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ISSN: 0974-4908
Res. Environ. Life Sci.
9(9) 1147-1149 (2016)

Effect of seed rate and weed control methods on yield of direct seeded rice (*Oryza sativa* L.)

Rajneesh Singh*, Brijesh Kumar Verma, O.P. Rai, N.B. Singh and G. Singh
Department of Agronomy, Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad, India
***e-mail:** rajneesh6838@gmail.com

(Received: December 22, 2015; Revised received: June 17, 2016; Accepted: June 26, 2016)

Abstract: A field experiment was conducted during *kharif* season of 2013 to evaluate the bio efficacy of pre and post emergence herbicides and three seed rate of rice (40,50 and 60 kg ha^{-1}) weed free and weedy check were also included in the experiment. The field experiment was laidout in randomized block design (factorial) with three replications. *Echinochloa colona* & *E. crusgalli* among grasses, *Commelina benghalensis* among broad leaved and *Cyperus rotundus* among sedges were the predominant weed species in experimental field. Uncontrolled weeds in caused a substantial reduction in grain yield (66.07 %) over weed free check. The lower weed density and dry weight and higher value of germination are yield attributes as well as grain yield (25.39qha^{-1})were recorded under 60 kgha^{-1} seed rate. Post-emergence application of bispyribac-sodium @ 25 g ha^{-1} applier at 30 DAS, recorded higher grain yield of rice (24.45qha^{-1}) followed by Pendimethalin @ 1.0 kg ha^{-1} (PE) reducing population & dry matter of weeds and it lead to highest grain yield which ultimately fetched highest net return.

Keywords: Rice, Seed rate, Weed, Herbicides, Yield

Introduction

Rice (*Oryza sativa* L.) is the important food of majority of people in the world and also called as the prince of the cereals. It is an important food grain crop, grown extensively in tropical and subtropical regions of the world. About 90 per cent of rice grown in the world is produced and consumed in the Asian region. India ranks first in acreage (43.1 m ha) and second in production (96.43 mill t) only after China. Uttar Pradesh is the largest rice growing state after West Bengal where rice is grown in 5.69 m ha of area with a production of 11.7 m tones ha^{-1}. The average productivity of U.P. (2.2 t/ha) is much lesser than that of other rice growing states in the country. Conventional method of rice growing in Pakistan is the raising of rice nursery in a nursery bed and transplanting one month old nursery seedlings in a puddled and flooded field (Ehsanullah *et al.,* 2007). This method not only effectively suppresses the rice weeds by preventing the light to reach the weeds through a layer of the standing water and also provides the rice plants with a better growing environment (Begum *et al*. 2006; Chauhan and Johnson, 2009; Farooq *et al.,* 2011). However, immense labour and water is required to grow rice by conventional flooded method (Bouman *et al*., 2007; Bhushan *et al.,* 2007). In the backdrop of the declining water resources and reduced availability of the labour, the conventionally flooded rice growing system is losing its sustainability and economic viability (Guerra *et al.,* 1998; Bhushan *et al.,* 2007). Direct seeding of rice is an alternative option to cope with the problems of water and labour scarcity associated with conventionally flooded rice (Weerakoon *et al.,* 2011). Direct seeding of rice is accomplished by either of the methods as water seeding, wet seeding and dry seeding (Farooq *et al*., 2011). Direct seeded rice is being cultivated successfully in many parts of the world like China, Australia, Malaysia, United States, and Sri Lanka etc. (Weerakoon *et al.* 2011). Weeds are the serious constraint to the productivity of direct seeded rice (Rao *et al*., 2007). Weeds grow quickly in direct seeded rice compared with the weeds growth in transplanted flooded rice and other crops (Chauhan and Johnson, 2009). Different weed control practices have been evaluated to minimize the weed pressure in direct seeded rice (Chauhan *et al.,* 2010). Direct seeded (line sowing) is a good alternative of transplanting and yield potential of direct seeded rice is equivalent to the transplanted rice under good water management and weed control conditions.

