Journal of Crop and Weed, 12(1):107-111(2016)

Weed dynamics and grain yield as influenced by sowing time and system of cultivation of rice genotypes

S. K. DWIBEDI, [1] G. C. DE AND [2] S. R. DHUA

Department of Agronomy, OUAT, Bhubaneswar, Odisha;
[1] Department of Agronomy, ASEPAN, Visva Bharati University, Bolpur, West Bengal
[2]CRRI, Cuttack, Odisha

Received: 07-07-2015, Revised:09-05-2016, Accepted: 05-06-2016

ABSTRACT

The field experiments to study the 'floristic dynamics' of weeds as influenced by sowing time and system of cultivation of rice genotypes' were carried out in coastal Odisha during 2009 and 2010 in split split-plot design with early (20 June), normal (5 July) and late (20 July) sowings in main plots; best management practice (BMP), system of rice intensification (SRI) and modified SRI (MSRI) in sub-plots and; hybrid Ajay and cv. Tapaswini in sub sub-plots, giving rise to 18 treatment combinations that were replicated thrice. Early sowing of rice was the most promising in recording significantly the highest grain yield that provided an additional yield 6.08 per cent over normal date of sowing. While normal sowing produced significantly higher grain yield (13.77 per cent) over delayed sowing due to diminishing trend in yield components of late sown rice. SRI produced 10.17 per cent less yield f than that of MSRI but 21.69 per cent more than in BMP. Hybrid Ajay produced 9.07 per cent more grains than cv.Tapaswini which could possibly be due to genetic potential of the former accompanied with lesser weed infestation. Weed biomass at 40 DAS decreased significantly with delay in sowing beyond 20 June. SRI had the highest weed biomass followed by MSRI and BMP. BMP had the highest per cent of sedges while MSRI and SRI had the highest per cent of grasses and broad leaved weeds, respectively.

***Keywords*:** Floristic composition, grain yield, sowing time, weed biomass

A set of water-saving rice cultivation management practices popularly known as System of Rice Intensification (SRI) has been introduced from Madagascar to many countries including India. Its changes in management practices by transplanting of very young seedlings singly in a square pattern, maintaining non-flooded soil rhizosphere up to panicle initiation though alternate wetting and drying, mechanical weeding and much stress to organic nutrient and plant protection measures (Uphoff *et al*., 2002). Although, the benefits of SRI in and around Odisha compared to the continuous flooded traditional farmers' practices are well established, but studies on its relative performance in comparison to the "Best Management Practices" (BMP) and "Modified System of Rice Intensification" (MSRI) in flood, drought and cyclone affected farming situations of coastal Odisha under assured irrigation system during *kharif* season need careful evaluation.

The competition in crop and weed for same resources results in the reduction in biomass of rice *vis-à-vis* the grain yield as weeds usually absorb nutrients faster and accumulate them relatively in large amount (Gupta, 2000). Babar and Valayutham (2012) in Madras reported the major weed flora like *Echinochloa crusgalli* (L.), *Cyperus difformis* (L.), *Eclipta alba* (L.) and *Ammania baciferta* (L.) in SRI experimental field. Kumar and Singh (2013) observed dominant weed flora in rice field like *Alternanthera triandra*, *Echinochloa colona*, *Fimbristylis miliacea* and *Cypeus iria* throughout *kharif* season. Satyanarayana (2004) opined that weeding through mechanical weeder under saturated condition encouraged more root growth due to reduced weed competition and aeration of soil.

In coastal irrigated areas, the farmers are oriented towards delayed planting in more than 60 per cent of rice area. Singh *et al*., (1989) reported heavier weed-infestation in crop planted on 16 June compared to the weeds in crops planted on 1 and 16 July. However, Hassan *et al*. (1998) reported that delayed planting of rice cv. Giza-175 from June to July resulted in greater number of weeds, especially *Cyperus difformis* and broad leaved weeds. However, no such work has yet been undertaken to study the relative performance of delayed planting under SRI and BMP in coastal plains.

