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Correlation Studied on Several Quantitative Traits in Induced Mutagenic Population of Grasspea (*Lathyrus sativus* L.)

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A B S T R A C T

Seeds of three diverse genotypes of grasspea viz. Nirmal, Biol-212 and Berhampur Local treated with EMS (0.5% and 1%), gamma rays (400, 500 and 600 Gy) and in combination (400Gy+0.5% EMS and 400 Gy+1% EMS) were constituted as initial material for the present study. The experiment was conducted for 2012-15 winter seasons at District Seed Farm, BCKV, West Bengal, India. Correlation study was computed between yield and nine different yield components at different chemical concentration and radiation level in M_2 and M_3 generations. The correlation coefficient between seed yield per plant and its components were estimated at phenotypic level. The result revealed that all the characters showed significant and positive correlation with seed yield at different mutagenic treatment but not in all treatments however, 100 seed weight was positively correlated with seed yield at all mutagenic treatment in both generations (except 500 Gy treatment of Nirmal in M_2 generation) professing that 100-seed weight was vital yield improving character in all three varieties of lathyrus under study. Henceforth, it can be suggested that selection of plant for different yield improving characters will be more effective in combination treatments in case of grasspea varieties under studied as maximum significant and positive relationship between yield and its components were noted in combination treatments.

Introduction

The genus *Lathyrus*is large with 187 species and sub-species being recognized (Allkin *et al.*, 1983), out of which, four species viz. *Lathyrussativus*, *Lathyrusodoratus*, *Lathyrusochyrous* and *Lathyrusaphaca* are found in India. However, only *Lathyrus sativus* L. is the most commonly used for nutritional purposes, in the form of Seeds while, other species are cultivated to a lesser extent for both food and forage. The grasspea is endowed with many properties that combine to make it an attractive food crop in drought stricken, rain-fed areas where soil quality is poor and extreme environmental conditions prevail (Palmer *et al.*, 1989, Ali M. Abd El-Moneim *et al.*, 2000). Regardless of its tolerance to drought it has a very hardy and penetrating root system and therefore can be grown on a wide range of soil types, including very poor soil and heavy clays.

Apart from the above mentioned incontestable advantages, grasspea is also characterized by a number of less favourable features, such as strong lodging, indeterminate growth habit, or excessively long period till ripeness, as well as the presence of anti-nutritional substances (β-ODAP) in seeds (Rybiñski and Pokora, 2002) which render the crop unsuitable for human consumption if present in higher amount (Mandal *et al.*, 2015; Dixit *et al.*, 2016; Sarker *et al.*, 2017). Hence, one of the conditions for the introduction of the species to greater extent in Indian Agriculture is the genetic improvement of a number of unfavourable characteristics including yield. Since grasspea is self-pollinating crop and also exhibited inter specific incompatibility so its improvement through conventional breeding cannot be achieved exclusively. Induced mutagenesis thus seems to be an ideal methodology for the induction of desirable genetic variability and selection of several putative mutants.

Grain yield is the prime focus of any breeding programme including mutation breeding which is a complex and polygenic trait, highly influenced by many genetic factors and environmental fluctuations. Increase in yield is not the direct action of mutagen alone rather it also depends on other yield attributing interrelated characters hence direct selection for yield as such can be misleading. Therefore, knowledge of relationship between important yield traits and seed yield may help the researcher to identify suitable donors for a potential and successful breeding programme (Kumaresan and Nadrajan, 2002). In other words, character associations between yield components can be used as the best guide for successful yield improvement by indirect selection. The value of phenotypic and genotypic correlation provides the information about the relationship between the two or more than two independent variables. In plant breeding and genetics through correlation analysis of different traits can be valued. Knowledge with respect to association of various traits with seed yield would be of immense help in formulation of an effective and efficient selection and screening programme. Sufficient information regarding association among yield and yield components has already been reported in grasspea by various workers (Kumar and Dube, 2001; Parihar *et al.*, 2013; Kamadi *et al.*, 2015; Parihar *et al.*, 2015 and Kour and Agarwal, 2016), but very few information is available in case of induced mutants of grasspea.

