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Research Article

Correlation and Path Analysis Studies for Quantitative Traits in F_3 Generations of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

In groundnut, correlation and path coefficient analysis was carried out to identify the suitable selection indices in F_3 generations of nine crosses viz., J-87 x ICGV-00440, KDG-128 x ICGV-6100, K-1563 x TLG-45, JVB-2336 x CS-319, RG-510 x ICGV-86590, TG-26 x NRCG-CS-574, TAG-24 x IVK-I-16-21, TPG-41 x CSMG-210-11 and JL-501 x 461-C. Correlation analysis revealed that the traits viz., pod yield per plant had positive and highly significant correlation with number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel and harvest index. These characters can be considered as selection criteria for higher yield as they were mutually and directly associated with pod yield per plant. Out of thirteen characters studied, kernel yield per plant had exerted maximum positive direct effect on pod yield per plant. Indirect effect of harvest index through kernel yield per plant was high. Therefore, number of matured pods per plant, kernel yield per plant, shelling outturn and harvest index should be considered as selection criteria for improving pod yield per plant in groundnut.

Keywords: *Groundnut, Correlation, Path coefficient analysis, Pod yield.*

INTRODUCTION

Groundnut is an allotetraploid (2n=4x= 40) with a basic chromosome number of x=10 and it is highly self-pollinated crop having cleistogamous flowers. Groundnut is an unpredictable crop due to its underground pods development. It is an annual legume with high quality edible oil and easily digestible protein of its kernels. Pod yield is not only polygenically controlled, but also influenced by its component characters. Direct selection of pod yield would not be reliable approach without giving due importance to its genetic nature, owing to its complex nature of inheritance.

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Information on phenotypic and genotypic interrelationship of pod yield with its components characters and also among the characters themselves would be very much useful to the plant breeder in developing an appropriate breeding strategy.

But, the correlations give information about the component traits; they do not provide a true picture of relative importance of direct and indirect effects of these component traits on pod yield. Hence, the path coefficient analysis permits the separation of direct effects from indirect effects and gives more realistic relationship of the characters and help in effective selection. Therefore, the present study on Spanish bunch genotypes was conducted to study the correlation and path coefficients.

MATERIALS AND METHODS

The present investigation was carried out to assess the correlation and path coefficient analysis in F_3 generations of groundnut. The required quantity of seeds of F_3 populations and parents of nine crosses were obtained from the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh (Gujarat) and was sown in the summer- 2019 at the Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh (Gujarat).

The experimental material consisted of F_3 generations of nine crosses derived from crossing among 18 parents. The crosses of the study were; Cross 1(J-87 x ICGV-00440, Cross 2 (KDG-128 x ICGV-6100), Cross 3 (K-1563 x TLG-45), Cross 4 (JVB-2336 x CS-319), Cross 5 (RG-510 x ICGV-86590), Cross 6 (TG-26 x NRCG-CS-574), Cross 7 (TAG-24 x IVK-I-16-21), Cross 8 (TPG-41 x CSMG-210-11) and Cross 9 (JL-501 x 461-C). Nine F_3 populations and 18 parental lines have been sown during summer season on 6th February, 2019 in a Randomized Complete Block Design with two replications. The observations were taken from randomly selected 5 plants from parents and 10 plants from each of 15 sown rows of every crosses to record for the characters, *viz*., days to appearance of first flower, days to maturity, number of primary branches per plant, plant height, number of matured pods per plant, pod yield per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant and harvest index. Days to appearance of first flower and days to maturity, where data recorded on plot basis. Average value was used for the statistical analysis. The data was analysed to work out correlation and path coefficient analysis.

In the present study, simple correlation coefficient between the characters was worked out according to the procedure of Al-Jibouri et al. (1958). The path coefficient analysis was adopted to partition the correlation coefficient into direct and indirect effects and it was done as per the method suggested by Dewey and Lu (1959) and ranked on the scales given by Lenka and Misra (1973).

RESULTS AND DISCUSSION

The aim of correlation studies is a primarily to know the suitability of various characters for indirect selection (Prabhu et al., 2016). Correlation studies provide information on the nature and extent of association between any two metric traits and it will be possible to bring about genetic up gradation in one trait by selection of the other of a pair. Path analysis splits the correlation coefficient into direct and indirect effects. Path analysis showing direct and indirect effects are effective to get high selection response simultaneously for several characters from the diverse populations.

Correlation coefficient

Correlation may result from pleiotropy, linkage or physiological association among characters. The linkage is a cause of transit correlations particularly in a population derived from crosses between divergent strains. The correlation is the overall or net effect of the segregating genes. Some of the genes may increase both characters causing the positive correlation, while others may increase one and decrease the other causing the negative correlation. Thus, to accumulate optimum combination of yield contributing characters in a single genotype, it is essential to know the implication of the interrelationship of various characters.

The association of yield with different yield components in nine F_3 populations *viz.*, J-87 x ICGV-00440, KDG-128 x ICGV-6100, K-1563 x TLG-45, JVB-2336 x CS-319, RG-510 x ICGV-86590, TG-26 x NRCG-CS-574, TAG-24 x IVK-I-16-21, TPG-41 x CSMG-210-11 and JL-501 x 461-C were estimated and presented in Table 1.

Days to appearance of first flower with others

At both genotypic and phenotypic levels, days to appearance of first flower was positively and significantly associated with days to maturity, number of primary branches per plant, plant height, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content and biological yield per plant. With number of matured pods per plant in Cross 1 (r_g = 0.2563**, r_p = 0.2289**) and kernel yield per plant in Cross 8 (r_g = 0.9488**, r_p = 0.6562**). Parameshwarappa et al. (2008) found similar results for this character. While, negative and significant associations with days to maturity, plant height, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant and harvest index. With days to maturity in Cross 1 (r_g = -0.2216**, r_p = -0.2245**); kernel yield per plant in Cross 3 (r_g = -0.6714**, r_p = -0.4757**), Cross 4 (r_g= -0.6055**, r_p = -0.4042**) and Cross 9 (r_g = -0.3050**, r_p = -0.2474**). This suggested that early flowering would tend to early maturity. Therefore, days to first flowering should be considered important component for identifying early flowering genotypes in groundnut.

Thus, association of days to appearance of first flower with these traits varied from cross to cross. Such variation in strength and direction of associations could be attributed to the reflection of gene combinations specific for theses genotypes and not genetic linkage or pleiotropy.

Days to maturity with others

At both genotypic and phenotypic levels, days to maturity was positively and significantly associated with number of primary branches per plant, plant height, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. With number of matured pods per plant in Cross 6 (r_g = 1.005**, r_p = 0.6803**); kernel yield per plant in Cross 4 (r_g = 0.3371**, r_p = 0.3362**) and Cross 6 (r_g = 0.6688**, r_p = 0.4668**); harvest index in Cross 5 (r_g = 0.2440**, r_p = 0.2438**); pod yield per plant in Cross 6 (r_g = 0.5358**, r_p = 0.4591**); Bhargavi et al. (2015) reported same results for this character. While, negative and significant associations with days to appearance of first flower, number of primary branches per plant, plant height, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, harvest index and pod yield per plant. With kernel yield per plant in Cross 3 (r_g = -0.4908**, r_p = -0.3578**) and Cross 5 (r_g = -0.3453**, r_p = -0.2815**); pod yield per plant in Cross 2 (r_g = -0.4054**, r_p = -0.3426**); Jogloy et al. (2011) reported same results for this character.

