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EFFECT OF MUTAGENS ON CHARACTER ASSOCIATION AND SELECTION RESPONSE IN MUTAGENISED POPULATIONS OF GRASSPEA (*LATHYRUS SATIVUS L.*)

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ABSTRACT

Character association and component analysis at genotypic level were studied in mutagenised populations (M_2) of grasspea land race "Dhenkanal local" following seed treatment with gamma-rays, EMS, NG and their combinations. Seeds/plant emerged as an independent direct yield contributing trait in all treatments except 40kR gamma-rays + 0.2% EMS. In general, number of branches/plant, pods/plant and seeds/plant exhibited very high and significant positive association with seed yield/plant. High correlation of 100-seed weight accompanied by its high direct effect on seed yield in 70kR gamma-rays, 0.03% NG and 40kR gamma-rays revealed breakage of undesirable linkage of this trait with seed yield. Negative association of plant height with seed yield in 0.2% EMS also provided a scope for selection of dwarf plant type coupled with high seed yield.

INTRODUCTION

Grasspea, despite its high protein content (21.8%-40%) and stress resistance, it still remains as a slow runner in terms of its productivity. Mutation breeding is the only feasible and sustainable technique to create a gene pool of numerous desirable traits of economic importance. Genetic improvement for seed yield is often constrained with unfavourable linkages. Mutagenesis could be an important tool for creating new alleles (Laskar and Khan, 2014) which can break such linkage drag and thereby reconstitute the plant types. Information in this aspect is not widely available in grasspea. However, changes in character association following mutagenesis have been reported in other crops e.g., mungbean (Mohapatra and Singh, 1988), lentil (Sharma and Sharma, 1981), cowpea (Choulwar and Borikar, 1986) and groundnut (Ramanathan and Rathinam, 1983). Besides, mutagens has significant role in altering inter-relationship of seed yield with biochemical attributes in sesame (Begum and Dasgupta, 2011) and sufflower (Vienna and Ravikumar, 2003). Study of path analysis is more important over correlation, in that, it partitions the total correlation into various direct and indirect effects. Therefore, in the present pursuit, correlation coupled with path analysis have been studied to examine the nature of changes in interrelationship of component traits with seed yield and their effect on seed yield for effective selection of plant types in the mutagenised populations of grasspea.

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MATERIALS AND METHODS

300 pure seeds of grasspea, cv. Dhenkanal local were treated with gamma-rays (10, 40 and 70kR), EMS (0.2, 0.4 and 0.6%), NG (0.01, 0.02 and 0.03%) and combination of 40 kR gamma-rays with 0.2% EMS and/or 0.01% NG. and sown in the field to raise M_1. Seeds of each M_1 plant and that of control (parent variety) were sown in single progeny rows following a compact family block design (CFBD) with three replications. Observations on seed yield and its component traits e.g., plant height (cm), number of branches/plant, number of pods/plant, number of seeds/pod, number of seeds/plant, 100-seed weight (g) and seed yield/plant (g) were recorded on randomly chosen ten normal looking competitive plants from only 18 progeny rows, treatment-wise and replication-wise, and averaged to single plant basis.

Table 1. Genotypic path Co-efficients of different yield contributing traits on seed yield in different M_2 mutant populations

