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Character association and path analysis in terminal drought tolerant groundnut (*Arachis hypogaea* L.) genotypes

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Abstract
Forty nine terminal drought tolerant groundnut genotypes were assessed for associations among various characters and also path analysis for pod yield per plant. The magnitudes of genotypic correlation coefficients were generally higher compared to the corresponding phenotypic correlation coefficients for most of the traits. The highly significant positive association recorded for kernel yield, haulm yield, root diameter and root dry weight with pod yield per plant at both phenotypic and genotypic levels under both control and terminal drought conditions. The path analysis study indicated that high positive direct effect by kernel yield per plant on pod yield. The weightage should be given to primary branches per plant, mature pods per plant, kernel yield, root diameter and root dry weight characters while fixing selection criteria for improvement of drought tolerant groundnut genotypes.

Keywords: Groundnut, terminal drought, correlation, character association, path analysis

Introduction
Groundnut (*Arachis hypogaea* L.), also known as peanut is a self pollinated crop an allotetrapoloid (2n=4x=40) and it is commonly called as 'king' of oilseeds and widely grown as an oil seed or food crop in about 114 countries of the world. Groundnut yield is not only polygenically controlled, but also influenced by its component characters. The groundnut seeds contain about 48 per cent oil, 25 per cent protein and 18 per cent carbohydrates and are a rich source of B-complex vitamins, minerals, antioxidants, biologically active polyphenols, flavanoids and isoflavones (Desai *et al*., 1999) [2]. A knowledge of direction and magnitude of association between various traits is essential to plant breeders for selection of high yielding genotypes. Correlation coefficient reveals the type, nature and magnitude of correlation between any pair of characters. The information derived from the correlation coefficients can be augmented by partitioning correlations into direct and indirect effects by path coefficient analysis. The present study was carried out to obtain information about relationship of individual yield components on yield, interrelationships among themselves and their relative importance in selection of genotypes.

Material and Methods
The present investigation was carried out during *kharif*, 2016 at Main Agricultural Research Station, University of Agricultural Sciences, Raichur. The experimental material consist of forty nine terminal drought tolerant groundnut genotypes (Table 1).

Table 1: List of groundnut (*Arachis hypogaea* L.) genotypes used for investigation

Source	Genotypes	No.
ICRISAT, Patancheru, Hyderbad, Telangana. India	Spanish types: series of ICGVs-97058,02242,01274,01464,03043,95440,13245,05198,13241,07235,06188,05057,07390,97092,3343,98184,4729,97182,07213,3102,99161, 99206,96155,91114,07408,02317,07120,07273,05193,00351.	31
	Virginia type: CS-39.	
BARC, Trombay, Mumbai, India	Spanish types: TAG-24, TG-37A, TG-47, TG-72, TG-80, and TG36.	7
	Virginia type: Somanatha.	
PAU, Ludhian, Punjab, India	Spanish types: 49-M-16.	1
ARS, Kadiri India	Spanish types: Kadiri-6.	1
UAS Dharawad, Karnataka, India	Spanish types: GPBD-5, Mutant-3 and Dh-216.	5
	Virginia types: DSG-41 and TDG-39.	
UAS Raichur, Karnataka, India	Spanish types: R-2001-2, Kadiri-9, R-8808 and TMV-2.	4
Total		49

The line-source sprinkler irrigation system was used for screening the terminal drought tolerance in groundnut genotypes. The experiment was laid out in a simple lattice design with two replications. In each replication every genotype was sown in two rows of 5 m length with a spacing of 30 cm between the rows and 10 cm between the plants within the rows. Standard agronomic practices as per recommendations in package of practices were followed. Observations were recorded on five randomly labelled plants for quantitative and physiological traits. The analysis of variance was calculated by using by Cochran and Cox (1957) [1] method. The phenotypic and genotypic correlation coefficients of all the characters were worked out as per Johnson *et al*. (1955) [5] and path coefficient analysis was suggested by Dewey and Lu (1959) [3].

