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Weed dynamics in transplanted rice after intensification of rice-fallow cropping system in Jharkhand

Devkant Prasad*, M S Yadava and Anjani Kumar[1]
Birsa Agricultural University, Ranchi 834006 (Jharkhand)
[1]Central Rice Research Institute, Cuttack, Odisha 753006
Email : prasaddevkant@rediffmail.com

ABSTRACT

A field experiment was initiated in 2006-07 at Kanke centre of AICRP on cropping systems. The present study was conducted to observe the effect of intensification of rice-fallow cropping system on weed dynamics in transplanted rice var. Lalat in 2008 and 2009 i.e. 4th and 5th year. Results showed that intensification of rice - fallow cropping system at 300% cropping intensity considerably reduced the weed population and weed dry matter production as compared to 200% (rice-wheat) and 100% (rice-fallow) cropping systems. Among the cropping systems tested, rice - potato + wheat (1:1) - green gram recorded significantly lowest weed population and weed dry matter (at par with rice-potato-green gram). Intensification of rice-fallow was found to produce higher production and productivity of rice. Nevertheless, the yield differences were significant only in 2009 during which rice - potato - green gram recorded maximum rice grain yield being at par with the grain yield in rice - potato + wheat (1:1) - green gram. Effect of cropping system on harvest index of rice crop was also significantly higher at 300% intensification in rice - potato + wheat (1:1) - green gram and rice - potato - green gram over others

Key words: *cropping system, crop diversification, crop intensification, weed dynamics, rice-fallow*

In Jharkhand, cropping intensity is reported to be low (114%) due to the prevailing land situation in the state which consists of the lands on upper slope (uplands) and lands fallowing down slope (medium and low lands) which is mainly ccupied by rice (15 lakh ha) out of net sown area (18.07 lakh ha), thus, rice enjoys the status of major crop in all land situations (highest coverage in medium lands, Singh *et al*., 2008). Fields remain fallow in uplands due to inadequate water availability while in low lands due to excessive wetness and stickiness after rice harvest which restricts tillage operation because of heavy texture & poor drainage (Raman, 2008). A key strategy to increase intensity and income of farm family in rice based cropping system is to have second crop after rice. It is easily possible for growing an assured dry season crop by adoption of water conservation technology and advancing date of wet season rice. Second important crop after rice can be wheat, rajmah, mustard, potato etc. to fulfill the food requirement of farm family and summer, green gram to maintain sustainability and fertility of the system. The crop intensification through use of farm resources and improved technologies under these situations is one of the most feasible option. Among improved technology, weed management is most important as, weeds pose serious problems in rice cultivation under rice- based cropping system. The major weeds in rice are *Echinochloa spp*, *Digitaria sanguinalis*, *Commelina benghalensis*, *Celosia argentina*, *Cyperus rotundus*, *Cyperus iria* and *Cyperus difformis* (Singh and singh, 1996). Reduction in yield due to weeds has been reported to the extent of 45% depending upon the soil type and rainfall pattern of a particular area (De Datta, 1981).

The prolonged cultivation of one crop e.g. rice in rice-based cropping system has increased weed population and specialized weed species to a greater extent. The behavior of weeds in rice as a function of

preceding rabi and summer season crop may change due to diversification of the traditional rice-fallow cropping system. Therefore, a study was undertaken to observe the effect of intensification of rice fallow cropping system on weed dynamics.