The performance of newly released hybrid rice "Ajay" in comparison to the ruling high yielding

Email:sanatdwibedi@rediffmail.com

"Tapaswini" variety is also yet to be established under such delayed situation and also under different systems of cultivation.

MATERIALS AND METHODS

The field experiments were conducted during *kharif*, 2009 and 2010 in the village Nimakana of Tirtol block, Jagatsinghpur district, Odisha, India under agro-climatic zone of 'East and South East Coastal Plain' at 25.6 km air distance from the Bay of Bengal at east. The experiment site in particular was located at $86^{0}22'$E longitude, 20^{0} 17'N latitude and 14.0 m above the mean sea level. The antecedents of cropping of the site for five consecutive years just preceeding to this experiment indicated either sole crop of rice or rice-green gram system. The physico-chemical properties of the experimental soil indicated clay loam texture, moderately acidic soil reaction (5.6 to 5.5), high organic carbon (0.79 to 0.87) and electrical conductivity (0.96 to 0.98 ds m^{-1}).

The climate of the experimental location is characterized as 'warm and moist' with a hot and humid summer and normal cold winter which broadly falls in the 'moist hot' group. The range of maximum and minimum temperatures during the experimental cropping years was more or less similar as the long term average. The mean annual rainfall is 1,333.9 mm and nearly 62.0 per cent of rainfall was being received between June and October (827.0 mm). The monsoon usually sets in around mid June and recedes by first week of October. July and August are wettest months, while December is the driest one.

The treatments consisted of three dates of sowing *i.e.* 20 June, 5 July and 20 July; three systems of cultivation of rice *i.e.* Best Management Practice (BMP), SRI and Modified SRI; and two medium duration rice genotypes released from Central Rice Research Institute, Cuttack *i.e.* high yielding variety (HYV) 'Tapaswini' (IET 12168) and hybrid 'Ajay'(CRHR-7, IET 18166). The experiment was carried out in a split-split plot design with 18 treatment combinations replicated thrice. The first treatment involving three dates of sowing were assigned to the main plots. The second treatment of three systems of cultivation was allotted to three sub plots and the two rice genotypes were grown in sub sub-plots. The treatments were allotted at random by the help of two digit random number table.

Seedlings from the raised nursery beds were uprooted at 25 days old stage for transplanting under BMP. The beds were irrigated before uprooting for smooth lifting of the seedlings. Two seedlings $hill^{-1}$ were transplanted in the main field at 25.0 x 12.5 cm spacing in lines.

The main field was puddled and measured quantities of fertilizers were added to the field before final puddling. For transplanting under SRI and MSRI, seedlings from the raised bamboo beds were uprooted at 10 days by scooping the seedlings in bulk at 2 to 3 cm below the nursery bed surface along with the moist mother soil. Due care was taken up to reduce damage to the root system of the seedlings during uprooting. The seedlings were then carried away to the main field by trays without much delay and the transplanting was carried out preferably within half an hour of uprooting. Single seedling $hill^{-1}$ in SRI and two seedlings $hill^{-1}$ in MSRI were then transplanted in the main field at 25.0 x 25.0 cm and 25.0 x 12.5 cm spacing, respectively in lines.

In SRI, 25.0 cm spacing was maintained in both the directions. However, in MSRI, 12.5 cm spacing was maintained in east-west direction and 25.0 cm spacing was maintained in north-south direction so as to facilitate easy penetration of solar radiation throughout the entire day.

In BMP sub plots FYM @ 5.0 t ha^{-1} along with total P and $1/3^{rd}$ of the total recommended dose (100:50:50 kg ha^{-1} of $N:P_2O_5:K_2O$) of the nitrogenous and potassic fertilizers were applied before final puddling. Rest of the nitrogenous and potassic fertilizers were applied in two equal halves *i.e.*$1/3^{rd}$ at maximum tillering (40 DAS) and $1/3^{rd}$ at panicle initiation (PI) stage (70 DAS).

