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Character association analysis for yield and its component traits in groundnut (*Arachis hypogaea* L.)

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Abstract
Twenty-one groundnut genotypes with two checks *viz*., LGN-1 and JL-24 were evaluated for character association analysis in randomized block design with 3 replications under rainfed condition at Oilseeds Research Station, Latur (E_1), Oilseeds Research Sub-Station, Ambajogai (E_2) and Agricultural Research Station, Badnapur (E_3) *kharif*, 2018-19. The character association studies revealed that the improvement in pod yield in groundnut is achieved through improvement in yield components. The component characters like number of mature pods per plant, kernel yield per plant, 100 kernel weight and sound mature kernel exhibited positive and significant association with pod yield.

Keywords: Groundnut, correlation, genotypic, phenotypic, yield components

Introduction
Groundnut (*Arachis hypogaea* L.) is the most important oilseed crop of tropical, sub-tropical and warm temperate regions of the world. It is commonly called as the poor man's nut, peanut or monkey-nut. Groundnut is the 13th most important food crop of the world and world's 4th important source of edible oil and 3rd most important source of vegetable protein. Globally, 50 percent of groundnut produce is used for oil extraction, 37 percent for confectionary use and 12 percent for seed purpose. The principal peanut growing countries are India, China, Africa (Senegal and Nigeria), USA, Pakistan and Sri-Lanka. India ranks first in the world in terms of area. In India, it is being grown on an area of 5.33 million hectares with production of 7.4 million tones. India ranks second in the world regarding groundnut production, but still the country is in deficit in productivity as compared to the world average. The low yield levels are attributed to cultivation of crop on marginal and sub-marginal lands under rain fed condition, lack of plant protections and use of low yielding varieties etc.
The study of inter association is essential to understand the relationship of simple traits with complex yield contributing traits. Yield is complex and polygenic in nature, which is highly influenced by environment. A clear picture of contribution of each component is the final expression of character would emerge through the study of correlation. The study of genetic correlation gives an idea about extent of which the characters are under the control of same set genes. The present investigation was carried with objectives to estimate the character association for yield and its components traits. This study will be helpful for harnessing present variability among them and helps in select the superior genotype through yield and related traits from correlation response which in turn can support the ongoing and future groundnut breeding programme.

Materials and Methods
Twenty-one groundnut genotypes *viz.*, LGN-125, LGN-162, LGN-163, LGN-169, LGN-176, LGN-184, LGN-188, LGN-189, ICGV-00191, ICGV-00201, ICGV-00202, ICGV-00206, ICGV-00211, ICGV-00213, ICGV-241, ICGV-00247, ICGV-07211 and ICGV-99058 with two checks (LGN-1 and JL-24) were obtained from Oilseeds Research Station, Latur. The experiments involving all twenty-one genotypes was laid out in Randomized Block Design (RBD) with three replications were at Oilseeds Research Station, Latur (E_1), Oilseeds Research Sub-Station, Ambajogai (E_2), and Agricultural Research Station, Badnapur (E_3) during *kharif*, 2018. The sowing was carried out at the spacing of 30 cm between rows and 10 cm between the plants. The method of sowing followed was dibbling. The gross plot size 6.5 x 0.90 m^2 while net plot size was 6.3 x 0.90 m^2. The recommended dose of fertilizer 25: 50: 00 NPK kg/ha was applied at the time of sowing.

All other package of practices and plant protection measures to raise a good crop were timely and uniformly carried out. Five plants were selected from each treatment randomly for recording observations *viz.* days to 50% flowering, days to maturity, number of mature pods per plant, kernel yield per plant, selling percentage, 100 kernel weight, sound mature kernel, oil content. In this study, the genotypic and phenotypic correlation coefficients obtained from twenty-one genotypes for eight yield contributing characters in individual and pooled environment are discussed as below.

Results and Discussion

In the present investigation, correlation coefficients were estimated among eight characters to find out association of yield and its component traits at genotypic as well as phenotypic level. Days to 50 % flowering had positive and significant association with days to maturity in all environments, number of mature pods per plant, 100-kernel weight in E_1 at both genotypic and phenotypic level and positively significant for kernel yield per plant, pod yield per plot in E_1, shelling percentage in E_2 and oil content in $E_1$and E_2 at genotypic level. This character showed positive but non-significant association for shelling percentage in E_1 and E_3, 100-kernel weight in E_2 at genotypic level and kernel yield per plant in E_1, sound mature kernel E_1 and E_3, shelling percentage in all environments, pod yield per plot in $E_1$and number of mature pods per plant in E_2 and E_3 at phenotypic level. The pooled result revealed that the days to 50 % flowering exhibited significant positive association with days to maturity, sound mature kernel and pod yield per plot at genotypic level and days to maturity, number of mature pods per plant and 100-kernel weight at phenotypic level.

