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Studies on the Effect of X-Irradiation on *Cyamopsis tetragonoloba* (L.) Taub

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Effect of X-rays on certain morphological and physiological variabilities in *Cyamopsis tetragonoloba* (guar) was studied for two generations. Germination percentage decreased linearly with increase in the dose rate. Stimulatory effect on seedling length and plant height was noticed in 10 kR treatment. However at higher doses gradual decrease in seedling length and plant height was noticed, this was accompanied by decrease in amylase and increase in peroxidase activity. Early flowering was induced at 10 and 20 kR treatments, flowering was delayed at higher doses. Yield attributes like number of pods per plant, number of seeds per pod and 100 seed weight increased at lower doses and decreased linearly.

The second generation studies revealed similar results as in the first generation. However, in some cases the inhibitory effect of X-rays was overcome to some extent.

Key Words: X-Rays, Germination percentage, Seedling length, Enzyme activities, Yield attributes, 'Guar'

Introduction

Radiations have played a significant role in biological studies.

A review of literature reveals that guar *(Cyamopsis tetragonoloba)* has received little attention by researchers particularly from the point of view of mutagenesis. Improvement in guar so far brought about in India is only through selection in local stocks. Radiation induced studies on this species are meagre. Singh and Chowdhury (1972) studied the effect of gamma rays. Singh et al. (1975) reported meiotic abnormalities after gamma irradiation in this species. The present work is carried on with a view to study the effect of X-rays on various morphological and physiological variabilities in this species with particular reference to yield components.

Material and Methods

Certified seed material of *Cyamopsis tetragonoloba* var. Pusanavbahar was obtained from National Seeds Corporation of India, Warangal Branch. The seeds were selfed once for the genetic purity.

The seeds obtained from these inbred lines were used for the various investigations in the present study. The dry seeds were subjected to X-irradiation at M.G.M. Hospital, Warangal, Andhra Pradesh. For each treatment of the radiation including the controls 200 seeds were used, 150 seeds were sown in three replicates in a well prepared field. The remaining 50 seeds in each treatment were soaked in tap water for 6 hours and then transferred to sterilized Petri dishes lined with moist Whatmann No. 1 filter paper in order to study the effect of different X-irradiation doses on the germination, growth and enzyme activities of the seedlings. Amylase and Peroxidase activities were studied after 48 hours of growth, following the method of Mehta et al. (1975) and George (1953) respectively. Plant height has been taken when the plants were 50 days old. Data was statistically analysed wherever necessary.

Results and Discussion

Germination Percentage

Germination percentage decreased linearly with increasing dose rate. Maximum mortality of the seeds was seen in 60 kR treatment (52%). Sinha and Sinha (1977) observed damaging effects of X-rays on germination and survival of R_1 plants in *Coriandrum sativum*. According to Gaul (1964) M_1 damage by radiations may be due to damage of genetic and non-genetic targets (Physiological damage). The second generation results were inconsistent with those of the first generation, the inhibitory effect on germination was found to be more pronounced in the M_2 than in M_1 generation at 60 kR doses. This may be explained because of the smaller seeds with reduced weight (indicating less vigour) obtained due to 60 kR treatment.

Seedling Length

Slight stimulatory effect was noticed in the 10 kR treatments. From 20 kR onwards, there was a gradual reduction in the seedling length. Increase in the seedling length following lower doses of X-rays (5 kR) has been reported by Rao and Rao (1980) in Okra. Growth stimulation arising as after effects of radiation may be due to increased growth by cell expansion with cell division proceeding at the usual rate. Such a behaviour has been described in maize by Schwartz and Bay (1954). However, the higher doses of X-rays decreased the seedling length. Woodwell and Miller (1963) opined that reduction in the growth following radiation was due to reduced auxin production in terminal meristem, resulting in the suppression of the growth. It is quite likely that metabolic disorders due to the cellular damage to the shoot meristem and also the chromosomal damage caused by the ionizing radiations are jointly responsible for suppression of the growth of seedlings. Similar observations have also been made by Gaul (1964). In the second generation too there was reduction in the seedling length with increase in the dose rate the inhibition being more than in the first generation.

Enzyme Activities

Activity of the enzyme amylase increased slightly in 10 kR treatment. Similar increase in amylase activity at lower doses of irradiation has been reported by Mehta et al. 1975). From 20 kR onwards, a linear decrease in the amylase activity was noticed accompanied by decrease in the seedling growth. Nilovao (1936) has reported that X-ray irradiation of sprouting barley seeds caused reduction in amylase activity which influenced growth in reductional way.