Results and Discussion

In the present investigation, Analysis of variance revealed that there were significant differences among the genotypes for all the traits studied, indicating genetic variability present in the material studied. The genotypic correlation coefficients were relatively higher than their corresponding phenotypic correlations for all the characters studied indicating environmental effect was less on the expression of these traits. Dry pod yield per plant was positively and significantly correlated at both genotypic as well as phenotypic level with days to 50 per cent flowering, days to physiological maturity, primary branches per plant, matured pods per plant, immature pods per plant, hundred kernels weight, kernel yield and haulm yield under control condition (Table 2 and Table 3). These findings are in accordance with vekariya *et al*. (2011) [13] for haulm yield, Makinde and Ariyo (2013) [8] for days to 50 per cent flowering, primary branches per plant and days to physiological maturity, John *et al*. (2015) [4] matured pods per plant, kernel yield and hundred kernels weight and Shashikumar *et al.* (2015) [11] for kernel yield and matured pods per plant. Dry pod yield per plant was positively and significantly correlated at both genotypic as well as phenotypic level with lateral roots per plant, average root diameter, root volume and root dry weight under control condition. Junjittakarn *et al*. (2014) [6] observed similar results for root parameters.

The non significant positive correlation of pod yield with root length, oil content, SPAD chlorophyll meter reading were observed. The dry pod yield per plant showed non significant negative correlation with canopy temperature at100 DAS, relative water content, specific leaf area at 80 DAS at both genotypic and phenotypic level (Table 4). Similar findings recorded by John *et al*. (2015) [4].

Under terminal drought condition, dry pod yield per plant showed significant and positive correlation with matured pods per plant, immature pods per plant, kernel yield, haulm yield, average root diameter and root dry weight. As these characters are inter related and also had strong association with pod yield per plant, the improvement in one component will automatically result in improvement in another component and finally pod yield per plant. Therefore, due weightage should be given to these attributes while fixing selection criteria for improvement of drought tolerant groundnut genotypes.

Out of these characters kernel yield per plant exhibited positive significant association with dry pod yield per plant, hence only these character was described for path analysis study. Kernel yield per plant had high positive direct effect on dry pod yield at both genotypic and phenotypic level under both control and terminal drought conditions (Table 5 and Table 6). Similar results were observed by Lakshmidevamma *et al.* (2004) [7], Sawargaonkar *et al*. (2010) [10], Surbhi Jain *et al*. (2016) [12] and Ram *et al*. (2017) [9]. The highest positive direct effect on pod yield per plant also confirmed by Plant height, number of matured pods per plant, shelling outturn, hundred kernels weight, haulm yield, average root diameter, root dry weight and oil content had indirect effect on dry pod yield through kernel yield (Fig. 1).