Pod yield and days to maturity exhibited significant association between them in most of the crosses studied, which was positively associated at genotypic level in Cross 6; hence, it may be possible to select lines with higher yield without changing in maturity time. Tekale et al. (1988) showed positive and significant correlation between pod yield per plant and days to maturity.

Number of primary branches per plant with others

At both genotypic and phenotypic levels, number of primary branches per plant was positively and significantly associated with days to appearance of first flower, days to maturity, plant height, number of matured pods per plant, kernel yield, 100-kernel weight, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. With days to maturity in Cross 1 (r_g = 0.5825**, r_p = 0.5138**) and Cross 6 (r_g = 0.6401**, r_p = 0.6007**); number of matured pods per plant in Cross 1 (r_g = 0.3826**, r_p = 0.3761**), Cross 2 (r_g = 0.3407**, r_p = 0.3741**), Cross 3 (r_g = 0.6900**, r_p = 0.6969**), Cross 4 (r_g = 0.1884**, r_p = 0.3294**), Cross 6 (r_g = 1.1313**, r_p = 0.9163**), Cross 7 (r_g = 0.5368**, r_p = 0.3956**) and Cross 8 (r_g = 0.4155**, r_p = 0.4589**); kernel yield per plant in Cross 6 (r_g = 0.4735**, r_p = 0.4954**); harvest index in Cross 2 (r_g = 0.8460**, r_p = 0.5641**) and Cross 6 (r_g = 0.3012**, r_p = 0.3013**). Vasanthi et al. (2015) reported same results for this character. While, negative and significant associations with days to appearance of first flower, days to maturity, plant height, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant.

Plant height with others

Associations between plant height with other characters were found significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, number of primary branches per plant, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. So, in Cross 6 (r_g = 0.3043**, r_p = 0.2864**) and Cross 8 (r_g = 0.3328**, r_p = 0.1874*) in days to maturity, Cross 1 (r_g = 0.3551**, r_p = 0.3350**) and Cross 9 (r_g = 0.2664**, r_p = 0.2422**) in number of matured pods per plant, Cross 3 (r_g = 0.3723**, r_p = 0.2759**), Cross 6 (r_g = 0.4723**, r_p = 0.3277**) and Cross 8 (r_g = 0.3617**, r_p = 0.3116**) in kernel yield per plant. Similar observations were also reported by Tekale et al. (1988). At genotypic and phenotypic levels both negative and significant associations with days to appearance of first flower, days to maturity, number of primary branches per plant, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, harvest index and pod yield per plant.

Number of matured pods per plant with others

At both genotypic and phenotypic levels, number of matured pods per plant was positively and significantly associated with days to appearance of first flower, days to maturity, number of primary branches per plant, plant height, kernel yield per plant, 100-kernel weight, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. So, in days to maturity in Cross 8 (r_g = 0.3328**, r_p = 0.3065**) and Cross 9 (r_g = 0.3924**, r_p = 0.2993**); kernel yield per plant in Cross 1 (r_g = 0.2168**, r_p = 0.2415**); pod yield per plant in Cross 1 (r_g = 0.5561**, r_p = 0.4411**), Cross 2 (r_g = 0.5392**, r_p = 0.5562**), Cross 3 (r_g = 0.4033**, r_p = 0.4257**), Cross 8 (r_g = 0.2822**, r_p = 0.3137**) and Cross 9 (r_g = 0.4018**, r_p = 0.3252**). Nirmala and Jayalakshmi (2015) reported same results for this character. While, negative and significant associations with days to maturity, plant height, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant and harvest index.

Kernel yield per plant with others

Correlation of kernel yield per plant was significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, plant height, number of primary branches per plant, number of matured pods per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. Similar observations reported by Choudhary et al. (2016). Negative and significant associations with days to appearance of first flower in Cross 3 (r_g = -0.6714**, r_p = -0.4757**) and Cross 4 (r_g = -0.6055**, r_p = -0.4042**); plant height in Cross 5 (r_g = -0.3683**, r_p = -0.3391**).

100-kernel weight with others

Correlation of 100-kernel weight was significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, plant height, number of primary branches per plant, number of matured pods per plant, kernel yield per plant, shelling outturn, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. Similar observations reported by Choudhary et al. (2016). Negative and significant associations with days to appearance of first flower in Cross 1 (r_g = -0.5708**, r_p = -0.3538**), Cross 4 (r_g = -0.6067**, r_p = -0.5288**), Cross 6 (r_g = -0.4846**, r_p = -0.3434**) and Cross 9 (r_g = -0.6894**, r_p = -0.4605**) and plant height in Cross 9 (r_g = -0.4964**, r_p = -0.4874**).

Shelling outturn with others

Correlation of shelling outturn was significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, plant height, kernel yield per plant, 100-kernel weight, sound mature kernel, oil content, biological yield per plant, harvest index and pod yield per plant. Similar observations reported by Nirmala and Jayalakshmi (2015). While, negative and significant association with days to appearance of first flower in Cross 1 (r_g = -0.7652**, r_p = -0.6208**), Cross 2 (r_g = -0.3170**, r_p = -0.2431**) and Cross 5 (r_g = -0.4552**, r_p= -0.3560**); number of matured pods per plant in Cross 1 (r_g = -0.6673**, r_p = -0.6588**), Cross 2 (r_g = -0.8772**, r_p = -0.8581**), Cross 3 (r_g = -0.9031**, r_p = -0.8813**), Cross 5 (r_g = -0.7558**, r_p = -0.7439**), Cross 6 (r_g = -0.4142**, r_p = -0.3247**) and Cross 8 (r_g = -0.2131**, r_p = -0.2000*).

Sound mature kernel with others

Correlation of sound mature kernel was significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, number of primary branches per plant, plant height, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, oil content, biological yield per plant, harvest index and pod yield per plant. Similar observations reported by Nirmala and Jayalakshmi (2015). While, negative and significant associations with days to appearance of first flower in Cross 2 (r_g = -0.6185**, r_p = -0.4940**), Cross 3 (r_g = -0.9103**, r_p = -0.2144**) and Cross 4 (r_g = -0.3771**, r_p = -0.3317**); number of matured pods per plant in Cross 3 (r_g = -0.4844**, r_p = -0.4782**). Similar observation for this character was reported by Sharma and Dashora (2009).

Oil content with others

Oil content had significantly positive correlations at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, number of primary branches per plant, plant height, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, biological yield per plant, harvest index and pod yield per plant. Similar observations reported by Nirmala and Jayalakshmi (2015). While, negative and significant associations with days to appearance of first flower in Cross 2 (r_g = -0.6323**, r_p = -0.2916**), Cross 3 (r_g = -0.9027**, r_p = -0.1797**) and Cross 6 (r_g = -0.2862**, r_p = -0.1948**); number of matured pods per plant in Cross 4 (r_g = -0.5826**, r_p = -0.4851**) and Cross 5 (r_g = -0.5381**, r_p = -0.4780**). Similar observation for this character was reported by Sharma and Dashora (2009).