The objective of the present study was conceived to investigate whether physical radiation and chemical mutagen disturbed the normal relationship or not between different yield attributing characters during mutagenesis programme. The present study was undertaken to find out the association between yield and yield components in M_2 and M_3 generations in three grasspea varieties so that the derived information would be helpful in developing appropriate selection methods and improving the economically important characters.

Materials and Methods

The field experiment was conducted for 2012-15 winter seasons at District Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India. The experimental site comes under the Gangetic plains of West Bengal, India at latitude 22°58´ N and longitude 88°32´ E with average altitude of 9.75 m above mean sea level (AMSL). BioL-212 is a somaclonal mutant of P-24 having lower ODAP content (<0.1%) but with longer duration and is poorly fitted in the cropping sequence of Coastal Bengal having short and mild winter. Nirmal variety, though adapted in grasspea growing areas for *utera* (relay) crop, was released long back in 1981 and has moderate ODAP content (0.2% or higher). The later genotype, Berhampore Local, is locally adapted in some parts of Murshidabad district of West Bengal but has very high ODAP content (>0.5%). Dry and healthy seeds of the three varieties were used to treated with physical (gamma ray) and chemical (EMS) mutagens.

The gamma radiation (400, 500 and 600 Gy) was given to 300 seeds for each treatment at UGC- DAE consortium for scientific research, Kolkata centre (South campus of Jadavpur University, Salt Lake, Kolkata). The source of gamma rays was ^{60}Co and the dose rate was 7.12 Gy/ minute. Similarly, same number of pre-soaked (9 h, in distilled water) seeds was treated with 0.5% and 1% ethyl methane sulphonate (Sigma Chemical Company, USA) for 6h at ±25°C. All solutions of the chemical mutagens were prepared in freshly prepared phosphate buffer having pH-7. For combination treatments, 300 seeds each were first irradiated with 400 Gy of gamma rays and then followed by the two EMS concentrations (0.5% and 1%). Subsequently the EMS treated seeds were thoroughly washed with running water for 1 hour before sowing to remove the residual effect of the chemical mutagen.

The treated seeds were sown immediately in the main field along with their respective controls in randomized block design (RBD) with three replications to raise the M_1 generation (2012-13). The M_2 generation (2013-14) was raised from the composite sample of 25 seeds obtained from each M_1 harvested plant of a treatment. In M_2 generation observations were recorded for nine agronomic characters namely plant height (cm), number of primary branches per plant, number of secondary branches per plans, number of pods per plant, number of seeds per pod, number of seeds per plant, 100-seed weight (g), fresh weight per plant (g) and pod length (cm). Based on yield and its component means ten plants were selected irrespective of treatments from each treatment. Seeds from selected M_2 progeny of each treatment were bulked by taking an equal amount of seeds from all M_2plants and mixed thoroughly. A random sample of this bulk was sown to obtain M_3 progeny during 2014-15. Observation for same agronomic character was taken during M_3 generation also. Treatment wise association analysis of all varieties individually for different morphological characters with seed yield per plant was estimated in M_2 and M_3 generation. Phenotypic correlation among various character pairs were calculated by the formulae suggested by Khan and Khanum (1994).

Results and Discussion

The correlation coefficient between seed yield per plant and its components in M_2 and M_3 generation were estimated at phenotypic level for variety Nirmal (Table 1), Biol-212 (Table 2) and Berhampur Local level (Table 3). Interestingly, mutant population exhibited change of relationship in all correlated characters. In most of the mutagenic treatment of all varieties, the correlations coefficient was found to be higher than the control. Seed yield per plant in all the three varieties showed significant positive and negative association with nine characters studied at different radiation level and chemical mutagen treatment in both M_1 and M_2 generations. However, control population for most of the character showed non-significant positive correlation with seed yield per plant in all the three varieties.

Non-significant negative correlation was noted for secondary branches per plant in both generations, pod length in M_3 generation in variety Nirmal; secondary branches per plant in both generation, plant height and primary branches per plant in M_2 generation and pod length in M_3 generation only in variety Biol-

212 and pod per plant, fresh weight per plant and pod length in both generation, primary branches per plant in M_3 generation and secondary branches per plant in M_2 generation only in variety Berhampur Local.

