

Character Association and Path Analysis in Recombinant Inbred Line Population of the Cross JL 24 X ICG 13919 in Groundnut (*Arachis Hypogaea* L.)

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Abstract— The present study was undertaken to study the correlation coefficients among yield contributing traits and late leaf spot score at 75, 90 and 102 DAS with their path effects towards pod yield were investigated in RIL population of groundnut cross JL 24 X ICG 13919 during Kharif 2010. The studies on phenotypic and genotypic correlation coefficients revealed that pod yield per plant had strong positive correlation with number of mature pods per plant, immature pods per plant, total pods per plant, mature seed per plant, immature seeds per plant, hundred seed weight, shelling per cent and haulm weight per plant indicating that improvement of these characters will lead to improvement in yield. Whereas significant negative correlation with LLS disease score at 75 and 90 DAS. Among these characters, number of mature seeds per plant manifested maximum positive direct effect towards the pod yield per plant followed by total pods per plant and haulm weight per plant and other characters had high indirect effects through number mature pods per plant and mature seeds per plant. This suggested that emphasis should be given to number of mature pods per plant, total number of pods per plant, mature seeds per plant and haulm weight per plant in selection for high yielding lines in groundnut. It was observed that selection for these traits would be useful in the genetic improvement of these traits.

Key words: Character Association, Path Analysis, Groundnut, Late Leaf Spot and RIL Population

I. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important annual oilseed legume crop, valued as a rich source of protein, minerals and vitamins. It is the major oilseed crop in India and in Andhra Pradesh and Telangana. Groundnut has to play a major role in bridging the vegetable oil gap in the country. The average groundnut yield in the country was low (1305 kg per hectare) as compared to china (3568 kg per hectare) and USA (4699 kg per hectare) (FAOSTAT, 2014). The productivity is considered to be low because of number of constraints like abiotic (frequent droughts) and biotic stresses (attacks by pests and diseases).

Among the biotic stresses, foliar fungal diseases are important globally for groundnut (*Arachis hypogaea* L.). The two major foliar diseases viz., late leaf spot (*Phaeoisariopsis personata* (Berk. and Curt.) Deighton] and rust (*Puccinia arachidis* Speg.) are widespread and are economically most important. Yield losses range from 10 to 80 % depending on the severity of the disease and its occurrence in combination with other foliar diseases (Grichar et al., 1998). Use of fungicides to control leaf spots usually increases production costs by 10% (Coffelt and

Porter, 1986). Therefore, adoption of resistant cultivars is the best option as it minimizes losses at farm level and maintains good product quality (Dwivedi et al., 1993). Leaf spot resistant cultivars are also needed because of ever escalating costs of fungicides, their effect on non-target pathogens, and plant injury during application and environmental pollution (Janila et al., 2012).

In peanut breeding programs the selection of productive lines based on the phenotypic traits of pods is difficult since the fruits are hypogeal. Therefore, the choice of directly or indirectly yield-related traits is highly useful for breeders, particularly when working with divergent or segregating populations. Correlation analyses are useful in this regard since information on the nature and magnitude of interrelationships among traits is not only helpful to define the selection potential of an isolated trait but also detects the effects on one particular trait due to the selection for another (Cruz and Regazzi 1997). According to Santos et al. (2000), the importance of the correlations between traits in genetic improvement lies in the fact that they show how the alteration in one trait can affect others during selection. However, selection strategies based on the correlations between two traits only can induce errors, since their association may be linked to a third variable or even a group of characters (Cruz and Regazzi 1997).

The applicability of correlations can be more clearly understood in the path analysis, which allows the partitioning of correlation in direct and indirect effects and is therefore a valuable tool in breeding programs of various crops (Vieira et al. 2007). In literature, several studies have demonstrated the utility of correlation analysis in peanut selection based on plant and reproductive traits (Gomes and Lopes 2005). This study had the aim of estimating genetic parameters of yield components and LLS disease score at three stages and to split the coefficients of genotypic correlation between the yield and the components of the yield and LLS score in direct and indirect effects.

