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Short Communication

Effect of agronomic and weed management practices on crop growth rate and relative growth rate of direct seeded rice under agro climatic condition of eastern Uttar Pradesh

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Rice (*Oryza sativa* L.) is the most important and extensively grown crop in tropical and subtropical regions of the world being the staple food crop for more than 70% of the world population. Uttar Pradesh is the largest rice growing state after West Bengal in India. However, to sustain the present food self sufficiency and to meet future food requirements, there is need to increase rice productivity. Direct seeded rice is a viable alternative over transplanting in rescuing farmers (Farooq *et al.*, 2011). Direct seeded rice is replacing traditional transplanting in areas with good drainage and water control (Balasubramanian and Hill, 2002). It needs only 34% of the total labour requirement and saves 29% of the total cost of transplanted crop (Ho and Romli, 2000). The additional benefits of DSR are water conservation, soil temperature moderation and buildup of soil organic carbon status due to residue retention at the surface. This practice of residue retention will facilitate integrated nutrient management, weed suppression and will have direct bearing on the nutritional status of soil (Shoran *et al.,* 2005). Weeds are the prime yield limiting biotic constraints that compete with rice for moisture, nutrients and light. Weed competition reduces the grain yield by 50-60% in direct seeded rice. The use of only one method of weed control in a DSR crop may not be successful for raising a good crop. Manual weeding has become difficult because of labour scarcity and increased cost (Rao *et al.*, 2007) and sole dependence on herbicidal control is not good considering the environmental aspect and also chances of weed resistance towards herbicides cannot be neglected. Therefore crop management technologies that help to reduce the competitive effects of weeds on crops, environmental friendly and economical are needed. Mulching is a technique to reduce weed problems in direct seeded rice. It also helps in maintaining optimum surface soil moisture for germination and rooting of the crop along with controlling weeds. *Sesbania* can be grown as live mulch with rice. Brown manuring is simply a no-till version of green manuring, in which selective herbicide 2, 4 –D @ 400-500 g/ha is applied to knockdown and desiccate the *Sesbania* nearly at blooming (30- 40 days) stage. Integration of suitable herbicides (pre and post-emergence) (Singh, 2009) or/and *Sesbania* co-culture (Maity and Mukherjee, 2011) can help in effective reduction of crop-weed competition by reducing weed

population and their biomass in direct seeded rice and improved growth parameters which ultimately results in higher yield. Manipulation of crop fertilization is a promising approach to reduce weed infestation and may contribute to long-term weed management. Fertilizer management should aim at maximizing nutrient uptake by crop and minimizing nutrient availability to weeds. It is important to understand weed responses to N rates for the development of strategies that reduce N availability to weeds. Therefore, the study of inclusion of live mulch under different nitrogen levels and application of herbicides in combination or sequence was conducted.

The experiment was laid out in split-plot design with three replications. The mulching (no mulch and live mulch *i.e.* brown manuring with *Sesbania*) and nitrogen doses (120, 150 and 180 kg ha^{-1}) were assigned to main plots and weed management practices (weedy; two hand weeding at 20 and 40 DAS; azimsulfuron @ 30 g ha^{-1} + bispyribac-sodium @ 25 g ha^{-1} at 10-15 DAS; pendimethalin @ 1 kg ha^{-1} at 1-3 DAS *fb* bispyribac-sodium @ 25 g ha^{-1} 15-20 DAS) in sub plots. Rice variety Sarjoo 52 was sown in the last week of June. Seed of *Sesbania* was broadcasted just after seeding of rice for brown manuring and was knock down at 25 DAS with the help of 2, 4 D @ 0.5 kg ha^{-1}. A uniform dose of 60 kg P_2O_5 and 60 kg K_2O ha^{-1} was applied in all the treatments through single super phosphate and murate of potash, respectively. Nitrogen doses of 120, 150 and 180 kg/ha was given as per treatment through urea. Half of total nitrogen and full dose of phosphorus and potassium were applied to rice crop as basal application before sowing. Remaining half dose of nitrogen in the form of urea was top dressed in two equal splits, at active tillering and panicle initiation stage during both the years.

