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Correlation Studies in M_2 and M_3 Generation of Cowpea [*Vigna unguiculata* (L.) Walp] treated with Gamma Rays and EMS

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ABSTRACT: *Gamma irradiated (100, 200, 300, 400, 500 Gy) and chemical mutagen Ethyl Methane Sulphonate (EMS) of concentration 0.25%, 0.30%, 0.35%, 0.40% and 0.45% for 6h.) M_2 and M_3 generation of Cowpea cv. Pusa Komal and Arka Garima were investigated for correlation among yield and its component characters. The character association studies among the yield components indicates that the degree of association between the yield components was decreased to a considerable extent in the mutagen treated population compared to control for most of the characters. Yield per plant had significant positive association with hundred seed weight, number of pods per plant and plant height in both control and treated population in M_2 and M_3 generation of Pusa Komal. But, in Arka Garima significant and positive association of yield per plant was recorded in number of primary branches per plant, number of pods per plant, number of seeds per pods, hundred seed weight and pod length in M_2 generation whereas, plant height, number of pods per plant and hundred seed weight in M_3 population.*

Key words*: Cowpea, gamma rays, EMS, correlation Coefficient, M_2 generation, M_3 generation*

INTRODUCTION

Cowpea is an important food legume crop especially throughout sub Saharan Africa and Asia. Its grain and leaves are rich source of high quality protein and vitamins which provide an excellent supplement to the lower quality cereals or root tubes protein (Kitch *et al*., 1998). Mutation breeding is one of the possible alternatives to conventional breeding for crop improvement and has been least applied in grain legume. In the post induced mutation have effectively been utilized in development of new and valuable alternation in plant characteristics that have contributed to increased yield potential (Dhanavel *et al*., 2012).

The identification of plants with suitable combination of characters from a population with genetic variability is dependent upon the knowledge of breeder on that population. Correlation coefficient analysis measures the mutual relationship between various characters and determines the component characters on which selection can be made for genetic improvement in yield. Association analysis measures the natural relationship between various plant characters and determines the components on which selection could be based on improvement. The association of character may be due to either genetic linkage or pleiotrophy (Harland, 1939). Knowledge of correlation that exists among important character may facilitate proper interpretation of results and provide basis for planning more efficient breeding programmes. Association of characters, the expression of which is governed by closely linked genes in the parental material has been reported to be altered in certain cases due to mutagenic treatments. Induced mutations could therefore be useful as a valuable tool in breaking linkages of undesirable traits with useful, productive ones.

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MATERIAL AND METHODS

In the present study two distinct cultivars of cowpea *viz.,* Pusa Komal and Arka Garima were treated with gamma rays and Ethyl Methane Sulphonate (EMS). Three hundred dry non-dormant seeds of two varieties were taken for irradiation with gamma rays. The sets of seeds were packed in paper cover for irradiation and treated with 100, 200, 300, 400, 500 Gy of gamma rays at the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, with the source strength of 2000 Curie Cobalt 60 at a dose of 3000 rads/minute. Aqueous solution of different concentrations (0.25%, 0.30%, 0.35%, 0.40% and 0.45%) of EMS was prepared using double distilled water. Healthy seeds of both the varieties were soaked in double distilled water for six hours at room temperature prior to treatment with mutagen. They were then soaked in the freshly prepared mutagenic solutions for six hours. Healthy well matured, non-dormant and untreated seeds were used as control. Seeds harvested from M_1 were sown in the M_2 generation in 6m long rows 60 cm apart in Randomized Complete Block Design with three replications along with untreated control. Mutants selected from the M_2 population were grown in M_3 to test the uniformity of the plants. The simple correlation coefficient in M_2 and M_3 generations was calculated.

RESULT AND DISCUSSION

Simple correlation coefficient of yield and its components were worked out for twelve characters in M_2 and M_3 generations of variety Pusa Komal and Arka Garima. Metric characters of economic importance are often associated with one another. Yield in particular is dependent on several other component characters. In the present study, it was evident from the data that the degree of association between the yield components decreased to a considerable extent in the mutagen treated population compared to control for most of the characters. Scossiroli *et al.,* (1966) also reported a definite decrease in correlation value in the mutagen treated population which indicates a breakage of relation existing in the control populations. The results of correlation in control and mutagen treated populations in M_2 and M_3 generation of variety Pusa Komal were summarized in Table 1 and 2 of respectively. However, the results of simple correlation in Arka Garima were depicted in Table 3 and 4 for M_2 and M_3 generation respectively.

