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Original Research Article

Effect of Gamma Radiations on Growth, Yield and Quality Traits of Dolichos Bean (*Lablab purpureus* L.)

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Keywords

Lablab, Dolichos bean, Gamma radiation, Germination, Quality, Protein

A B S T R A C T

A study was carried out at Dr. PDKV, Akola during 2015-16 with the objective to evaluate the effect of gamma radiations on growth, yield and quality traits of cultivars Deepali and Konkan Bhushan of dolichos bean. The gamma radiation treatment on seeds was carried out at BARC, Trombay, Mumbai. In M_1 generation, treatments with 65kR had registered the minimum germination (62% in Deepali and 59% in Konkan Bhushan) and the LD_{50} was reported 51.2kR in Deepali and 48.6kR in Konkan Bhushan. The seeds procured from M_1 generation were sown in progeny rows to raise the M_2 generation according to the treatments (*viz.,* 25 kR, 35 kR, 45 kR and 55 kR) of both cultivars along with controls. All the treatments had shown a gradual variations among the different growth, yield and quality traits and expressed a decreasing pattern with increasing doses of gamma radiations except fibre content. Among all the treatments the maximum green pod yield (1560.80g and 866.15g) and seed yield (141.30g and 97.55g), protein content of pods (18.53% and 22.18%), chlorophyll-a (1.111mg/g and 1.480mg/g), chlorophyll-b (0.407mg/g and 0.457mg/g) and total chlorophyll content (1.518mg/g and 1.937mg/g) were recorded in 25kR and the germination was maximum in 35kR (90.00%) and 25kR (94.33%) in Deepali and Konkan Bhushan respectively. The fibre content of green pods and seeds was slightly increased at higher doses as compared to the lower doses and controls in both the cultivars.

Introduction

The dolichos bean (*Lablab purpureus* L.) belongs to the family Leguminoceae (Fabaceae). The chromosome number in genus *Lablab* varies, with 2n = 20, 22, 24 (Philip, 1982). It is one of the most ancient among the cultivated plants and is presently grown throughout the tropical regions of Asia, Africa and America (Purseglove, 1968 and Kay, 1979). The wild forms of *Lablab* are believed to have originated in India and it is also known as Indian bean lablab bean and hyacinth bean. Lablab bean is an important food source in Asia tropical Africa and being used as a grain legume and vegetable as well as for animal fodder and green manure in mixed crop-livestock systems. Dolichos bean is mainly grown for its green pods, while the dry seeds are used in various vegetable preparations. 100 g of green pods contain 6.7 g carbohydrates, 3.8 g proteins, 1.8 g fibre, 210 mg calcium, 68.0 mg phosphorus and 1.7 mg iron. It is one of the major sources of protein in the diet of South India. The *Lablab purpureus* leaf contains 21-38% of crude protein while the grain contains 20-28% (Norton 1982). The protein in *Lablab* has high levels of amino acids like lysine (6.2%) which is low in cereal grains. It can therefore play a major role in improving the diets of vulnerable rural communities in developing countries. Large proportion of Indian population relies on grain legumes as a dietary source of proteins due to economic or cultural reasons. The demand for food and feed is growing with increasing population, while natural resources are limited. The yield potential of crop plants has to be significantly increased to combat the increasing demand. Success of a crop improvement programme depends on the availability of large genetic variability, which a plant breeder can combine to generate new varieties. This variability is the outcome of naturally occurring mutations (Hazra and Som, 1999). In nature, Occurrence of natural variability in the form of spontaneous mutations is extremely low, which can be enhanced to several folds by using ionizing radiations or chemical mutagens. Induced mutagenesis has assumed an improvement role in plant breeding by increasing variability in plants. Gamma rays are the most energetic and penetrating form of electromagnetic radiation (Kovacs and Keresztes, 2002). Gamma radiation can be useful for the alteration of physiological characters. Gamma radiations have been reported to affect differentially the morphology, anatomy, biochemistry and physiology of plants (Ashraf *et al.*, 2003). Dolichos bean is a highly self-pollinated (cleistogamous) crop and naturally variability percentage is very low. Gamma rays have tremendous capacity to create variability (Chakraborthy and Parthasarathy, 2003). Hence, this experiment is framed out to create the variability in dolichos bean.