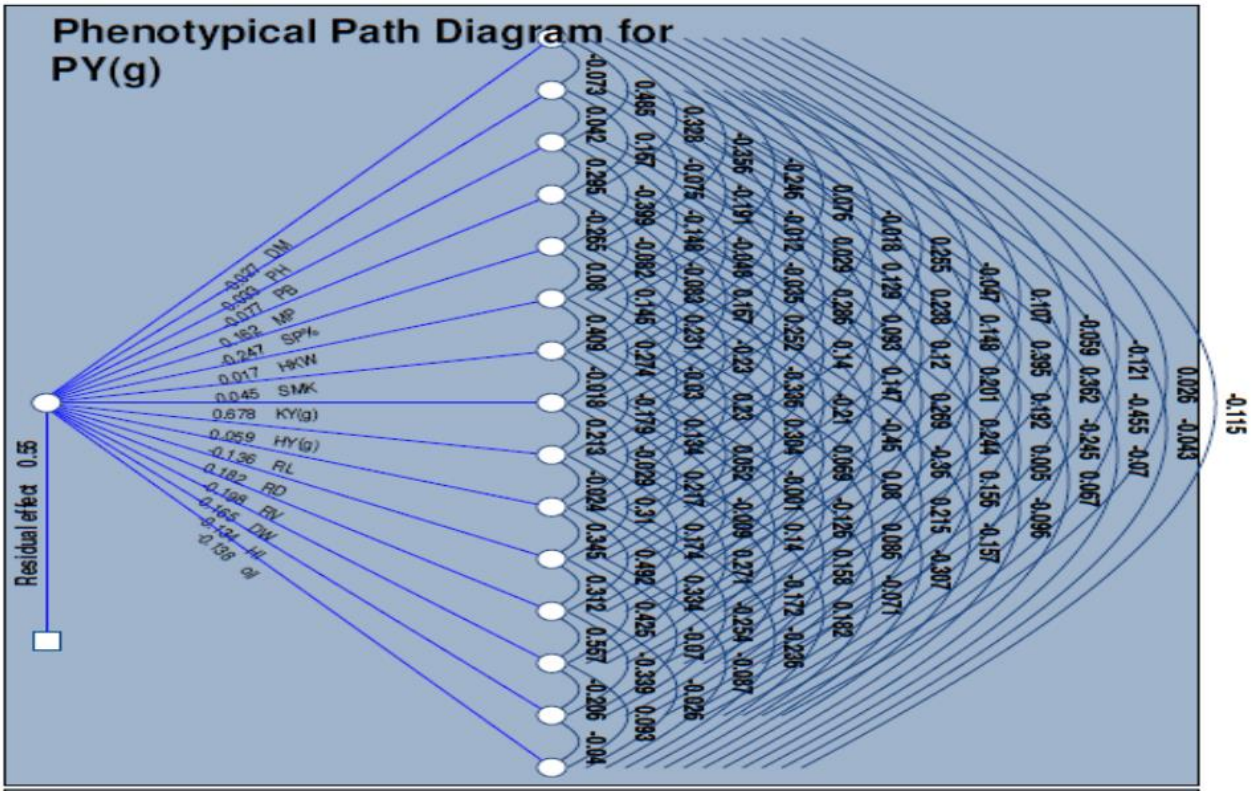

Fig 1: Phenotypic path diagram showing the influence of yield and its component on dry pod yield per plant in control condition

Table 2: Correlation coefficient between yield and yield attributing traits in groundnut genotypes in control condition

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
X_1	1	0.684**	0.088	0.428**	0.363 **	0.316**	-0.376 **	-0.098	-0.193	0.137	0.345 **	0.178	0.291**	0.020	0.129	0.165	0.226*	0.260**
X_2	0.706**	1	-0.058	0.460**	0.396**	0.192	-0.357 **	-0.248*	-0.137	0.100	0.337**	-0.001	0.084	-0.072	-0.043	-0.020	0.137	0.215*
X_3	0.079	-0.085	1	0.009	0.103	-0.012	0.018	-0.065	0.104	0.121	0.224 *	0.202 *	0.016	0.026	0.447**	0.180	0.046	0.118
X_4	0.457**	0.498**	0.041	1	0.443 **	0.280**	-0.316 **	-0.119	-0.126	0.161	0.254 *	0.130	0.156	-0.010	0.098	0.183	0.196	0.268**
X_5	0.424**	0.463**	0.014	0.564**	1	0.041	-0.295 **	-0.253 *	-0.149	0.165	0.187	0.068	0.145	0.013	0.207*	0.281* *	0.147	0.267**
X_6	0.404**	0.214*	0.003	0.437**	0.119	1	-0.218 *	0.11	-0.100	0.190	0.285**	0.238*	0.096	0.065	0.136	0.181	0.048	0.270**
X_7	-0.475**	-0.457**	-0.022	-0.442**	-0.581**	-0.371**	1	0.085	0.204 *	0.076	-0.219 *	-0.268 **	-0.388**	-0.193	-0.280**	-0.276**	-0.122	-0.275**
X_8	-0.103	-0.259**	-0.023	-0.132	-0.281*	0.143	0.198*	1	0.213 *	0.258*	0.084	0.078	0.035	0.277 **	0.115	0.036	0	0.219*
