Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.2804

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (3):** 306-311 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Character Association and Path Analysis of Yield and Yield Components in M_3 Generation of Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) Treated with Ethyl Methane Sulphonate (EMS)

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Received: 6.04.2017 | Revised: 15.04.2017 | Accepted: 16.04.2017

ABSTRACT

*The research was conducted to investigate the correlations among agronomic and yield-related characters in M_3 generation of Bambara groundnut genotype SB-42 and to verify their direct and indirect effects which will be used for the selection for seed yield per plant. The 64 M_3 mutants were raised during kharif season of the year 2014-15. Seed yield per plant had highly significant and positive correlation with the pod yield per plant with pod yield per plant (0.935**), number of pods per plant (0.824**), plant spread (0.675**), plant height (0.681**), plant dry weight (0.476**) and number of branches per plant (0.314*). Path analysis revealed that pod yield per plant (1.0596), shelling percentage (0.3644), number of pods per plant (0.0626), 100 seed weight (0.0461), plant spread (0.0243) and plant dry weight (0.0138) had high of direct effect positive on seed yield. Such characters will be useful in selection programme for increasing yield. Among all the characters pod yield had highest indirect effect on seed yield. Those characters which showed significant positive correlation and exerted direct positive effect on the yield like pod yield per plant, numbers of pods per plant, plant spread and plant dry weight could be selected for making improvement in yield.*

Key words: *Vigna subterranea, EMS, Yield Components, Correlation, Path Analysis.*

INTRODUCTION

Bambara groundnut is an important food legume crop grown by resource poor farmers mainly in semi-arid parts of African countries. In much of Africa, Bambara groundnut is the third most important legume after groundnut (*Arachis hypogaea*) and cowpea (*Vigna unguiculata*) (Howell 1994). Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) is a member of family Fabaceae and subfamily Faboideae with a chromosome number 2n=22.

Cite this article: Pranesh, Nandini , R., Chandra, K., Rangaiah, S. and Nagaraju, N., Character Association and Path Analysis of Yield and Yield Components in M_3 Generation of Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) Treated with Ethyl Methane Sulphonate (EMS), *Int. J. Pure App. Biosci.* **5(3):** 306-311 (2017). doi: http://dx.doi.org/10.18782/2320-7051.2804

It is an autogamous diploid grain legume (2n=22). It is cultivated principally by farmers as a "famine culture" crop because it has several natural agronomic advantages including high nutritional value, drought tolerance and the ability to produce in soils considered insufficiently fertile for cultivation of other more favoured species such as common beans and groundnuts[3]. It is native grain legume of the South Sahara. Botanical studies undertaken by Marechal *et al*.[10] showed great similarities between Bambara groundnut and plant species of the genus *Vigna*. This confirmed the current name *Vigna subterranea* (L.) Verdc proposed by Verdcourt[16]. The common name actually appears to be derived from a tribe "Bambara" who now live mainly in Mali[7]. According to Swanevelder[15] there are two botanical varieties reported namely *Vigna subterranea* var *spontanea* which includes the wild varieties and *Vigna subterranea* var s*ubterranea* which includes all the cultivated varieties. Bambara groundnut is an herbaceous, intermediate, annual legume, and self-pollinated with a compact well developed tap root with many short lateral stems on which leaves are borne. Leaves are trifoliate and flowers borne in a receme[4,11]. Its podding habit is either in the soil or on the surface of the ground[1]. The seed is regarded as a completely balanced food because rich in iron and protein compared to most of the food legumes. Protein is rich in essential amino acid content like lysine and methionine[13] and the gross energy value of Bambara groundnut seed is greater than that of several other pulses[2]. Correlation co-efficient study reveals the existence of association between the characters. As the indirect association of characters increases it is difficult to explain a system of correlation. The method of path-coefficients developed by Wright[18] is helpful in assessing whether association of characters with yield is due to their direct effect on yield, or it is a consequence of their indirect effect through some other traits. However, the inheritance of quantitative characters is often influenced by variation in other characters which may be due to pleiotropy or genetic linkage. Therefore, the knowledge of character association helps in determining the extent of improvement that could be brought about in the component characters and in selecting suitable and high yielding genotypes.

