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## Jyothilekshmi S and Dijee Bastian

#### Abstract

Quality and quantity of crops are adversely affected by both biotic and abiotic stresses. Abiotic stresses can even lead to complete loss of the standing crop and one among the major constraints is lodging. As far as cereals are concerned lodging is a major problem and climatic conditions can even enhance the chances for lodging. The biochemical components in the plant like starch, cellulose and lignin can provide resistance to lodging. Variability if lacking for the particular characters can be induced by mutagenesis thereby increasing the chance of selection for resistant types. The present study was conducted with the objective of assessing the correlation of biochemical components and lodging resistance in rice varieties after mutagenesis. Positive correlation was noticed for starch and cellulose content in the stem and it shows that stem rigidity is associated with these biochemical components in the stem.

Keywords: Upland rice, lodging resistance, mutation breeding

## Introduction

Lodging is a major abiotic constraint in cereal crops including rice. In the scenario of changing climatic conditions, the problem of lodging needs to be addressed for sustaining the agricultural production. It reduces the yield as well as adversely affects the quality of produce. Severity of yield loss occurred due to lodging is determined by the percentage of lodging and the climatic conditions existing in the area of cultivation. Many strategies are employed for breeding for lodging resistance and one of the strategies for up gradation of well established variety having susceptibility for lodging is by mutation breeding. Mutation breeding can alter the limiting trait for varietal improvement. The use of physical mutagens can create lot of variability for various desired traits in food crops (Mostafa, 2011) <sup>[5]</sup>. Several varieties were released in rice using induced mutagenesis which combines yield attributes along with stress tolerance. Structural carbohydrates in stem like cellulose, hemicellulose, physical strength of stem were positively correlated with total amount of soluble sugars in the culm and hence biochemical components in the stem plays a significant role in conferring resistance to lodging (Girija *et al.*, 2017) <sup>[3]</sup>. High cellulose content in the stem is conducive for increasing lodging resistance.

Swarnaprabha (PTB 43) and Vaisakh (PTB 60) are the varieties released from Kerala Agricultural University suited for upland cultivation. Even though they are high yielding these varieties are susceptible to lodging. Irradiation of crop varieties with sufficient dosage can induce variability which can be further used to develop varieties resilient to climatic changes. Combination of mutagenesis with novel techniques can identify mutant lines with desirable traits (Sikora *et al.*, 2011)<sup>[9]</sup>

## **Materials and Methods**

The experimental material consisted of two rice varieties released from Kerala Agricultural University namely Swarna Prabha (PTB 43) and Vaishak (PTB 60), suited for upland growing conditions. Irradiation of the varieties was carried out from Gamma chamber facility provided at Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. Seeds with good germination percentage were treated with radiation dose ranged from 375-550 Gy. Germination test of irradiated seeds were carried out and the responses were marked as germinated and non germinated. Observations were recorded on 14<sup>th</sup> day after sowing and germination per cent was calculated. On the basis of germination percentage Lethal Dose (LD<sub>50</sub>) was calculated for each variety using probit analysis (Cheema and Atta, 2003) <sup>[2]</sup> and effective doses were fixed for both the varieties for inducing variability.

Corresponding Author: Jyothilekshmi S Onattukara Regional Agricultural Research Station, Kayamkulam, Kerala, India  $M_1$  generations from all the treatments were sown in the field along with untreated controls. The experiment was carried out in Randomized Block Design at a spacing of 20 x 15 cm. The cultural, manurial and plant protection measures were done as per the Package of Practices Recommendation of Kerala Agricultural University. Field observations were noted for different characters and the selected plants carried forward to  $M_2$  generation following the pedigree method of selection. Observations for both morphological and biochemical parameters were noted for  $M_2$  generation

Morphological observations were recorded at various stages of plant growth following the Standard Evaluation System of Rice and biochemical components like Cellulose and starch content were estimated as per the procedure suggested by Sadasivam and Manickam (1996)<sup>[8]</sup>. Along with other characteristics visual scoring for lodging was carried out at maturity based on the degree of lodging.

## **Results and Discussions**

Lodging resistant cultivar identification and selection is difficult in cereals as screening is cumbersome in field conditions. Plant height is considered to be the main trait for inducing lodging resistance but the correlations can be different. Lodging tendency can differ among plants with similar height distribution (Navabi *et al.*, 2006) <sup>[6]</sup>. Biochemical components associated with cell wall rigidity confers lodging resistance.