The results revealed that, seed yield per plant for a character associated significantly in different ways in M_2 and M_3 generation in all three varieties. For a character, some mutagenic treatments showed positive association in one generation and negative association in another generation, some were associated positively in both generation while only treatment 400 Gy in variety Berhampur Local exhibited significant negative correlation between secondary branches per plant and seed yield per plant in both generation (Table 3). Primary branches per plant (600 Gy and 400 Gy+1% EMS), secondary branches per plant (600 Gy and 400 Gy+0.5% EMS), number of seeds per pod (400 Gy+1% EMS), number of seeds per plant (600 Gy and 400 Gy+1% EMS) and 100 seed weight (0.5% EMS, 1% EMS, 600 Gy and 400 Gy+0.5% EMS) exhibited significant positive association with seed yield per plant in variety Nirmal in M_2 and M_3 generation both (Table 1).

In variety Biol-212, plant height (0.5% EMS and 400 Gy), primary branches (1% EMS), seed per pod (500 Gy and 400Gy+0.5% EMS), seed per plant (400Gy+0.5% EMS), fresh weight (400 Gy), 100 seed weight (0.5% EMS and 400 Gy) and pod length (0.5% EMS) showed significant and positive correlation with seed yield per plant in both M_2 and M_3 generations (Table 2). However, in variety Berhampur Local plant height (400 Gy+1% EMS), primary branches (1% EMS and 600 Gy), pods per plant (600 Gy), seeds per pod (400 Gy and 400 Gy+1% EMS), seeds per plant (600 Gy and 400 Gy+1% EMS), fresh weight (400 Gy+1% EMS), 100 seed weight (600 Gy and 400 Gy+1% EMS) and pod length (400 Gy+1% EMS) revealed significant positive association in both generation with seed yield per plant (Table 3). Selection at such treatment for respective character will be rewarding for improvement of seed yield. Apart from these fresh weights per plant with seed yield in 1% EMS treatment showed significant negative correlation in M_2 generation while it was positively correlated in M_3 generation in variety Nirmal. In 500 Gyradiation dose of variety Biol-212, primary branches per plant exhibited negative and positive association with seed yield in M_2 and M_3 generation respectively whereas, in case of secondary branches per plant in 600 Gy, the circumstance was reverse that is it was positively correlated in M_2 generation and negatively correlated in M_3 generation with seed yield. Hence selection for such characters at that treatment would not be effective for yield improvement.

Significant positive correlation of seed yield per plant with number of pods per plant in mutated population was also reported by Hassan *et al.,* (2005) in chickpea. On the other hand, the characters like plant height, pods per plant, primary branches per plant, seeds per pod and 100-seed weight showed highly significant positive correlation with yield per plant in twent ysix induced genetic variant lines of blackgram reported by Baisakh *et al.,* (2014). Senapati (2007) reported strong positive significant association of plant height, pods per plant, seeds per pod and 100-seed weight with yield at both phenotypic and genotypic levels in mutagenic population similar kind of significant positive association of different traits with yield were reported earlier by Vijayalakshmi *et al.,* (2000) in chickpea, Venkatesan *et al.,* (2004), Veeramani *et al.,* (2005) and Isha Praveen *et al.,* (2011) in blackgram in normal population.

Table.1 Correlation between seed yield and its components in M_2 and M_3 generation for variety Nirmal