Crop growth rate (CGR) was calculated by using the formula given by Fischer (1981).

$$\text{CGR (g m}^{-2}\text{ day}^{-1}) = \frac{W_2 - W_1}{T_2 - T_1}$$

Where, W_2= final weight of plant (g m^{-2}) at time T_2 (in days)

W_1= initial weight of plant (g m^{-2}) at time T_1 (in days)

Relative growth rate (RGR) was calculated by using the formula

$$\text{RGR (mg g}^{-1}\text{ day}^{-1}) = \frac{\ln W_2 - \ln W_1}{T_2 - T_1}$$

Where, W_2 = final weight of plant (mg m^{-2}) at time T_2 (in days)

W_1 = initial weight of plant (mg m^{-2}) at time T_1 (in days

Crop growth rate (g m^{-2} day^{-1})

The experimental data related to crop growth rate of direct seeded rice [Table 1] revealed that it increased gradually with advancement of growth stages reaching its maximum at 60-90 DAS and after 90 DAS till harvest it declined drastically. Mulching, nitrogen levels and different weed management practices significantly influenced crop growth rate under direct seeded rice. At 0-30 DAS the effect of brown manuring with *Sesbania* was found non-significant. However, brown manuring with *Sesbania* resulted in significantly higher crop growth rate over no mulching at 30-60 DAS, 60-90 DAS and 90 DAS to harvest for both the years. CGR was found lowest with 120 kg N ha^{-1} and highest with 180 kg N ha^{-1} which was statistically at par with 150 kg N ha^{-1} at all the stages of crop growth for both the years. Among different weed management practices, application of pendimethalin @ 1kg ha^{-1} *fb* bispyribac- sodium @ 25 g ha^{-1} ha recorded maximum and significantly higher crop growth rate at all the crop growth stages during both the years. It was also observed that treatments azimsulfuron @ 30 g ha^{-1} + bispyribac- sodium @ 25 g ha^{-1} and two hand weeding (20 and 40 DAS) were statistically at par with each other except at 90 DAS to harvest stage for the year 2015.

Table 1: Effect of agronomic and weed management practices on crop growth rate (g $m^{-2}day^{-1}$) of direct seeded rice

Treatments	0-30 DAS		30-60 DAS		60-90 DAS		90DAS-At harvest	
	2014	2015	2014	2015	2014	2015	2014	2015
Mulching								
No mulch	5.40	5.63	6.68	6.83	17.09	17.70	1.58	2.02
Live mulch (Brown manuring with *Sesbania*)	5.58	5.71	6.96	7.19	17.33	17.94	1.86	2.14

SEm±	0.08	0.05	0.04	0.04	0.07	0.06	0.05	0.05
CD (P=0.05)	NS	NS	0.13	0.14	0.19	0.18	0.13	0.11
Nitrogen levels (kg ha^{-1})								
120	5.09	5.20	6.51	6.87	16.08	16.88	1.57	1.70
150	5.65	5.86	6.95	7.05	17.73	18.26	1.77	2.24
180	5.73	5.95	7.01	7.12	17.83	18.33	1.81	2.30
SEm±	0.08	0.05	0.04	0.04	0.07	0.06	0.05	0.05
CD (P=0.05)	0.27	0.14	0.13	0.14	0.19	0.18	0.13	0.11
Weed management practices								
Weedy	5.09	5.20	5.78	5.9	16.09	16.43	1.15	1.51
Two hand weeding (20 and 40 DAS)	5.49	5.70	7.04	7.11	17.35	18.01	1.78	2.23
Azimsulfuron @ 30 g ha^{-1} + Bispyribac-sodium @ 25 g ha^{-1}	5.47	5.61	6.96	7.09	17.30	17.95	1.75	2.00
Pendimethalin @ 1kg ha^{-1} *fb*Bispyribac-sodium @ 25 g ha^{-1}	5.90	6.16	7.49	7.94	18.11	18.90	2.19	2.57
SEm±	0.03	0.04	0.04	0.03	0.06	0.05	0.04	0.03
CD (P=0.05)	0.08	0.11	0.12	0.10	0.12	0.14	0.11	0.09

