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Character association studies between pod yield and its attributes in F_2 populations derived from three connected crosses of groundnut (*Arachis hypogaea* L)

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Abstract

Ground nut is an important oil seed crop and third largest oilseed crop produced in the world and second largest in India. There is huge gap between world and national average in terms of productivity. TMV-2 being a popular variety was crossed to three improved variety to get the variants with higher yield and qualities of TMV-2. F_2 populations of three crosses *viz.*, TMV-2 × ICGV-91114, TMV-2 × TG-69 and TMV-2 × ICGV-00350 were assessed to estimate the nature and direction of association of pod yield attributes with pod yield in groundnut during *kharif* -2017 at ARS, Chintamani. All the three crosses showed significant and positive correlation between branches plant^{-1} and pods plant^{-1} with pod yield plant^{-1} where as plant height had significant and negative correlation with pod yield plant^{-1} and exerted high direct effect on pod yield plant^{-1}. This suggests that pods plant^{-1}, branches plant^{-1} and plant height would serve as surrogate traits or as an indirect selection criterion for selecting desirable genotypes in the early segregating generations of groundnut. Shelling percent and sound mature kernel percent had significant and positive correlation with pod yield and kernel yield plant^{-1} however, no significant association was observed between days to first flowering and all other traits in F_2 generation of all the three crosses.

Keywords: F_2 segregation, correlation, path analysis

Introduction

Groundnut (*Arachis hypogaea* L.), known as king of oilseeds, is an important oilseed crop in the world as well as in India. It is a highly self-pollinated crop belonging to the family Fabaceae and an allotetraploid. The seed contains about 40-54 percent oil, 25-28 percent protein and 18 percent carbohydrates in addition to minerals and vitamins. Groundnut is the third largest oilseed crop produced in the world and second largest in India. It is grown in 90 countries around the world in an area of 23.4 million hectares with 42 million tonnes production and 17.96 quintals of productivity per hectare. Groundnut is cultivated in India in an area of 5.25 million hectares with production of 9.47 million tonnes and productivity of 12.00 quintals per hectare. Karnataka is the fourth largest producer of groundnut in India with productivity 7.32 quintals per hectare, after Gujarat, Andhra Pradesh and Tamil Nadu, respectively (Anon., 2017) [3]. Current productivity level of groundnut in Karnataka (0.73 t ha^{-1}) is less than half of national average (1.8 t ha^{-1}) (Anon., 2017) [3]. TMV-2, the variety developed and released in 1940 (78 years back) is still ruling despite other varieties better than TMV-2 are released. Traders or oil mill owners still prefer TMV-2 variety for oil extraction because of its even-sized pods and kernels with good quality oil. However, the government has denotified the variety and hence it is not available in the official seed chain. There is an urgent need to develop a variety with yield potential better than that of TMV-2 but with good pod and kernel features of TMV-2 so that the gap between the current productivity level of groundnut in Karnataka and national average, can be bridged.

Yield is a complex trait governed by many characters and there are ample evidences to show that selection directly for yield in plants is not so easy. Since the economic part of groundnut is pod which is developed under the soil, prediction of its performance based on aerial morphological characters is almost difficult (Weiss, 2000) [15]. Gain under direct selection for pod yield in groundnut is low and slow as pod yield is not only polygenically controlled, but also influenced by its component characters (Alam *et al*., 1985) [1]. The knowledge of existing variability and degree of association between pod yield and its attributing traits and their relative contribution to pod yield is essential for developing high yielding genotypes. Correlation and path analysis is helpful to determine the magnitude of association among the characters and the relative contribution of them on pod yield.

Material and Methods

The material for the present investigation constituted of F_2 populations of three connected crosses *viz*., TMV-2 × ICGV-91114, TMV-2 × TG-69 and TMV-2 × ICGV-00350 where, TMV-2 was the common female parent, which is comparatively low yielding but has desirable pod type and kernel type. It was crossed to the three high yielding varieties, ICGV-91114, TG-69 and ICGV-00350. Parent material was obtained from AICRP on Groundnut, ARS, Chintamani.

The F_2 plants derived from each of the three connected crosses and their parents were grown in plots of 18 m^2 area with a spacing of 0.3×0.2 m. The parents were evaluated in Randomised Block Design with three replications. Both the parents and F_2 population were evaluated during *kharif*- 2017 at the field unit of ARS, Chintamani. In total, 189 F_2 plants from cross TMV-2 × ICGV-91114, 196 from cross TMV-2 × TG-69 and 200 F_2 plants from cross TMV-2 × ICGV-00350 were available for recording observations.

The crop was grown by following all the agronomic practices as per the package of practices recommended for Eastern Dry Zone of Karnataka (Anon., 2016) [2]. The data was recorded on individual plants in the F_2 generation and on five randomly selected plants from each of the crosses and in each of the three replications.