Treatment	Plant height		Primary branches		Secondary branches		Pods per plant		Seeds per pod		Seeds per plant		Fresh weight		100 seed weight		Pod length	
	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3
Control	0.229	0.079	0.243	0.207	-0.378	-0.108	0.232	0.193	0.097	0.193	0.109	0.100	0.273	0.311	0.271	0.189	0.069	-0.227
0.5% EMS	0.052	0.234	0.288	0.311	0.018	0.258	0.424*	-0.170	0.133	-0.363	0.285	0.375	0.133	0.400*	0.465*	0.441*	-0.613**	-0.309
1% EMS	0.009	0.473*	-0.316	0.436*	0.259	0.433*	0.074	-0.008	-0.372	0.580**	0.203	0.675**	-0.542**	0.437*	0.440*	0.729**	-0.332	0.508**
400 Gy	0.228	-0.324	0.429*	0.086	-0.491*	-0.135	-0.182	0.398*	-0.633**	0.153	0.169	0.291	0.474*	-0.237	0.628**	0.194	0.300	-0.403*
500Gy	-0.418*	-0.053	0.139	0.108	-0.278	-0.173	0.320	0.287	0.127	0.371	0.399*	-0.208	0.219	0.206	-0.409*	-0.159	0.132	0.295
600 Gy	-0.232	-0.544**	0.632**	0.399*	0.463*	0.569**	0.446*	-2.970	0.716**	0.239	0.684**	0.457*	-0.142	0.088	0.708**	0.692**	-0.150	-0.174
400 Gy+0.5%EMS	-0.536**	0.093	0.498*	-0.119	0.648**	0.429*	0.400*	0.146	-0.379	0.431*	-0.260	0.061	-0.098	0.294	0.527**	0.493*	-0.518**	-0.191
400 Gy+1%EMS	0.227	0.382	0.552**	0.557**	0.236	0.307	-0.242	0.483*	0.584**	0.455*	0.718**	0.715**	0.388	0.529**	-0.208	0.389	0.088	0.397*

* Significant at 5% level, ** Significant at 1% level.

Table.2 Correlation between seed yield and its components in M_2 and M_3 generation for variety Biol-212

Treatment	Plant height		Primary branches		Secondary branches		Pods per plant		Seeds per pod		Seeds per plant		Fresh weight		100 seed weight		Pod length	
	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3
Control	-0.125	0.269	-0.155	0.128	-0.197	-0.270	0.231	0.209	0.085	0.266	0.182	0.161	0.063	0.166	0.165	0.194	0.163	-0.108
0.5% EMS	0.451*	0.449*	0.099	0.092	0.288	0.499*	0.308	0.327	0.285	0.444*	0.447*	0.341	-0.278	0.078	0.738**	0.591**	0.462*	0.466*
1% EMS	-0.559**	-0.259	0.396*	0.409*	-0.214	-0.292	-0.174	-0.098	-0.425*	-0.377	-0.097	0.010	-0.538**	0.295	0.407*	0.385	-0.306	0.272
400 Gy	0.563**	0.518**	0.264	0.588**	-0.174	0.594**	0.067	0.609**	-0.333	0.539**	-0.207	0.772**	0.441*	0.553**	0.533**	0.418*	-0.253	-0.435*
500Gy	-0.338	0.286	-0.414*	0.424*	-0.466*	0.390	0.182	0.401*	0.403*	0.399*	0.199	0.283	-0.079	0.433*	0.363	0.633**	0.094	0.358
600 Gy	0.338	-0.261	0.249	0.079	0.711**	-0.426*	0.284	-0.116	0.537**	0.153	0.488*	-0.234	0.420*	-0.340	0.675**	-0.137	-0.537**	0.065
400 Gy+0.5%EMS	-0.195	-0.351	-0.372	0.175	0.137	0.228	0.733**	0.253	0.749**	0.491*	0.793**	0.437*	-0.138	-0.410*	0.281	0.343	0.315	-0.398*
400 Gy+1%EMS	-0.086	-0.148	0.616**	-0.319	0.447*	0.205	0.492*	0.304	-0.164	-0.365	0.509**	-0.245	0.101	0.100	-0.076	0.491*	0.491*	0.395

* Significant at 5% level, ** Significant at 1% level.

Table.3 Correlation between seed yield and its components in M_2 and M_3 generation for variety Berhampur Local