Biological yield per plant with others

Biological yield per plant had significantly positive correlations at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, plant height, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content and pod yield per plant. Similar observation reported by Nirmala and Jayalakshmi (2015). While, negative and significant association with days to appearance of first flower in Cross 3 (r_g = -0.3093**, r_p = -0.2778**) and Cross 4 (r_g = -0.3761**, r_p = -0.3517**); number of matured pods per plant in Cross 3 (r_g = -0.2272**, r_p = -0.2138**) and Cross 8 (r_g = -0.3302**, r_p = -0.3225**). Similar observation for this character was reported by Sharma and Dashora (2009).

Harvest index with others

Correlation of harvest index was significantly positive at both genotypic and phenotypic levels with days to appearance of first flower, days to maturity, number of primary branches per plant, number of matured pods per plant, kernel yield per plant, 100-kernel weight, shelling outturn, sound mature kernel, oil content and pod yield per plant. While, negative and significant only at genotypic level with plant height in Cross 5 (r_g = -0.1755*). Such relationships between these characters were earlier reported by Bhargavi et al. (2015).

Path coefficient

In fact, pod yield per plant is a polygenic trait, influenced by its several components as well as indirectly *via* other traits, which create complex situation before a breeder for making selection. In such situation, path coefficient analysis could provide a more realistic picture of the interrelationship as it considers direct as well as indirect effects of the variables by partitioning the correlation coefficient. In the present study, path coefficient was worked out for all significant characters in all significant groundnut crosses and the results have been presented and discussed in the following pages:

Days to appearance of first flower and others

The partitioning of correlation coefficient into direct and indirect effects of days to appearance of first flower with other traits (Table 2) indicated that direct effect of this trait was negligible to low in both directions towards pod yield per plant in all the crosses. Our results are in accordance with the results reported by Misangu et al. (2007) and Mane et al. (2008). Its indirect effect was very high towards pod yield per plant through kernel yield per plant in Cross 8 (0.5953) and low in Cross 1 (0.0323). Earlier such type of relationship was reported by Giri et al. (2009) and Thakur et al. (2013). Its indirect effect through other characters towards pod yield per plant was negligible and low in most of the crosses. Although, the correlations of days to appearance of first flower with pod yield per plant was positive and significant in the Cross 8 (0.2473).

Days to maturity and others

Direct and indirect effects of days to maturity with other traits (Table 2) indicated that direct effect of this trait was negligible to high in both directions towards pod yield per plant in all the crosses. Its indirect effect was high towards pod yield per plant through kernel yield per plant in Cross 6 (0.5358) and moderate in Cross 3 (0.1180). Giri et al. (2009) reported similar results. Its indirect effect through other characters towards pod yield per plant was negligible in all the crosses. The correlation of days to maturity with pod yield per plant was positive and significant Cross 6 (0.4591).

Number of primary branches per plant and others

The examination of direct and indirect effects of primary branches per plant (Table 2) revealed that the contribution of direct effect with other traits were negligible in both direction. Raju et al. (1981) reported number of primary branches per plant had negligible direct effect on pod yield per plant. Its indirect effect was high towards pod yield per plant through kernel yield per plant in Cross 6 (0.5686) and low in Cross 7 (0.0687). Its indirect effect through other character towards pod yield per plant was negligible in all the crosses. The correlation of number of primary branches per plant with pod yield per plant was found positive significant in Cross 2 (0.5404), Cross 3 (0.4511) and Cross 6 (0.5211).

Plant height and others

The examination of direct and indirect effects of plant height (Table 2) revealed that the contribution of direct effect with other traits were negligible in both directions except for Cross 3 (-0.3232). Its indirect effect was high towards pod yield per plant through kernel yield per plant in Cross 3 (0.5103). Singh and Singh (2001) reported that most of the characters contributed indirectly to pod yield per plant *via* kernel yield. Its indirect effect through other characters towards pod yield per plant was negligible to low in all the crosses. The correlation of plant height with pod yield per plant was positive and significant in Cross 1 (0.3465), Cross 2 (0.4019), Cross 3 (0.2913) and Cross 6 (0.2527).

Number of matured pods per plant and others

The partitioning of correlation coefficient into direct and indirect effects of number of matured pods par plant with other traits (Table 2) indicated that direct effects of this trait was low to moderate in both directions towards pod yield per plant in all the crosses. Babariya and Dobariya (2012) reported number of matured pods per plant had moderate direct effect on pod yield per plant. Its indirect effect was higher towards pod yield per plant through kernel yield per plant in all the crosses that is in Cross 8 (0.1685), Cross 1 (0.1465) and low in Cross 5 (0.0167) and Cross 9 (0.0022). Earlier such type of relationship was reported by Abraham et al. (1990). Its indirect effect through other characters towards pod yield per plant was negligible in most of the crosses. Although, the correlations of number of matured pods per plant with pod yield per plant was positive and significant in all the crosses except in Cross 5 (0.0204).

Kernel yield per plant and others

Path coefficient values presented in Table 2 for kernel yield per plant indicated that this character was identified as an important component of pod yield per plant since it exhibited strong and positive association with pod yield per plant and also expressed high and positive direct effect in most the crosses. Such direct effect towards pod yield per plant was reported earliest by Kumar et al. (2012). Hence, it would be rewarding to give due importance on the selection of this character for rapid improvement in pod yield of groundnut.

Its indirect effect was negligible in all the crosses for all the characters except for shelling outturn in all the crosses. It's high and positive direct effects indicated that this character should be considered as important component of pod yield per plant and maximum weightage should be given to this trait during selection programme. Earlier Sawarganokar et al. (2010) also reported high direct effect of kernel yield per plant towards pod yield per plant. The correlation of kernel yield per plant with pod yield per plant was positive and significant in all the crosses.

Shelling outturn and others

Contribution of direct effect towards pod yield per plant was moderate to high in both directions towards pod yield per plant in all the crosses (Table 2). Earlier such type of relationship was reported by Trivikrama et al. (2017). Its indirect effect was also positive and high towards pod yield per plant through kernel yield per plant in Cross 6 (0.3832) and positive and high indirect effect found in all the crosses except Cross 5 (-0.0537). Such relationships between these characters were reported earlier by Azad and Hamid (2000). Its indirect effect through other characters towards pod yield per plant was negligible in most of the crosses. The correlation of shelling outturn with pod yield per plant was found negative and positive significant results in most of the crosses.

Sound mature kernel and others

Contribution of direct effect towards pod yield per plant was moderate to high in both directions towards pod yield per plant in all the crosses (Table 2). Earlier such type of relationship was reported by Trivikrama et al. (2017). Its indirect effect was also positive and high towards pod yield per plant through kernel yield per plant in Cross 8 (0.7868) and positive and high indirect effect found in all the crosses except Cross 5 (-0.1988). Such relationships between these characters were reported earlier by Azad and Hamid (2000). Its indirect effect through other characters towards pod yield per plant was negligible in most of the crosses. The correlation of sound mature kernel with pod yield per plant was found positive and significant results in the Cross 1 (0.6687), Cross 3 (0.1736), Cross 4 (0.2096), Cross 7 (0.6812) and Cross 8 (0.5059).

