SKUAST Journal of Research 26(2): 340-344; (2024)
(DOI No: 10.5958/2349-297X.2024.00032.6); NASS rating: 4.88

Research Paper

Leaf area index and SPAD of rice (*Oryza sativa* L.) as influenced by different genotypes and weed control methods under temperate conditions

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(Received Deceber 15, 2023; accepted February 30, 2024)

ABSTRACT

A field experiment was conducted at Agronomy Research Farm, Faculty of Agriculture, Wadura, Sopore, SKUAST-Kashmir during *Kharif* 2021 and 2022 on silty clay loam soil. The soil of the experimental field was neutral in reaction, medium in available N, P and K and organic carbon. The experiment was laid out in split plot design with three main plot treatments Viz., G1: Shalimar rice-2, G2: Shalimar rice-3 and G3: Shalimar rice-4 and 6 sub plot treatments Viz., W1: Butachlor (Butachlor:1.5 kg a.i ha^{-1}), W2: Pyrazosulfuron + pretilachlor (15 and 600 g *a.i.* ha^{-1}), W3: Bensulfuron-methyl + pretilachlor (60 and 600 g *a.i.* ha^{-1}), W4: Penoxsulam(22.5g a.i ha^{-1}), W5: Weedy and W6: Weed free. The results of the experiment revealed that among the different genotypes, Shalimar rice-2 recorded significantly higher leaf area index and SPAD values at all the periodic intervals of the crop followed by Shalimar rice-4 whereas Shalimar rice-3 recorded significantly lowest leaf area index and SPAD values during both the years of experimentation. Among the different herbicides used, penosxulam treatment recorded higher SPAD values which were significantly superior as compared to other herbicides and weedy check at all the periodic intervals during both the years. With respect to yield Shalimar rice-4 outperformed Shalimar rice-2 and Shalimar rice-3 and among different weed control treatments, apart from weed free treatment, Penoxsulam recorded significantly higher yield as compared to all other weed control treatments.

Key words: Genotype, herbicides, penoxsulam, rice, weed

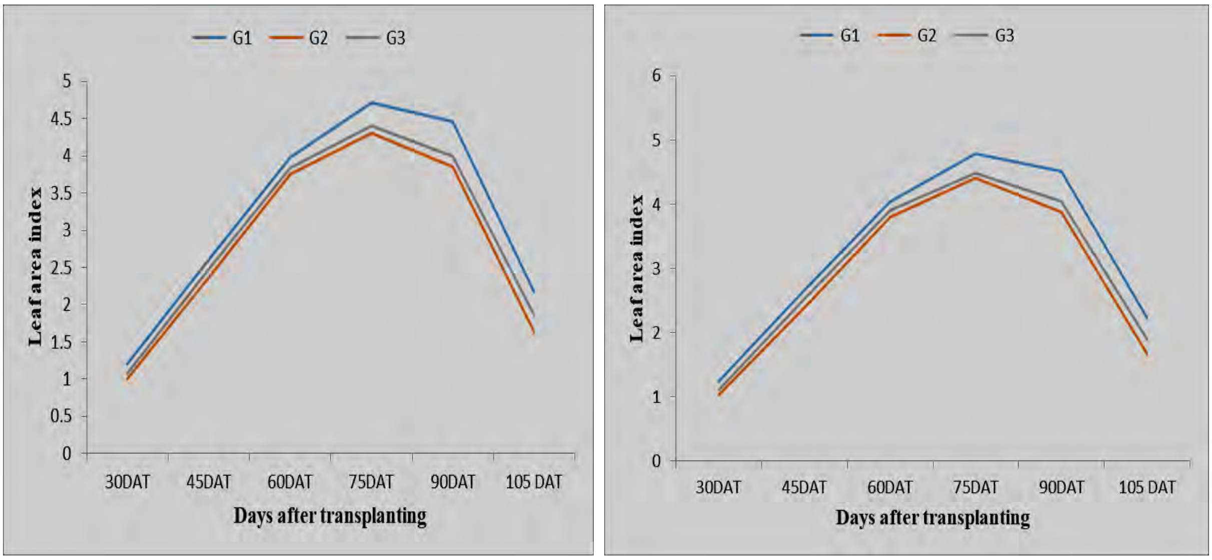
Rice (*Oryza sativa* L.) is the primary food source for almost half of the world population (Zhao *et al.*, 2023). Rice is cultivated over an area of about 158.8 million hectares (M ha) with a production of 751.9 million tonnes (M t) annually (FAO, 2017). About 90% of the crop is grown in Asia (Rabbani *et al.*, 2011). In India rice is grown on 43.78 M ha with a production and productivity of 118.43 Mt and 25.5 q ha^{-1}, respectively (DES, 2019-20). In Jammu and Kashmir rice is grown from time immemorial and stands as the most important staple food crop. Weeds are the most severe and the most widespread biological constraint to rice production (Rao, 2000). The most popular and successful method of controlling weeds in rice is hand weeding; but, because manpower is scarce and wages are high, this method is becoming more and more difficult and expensive. It is, therefore, essential to find out the alternative practices for managing the menace of this weed. Herbicide use has been shown to be effective in controlling weeds in a variety of crops (Chauhan *et al.*, 2014), and it is the cornerstone of weed management in contemporary agricultural production systems. Use of herbicides has been found promising for managing weeds in different crops (Chauhan *et al.,* 2014) and constitutes the foundation of weed management in modern agricultural production systems. Thus, the herbicide usage seems to be indispensable for weed management in rice. Although, rice is a weak competitor against weeds, identification or development of superior weed competitive rice genotypes may be an attractive, cost effective and safe approach for sustaining rice productivity, particularly for resource-poor farmers.