Materials and Methods

The present investigation was carried out at Chilli and Vegetable Research Unit, Department of Horticulture, Dr. PDKV, Akola during year 2015-16. The gamma radiation treatment on seeds of two cultivars Deepali and Konkan Bhushan was done at Bhabha Atomic Research Centre (BARC), Trombay, Mumbai.

The experiment on M_1 generation was laid out in the progeny rows as per the treatments (25, 35, 45, 55 and 65 kR) along with controls and the observations on seed germination and mortality of plants were used to calculate the LD_{50} for both cultivars.

$$\text{Germination (\%)} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

$$\text{Mortality (\%)} = \frac{\text{Number of plants failed to survive upto maturity}}{\text{Number of seeds germinated}} \times 100$$

Determination of LD_{50} by using Probit analysis and Finney's table (Finney, 1971)

$PT= (P_0-P_c)/100- P_c$ x100

The seeds procured from M_1 generation were sown in progeny rows to raise the M_2 generation according to the treatments (*viz.*, 25 kR, 35 kR, 45 kR and 55 kR) of both cultivars along with controls.

All necessary cultural operations *viz.*, hoeing, weeding, irrigation and plant protection practices were carried out during the growth period of crop. In field, observation on the growth and yield parameters (germination, mortality, green pod yield and seed yield per plant). Further analysis of chlorophyll, protein and fibre content was carried out in laboratory of Department of Horticulture. All the chemicals and equipments required for analysis was provided by the Department of Horticulture.

Chlorophyll content (mg/g)

The chlorophyll content of the leaves was estimated in percentage by using the DMSO (dimethyl sulphoxide solution) method suggested by Arnon, 1949. Determination of optical density was done by using spectro-photometer.

Total chlorophyll = (O.D at 652 nm x 100/34.5) x (V/100 x W)

Chlorophyll 'a' (mg/g fresh weight) = 12.7 (O.D. at 663) - 2.69 (O.D. at 645) x (V/1000 x W)

Chlorophyll 'b' (mg/g fresh weight) = 22.9 (O.D. at 645) - 4.68 (O.D. at 663) x (V/1000 x W)

Where,

O.D. = Optical density
V = Final volume i.e. 10 ml of DMSO
W = Weight of fresh leaves

Protein content (%)

The protein content estimated by determining total nitrogen content of green by adopting Micro-Kjeldahl's distillation method and the per cent protein was calculated by using following formula (AOAC-official methods of analysis, 1990).

Protein (%) = N (%) x 6.25

Results and Discussion

M_1 generation

Germination, mortality and LD_{50}

The disastrous decrease in germination percentage and increase in mortality was observed in M_1 generation with increasing doses of gamma radiations. The maximum germination percentage was in control treatments of both cultivars and the minimum (62% in Deepali and 59% in Konkan Bhushan) in 65 kR treatments (Table 1). The mortality rate increased linearly with increasing doses of gamma radiations, though the mortality percentage of Konkan Bhushan was higher than the Deepali. The maximum mortality percentage (74.19% in Deepali and 77.97% in Konakan Bhushan) was recorded in 65 kR treatment of both cultivars. The similar results were also obtained by Ahirwar *et al.,* (2014) and Lavanya *et al.,* (2017).

In the present investigation 55 kR and 65 kR treatments were found comparatively more lethal than the lower doses for both cultivars. The lethal doses (LD_{50}) determined by the Probit analysis were 51.2 kR for Deepali and 48.6 kR for Konkan Bhushan. The results of present investigation were also been supported earlier by Priya Ranjan Tah (2006) in mungbean, Kamau *et al.,* (2011) and Monica and Seetharaman (2014) in dolichos bean and Ariraman *et al.,* (2014) in pigeon pea.