In var. Pusa Komal the correlation coefficient between yield per plant and hundred seed weight, number of pods per plant, plant height and number of seeds per pods was significant and positive in both control and treated population in M_2 population. Similar results were reported by Arshad *et al.,* (2003) in chickpea where they observed highest positive and significant correlation among yield per plant with number of pods per plant followed by 100 grain weight. When characters having direct bearing on yield are selected, their associations with other characters are to be considered simultaneously as this will indirectly affect yield (Kole *et al.,* 2008). Whereas, traits *viz.,* days to first picking, days to last picking and days to first flowering had significant but negative effect in the treated population. The association of yield per plant was significant and positive with number of pods per plant, hundred seed weight and plant height in untreated as well as populations treated with mutagen in M_3 generation. The trait days to first flowering, days to first picking and days to last picking had significant negative effect in treated population, while it was positive in control. The trait plant height, hundred seed weight and number of pods per plant had significant positive correlation in control whereas, in the treated population it had negative but significant effect. This is expected because as the flowering is delayed there is more duration for vegetative growth and plant height increases naturally. Conversely, number of pods per cluster had significant negative correlation coefficient in untreated population and positive effect in mutagen treated population. The results obtained indicated that yield was increased whenever there was increase in hundred seed weight, number of pods per plant and plant height in both control and treated population (Table 1 and 2) in M_2 and M_3 generation of Pusa Komal. The correlation coefficient of pod length was found to be non-significant in control but significantly positive in mutagen treated population. The correlation of hundred seed weight was significant positive in both the population of M_2 although in M_3 generation, untreated control was significantly and negatively correlated. In case of protein percent the association was non-significant in both treated as well as untreated control of M_2 as well as M_3 generation.

The estimated simple correlation coefficient (Table 3 and 4) in Arka Garima indicates that the traits number of primary branches per plant, number of pods per plant, number of seeds per pods, hundred seed weight and pod length had significant positive value in control as well as the treated population in M_2 generation. While, that of days to first flowering

Table 1
Estimates of Simple Correlation Coefficient among Yield and its Attributing Characters in M_2 Generation Cowpea [*Vigna unguiculata* (L) Walp] var. Pusa Komal

Characters		*Days to first picking*	*Days to last picking*	*Plant height*	*No. of primary branches per plant*	*No. of pods per cluster*	*No. of pods per plant*	*Pod length (cm)*	*No. of seeds per pod*	*100 seed weight (g)*	*Protein percent*	*Yield per plant*
Days to first	C	0.320	0.501	0.977**	0.596*	0.236	0.664*	-0.520	0.699*	0.767**	0.172	0.996**
flowering	T	0.903**	0.874*	-0.641*	-0.448	-0.808**	- 0.856**	-0.720**	-0.445	-0.900**	-0.354	-0.846**
Days to first	C		0.981**	0.111	0.599**	-0.844**	0.998**	0.641*	0.307	-0.361	-0.357	0.403
picking	T		0.954**	-0.709**	-0.402	-0.886**	0.888*	-0.731**	-0.558	0.898**	-0.272	-0.913**
Days to last	C			0.304	0.974**	-0.723**	0.967**	0.479	0.488	-0.171	-0.167	0.575
picking	T			-0.676*	0.393	-0.841**	0.840**	-0.606*	-0.518	-0.913**	0.206	-0.873**
Plant height	C				0.779**	0.437	0.053	-0.690*	0.979**	0.886**	0.088	0.954**
(cm)	T				0.777**	0.584*	0.694*	0.541	0.703*	0.904**	0.362	0.704*
No. of primary branches	C					-0.561	0.899**	0.666*	0.277	-0.390	-0.398	0.373
per plant	T					0.419	0.701*	0.440	0.599*	0.498	0.421	0.497
No. of pods	C						0.874**	-0.952**	0.249	0.803**	0.506	0.149
per cluster	T						0.952**	0.728**	0.664*	0.867**	0.269	0.926**
No. of pods	C							0.686*	0.251	-0.414	-0.411	0.749**
per plant	T							0.748**	0.666*	0.884**	0.239	0.963**
Pod length (cm)	C								-0.535*	-0.947**	-0.545	-0.443
	T								0.662*	0.680*	0.136	0.813**
No. of seeds	C									0.776**	0.478	0.994**
per pod	T									0.586*	0.182	0.724**
100 seed	C										0.309	0.708**
weight (g)	T										0.302	0.906**
Protein per cent	C											0.418
	T											0.225