MATERIALS AND METHODS

The experiment was laid out at research farm of Division of Agronomy, Faculty of Agriculture, Wadura, SKUAST-Kashmir in Kharif 2021 and 2022. The field is situated between 34^{O} 21' N latitude and 74^{O} 23' E longitude and at an altitude of 1590 meters above mean sea level. A temperate climate prevails in the area, with freezing temperatures in the winter and hot weather in the summer. The soil of the experimental field was silty-clay loam in texture, medium in organic carbon, medium in available nitrogen, phosphorus and potassium with neutral pH. The experiment was laid out in split plot design with three main plot treatments Viz., Shalimar rice-2(G1), Shalimar rice-3(G2) and Shalimar rice-4 (G3) and 6 sub plot treatments Viz., Butachlor (W1), Pyrazosulfuron + pretilachlor (W2), Bensulfuron- methyl + pretilachlor (W3), Penoxsulam(W4), Weedy(W5) and weed free(W6). The size of each experimental plot was 5.0 m x 3.0 m. The Cochran and Cox technique, (1936) was used to statistically analyse the data obtained for a number of observations. Treatment differences were assessed using the F test of significance.

RESULTS AND DISCUSSION

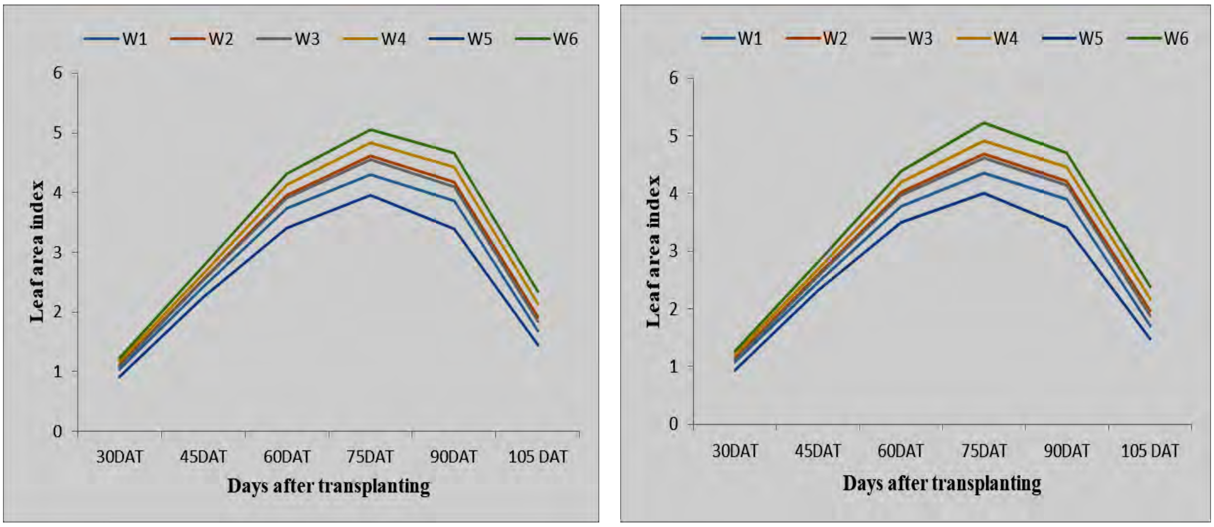
Leaf area index was found to increase up to 75 DAT (days after transplanting) along with the growth of the leaf and decreased subsequently due to withering of leaves. It was found that genotypes as well as weed control methods had a significant effect on periodic leaf area index of rice during both the years of experimentation as depicted in Fig 1 and 2. Among the different genotypes Shalimar rice-2 recorded significantly highest leaf area index whereas, Shalimar rice rice-3 recorded the lowest leaf area index during both the years of experimentation. Higher leaf area index attained by Shalimar rice-2 followed by Shalimar rice-4 could be due their genetic makeup and their ability to compete with weeds.



