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Studies on growth parameters and fresh pod yield in M_5 generation mutants of dolichos bean [*Lablab purpureus* var. *lignosus* (L.) Prain]

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Abstract
The study, conducted in the Rayalaseema region of Andhra Pradesh in 2022, involved the evaluation of 17 elite mutants generated through gamma irradiation of the TFB-2 field bean variety. These mutants were assessed alongside the parent variety, which served as the control group. The research employed a randomized block design, incorporating 18 different treatment combinations, each replicated twice. The findings revealed that $M_{5.16}$ exhibited the greatest plant height, while $M_{5.18}$ displayed an increased number of branches per plant. In contrast, $M_{5.17}$ exhibited a reduced time to flowering, and $M_{5.18}$ had the shortest duration to reach 50% flowering. Additionally, $M_{5.3}$ showed the shortest time for the initial pod set. Notably, mutant $M_{5.17}$ exhibited the highest fresh pod yield among the evaluated mutants.

Keywords: Mutants and gamma irradiation

Introduction
Field beans stand as one of the oldest cultivated legume species, potentially tracing their roots back more than 3,000 years. This versatile legume crop serves a dual purpose, with its fresh pods being harvested as a vegetable, while its dry seeds are collected for use as a pulse (Ramesh and Byregowda. 2016) [10], making it a valuable addition to diets. Known as the "carpet legume," field beans are recognized for their remarkable ability to create a dense and protective vegetative covering on the ground, contributing to soil health and weed control. Additionally, they have earned the moniker "poor people's meat" owing to their inherent richness in proteins, fibers, lipids, carbohydrates, and essential minerals, making them an essential and nutritious food source for many communities around the world.

Dolichos bean, scientifically known as *Lablab purpureus* var. *lignosus* (L.) Prain, belongs to the Fabaceae family and possesses a chromosome number of 2n=22. In India, this bean variety is prominently cultivated in the southern, eastern, and north-eastern regions of the country. It is primarily grown as a rainfed crop in Andhra Pradesh and neighbouring districts of Karnataka, Tamil Nadu, and Maharashtra.

Dolichos bean holds significant importance in the South Indian diet as it serves as a major source of protein. Moreover, it has versatile uses, serving as a vegetable, pulse, fodder, green manure, cover crop, medicinal plant, and even an ornamental crop (Dewangan *et al*., 2018) [5].

Lablab purpureus is a self-fertilizing plant, which means it tends to have limited genetic diversity naturally. This can be a challenge when trying to improve the crop. To address this issue, mutation breeding using radiation has proven to be a valuable tool for introducing specific desirable agronomic traits.

Mutagens like Gamma rays, Ethyl methane sulphonate, and X-rays have been recognized for their ability to induce various changes in plant growth and development, including cytological, genetic, biochemical, and physiological alterations (Girija and Danavel, 2009) [6]. Among these mutagens, Gamma radiation stands out as an effective agent for generating genetic diversity. Gamma rays are a type of electromagnetic ionizing radiation with a high penetration frequency (1019 Hz). They are harnessed as physical mutagens and have demonstrated their effectiveness in inducing novel characteristics in a wide range of agricultural plants (Yasmin and Arulbalachandran, 2022) [14]. The main objective of this study is to evaluate the extent of genetic variability introduced and investigate the correlation between pod yield and related traits in the M_5 generation. The aim is to pinpoint and choose top-performing and superior mutants within the selected field bean variety, TFB-2.

Materials and Methods

In the context of the current study, around 17 morphological variants that exhibited enhanced primary branch count, elevated pod yield, and increased seed yield per plant were pinpointed within the M_4 generation and were employed to establish the M_5 generation. These selected variants constituted the experimental material for the present investigation in randomized block design with 18 different treatment combinations, and each treatment was replicated twice in the Rayalaseema region of Andhra Pradesh during the year 2022. In a prior experiment conducted at the Department of Vegetable Science, College of Horticulture, Anantharajupeta, a locally cultivated field bean variety known as TFB-2 (Tirupati Field Bean-2) was employed. Dry and healthy seeds of this variety were subjected to gamma irradiation treatments utilizing Co_{60} (Cobalt-60) as the radiation source, at the Bhabha Atomic Research Station located in Trombay, Mumbai, Maharashtra. The irradiation doses included 10 kR, 20 kR, 30 kR, 40 kR, 50 kR, and 60 kR, aiming to ascertain the LD_{50} value of gamma irradiation. Concurrently, untreated seeds served as the control group. The outcomes of this experimentation established the LD_{50} value as 30 kR.

Subsequently, a batch of 1000 seeds from the TFB-2 field bean, treated with 30 kR gamma irradiation, was sown to initiate the development of the M_1 generation. The untreated TFB-2 seeds were also included as a control. In the M_1 generation, approximately 32 distinct morphological variations were identified, characterized by enhanced primary branch count, increased pod yield, and heightened seed yield per plant. These variants were segregated to elevate the M_2 generation.