II. MATERIALS AND METHODS

Material for the present study consisted of 154 recombinant inbred lines (RILs) of the cross JL 24 × ICG 13919 in 8th generation. ICG 13919 is a resistant parent for LLS with high yielding and late maturity. JL 24 is a susceptible parent for LLS with early maturity and wider adoptability. The material was developed at ICRISAT and the experiment was conducted on conserved soil moisture in kharif 2010. These RILs were evaluated along with two parents (JL 24 and ICG 13919) and four checks (one susceptible check, TMV 2 and two resistant checks, ICG 11337 and ICGV 86699 and one moderately resistant check, ICGV 86590). The

experiment was laid out in ALPHA design with two replications eight blocks with 20 rows of 3 m length with a spacing of 60 cm between the rows and 10 cm between the plants. Artificial disease epiphytotic was created by using "spreader row technique". TMV 2 susceptible to LLS, hence was planted at every 10th row as well as five rows border around the field to maintain the effective inoculum load. Forty five days after sowing, plants were inoculated uniformly in the evening with the inoculum containing 20,000 conidia/ml water and mixed with Tween 80 (0.2 ml/1000 ml of water) as a mild surfactant and sprayed on the plants using knapsack sprayer. The weather conditions favoured good development of diseases. High humidity was maintained by irrigating the field in the evening for 30 minutes by sprinkler on rain-free days for 30 days from the day of inoculation. Additional inoculum was provided by placing pots containing diseased plants in the infector row for every 2 m. Rust disease was controlled by spraying calixin 1 ml /litre , while rest of the cultural operations and plant protection measures were followed as per recommended practices ensuring uniform and healthy crop stand. Following observations were recorded from five randomly selected plants viz., days to 50 % flowering, days to maturity, mature pods / plant, total pods / plant, mature seeds / plant, haulm weight / plant, 100- seed weight, shelling % , LLS disease score at 75 , 90 and 102 DAS and pod yield / plant. The mean values were used for statistical analysis. The data was subjected to analysis of variance (Fisher and Yates 1967). The correlation coefficients were worked out using the formula of Webber and Moorthy (1952) and were then compared with 'r' values given by Snedecor (1961) at n-2 degrees of freedom at the probability levels of 0.05 and 0.01 to test their significance. The path coefficient analysis was carried out as suggested by Wright (1921) and illustrated by Dewey and Lu (1959), which unveil the direct and indirect effects of different components on pod yield per plant.

III. RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated highly significant difference among the lines for all the traits studied except for number of immature seeds per plant. Similar findings were observed by Khote et al. (2009) and Shinde et al. (2010). The result indicates that the parents are highly diverse.

In the present study phenotypic and genotypic correlation values between traits were calculated by regressing phenotypic values of one trait on those of other. The result pertaining to this has been presented in Table 2. In general genotypic correlations was higher than phenotypic correlation in all the characters studied indicating the strong, inherent association between various characters and involvement of genetic factors in governing the characters (Dolma et al. 2010). Pod yield per plant showed positive association both at phenotypic and genotypic level with positive significant correlation with mature pods per plant, immature pods per plant, total pods per plant, mature seeds per plant, immature seeds per plant hundred seed weight, shelling per cent, haulm weight per plant. The result indicating that improvement in these characters will lead to improvement in yield. Similar results were also earlier reported by Khanpara et al. (2010) and

Janila et al. (2013) for mature pods per plant, John et al. (2007) for number of immature pods per plant, Patil et al. (2006) and Janila et al. (2013) for total number of pods per plant and sound mature kernel per cent with pod yield per plant. Pushkaran and Nair () found positive significant association of pod yield per plant with haulm weight per plant, hundred seed weight and shelling percent.

Pod yield per plant showed negative significant correlation with LLS disease score at 75 DAS and LLS disease score at 90 DAS. These results are similar with the earlier reports of Das and Roy (1995) and Sawargaonkar et al. (2010). Correlation between LLS scores were negative revealing antagonistic nature of the disease. This negative association between pod yield and late leaf spot severity suggests that it would be possible to select genotypes combining leaf spot resistance and yield through selection made under disease pressure in early generations.

LLS disease score at 75 DAS recorded positive and significant correlation with LLS disease score at 90 and 102 DAS. The results indicate that, high disease incidence at 75 DAS correspondingly increases disease score at 90 and 102 DAS. It implies that in breeding programmes, selections based on disease score at 90 DAS is good enough as it corresponds to score at 102 DAS. The resources can then be minimized by recording disease score at one stage rather than two. The results are in agreement with the findings of Dolma et al. (2010) who reported positive significant correlation of DS_70 with disease scores at 80 and 90 DAS. LLS disease score at 102 DAS showed negative non-significant association with pod yield per plant. Thus in breeding programmes it is better to rely on LLS disease score at 90 DAS. Haulm weight per plant had negative significant correlation with disease scores as the pathogen damages the foliage of the plant affecting haulm yield.