Treatment	Plant height		Primary branches		Secondary branches		Pods per plant		Seeds per pod		Seeds per plant		Fresh weight		100 seed weight		Pod length	
	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3	M_2	M_3
Control	0.092	0.282	0.159	-0.137	-0.204	0.197	-0.131	-0.014	0.289	0.187	0.153	0.122	-0.334	-0.190	0.137	0.329	-0.329	-0.306
0.5% EMS	-0.202	0.437*	-0.197	-0.167	0.093	-0.224	0.169	0.230	-0.094	-0.255	0.119	-0.095	0.088	-0.128	0.461*	0.388	-0.156	-0.164
1% EMS	-0.374	-0.203	0.774**	0.398*	0.090	0.404*	0.083	-0.175	-0.221	0.251	-0.142	-0.148	0.208	0.094	0.377	0.428*	0.249	0.227
400 Gy	-0.413*	-0.293	0.114	0.090	-0.551**	-0.461*	0.404*	-0.403*	0.441*	0.466*	0.201	0.277	0.441*	-0.399*	-0.286	0.404*	-0.333	0.294
500Gy	0.212	0.366	-0.443*	0.307	0.148	0.439*	-0.158	0.243	0.296	0.191	0.209	0.599**	-0.118	0.368	0.228	0.558**	0.306	0.321
600 Gy	-0.714**	0.409*	0.531**	0.658**	0.633**	0.215	0.511**	0.582**	-0.482*	0.633**	0.529**	0.708**	0.377	0.341	0.711**	0.688**	0.156	-0.417*
400 Gy+0.5%EMS	-0.177	-0.089	0.319	0.255	0.426*	0.193	-0.094	0.359	-0.384	-0.446*	0.338	-0.203	-0.306	0.257	0.055	-0.386	-0.413*	-0.284
400 Gy+1%EMS	0.406*	0.722**	-0.287	0.481*	-0.241	-0.377	0.261	0.472*	0.559**	0.409*	0.641**	0.500*	0.568**	0.553**	0.566**	0.502*	0.493*	0.477*

* Significant at 5% level, ** Significant at 1% level.

However, Ahmad *et al.,* (2012) reported that plant height at maturity, cluster per plant and number of pods per plant had negative significant phenotypic correlation with seed yield per plant whereas number of branches per plant showed negative and insignificant phenotypic correlation with seed yield per plant in gamma rays irradiated population of mungbean. Among the correlated characters,seed yield per plant showed highest magnitude of positive correlation coefficient with100 seed weight (0.729) at 1% EMS treatment in variety Nirmal, number of seeds per plant (0.793) at 400 Gy+ 0.5% EMS in Biol-212 and number of primary branches per plant (0.774) at 1% EMS treatment in Berhampur Local agreeing that these characters at that particular treatment was most important yield contributing character in both normal and mutant populations of respective genotypes (Tables 1, 2 and 3). Similar significant positive correlation of yield per plant with number of pods per plant and fertile branches and 100 seed weight with yield per plant in mutagenic population were reported by Khan *et al.,* (2004) in greengram. Fascinatingly, 100 seed weight was positively correlated with seed yield per plant at all mutagenic treatment in both generations (except 500 Gy treatment of Nirmal in M_2 generation) professing that 100-seed weight was vital yield attributing character irrespective of mutagenic treatments in all three varieties of lathyrus under study. The result agrees with Amaranath *et al.,* (1990) and Singh and Singh (1999) reported positive correlation of 100-seed weight with total plant yield in soybean.

Combining all, affirmed plant height, fresh weight per plant and pod length were mostly associated negatively with yield per plant hence number of primary and secondary branches per plant, number of pods per plant, number of seeds per pod, number of seeds per plant, and 100 seed weight were found to be important yield contributing characters consistently in all mutant population. The results, consequently, inferred that 100-seed weight would like to produce significant correlated positive response to yield in all mutant population. Plant breeder always seeks minimum number of characters during selection procedure, which are effective in improving yield. Therefore, 100-seed weight should be considered as most important selection criteria for yield improvement in Lathyrus. Selection for plant having bold seed would obviously result in plant types with more seed yield. Along with pods per plant, number of branches per plant, number of seeds per podand number of seeds per plant was observed to be important yield components in the mutagen treated population. Though fresh weight per plant was mostly associated negatively with seed yield hence selection of plant with high fresh weight might be used for fodder purpose. Thus, restructuring or selection of plants with bold seed, more number of pods per plant, number of branches per plant, number of seeds per pod and number of seeds per plant would likely to aid in evolving varieties with high seed yield on the other hand selection of plant with high fresh weight resulting in development of high fodder yielding verities. Irrespective of different mutagenic treatments, maximum significant and strong positive association between different yield attributing character and yield per plant were noted in combination treatments. Hereafter, it can be suggested that selection of plant for different yield improving characters will be more effective in combination treatments of physical and chemical mutagens in case of Lathyrus varieties under studied.

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