Throughout both the M_2 and M_3 generations, certain mutants displaying morphological deviations and suboptimal performance compared to the parental traits were excluded. In contrast, 31 mutants demonstrating superior and desirable morphological and yield attributes were selected to advance the M_3 and M_4 generations, respectively.

Results and Discussion

The effect of gamma irradiation on growth and yield parameters of M_5 generation mutants of field beans are furnished in Table.1.

Growth parameters and fresh pod yield

In the M_5 generation, plant height exhibited a range of variation, spanning from 274.19 cm to 175.38 cm. Among the mutant lines, the highest plant height (274.19 cm) was observed in mutant line $M_{5.16}$ and was coequal with $M_{5.3}$, $M_{5.19}$, $M_{5.17}$ and $M_{5.18}$. Out of the 17 mutant lines, six lines displayed greater height than the parent. As stated by Hanafiah *et al.* (2010) [7], the application of gamma rays has the capacity to increase plant height in *Glycine max* (L.) Merr. However, the reduction in plant height observed in the mutants could be attributed to a decrease in mitotic activity within the meristematic tissues.

The count of primary branches/plant ranged from 4.60 to 3.20. The mutant line $M_{5.18}$ displayed the highest number of primary branches per plant at 4.60. Interestingly, it was found to be on par with $M_{5.18}$ (4.50), $M_{5.3}$ (4.50), and $M_{5.19}$ (4.40). These mutants, including $M_{5.18}$, $M_{5.3}$, $M_{5.19}$, $M_{5.16}$, and $M_{5.4}$, displayed a significant increase in branches compared to the parent $M_{5.32}$ (4). Similar observations were documented by Vanmathi *et al.* (2021) [13] in cowpeas, Horn (2016) [8] in cowpea and Girija and Dhanavel (2013) [6] in cowpea.

Early flowering was observed particularly in $M_{5.17}$ (45.2 days), which was statistically comparable to $M_{5.4}$ (46 days), $M_{5.18}$ (46 days), and $M_{5.6}$ (46.05 days). Conversely, late flowering was noticed in the mutant line $M_{5.28}$ (56.70 days). Notably, the mutant lines $M_{5.19}$ and $M_{5.3}$ exhibited early flowering compared to the parent $M_{5.32}$. These outcomes align with the research findings of Devi and Mullainathan (2012) [4] in *Vigna mungo* L. Hepper and David (2018) [3] in *Solanum aethiopicum*.

The duration for 50% flowering within the plot varied from 50 days to 66.50 days. Among the mutant lines, $M_{5.18}$ (50 days) exhibited the shortest flowering period, similar to $M_{5.17}$, $M_{5.4}$ and $M_{5.19}$. Conversely, $M_{5.28}$ (66.50 days) displayed delayed flowering, while the overall average was 57.06 days. Among the 17 mutant lines, six lines achieved earlier 50% flowering than the parent, with $M_{5.32}$ reaching 56.50 days. These findings align with research by Horn (2016) [8] in Cowpea and Sudhagar *et al*. (2023) [11] in horse gram.

The duration for the initiation of the first pod set ranged from 54.70 to 68.90 days, with an average of 61.04 days. Among the mutants, $M_{5.3}$ exhibited the shortest time (54.70 days) for the first pod set, demonstrating parity with $M_{5.17}$ and $M_{5.18}$, both at 56.10 days, as well as $M_{5.4}$ (56.90 days), $M_{5.6}$ (57.10 days). Subsequently, $M_{5.19}$ (58.80 days) and $M_{5.32}$ (58.80 days) displayed an efficient first pod set, while the longest time was recorded by $M_{5.28}$ (68.90 days). It is noteworthy that five mutants demonstrated a reduced duration for the first pod set over the parent. These findings are consistent with the research outcomes of Abou El-Yazied (2011) [1] and Parmar *et al*. (2013) [9] in the context of dolichos bean.

The fresh pod yield per plant exhibited a wide range, varying from 463.66 g to 1476.64 g, with an average yield of 904.57 g. The highest fresh pod yield was recorded in $M_{5.17}$ (1491.64 g), followed by $M_{5.3}$ (1398.14 g), $M_{5.19}$ (1331.25 g), $M_{5.16}$ (1266.23 g), $M_{5.18}$ (1255.23 g), and $M_{5.4}$ (1180.12 g). Additionally, the mutant line $M_{5.23}$ (936.85 g) showed a yield statistically equivalent to the parent $M_{5.32}$ (981.01 g). On the other hand, the lowest pod yield was observed in $M_{5.20}$ (463.16 g). Among the 17 mutants, only six lines exhibited a higher pod yield compared to the parent. These findings align with the results reported by Aruna *et al*. (2010) [2] in brinjal, Thilagavathi and Mullainathan (2011) [12] in black gram.