MATERIAL AND METHODS

The present study was carried out at K-block, Department of Genetics and Plant Breeding, University of Agriculture Sciences, GKVK, Bengaluru located at an altitude of 899 m above Mean Sea Level and at 13 00°N latitude and 77 35°E longitude. The 64 mutants of M_3 generation was raised during kharif season of the year 2014. Bambara groundnut variety 'SB-42' was used for present investigation. The seeds were obtained from National Research Centre on Groundnut Junagadh. The seeds were treated with the 0.3 % (LD_{50}) of Ethyl Methane sulphonate. Seeds were sown in plant to row progenies in a single replication along with control with spacing 30 cm between rows and 10 cm within a row at K-block, GKVK, and Bangalore. N: P: K fertilizers dose of 25:75:38kg per hectare was applied.The field was irrigated once in a week. Suitable crop protection measures were taken during the period of the crop. Data collected for Plant height (cm), Branches per plant, Plant spread (cm) Days to flowering, pods per plant, Pod yield per plant (g), shelling percentage (%),weight of 100 seeds (g) and seed yield per plant (g) and plant dry weight(g) in M3 generations were subjected to statistical analysis in order to assess the association between the seed yield and other yield contributing characters and to know the direct and indirect effects of yield contributing characters on seed yield.

RESULTS AND DISCUSSION

A thorough understanding of the association of plant characters among themselves and with yield is essential for successful crop improvement programmes. It enables the breeders to manipulate the expression of these traits in crop improvement. The efficiency of

selection for yield mainly depends on the direction and magnitude of association between yield and its components and among themselves. In the present study, effect of EMS on the phenotypic correlation was studied in M_3 generation of Bambara groundnut genotype SB-42. Among 10 quantitative characters, seed yield had significantly high positive correlation with the pod yield per plant (0.935) followed by number of pods (0.824), plant height (0.681), plant spread (0.675), plant dry weight (0.476) and number of branches per plant (0.314). Such highly significant positive correlation with pod yield per plant has also been reported by Makanda *et al*.[9] Vijaykumar[17] and Jonah[8] in Bambara groundnut. Thus these reports suggest that lesser thickness of shell is one of the indirect measures to select higher seed yield. Therefore it would be desirable for selection of plant. The significantly high positive correlation between the number of pods per plant and seed yield per plant suggesting that as the number pods increase seed yield will also increases. Similar findings also reported by Makanda *et al*.[9] and Maunde *et al*.[12] in Bambara groundnut. Plant height plant spread also had significant correlation with the seed yield which indicates that these character to be selected for high yield. Thus it would be desirable to select plants having good height and maximum plant spread. Such results have also been documented by Diriba *et al*.[6] in cowpea. Number of branches per plant was found to be have positively and significantly with seed yield indicates the seed yield increases with increase in number of branches as reported by Diriba *et al*.[6] in cowpea. Plant dry weight was found to be have positively and significantly correlated with seed yield indicates that increase in biomass leads to the increase in seed yield, such reports have also been documented by Chauhan *et al*.[5] in black gram. Therefore, from the present study it can be concluded that, greater importance has to be given to the characters *viz*., pod yield per plant, number of pods, plant height, plant spread, plant dry weight and number of branches per plant during selection process for improving seed yield per plant as these characters show positive and highly significant correlation with seed yield per plant.

In the present study out of nine quantitative characters six showed the significant association with the seed yield. These characters were subjected to path analysis to determine direct and indirect effect and the results are discussed here. In M_3 population path analysis revealed that, the characters like pod yield per plant (1.0596), shelling percentage (0.3644), number of pods per plant (0.0626), 100 seed weight (0.0461), plant spread (0.0243) and plant dry weight (0.0138) had positive direct effect on seed yield while, plant height (-0.0123), days to flowering (-0.0038) and number of branches per plant (-0.003) had negative direct effects on seed yield. Among these pod yield per plant had maximum positive effect and plant height had maximum negative effect on seed yield. Highly significant correlation between pod yield per plant and seed yield was observed. This positive correlation was due to the direct effect of pod yield per plant on seed yield. Indirect positive effect via plant spread, number of pods per plant and plant dry weight while Indirect negative effect via days to flowering, plant height, number of branches per plant, shelling percentage and 100 seed weight. Highly significant correlation between number of pods per plant and seed yield was observed. This positive correlation was mainly due to the indirect positive effect of pod yield per plant on seed yield. Indirect positive effect via pod yield per plant, plant spread and plant dry weight while Indirect negative effect via days to flowering, plant height, number of branches per plant, shelling percentage and 100 seed weight. Highly significant correlation between plant spread and seed yield was observed. This positive correlation was mainly due to the indirect positive effect of pod yield per plant on seed yield. Indirect positive effect via pod yield per plant, number of pods per plant, 100 seed weight and plant dry weight while Indirect negative effect via days to flowering, plant height, number of branches