MATERIALS AND METHODS

A long term field experiment on need based cropping system was initiated under AICRP on cropping systems during wet season 2006 at Kanke, Ranchi. The impact of different crop sequences on the weed dynamics of rice was studied during wet season 2008 and 2009. The experimental soil was analyzed as poor in fertility with acidic in reaction (pH 6.0), sandy-clay-loam texture, low in organic carbon (3.8g kg^{-1}), available nitrogen (225.0 kg ha^{-1}), available phosphorus (20.0 kg ha^{-1}), available potassium (115.0 kg ha^{-1}), available sulphur (13.5 kg ha^{-1}) and available zinc (0.650 ppm). Eight rice-based cropping systems viz. rice- fallow, rice-wheat, rice-mustard–green gram, rice-rajmah – green gram, rice-potato-greengram, rice-wheat+ mustard (5:1)-green gram, rice-wheat+ rajmah (5:1) – greengram, and rice-potato+wheat (1:1)-green gram were tested in randomized block design with three replications. Gross plot size was 6.0 x 5.5 m. Recommended crop cultivation practices were followed. Twenty one days old seedling of rice var. Lalat was transplanted @ 2 seedlings $hill^{-1}$ and spacing of 20 x 15 cm on 03.07.08 and 13.07.09 in 2008-09 and 2009-10, respectively. Crop was fertilized @ 120, 60, 40 NPK kg ha^{-1}. Weed population in each plot was recorded at 25 DAT. Green gram after 2nd picking was cut from the ground level and green biomass so obtained was incorporated in situ as per cropping system. All the component crops were harvested at maturity. During wet season 2008, 1169.2 mm rain was received by rice crop and in 2009, the rain recorded during wet seasonwas 1063.7 mm. Weed population and dry weight of weeds were recorded per m^2 area and were subjected to transformation for statistical analysis.

RESULTS AND DISCUSSION

Weed infestation in rice was relatively higher in 2008 than 2009 (Table 1). It could be due to 325 mm rain received during one month after transplanting in 2008 as against 160.5 mm during the same period in 2009. It provided congenial environment for weed growth. Density of grassy (narrow leaved) weeds, sedges and broad leaved weeds were recorded 20.93, 29.38, 49.71 and, 21.26, 29.74, 48.84 percent during 2008 and 2009, respectively. The higher rainfall received during 2008 caused higher emergence of broad leaved weeds while on contrary, grassy weeds emergence was favoured in lower rainfall during 2009.

Among the grassy (narrow leaved) weeds *Echinochloa crusgalli* (L.) was predominant and was followed by *Echinochloa colona* (L.) with little infestation of *Cynodon dactylon.* In sedges, *Cyprus rotundus* (L.) was considerably higher followed by *Cyprus irria* (L.). Major broad leaved weeds were *Nymphea spp*. and *Oxalis acetosella.*

The effect of different cropping intensities (100-300%) on weed density was clearly observed. In general, diversification and intensification of rice-fallow caused significant reduction in weed density. At 300% cropping intensity, rice-potato + wheat (1:1) – green gram had the lowest population of weeds but, it remained *at par* with the rice-potato-green gram cropping system. Specially, lower density of narrow leaved, sedges and broad leaved weeds were recorded. Intensification of rice-fallow recorded marked decline of weed density in rice. So, inference can be made that intensification is an effective way to overcome menace of weeds in wet season. The traditional cropping of rice-fallow recorded the highest population of all the category of weeds as compared to rice-wheat system at 200 % cropping intensity.

Weed dry matter production was similar to total weed dry matter production in rice-potato + wheat (1:1) -green gram followed by rice-potato-green gram. All the sequences at 300% cropping intensity remained comparable among themselves and showed significantly lower weed dry matter than rice-fallow followed by rice-wheat at 100% and 200% cropping intensity, respectively. It means higher intensity of cropping system has lower weed dry matter production in wet seasonseason. A better performance of rice-potato + wheat (1:1)-green gram sequence was observed mainly because it occupied the field under cultivation for maximum number of days than other sequences namely rice-fallow and rice-wheat. Intensification of cropping system by including potato effectively controlled weeds without herbicide application or manual weeding (ICAR, 2002).