X_9	-0.281**	-0.162	0.184	-0.193	-0.062	-0.137	0.313**	0.273**	1	0.061	-0.127	-0.023	-0.123	0.121	-0.010	-0.171	-0.135	-0.014
X_{10}	0.294**	0.162	0.357**	0.202*	0.400**	0.335**	-0.222*	0.366**	0.158	1	0.278* *	-0.012	0.210 *	0.187	0.110	0.248 *	0.033	0.932**
X_{11}	0.358**	0.363**	0.284**	0.284**	0.221	0.399**	-0.304**	0.097	-0.154	0.534**	1	-0.071	0.201*	0.027	0.296* *	0.373**	0.238 *	0.351**
X_{12}	0.210*	-0.009	0.245*	0.148	0.095	0.360**	-0.414**	0.092	-0.018	0.001	-0.099	1	0.255 *	0.309**	0.378 **	0.285**	-0.034	0.080
X_{13}	0.369**	0.127	0.095	0.17	0.143	0.316**	-0.675**	0.034	-0.189	0.406**	0.237*	0.482**	1	0.151	0.352**	0.428**	0.161	0.354**
X_{14}	0.071	-0.135	0	-0.049	0.139	0.219*	-0.431**	0.365**	0.340**	0.154	0.079	0.369**	0.511**	1	0.331**	0.279*	0	0.242*
X_{15}	0.242*	-0.076	0.500	0.167	0.307*	0.314**	-0.589**	0.229*	0.01	0.375**	0.374**	0.551**	0.449**	0.601**	1	0.504**	0.031	0.227*
X_{16}	0.156	-0.004	0.231*	0.174	0.375**	0.317**	-0.394**	0.062	-0.225*	0.391**	0.398**	0.333*	0.561**	0.382**	0.681**	1	0.097	0.361**
X_{17}	0.259**	0.179	0.070	0.221*	0.277	-0.008	-0.158	-0.370**	-0.347**	0.003	0.301**	-0.071	0.269**	-0.401**	0.06	0.056	1	0.082
X_{18}	0.406**	0.280**	0.314**	0.321**	0.521**	0.211*	-0.527**	0.244*	0.037	0.943**	0.564**	0.143	0.588**	0.279**	0.509**	0.495**	0.067	1