M_2 generation

Germination

The seeds harvested from M_1 generation were passed through a germination test and all treatments has been registered a remarkable reduction in germination percentage in both cultivars compared to controls. In Deepali the minimum germination was recorded in 25 kR and the maximum was in 35 kR. While, in Konkan Bhushan it was minimum in 55 kR and maximum in 25 kR. The gradual reduction in germination might be due to the delayed the emergence of roots, reduction in vigour, low metabolic and enzymatic activity, losses in membrane integrity, which might leads to failure of germination induced by application of gamma radiations. The similar results have also been reported by earlier workers Kamau *et al.*, (2011) and Avinash (2013).

Pod and seed yield

The green pod yield per plant was decreased with increasing dose of gamma radiations in both cultivars. The maximum green pod yield was observed in 25 kR and the minimum in 55 kR of both cultivars. The seed yield per plant had shown a decreasing trend with increasing dose of radiations. The maximum seed yield was observed in 25 kR treatment and the minimum in 55 kR of both cultivars. This reduction in pod and seed yield in gamma radiation treated plants might be due to chromosomal damage and inhibition of mitotic activity of cells which brought down the rate of cell division which might be resulting into poor pod growth in both cultivars. Thus reduction in pod and seed yield per plant might be due to the reduction in number of pod per plant and number of seeds per pod. The findings of this experiment were also supported by Barshile *et al.*, (2006), Thilagavathi and Mullainathan (2011) and Avinash (2013).

Protein content (%)

The protein content of green pods was decreased significantly with increasing doses of gamma radiations and the maximum protein content was recorded in controls of both cultivars. Among the treatments of both cultivars the maximum protein content was observed on 25 kR (18.53% in Deepali and 22.18% in Konkan Bhushan) and the minimum was in 55 kR (16.68% in Deepali and 20.63% in Konkan Bhushan). All the radiation treatments had displayed a gradual variation in protein content than the controls. Reduction in protein content of pods of the gamma irradiated plants might be due to the reduction in rate of various physiological processes of the plant. Priya Ranjan Tah (2006) in mungbean and Abdelwhab *et al.*, (2009) in French bean also reported the significant reduction in protein content at higher doses of gamma radiation as compared to control treatment in mungbean.

Table.1 Effect of gamma radiation on germination percentage of Dolichos bean cultivars Deepali and Konkan Bhushan in M_1 generation

Treatments	Germination (%)					
	Control	25 kR	35 kR	45 kR	55 kR	65 kR
Deepali	98	86	82	75	71	62
Konkan Bhushan	98	89	81	76	69	59

Table.2 Effect of gamma radiations on mortality percentage and LD_{50} value of Dolichos bean cultivars Deepali and Konkan Bhushan in M_1 generation

Cultivars	Control		25 kR		35 kR		45 kR		55 kR		65 kR		LD_{50} (kR)
	P_c	PT	P_o	PT	P_o	PT	P_o	PT	P_o	PT	P_o	PT	
Deepali	2	2	22.09	18.09	28.05	24.05	37.33	33.33	52.11	48.11	74.19	70.19	51.2
Konkan Bhushan	3	3	15.73	9.73	24.69	18.69	40.79	34.79	55.07	49.07	77.97	71.97	48.6

P_0 = observed mortality percentage; P_c = control mortality percentage and PT = corrected mortality percentage.

Table.3 Effect of gamma radiation on yield and quality traits of cv. Deepali

Characters / Doses of gamma rays	Germination (%)	Green pod yield/plant (g)	Seed yield/plant (g)	Protein (%)	Fibre (%)	
					Green pods	Seeds
T_1 – 25 kR	87.33	1560.80**	141.30*	18.53**	13.82*	4.41*
T_2 – 35 kR	90.00	1493.90**	135.25**	18.37**	13.46**	4.38**
T_3 – 45 kR	89.33	1410.10**	129.80**	17.71**	13.95**	4.57**
T_4 – 55 kR	88.33	1291.20**	116.45**	16.68**	14.04**	4.62**
T_5 – Control	98.67	1631.97	146.83	18.80	13.88	4.43

* and ** significant at 5% and 1%

Table.4 Effect of gamma radiation on yield and quality traits of cv. Konkan Bhushan