The path analysis using genotypic correlation coefficients (Table 3) between pod yield and various characters indicated that the mature seeds per plant exerted the highest positive direct effect on pod yield followed by total pod per plant, hundred seed weight and haulm weight per plant. Suggesting to give prime importance to selection of these traits for improving pod yield. While, shelling percent and immature pods per plant had moderate negative direct effect on pod yield and also had low negative indirect effects through other traits studied. Patil et al. (2006) observed strong to substantial direct effect of total pods per plant, sound mature kernel per cent, hundred seed weight on pod yield. Korat et al. (2010) reported positive direct effect of haulm weight per plant on pod yield. While, Sawargaonkar et al. (2010) reported shelling percent and LLS disease score at 90 DAS recorded negative direct effect on pod yield. Sumathi and Muralidharan (2007) recorded low negative direct effect of number of mature pods per plant with pod yield. Korat et al. (2010) found low negative direct effect of days to maturity with pod yield. All these findings are in conformity with the findings of the present investigation. The LLS disease scores at three stages (DS_75, DS_90 and DS_102) recorded positive or negative direct effect on pod yield. The results indicate that, when LLS disease incidence was more it reduces the yield. The positive direct effect was nullified by negative indirect effect via yield contributing characters. Selecting the plants

for high yield contributing characters and less disease score can be rewarding in groundnut breeding programmes.

Thus the present study indicated that high positive direct effect through mature seeds per plant and indirect

effect through total pods per plant, mature pods per plant and haulm weight per plant. Hence, priority should be given to these characters while selecting genotypes for high yield.

Source	DO F	DF	DM	MPD	IPD	TPD	MS D	HSW (g)	SH (%)	HUW (g)	DS_7 5	DS_9 0	DS_10 2	PYD (g)
Blocks	14	1.63	40.72	10.22	2.02	8.25	3.07	32.75	6.89	9.96	0.30*	0.43	0.18	5.40
Genotypes	159	2.11*	49.05*	31.51*	3.60*	36.69*	7.17 NS	61.34*	14.83*	51.65*	0.85*	1.67*	1.19**	12.28*
Error	--	1.42 (145)	31.13 (145)	14.29 (134)	2.38 (117)	18.19 (134)	5.50 (134)	14.97 (134)	7.21 (120)	12.07 (144)	0.15 (144)	0.28 (144)	0.18 (144)	5.65 (138)

Table 1: Analysis of variance (mean squares) for agronomic traits and late leaf spot in RIL population of a groundnut cross JL 24 × ICG 13919

DF - Days to 50 per cent flowering

DM - Days to maturity

DS_75 - LLS disease score at 75 days after sowing

MPD - Mature pods per plant

IPD - Immature pods per plant

TPD - Total pods per plant

DS_90 - LLS disease score at 90 days after sowing

MSD - Mature seeds per plant

HSW - Hundred seed weight (g)

DS_102 - LLS disease score at 102 days after sowing

SH - Shelling per cent (%)

HUW - Haulm weight (g)

PYD - Pod yield per plant (g)

** Significant at P ≤ 0.01,

* Significant at P ≤ 0.05

Trait	DF F	DM	MP D	IPD	TPD	MSD	ISD	HSW	SH	HU W	DS_7 5	DS_9 0	DS_1 02	PYD
DF	1.00	0.73* (1.09)**	0.01 (0.08)	0.05 (0.30)**	0.02 (0.19)**	-0.04 (0.01)	-0.02 (0.27)**	0.16* (0.53)**	0.02 (0.16)**	0.29* (0.60)**	0.15* (-0.52)**	0.19* (-0.63)**	0.34* (-0.86)**	0.05 (0.15)**
DM		1.00	-0.04 (0.03)	0.17* (0.40)**	0.01 (0.13)*	-0.07 (-0.04)	-0.03 (-0.07)	0.18* (0.34)**	0.00 (0.18)**	0.25* (0.40)**	0.22* (-0.54)**	0.27* (-0.53)**	0.44* (-0.80)**	0.00 (0.03)
MPD			1.00	0.21* (0.13)*	0.96* (0.97)**	0.93* (0.96)**	0.44* (0.68)**	0.08 (-0.34)**	0.33* (-0.25)**	0.19* (0.02)	-0.12* (-0.34)**	0.17* (-0.43)**	0.02 (-0.14)**	0.77* (0.70)**
IPD				1.00	0.43* (0.35)**	0.19* (-0.03)	0.31* (0.20)**	0.28* (0.45)**	0.17* (1.06)**	0.16* (0.30)**	0.22* (-0.44)**	0.17* (-0.36)**	0.17* (-0.42)**	0.22* (0.24)**
TPD					1.00	0.89* (0.88)**	0.48* (0.75)**	0.13* (-0.22)**	0.33* (0.00)	0.23* (0.12)*	0.18* (-0.44)**	0.20* (-0.51)**	-0.05 (-0.27)**	0.76* (0.73)**
MSD						1.00	0.32* (0.64)**	0.00 (-0.47)**	0.31* (-0.29)**	0.08 (-0.19)**	-0.06 (-0.18)**	-0.10 (-0.27)**	0.08 (0.06)	0.73* (0.57)**
ISD							1.00	0.06 (-0.13)	0.19* (0.03)	0.17* (0.43)	-0.07 (-0.40)	-0.09 (-0.34)	-0.07 (-0.37)	0.33* (0.74)