Methods and Materials

The experiment was conducted during kharif season of 2013-14 at Agronomy Research Farm of N.D.U.A.&T., Faizabad whier is situated at 26^0 47' N latitude, 82^0 12' E longitudes and an altitude of 113 meters above mean sea level. Soil of the experiment at field was Silt loam in texture, with a pH of 8.0, the organic carbon and available NPK were 0.35%, 185.0, 10.21, and 215.10 kgha^{-1}, respectively. The experiment was laidout in Randomized Block Design (R.B.D.) with three replications. The treatments comprised of three seed rate (40, 50 and 60 kg ha^{-1}) and five weed control methods (pendimethalin 1.0 kg ha^{-1} at 2 DAS, bispyribac-sodium 25 g ha^{-1} at 30 DAS and almix mix chlorimuron-ethyl @ 4 g ha^{-1} and metsulfuron methyl at 30 DAS, weed free and weedy check) comprising fifteen treatment combinations. Treatments were replicated three times. A rice cultivar NDR-97 was sown using seed rate as per the treatments. The sprouted seeds with radicle length one to two millimetre are uniformly sown by hand in the puddled field on 25th June, 2013. Recommended dose of N, P and K 120 kg N; 60 kg P_2O_5 and 60 kg K_2O ha^{-1}, were applied as half dose of nitrogen, full dose of phosphorus and potassium were applied as basal are nitrogen was applied as top dressing in two equal splits each at tillering (25-30 DAS) and panicle initiation stages (55-65 DAS), respectively.

Result and Discussion

Effect on weed: The major weeds were *Echinochloa colona* & *E. crusgalli* among grasses and *Commelina benghalensis* among non-grasses were pre-dominant weed species. *Cyperus rotundus* was the only sedge in the experimental field irrespective of treatments. Among grasses *Echinochloa colona* was recorded (36.5%) and *E. crusgalli* was recorded (53.92%) under sown crop in weedy check

Table-1: Effect of seed rate and weed control methods on density and dry weight (g m^{-2}) of weeds

Treatment	Weeds density (No.m^{-2})												Weed dry weight	
	E. colona		*E. crusgalli*		*C. benghalensis*		*C. rotendus*		Other weeds (No.m^{-2})		Total			
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Seed rate (kg ha^{-1})														
S_1	3.67	4.18	4.43	5.06	3.01	3.41	3.31	3.76	5.68	6.97	9.00	10.61	5.86	14.91
	(15.84)	(20.70)	(23.52)	(30.98)	(10.280)	(13.46)	(12.68)	(16.58)	(39.64)	(60.10)	(101.96)	(141.84)	(41.99)	(282.30)
S_2	3.61	4.10	4.35	4.97	2.96	3.35	3.25	3.69	5.58	6.84	8.83	10.41	5.75	14.63
	(15.24)	(19.92)	(22.64)	(29.82)	(9.90)	(12.96)	(12.20)	(15.96)	(38.12)	(57.84)	(98.10)	(136.50)	(40.41)	(271.56)
S_3	3.49	3.97	4.20	4.80	2.86	3.24	3.15	3.57	5.39	6.61	8.53	10.05	5.55	14.12
	(14.18)	(18.56)	(21.41)	(27.74)	(9.20)	(12.06)	(11.36)	(14.84)	(35.50)	(53.80)	(91.30)	(127.00)	(37.61)	(252.72)
SEm±	0.04	0.04	0.06	0.05	0.03	0.03	0.03	0.04	0.06	0.09	0.11	0.13	0.07	0.19
C.D.(P=0.05)	0.12	0.13	0.17	0.17	0.10	0.10	0.10	0.14	0.18	0.28	0.34	0.39	0.22	0.55
Weed control methods														
W_1	5.78	6.48	6.99	7.90	4.68	5.23	5.18	5.80	9.11	10.98	14.56	16.86	9.22	23.65
	(32.97)	(41.50)	(48.50)	(62.00)	(21.40)	(26.93)	(26.40)	(33.23)	(82.50)	(120.33)	(211.77)	(284.00)	(84.55)	(559.70)
W_2	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
W_3	3.51	4.38	4.30	5.33	2.86	3.56	3.15	3.93	5.47	7.39	8.76	11.33	5.72	16.39
	(11.80)	(18.70)	(18.00)	(28.00)	(7.70)	(12.20)	(9.43)	(14.97)	(29.50)	(54.27)	(76.43)	(123.13)	(32.22)	(268.50)
W_4	3.87	4.06	4.69	4.95	3.14	3.30	3.48	3.64	6.06	6.84	9.67	10.49	6.25	14.72
	(14.47)	(15.97)	(21.50)	(24.07)	(9.37)	(10.40)	(11.60)	(12.77)	(36.27)	(46.40)	(93.20)	(109.60)	(38.62)	(216.60)
W_5	4.08	4.79	4.95	5.83	3.31	3.88	3.67	4.30	6.40	8.10	10.23	12.41	6.71	17.31
	(16.20)	(22.50)	(24.03)	(33.50)	(10.50)	(14.600	(12.97)	(18.00)	(40.50)	(65.23)	(104.20)	(153.83)	(44.63)	(299.50)
SEm±	0.03	0.04	0.05	0.05	0.03	0.03	0.03	0.04	0.05	0.08	0.10	0.11	0.06	0.16
C.D.(P=0.05)	0.11	0.12	0.15	0.14	0.09	0.09	0.09	0.12	0.15	0.24	0.29	0.34	0.19	0.48