However, in SRI and MSRI, FYM @ 15.0 t ha^{-1} along with total P and $1/4^{th}$ of the total (50:50:50 kg ha^{-1} of $N:P_2O_5:K_2O$) nitrogenous and potassic fertilizers were applied before final puddling. Rest of the nitrogenous and potassic fertilizers were applied in three equal splits *i.e.* $1/4^{th}$ each at 25, 40 and 70 DAS. The share of the N fertilizer from chemical source has been reduced to half of the recommended dose keeping in view its availability from the 10.0 t extra FYM applied to the field at the time of final land preparation.

In BMP, three hand weeding operations at 40, 55 and 70 DAS were carried out incorporating the weeds *in situ*. Whereas in SRI and MSRI systems of cultivation, four weeding operations at 20, 30, 40 and 50 DAS were carried out by using conoweeder. In SRI the weeder was operated in criss-cross manner and the weeds were incorporated into the soil. However, in MSRI, the weeder was run in east west direction only.

In BMP, water was allowed to stand in the plots since planting of the seedlings by irrigating at alternate days so as to maintain a layer of 5 to 8 cm depth of water during the entire crop period till 15 days before harvest. While in SRI and MSRI, water was not allowed to stand in the plots and special care was taken to avoid submergence of 10 days' old tiny seedlings just after transplanting in the main field. The soil was kept moist above the field capacity by irrigating the sub sub-plots as per requirement till PI was attained. These plots were first irrigated 5 days after transplanting to moisten the field without ponding. A second irrigation was given on the evening of 9th day after planting at a ponding depth of 2.0 to 5.0 cm and the next morning first weeding was performed by using cono-weeder. Thereafter alternate wetting and drying method of irrigation was practiced and subsequent irrigation were applied three days after disappearance of the ponded water or immediately after the development of hair cracks on the soil surface. However, after PI stage, the plots were allowed to hold standing water of 5.0 cm height up to two weeks before harvest.

Prophylactic sprays of neem oil @ 5.0 ml liter^{-1} of water at 15 days intervals were carried out to avoid any possible damage by insects and diseases. In addition, Trichocards with 1,00,000 viable eggs of *Trichogramma japonicum* ha^{-1} were released at 15 days intervals *i.e.* at 40, 55 and 70 DAS for preventing the infestation by stem borers in all three systems of planting. Sex pheromone traps @ 20 traps ha^{-1} were installed and lures were regularly changed at 15 days intervals. However, necessary and adequate plant protection measures were adopted depending upon the possibility and incidence of the disease and pest infestation reached at economic threshold limit (ETL).

For the determination of grain yield, the crop randomly from 5.0 x 1.0 m area in each sub sub-plot leaving border distance of 0.5 m was harvested. The harvested crop samples were labeled properly and sun-dried for 3-4 days before threshing to reduce moisture content to 14 per cent.

The study on total dry matter of various medium land weeds (both narrow and broad leaved) was carried out 40 DAS to assess the mode of weed growth and the extent of damage in different environments.

RESULTS AND DISCUSSION

Early sowing (20 June) *i.e.* 15 days ahead of normal sowing was the most promising in recording significantly the highest grain yield of 5.81 t ha^{-1} that provided an additional yield of 0.33 t ha^{-1} (6.08 per cent more) over normal date (5 July) of sowing (Table 1). Normal sowing by 5 July had the advantage of producing significantly higher grain yield (5.48 t ha^{-1}) than that of delayed sowing by 15 days causing saving of 0.663 t ha^{1} *i.e.* 13.77 per cent yield.