* 5 % level of significance **1 % level of significance
Note: C- control and T- Mutagen treated population

Table 2
Estimates of Simple Correlation Coefficient among Yield and its Attributing Characters in M_3 Generation Cowpea [*Vigna unguiculata* (L) Walp] var. Pusa Komal

Characters		*Days to first picking*	*Days to last picking*	*Plant height*	*No. of primary branches per plant*	*No. of pods per cluster*	*No. of pods per plant*	*Pod length (cm)*	*No. of seeds per pod*	*100 seed weight (g)*	*Protein percent*	*Yield per plant*
Days to first	C	0.994**	0.756**	0.268	-0.434	0.555	-0.233	0.789**	-0.100	0.709**	-0.520	0.757**
flowering	T	0.854**	0.846**	-0.522	-0.349	-0.829**	-0.834**	-0.713*	-0.437	-0.963**	-0.546	-0.876**
Days to first	C		0.980**	-0.162	0.528**	0.641*	0.337	0.850**	-0.008	0.780**	0.401	0.659*
picking	T		0.858**	-0.596*	-0.441	-0.824**	-0.820**	-0.693*	-0.464	-0.892**	-0.510	-0.847**
Days to last	C			-0.354	0.649*	-0.478	0.144	0.729**	0.190	0.642**	0.546	0.769**
picking	T			-0.598*	-0.436	-0.796**	-0.809**	-0.694*	-0.445	-0.932**	0.507	-0.845**
Plant height	C				0.752**	-0.649*	0.874**	0.381	-0.985**	0.688*	0.289	0.862**
(cm)	T				0.933**	0.772**	0.741**	0.416	0.749**	0.663*	0.391	0.679*
No. of primary branches	C					0.488	0.977**	0.896**	0.853**	0.943**	0.179	0.982**
per plant	T					0.342	0.635*	0.246	0.687**	0.488	0.418	0.552
No. of pods	C						0.935**	-0.948**	0.768**	-0.971**	-0.494	-0.943**
per cluster	T						0.950**	0.682*	0.627*	0.893**	0.551	0.863**
No. of pods	C							0.782**	-0.944**	0.851**	0.307	0.997**
per plant	T							0.705*	0.658*	0.902**	0.211	0.902**
Pod length	C								-0.532	0.993**	0.471	0.197
(cm)	T								0.684*	0.712**	0.489	0.702*
No. of seeds	C									-0.630*	-0.518	0.936**
per pod	T									0.549	0.405	0.575
100 seed	C										0.112	0.863**
weight (g)	T										0.245	0.935**
Protein per cent	C											0.217
	T											0.334

* 5 % level of significance **1 % level of significance

Table 3
Estimates of Simple Correlation Coefficient among Yield and its Attributing Characters in M_2 Generation Cowpea [*Vigna unguiculata* (L) Walp] var. Arka Garima

Characters		*Days to first picking*	*Days to last picking*	*Plant height*	*No. of primary branches per plant*	*No. of pods per cluster*	*No. of pods per plant*	*Pod length (cm)*	*No. of seeds per pod*	*100 seed weight (g)*	*Protein percent*	*Yield per plant*
Days to first	C	0.500	0.403	-0.221	0.259	-0.475	0.896**	0.749**	0.243	0.887**	0.128	0.976**
flowering	T	0.866**	0.916**	-0.055	0.148	-0.799**	-0.827**	-0.862**	-0.598**	0.557*	0.131	-0.836**
Days to	C		0.494	0.233	0.235	0.840**	0.627*	0.848**	0.207	0.819**	-0.402	0.302
first picking	T		0.583**	-0.381	0.567	-0.701*	0.675*	-0.855**	-0.665*	0.607*	-0.144	-0.674*
Days to last	C			0.302	0.129	0.897**	0.578*	0.809**	0.310	0.876**	-0.498	0.197
picking	T			-0.274	0.448	0.561*	0.733**	-0.739**	-0.679**	0.652*	-0.109	0.737**
Plant height	C				0.588*	0.989**	0.701*	0.479	0.317	0.690*	-0.419	-0.427
(cm)	T				0.969**	0.758**	0.816**	0.392	0.492	0.599*	0.190	0.651**
No. of primary branches	C					-0.359	0.779**	0.531	0.203	0.364	0.796**	0.998**
per plant	T					0.790**	0.654**	0.478	0.193	0.731**	0.167	0.757**
No. of pods	C						0.158	-0.616*	0.334	0.195	-0.447	-0.291
per cluster	T						0.579**	-0.591*	-0.762**	0.276	0.294	0.644*
No. of pods	C							0.692*	0.496	0.168	0.357	0.990**
per plant	T							0.656*	0.553	0.546	0.269	0.859**
Pod length	C								0.114	0.595	-0.089	0.589*
(cm)	T								0.884**	0.689*	0.137	0.656*
No. of seeds	C									0.430	0.179	0.870**
per pod	T									0.632*	0.171	0.728*
100 seed	C										-0.539	0.752**
weight (g)	T										-0.314	0.617*
Protein per cent	C											-0.299
	T											0.185