Values in parentheses are original values, which were subjected to square root transformation. **Note: Seed rate; S_1**: 40, **S_2**: 50, **S_3:** 60 kg ha^{-1} **Weed control methods; W_1**: Pendimethalin @ 1.0 kg ha-1 (PE) at 2-4DAS, **W_2:** Bispyribac -sodium @ 25 g ha-1 (POE) at 30 DAS, **W_3**: Ready mix chlorimuron-ethyl @ 4 g ha-1 (POE.) at 30 DAS, **W_4**: Weed free, **W_5**: Weedy check.

Table-2: Effect of seed rate and weed control methods on growth, yield attributes and yield of direct seeded rice

Treatment	Plant height (cm)		Leaf area index		Dry matter (g m^{-2})		Length of panicle	Number of	Test weight	Grain yield	H.I. (%)
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	(cm)		grain $panicle^{-1}$	(g)	(q ha^{-1})
Seed rate (kg ha^{-1})											
S_1	23.76	55.09	1.95	3.04	33.26	199.52	20.90	157.04	22.33	21.15	36.83
S_2	25.27	58.57	2.07	3.23	35.35	212.12	20.30	152.50	21.90	23.98	37.15
S_3	26.06	60.31	2.13	3.33	36.41	218.41	19.10	143.44	21.46	25.39	38.02
SEm±	0.55	1.17	0.04	0.07	0.82	5.17	0.53	3.87	NS	059	-
C.D. (P=0.05)	1.60	3.41	0.14	0.22	2.39	14.98	1.54	11.22	NS	1.73	-
Weed control methods											
W_1	22.05	51.05	1.80	2.82	30.82	184.83	18.30	132.87	19.27	20.68	37.05
W_2	27.08	62.63	2.21	3.46	37.80	226.83	21.10	163.07	23.64	25.38	37.80
W_3	25.27	58.57	2.07	3.23	35.37	212.10	25.30	152.53	22.12	23.74	37.11
W_4	26.00	60.30	2.13	3.32	36.40	218.42	20.90	157.00	22.78	24.45	37.57
W_5	24.75	57.40	2.03	3.17	34.65	207.90	19.90	149.50	21.68	23.28	37.14
SEm±	0.47	1.02	0.04	0.06	0.71	4.48	0.46	3.35	NS	0.51	-
C.D. (P=0.05)	1.38	2.95	0.12	0.19	2.07	12.98	1.34	9.72	NS	1.50	-

Note: Seed rate; S_1: 40, **S_2**: 50, **S_3:** 60 kg ha^{-1} **Weed control methods; W_1**: Pendimethalin @ 1.0 kg ha-1 (PE) at 2-4DAS, **W_2:** Bispyribac -Na @ 25 g ha-1 (POE) at 30 DAS, **W_3**: Ready mix chlorimuron-ethyl @ 4 g ha-1 (POE.) at 30 DAS, **W_4**: Weed free, **W_5**: Weedy check

plots. Among non-grassy weeds, *Commelina benghalensis* was recorded (66.7%) in sown crop in weedy check plots. Among the sedges, *Cyperus rotundus* was recorded (29.22%) and 71.47% other weeds in sown crop in weedy check plots. The "other weeds" were *Panicum maximum* among grasses, *Triantheama monogyna* & *Caesulia axillaris* among non-grasses and *Cyperus iria* among sedges and their population was erratic and less in number. The predominance of these species in direct seeded rice has also been reported by Singh (1997) and Singh *et al.* (2002).