Oil content and others

Direct and indirect effects of oil content with other traits (Table 2) indicated that direct effects of this trait were negligible and low in both directions towards pod yield per plant in all the crosses. Its indirect effect was higher towards pod yield per plant through kernel yield per plant in Cross 2 (0.7864). Earlier such type of relationship was reported by Giri et al. (2009) and Sawarganokar et al. (2010). Its indirect effect through other characters towards pod yield per plant was negligible in most of the crosses. The correlation of oil content with pod yield per plant was positive and significant in Cross 2 (0.3115) and Cross 3 (0.5469).

Biological yield per plant and others

Path coefficient values presented in (Table 2) for biological yield per plant indicated that this character was identified as an important component of pod yield per plant since, it exhibited strong and positive association with pod yield per plant and also expressed moderate to high and positive direct effect in all the crosses except Cross 8 (-0.1330) and Cross 9 (-1.0752). Such direct effect towards pod yield per plant was reported earlier by Gupta et al. (2015) and Choudhary et al. (2016). Therefore, greater emphasis should be given on this character while selecting for higher yield and related traits. Its indirect effect was higher towards pod yield per plant through kernel yield per plant in all the crosses except Cross 5 (-0.0626). Earlier such type of relationship was reported by Abraham et al. (1990). Its indirect effect through other characters towards pod yield per plant was negligible and low in most of the crosses. Although, the correlations of biological yield per plant with pod yield per plant was positive and significant in Cross 3 (0.4377), Cross 4 (0.1739), Cross 5 (0.2714) and Cross 7 (0.3967).

Harvest index and others

Path coefficient values presented in (Table 2) for harvest index indicated that this character was identified as an important component of pod yield per plant since it exhibited strong and positive association with pod yield per plant and also expressed high and positive direct effect in all the crosses except Cross 6 (-0.2988) and Cross 7 (-0.0526). Such direct effect towards pod yield per plant was reported earlier by Choudhary et al. (2016). Its indirect effect was higher towards pod yield per plant through kernel yield per plant in all the crosses except in Cross 5 (-0.0863). Earlier such type of relationship was reported by Abraham et al. (1990). Its indirect effect was negligible in all the crosses for all the characters. It's high and positive direct effects indicated that this character should be considered as important component of pod yield per plant and maximum weightage should be given to this trait during selection programme. Kumar et al. (2012) also reported high direct effect of harvest index towards pod yield per plant. The correlation of harvest index with pod yield per plant was positive and significant in all the crosses.

Table 1: Simple correlations among yield and yield attributes in F_3 populations of groundnut

S. N.	Characters	Crosses	Days to appearance of first flower	Days to maturity	No. of primary branches/ plant	Plant height (cm)	No. of matured pods/plant	Kernel yield/ plant (g)	100-kernel weight (g)	Shelling outturn (%)	Sound mature kernel (%)	Oil content (%)	Biological yield per plant (g)	Harvest index (%)
			1	2	3	4	5	6	7	8	9	10	11	12
1	Days to maturity	1	-0.2216**	--	--	--	--	--	--	--	--	--	--	--
		2	--	--	--	--	--	--	--	--	--	--	--	--
		3	0.5141**	--	--	--	--	--	--	--	--	--	--	--
		4	0.3478**	--	--	--	--	--	--	--	--	--	--	--
		5	--	--	--	--	--	--	--	--	--	--	--	--
		6	--	--	--	--	--	--	--	--	--	--	--	--
		7	--	--	--	--	--	--	--	--	--	--	--	--
		8	0.0379	--	--	--	--	--	--	--	--	--	--	--
		9	0.5675**	--	--	--	--	--	--	--	--	--	--	--
2	Number of primary branches/plant	1	0.0539	0.5825**	--	--	--	--	--	--	--	--	--	--
		2	--	-0.2233**	--	--	--	--	--	--	--	--	--	--
		3	0.2800**	0.0403	--	--	--	--	--	--	--	--	--	--
		4	0.3023**	-0.4768**	--	--	--	--	--	--	--	--	--	--
		5	--	-0.6097**	--	--	--	--	--	--	--	--	--	--
		6	--	0.6401**	--	--	--	--	--	--	--	--	--	--
		7	--	-0.5664**	--	--	--	--	--	--	--	--	--	--
		8	0.2472**	--	--	--	--	--	--	--	--	--	--	--
		9	0.4715**	--	--	--	--	--	--	--	--	--	--	--
3	Plant height (cm)	1	0.4762**	0.1348	-0.1090	--	--	--	--	--	--	--	--	--
		2	--	0.4285**	-0.4161**	--	--	--	--	--	--	--	--	--
		3	-0.1875*	-0.4103**	-0.4404**	--	--	--	--	--	--	--	--	--
		4	-0.1619*	0.1283	-0.4832**	--	--	--	--	--	--	--	--	--
		5	--	-0.4546**	0.5123**	--	--	--	--	--	--	--	--	--
		6	--	0.3043**	0.0079	--	--	--	--	--	--	--	--	--
		7	--	-0.4307**	0.3799**	--	--	--	--	--	--	--	--	--
		8	0.9576**	--	0.0256	--	--	--	--	--	--	--	--	--
		9	0.4785**	--	0.5612**	--	--	--	--	--	--	--	--	--

(*Contd.*)

Table 1: (*Contd.*)

S.N.	Characters	Crosses	Days to appearance of first flower	Days to maturity	No. of primary branches/ plant	Plant height (cm)	No. of matured pods/plant	Kernel yield/ plant (g)	100-kernel weight (g)	Shelling outturn (%)	Sound mature kernel (%)	Oil content (%)	Biological yield per plant (g)	Harvest index (%)
			1	2	3	4	5	6	7	8	9	10	11	12
4	Number of matured pods/plant	1	0.2563**	-0.1916*	0.3826**	0.3551**	--	--	--	--	--	--	--	--
		2	--	-0.2069*	0..3407**	--	--	--	--	--	--	--	--	--
		3	-0.8156**	-0.4862**	0.6900**	-0.2470**	--	--	--	--	--	--	--	--
		4	0.0060	0.1793*	0.1884*	--	--	--	--	--	--	--	--	--
		5	--	0.1185	0.1541	-0.4388**	--	--	--	--	--	--	--	--
		6	--	1.0048**	1.1313**	-0.1009	--	--	--	--	--	--	--	--
		7	--	-0.4052**	0.5368**	0.0391	--	--	--	--	--	--	--	--
		8	0.1325	--	0.4155**	-0.1577	--	--	--	--	--	--	--	--
		9	0.0419	--	0.1279	0.2664**		--	--	--	--	--	--	--
5	Kernel yield/plant (g)	1	0.0326	-0.0619	-0.2646**	0.0800	0.2168**	--	--	--	--	--	--	--
		2	--	-0.1488	-0.1874*	--	-0.2453**	--	--	--	--	--	--	--
		3	-0.6714**	-0.4908**	-0.4955**	0.3723**	-0.2390**	--	--	--	--	--	--	--
		4	-0.6055**	0.3371**	-0.8119**	--	--	--	--	--	--	--	--	--
		5	--	-0.3453**	0.0794	-0.3683**	-0.1261	--	--	--	--	--	--	--
		6	--	0.6688**	0.4735**	0.4723**	--	--	--	--	--	--	--	--
		7	--	-0.0896	0.0327	-0.1660**	--	--	--	--	--	--	--	--
		8	0.9488**	--	-0.1344	0.3617**	0.1832*	--	--	--	--	--	--	--
		9	-0.3050**	--	0.1454	-0.1770*	0.0213	--	--	--	--	--	--	--
6	100-kernel weight (g)	1	-0.5708**	-0.2433**	0.1345	0.1875*	0.4256**	0.3115**	--	--	--	--	--	--
		2	--	0.1853*	-0.4427**	--	0.3730**	0.1663*	--	--	--	--	--	--
		3	0.3355**	-0.0327	-0.5757**	0.4390**	-0.3410**	0.4354**	--	--	--	--	--	--
		4	-0.6067**	0.2534**	-0.6968**	--	--	0.0347	--	--	--	--	--	--
		5	--	-0.1378	-0.0360	0.1193	-0.6147**	0.6091**	--	--	--	--	--	--
		6	--	0.6202**	0.6353**	0.2138**	--	--	--	--	--	--	--	--
		7	--	-0.1498	0.0763	0.4207**	--	0.5308**	--	--	--	--	--	--
		8	0.5643**	--	-0.0526	0.4656**	-0.1064	0.5437**	--	--	--	--	--	--
		9	-0.6894**	--	0.1528	-0.4964**	-0.1578	--	--	--	--	--	--	--

