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National Academy of Agricultural Science (NAAS) Rating : 3. 03

Effect of Defoliation in Rainfed Rice Genotypes, Tolerant and Susceptible to Drought Stress

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ABSTRACT: *An experiment was carried out at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during* kharif *season. The impact of source limitation on assimilate partitioning and yield attributes to optimize the production potential and physiological basis of higher yield contributing traits in the ten genotypes. Flag leaf area was found maximum in Dagad Desi, PSBRC-9 and Poornima x Azucina. The highest reduction in flag leaf area was recorded in MTU 1010 and Ananda. The stability in flag leaf area contribute to photosynthetic efficiency and consequently resulting moderately stable yield under irrigated condition. Grain yield was found higher in Dagad Desi and Mahamaya under both the (irrigated and rainfed) condition, respectively. It was mainly due to the proline association with the morphological and phenological parameters as well as physiological behaviour, which ultimately raised the growth rate. It can be suggested that the leaves (source) could determine the degree of plant performance and control the level of portioning to the filled grain in rice. It is very interesting to conclude the reduction in leaf area of mother tillers indicated the importance of upper positional leaves to raise the present yield ceiling.*

Keywords: *Source-Sink, Defoliation, Assimilate partitioning, Source limitation*

INTRODUCTION

"Rice is Life" aptly describes the importance of rice in food and nutritional security, particularly for the Asian countries including India. For achieving and maintaining self sufficiency in rice, in view of ever increasing population, rice production has to be enhanced on a continual basis. Present world population of 6.3 billion is likely to reach 8.5 billion by 2030. Out of this 5 billion will be rice consumers. (Khush , 2006 [6]).

Chhattisgarh state is regarded as the "Rice Bowl" and about 82 per cent population of the state is dependent on agriculture for their livelihood. The total rice grown area is 3.46 million hectare with the production of 4.68 million tones and productivity 1323 kg ha^{-1}. (Anonymous, 2005. [1]).

The productivity of rice not only depend on total accumulation of dry matter but its effective partitioning to its economic parts. This may be especially important in drought prone environments, where current photosynthesis is restricted due to drought. At reproductive stage, enhanced capacity to allocate dry matter from various plant parts to grain can play an important role in yield stability. (Kumar *et al.*, 2000.[8]). Plant need a suitable morphological frame together with an inherent physiological capacity geared to serve the useful economic sink for maximum utilization of the sources.

Growth and development of plant depend upon availability of assimilates and their utilization in the sink tissue. If the current photosynthesis is limited by any stress (defoliation treatments, nutrient stress, chemical stress, water stress) the plant is forced to depend on stored assimilates. Based on their ability to produce or consume assimilates plant organs can be divided into (a) photosynthetically source organ which are known as net exporters of photoassimilates. (b) sink organ defined as net importer of fixed carbon. A leaf during initial stages of its development act as sink which is the seat of most vital functions of plants, however, all leaves borne by plant may not be equally productive under certain period may become reductant and inflict the adverse effect on crop productivity through excessive utilization of the

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moisture and nutrient sources of the soil. Source limitation serves as an ideal technique for maintaining suitable source sink ratio which spells out the optimum source requirement for effective photosynthesis to set maximum yield. (Pollock and Farras, 1996. [10]). In view of the above facts, the present investigation was conducted to Impact of pre-anthesis stem reserve mobilization in rainfed rice genotypes, tolerant and susceptible to drought stress.

MATERIALS AND METHODS

The experiment was laid out in *Factorial* randomized block design with two replications at the Research cum Instructional Farm, IGKV, Raipur (C.G.) during *kharif* season. The treatments consisted of two treatments *i.e.* complete defoliation from mother tillers of ten genotypes *viz.*, T_1 (control) and T_2 stress imposed (leaf removal). The plot size was 3.60 x 1.60 meters; distance between plot to plot was 20 cm and row to row was 20 cm. Defoliation treatments were imposed at 10 days after anthesis. The treatments were given only in the main culm of plant with the help of sharp scissors. The morphological, biochemical and yield parameters were analyzed at various growth stages.