Significant at 0.05= * and Significant at 0.01= **, Genotypic level=Downword left side of diagonal, Phenotypic level =Upword right side of diagonal

Where,

X_1= Days to 50% flowering, X_2=Days to physiological maturity, X_3= Plant height (cm), X_4= Primary branches/plant, X_5= Matured pods/plant,
X_6= Immatured pods/plant, X_7= Shelling outturn (%), X_8= Hundred kernels weight (g), X_9= sound mature kernel (%), X_{10}=Kernel yield (g/plant),
X_{11}= Haulm yield (g/plant), X_{12}= Root length (cm), X_{13}= Average root diameter (cm^2), X_{14}= Lateral roots/plant, X_{15}= Root volume (cm^3),
X_{16}= Root dry weight (g), X_{17}=Oil (%), X_{18}=Dry pod yield (g/plant).

Table 3: Correlation coefficient between yield and yield attributing traits in groundnut genotypes in terminal drought condition

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}
X_1	1	0.590 **	0.02	0.527 **	0.343**	0.304**	-0.34*	-0.173	-0.142	0.137	0.300**	0.034	0.050	-0.041	0.103	0.057	0.125	0.197
X_2	0.656**	1	-0.073	0.485 **	0.328 **	0.082	-0.356 **	-0.245*	0.077	-0.018	0.255*	-0.047	0.107	-0.002	-0.059	-0.121	-0.115	0.106
X_3	-0.001	-0.077	1	0.042	0.167	-0.047	-0.075	-0.191	-0.012	0.029	0.129	0.237*	0.148	0.05	0.395**	0.362**	-0.043	0.144
X_4	0.659**	0.6	0.04	1	0.294 **	0.348**	-0.399 **	-0.148	-0.048	-0.035	0.285* *	0.094	0.120	0.05	0.200*	0.192	-0.07	0.09
X_5	0.443**	0.375**	0.187	0.374**	1	0.288**	-0.265**	-0.082	-0.083	0.167	0.251*	0.14	0.147	0.092	0.269**	0.244*	0.067	0.309**
X_6	0.348**	0.073	-0.051	0.480**	0.394**	1	-0.201*	0.226 *	-0.151	0.359**	0.244 *	0.222 *	0.335**	0.001	0.175	0.294**	0.01	0.224*
X_7	-0.417**	-0.378**	-0.112	-0.546**	-0.319**	-0.229*	1	0.08	0.146	0.231*	-0.230*	-0.336 *	-0.210*	-0.187	-0.450**	-0.359**	-0.096	-0.071
X_8	-0.18	-0.267**	-0.244*	-0.191	-0.130	0.296**	0.082	1	0.409 **	0.273**	-0.030	0.230*	0.303**	0.346**	0.069	0.080	-0.157	0.214*
X_9	-0.158	0.122	-0.100	-0.099	-0.163	-0.276**	0.148	0.754**	1	-0.017	-0.179	0.134	0.052	0.227*	-0.001	-0.126	-0.307**	-0.018
X_{10}	0.065	-0.044	0.067	-0.029	0.270**	0.551**	0.501**	0.486**	0.299**	1	0.213*	-0.029	0.217*	0.122	-0.009	0.140	-0.071	0.726**
X_{11}	0.364**	0.26	0.188	0.384**	0.306**	0.295**	-0.291**	-0.067	-0.227*	0.411**	1	-0.024	0.310**	0.011	0.174	0.270**	0.182	0.336**
X_{12}	0.027	-0.109	0.360	0.217*	0.277**	0.295**	-0.351**	0.340**	0.185	-0.133	-0.146	1	0.345**	0.305**	0.491**	0.334**	-0.235*	0.048
X_{13}	0.054	0.139	0.164	0.186	0.300**	0.427**	-0.310**	0.480**	0.249*	0.235*	0.473**	0.566**	1	0.377**	0.312**	0.425**	-0.087	0.406**
X_{14}	-0.036	-0.002	0.039	0.059	0.155	0.009	-0.211*	0.476**	0.326**	0.074	0.046	0.348**	0.496**	1	0.342**	0.348**	-0.242*	0.203*
X_{15}	0.134	-0.084	0.494**	0.252*	0.368**	0.219*	-0.534**	0.162	-0.166	0.036	0.253*	0.699**	0.406**	0.460**	1	0.557**	-0.026	0.092
X_{16}	0.061	-0.136	0.453**	0.220*	0.337**	0.318**	-0.433**	0.099	-0.275**	0.197	0.308**	0.402**	0.564**	0.403**	0.634**	1	0.093	0.337**

X_{17}	0.102	-0.135	-0.009	-0.109	0.112	0.028	-0.142	-0.189	-0.247*	-0.204*	0.263**	-0.262**	-0.161	-0.330**	-0.021	0.073	1	-0.109
X_{18}	0.201*	0.133	0.199	0.143	0.485**	0.276**	-0.055	0.364**	0.114	0.730**	0.597**	0.069	0.580**	0.160	0.315**	0.465**	-0.253*	1

Significant at 0.05= * and Significant at 0.01= **, Genotypic level=Downword left side of diagonal, Phenotypic level=Upword right side of diagonal

Where,

X_1= Days to 50% flowering, X_2=Days to physiological maturity, X_3= Plant height (cm), X_4= Primary branches/plant, X_5= Matured pods/plant,
X_6= Immatured pods/plant, X_7= Shelling outturn (%), X_8= Hundred kernels weight (g), X_9= sound mature kernel (%), X_{10}=Kernel yield (g/plant),
X_{11}= Haulm yield (g/plant), X_{12}= Root length (cm), X_{13}= Average root diameter (cm^2), X_{14}= Lateral roots/plant, X_{15}= Root volume (cm^3),
X_{16}= Root dry weight (g), X_{17}=Oil (%), X_{18}=Dry pod yield (g/plant).