								*		**	**	**	**	**
HSW								1.00	0.32* * (0.31) **	0.37* * (0.69) **	- 0.13* (- 0.34) **	- 0.22* * (- 0.49) **	- 0.22* * (- 0.60) **	0.34* * (0.36) **
SH								1.00	0.03 (0.16) **	-0.04 (0.33) **	-0.06 (0.36) **	0.02 (0.11) *	0.17* * (- 0.06)	
HU W									1.00	- 0.21* * (- 0.45) **	- 0.25* * (- 0.51) **	- 0.33* * (- 0.69) **	0.42* * (0.44) **	
DS_7 5										1.00	0.72* * (0.94) **	0.56* * (0.66) **	- 0.14* * (- 0.33) **	
DS_9 0											1.00	0.63* * (0.79) **	- 0.19* * (- 0.44) **	
DS_1 02												1.00	-0.09 (- 0.29) **	
PYD													1.00	

Table 2: Phenotypic and genotypic correlation coefficients of different characters in RIL population of a groundnut cross JL 24 × ICG 13919

Figures in parenthesis are genotypic correlation coefficients
 DFF - Days to 50 per cent flowering
 DM - Days to maturity
 MPD- Mature pods per plant
 DS_75 - LLS score at 75 days after sowing
 IPD -Immature pods per plant
 TPD -Total pods per plant
 MSD - Mature seeds per plant
 DS_90 - LLS disease score at 90 days after sowing
 ISD - Immature seeds per plant

HSW - Hundred seed weight (g)
 SH - Shelling per cent (%)
 DS_102 - LLS disease score at 102 days after sowing
 HUW - Haulm weight per plant (g)
 PYD - Pod yield per plant (g)
 ** Significant at $r \geq 0.01$,
 * Significant at $r \geq 0.05$
 Significance Levels 0.05 0.01
 If correlation $r \Rightarrow 0.11$ 0.14

	DFD	DM	MPD	IPD	TPD	MSD	ISD	HSW	SH	HUW	DS_75	DS_90	DS_102	Correlation with pod yield
DFD	0.01 (- 1.34)	-0.06 (- 0.25)	0.00 (- 0.08)	-0.01 (0.37)	0.01 (- 0.94)	-0.02 (0.06)	0.00 (- 0.02)	0.05 (- 1.14)	0.00 (- 0.14)	0.06 (1.26)	0.00 (-1.13)	0.00 (2.56)	0.00 (0.94)	0.05 (0.15)**
DM	0.01 (- 1.47)	-0.08 (- 0.23)	0.00 (- 0.03)	-0.02 (0.50)	0.00 (- 0.64)	-0.03 (- 0.22)	0.00 (0.01)	0.05 (- 0.74)	0.00 (0.16)	0.06 (0.84)	0.00 (-1.16)	0.00 (2.13)	0.00 (0.88)	0.00 (0.03)
MPD	0.00 (- 0.11)	0.00 (- 0.01)	-0.04 (- 0.95)	-0.02 (0.17)	0.36 (- 4.82)	0.45 (4.77)	0.01 (- 0.05)	0.02 (0.73)	-0.06 (- 0.22)	0.04 (0.04)	0.00 (-0.74)	0.00 (1.74)	0.00 (0.16)	0.77** (0.70)**
IPD	0.00 (- 0.40)	-0.01 (- 0.09)	-0.01 (- 0.13)	-0.11 (1.26)	0.16 (- 1.74)	0.09 (- 0.16)	0.01 (- 0.02)	0.09 (- 0.97)	-0.03 (0.92)	0.04 (0.62)	0.00 (-0.95)	0.00 (1.44)	0.00 (0.46)	0.22** (0.24)**
TPD	0.00 (-)	0.00 (-)	-0.04 (-)	-0.05 (0.44)	0.37 (-)	0.43 (4.37)	0.01 (-)	0.04 (0.48)	-0.06 (0.00)	0.05 (0.26)	0.00 (-0.96)	0.00 (2.07)	0.00 (0.30)	0.76** (0.73)**