Significantly positive association exhibited by days to maturity with number of mature pods per plant and shelling percentage in E_2 at genotypic and phenotypic level and kernel yield per plant in E_1, number of mature pods per plant and oil content in E_3 at genotypic level. This character showed positive but non-significant association with number of mature pod per plant, shelling percentage, oil content and pod yield per plot in E_1 and 100-kernel weight and oil content in E_2 and kernel yield per plant, shelling percentage in E_3 at genotypic level and number of mature pods per plant, kernel yield per plant, and shelling percentage in E_1 and E_3, 100-kernel weight in E_2, oil content in all environment and pod yield per plot in E_3 at phenotypic level. The pooled result showed that the days to maturity exhibited significant positive association with number of mature pods per plant and shelling percentage at genotypic and phenotypic level and kernel yield per plant, sound mature kernel, and pod yield per plot at genotypic level.

Number of mature pods per plant exhibited positive and significant association with kernel yield per plant in all three environments, 100-kernel weight in E_2, sound mature kernel and pod yield per plot in E_1 and E_3, shelling percentage in E_1at genotypic level and also positively significant association was exhibited in kernel yield per plant in E_1 and E_3, sound mature kernel, shelling percentage, and pod yield per plot in E_1at phenotypic level. This character showed positive but non-significant association with 100-kernel weight in E_1 and E_3, shelling percentage in E_3, and oil content and pod yield per plot in E_2 at genotypic level and kernel yield per plant and oil content in E_2, 100-kernel weight in all three environments, sound mature kernel and shelling percentage in E_3, and pod yield per plot in E_2 and E_3 at phenotypic level. Pooled result revealed that the number of mature pods per plant showed positive and significant association with kernel yield per plant, sound mature kernel, shelling percentage and pod yield per plot at genotypic and phenotypic level. Negative and significant association was observed with oil content at phenotypic level.

Kernel yield per plant depicted positive and significant association with shelling percentage in all three environments at both genotypic and phenotypic level and 100-kernel weight in E_1 and E_3, sound mature kernel in E_1 and E_2, and pod yield per plot in E_1 at genotypic level and positively significant association was observed for sound mature kernel in E_1, and pod yield per plot in all three environment at phenotypic level. This character showed positive but non-significant association with 100-kernel weight and pod yield per plot in E_2, and sound mature kernel in E_3 at genotypic level and 100-kernel weight per plant in all three environments, and sound mature kernel in E_2 and E_3 at phenotypic level. Pooled result revealed that the kernel yield per plant exhibited positive and significant association with sound mature kernel and shelling percentage at genotypic and phenotypic level and 100-kernel weight and pod yield per plot at phenotypic level.

100 kernel weight exhibited positive and significant association with pod yield per plot in all three environment at both genotypic and phenotypic level and sound mature kernel in E_1 and E_3 at genotypic level and sound mature kernel in E_1 at phenotypic level only. This character was showed positive but non-significant association with shelling percentage in E_1, oil content in E_2 and E_3, and sound mature kernel in E_2 at genotypic level and shelling percentage in E_1, oil content and sound mature kernel in E_2 and E_3 at phenotypic level. Pooled result revealed that 100-kernel weight showed positive and significant association with pod yield per plot at genotypic and phenotypic level and sound mature kernel at genotypic level only.

Sound mature kernel showed positive and significant association with shelling percentage in E_1 and pod yield per plot in all three environments at genotypic level and shelling percentage E_1 and pod yield per plot in $E_1$and E_2 at phenotypic level. This character exhibited positive but non-significant association with pod yield per plot in E_3 at phenotypic level. Negative and significant association was observed with shelling percentage in E_1 and E_3 at phenotypic level. Pooled result revealed that the sound mature kernel showed positive and significant association with pod yield per plant at genotypic and phenotypic level and shelling percentage at genotypic level only. Negative and significant association was observed with oil content at phenotypic level.