(*Contd.*)

Table 1: (*Contd.*)

S.N.	Characters	Crosses	Days to appearance of first flower	Days to maturity	No. of primary branches/ plant	Plant height (cm)	No. of matured pods/plant	Kernel yield/ plant (g)	100-kernel weight (g)	Shelling outturn (%)	Sound mature kernel (%)	Oil content (%)	Biological yield per plant (g)	Harvest index (%)
			1	2	3	4	5	6	7	8	9	10	11	12
7	Shelling outturn (%)	1	-0.7652**	0.0580	-0.3606**	-0.3812**	-0.6673**	0.1042	0.2172**	--	--	--	--	--
		2	--	0.1242	-0.4666**	--	-0.8772**	0.1698*	-0.0515	--	--	--	--	--
		3	0.3811**	0.4783**	-0.7223**	0.1978*	-0.9031**	0.0484	0.3216**	--	--	--	--	--
		4	-0.3380**	0.3161**	-0.2281**	--	--	-0.1926*	0.3008**	--	--	--	--	--
		5	--	-0.3551**	-0.0901	0.3054**	-0.7558**	0.2192**	0.6603**	--	--	--	--	--
		6	--	0.1606*	-0.4728**	0.4362**	--	--	0.2196**	--	--	--	--	--
		7	--	0.4224**	-0.3232**	-0.9108**	--	-0.1448	--	--	--	--	--	--
		8	0.2651**	--	-0.1826*	0.2475**	-0.2131**	0.3008**	0.1145	--	--	--	--	--
		9	-0.0512	--	0.1522	0.3667**	-0.0031	--	0.0488	--	--	--	--	--
8	Sound mature kernel (%)	1	0.0552	0.2696**	0.0065	-0.2366**	0.1409	0.8637**	-0.0998	0.0424	--	--	--	--
		2	--	-0.4047**	0.0554	--	0.1825*	0.3400**	-0.0037	0.0163	--	--	--	--
		3	-0.9103**	-0.0101	-0.3170**	0.1745*	-0.4844**	0.9130**	0.3715**	0.2223**	--	--	--	--
		4	-0.3771**	0.6723**	-0.6541**	--	--	0.5774**	0.3422**	--	--	--	--	--
		5	--	-0.4444**	0.4003**	-0.0262	-0.1060	0.7838**	0.1136	0.0009	--	--	--	--
		6	--	0.5116**	0.3720**	0.3907**	--	--	--	0.6606**	--	--	--	--
		7	--	-0.1736*	0.1631*	-0.0821	--	0.8562**	0.6925**	--	--	--	--	--
		8	0.8957**	--	0.2819**	0.2888**	0.3644**	0.9109**	0.4423**	0.2364**	--	--	--	--
		9	0.2185**	--	-0.2989**	-0.2030*	0.1897*	--	0.0368	0.4502**	--	--	--	--

9	Oil content (%)	1	0.0648	-0.5551**	-0.0910	-0.0020	0.5035**	0.0595	0.3137**	-0.1228	-0.0656	--	--	--
		2	--	-0.3591**	0.0133	--	0.6298**	0.1449	0.5327**	-0.3519**	0.3668**	--	--	--
		3	-0.9027**	-0.1974*	0.3516**	0.0543	0.3940**	0.2954**	-0.0837	-0.3800**	0.1101	--	--	--
		4	0.3766**	0.2548**	-0.1806*	--	--	-0.2302**	0.1963*	--	0.1194	--	--	--
		5	--	-0.2529**	0.1150	0.7181**	-0.5381**	0.1345	0.5065**	0.3961**	0.1103	--	--	--
		6	--	0.2902**	0.1913*	-0.2987**	--	--	0.7433**	-0.0213	--	--	--	--
		7	--	-0.1653*	0.2601**	-0.1570	--	0.4379**	--	--	0.2031*	--	--	--
		8	0.5590**	--	-0.2452**	0.5471**	-0.2005*	0.2864**	-0.2982**	0.5206**	0.2095**	--	--	--
		9	-0.2954**	--	-0.1938*	-0.0481	0.1449	--	0.1367	0.2027*	--	--	--	--

(*Contd.*)

Table 1: (*Contd.*)

