	-0.120	-0.079	-0.112	0.191
	P	-0.008	0.008	-0.008	-0.008	0.004	0.005	0.014	-0.008	0.033	-0.010	0.007	-0.003	-0.002	-0.001	0.000	-0.130
PBPP	G	0.024	-0.024	-0.035	-0.021	0.001	-0.013	0.006	-0.021	0.041	0.027	-0.029	0.033	-0.001	-0.013	-0.013	-0.036
	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	-0.002	0.009	0.006	-0.010	0.123
SCBP	G	-0.119	0.056	0.052	0.014	-0.027	0.102	-0.101	0.086	-0.185	-0.278	0.083	0.012	0.076	0.105	0.108	-0.271*
	P	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.065
SP	G	-0.224	0.341	0.000	0.010	0.484	0.270	0.557	0.104	0.293	-1.037	-0.410	-0.008	0.234	0.659	-0.183	0.005
	P	0.009	-0.028	0.004	-0.037	-0.030	-0.041	-0.021	-0.029	0.045	0.039	-0.029	0.000	-0.051	0.017	-0.029	-0.185
OC	G	0.210	-0.465	-0.585	-0.585	-0.450	0.086	0.171	-0.193	-0.117	0.373	0.034	1.243	-0.152	-0.257	-0.009	0.289
	P	-0.006	0.017	0.017	0.017	0.013	-0.002	-0.004	0.009	0.003	-0.001	0.011	-0.055	0.010	0.013	0.007	0.015
PYPP	G	-1.319	1.331	-0.458	0.932	0.189	-0.043	-0.227	1.023	-0.044	-0.810	0.467	-0.439	-0.077	0.006	0.140	0.797**
	P	-0.192	0.214	-0.048	0.138	0.000	-0.005	-0.048	0.152	-0.037	-0.108	0.038	-0.095	0.541	0.433	-0.011	0.800**
KY	G	1.747	-1.223	0.894	-1.070	1.288	0.596	0.307	-0.825	1.110	1.369	-1.626	0.905	2.946	2.376	0.079	0.872**
	P	-0.128	0.101	-0.071	0.083	-0.142	-0.066	-0.029	0.065	-0.070	-0.102	0.128	-0.083	0.290	0.362	0.098	0.873**
HY	G	0.025	0.049	0.038	0.037	0.117	0.121	0.020	0.083	-0.009	0.003	0.028	0.032	-2.933	-3.637	-0.231	0.362**
	P	-0.003	-0.011	-0.010	-0.008	-0.031	-0.028	-0.001	-0.018	0.002	0.001	-0.007	-0.007	-0.001	0.016	0.059	0.372**

DFF-Days to 50% flowering; HSW: Hundred seed weight; PL: Pod length; SMK: Sound mature kernels; NPP: Number of pods per plant; MPP: Mature pods per plant; DTM: Days to maturity; PH: Plant height (cm); PBPP: Primary branches per plant; SBPP: Secondary branches per plant; SP: Shelling percentage; OC: Oil content; PYPP: Pod yield per plant; KY: Kernel yield (kg/ha); HY: Haulm yield (kg/ha); PY: Pod yield (kg/ha).

Conclusion

From the 31 advanced breeding lines along with four parents TG-76, GPBD-5, ICGV 86699 and TGLPS-3 and one check ICGV- 06189, pod length, sound mature kernels, mature pods per plant, plant height, pod yield per plant and pod yield showed a significant and positive correlation with the hundred seed weight. These characteristics are used as selection criteria for higher yield. The highest positive and direct effect on pod yield was found in kernel yield, hundred seed weight, days to 50% flowering, and sound mature kernel. As a result, direct selection for this trait could be successful.

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