Table 1: Average performance of 17 mutants and parent (TFB-2) as check variety with respect to growth and yield parameters

Mutant lines	Plant height at last harvest (cm)	Number of primary branches	Days to first flower	Days to 50% flowering	Days to first pod set	Fresh pod yield (g)
$M_{5.1}$	217.07	3.75	52.00	57.00	60.00	763.28
$M_{5.3}$	265.90	4.50	47.00	52.00	54.70	1398.14
$M_{5.4}$	246.48	4.30	46.00	51.00	56.90	1180.12
$M_{5.6}$	194.53	3.90	46.05	52.50	57.10	594.89
$M_{5.7}$	203.76	3.65	48.90	56.50	61.60	514.04
$M_{5.10}$	207.00	3.70	53.30	61.50	65.60	706.95
$M_{5.12}$	219.93	3.80	54.95	61.50	63.70	752.50
$M_{5.14}$	210.99	4.00	54.00	60.50	63.70	855.30
$M_{5.15}$	231.26	3.90	53.50	62.00	62.60	616.01
$M_{5.16}$	274.19	4.30	53.00	60.00	63.40	1266.23
$M_{5.17}$	265.39	4.50	45.20	50.50	56.10	1491.64
$M_{5.18}$	258.64	4.60	46.00	50.00	56.10	1255.23
$M_{5.19}$	265.54	4.40	46.85	51.50	58.80	1331.25
$M_{5.20}$	175.38	3.20	50.60	60.00	61.30	463.16
$M_{5.23}$	222.93	3.60	53.05	59.50	64.50	936.85
$M_{5.28}$	201.92	3.45	56.70	66.50	68.90	634.16
$M_{5.30}$	189.35	3.35	51.85	58.00	64.90	541.45
$M_{5.32}$ (parent)	243.78	4.00	48.90	56.50	58.80	981.01
Mean	227.44	3.94	50.41	57.06	61.04	904.57
SE(m)±	5.88	0.08	0.29	0.58	0.83	15.30
CD 5%	17.53	0.24	0.86	1.74	2.48	45.66

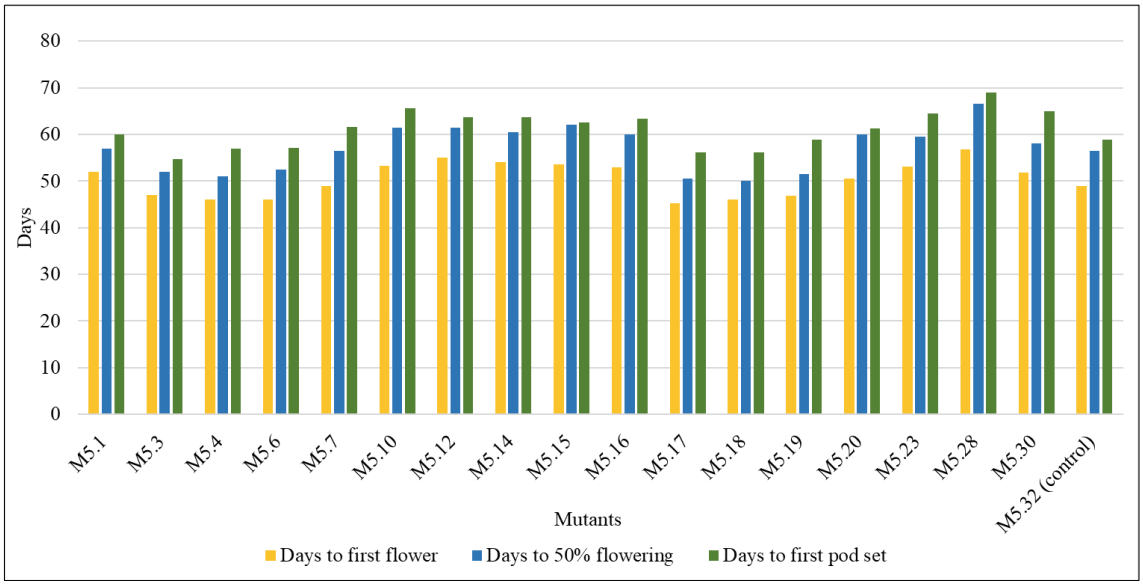

Fig 1: Mean values in the mutants of M_5 generation for days to first flower, days to 50% flowering and days to first pod set

Conclusion

The effect of gamma irradiation in M_5 generation mutants of dolichos bean revealed that $M_{5.16}$ achieved the highest plant height, whereas $M_{5.18}$ exhibited more branches per plant and also took the shortest duration to reach 50% flowering. In contrast, $M_{5.17}$ achieved a quicker time to flowering. $M_{5.3}$ exhibited the shortest time for the first pod set. The mutant $M_{5.17}$ stood out with the highest pod yield and dry seed yield.

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