Table 4: Correlation coefficient between yield and physiological traits in groundnut genotypes

Traits	Conditions	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	C	1	0.040	-0.138	0.127	0.214*	-0.050	-0.016	-0.233*	-0.207*	0.048
	TD	1	0.247 *	0.118	0.084	0.316 *	0.050	0.069	-0.168	-0.079	-0.003
X_2	C	0.041	1	0.554 **	-0.116	-0.081	0.025	-0.005	0.091	0.164	-0.154
	TD	0.273**	1	0.580 **	-0.070	-0.141	0.088	0.088	0.084	0.144	0.124
X_3	C	-0.137	0.630**	1	-0.012	-0.146	0.012	0.000	-0.018	0.260**	-0.123
	TD	0.193	0.681**	1	0.072	-0.114	-0.057	-0.013	0.023	0.066	-0.037
X_4	C	0.184	-0.105	-0.024	1	0.025	0.005	0.008	-0.037	0.009	-0.144
	TD	0.126	-0.063	0.068	1	0.335 **	-0.008	-0.067	0.019	-0.087	-0.112
X_5	C	0.299**	-0.119	-0.224*	0.022	1	-0.264 **	-0.225 *	0.147	0.008	0.023
	TD	0.411**	-0.152	-0.133	0.348**	1	-0.153	-0.187	0.042	-0.126	-0.136
X_6	C	-0.052	0.015	-0.016	0.01	-0.320**	1	0.795 **	-0.140	0.090	0.104
	TD	0.071	0.101	-0.067	-0.015	-0.160	1	0.731 **	-0.110	-0.046	0.163
X_7	C	0.020	0.002	0.038	0.010	-0.356**	0.872**	1	-0.030	0.181	0.149
	TD	0.088	0.067	-0.017	-0.064	-0.209*	0.814**	1	-0.127	0.026	0.143
X_8	C	-0.281**	0.102	-0.010	-0.036	0.167	-0.158	-0.054	1	0.262**	-0.013
	TD	-0.205*	0.113	0.003	0.006	0.052	-0.137	-0.096	1	0.389 **	0.088
X_9	C	-0.341**	0.190	0.275**	0.016	0.049	0.090	0.202*	0.309**	1	-0.099
	TD	-0.119	0.144	0.094	-0.096	-0.111	-0.054	0.001	0.421**	1	0.036
X_{10}	C	0.248*	-0.213*	-0.117	-0.185	-0.067	0.193	0.114	-0.069	-0.116	1
	TD	-0.044	0.209*	-0.087	-0.152	-0.188	0.199*	0.268**	0.096	0.098	1

Significant at 0.05= * and Significant at 0.01= **,Genotypic level=Downword left side of diagonal, Phenotypic level=Upword right side of diagonal

Where, C=Control, TD=Terminal drought condition.

Where,

X_1= Harvest Index (%), X_2= Canopy temperature (^oC)@ 80 DAS, X_3= Canopy temperature (^oC) @100 DAS, X_4= Specific Leaf Area (cm^2/g) @80 DAS,
X_5= Specific Leaf Area (cm^2/g) @100DAS, X_6= SCMR @80 DAS, X_7= SCMR @100DAS, X_8= Relative water content @80 DAS,
X_9= Relative water content @100DAS, X_{10}= Dry pod yield (g/plant).

Table 5: Phenotypic path co-efficient among dry pod yield and its attributing characters in 49 groundnut genotypes under control condition

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}
X_1	0.0021	-0.0001	0.001	0.0008	-0.0008	-0.0005	-0.0003	0.0002	0.0007	0	0.0002	-0.0001	0	0.0002	0.0003	0.2152
X_2	-0.0001	0.002	0	0.0002	0	-0.0001	0.0002	0.0002	0.0004	0.0004	0	0.0009	0.0004	-0.0007	0.0001	0.1175
X_3	0.0027	0.0001	0.0059	0.0026	-0.0019	-0.0007	-0.0007	0.0009	0.0015	0.0008	0.0009	0.0006	0.0011	-0.0009	0.0012	0.2684
X_4	-0.0004	-0.0001	-0.0005	-0.0011	0.0003	0.0003	0.0002	-0.0002	-0.0002	-0.0001	-0.0002	-0.0002	-0.0003	-0.0001	-0.0002	0.2675
X_5	0.1192	-0.0059	0.1055	0.0986	-0.3334	-0.0284	-0.0683	-0.0252	0.0733	0.0895	0.1294	0.0934	0.0921	-0.0202	0.0408	-0.2754