Weed flora of the experimental plot was increased up to 60 DAS and thereafter decreasing trend was recorded up to harvest. Among the seed rate minimum density of total weeds was recorded from 60 kg ha^{-1} being at par with 50 kg ha^{-1} significantly lower than 40 kg ha^{-1} seed rate all the stages of crop growth. It has also been reported to be very sensitive by Reddy (1988) and Singh (1999). The population and dry matter of total weeds were recorded significantly higher in higher seed rate as compared to other seed rate due to stale seed effect on weeds. Similar results were also reported by Kathiresan *et al.* (1997) from Madurai (Tamil Nadu) and they found that the crop sown after onset of monsoon due to stale seed bed effect on weeds and weed germination might have initiated even before the onset of monsoon under dry conditions with least available water in sub-soil layers. The dry matter accumulation of total weeds in weedy check plots was 84.55, 559.70 and 765.53,723.42 g m^{-2} day^{-1} between 30 to 60 DAS, 60 to 90 DAS and 90 to at harvest stages, respectively. Among the weed control treatments, bispyribac-sodium @ 25 g ha^{-1} at 30 DAS, recorded efficient control of all the weeds (grasses, non-grasses and sedges). This treatment gave the highest grain yield which was significantly higher than other treatments. Increase in grain yield in this treatment due to more number of tillers (m^{-2}), higher dry matter accumulation by crop (g m^{-2}) and less dry matter accumulation by total weeds (g m^{-2}) at all the stages of crop growth. The finding was supported by Moorthy and Saha (2003) from Cuttack, (Orissa) and Saha (2005).

Effect on crop: Perusal of response exhibited to seed rate in the present study revealed that the highest crop dry matter (g m^{-2}), plant height (cm) and This difference in dry matter accumulation (g m^{-2}), plant height (cm) and number of shoots (m^{-2}) might be due to less weed infestation in terms of total weeds density and dry matter accumulation by total weeds as compared to other seed rate, the finding was supported by Kathiresan *et al.* (1997) and Mane and Raskar (2002). The yield contributing characters namely number of effective tillers (m^{-2}), length of panicle (cm) and number of grains per-panicle were recorded significantly higher in other seed rate, due to less population and dry weight of total weeds. The finding was also supported by Mane and Rasker (2002) from Dapoli (Maharastra).

The higher grain yield in S_3 seed rate was related to higher straw yield than other seed rate. This character indicates that production and accumulation of photosynthates towards the grains were higher in per-panicle, in sown crop. Uncontrolled weeds in weedy check plots caused on an average reduction in yield 66.07 per cent over weed free plots. This finding was supported by Kolhe and Tripathi (1999). The reduction in grain yield was mainly due to high density of weeds (284.00 m^{-2}) and more dry matter accumulation of total weeds (723.42 g m^{-2}) at maturity in weedy check plots. In direct seeded rice, the extent of losses due to weeds was more than transplanted, varied from 40 to 100 per cent (Choubey *et al.,* 2001). The lowest grain yield obtained in weedy check plots was also associated with lowest number of shoots (m^{-2}) (Table 2), lowest number of effective tillers (m^{-2}), lower test weight (g) and lowest length of panicle (Table 2) due to higher crop-weed competition. Out of total weeds, the higher percentage at the stage of 60 DAS was of the *Cyperus rotundus* (34.9%). *Cyperus rotundus* has also been reported to be one of the predominant weed in direct seeded rice by Singh (1997).

Bispyribac-sodium @ 25 g ha^{-1} with the post-emergence application gave almost complete control of *Echinochloa colona, E. crusgalli* and *Commelina benghalensis* except sedges and population of sedges was recorded higher in this treatment as compared to all other weed control treatments.and produced significantly higher grain yield as compared to Pendimethalin @ 1.0 kg ha^{-1} and readymix-chlorimuron-ethyl @ 4 g ha^{-1} at 30 DAS. The finding was supported by, Bhowmik *et al.* (2000) and Bahar and Singh (2004) and he found that the post-emergence application of bispyribac-sodium @ 25 g ha^{-1} controlled grasses dominated by *Echinochloa colona* and *E. crusgalli*, except broad leaves weeds and sedges than other treatments. Bispyribac-sodium @ 25 g ha^{-1} was recorded significantly higher number of tillers (m^{-2}), number of effective tillers (m^{-2}), number of grains per panicle and test weight (g) as compared to weedy check due to less population and dry weight of weeds. It gave higher grain yield and straw yield bispyribac-sodium @ 25g ha^{-1} at 30 DAS than other weed control treatment. On the basis of one year results of the experiment, it may be concluded that Bispyribac-sodium @ 25 g ha^{-1} is best of other weed control treatments.

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