Characters / Doses of gamma rays	Germination (%)	Green pod yield/plant (g)	Seed yield/plant (g)	Protein (%)	Fibre (%)	
					Green pods	Seeds
T_1 – 25 kR	94.33	866.15**	97.55**	22.18**	14.49*	4.72*
T_2 – 35 kR	92.67	839.70**	92.50**	21.90**	14.61*	4.77**
T_3 – 45 kR	87.33	808.90**	82.60**	21.29**	14.59**	4.74**
T_4 – 55 kR	86.67	785.85**	79.95**	20.63**	14.67**	4.80**
T_5 – Control	98.00	891.07	102.73	22.56	14.54	4.72

*and ** significant at 5% and 1%

Table.5 Effect of gamma radiation on chlorophyll content of leaf of cv. Deepali and Konkan Bhushan

Characters / Treatments	Deepali			Konkan Bhushan		
	Chlorophyll-a (mg/g)	Chlorophyll-b (mg/g)	Total chlorophyll (mg/g)	Chlorophyll-a (mg/g)	Chlorophyll-b (mg/g)	Total chlorophyll (mg/g)
T_1 – 25 kR	1.111	0.407	1.518	1.480*	0.457	1.937*
T_2 – 35 kR	1.073*	0.415	1.487*	1.452*	0.432*	1.884**
T_3 – 45 kR	1.061*	0.397	1.458*	1.435**	0.431	1.866**
T_4 – 55 kR	0.996**	0.376	1.371**	1.381*	0.398*	1.779*
T_5 – Control	1.155	0.416	1.571	1.526	0.463	1.989

*and ** significant at 5% and 1%

Fibre content (%)

As presented in Table 1 the fibre content had shown significantly a wide range of variability in both the cultivars with increasing doses of gamma radiations. In Deepali, the fibre content of pods was found increased with increasing doses and it was the maximum in 55kR and the minimum in 25kR. Whereas, in Konkan Bhushan the minimum fibre content in pods was registered in 25kR and the maximum in 55kR treatment. The fibre content of seeds was also increased with increasing doses of gamma radiations in Konkan Bhushan and it was observed the maximum in 55kR and minimum in control. While, in case of Deepali the fibre content had first expressed a depression and then increased at higher doses. It was observed the maximum in 55kR and the minimum in 35kR which was lower than the control. Bhat *et al.*, (2007) in velvet bean and Osman *et al.,* (2014) in faba bean have been also reported a remarkable variation in fibre content in gamma radiation treatments.

Chlorophyll content (mg/g)

Both the cultivars had shown a gradual variation in chlorophyll content of both cultivars as compared to the controls and chlorophyll-a, chlorophyll-b and total chlorophyll was found reduced with increasing doses of gamma radiations (Table 5).

The maximum chlorophyll content (chlorophyll-a, chlorophyll-b and total chlorophyll) was observed in the controls of both cultivars. Among the gamma radiation treatments the maximum chlorophyll content was observed in 25kR and the minimum was in 55kR in both cultivars. This remarkable reduction in chlorophyll content of leaves of the gamma irradiated plants might be due to the reduction in rate of various physiological processes of the plant. Similarly the earlier workers Sinha and Himanshu (1984) in dolichos bean, cowpea, French bean and lima bean. Gnanamurthy and Dhanavel (2014) in cowpea also recorded the reduction in chlorophyll content with increased dose of gamma radiation as compared to controls.

The gamma radiations had induced a remarkable range of variation among all the growth, yield and quality parameters of both cultivars of dolichos bean. The lethal dose (LD_{50}) was recorded 51.2 kR for Deepali and 48.6 kR for Konkan Bhushan in M_1 generation. In M_2 generation the maximum green pod yield and seed yield, protein content of pods, chlorophyll-a, chlorophyll-b and total chlorophyll content were recorded in 25kR in both cultivars and the germination was maximum in 35kR and 25kR in Deepali and Konkan Bhushan respectively. The fibre content of green pods and seeds was slightly increased at higher doses. The higher doses had induced wide range of variations as compared to lower doses of gamma radiations.

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