S. N.	Characters	Crosses	Days to appearance of first flower	Days to maturity	No. of primary branches/ plant	Plant height (cm)	No. of matured pods/plant	Kernel yield/ plant (g)	100-kernel weight (g)	Shelling outturn (%)	Sound mature kernel (%)	Oil content (%)	Biological yield per plant (g)	Harvest index (%)
			1	2	3	4	5	6	7	8	9	10	11	12
10	Biological yield per plant (g)	1	-0.2607**	0.0709	0.5572**	0.0053	0.5490**	0.3922**	0.1683*	-0.0848	0.4522**	-0.0100	--	--
		2	--	0.4958**	0.1379	--	-0.3333**	0.4237**	0.1129	0.6538**	0.3758**	0.0446	--	--
		3	-0.3093**	-0.0379	-0.3408**	0.2509**	-0.2272**	0.9254**	0.2715**	0.0944	0.7908**	0.3727**	--	--
		4	-0.3761**	0.2637**	0.0994	--	--	0.2219**	0.0657	--	0.5815**	0.0023	--	--
		5	--	-0.0139	-0.1443	-0.0876	0.0144	0.2582**	0.2201**	0.0399	0.1628*	0.0598	--	--
		6	--	0.4693**	0.3980**	0.7315**	--	--	0.1840*	0.0279	--	-0.3927**	--	--
		7	--	0.1667*	-0.1289	0.1011	--	0.2119**	--	--	-0.1389	--	--	--
		8	0.6046**	--	-0.0803	0.2905**	-0.3302**	0.2695**	-0.0067	0.5014**	0.1068	--	--	--
		9	0.0017	--	0.1594	-0.0367	0.1378	--	0.2582**	0.1133	--	-0.3703**	--	--
11	Harvest index (%)	1	0.1833*	0.1640*	-0.1184	-0.0389	0.1047	0.7551**	-0.1602*	0.0945	0.8369**	0.3834**	--	--
		2	--	-0.4144**	0.8460**	--	0.5024**	0.8716**	0.0142	-0.4955**	0.3894**	0.4710**	--	--
		3	-0.9994**	-0.2970**	0.0230	-0.0523	-0.0263	0.6165**	-0.1595	-0.1375	0.4049**	0.0571	0.1435	--
		4	-0.2464**	-0.0234	-0.2203**	--	--	0.3442**	0.1470	--	0.1192	0.1740*	0.0165	--
		5	--	0.2440**	-0.1529	-0.2996**	-0.2983**	0.3160**	0.6166**	0.2658**	-0.0563	-0.0950	0.0427	--
		6	--	0.0772	0.3012**	-0.1755*	--	--	0.3284**	0.0673	--	0.0787	--	--
		7	--	-0.0806	-0.0010	-0.0698	--	0.6795**	--	--	0.7570**	--	-0.5532**	--
		8	0.1743*	--	-0.3254**	0.0707	0.1919*	0.4918**	0.1974*	-0.0584	0.4862**	--	-0.4082**	--
		9	-0.1592	--	-0.5822**	0.2156**	-0.0239	--	-0.4505**	0.0983	--	0.6545**	-1.1354**	--
12	Pod yield per plant (g)	1	-0.0061	0.0446	-0.0504	0.2464**	0.5561**	1.0559**	0.5495**	-0.0997	0.8766**	-0.1193	--	--
		2	--	-0.4054**	0.5031**	--	0.5392**	0.3564**	0.2225**	-0.5663**	0.0237	0.2965**	--	--
		3	-1.3242**	0.0810	0.4356**	-0.0135	0.4033**	0.3108**	-0.2169**	-0.4834**	0.1985*	0.5817**	0.4472**	0.3269**
		4	-0.1226	0.0451	-0.1591	--	--	0.6270**	-0.2576**	--	0.2282**	-0.2137**	0.2012*	0.6177**
		5	--	0.1723*	-0.3179**	-	-0.0270	0.2473**	0.3814**	0.1789*	0.02	-	0.315	0.77

						0.4846**					15	0.1826*	7**	57**
			6	--	0.5358**	0.6568**	0.4644**	--	--	0.7653**	0.2375**	--	-0.0794	--	0.4672**
			7	--	0.0903	-0.0654	-0.1640**	--	0.9642**	--	--	0.7016**	--	0.3999**	0.5359**
			8	0.3866**	--	-0.3801**	0.3109**	0.2822**	0.6614**	0.1201	0.4507**	0.5406**	--	0.1138	0.6601**
			9	-0.2629**	--	-0.3136**	-0.0735	0.4018**	--	0.0108	0.6566**	--	0.0295	0.1195	--

(--) column shows non-significant cross for that of particular character.

* and ** indicates significant at 5% and 1% level of significance, respectively.

Table 2: Direct and indirect effects of yield components on kernel yield on F_3 populations of groundnut

S. N.	Characters	Crosses	Days to appearance of first flower	Days to maturity	No. of primary branches /plant	Plant height (cm)	No. of matured pods /plant	Kernel yield/ plant (g)	100-kernel weight (g)	Shelling outturn (%)	Sound mature kernel (%)	Oil content (%)	Biological yield/ plant (g)	Harvest index (%)	Correlation with pod yield
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Days to appearance of first flower	1	0.0438	-0.0098	-0.0012	0.0118	0.0100	0.0023	-0.0155	-0.0272	0.0009	-0.0014	--	--	-0.0035
		2	--	-0.0311	-0.0886	--	-0.0519	0.0391	0.0278	0.0807	0.1641	0.0969	--	--	--
		3	-0.0411	-0.0211	-0.0041	0.0095	0.0054	0.0195	0.0002	-0.0107	0.0088	0.0074	0.0114	0.0122	-0.1619*
		4	0.4436	-0.1348	0.1238	--	--	-0.1793	-0.2346	--	-0.1471	0.1529	-0.1560	-0.1088	-0.0745
		5	--	0.2068	-0.1310	-0.2759	0.1380	0.2256	0.1046	-0.1681	0.0150	0.0416	-0.0520	0.1314	--
		6	--	0.0621	-0.3115	0.4115	--	--	-0.3193	0.2185	--	-0.1811	--	-0.3029	--
		7	--	-0.0090	0.0139	0.0238	--	-0.0322	--	--	-0.0522	--	-0.0121	-0.0241	--
		8	-0.4697	--	-0.0572	-0.2787	-0.0186	-0.3083	-0.1903	-0.0870	-0.3015	--	-0.2081	-0.0680	0.2473**
		9	0.1224	--	0.0399	0.0342	0.0087	--	-0.0564	-0.0027	--	-0.0160	-0.0063	--	-0.0122
2	Days to maturity	1	-0.0967	0.4307	0.2213	0.0653	-0.0632	-0.0122	-0.0974	0.0273	0.1093	-0.1936	--	--	0.0471
		2	--	0.0194	-0.0038	--	-0.0039	-0.0025	0.0024	0.0021	-0.0071	-0.0050	--	--	-0.3426**
		3	0.5110	0.9972	0.0290	-0.3968	-0.4255	-0.3567	-0.0233	0.4392	-0.0156	-0.1577	-0.0600	-0.2504	0.0682
		4	0.0086	-0.0284	0.0109	--	--	-0.0096	-0.0073	--	-0.0178	-0.0056	-0.0074	0.0008	0.0431
		5	--	-0.1876	0.1114	0.0776	-0.0202	0.0528	0.0239	0.0655	0.0809	0.0480	0.0007	-0.0457	0.1411
		6	--	-0.4385	-0.2634	-0.1256	--	--	-0.2492	-0.0668	--	-0.1167	--	-0.0383	0.4591**
		7	--	0.1561	-0.0813	-0.0597	--	-0.0160	--	--	-0.0268	--	0.0238	-0.0145	0.0885
		8	0.0327	--	-0.0991	-0.1224	-0.2003	-0.0352	0.1764	-0.1961	-0.1601	--	0.1813	-0.2872	--
		9	0.0210	--	-0.0055	-0.0042	0.0166	--	-0.0053	0.0205	--	0.0002	0.0239	--	--
3	Number of primary branches/plant	1	0.0152	-0.2913	-0.5668	0.0165	-0.2132	0.1175	-0.0394	0.1856	-0.0047	0.0681	--	--	-0.0761
		2	--	-0.0367	0.1887	--	0.0706	0.0119	-0.0783	-0.0804	0.0050	0.0165	--	--	0.5404**
		3	-0.0043	-0.0013	-0.0433	0.0167	-0.0302	0.0135	0.0201	0.0295	0.0131	-0.0151	0.0134	-0.0006	0.4511**
		4	-0.0536	0.0738	-0.1919	--	--	0.1076	0.0937	--	0.1156	0.0314	-0.0179	0.0442	-0.0557
		5	--	-0.0357	0.0600	0.0259	0.0111	0.0093	0.0001	-0.0049	0.0227	0.0082	-0.0080	-0.0093	-0.1940*
		6	--	-0.2797	-0.4657	0.0044	--	--	-0.2781	0.2135	--	-0.0908	--	-0.1403	0.5211**
		7	--	0.0371	-0.0713	-0.0281	--	-0.0074	--	--	-0.0123	--	0.0078	0.0003	-0.0160
		8	0.0217	--	0.1786	-0.0005	0.0820	-0.0148	-0.0042	-0.0281	0.0427	--	-0.0128	-0.0492	-0.2579**
		9	-0.1021	--	-0.3133	-0.1574	-0.0413	--	-0.0443	-0.0481	--	0.0640	-0.0460	--	-0.2105**