## **Germination study**

The percentage of seeds germinated was inversely proportional to the dose of radiation. Significant reduction was noticed for higher doses. There was prominent percentage of reduction in germination of irradiated seeds compared to the control Amirikhah *et al.* (2021) <sup>[1]</sup> and the result is given in Table (1).

#### Fixation of LD<sub>50</sub>

For determining the effectiveness of a mutagen  $LD_{50}$  is of great significance and for fixing this germination percentage was worked out. Lethal dose for each genotype is to be fixed and critical dose need to be fixed as suggested by Usharani *et al.* (2017) <sup>[10]</sup>. Based on the lethal dose two effective doses viz. 400 Gy and 450 Gy for Swarna Prabha and for Vaishak 375 Gy and 450 Gy were used for further studies

#### Performance of mutants for morphological characteristics

Mutants were evaluated on the basis of comparison of mean performance of mutants and parents for yield and yield related traits and it was observed that for almost all characters mutants performed better than their parents. The mean value for grain yield per plant was 7.58 g and the highest value (8.31 g) was recorded by Vaisakh mutant line.

Simple correlation was worked out for both agronomic and biochemical characters associated with lodging resistance such as plant height, length of the first four internodes from the top of the plant, culm diameter, starch content and cellulose content. Characters such as plant height, length of the first and third internodes, culm diameter, starch content and cellulose content recorded highly significant positive correlation with lodging resistance and characters such as length of the second and fourth internodes from the top of the plant had highly significant negative correlation with lodging resistance. Among the characters studied cellulose content had highest positive correlation (0.905) with lodging resistance (Table 2).

From the present experiment it was noted that genotypic correlation coefficients were higher than phenotypic correlation coefficients for all the characters studied. Masking effect of the environment in the association of genes might cause low phenotypic correlations for the characters under consideration (Sackton and Hartl, 2016)<sup>[7]</sup>. Similar reports for positive correlation of cellulose content and lodging resistance was also reported by Khobra et al. (2019)<sup>[4]</sup>. Several studies reported that cellulose determines physical strength, as it was seen that lower cellulose content cause the stem to be brittle. Greater accumulation of starch and cellulose give stiffness to strength and thereby resists breaking and thus confers lodging resistance. In the present study it was noted that mutation breeding can induce variability in the genes which influence cellulose and starch biosynthesis and there by enhancing the chance of breeding for lodging resistance.

 Table 1: Germination percent for seeds of Swarnaprabha and

 Vaisakh after irradiation

Radiation	Number of	Swarna Prabha	Vaishak		
Dose (Gy)	seeds	Germination %	Germination %		
375	100	65	52.5		
400	100	50	60		
425	100	52.5	30		
450	100	67.5	45		
475	100	45	37.5		
500	100	17.5	30		
525	100	28	22.5		
550	100	27.5	32.5		
Control	100	82.5	85.3		



Fig 1: Correlation of lodging resistance and its related characters

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Characters	Plant	Internode	Internode	Internode	Internode	Culm	Starch	Cellulose	Lodging
	height	length 1	length 2	length 3	length 4	diameter	content	content	resistance
Plant height	1								
Internode length 1	0.467**	1							
Internode length 2	-0.353**	-0.491**	1						
Internode length 3	0.575**	0.478**	-0.342**	1					
Internode length 4	-0.218**	-0.175*	-0.093	-0.669**	1				
Culm diameter	0.318**	0.341**	-0.147	0.376**	-0.217**	1			
Starch content	0.136	0.356**	-0.131	0.328**	-0.305**	0.245**	1		
Cellulose content	0.252**	0.456**	-0.198*	0.413**	-0.386**	0.269**	0.944**	1	
Lodging resistance	0.404**	0.502**	-0.237**	0.498**	-0.441**	0.325**	0.765**	0.905**	1

Table 2: Correlation between lodging resistance and its related morphological and biochemical characters



Fig 2: Comparative germination of irradiated and untreated

## Conclusion

Starch and cellulose content in the stem were found to have significant correlation with lodging resistance .There are other components in stem like potassium, silicon and lignin which also contribute to stem rigidity. Lodging resistance in rice can be improved only through alteration in cellulose and starch synthase genes and the variability in these genes can confer resistance to lodging. Mutation breeding have been reported to have utilized for inducing variability for different parameters related to yield and yield related traits. Internodal length and lodging resistance were found to have negative correlation and it suggests that long internodes in the basal portion makes the plant susceptible to lodging. Alterations in plant architecture and reduction in internode length can also reduce the lodging susceptibility. Hence a combination of plant architectural alteration through usage of growth regulators and enhancement of variability through mutagenesis can preferably result in development of varieties resistant to lodging.

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