Table 1: Effect of treatments on dry weight of weeds at 40 DAS and grain yield of rice

Treatments	Weed biomass (g m^{-2})			Grain yield (q ha^{-1}) of rice		
	2009	2010	Pooled	2009	2010	Pooled
Dates of sowing						
20 June	22.27	33.25	27.76	5.57	6.05	5.81
5 July	26.91	23.73	25.32	5.56	5.39	5.48
20 July	22.35	19.84	21.09	4.60	5.03	4.82
SEm (±)	**0.54**	**0.51**	**0.37**	**0.112**	**0.120**	**0.08**
LSD (0.05)	**2.12**	**2.02**	**1.21**	**0.439**	**0.470**	**0.27**
Systems of cultivation						
BMP	21.14	18.04	19.59	4.64	4.38	4.51
SRI	26.74	32.08	29.41	5.22	5.75	5.49
MSRI	23.65	26.70	25.17	5.88	6.34	6.11
SEm (±)	**0.77**	**0.90**	**0.59**	**0.12**	**0.11**	**0.08**
LSD (0.05)	**2.38**	**2.78**	**1.73**	**0.37**	**0.32**	**0.23**
Genotypes						
Tapaswini	28.72	25.24	26.98	5.04	5.23	5.14
Ajay	18.97	25.97	22.47	5.45	5.76	5.60
SEm (±)	**0.4**	**0.43**	**0.29**	**0.07**	**0.07**	**0.05**
LSD (0.05)	**1.2**	**1.27**	**0.84**	**0.20**	**0.21**	**0.14**

Thus there was reduction of grain yield to the tune of 0.04 t ha^{-1} d^{-1} due to delay in sowing time beyond 5th July. This could be due to diminishing trend in yield components of late sown rice.

The dry weight m^{-2} (Table 1) and floristic composition (Table 2, Fig. 1) of weeds were recorded at 40 DAS. Early sowing of rice by 20 June recorded significantly the highest dry weight of weeds (27.76 g m^{-2}) that was followed by subsequent fortnightly delay in sowing. The dry weight of weeds in SRI was significantly higher (29.41 g m^{-2}) than both MSRI and BMP while BMP had the least. Regarding population infestation of sedges the sequence was SRI < MSRI < BMP while the dry weight of weeds was in order of BMP < MSRI < SRI. Suppression of weeds with monsoonal rain water at subsequent dates of sowing could possibly be the reason behind such diminishing trend of weed biomass.

All the three systems of cultivation had significant effect on grain yield (Table 1). The lowest yield of 4.51 t ha^{-1} was in BMP on the contrary the highest yield of 6.108 t ha^{-1} was in MSRI while SRI produced moderate yield of 5.49 t ha^{-1} *i.e.* 0.62 t ha^{-1} (10.17 per cent) less than that of MSRI but 0.98 t ha^{-1} (21.69 per cent) more than in BMP. Wider spacing in SRI resulting in reduced effective tiller m^{-2} might have moderated the productivity in-spite of its superiority in recording yield contributing components in its panicle.

The floristic composition of weeds (Table 2) indicated that the broad leaved weeds constituted about 68.28 per cent, 56.61 per cent and 46.97 per cent in SRI, MSRI and BMP, respectively followed by sedges and grasses. Among broad leaved weeds *Cyanotix curculata, Marsilia quadrifolia, Astercantha cognifolia and Chrozoffera rotleri* were predominant. In case of sedges, *Cyperus iria, C. difformis and C.rotundus* were important. *Echinochloa crusgalli* was dominant grass with 6.31per cent, 4.41 per cent and 4.12 per cent infestation followed by *Echinochloa colonum* in MSRI, SRI and BMP respectively. Higher weed infestation in SRI and MSRI than BMP field could be due to non-availability of standing water in the field in former two systems of cultivation of plant rice while in BMP, availability of standing water could have suppressed weeds. BMP had the highest per cent of sedges while MSRI and SRI had the highest per cent of grasses and broad leaved weeds, respectively. In SRI and MSRI, restricted water supply might have created relatively aerobic condition of soil facilitating prolific growth of grasses and broad leaved weeds. However, broadleaved weed like *Marsilia quadrifolia* was absent in both SRI and MSRI while it was present in BMP field only. It

Table 2: Floristic composition of weeds (%) at 40 DAS as influenced by systems of cultivation