Table 1. Weed density (no. m^{-2}) and weed dry weight (g m^{-2}) in wet season crop rice (Var. Lalat) at 25 DAT under different crop sequences during 2008 and 2009

Cropping systems and cropping intensity	Narrow leaved weed m^{-2}			Sedges m^{-2}			Broad leaved weeds m^{-2}			Total weeds m^{-2}			Weed dry matter (g m^{-2})		
	2008	2009	Pooled	2008	2009	Pooled	2008	2009	Pooled	2008	2009	Pooled	2008	2009	Pooled
Rice- Fallow (100%)	12.01 (145)	12.10 (146)	12.06 (145)	14.30 (204)	14.10 (198)	14.20 (201)	17.43 (303)	17.09 (292)	17.26 (298)	43.74 (651)	25.23 (636)	34.48 (644)	14.31 (205)	15.36 (235)	14.83 (220)
Rice-Wheat (200%)	11.65 (135)	11.21 (125)	11.43 (130)	13.84 (191)	13.53 (183)	13.68 (187)	17.10 (292)	15.92 (253)	16.51 (273)	42.58 (618)	23.70 (561)	33.14 (590)	13.93 (194)	14.42 (208)	14.18 (201)
Rice-Mustard-Greengram(300%)	10.16 (102)	9.88 (97)	10.02 (100)	11.55 (133)	11.10 (123)	11.32 (128)	15.80 (249)	15.17 (230)	15.49 (240)	37.52 (485)	21.21 (450)	29.37 (467)	12.44 (155)	12.92 (166)	12.68 (161)
Rice-Rajmash-Greengram(300%)	9.27 (85)	9.02 (80)	9.14 (83)	11.29 (127)	11.13 (123)	11.21 (125)	14.18 (201)	13.67 (186)	13.93 (193)	34.74 (413)	19.78 (391)	27.26 (402)	11.43 (130)	12.04 (145)	11.74 (137)
Rice-Potato-Greengram(300%)	7.50 (55)	7.26 (52)	7.38 (54)	10.02 (100)	9.53 (90)	9.78 (95)	13.59 (184)	12.79 (163)	13.19 (174)	31.12 (340)	17.50 (306)	24.31 (323)	10.46 (109)	10.66 (113)	10.56 (111)
Rice-Wheat+ Mustard (5:1)-Green gram (300%)	11.27 (126)	10.96 (119)	11.11 (123)	12.98 (168)	12.38 (153)	12.68 (160)	16.79 (281)	16.03 (257)	16.41 (269)	41.04 (576)	23.01 (529)	32.02 (553)	13.55 (183)	14.01 (196)	13.78 (190)
Rice-Wheat+ Rajmah (5:1)-Greengram (300%)	11.00 (120)	10.62 (112)	10.81 (116)	12.03 (144)	11.68 (136)	11.86 (140)	16.52 (272)	15.80 (249)	16.16 (261)	39.55 (537)	22.32 (498)	30.93 (517)	13.11 (172)	13.59 (184)	13.35 (178)
Rice-Potato+ Wheat (1:1)-Greengram (300%)	7.01 (49)	6.93 (47)	6.98 (48)	9.26 (85)	9.02 (81)	9.14 (83)	12.93 (167)	12.47 (155)	12.70 (161)	29.20 (301)	16.85 (284)	23.03 (292)	9.76 (95)	10.26 (105)	10.01 (100)
SEm±	0.21	0.19	0.14	0.15	0.13	0.10	0.13	0.14	0.09	0.33	0.16	0.18	0.32	0.12	0.17
CD (P = 0.05)	0.65	0.55	0.42	0.46	0.40	0.29	0.39	0.42	0.27	1.01	0.48	0.53	0.99	0.36	0.50

*Data in parenthesis were transformed to √x+0.5

Inclusion of potato in rice-fallow (100%) caused significant reduction in weed population. The minimum grassy weed population was observed in rice -potato + wheat (1:1)-green gram and remained at par with in rice-potato-green gram sequence. The highest population was recorded in rice-fallow being *at par* with rice-wheat cropping system.

Sedges were lowest under rice-potato+wheat (1:1) being *at par* with rice-potato-green gram sequence which recorded significantly lower number of sedges than all other cropping sequences. The population of sedges were highest in rice-fallow which was *at par* with the rice-wheat.

The population density of broad leaved weeds was significantly lower in cropping sequences involving potato crop in dry season (potato + wheat and potato alone) than rice-fallow. Rice-potato + wheat (1:1)-green gram sequence recorded significantly lower number of broad leaved weeds than all other cropping systems and the highest population of broad leaved weeds was observed in rice-fallow followed by rice-wheat.