* 5 % level of significance **1 % level of significance

Table 4
Estimates of Simple Correlation Coefficient among Yield and its Attributing Characters in M_3 Generation Cowpea [*Vigna unguiculata* (L) Walp] var. Arka Garima

Characters		*Days to first picking*	*Days to last picking*	*Plant height*	*No. of primary branches per plant*	*No. of pods per cluster*	*No. of pods per plant*	*Pod length (cm)*	*No. of seeds per pod*	*100 seed weight (g)*	*Protein per cent*	*Yield per plant*
Days to first	C	0.627*	0.786**	0.644*	0.890**	-0.587	-0.782**	-0.562	-0.873**	-0.890**	-0.550	-0.615*
flowering	T	0.971**	0.923**	-0.902**	-0.885**	0.267	-0.769**	-0.889**	-0.863**	-0.650*	-0.322	-0.895**
Days to first	C		0.289	-0.676*	0.564	0.750**	-0.759**	0.651*	-0.595*	-0.898**	-0.082	-0.995**
picking	T		0.579*	-0.874**	-0.849**	-0.704*	-0.723*	-0.869**	-0.867**	-0.711*	-0.422	-0.856**
Days to last	C			0.509	0.953**	-0.441	-0.842**	-0.416	-0.942**	-0.978**	-0.481	-0.278
picking	T			-0.879**	-0.846**	-0.653*	-0.672**	-0.837**	-0.856**	-0.713**	-0.491	-0.884**
Plant height	C				0.625*	0.146	0.635*	-0.296	-0.189	-0.679*	0.283	0.685*
(cm)	T				0.982**	0.397	0.771**	0.756**	0.789**	0.682**	0.333	0.955**
No. of primary branches per	C					0.144	0.967**	-0.122	0.299	-0.868**	‘-0.170	0.554
plant	T					-0.216	0.783**	0.728**	0.384	0.676*	0.336	0.796**
No. of pods	C						0.651*	0.301	0.106	-0.622**	-0.372	-0.759*
per cluster	T						0.596*	-0.576*	-0.759**	-0.709**	0.393	0.630*
No. of pods	C							-0.139	0.374	0.709**	0.368	0.752*
per plant	T							0.575*	0.384	0.650*	-0.400	0.753**
Pod length (cm)	C								0.785**	-0.597*	-0.383	-0.459
	T								0.886**	0.623*	0.359	0.419
No. of seeds	C									0.848**	0.488	0.485
per pod	T									0.705*	0.420	0.774**
100 seed	C										0.511	0.892**
weight (g)	T										0.548	0.730**
Protein per cent	C											0.069
	T											0.375

* 5% level of significance **1% level of significance

was significant positive in control and negative in mutagen treated population. The traits days to last picking, plant height and number of pods per cluster were positively and significantly correlated with yield in the mutagen treated population. Thus the traits plant height, number of primary branches per plant, number of pods per plant, number of seeds per pods, hundred seed weight and pod length which had significant and positive association of yield per plant can be considered as criteria for selection for higher yield as these were mutually and directly associated with pod and seed yield. Studies of Khan (1985) in the mutagen treated population of mungbean also revealed that yield has shown positive correlation with number of branches and number of pods per plant.

It is also manifested from the study that a shift in correlation from positive to negative direction was observed for yield per plant with days to first flowering, days to first picking and days to last picking in both the generations of Pusa Komal and M_2 generation of Arka Garima. This proves that mutagen treatment leads to earliness and these early mutants are high yielders. While, a shift in correlation from negative to positive direction was observed for number of pods per cluster and pod length in the mutagen treated plant populations. This is in proximity to the results obtained by Reddy (1981) who recorded a shift in correlation coefficients from negative to positive direction for pod length with yield per plant in the mutant populations.