X_6	-0.0009	-0.0002	-0.0004	-0.0009	0.0003	0.0037	0.0008	0.001	0.0003	0.0003	0.0001	0.0004	0.0001	-0.0002	-0.0011	0.2185
X_7	-0.0003	0.0002	-0.0002	-0.0003	0.0004	0.0004	0.0019	0.0001	-0.0002	0	-0.0002	0	-0.0003	0	-0.0003	-0.0139
X_8	0.0946	0.1143	0.1522	0.1557	0.0714	0.2442	0.0579	0.9453	0.2634	-0.0117	0.1985	0.1043	0.2348	0.071	0.0308	0.9321**
X_9	-0.0027	-0.0018	-0.0021	-0.0015	0.0018	-0.0007	0.001	-0.0022	-0.0081	0.0006	-0.0016	-0.0024	-0.003	0.002	-0.0019	0.3509*
X_{10}	0	-0.0034	-0.0022	-0.0011	0.0045	-0.0013	0.0004	0.0002	0.0012	-0.0168	-0.0043	-0.0063	-0.0048	0.0045	0.0006	0.0797
X_{11}	0.001	0.0002	0.0019	0.0018	-0.0048	0.0004	-0.0015	0.0026	0.0025	0.0032	0.0124	0.0044	0.0053	-0.0003	0.002	0.3542*
X_{12}	-0.0008	0.0089	0.0019	0.0041	-0.0055	0.0023	-0.0002	0.0022	0.0059	0.0075	0.007	0.0198	0.01	-0.0059	0.0006	0.2267
X_{13}	-0.0005	0.0046	0.0047	0.0073	-0.0071	0.0009	-0.0044	0.0064	0.0096	0.0074	0.011	0.013	0.0258	-0.0049	0.0025	0.3609**
X_{14}	0.0004	-0.0013	-0.0006	0.0004	0.0002	-0.0002	0.0001	0.0003	-0.0009	-0.001	-0.0001	-0.0011	-0.0007	0.0038	-0.0001	0.0482
X_{15}	0.0009	0.0003	0.0012	0.0009	-0.0008	-0.0018	-0.0008	0.0002	0.0015	-0.0002	0.001	0.0002	0.0006	-0.0002	0.0062	0.0815

Residual effect at Phenotypic level = 0.0981, Significant at 0.05= * and Significant at 0.01= **

Where,

X_1= Days to physiological maturity, X_2= Plant height (cm), X_3= Primary branches/plant, X_4= Matured pods/plant, X_5= Shelling outturn (%),
X_6= Hundred kernels weight (g), X_7= Sound mature kernel (%), X_8=Kernel yield (g/plant), X_9= Haulm yield (g/plant), X_{10}= Root length (cm),
X_{11}= Average root diameter (cm^2), X_{12}= Root volume (cm^3), X_{13}= Root dry weight (g/plant), X_{14}= Harvest index (%), X_{15}= Oil content (%),
X_{16}=Dry pod yield (g/plant).

Table 6: Phenotypic path coefficient among dry pod yield and its attributing characters in 49 groundnut genotypes under terminal drought condition