The simple correlation coefficients were calculated to determine the direction and magnitude of associations among different characters and tested against table 'r' values (Fisher and Yates, 1963) [6] for (n-2) degrees of freedom both at 0.05 and 0.01 probability levels for their significance. Simple correlations were calculated by using the formula as given by Weber and Murthy (1952).

$$r\,(x,y) = \frac{\mathrm{CoV}(x.y)}{\sqrt{Vpx.Vpy}}$$

Where,
r_{xy} = Correlation coefficient between x and y
CoV (x.y) = Covariance of x and y
σ_x = Standard deviation of x
σ_y = Standard deviation of y

Phenotypic correlation coefficient was estimated in F_2 generation by following the formula given by Sundararaj *et al*. (1972) [12].

$$r_p\,(x,y) = \frac{p_x p_y}{\sqrt{Vpx.Vpy}}$$

Where,
P_xP_y = Phenotypic covariance of x and y
Vp_x = Phenotypic variance of x
Vp_y = Phenotypic variance of y
r_p (x,y) = Phenotypic correlation of x and y

Path coefficient analysis was carried out using phenotypic correlation values to ascertain the direct and indirect effects of the yield components on yield as suggested by Wright (1921) [16] and as illustrated by Dewey and Lu (1959) [5].

Results and Discussion:

Estimation of correlation coefficients: Pod yield and its component traits are predominantly governed by large number of genes and are greatly influenced by environment. Therefore, selection solely based on pod yield or kernel yield may not be effective. Pod yield improvement can be done by effecting indirect selection on pod yield related traits, whose heritability is high and show strong association with pod yield. From the breeder's point of view, identification of easily observable or assayable morphometric traits that are significantly associated with pod yield and its component traits has paramount importance as selection can be practiced for these traits right in the field. Hence, correlation coefficients of traits with pod yield plant^{-1} and kernel yield plant^{-1} in F_2 generation of all the three crosses along with their inter-relationships were estimated. Their association between the three crosses are compared and presented in Table 1. The graphical representation of correlation of easily assayable morphometric traits with pod yield plant^{-1} and kernel yield plant^{-1} in F_2 generation of all the three crosses is given in Figure 1and 2.

Table 1: Estimates of correlation coefficients of pod yield attributes with pod yield plant^{-1} in F_2 population of three crosses

Traits	Crosses	Plant height	Branches Plant^{-1}	Days to first flowering	Pods plant^{-1}	Shelling %	SMK %
Plant height	C_1	1	-0.69***	-0.06	-0.62***	-0.44***	-0.34***
	C_2	1	-0.72***	0.11	-0.60***	-0.23**	-0.32***
	C_3	1	-0.74***	-0.03	-0.63***	-0.30***	-0.33***
Branches	C_1	-0.69***	1	0.06	0.59***	0.37***	0.34***
plant^{-1}	C_2	-0.72***	1	-0.19**	0.65***	0.25***	0.28***
	C_3	-0.74***	1	-0.01	0.65***	0.29***	0.34***
Days to first flowering	C_1	-O.06	0.06	1	-0.01	0.04	0.08
	C_2	0.11	-0.19**	1	-0.07	-0.03	-0.09
	C_3	-0.03	-0.01	1	0.09	-0.05	-0.14*
Pods	C_1	-0.62***	0.59***	-0.01	1	0.07	0.04
plant^{-1}	C_2	-0.60***	0.65***	-0.07	1	0.04	0.06
	C_3	-0.63***	0.65***	0.09	1	-0.05	0.03
Shelling%	C_1	-0.44***	0.37***	0.04	0.07	1	0.56***
	C_2	-0.23**	0.25***	-0.03	0.04	1	0.38***
	C_3	-0.30***	0.29***	-0.05	-0.05	1	0.27***
SMK%	C_1	-0.34****	0.34****	0.08	0.04	0.56***	1
	C_2	-0.32***	0.28***	-0.09	0.06	0.38***	1
	C_3	-0.33***	0.34***	-0.14*	0.03	0.27***	1
Pod yield	C_1	-0.76***	0.77***	0.1	0.85***	0.19**	0.27***
plant^{-1} (g)	C_2	-0.76***	0.84***	-0.14*	0.82***	0.12	0.22**
	C_3	-0.79***	0.81***	0.1	0.88***	0.04	0.25***
Kernel yield	C_1	-0.82***	0.82***	0.1	0.77***	0.48***	0.41***

plant^{-1} (g)	C_2	-0.78***	0.86***	-0.14*	0.79***	0.31***	0.29***
	C_3	-0.83***	0.87***	0.07	0.79***	0.29***	0.34***

C_1- TMV-2 × ICGV-91114, C_2- TMV-2 × TG-69 and C_3- TMV-2 × ICGV-00350
*: Significant at P=0.05, **: Significant at P=0.01 and ***: Significant at P=0.001

From the results on association of pod yield attributes with pod yield, it is evident that plant height was highly significant and negatively correlated with pod yield plant^{-1} and kernel yield plant^{-1} in F_2 generation of all the three crosses suggesting, short statured plants should be selected for improving pod yield and kernel yield plant^{-1}. The similar association was noticed with all other traits as well in all the three crosses except for days to first flowering. Highly significant and positive correlation was found for branches plant^{-1} and pods plant^{-1} with pod yield plant^{-1} and kernel yield plant^{-1} (Table 1) in F_2 generation of all the three crosses, suggesting the selection of plants with high number of branches and pods will assure high pod yield and kernel yield plant^{-1}. Similar observations were recorded for plant height by Yadlapalli (2014) [17], for pods plant^{-1} by John *et al*. (2008) [7] and Pavan Kumar *et al.* (2014) and for both branches and pods plant^{-1} by Venkataravana *et al*. (2000) [13].