Treatment	Traits	Plant height (PHT)	No. of branches / plant (NB)	No. of pods/plant (NP)	No. of seeds/pod (S/P)	No. of seeds/ plant (S/PL)	100 –seed weight (SW)	Genotypic Correlation with seed yield	Residual effect
1	2	3	4	5	6	7	8	9	10
Gamma- rays									
10 kR	PHT	0.036	0.039	-0.020	0.023	0.714	-0.116	0.677**	0.075
Gamma-ray	NB	0.010	0.140	-0.023	-0.011	0.377	0.206	0.699**	
	NP	0.018	0.082	-0.040	-0.008	0.800	0.010	0.863 **	
	S/P	0.017	-0.033	0.006	0.048	0.458	-0.266	0.231	
	S/PL	0.026	0.053	-0.032	0.022	0.999	-0.171	0.897**	
	SW	-0.010	0.070	-0.001	-0.031	-0.415	0.412	0.024	
40 kR	PHT	-0.043	-0.010	-0.086	0.021	0.341	0.223	0.446**	0.099
Gamma-ray	NB	-0.010	-0.044	-0.279	0.097	0.836	0.241	0.841**	
	NP	-0.011	-0.038	-0.323	0.154	0.753	0.148	0.684**	
	S/P	-0.003	-0.014	0.168	-0.297	0.422	-0.339	-0.029	
	S/PL	-0.012	-0.030	-0.200	-0.103	1.215	-0.079	0.790**	
	SW	-0.016	-0.018	-0.079	0.167	-0.160	0.602	0.496**	
70 kR	PHT	0.004	0.062	-0.651	0.008	1.052	-0.093	0.383 **	0.046
Gamma-ray	NB	0.003	0.103	-0.893	-0.069	1.575	0.121	0.841**	
	NP	0.003	0.090	-1.019	-0.010	1.667	0.089	0.821 **	
	S/P	0.000	0.021	-0.031	-0.332	0.642	0.099	0.399 **	
	S/PL	0.003	0.092	-0.958	-0.120	1.774	0.106	0.897**	
	SW	-0.001	0.027	-0.198	-0.072	0.413	0.458	0.627**	
EMS									
0.2% EMS	PHT	0.0012	0.012	-0.059	-0.063	0.573	-0.506	-0.041	0.061
	NB	0.0001	0.185	-0.316	-0.023	1.113	-0.569	-0.391**	
	NP	0.0002	0.161	-0.364	0.008	1.085	-0.270	0.620**	
	S/P	0.0003	0.018	0.012	-0.234	1.184	-0.398	0.583**	
	S/PL	0.0004	0.125	-0.240	-0.169	1.642	-0.485	0.874**	
	SW	-0.001	-0.141	0.131	0.124	-1.062	0.749	-0.199	
0.4% EMS	PHT	-0.077	0.011	0.050	0.083	0.163	0.090	0.322*	0.104
	NB	0.006	-0.149	0.303	-0.022	0.353	0.058	0.550**	
	NP	-0.011	-0.128	0.353	0.014	0.472	0.100	0.801**	
	S/P	-0.026	0.013	0.020	0.244	0.373	-0.112	0.513**	
	S/PL	-0.021	-0.089	0.284	0.155	0.588	-0.008	0.908**	
	SW	-0.016	-0.020	0.082	-0.063	-0.011	0.432	0.404**	
0.6%EMS	PHT	-0.027	0.043	-0.393	-0.446	1.369	-0.018	0.528**	0.033
	NB	-0.010	0.113	-0.937	-0.308	1.957	0.011	0.827**	
	NP	-0.009	0.094	-1.129	-0.208	2.167	-0.090	0.826**	
	S/P	-0.016	0.047	-0.316	-0.743	1.787	-0.031	0.728**	
	S/PL	-0.015	0.089	-0.977	-0.530	2.503	-0.126	0.943**	
	SW	0.001	0.003	0.214	0.049	-0.668	0.473	0.072	
NG									
0.01% NG	PHT	-0.101	-0.029	-0.438	0.112	0.823	0.140	0.508**	0.106
	NB	-0.061	-0.049	-0.311	0.075	0.551	0.605	0.811**	
	NP	-0.084	-0.029	-0.528	-0.063	1.354	0.136	0.787**	
	S/P	0.016	-0.005	-0.049	-0.686	1.565	-0.467	0.386**	
	S/PL	-0.042	-0.014	-0.360	-0.540	1.989	-0.333	0.701**	
	SW	-0.016	-0.033	-0.079	0.353	-0.730	0.908	0.403**	
0.02% NG	PHT	-0.709	-0.006	-0.337	0.139	0.354	1.201	0.643**	0.160
	NB	0.016	0.269	-1.762	0.139	2.510	-0.636	0.537**	
	NP	-0.121	0.240	-1.973	0.309	2.448	-0.184	0.719**	
	S/P	0.115	-0.044	0.712	-0.855	0.641	-0.587	-0.018	
	S/PL	-0.085	0.229	-1.635	-0.186	2.953	-0.522	0.754**	
	SW	-0.573	-0.115	0.245	0.338	-1.037	1.487	0.345**	
0.03% NG	PHT	0.671	-2.249	-5.558	3.194	4.241	0.306	0.606**	0.631
	NB	0.542	-2.783	-7.607	2.478	8.041	0.000	0.671**	
	NP	0.435	-2.469	-8.577	3.230	8.151	0.052	0.823**	
	S/P	-0.473	1.522	6.115	-4.530	-2.880	-0.162	-0.408**	
	S/PL	0.309	-2.432	-7.600	1.418	9.201	-0.063	0.834**	
	SW	0.298	0.000	-0.643	1.069	-0.837	0.688	0.575**	
Combinations									
40kRGamma-	PHT	-0.748	.608	1.233	-0.416	-0.423	0.117	0.371**	0.225
ray+0.2% EMS	NB	-0.398	1.143	2.081	0.318	-2.234	0.019	0.929**	
	NP	-0.385	0.993	2.395	0.200	-2.344	-0.042	0.816**	
	S/P	0.454	0.529	0.697	0.686	-1.701	-0.125	0.540**	
	S/PL	-0.123	0.997	2.191	0.455	-2.562	-0.086	0.872**	
	SW	-0.289	0.072	-0.335	-0.284	0.730	0.303	0.197	
40kRGamma-	PHT	0.046	0.019	-0.004	-0.019	-0.012	0.073	0.102	0.092
ray+0.01% NG	NB	0.004	0.229	-0.032	-0.005	0.685	-0.010	0.870**	
	NP	0.006	0.216	-0.034	-0.002	0.735	0.025	0.946**	
	S/P	-0.018	-0.025	0.002	0.048	0.231	-0.190	0.048	
	S/PL	-0.001	0.201	-0.032	0.014	0.782	-0.036	0.928**	
	SW	0.009	-0.006	-0.002	-0.024	-0.074	0.382	0.284*	

Continue…….