Types of weeds	Composition (%)		
	BMP	**SRI**	**MSRI**
Grasses			
Elusine indica	0.95	2.13	2.54
Echinocloa colonum	2.64	3.35	4.85
Echinocloa crusgalli	4.12	4.41	6.31
Digitaria sanguinalis	2.14	2.75	3.41
Panicum repens	1.49	0.70	0.73
Total	**11.14**	**13.34**	**16.38**
Sedges			
Cyperus difformis	10.32	5.35	8.51
Fimbristylis milacea	7.25	2.21	4.09
Cyperus iria	13.30	6.19	8.07
Cyperus rotundus	11.02	4.63	6.34
Total	**41.89**	**18.38**	**27.01**
Broad leaved weeds			
Cyanotix curculata	20.12	41.32	37.51
Chrozoffera rotleri	3.52	11.38	9.31
Astercantha cognifolia	7.04	4.61	3.28
Marsilia quadrifolia	12.34	-	-
Eclipta alba	2.08	7.31	4.04
Ludwigia parviflora	1.87	3.66	2.47
Total	**46.97**	**68.28**	**56.61**
Grand total	**100.00**	**100.00**	**100.00**

could be due to availability of standing water in BMP creating suitable habitat for its growth.

Grain yield production was significantly influenced by genotypes (Table 1). The hybrid Ajay produced 0.466 t ha^{-1} (9.07 per cent) more grains than the high yielding variety Tapaswini which could possibly be due to genetic potential of the former accompanied with lesser weed infestation.

The rice variety Tapaswini had recorded higher dry weight (26.98 g m^{-2}) of weeds than hybrid Ajay. Vigorous vegetative growth of hybrid Ajay might have suppressed weeds at its tillering stage *i.e.* 40 DAS compared to cv. Tapaswini.

Early sowing of rice by 20 June produced significantly the highest grain yield (5.811 t ha^{-1}) while subsequent fortnight by delay in sowing was of second order (5.48 t ha^{-1}) and late sown rice lagged behind (4.82 t ha^{-1}) in this regard. MSRI had the advantage of recording the highest grain yield (6.11 t ha^{-1}) in rice followed by SRI (5.49 t ha^{-1}) and BMP (4.51 t ha^{-1}). MSRI under early sowing by 20 June produced the highest grain yield of 6.46 t ha^{-1} while BMP sown late by 20 July produced the lowest (3.77 t ha^{-1}). HR rice Ajay produced significantly higher grain yield (5.60 t ha^{-1}) than cv. Tapaswini.

Dry matter of weeds m^{-2} infesting plant rice at 40 DAS decreased significantly with delay in sowing beyond 20th June. SRI had the highest weed biomass followed by MSRI and BMP. BMP had the highest per cent of sedges while MSRI and SRI had the highest per cent of grasses and broad leaved weeds, respectively.

REFERENCES

Uphoff, N., Fernandes, B. C. M.,Yuan, L. P., Peng, L. M., Rafaralahy, S. and Rabenandrasena, J. 2002. Assessment of the system of rice intensification (SRI). *Proc. Int. Conf.*, Sanya, China. 1-4 April, 2002.

Babar, S. R. and Valayutham, A. 2012. Weed management practices on nutrient uptake, yield attributes and yield of rice under system of rice intensification. *Madras Agril. J.*, **99**: 51-54.

Gupta, O. P. 2000. *Modern Weed Management*. Agrobios (India), Jodhpur, pp.18.

Hassan, S. M., Aidy, I. R., Bastawisi, A. O. and Draz, A. E. 1998. Weed management in rice using allelopathic rice varieties in Egypt. *Proc. Workshop on Allelopathy in Rice*, 25–7 Nov. IRRI, Manila, Philippines, pp. 27-37.

Satyanarayana, A. 2004. Rice, research and real life in the field. *Nature*, **429**: 803.

Singh, S., Sinha, K. K. and Mishra, S. S. 1989. Weed management studies in different rice cultivars. *Indian J. Weed Sci.*, **21**: 27-30.