Research Article

Gamma Radiation Effects on some Growth Patterns in Hedge Lucerne (*Desmanthus virgatus* L.)

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Abstract
Seeds of Hedge lucerne (*Desmanthus virgatus*) were exposed to different doses (50 to 500 Gys, with an interval of 50 Gys) of gamma rays (Cobalt-60) to determine the effectiveness of different doses on growth behaviour and biomass characteristics. The lethal dose (LD_{50}) was found to be 250 Gys. About thirty five mutants were identified. High biomass yielding dwarf statured plants were identified from the treatments of 350 and 500 Gys irradiation. Similarly high fodder yielding superior plants as a result of increased number of branches ranging from 22-34 were observed in 400 and 450 Gys population when compared to the control (12-16 branches). Plants of bushy stature with shorter intenodal length (2.25 cm) when compared to control (3.75 cm) were found among the 450 Gys population. Prostrate types were also identified among the 50, 350, 400 and 500 Gys population suited for grazing pastures. Based on single plant performance, plants which record high biomass will be identified and M_1 seeds will be collected and studied in further generations.

Keywords :
Desmanthus, gamma rays, biomass, shoot inter node

Introduction

Despite India supports 20 percent of the world's cattle population, there is a wide gap between demand and supply of meat, milk, wool and other animal products. The low productivity of our animals is due to the reason that they are not fed with sufficient quantity of nutritious food. About 20-25 percent reduction in the cost of production of milk can be brought about by feeding the animal with green fodder. Fodder legumes play an important role in the dairy cattle nutrition. They are superior to grasses in terms of quality protein content. They are rich in proteins and minerals like Calcium and Phosphorus in an amount almost twice than that of grasses and these proteins and minerals are required in optimum quantities for sustainable milk production. Fodder legumes improve the quality of fodder when mixed with non-leguminous fodder by an increase in crude protein content.

Desmanthus virgatus commonly known as hedge Lucerne is an introduction from Thailand. Since the time of introduction in the year 1976 in Tamil Nadu, intensive research efforts were made and it was identified as a valuable and highly nutritious legume fodder. It belongs to the tribe Mimoseae of the subfamily Mimosoideae under the family Leguminosae. It is a perennial shrub which withstands repeated cuttings and regenerates quickly. It is suitable for cultivation in all types of soils and seasons alike. Hedge Lucerne being an important forage legume crop, faces problem in hybridization due to the small sized florets. Hence creating variation in a significant level is a challenging task. This species also has problems in seed dormancy and germinability.

Mutation breeding is one of the conventional breeding methods in plant breeding. It is relevant with various fields like, morphology, cytogenetics, biotechnology and molecular biology. Mutation breeding has become increasingly popular in recent times as an effective tool for crop improvement and an efficient means supplementing existing germplasm for cultivar improvement in breeding programmes. Shah *et al.* (2008) reported that mutagens may cause genetic changes in an organism, break the linkages and produce many new promising traits for the improvement of crop plants.

Gamma rays are known to influence plant growth and development by inducing cytological, genetical, biochemical, physiological and

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morphogenetic changes in cells and tissues (Gunckel and Sparrow 1961). Several positive mutations have been created in agricultural crops by using gamma irradiations. Crops with improved characteristics have successfully been developed by mutagenic inductions (Rehman *et al.,* 1987; Javed *et al*., 2000). Gustaffson *et al. (*1971) developed a high yielding barley variety with early maturity, high protein contents and stiff straw by mutation breeding techniques. In the present study also, the seeds of *Desmanthus* were irradiated with gamma rays to assess the effectiveness of different doses on growth behaviour and yield traits.

Materials and Methods

The present study is conducted in the New area, Department of Forage Crops, TamilNadu Agricultural University, Coimbatore. The seeds of *Desmanthus virgatus* cv TNDV-1 was employed as experimental material for the present study. Seeds were presoaked for 12 hours and sun dried. Well filled, hand picked, uniform sized and dry seeds with a moisture percentage of 10-12 percent were chosen. A total of 100 seeds were packed in paper covers per treatment and were irradiated with different doses of gamma rays *viz.* 50 to 500 Gys at an interval of 50 Gys at the ^{60}Co gamma chamber 1200. Irradiated seeds along with control (parental variety), were raised in randomized block design for further evaluation. All the treated seeds including the control were sown adopting a spacing of 75 cm in between rows and 45 cm in between plants. All the recommended cultural measures namely, irrigation, weeding and plant protection methods were carried out during the growth period of the crop. Data on growth parameters such as days to germination, days to completion of germination, germination percentage, survival percentage, shoot length, number of leaves and number of primary branches were recorded and analysed.