(*Contd.*)

Table2. (*Contd.*)

Sr.	Ch.	Cr.	1	2	3	4	5	6	7	8	9	10	11	12	13
4	Plant height (cm)	1	-0.0663	-0.0372	0.0072	-0.2455	-0.0822	-0.0164	-0.0298	0.0790	0.0457	-0.0049	--	--	0.1403
		2	--	-0.0797	0.0623	--	-0.0388	-0.0046	-0.1246	-0.0173	-0.0055	-0.1102	--	--	--
		3	-0.1340	-0.2303	-0.2237	0.5787	-0.1361	0.1597	0.2353	0.1045	0.1015	0.0432	0.1346	-0.0551	-0.0302
		4	0.0001	-0.0003	0.0027	--	--	0.0011	-0.0017	--	0.0011	-0.0004	0.0026	0.0008	--
		5	--	0.0783	-0.0818	-0.1893	0.0823	0.0642	-0.0177	-0.0558	0.0021	-0.1142	0.0115	0.0520	-0.4608**
		6	--	-0.1622	0.0054	-0.5663	--	--	-0.1035	-0.2413	--	0.1533	--	0.0907	0.3593**
		7	--	0.0803	-0.0829	-0.2099	--	0.0274	--	--	0.0150	--	-0.0172	0.0160	-0.1310
		8	0.3668	--	-0.0017	0.6183	-0.0977	0.1927	0.2603	0.1492	0.1619	--	0.1727	0.0447	0.2572**
		9	-0.0210	--	-0.0377	-0.0751	-0.0182	--	0.0366	-0.0257	--	0.0049	0.0015	--	-0.1641*
5	Number of matured pods/plant	1	0.0855	-0.0548	0.1404	0.1251	0.3735	0.0902	0.1435	-0.2460	0.0530	0.1625	--	--	0.4411**
		2	--	-0.2671	0.5006	--	1.3382	-0.1172	0.4625	-1.1484	0.2208	0.7864	--	--	0.5562**
		3	-0.1386	-0.4513	0.7370	-0.2487	1.0576	-0.1315	-0.3197	-0.9320	-0.5058	0.4115	-0.2261	-0.0275	0.4257**
		4	0.0063	0.0960	0.2110	--	--	0.1939	-0.3522	--	-0.0246	-0.3107	0.0242	-0.0407	--
		5	--	0.0287	0.0492	-0.1157	0.2662	-0.0151	-0.1532	-0.1980	-0.0276	-0.1273	0.0039	-0.0717	0.0204
		6	--	0.3694	0.4975	-0.0471	--	--	0.3272	-0.1763	--	0.1231	--	0.2757	--
		7	--	0.0387	-0.0527	-0.0142	--	-0.0664	--	--	-0.0601	--	-0.0163	-0.0377	--
		8	0.0160	--	0.1858	-0.0640	0.4050	0.0752	-0.0379	-0.0810	0.1352	--	-0.1306	0.0723	0.3137**
		9	0.0279	--	0.0520	0.0956	0.3944	--	-0.0581	-0.0005	--	0.0566	0.0483	--	0.3252**
6	Kernel yield/plant (g)	1	0.0323	-0.0172	-0.1258	0.0405	0.1465	0.6068	0.1769	0.0570	0.5072	0.0223	--	--	0.8107**
		2	--	-0.0613	0.0300	--	-0.0417	0.4763	0.0558	0.0659	0.1144	0.1015	--	--	0.4421**
		3	-0.1562	-0.1175	-0.1026	0.0906	-0.0408	0.3284	0.1238	0.0124	0.2578	0.0917	0.2662	0.1631	0.3801**
		4	-0.1418	0.1180	-0.1967	--	--	0.3509	0.0376	--	0.1824	-0.0613	0.0616	0.0941	0.6279**
		5	--	0.0827	-0.0457	0.0996	0.0167	-0.2938	-0.1753	-0.0537	-0.1988	-0.0299	-0.0626	-0.0863	0.3754**
		6	--	0.5358	0.5686	0.3761	--	--	0.7639	0.3832	--	-0.0090	--	0.7134	--
		7	--	-0.0678	0.0687	-0.0865	--	0.6621	--	--	0.5422	--	0.1485	0.4154	0.9467**
		8	0.5953	--	-0.0752	0.2827	0.1685	0.9071	0.5078	0.2692	0.7868	--	0.2358	0.4194	0.6595**
		9	-0.0852	--	0.0275	-0.0519	0.0022	--	0.1385	0.1753	--	-0.0830	0.1293	--	--

(*Contd.*)

Table 2: (*Contd.*)