Table 1 *Effect of X-rays on* Cyamopsis tetragonoloba *M_1 Generation*

Parameters	Dose rate in kR						
	0	10	20	30	40	50	60
Germination percentage	81.25	78.00+	74.46*	70.21*	67.21*	63.82*	60.00*
Seedling length (one week old) in cms	14.51 ±0.43	16.90* ±0.43	14.28+ ±0.37	13.21+ ±0.36	12.05* ±0.47	10.84* ±0.24	9.25* ±0.26
Amylase activity†	32.6 ±0.15	50.6* ±0.20	30.4+ ±0.16	26.2** ±0.12	22.5* ±0.14	18.6* ±0.10	15.2* ±0.10
Peroxidase activity††	0.64	0.42	0.64	0.68	0.72	0.86	1.20
Plant height (50 days old) in cms.	38.51 ±0.95	43.62* ±1.27	40.20* ±0.99	38.20+ ±1.01	36.25+ ±1.08	33.61* ±0.89	31.80* ±0.99
Average number of days required for flowering	28.60 ±0.84	24.62* ±1.26	22.80* ±1.34	26.51+ ±0.92	30.82+ ±0.86	32.61* ±0.75	34.24* ±1.26
Percentage of pollen viability	86.46	82.52	78.54	76.42	72.62	68.58	60.21
Number of pods per plant	36.50 ±1.71	44.70* ±0.52	40.60* ±0.87	37.78+ ±0.92	34.00+ ±0.68	32.60* ±0.87	28.20* ±1.13
Number of seeds per pod	10.52 ±0.16	11.25+ ±0.24	11.08+ ±0.26	10.46+ ±0.16	8.40** ±0.12	7.62* ±0.14	6.14* ±0.20
100 seed weight in gms	4.860 ±0.52	5.620* ±0.58	5.480** ±0.64	5.220+ ±0.60	4.530+ ±0.42	4.420+ ±0.38	4.240* ±0.36

* Significant at 1% level, ** Significant at 5% level, +Not significant † Amylase activity expressed as mg starch hydrolysed /g fresh weight of tissue; †† Peroxidase activity expressed as absorbance/min/g weight of tissue

In the present investigations the reduction in the growth of the seedlings at higher doses of X-rays may be attributed to decreased amylase activity, which in turn effects the hydrolysis of starch into sugar, needed for proper growth of the seedlings.

A marked increase in the peroxidase activity was noticed at higher doses of radiation which was accompanied by reduced seedling growth. Peroxidase is considered to be growth inhibitor in plants (Maccune 1961). Ram et al. (1977) reported that morphactin treatment of *Phaseolus radiatus* increased the peroxidase activity and decreased the seedling height. Increased peroxidase activity might oxidise IAA resulting in low IAA levels, thereby causing decreased amylase activity which in turn results in reduced seedling growth (Ram et al. 1977). In the present investigation also reduction in the seedling growth observed at higher doses, may be attributed to the increased peroxidase activity. The second generation results are inconsistant with the first generation, though the inhibition effect was slightly overcome.

Plant Height

Increase in the plant height was noticed in 10 and 20 kR treatments. From 30 kR onwards, gradual reduction in the plant height was noticed, with increase in the dose rate. Sastry and Ramaiah (1961) observed that irradiation with X-rays markedly reduced the height of the plants in rice. Gunckel (1957 and 1965) in his review on the morphological effects of ionizing radiations has stated that the possible influence of phytohormones and other physiological disturbances associated with cytological change is the reason for the stunted growth of plants. Err (1955) indicated that chromosomes may be the primary site of damage in seeds and that this can be expressed at the metabolic level before it can effect morphology or growth. Stimulatory effect in 10 kR treatment was noticed as in the first generation, however, the plant height was more when compared with that of the first generation result. A linear decrease in the plant height was noticed with an increase in the dose rate, as was seen in the first generation.

Flowering

Flowering is a decisive stage in plant life and it attracts scientists attention because it precedes fruiting and the yielding ability of crops. Hence, in the present investigation the effect of X-rays was investigated on flowering time. It was noticed that the lower doses of X-ray treatment resulted in early flowering. Early flowering following 10 kR X-rays treatment has been reported by Rao and Rao (1980) in *Abelmoschus esculentus.* Biaanchi (1963) observed delayed flowering following irradiation in tomato and attributed it to the delay in the initiation of germination and growth. Delay in flowering observed during the present study may be associated with delay in germination and reduced growth rate observed in many plants at the higher doses. In the second generation the inhibitory effect at higher doses was somewhat diluted though delay in the flowering was noticed; it was less when compared with the first generation results.

Yield Components

Data on important yield components like number of pods per plant, number of seeds per pod and 100 seed weight shows that these components increased in the lower doses of X-irradiation and

decreased linearly as the dose rate increased.

Increase in the number of fruits per plant at lower doses of X-irradiation has been reported by Khanna and Singh (1971) in opium poppy. Considerable increase in the mean number of fruits per plant in *Lycopersicon esculentum* and *Capsicum annum* was reported by Subhash (1976), at lower doses of X-irradiation. Reduction in the yield following higher doses of irradiation, as in the present investigation, has been reported in *Lens culinaris* (Sinha & Godword 1972).

Reduction in the yield in M_1 generation is attributed to radiation induced structural changes involving translocations, inversions and deletions (Caldecott et al. 1954) Sato and Gaul (1967) suggested inbalanced genomic constitution of micro/megaspore to be the possible reason for reduction in yield. Ramulu (1970) based on his studies on *Sorgham* using gamma rays, attributed the causes for reduction in the yield in M_1 plants to be due to reduced pollen fertility. In the present study higher frequencies of pollen sterility were observed at higher doses this might have resulted in low yield. At higher doses it was noticed that a large number of ovules were abortive (nearly 60%) and did not develop into seeds, resulting in low seed setting.

Increase in the yield attributes was noticed in the lower doses as in the first generation. Though the higher doses had inhibitory effect on these parameters it was not so much as noticed in the first generation.

A plant with branches and more number of pods (64) when combined with controls (3.64) was obtained at 10 kR treatment. This plant flowered 8 days earlier than controls and bread true in the second and third generations. Studies on subsequent generations are in progress.

Conclusion

Variability with regard to height of the plant, flowering and yield attributes in the positive directions can be induced by low doses of X-rays, by proper selection and breeding can contribute towards obtaining high yielding varieties in this species.

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