2021 **2022**

Fig. 1: Effect of different rice genotypes on Leaf Area Index of rice

The results are in conformity with the findings of Mahajan *et al.* (2014). Apart from weedy free treatment, Penoxsulam (22.5 g *a.i.* ha^{-1}) treatment recorded significantly highest leaf area index among the weed control treatments, whereas weedy check treatment recorded the lowest leaf index at all the periodic intervals during both the years. Similar results have been reported by Shan *et al*. (2012).



2021 2022

Fig. 2: Effect of different weed control methods on Leaf Area Index of rice

SPAD (soil plant analysis development) values were measured in order to determine the status of chlorophyll in leaves at periodic intervals of rice. Perusal of the data revealed that SPAD values of rice were significantly influenced by different genotypes as well as weed control methods during both the years of experimentation (Table 1). The periodic data revealed that SPAD values increased with the advancement in crop age up to 60 DAT and thereafter declined.

Table 1: Effect of different genotypes and weed control methods on SPAD values of rice

Treatments	30DAT		45DAT		60DAT		75DAT		90 DAT	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Rice Genotypes										
G1 (Shalimar Rice-2)	35.94	36.12	40.92	41.16	44.09	44.33	39.43	39.58	31.43	31.58
G2 (Shalimar Rice-3)	33.35	33.52	36.75	36.97	40.01	40.24	34.88	35.01	26.88	27.01
G3 (Shalimar Rice-4)	34.07	34.21	39.00	39.19	42.35	42.55	37.07	37.18	29.07	29.18
SE(m)±	**0.23**	**0.22**	**0.37**	**0.41**	**0.38**	**0.36**	**0.28**	**0.27**	**0.28**	**0.27**
CD p≤0.05	**0.29**	**0.66**	**1.10**	**1.23**	**1.13**	**1.08**	**0.84**	**0.81**	**0.84**	**0.81**
Weed control methods										
W1 (Butachlor:1.5 kg a.i ha^{-1})	33.07	33.20	38.00	38.20	41.15	41.34	36.34	36.44	28.34	28.44
W2 (Pyrazosulfuron-ethyl + Pretilachlor: 15 and 600 g *a.i.* ha^{-1})	35.09	35.25	39.04	39.26	42.19	42.42	37.43	37.57	29.43	29.57
W3 (Bensulfuron-methyl + Pretilachlor :60 and 600 g *a.i.* ha^{-1})	34.78	34.93	38.86	39.06	42.01	42.22	37.24	37.37	29.24	29.37
W4 (Penoxsulam 22.5g a.i ha^{-1})	35.62	35.82	39.85	40.08	43.21	43.47	38.44	38.61	30.44	30.61
W5 (Weedy)	31.28	31.38	36.67	36.83	39.93	40.09	33.95	34.02	25.95	26.02
W6 (Weed free)	36.89	37.11	40.93	41.20	44.41	44.70	39.35	39.54	31.35	31.54
SE(m)±	**0.43**	**0.42**	**0.33**	**0.37**	**0.38**	**0.37**	**0.30**	**0.32**	**0.31**	**0.30**
CD p≤0.05	**1.25**	**1.25**	**0.98**	**1.11**	**1.14**	**1.10**	**0.88**	**0.96**	**0.93**	**0.97**

Among the different genotypes, Shalimar Rice-2 recorded significantly higher SPAD values 30 (35.94, 36.12), 45 (40.92, 41.16), 60 (44.09, 44.33), 75 (39.43, 39.58) and 90 DAT (31.43, 31.58) as compared to Shalimar Rice-4 and Shalimar Rice-3 during 2021 and 2022, respectively. Shalimar Rice-3 recorded significantly the lowest SPAD values at 30 (34.07, 34.21), 45 (39.00, 39.19), 60 (42.35, 42.55), 75 (37.07, 37.18) and 90DAT (29.07, 29.18) during 2021 and 2022, respectively. Genetic makeup could be the reason for higher SPAD values recorded by Shalimar rice-2. Kumar *et al.* (2016) has also reported similar results. Among the different weed control treatments, SPAD values were recorded significantly higher under weed free treatment as compared to other weed control methods at 30 (36.89, 37.11), 45 (40.93, 41.20), 60 (44.41, 44.70), 75 (39.35, 39.54) and 90 (31.35, 31.54) DAT and significantly lowest SPAD values were recorded in weedy treatment at 30 31.28, 31.38), 45 (36.67, 36.83), 60 (39.93, 40.09), 75 (33.95, 34.02) and 90 (25.95, 26.02) DAT. Among the different herbicides used in the experiment, penoxsulam (22.5 g a.i. ha^{-1}) treatment recorded significantly higher SPAD values at 30 , 45, 60, 75 and 90 DAT as compared to butachlor (1500 g a.i. ha^{-1}), Pyrazosulfuron ethyl+ Pretilachlor (15 and 600 g a.i. ha^{-1}) and Bensulfuron methyl + Pretilachlor (60 and 600 g a.i. ha^{-1}) during both the years of experimentation. Pyrazosulfuron ethyl+ Pretilachlor (15 and 600 g a.i. ha^{-1}) and Bensulfuron methyl + Pretilachlor (60 and 600 g a.i. ha^{-1}) were at par with each other during both the years. The reason behind the higher SPAD values recorded by weed free and penoxsulam treatment could be the higher uptake of macro nutrients by these treatments because of no or very less weed competition experienced by the crop. Geethalakshmi *et al*. (2009) reported similar results.