per plant and shelling percentage. Highly significant correlation between plant height and seed yield was observed. This positive correlation was mainly due to the indirect positive effect of pod yield per plant on seed yield. Indirect positive effect via pod yield per plant, plant spread, number of pods per plant, 100 seed weight and plant dry weight while Indirect negative effect via days to flowering, number of branches per plant and shelling percentage. Highly significant correlation between number of branches per plant and seed yield was observed. This positive correlation was mainly due to the indirect positive effect of pod yield per plant on seed yield and indirect positive effect via pod yield per plant, plant spread, number of pods per plant, 100 seed weight and plant dry weight while Indirect negative effect via days to flowering, plant height and shelling percentage. Highly significant correlation between plant dry weight and seed yield was observed. Such positive correlation was mainly due to the indirect positive effect of pod yield per plant on seed yield. Indirect positive effect via pod yield per plant, plant spread, number of pods per plant and 100 seed weight while Indirect negative effect via days to flowering, plant height, number of branches per plant and shelling percentage. These results are similar in accordance with result of Vijaykumar[18] and Smita *et al*.[14] in gamma irradiated Bambara groundnut.

Table 1: Phenotypic correlation coefficient for 10 quantitative characters studied in M_3 generation of Bambara groundnut

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	1									
X_2	0.099	1								
X_3	0.085	0.312*	1							
X_4	0.019	0.809**	0.257*	1						
X_5	0.097	0.536**	0.242	0.539**	1					
X_6	0.073	0.648**	0.332**	0.639**	0.884**	1				
X_7	0.052	0.681**	0.314*	0.675**	0.824**	0.935**	1			
X_8	-0.068	-0.158	-0.151	-0.161	-0.444**	-0.505**	-0.175	1		
X_9	-0.065	0.082	0.018	0.037	-0.517**	-0.167	0.031	0.530**	1	
X_{10}	0.122	0.679**	0.183	0.552**	0.367**	0.409**	0.476**	-0.011	0.106	1

**Significant at 0.01

*Significant at 0.05

X_1= Days to flowering X_2= Plant height (cm) X_3= Number of branches

X_4= Plant spread (cm) X_5= Number of pods per plant X_6=Pod yield per plant (g)

X_7=Seed yield per plant (g) X_8=Shelling percentage (%) X_9=100 seed weight (g)

X_{10}=Plant dry weight (g)

Table 2: Estimates of direct and indirect effects of yield components on seed yield at phenotypic level in M_3 generation of Bambara Groundnut

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	r
X_1	**-0.0038**	-0.0012	-0.0003	0.0005	0.0061	0.0775	-0.0249	-0.003	0.0017	0.0525
X_2	-0.0004	**-0.0123**	-0.0009	0.0197	0.0336	0.6863	-0.0577	0.0038	0.0094	0.6814**
X_3	-0.0003	-0.0038	**-0.003**	0.0062	0.0152	0.3514	-0.0549	0.0008	0.0025	0.3142**
X_4	-0.0001	-0.0099	-0.0008	**0.0243**	0.0338	0.6769	-0.0587	0.0017	0.0076	0.6748**
X_5	-0.0004	-0.0066	-0.0007	0.0131	**0.0626**	0.9366	-0.1619	-0.0238	0.0051	0.824**
X_6	-0.0003	-0.0079	-0.001	0.0155	0.0554	**1.0596**	-0.1839	-0.0077	0.0056	0.9353**
X_7	0.0003	0.0019	0.0005	-0.0039	-0.0278	-0.5347	**0.3644**	0.0244	-0.0001	-0.1752
X_8	0.0002	-0.001	-0.0001	0.0009	-0.0324	-0.1768	0.193	**0.0461**	0.0015	0.0314
X_9	-0.0005	-0.0083	-0.0006	0.0134	0.023	0.4337	-0.0039	0.0049	**0.0138**	0.4756**

RESIDUAL EFFECT = 0.0794

X_1= Days to flowering X_2= Plant Height (cm) X_3= Number of branches

X_4= Plant spread (cm) X_5= Number of pods per plant X_6=Pod yield per plant (g)

X_7=Shelling percentage (%) X_8=100 seed weight (g) X_9=Plant dry weight (g)

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