Results and Discussion

Germination and survival percentage

Days to initiation of germination and days to completion of germination (mean germination time) were significantly delayed by higher doses of gamma irradiation (Fig.1). Delay in germination may be due to be inhibitory effects of gamma rays on seed dormancy. Similar results were reported by Din *et al*., (2003) in *Triticum aestivum* L. Increase in higher germination percentage at higher doses might be due to their stimulating effects on activating RNA synthesis or protein synthesis (Kuzin *et al*., 1975) or it could be due to the elimination of germinating bacterial populations, their spores and mould fungi (Gruner *et al.,* 1992).

Higher doses of gamma rays significantly increased days to germination and days to completion of germination and recorded maximum at 500 Gys. High germination percentage was noted at 450 and 500 Gys. This would be a positive outcome to obtain a uniform crop stand from the optimum seed rate, thereby contributing to high biomass yield at lesser input.

The reduction in germination percent due to gamma rays may be attributed to a drop in the auxin level (Gordon and Webber, 1955) or chromosomal aberrations as reported by Sparrow (1961). A characteristic effect of irradiation in dicot seems to be that the affected seedlings, after the emergence of cotyledonary leaves, remain alive in the critical stage for a considerably long time (Dubinin, 1961). During this phase, there is some type of repair or compromise that enable the seedlings to form side shoots from the unaffected cells after the primary shoots die or the intra-somatic or diplontic selection operates and unwanted cells and other disturbances detrimental to the plants are eliminated.

Morphological attributes

The following mutants were identified with different morphological attributes from the parent/ control (Fig. 2).

Primary branches

Some mutants were identified with higher number of primary branches when compared to the parent. Mutants identified from the 400 Gys population showed 22-24 branches and mutants in 450 Gys population showed 28-34 branches when compared to the parent which produced 12-16 branches (Fig. 3).

The increase in the biomass yield is primarily indicated by the increase in the number of primary branches which was noted among the 400 and 450 Gys population. The increased number of primary branches along with increased number of leaflets possess a selection advantage for high biomass yield.

The parent had medium sized branches whereas the identified mutants had branches which ranged from short (28 cm) in the 100 and 200 Gys population to very long (74 cm) in the 400 and 450 Gys population.

Shoot length

Seeds exposed to higher doses produced dwarf plants. This inhibitory effect of gamma rays on shoot length of plants was more pronounced in the 450 and 500 Gys population. Shakoor *et al*., (1978) and Khalil *et al.,* (1986) attributed decreased shoot lengths at higher doses of gamma rays to reduced mitotic activity in meristematic tissues and reduced moisture contents in seeds respectively.

Dwarf mutant

Dwarf mutants with 28-39 erect sturdy branches were observed among the 350, 450 and 500 Gys population (Fig. 4). Some mutants with bushy stature and shorter internodal length of 2.25 cm were also identified among the 450 Gys population when compared to control with internodal length of 3.75 cm (Fig. 5).

The dwarf mutant that was identified may possess the advantage of lodging resistance due to their short basal branches. Dwarfness can also be utilized for high density planting, thereby improving the land use efficiency. The bushy mutant with lesser internodal length will yield high biomass. The tall mutant can be used as live fence or as hedges.

Tall mtant

A distinguishing tall mutant (178 cm) against the control measuring 106 cm, was identified in the 400 Gys population with wide spaced branches and thick stem.

Leaf mutants

There was a significant variation in the number of leaflets among the 150, 200, 300, 350, 450 and 500 Gys population when compared to the parent (Fig. 6). A mutant was observed in the 450 Gys population with variation having dark green coloured and smooth textured leaflets with nine pinnae as against seven pinnae in the control (Fig. 7).