Traits	**X_1**	**X_2**	**X_3**	**X_4**	**X_5**	**X_6**	**X_7**	**X_8**	**X_9**	**X_{10}**	**X_{11}**	**X_{12}**	**X_{13}**	**X_{14}**	**X_{15}**	**X_{16}**
X_1	-0.0272	0.002	-0.0132	-0.0089	0.0097	0.0067	-0.0021	0.0005	-0.007	0.0013	-0.0029	0.0016	0.0033	-0.0007	0.0031	0.106
X_2	-0.0024	0.0326	0.0014	0.0054	-0.0024	-0.0062	-0.0004	0.001	0.0042	0.0078	0.0048	0.0129	0.0118	-0.0148	-0.0014	0.1436
X_3	-0.0372	-0.0032	-0.0766	-0.0226	-0.0306	0.0113	0.0036	0.0027	-0.0219	-0.0072	-0.0092	-0.0154	-0.0147	0.0188	0.0054	0.0901
X_4	0.0531	0.027	0.0477	0.162	-0.0429	-0.0133	-0.0134	0.027	0.0408	0.0227	0.0238	0.0436	0.0395	0.0008	0.0109	0.3089*
X_5	0.0879	0.0185	0.0985	0.0654	-0.2466	-0.0197	-0.0359	-0.057	0.0568	0.0829	0.0519	0.111	0.0887	-0.0386	0.0237	-0.0713
X_6	-0.0042	-0.0033	-0.0026	-0.0014	0.0014	0.0173	0.0071	0.0047	-0.0005	0.004	0.0052	0.0012	0.0014	0.0037	-0.0027	0.2144
X_7	0.0034	-0.0006	-0.0021	-0.0037	0.0065	0.0182	0.0446	-0.0008	-0.008	0.006	0.0023	-0.0001	-0.0056	0.0038	-0.0137	-0.0175
X_8	-0.0124	0.0198	-0.0236	0.1131	0.1566	0.1856	-0.0121	0.6782	0.1447	-0.0196	0.1473	-0.0058	0.0951	0.1075	-0.0483	0.7258**
X_9	0.0151	0.0076	0.0169	0.0149	-0.0136	-0.0018	-0.0106	0.0126	0.0591	-0.0014	0.0183	0.0103	0.016	-0.0101	0.0108	0.336*
X_{10}	0.0063	-0.0323	-0.0127	-0.019	0.0457	-0.0313	-0.0181	0.0039	0.0032	-0.1358	-0.0469	-0.0668	-0.0454	0.0346	0.032	0.0479
X_{11}	0.0195	0.0269	0.0218	0.0267	-0.0382	0.0552	0.0094	0.0395	0.0564	0.0627	0.1818	0.0568	0.0773	-0.0127	-0.0158	0.4063**
X_{12}	0.0116	-0.0783	-0.0398	-0.0534	0.0892	-0.0136	0.0002	0.0017	-0.0345	-0.0975	-0.0619	-0.1982	-0.1104	0.0672	0.0051	0.0923
X_{13}	-0.0199	0.0599	0.0318	0.0404	-0.0595	0.0131	-0.0209	0.0232	0.0448	0.0553	0.0703	0.0921	0.1654	-0.0341	0.0154	0.337*
X_{14}	-0.0035	0.0611	0.0329	-0.0006	-0.021	-0.0288	-0.0115	-0.0213	0.023	0.0341	0.0094	0.0455	0.0277	-0.1342	0.0054	-0.0034
X_{15}	0.016	0.006	0.0097	-0.0093	0.0133	0.0217	0.0426	0.0099	-0.0252	0.0327	0.0121	0.0036	-0.0129	0.0055	-0.1385	-0.1087

Residual effect at Phenotypic level = 0.5498, Significant at 0.05= * and Significant at 0.01= **

Where,

X_1= Days to physiological maturity, X_2= Plant height (cm), X_3= Primary branches/plant, X_4= Matured pods/plant, X_5= Shelling outturn (%),
X_6= Hundred kernels weight (g), X_7= Sound mature kernel (%), X_8=Kernel yield (g/plant), X_9= Haulm yield (g/plant), X_{10}= Root length (cm),
X_{11}= Average root diameter (cm^2), X_{12}= Root volume (cm^3), X_{13}= Root dry weight (g/plant), X_{14}= Harvest index (%), X_{15}= Oil content(%),
X_{16}=Dry pod yield (g/plant)

Conclusion

From this study concluded that, mature pods per plant, kernel yield, haulm yield, number of primary branches per plant, average root diameter and root dry weight with pod yield per plant highly significant positive association at both phenotypic and genotypic levels and high positive direct effect by kernel yield per plant, average root diameter, root dry weight and indirect effects of plant height, primary branches per plant, and haulm yield through kernel yield per plant at both control and terminal drought conditions. The importance should be given to these traits, while fixing selection criteria for drought tolerant improvement in groundnut.

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