The data pertaining to days to first flowering in both the generations of Pusa Komal and M_2 population of Arka Garima indicates that plant height, hundred seed weight, number of pods per plant and pod length had significant positive correlation as observed in control whereas, in the treated population it had significant negative effect. Hence, it is substantiated that in the treated population dwarf mutants were early in flowering. The traits pod length, number of pods per plant, number of pods per cluster in Pusa Komal and number of seeds per pod in Arka Garima had significant negative effect in the treated population indicating that late flowering lead to low yielding plants. Days to first and last picking had significant negative association with length of pod, hundred seed weight and number of pods per cluster in treated population of Pusa Komal, which indicates that early maturing mutants had more pod length and seed weight.

Data on plant height signify that number of pods per plant, number of seeds per pod, hundred seed weight and number of primary branches per plant had significant positive effect in Pusa Komal. In Arka Garima number of pods per cluster, hundred seed weight and number of pods per plant had significant positive correlation in mutagen treated population with number of primary branches per plant. The correlation of number of primary branches per plant was significant and positive with number of pods per plant in M_3 generation of both the varieties. This is similar to the results were observed earlier by Murugan *et al.,* (1995) in 50 kR gamma irradiated cowpea var. CO 4. In Arka Garima, the association of primary branches per plant with number of seeds per pod was non-significant in both control and treated population this was in corroboration with Murugan *et al.,* (1995). Number of pods per cluster had significant negative association with hundred seed weight and pod length in control and positive correlation in treated population of Pusa Komal. In population treated with gamma rays and EMS increase in number of seeds per pod, hundred seed weight in Pusa Komal and pod length in Arka Garima was observed with the increase in number of pods per plant. However, in untreated population of Pusa Komal a significant negative association between seeds per pods and pods per plant would indicate that selection of genotypes for more number of pods would result in plant types with less number of seeds. Contrary to this result, Selvam and Das (1994) reported to have negative correlation of pod length and hundred seed weight with number of pods per plant in the treated population. According to NeWall and Eberhart (1961) when two characters show negative phenotypic and genotypic correlation it would be difficult to exercise simultaneous selection for these characters in the development of a variety. Hence, under such situations, judicious selection programme might be formulated for simultaneous improvement of such important developmental and component characters. The effect of pod length with number of pods per plant in Arka Garima was non-significant in control but was altered to positive significant association in the mutagen treated population. Similar, outcome in M_3 generation has been reported by Murugan *et al.,* (1995) in genotype TV× 944-02E treated with 30 and 40 kR gamma rays. Even though length of pod had significant positive association with pods per plant but its low heritability in both the varieties nullify its usefulness in improvement of yield of vegetable cowpea.

Pod length recorded significant negative correlation coefficient in control while it was

significant positive in treated population of M_2 generation for hundred seeds weight and number of seeds per pods in both the varieties. Contrary to this in M_2 generation of Arka Garima, the mutagen treated population had significant and positive association with number of seeds per pod and hundred seed weight while it was non-significant in control. In both the generations of the two varieties, protein percent had non-significant effect with all the traits in both treated and untreated population. As in the present investigation, Murugan *et al*., (1995) in cowpea var. CO 4 also recorded non-significant correlation coefficient between number of seeds per pods and pods per plant.

The result on correlation coefficient in M_3 generation indicates that traits *viz*., plant height, number of pods per plant and hundred seed weight had significant positive correlation with yield per plant in control as well as mutagen treated population. Whereas, days to first picking and days to first flowering had significantly negative effect. On the other hand, number of pods per cluster had negative but significant association in control and positive in treated population. Number of primary branches per plant, number of seeds per pod had significant positive correlation coefficient in treated population.

CONCLUSION

The character association studies among the yield components indicates that the degree of association between the yield components was decreased to a considerable extent in the mutagen treated population compared to control for most of the characters. A significant and positive association of yield per plant was observed with hundred seed weight, number of pods per plant and plant height in both control and treated population of both the varieties. The efficiency of plant breeding programme is determined by the amount of genetic variability available in the segregating population. Improvement in the quantitive characters have been achieved through accumulation of genes affecting their expression in a positive and negative direction and thus increasing variability.

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