Plants with increased number of leaflets may have high biomass yield advantage over the control with lesser number of leaflets. It implies high leaf area index which may result in higher photosynthetic rate. The rough texture of leaves may serve as an escape mechanism from leaf feeding insects. Mutants with dark green leaves will be more efficient in photosynthetic activities due to increase in the chlorophyll pigments. The smooth textured leaves will also increase the palatability.

Leaf textures ranged from smooth to slightly rough among the mutants. Colour of the leaflets also varied from light green to dark green.

Pigmentation

The parent had no pigmentation in the leaflets, stem and peduncles. However mutants in the 400 Gys population were found with pigmentation on the leaflets, stem and peduncles (Fig. 8). The presence of anthocyanin pigment on the stem and peduncles may confer selection advantage on such plant as it may likely exhibit better level of insect tolerance.

Prostrate type

Mutants of prostrate and spreading type were identified among the 50, 350, 400 and 500 Gys population which spread over an area of about 1.75 – 2.25 m^2 when compared to control which covered an area of 0.85 m^2 only (Fig. 9). The plants with spreading behaviour possess rough textured leaves which serve as an escape mechanism from drought by way of reducing transpiration. These plants also possess widely spread branches which have pigmentation on them which provides better tolerance to insect pests. The branches are oriented radially in all directions so as to provide a uniform spreading pattern on all sides.

The prostrate plants covered an area of nearly 1.75 to 2.25 m^2, for which 20-25 plants are enough to cover one cent area of waste land in regions with poor irrigation conditions. Being drought tolerant and hardy in nature, prostrate types would be valued for the production of palatable forage and intermittent grazing during drought periods in the tropics. Prostrate types would also be of great value in arresting soil erosion in dry lands as well as steep, arid and areas with insufficient soil depth with its hair like roots. The fibrous roots bind to the soil and prevent the top soil erosion by floods, heavy wind or rains.

Conclusion

Significant morphological variabilities was created among mutants of *Desmanthus* using gamma irradiation. The identified mutants show useful agronomic traits capable of conferring on them selection advantage for increased biomass yield and highly palatable fodder. There is therefore possibility for further improvement in hedge lucerne through induced mutations.

References

Din R., M.M. Khan., M. Qasim S. Jehan and M.M.I. Khan. 2003. Induced Mutability Studies in Three heat (*Triticum aestivum* L.) Varieties for Some Morphological and Agronomic Characteristics. Asian J. Plant Sci. 17(2): 1179-1182.

Dubinin, N.P., 1961. Problems of radiation genetics. Oliver and Boyd, London.

Gruner M., M. Horvatic D. Kujundzic and B. Magdalenic. 1992. Effect of gamma irradiation on the lipid components of soy protein products. Nahrung. 36: 443-450.

Gunckel, J.E. and A.H. Sparrow 1961. Ionizing radiation: Biochemical, Physiological andMorphological aspects of their effects on plants. In: Encycl. Plant Physiol. (ed.) W. Ruhland. XVI: pp. 555-611, Springer-verlag, Berlin.

Gustafsson A., A. Hagberg G. Persson and K. Wikland 1971. Induced mutation and barley improvement. Theoretical Appl. Gene. 41: 239-48.

Javed M.A., A. Khatri I.A. Khan, M. Ahmad, M.A. Siddiqui and A.G. Arain. 2000. Utilization of gamma irradiation for the genetics improvement of oriental mustard (*Brassica juncea* Coss.). Pak. J. Bot. 32: 77-83.

Kuzin A.M., M.E. Vagabova and V.N. Prinak-Mirolyubov. 1975. Molecular mechanisms of the stimulating effect of ionizing radiation on seed Activation of RNA synthesis. Radiobiologiya. 15: 747-750.

Rehman A., M.L. Das M.A.R. Howlidar and M.A. Mansur. 1987. Promising mutants in *Brassica campestris*. Mut. Breed. Newsletter. 29: 14-15.

Shah, T.M., J.I. Mirza, M.A. Haq and B.M. Atta, 2008. Induced genetic variability in chickpea (*Cicer arietinum L.*). II. Comparative mutagenic effectiveness and efficincy of physical and chemical mutagens. Pak. J. Bot., 40 (2): 605-613.