Marked variation in grain and straw yield of rice was observed in different cropping systems (Table 2). Cropping systems involving green gram produced higher grain and straw yield than rice- fallow. However, the differences were significant only during 2009. This showed that leguminous crops in different sequences enhanced the productivity of next crop due to legume effect. As the experiment was initiated in 2006, it took 4 years to exhibit significant legume effect in terms of rice yield. The cropping sequence viz. rice-potato-green gram recorded maximum grain yield being at par with rice-potato + wheat (1:1)-green gram and rice-rajmah-green gram while the lowest was recorded in rice-fallow. Intensification of the traditional rice based cropping (rice-fallow) by growing potato and /or potato + wheat (1:1) in dry season along with summer legume might have improved the physical properties as well as NPK status of soil. The improvement in soil fertility results in better vegetative characters, provides edge to crops in competition with weeds and improved yield attributing characters which ultimately leads to increase in yield of rice. Growing of tuber crop like potato improves soil physical condition and higher dose of nutrient application to potato crop increases soil nutrient availability which in turn facilitates the easy mining of nutrients by the rice plants and ultimately leads to higher yield.

Straw production was almost similar in all the rice based cropping sequences, which is in close agreement with the findings of Yadav *et al*. (2005). The puddling created similar rice-soil condition for transplanting. But, harvest index differed significantly (in 2009) which showed the need of intensification over rice-fallow because grain yield increased with the intensification of cropping systems at 200% and 300%. Rice-potato + wheat (1:1)-green gram and rice-potato -green gram sequence recorded significantly higher harvest index Followed by Rice-wheat+rajmah (5:1) - green gram and rice-rajmah-green gram. Harvest index (HI) was lowest in rice-fallow mainly due to lower grain yield, however the straw yield was similar as in other

Table 2. Effect of cropping sequences on yield (t ha^{-1}) of rice (var. Lalat) during 2008 and 2009

Cropping systems and cropping intensity	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})			Harvest index (%)		
	2008	2009	Pooled	2008	2009	Pooled	2008	2009	pooled
Rice- Fallow (100%)	3.35	3.46	3.41	5.05	5.34	5.19	3.98	3.93	3.96
Rice-Wheat (200%)	3.70	3.72	3.71	5.22	5.34	5.28	4.14	4.10	4.12
Rice-Mustard-Greengram (300%)	3.62	3.66	3.64	5.06	5.42	5.24	4.16	4.02	4.09
Rice-Rajmash-Greengram (300%)	3.67	3.83	3.75	5.10	5.44	5.27	4.18	4.13	4.16
Rice-Potato-Greengram (300%)	3.97	4.25	4.11	5.26	5.38	5.32	4.29	4.41	4.35
Rice-Wheat+ Mustard (5:1)-Green gram (300%)	3.64	3.65	3.64	5.16	5.34	5.25	4.13	4.06	4.10
Rice-Wheat+ Rajmah (5:1)-Greengram (300%)	3.75	3.77	3.76	4.76	5.26	5.01	4.40	4.17	4.29
Rice-Potato+ Wheat (1:1)-Greengram (300%)	3.82	4.18	4.0	4.86	5.22	5.04	4.39	4.44	4.41
SEm±	0.23	0.13	0.13	0.24	0.24	0.17	0.10	0.06	0.06
CD (P = 0.05)	NS	4.26	3.99	NS	NS	NS	NS	1.97	1.84

cropping. It means that conversion of photosynthetic product into grains was lower and the broadleaved weed density was higher in wet season paddy due to fallow land situation after rice harvest in the system which was closely followed by rice-wheat at 200%. But, at 300% i.e. higher intensification further caused reduction in population and dry matter production of weeds and thus produced more economic yield. So, it may be concluded that the intensification of rice- fallow system is essentially needed as one of the possible ways to reduce weed infestation and to enhance the production and productivity of rice based cropping systems.

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