The data further revealed that significant improvement in grain yield was recorded under Shalimar Rice-4 over Shalimar Rice-2 and Shalimar Rice-3 (Table 2). The superiority exhibited by Shalimar Rice-4 over Shalimar Rice-2 and Shalimar Rice-3 was 7.47, 7.14% and 20.48, 20.67 % during 2021 and 2022, respectively. This could be attributed to higher weed competitiveness, and higher yield potential of Shalimar rice-4 as compared to Shalimar rice-2 and Shalimar rice-3. The results are in conformity with the findings of Chaudhari *et al.,* (2014). Different weed control methods had a significant effect on yield of rice. The highest grain yield (8.45 and 8.52 t ha^{-1}) was recorded by weed free treatment which was significantly superior to weedy treatment and other weed control treatments. Among the different herbicides used, penoxsulam (22.5 g *a.i.* ha^{-1}) treatment recorded significantly higher grain yield over weedy treatment and other weed control treatments (Table 2). Penoxsulam (22.5 g *a.i.* ha^{-1}) treatment realized 16.23 and 16.00 %, 8.00 %, 8.05 and 9.10 and 9.15% and 40.34 and 40.34 % more grain yield as compared to butachlor (1500 g a.i. ha^{-1}), Pyrazosulfuron ethyl + Pretilachlor (15 and 600 g a.i. ha^{-1}), Bensulfuron methyl+ Pretilachlor (60 and 600 g a.i. ha^{-1}) and weedy treatment, during 2021 and 2022, respectively. This might be due to the reason that reduction in weed growth with the herbicide application favored the crop to get adequate supply of nutrient resulting in more accumulation of photosynthates, which in turn contributed to the sink resulting in higher grain yield. These results are in conformity with the findings of Jabran *et al*. (2012).

Table 2: Effect of different genotypes and weed control methods on yield (t/ha) of rice

Treatments	**Grain yield (t/ha)**	
	2021	**2021**
Rice Genotypes		
G1 (Shalimar Rice-2)	7.36	7.41
G2 (Shalimar Rice-3)	6.29	6.33
G3 (Shalimar Rice-4)	7.91	7.98
SE(m)±	**0.16**	**0.18**
CD p≤0.05	**0.48**	**0.54**
Weed control methods		
W1 (Butachlor:1.5 kg a.i ha^{-1})	6.81	6.88
W2 (Pyrazosulfuron-ethyl + Pretilachlor: 15 and 600 g *a.i.* ha^{-1})	7.48	7.53
W3 (Bensulfuron-methyl + Pretilachlor : 60 and 600 g *a.i.* ha^{-1})	7.39	7.44
W4 (Penoxsulam 22.5g a.i ha^{-1})	8.13	8.19
W5 (Weedy)	4.85	4.87
W6 (Weed free)	8.45	8.52
SE(m)±	**0.11**	**0.11**
CD p≤0.05	**0.33**	**0.32**

CONCLUSION

Weed suppressing rice genotypes and use of herbicides are an important aspect in managing weeds in rice crop. From the detailed inception of this experiment, it can be concluded that Shalimar rice-2 performed well as compared to Shalimar rice-4 and Shalimar rice-3 with respect to leaf area index and SPAD values of rice. Similarly among different herbicides used in the experiment, penosxulam performed well as compared to other herbicides during both the years of experimentation. With respect to grain yield Shalimar rice-4 outperformed Shalimar rice-2 and Shalimar rice-3 due to it's more competitive ability and higher yield potential. Penoxsulam recorded higher grain as compared to all the herbicides used.

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