Sparrow, A.H., 1961. In: Mutation and Plant Breeding. National Academy of Sciences, Nat. Res. Council Publ. Washington D.C., 892: 55-119.

Fig. 1 Germination and Survival percentage of the treated population

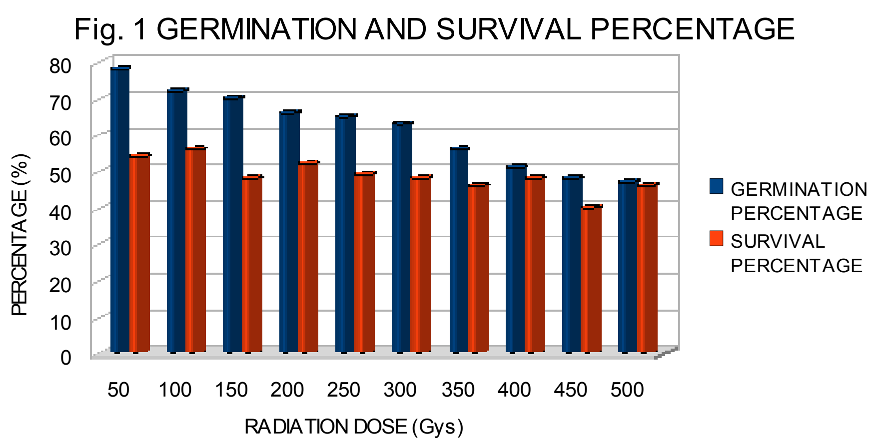

Fig.2 Control (Untreated plant)

Fig. 3 Plant showing maximum number of primary branches (34 branches)

Fig. 4 Dwarf mutant (83 cm)

Fig. 5 Plant showing high biomass characteristics with enormous branching and lesser internodal length (2.25 cm)

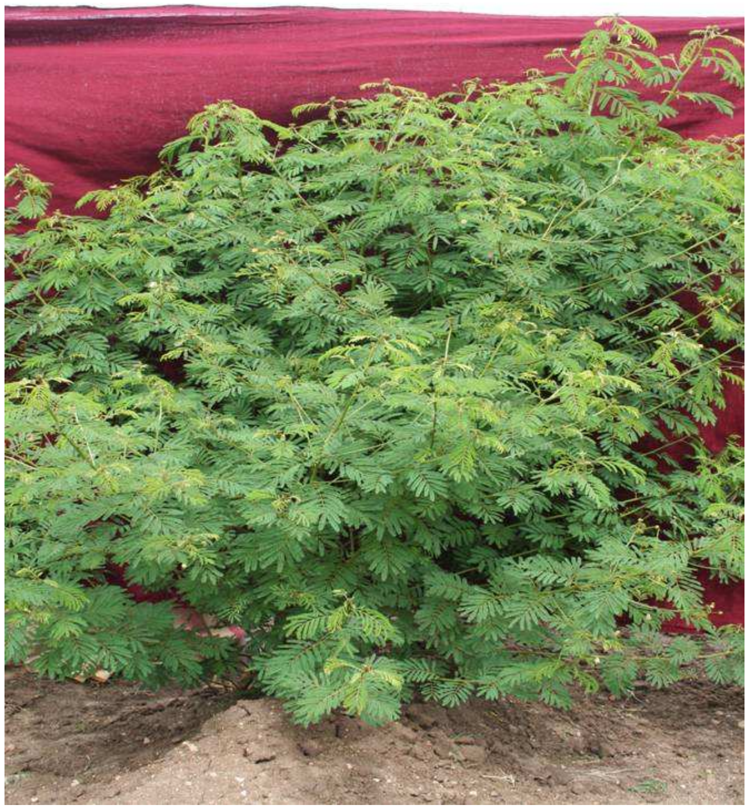

Fig. 6 Leaflets showing variation in the number of pairs of pinnae – 3 (150 Gys), 4 (200 Gys), 5 (300 & 350 Gys),6 (control),7 (500 Gys), 9 (450 Gys)

Fig. 7 Leaflet with 7 pinnae pairs (control) and 9 pinnae pairs (450 Gys)

Fig. 8 Stem without (control) and with (400 Gys) pigmentation

Fig. 9 Prostrate type covering an area of 2.25 m^2