Shelling percentage depicted positive and significant association with pod yield per plot in E_1 at genotypic level. This character showed positive but non-significant association with oil content in E_2 and E_3 at genotypic and phenotypic level and pod yield per plot in E_1 at phenotypic level only. Pooled result revealed that the shelling percentage exhibited negative but significant association with pod yield per plot in phenotypic level only. Oil content exhibited negative and non-significant association with pod yield per plot in E1 at phenotypic level. Pooled result revealed that the oil content showed negative and significant association with pod yield per plot at phenotypic level only.

In the present study the genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients suggesting strong inherent association among the character studied (Table 1 and 2). Pod yield exhibited positive and significant association with number of mature pods per plant, kernel yield per plant, 100 kernel weight and sound

mature kernel at genotypic and phenotypic level in pooled environment. This character showed positive and significant association with days to 50% flowering in E1 and with days to maturity at genotypic level. Similar kind of association reported by Vaddoria and Patel (1992), John *et al*. (2005b) [7], John and Reddy (2015) [7], Dhakar *et al*. (2017) [3] and Bharghavi *et al*. (2017) for number of mature pods per plant and 100 kernel weight, Moinuddin (1997) [10], Venkataravana *et al*. (2000a) [15], Lakshmide vamma *et al*. (2004) [9] and Garjappa (2005) [4] for 100-kernel weight, Ravana *et al*. (2015) [13] and Vachhani *et al*. (2016) for number of mature pods per plant, kernel yield per plant and sound mature kernel, Rao (2016) [12] for kernel yield per plant and 100-kernel weight. Pod yield had significant positive association with shelling percentage and sound mature kernel per plant. These results are in accordance with the earlier repot of John and Reddy *et al*. (2015) [7], whereas kernel yield per plant exhibited positive and significant association with pod yield. Similar kind of findings reported by Rosemary and Ramlingam (1997). Kernel yield per plant showed positive and significant association with shelling percentage at both genotypic and phenotypic level. Similar result was reported by Reddy *et al*. (2017) [14], Prabhu *et al*. (2017) [11] and Aparna *et al*. (2018) [1] for shelling percentage. Sound mature kernel exhibited positive and significant association with pod yield. Similar kind of association reported by Dhakar *et al*. (2017) [3] and Hampannavar *et al*. (2018) [5].

The positive and significant interrelationships among the yield contributing characters like number of mature per plant and pod yield with kernel yield per plant at both at genotypic and phenotypic level. These results are in accordance with the earlier finding of John *et al*. (2005b) [7], and Prabhu *et al*. (2016) for kernel yield per plant. Days to 50 % flowering did not contributed directly towards pod yield as evident from its low direct effects and non significant association with pod yield and days to maturity had negatively significant in E2 at phenotypic level. Similar kind of association reported by Korat *et al*. (2010) [8].

Table 1: Estimates of genotypic correlation coefficient between yield and yield components in groundnut

Sr. No.	Character		Days to maturity	No. of mature pod / plant	Kernel yield / plant	100 kernel weight (g)	Sound mature kernel (%)	Shelling (%)	Oil content (%)	Pod yield / plot
1	Days to 50% flowering	E_1	0.3935**	0.3871**	0.3633**	0.3571**	0.2434*	0.0941	- 0.4938	0.5934**
		E_2	0.3383**	- 0.0467	- 0.7129	0.1598	- 0.1667	0.0254*	0.3696**	- 0.2724
		E_3	0.4746**	- 0.0267	- 0.1459	- 0.4495	- 0.5690	0.1008	0.3426**	- 0.2613
		P	0.3283**	0.1059	0.0983	- 0.0744	0.2624**	0.0654	- 0.9674	0.2070**
2	Days to maturity	E_1		0.0879	0.2444*	- 0.2776	- 0.0746	0.0258	0.0443	0.1737
		E_2		0.5373**	- 0.0879	0.0139	- 0.1699	0.2618*	0.2138	- 0.3964
		E_3		0.3344**	0.0736	- 0.1600	- 0.4207	0.1761	0.4185**	- 0.1989
		P		1.0444**	0.4881**	- 0.0481	0.6423**	0.3552**	- 1.0743	0.5785**
3	No. of mature pods / plant	E_1			0.8409**	0.1759	0.7854**	0.6697**	- 0.5834	0.8768**
		E_2			0.2965*	0.2475*	- 0.1518	- 0.0379	0.0504	0.1665
		E_3			0.7643**	0.2236	0.3964**	0.1959	- 0.5994	0.2613*
		P			0.8045**	- 0.0262	0.4475**	0.4575**	- 0.7541	0.1844*
4	Kernel yield / plant	E_1				0.4095**	1.0296**	0.9041**	- 0.6545	0.8232**
		E_2				0.1006	0.3039*	0.5442**	- 0.0200	0.0746
		E_3				0.3425*	0.0790	0.7803**	- 0.1936	- 0.3257
		P				0.1199	1.2171**	0.7780**	- 1.1117	0.0467
5	100 kernel weight	E_1					0.4764**	0.1247	- 0.4031	0.7214**
		E_2					0.0269	- 0.5026	0.1900	0.6811**
		E_3					0.3345**	- 0.1572	0.0075	0.5475**
		P					0.3633**	- 0.5363	- 0.4698	1.0584**
6	Sound mature kernel	E_1						0.7241**	- 0.6466	0.8198**
		E_2						- 0.3551	- 0.0109	0.6109**
		E_3						- 0.2191	- 0.8131	0.4271**
		P						0.7338**	- 0.6815	0.3388**
7	Shelling (%)	E_1							- 0.3691	0.5319**
		E_2							0.0227	- 0.8292
		E_3							0.0632	- 0.8486
		P							- 0.6178	- 0.5966
8	Oil content (%)	E_1								-0.5761
		E_2								-0.1487
		E_3								0.2993
		P								-0.1187