Flag Leaf Area (cm^2)

Upper most fully expanded leaf on the mother tiller was selected for the estimation of flag leaf area at flowering stage. The length and maximum width of flag leaf were recorded at flowering stage. A factor of 0.75 was used to calculate the flag leaf area. It was expressed as cm^2.

Flag leaf area = Length x Width x K (factor = 0.75)

Number of Filled Grains Panicle^{-1}

Number of filled grains were counted on the main tiller panicle^{-1}

Total Reducing Sugar (%)

Reducing sugar in stem was determined by the method of Lan and Eynon as described by (Ranganna, 1986. [11]).

Reagents

1. Fehling's solution A: Copper sulphate 69.28 g and volume made upto one litre
2. Fehling's solution B: Potassium sodium tarterate 346 g and sodium hydroxide (NaOH) 100 g and volume made up to one litre.
3. Methylene blue indicator: Methylene blue 1% aqueous.
4. Neutral lead acetate (45%) solution.
5. Potassium oxalate (45%) solution.
6. Standard invert sugar solution: AR sucrose 9.5 g and concentrated HCl 5 ml and volume made up to 100 ml.

This solution is allowed to standard for further three days at 20-25°C for inversion to take place and can be used for several months during analysis. 25 ml of invert sugar solution was taken in a flask and added 50 ml distilled water, then neutralized with 20% NaOH in the presence of phenolphthalein as an indicator until the solution turned in the pink colour. Then acidified with 1 N HCl till pink colour disappears. The volume was mark with distilled water.

Estimation

A fixed quantity of filtered juice was transferred into volumetric flask and same quantity of distilled water was added and neutralized with alkali solution. In this solution a fixed quantity of leaf acetate solutions was added, shake and left undisturbed for some time and necessary amount of potassium oxalate solution was added. The process is necessary to get clarified solution. 5 ml "Fehling's solution 'A'" and Fehling's solution B was taken in a conical flask. Burette was filled with sugar solution. Conical flask was heated in an open flame. 20 to 4 g sugar solution was poured and 1-2 drop of methylene blue indicator was added. Now this solution was kept for heating and sugar solution was added tit. The end point appeared with brick red colour. The reducing sugar was expressed in per cent.

$$Reducing\ sugar\ (\%) = \frac{Mg.of\ inverst\ sugar \times dilution \times 100}{litre \times weight\ or\ volume\ of\ sample\ taken \times 100}$$

Grain Yield Plot^{-1} (Kg)

Five plants were taken for the grain yield plant^{-1} were harvested, threshed and weight of filled grains was taken as yield. Grain yield was taken from plot, the whole plot after the harvesting was threshed and the yield was taken out.

RESULTS AND DISCUSSION

The mean value of Flag Leaf Area, Total Reducing Sugar, Number of Filled Grain Panicle^{-1} and Grain Yield Plot^{-1} irrigated and rainfed rice genotypes in present study are summarized in Table 1. The results revealed that the flag leaf area was recorded significantly higher in Dagad Desi (58.29) followed by PSBRC-9 (53.83) and Poornima x Azucina (49.72)

Table 1

Mean value of Flag Leaf Area (cm^2), Total Reducing Sugar (%), Number of Filled Grain $Panicle^{-1}$ and Grain Yield $Plot^{-1}$(%) of irrigated and rainfed rice genotypes tolerant and susceptible to drought stress.