40kRGamma-ray +0.2%EMS + 0.01%NG	PHT	-0.050	-0.093	0.110	-0.025	0.444	0.157	0.544**	0.033
	NB	-0.027	-0.174	0.154	0.005	0.876	0.126	0.962**	
	NP	-0.033	-0.162	0.166	-0.008	0.848	0.089	0.900**	
	S/P	0.030	-0.022	-0.032	0.042	0.158	-0.050	0.126	
	S/PL	-0.024	-0.167	0.154	0.007	0.914	0.072	0.956**	
	SW	-0.023	-0.064	0.043	-0.006	0.192	0.341	0.483**	
Control	Genotypic variances of most of the traits including yield were zero or less than zero, hence, path and correlation coefficients could not be estimated.								

*, **- significance at $P_{0.05}$ and $P_{0.01}$ respectively.

Genotypic correlation coefficients of component traits with seed yield were computed from respective variance and covariance for individual character pairs (Robinson *et al.,* 1951). Genotypic correlations were partitioned into direct and indirect effects by path coefficient analysis as per Dewey and Lu (1959).

RESULTS AND DISCUSSION

Seed yield is an artifact, which is dependent on interrelated characters. Specific patterns of character association exist in populations and genotypes of crop plants. Each pattern of association is the combined effect of selection, genetic linkage and pleiotropy (Sakai and Suzuki, 1964). Character associations between yield components can be used as the best guide for successful yield improvement by indirect selection. In the present pursuit, comparative results obtained from different treated populations demonstrated mutable variations in degree of relationship between component traits with seed yield at different doses of treatments due to mutagenesis. Further, genotypic correlation coefficients of component traits with seed yield in M_2 were partitioned into direct and indirect effects.

Direct effects of yield components revealed seeds/plant followed by 100-seed weight to be the important factors for selection of seed yield in all treatments except 40kR gamma-rays + 0.2% EMS (Table 1). In the present pursuit, direct effect of seeds/plant and that of 100-seed weight on seed yield was highest in 0.03%NG and 0.02%NG respectively. In contrast, 40kR gamma-rays + 0.2% EMS had shown highest direct effect of number of pods followed by number of branches/plant on seed yield. Krarup (1983) observed pods/plant to have the highest direct effect on seed yield in a heterogeneous population of *Lathyrus sativus*. All the above traits except 100- seed weight had also very high genotypic correlation with seed yield in all mutagen treatments.

Existence of undesirable linkages involving yield attributes in the crop plants is common which hinder scope of genetic improvement for yield and its components resulting in genetic slippage (Dickerson, 1955) and limited genetic advance. Islam *et al*. (1989) reported seed size to have considerable direct effect but negatively correlated with seed yield. In normal population of a set of germplasm, 100-seed weight was reported to be the most limiting factor for selection of seed yield owing to its feeble association with plant height and seed yield, and negative association with all other component traits (Tripathy, 2005). However, various mutagenic treatments are reported to have role in weakening, strengthening, or altering character association in several crops (Borojevic, 1966; Amina *et al.,* 2015). In the present study, correlation of 100- seed weight with seed yield was significant and much enhanced in 70kR gamma-rays, 0.03% NG and 40 kR gamma-rays as compared to other mutagen treatments. This desirable change in plant architecture with altered and favourable manifestation, would certainly pave the way for increase in rate of selection response for seed yield. Besides, Sharma and Sharma (1981) in lentil and Birajdar (1982) in cowpea reported enhancement of positive correlation value due to mutagenesis.

Plant height had negative correlation with seed yield in 0.2% EMS and feeble positive association in 40kR gamma-rays + 0.01% NG. In addition, 0.02% NG and 40kR gamma-rays + 0.2% EMS had very high negative direct effect of plant height on seed yield. These mutagenised populations would provide a scope for selection of dwarf plant types coupled with high seed yield. 0.03%NG had very high positive indirect effect of number of branches and pods/plant through number of seeds/plant on yield while such estimates were shown to be very low and negative in 40kR gamma-ray + 0.2% EMS. Correlated response of number of branches/plant and pods/plant for seeds/plant could improve seed yield in these treatments.

The contribution of the residual effect revealed very low estimated value in all mutagenic treatments except 0.03% NG indicating validity of the analysis. In 0.03%NG, residual effect was shown to be 0.631 which envisaged that the independent component traits included in this pursuit explain only about 47% of the variability seed yield. The reason seems to be due to higher estimates of negative significant correlation of seeds/pod with grain yield. Besides, some other factors which have not been considered in the experiment, need to be included in the analysis to account fully for variation in seed yield.

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