* Significant at 5% level, ** Significant at 1% level, E1 = Latur, E2 = Ambajogai, E3 = Badnapur, P = Pooled data

Table 2: Estimates of phenotypic correlation coefficient between yield and yield components in groundnut

Sr. No.	Character		Days to maturity	No. of mature pod / plant	Kernel yield / plant	100 kernel weight (g)	Sound mature kernel (%)	Shelling (%)	Oil content (%)	Pod yield / plot
1	Days to 50% flowering	E_1	0.3540**	0.2819*	0.2055	0.2923*	0.1575	0.0913	- 0.3142*	0.2295
		E_2	0.3489**	0.0041	- 0.2202	0.1383	- 0.0897	0.0384	0.1282	- 0.0936
		E_3	0.4295**	0.0511	- 0.1372	- 0.3125*	0.1257	0.0760	0.1688	- 0.2280
		P	0.3310**	0.1850*	0.0035	0.1585*	0.0223	0.0609	- 0.0383	0.0167
2	Days to maturity	E_1		0.0798	0.2279	-0.1511	- 0.1091	0.0392	0.0179	0.1416
		E_2		0.3262**	- 0.0295	0.0110	- 0.1582	0.2616*	0.0734	- 0.2691*
		E_3		0.2082	0.0733	-0.1330	- 0.1299	0.1884	0.2443	- 0.1314
		P		0.2398**	0.0783	-0.0316	- 0.1383	0.1635*	0.1391	- 0.0814
3	No. of mature pods / plant	E_1			0.4621**	0.1150	0.5324**	0.5247**	- 0.3160*	0.4420**
		E_2			0.1218	0.0864	- 0.0668	-0.0241	0.0964	0.2246
		E_3			0.3395**	0.1110	0.0651	0.0672	- 0.2855*	0.2094
		P			0.3280**	0.0535	0.1827*	0.1961**	- 0.1820*	0.2778**
4	Kernel yield / plant	E_1				0.2220	0.4987**	0.6242**	- 0.3874**	0.5279**
		E_2				0.0850	0.2117	0.3797**	- 0.0553	0.3989**
		E_3				0.1679	0.0334	0.5042**	- 0.1183	0.3585**
		P				0.1565*	0.2516**	0.5083**	- 0.2160**	0.4198**
5	100 kernel weight	E_1					0.2954*	0.0551	- 0.2664*	0.3075*
		E_2					0.0005	-0.3964**	0.0425	0.3614**
		E_3					0.1988	-0.1428	0.0150	0.3237**
		P					0.1370	-0.1519*	- 0.0945	0.3114**
6	Sound mature kernel	E_1						0.5115**	0.5091**	0.3753**
		E_2						-0.1840	- 0.0805	0.3371**
		E_3						-0.0852	- 0.2594*	0.1462
		P						0.0727	0.2816**	0.2732**
7	Shelling (%)	E_1							- 0.2245	0.2101
		E_2							0.0514	-0.5002**
		E_3							0.1230	-0.5948**
		P							- 0.0132	- 0.3140**
8	Oil content (%)	E_1								- 0.4195**
		E_2								-0.0459
		E_3								-0.2186
		P								-0.2446**

* Significant at 5% level. ** Significant at 1% level. E1 = Latur, E2 = Ambajogai, E3 = Badnapur, P = Pooled

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