Varieties	*Flag Leaf Area*		*Total Reducing Sugar*				*Number of Filled Grain*		*Grain Yield*	
			Irrigated		*Rainfed*					
	Irrigated	*Rainfed*	*Stem*	*Seed*	*Stem*	*Seed*	*Irrigated*	*Rainfed*	*Irrigated*	*Rainfed*
1. Swarna/ IR	31.52	28.50	0.87	0.87	0.61	0.66	193.800	76.600	1.355	0.283
2. ARB-6	26.98	22.89	0.79	0.81	0.62	0.68	123.850	82.550	1.333	0.778
3. PSBRC-9	53.83	47.12	0.83	0.79	0.70	0.61	131.850	81.550	1.400	0.647
4. NDR 1045	29.69	27.45	0.74	0.70	0.65	0.70	129.150	107.250	1.268	0.320
5. Ananda	39.12	32.11	0.80	0.72	0.75	0.52	119.850	101.400	1.510	0.783
6. Poonima x Azucina	49.72	39.18	0.65	0.55	0.70	0.50	169.500	105.950	1.520	0.485
7. Swarna	37.24	31.29	0.74	0.66	0.68	0.50	183.700	68.650	0.935	0.523
8. Mahamaya	28.43	26.63	0.82	0.85	0.65	0.71	132.900	109.800	1.742	0.570
9. Dagad desi	58.29	49.08	0.86	0.87	0.62	0.75	168.450	163.050	1.197	0.250
10. MTU 1010	34.55	27.72	0.76	0.77	0.59	0.66	123.950	80.450	1.605	0.373
Mean	38.93	33.20	0.79	0.76	0.66	0.63	147.700	97.725	1.387	0.501
SEm±	2.28	1.24	-	-	-	-	7.8557	3.5132	0.5265	0.2355

under irrigated as well as rainfed condition. The lowest was recorded in the variety ARB-6 (26.98) followed by NDR 1045 (29.69). Flag leaf area in general is considered to be one of the desirable parameter for photosynthetic efficiency and its partitioning. The higher flag leaf area increases the grain yield and decreases spikelet sterility in rice. (Ghosh and Saran, 1990.[5]). The amount of photosynthates present in the second and third leaves was less when compared with flag leaf because the flag leaf supplies current photosynthates mainly to the panicle at the time of grain filling. (Yoshida, 1981.[13]).

There was reduction of sugar content of rice varieties in stressed condition over the controlled condition. In stress condition, the stem sugar content was estimated highest in variety Ananda while it was lowest in variety MTU 1010. The maximum mobilization of sugar was accelerated due to stress which was highest in variety Dagad Desi while, it was lowest in Swarna, Poornima x Azucina. It has been reported that stem reserve mobilization or the percentage of stem reserves in total grain mass is affected by sink size, environment and cultivar. The demand by the grain yield sink is a primary factor in determining stem reserve mobilization. When sink size was reduced by degraining, more reserves were stored in the stem. (Kuhbauch and Thome, 1989.[7]) (Palta *et al*. 1994 [9]) found that stem reserve mobilization was affected by water deficit during grain filling. Even the rate of development of water deficit may affect mobilization. Interestingly, water deficit during grain filling induced also carbon mobilization from tillers to the main stem. It has been found that amount of soluble sugars detected in the control plants was higher than in plants, which were subjected to defoliation. Similar findings were also observed by (Rane *et al*. 2003.[12]).

The highest number of filled grains under rainfed condition was observed in Dagad Desi (163.0) followed by Mahamaya (109.8) while the lowest in Swarna (68.65) followed by MTU 1010 (80.45). Under irrigated condition the maximum number of filled grains was found in Swarna/IR (193.8) followed by Swarna (169.5) and the lowest number of filled grain was found in Ananda (119.8) followed by ARB-6 (123.8).Pre-anthesis assimilates stored in stem and leaf tissue appear to contribute substantially to grain filling under water stress. (Chaturvedi and Ingram, 1989.[4]). proposed the use of chemical desiccation of the canopy after flowering as means for inhibiting plant photosynthesis and thus revealing the capacity of grain filling by stem reserves.

The grain yield was found to be highest in the variety Mahamaya (1.742) followed by MTU 1010 (1.605) and Poornima x Azucina (1.520) while the lowest grain yield was recorded in Swarna (0.935) under irrigated condition. Ananda (0.783) followed by ARB 6 (0.778) while lowest in Swarna (0.250) followed by Swarna/IR (0.283) under rainfed condition. Yield was directly correlated with maximum apparent translocation rate under stress condition. Water shortage during flowering and grain filling stages reduces yield drastically. (Boonjung and Fukai, 1996.[3]). The maintenance of plant internal water status regulates physiological functions and controls crop performance under drought. (Blum, 2002.[2]).

CONCLUSION

It can be concluded that the leaves (source) could determine the degree of plant performance and control the level of portioning to the filled grain in rice. It is very interesting to conclude the reduction in leaf area of mother tillers indicated the importance of upper positional leaves to raise the present yield ceiling.

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