Sr.	Ch.	Cr.	1	2	3	4	5	6	7	8	9	10	11	12	13
7	100-kernel weight (g)	1	-0.0808	-0.0516	0.0159	0.0278	0.0878	0.0666	0.2285	0.0470	-0.0222	0.0611	--	--	0.3295**
		2	--	0.0045	-0.0150	--	0.0125	0.0042	0.0361	-0.0016	0.0001	0.0147	--	--	0.1729*
		3	0.0015	0.0068	0.1351	-0.1184	0.0880	-0.1097	-0.2911	-0.0871	-0.1024	0.0173	-0.0711	0.0393	-0.2095*
		4	-0.2087	0.1012	-0.1927	--	--	0.0422	0.3946	--	0.1236	0.0536	0.0255	0.0469	-0.1613*
		5	--	0.0417	-0.0002	-0.0305	0.1880	-0.1950	-0.3268	-0.2086	-0.0369	-0.1502	-0.0662	-0.1913	0.3992**
		6	--	0.4049	0.4254	0.1302	--	--	0.7124	0.1487	--	0.4420	--	0.2408	0.6105**
		7	--	-0.0044	0.0012	0.0103	--	0.0133	--	--	0.0141	--	-0.0019	0.0137	--
		8	-0.2562	--	0.0150	-0.2663	0.0592	-0.3541	-0.6326	-0.0732	-0.2738	--	0.0008	-0.1237	0.1410
		9	0.0177	--	-0.0054	0.0187	0.0057	--	-0.0385	-0.0021	--	-0.0052	-0.0085	--	0.1171
8	Shelling outturn (%)	1	0.1396	-0.0143	0.0736	0.0724	0.1482	-0.0211	-0.0463	-0.2249	-0.0098	0.0240	--	--	-0.1059
		2	--	0.0867	-0.3384	--	-0.6821	0.1100	-0.0363	0.7949	0.0124	-0.2478	--	--	-0.5301**
		3	-0.0039	-0.0065	0.0100	-0.0027	0.0130	-0.0006	-0.0044	-0.0148	-0.0033	0.0054	-0.0014	0.0018	-0.4650**
		4	0.1073	-0.1031	0.0539	--	--	0.0388	-0.0963	--	-0.0817	-0.1159	-0.1677	-0.0620	--
		5	--	-0.1905	-0.0447	0.1610	-0.4061	0.0998	0.3485	0.5458	-0.0001	0.1974	0.0212	0.1372	0.1611*
		6	--	-0.0332	0.0999	-0.0928	--	--	-0.0455	-0.2178	--	0.0031	--	-0.0133	0.1910*
		7	--	-0.1054	0.1017	0.2603	--	0.0369	--	--	0.0202	--	0.0858	0.0041	--
		8	0.1249	--	-0.1059	0.1628	-0.1348	0.2001	0.0780	0.6743	0.1573	--	0.3350	-0.0386	0.4348**
		9	-0.0090	--	0.0619	0.1381	-0.0005	--	0.0222	0.4035	--	0.0773	0.0437	--	0.5382**
9	Sound mature kernel (%)	1	-0.0058	-0.0692	-0.0023	0.0508	-0.0386	-0.2278	0.0265	-0.0119	-0.2726	0.0112	--	--	0.6687**
		2	--	0.1707	-0.0125	--	-0.0773	-0.1124	-0.0002	-0.0073	-0.4682	-0.1367	--	--	0.0043
		3	-0.0310	-0.0023	-0.0438	0.0254	-0.0692	0.1136	0.0509	0.0322	0.1447	0.0147	0.1131	0.0485	0.1736*
		4	0.1180	-0.2232	0.2143	--	--	-0.1850	-0.1114	--	-0.3558	-0.0290	-0.2034	-0.0391	0.2096*
		5	--	-0.0654	0.0575	-0.0017	-0.0157	0.1026	0.0171	0.0001	0.1517	0.0147	0.0260	-0.0099	0.0267
		6	--	-0.0453	-0.0240	-0.0402	--	--	0.0171	-0.0663	--	0.0158	--	-0.0770	--
		7	--	-0.0457	0.0459	-0.0190	--	0.2183	--	--	0.2665	--	-0.0364	0.1962	0.6812**
		8	-0.2441	--	-0.0909	-0.0996	-0.1270	-0.3299	-0.1646	-0.0887	-0.3803	--	-0.0418	-0.1727	0.5059**
		9	-0.0313	--	-0.1514	-0.0848	0.0618	--	0.0405	0.1925	--	-0.1707	0.2509	--	--

(*Contd.*)

Table 2: (*Contd.*)

Sr.	Ch.	Cr.	1	2	3	4	5	6	7	8	9	10	11	12	13
10	Oil content (%)	1	0.0078	0.1084	0.0290	-0.0048	-0.1049	-0.0089	-0.0645	0.0257	0.0099	-0.2410	--	--	-0.0546
		2	--	0.0928	-0.0311	--	-0.2095	-0.0760	-0.1454	0.1112	-0.1041	-0.3566	--	--	0.3115**
		3	-0.0068	-0.0060	0.0131	0.0028	0.0146	0.0105	-0.0022	-0.0138	0.0038	0.0376	0.0133	0.0023	0.5469**
		4	0.0091	0.0052	-0.0043	--	--	-0.0046	0.0036	--	0.0022	0.0265	-0.0003	0.0048	-0.1517
		5	--	-0.0144	0.0077	0.0340	-0.0269	0.0057	0.0259	0.0204	0.0055	0.0563	0.0020	-0.0058	-0.1252
		6	--	-0.0372	-0.0272	0.0378	--	--	-0.0867	0.0020	--	-0.1398	--	-0.0112	0.0447
		7	--	-0.0305	0.0651	-0.0304	--	0.0934	--	--	0.0438	--	-0.0375	0.0947	--
		8	0.0072	--	-0.0043	0.0063	-0.0032	0.0045	-0.0029	0.0063	0.0021	--	0.0054	-0.0005	--
		9	-0.0167	--	-0.0261	-0.0083	0.0184	--	0.0172	0.0245	--	0.1279	-0.0457	--	0.0494
11	Biological yield per plant (g)	1	-0.1002	0.0457	0.1674	-0.0196	0.1650	0.1161	0.0690	-0.0277	0.1328	-0.0127	--	--	--
		2	--	-0.0840	-0.0266	--	0.0653	-0.0859	-0.0440	-0.1441	-0.0773	0.0067	--	--	--
		3	-0.0547	-0.0119	-0.0607	0.0458	-0.0421	0.1597	0.0481	0.0183	0.1540	0.0696	0.1970	0.0266	0.4377**
		4	-0.2114	0.1571	0.0561	--	--	0.1055	0.0386	--	0.3436	-0.0062	0.6011	0.0111	0.1739*
		5	--	-0.0013	-0.0505	-0.0230	0.0056	0.0811	0.0770	0.0148	0.0652	0.0138	0.3802	0.0069	0.2714**
		6	--	0.1091	0.1062	0.2234	--	--	0.0513	0.0117	--	-0.1311	--	-0.0161	--
		7	--	0.0341	-0.0245	0.0184	--	0.0502	--	--	-0.0305	--	0.2237	-0.1212	0.3967**
		8	-0.0589	--	0.0095	-0.0371	0.0429	-0.0346	0.0002	-0.0661	-0.0146	--	-0.1330	0.0519	0.1037
		9	0.0551	--	-0.1577	0.0221	-0.1317	--	-0.2376	-0.1165	--	0.3842	-1.0752	--	0.0317
12	Harvest index (%)	1	0.0222	0.0077	-0.0348	0.0001	0.0123	0.0975	-0.0220	0.0103	0.1192	0.0498	--	--	--
		2	--	-0.1568	0.2747	--	0.1747	0.1991	0.0171	-0.1859	0.1498	0.1452	--	--	--
		3	-0.1038	-0.0878	0.0050	-0.0333	-0.0091	0.1736	-0.0471	-0.0426	0.1171	0.0213	0.0472	0.3496	0.3097**
		4	-0.1522	-0.0183	-0.1428	--	--	0.1663	0.0737	--	0.0682	0.1130	0.0115	0.6203	0.5723**
		5	--	0.1978	-0.1258	-0.2229	-0.2185	0.2382	0.4750	0.2039	-0.0530	-0.0837	0.0148	0.8113	0.7188**
		6	--	-0.0261	-0.0900	0.0478	--	--	-0.1010	-0.0182	--	-0.0240	--	-0.2988	0.4228**
		7	--	0.0049	0.0002	0.0040	--	-0.0330	--	--	-0.0387	--	0.0285	-0.0526	0.4902**
		8	0.1117	--	-0.2127	0.0558	0.1377	0.3566	0.1508	-0.0441	0.3504	--	-0.3011	0.7715	0.6198**
		9	0.0090	--	0.3054	-0.0912	0.0092	--	0.3023	-0.0825	--	-0.3909	0.7157	--	--

(--) column shows non-significant cross for that of particular character.

* and ** indicates significant at 5% and 1% level of significance, respectively.

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