	0.25)	0.03)	0.92))	4.98))	0.06)))					
MSD	0.00 (- 0.02)	0.01 (0.01)	-0.04 (- 0.91)	-0.02 (- 0.04)	0.33 (- 4.38)	0.49 (4.96)	0.01 (- 0.05)	0.00 (1.00)	-0.06 (- 0.26)	0.02 (- 0.40)	0.00 (-0.39)	0.00 (1.11)	0.00 (-0.06)	0.73** (0.57)**
ISD	0.00 (- 0.36)	0.00 (0.02)	-0.02 (- 0.64)	-0.03 (0.25)	0.18 (- 3.74)	0.16 (3.19)	0.02 (- 0.08)	0.02 (0.27)	-0.03 (0.03)	0.04 (0.91)	0.00 (-0.87)	0.00 (1.36)	0.00 (0.41)	0.33** (0.74)**
HSW	0.00 (- 0.71)	-0.01 (- 0.08)	0.00 (0.32)	-0.03 (0.57)	0.05 (1.12)	0.00 (- 2.31)	0.00 (0.01)	0.31 (- 2.15)	-0.06 (0.27)	0.08 (1.44)	0.00 (-0.74)	0.00 (1.97)	0.00 (0.66)	0.34** (0.36)**
SH	0.00 (0.21)	0.00 (- 0.04)	-0.01 (0.24)	-0.02 (1.33)	0.12 (- 0.02)	0.15 (- 1.46)	0.00 (0.00)	0.10 (- 0.66)	-0.18 (0.87)	0.01 (0.34)	0.00 (0.72)	0.00 (-1.47)	0.00 (-0.13)	0.17** (-0.06)
HUW	0.00 (- 0.80)	-0.02 (- 0.09)	-0.01 (- 0.02)	-0.02 (0.37)	0.09 (- 0.62)	0.04 (- 0.95)	0.00 (- 0.03)	0.11 (- 1.48)	-0.01 (0.14)	0.22 (2.10)	0.00 (-0.97)	0.00 (2.04)	0.00 (0.76)	0.42** (0.44)**
DS_75	0.00 (0.70)	0.02 (0.12)	0.01 (0.32)	0.02 (- 0.55)	-0.07 (2.21)	-0.03 (- 0.89)	0.00 (0.03)	-0.04 (0.74)	0.01 (0.29)	-0.05 (- 0.95)	-0.01 (2.16)	0.01 (-3.78)	-0.01 (-0.73)	-0.14* (-0.33)**
DS_90	0.00 (0.85)	0.02 (0.12)	0.01 (0.41)	0.02 (- 0.45)	-0.07 (2.55)	-0.05 (- 1.36)	0.00 (0.03)	-0.07 (1.05)	0.01 (0.32)	-0.06 (- 1.06)	-0.01 (2.02)	0.02 (-4.05)	-0.01 (-0.86)	-0.19** (-0.44)**
DS_102	0.00 (1.15)	0.03 (0.18)	0.00 (0.13)	0.02 (- 0.53)	-0.02 (1.35)	0.04 (0.29)	0.00 (0.03)	-0.07 (1.29)	0.00 (0.10)	-0.07 (- 1.44)	-0.01 (1.43)	0.01 (-3.18)	-0.01 (-1.10)	-0.09 (-0.29)**

Table 3: Path coefficient analysis of component characters towards pod yield per plant in RIL population of a groundnut cross JL 24 × ICG 13919

Values in parenthesis indicates genotypic phenotypic values; Diagonal values (Bold letters) indicate direct effects and all other values are indirect effects

DFE - Days to 50 per cent flowering

DM - Days to maturity

MPD- Mature pods per plant

DS_75 - LLS score at 75 days after sowing

IPD -Immature pods per plant

TPD -Total pods per plant

MSD - Mature seeds per plant

DS_90 - LLS disease score at 90 days after sowing

ISD - Immature seeds per plant

HSW - Hundred seed weight (g)

SH - Shelling per cent (%)

DS_102 - LLS disease score at 102 days after sowing

HUW - Haulm weight per plant (g)

PYD - Pod yield per plant (g)

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