It was noticed that, shelling percent and sound mature kernel percent had significant and positive correlation with pod yield and kernel yield plant^{-1}. These results suggest that, emphasis should be laid on these traits for the improvement of pod yield and kernel yield plant^{-1} in groundnut. However, no significant association was observed between days to first flowering and all other traits in F_2 generation of all the three crosses except with pod yield plant^{-1}, kernel yield plant^{-1} and branches plant^{-1} in F_2 population of cross TMV-2 × TG-69, and sound mature kernels percent in cross TMV-2 × ICGV-00350, where it showed significant and negative correlation with these traits (Table 1). The results were in confirmation with the earlier reported results by Parameshwarappa *et al.* (2005) [10] for shelling percent and sound mature kernels percent.

Estimation of phenotypic path coefficients

Path analysis is a standardized partial regression co-efficient which splits the correlation co-efficient into measures of direct and indirect effects. In other words, it measures the direct and indirect contribution of various independent characters on a dependent character. Since many traits showed significant correlation with pod yield and kernel yield plant^{-1}, path co-efficient analysis was further carried out to estimate the direct and indirect effects of these traits on pod yield and kernel yield plant^{-1}.

A perusal of the estimates of path coefficients revealed that, pods plant^{-1} exerted highest positive direct effect on pod yield plant^{-1} in all the three crosses and on kernel yield plant^{-1} in cross TMV-2 × ICGV-91114, branches plant^{-1} also had positive direct effect on both pod yield plant^{-1} and kernel yield plant^{-1} in all the three crosses. This indicates that, due importance should be given on these traits during selection for the rapid improvement of pod yield and kernel yield plant^{-1} (Table 2) as these results were also in confirmation with Yogendra *et al.* (2001) [18] and Nagda and Joshi (2004) [9] for both branches plant^{-1} and pods plant^{-1}.

Table 2: Estimates of direct effects of pod yield and its attributes on pod yield plant^{-1} and kernel yield plant^{-1} in F_2 population of three crosses

Trait	Pod yield plant^{-1}(g)						Kernel yield plant^{-1}(g)					
	C_1	C_1 r	C_2	C_2 r	C_3	C_3 r	C_1	C_1 r	C_2	C_2 r	C_3	C_3 r
Plant height(cm)	-0.046	-0.745***	0.006	-0.724***	-0.03	-0.801***	-0.011	-0.806 ***	-0.016	-0.742 ***	-0.021	-0.824***
Branches plant^{-1}	0.013	0.769***	0.011	0.843***	0.013	0.828***	0.069	0.819***	0.017	0.858 ***	0.043	0.858***
Days to first flowering	-0.002	0.108	-0.002	-0.071	0.017	0.098	0.001	0.116	0.001	-0.066	-0.013	0.073
Pods plant^{-1}	0.216	0.850***	0.062	0.824***	0.128	0.869***	0.009	0.773 ***	-0.001	0.789 ***	-0.05	0.814***
Shelling %	-0.32	0.227**	-0.193	0.119	-0.231	0.324***	0.279	0.494 ***	0.187	0.310 ***	0.232	0.509***
SMK %	0.036	0.273***	-0.002	0.223**	0.027	0.248***	-0.009	0.405 ***	0.003	0.292 ***	-0.025	0.344***
Residual effect	0.15		0.027		0.029		0.088		0.161		0.093	

C_1 - TMV-2×ICGV-91114, C_2 - TMV-2×TG-69 and C_3 - TMV-2× ICGV-00350
r – Correlation coefficient
*: Significant at P=0.05, **: Significant at P=0.01 and ***: Significant at P=0.001

Plant height exerted significant negative direct effect on both pod yield and kernel yield plant^{-1} in all the three crosses, whereas shelling percent exhibited significant negative direct effect on pod yield plant^{-1} but significant positive direct effect on kernel yield plant^{-1}. This further reiterates that, selection of plants having short stature is desirable to improve pod yield and kernel yield plant^{-1} (Dandu *et al.* 2012) [4] and selecting plants with high shelling percent will be rewarding for enhancing kernel yield plant^{-1} (Table 2). These results clearly indicates that these traits can serve as surrogate traits for selecting high yielding genotypes as it help us to narrow down selection in the segregating generations and thus avoiding bulk of the work.

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