Table 2: Effect of agronomic and weed management practices on relative growth rate (mg g^{-1} day^{-1}) of direct seeded rice

Treatments	**30- 60 DAS**		**60-90 DAS**		**90 DAS -At Harvest**	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Mulching						
No mulch	21.19	23.50	25.12	25.27	1.85	2.20
Live mulch (Brown manuring with *Sesbania*)	23.23	25.68	27.13	27.61	1.94	2.33
SEm±	0.52	0.56	0.31	0.33	0.03	0.03
CD (P=0.05)	1.53	1.42	0.92	0.98	0.07	0.08
Nitrogen levels (kg ha^{-1})						
120	20.00	21.77	25.55	25.67	1.79	1.82
150	23.28	25.90	26.50	26.67	1.90	2.40
180	23.34	26.09	26.33	26.97	2.02	2.58
SEm±	0.52	0.56	0.31	0.33	0.03	0.03
CD (P=0.05)	1.53	1.42	0.92	0.98	0.07	0.08
Weed management practices						
Weedy	19.60	21.67	24.33	25.70	1.67	2.17
Two hand weeding (20 and 40 DAS)	22.30	24.88	26.44	26.60	1.86	2.27
Azimsulfuron @ 30 g ha^{-1} + Bispyribac-sodium @ 25 g ha^{-1}	22.07	24.81	25.78	26.57	1.84	2.25
Pendimethalin @ 1kg ha^{-1} *fb*Bispyribac-sodium @ 25 g ha^{-1}	24.88	26.98	27.96	26.88	2.22	2.40
SEm±	0.50	0.41	0.23	0.25	0.03	0.03
CD (P=0.05)	1.50	1.34	0.82	0.89	0.06	0.07

Relative growth rate (mg g^{-1} day^{-1})

From the experiment conducted it was found that the addition of live mulch (brown manuring with *Sesbania*) in direct seeded rice resulted in significantly higher relative growth rate (Table 2) over no mulch for both the years at all crop growth stages. Different nitrogen levels significantly influenced the relative growth rate of direct seeded rice. Highest relative growth rate was recorded when 180 kg N ha^{-1} was supplied at all the stages of observation during both the years of investigation. It was comparable to 150 kg N ha^{-1} as both were statistically at par except at 90 DAS to harvest where 180 kg N ha^{-1} was found to be significantly higher than rest of the nitrogen levels during both the years. Various weed management practices significantly affected relative growth rate of direct seeded rice crop at all stages of observation during both the years. It was observed that maximum relative growth rate was recorded with the treatment pendimethalin @ 1kg ha^{-1} *fb* bispyribac- sodium @ 25 g ha^{-1} followed by two hand weeding (20 and 40 DAS).

Crop growth rate and relative crop growth rate were affected by addition of mulch with various nitrogen levels. Application of a pre emergent and a post emergent weed management practice had lowered the dry matter accumulation of weeds over weedy check and consequently favoured crop growth with abundant supply of moisture, nutrient, light and space. So, it can be concluded that live mulching and application of 150 kg N ha^{-1} along with a combination of pre and post emergent herbicides shows better result in relation to growth parameters of DSR.

Author contributions

Conceptualization of research (GG, YS, MR & ACM); Designing of the experiments (GG, YS, MR & ACM); Contribution of experimental materials (GG, YS, MR & ACM); Execution of field/lab experiments and data collection (GG, YS, MR & ACM); Analysis of data and interpretation (GG, YS, MR & ACM); Preparation of the manuscript (GG, YS, MR & ACM).

Conflict of interest: No

Declaration

The authors declare no conflict of interest.

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