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Influence of Seed Rate and Weed Control Methods on Yield of Direct Seeded Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment entitled "Influence of seed rate and weed control methods on yield of direct seeded rice (Oryza sativa L.)" was conducted during kharif season of 2013-14 at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) to evaluate the efficacy of different herbicides viz., pendimethalin @ 1.0 kg ha^{-1} Pre emergence (PE), bispyribac-sodium @ 25 g ha^{-1} (POE) Post-emergence at 30 DAS and ready mix chlorimuron-ethyl @ 4 g ha^{-1} (POE) Post-emergence at 30 DAS with three seed rate 40,50,60 kg ha^{-1} to see their effect on weeds, crop growth, yield and economics of rice. Weed free and weedy check were also included in the experiment. The field experiment was layout in randomized block design (factorial) with three replications. Rice variety "NDR-97" was sown by direct line sowing method with recommended dose of fertilizers, 120 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare. Echinochloa colona & E. crusgalli among grasses, Commelina benghalensis among broadleaf weeds and Cyperus rotundus among sedges were the predominant weeds in experimental field. Uncontrolled weeds in weedy check plots caused an average reduction in grain yield by 66.07 per cent over weed free plots. The lowest weed population and dry weight and highest yield attributes and yield of 25.39 q ha $^{-1}$ were recorded under 60 kg ha $^{-1}$ seed rate. In chemical control Post-emergence application of bispyribac-sodium @ 25 g ha^{-1} at 30 DAS, produced highest grain yield (24.45 qha^{-1}) and reducing population & dry matter of weeds and it lead to highest grain yield.

Key words: *Seed rate, Weed control methods, Yield, Direct seeded rice*

INTRODUCTION

The direct seeding technique offers a useful option to reduce the limitations of transplanted paddy. Direct-seeded rice offers the advantage of faster and easier planting, ensures proper plant population, reduce labour and hence minimizes drudgery, hastens crop maturity by 10-12 days, increases water use efficiency and impart higher tolerance to water-deficit, and often results in higher profit in areas with assured water supply[12].

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Rice is primarily grown by transplanting of seedling in puddled field which is very cumbersome and labour intensive process as it requires 30 man days ha^{-1} [6]. Conventional flooded rice receiving the largest amount of fresh water compared to any other crop is the major contributor to the problem of declining ground water table and increasing energy use[10]. Moreover, under practical situation of contractually transplanted fields, it often, at cultivars' fields leads to lesser plant population, which generally varied from 16-21 hills m^2 against the optimum 33 hills m^2 and is major yield limiting factor at farmer's field[4].

Presently, the underground water is being over exploited by excessive pumping to meet the water need of transplanted paddy. As a consequence, it has been causing a sharp decline in water table. It is imperative to identify alternative methods of rice cultivation to overcome these constraints. 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 condition[2]. Direct seeded rice is being cultivated successfully in many parts of the world like China, Australia, Malaysia, United States, and Sri Lanka etc[12]. The productivity of the DSR is often reported to be lower, mainly due to problems associated with weed management. Chemical control is the most commonly used and reliable method for controlling weeds in rice.Chemical weed control has increased significantly over the last ten years. This is due to labour shortages, leading to an increased shift from transplanted rice to direct seeding, with a subsequent increase in herbicide use.

Although, transplanting method of establishment is reported to be the best for higher productivity of rice, but looming water crisis, water-intensive nature of rice cultivation and escalating labour costs drive the search for alternative management methods to increase water productivity and profitability in rice cultivation. Direct seeded rice (DSR) has received much attention because of its low input demand. However, weeds are a major limitation for the success of DSR[7,]. Chemical control is the most commonly used and reliable method for controlling weeds in rice. Chemical weed control has increased significantly over the last ten years. This is due to labour shortages, leading to an increased shift from transplanted rice to direct seeding, with a subsequent increase in herbicide use. Taking into consideration the necessity of chemical weed control for stable rice production, the objective of this study was to investigate the effectiveness of some herbicides for controlling weeds in rice crop, and at the same time, to estimate the optimum seed rate and weed control for DSR.

METHODS AND MATERIALS

A field experiment was conducted during kharif season of the year 2013-14 at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). Geographically, this region falls under sub-tropical zone of gangetic alluvium of eastern Uttar Pradesh (India). The annual rainfall of the region is about 1200 mm & 90 per cent of which are received from July to September. The history of the Cropping pattern (rice-wheat- fellow) of the experimental field for the last 5 years (2010-2014) was carefully examined. The soil samples were collected at random from the experimental field with the help of soil auger up to a depth of 15 cm prior to application of fertilizers. The soil samples were mixed properly and a composite sample was obtained for analysis.

The soil was silt loam in texture, with Soil pH (1:2.5) 8.0 and E.C (1:2.5) 0.23 $dsm^{-1}$and 0.35% organic carbon. It was low in Alkaline permanaganate oxidizable available nitrogen (185 $kgha^{-1}$), medium in Olsen's available phosphorus (10.3 kg/ha) and medium in flame photometer available potassium (215.10 kg/ha). The experiment was conducted in Randomized Block Design with three replications. The treatments consisted of three seed rate & five weed control methods comprising fifteen treatment combinations The treatments comprised of three seed rates viz.,(S1) 40, (S2) 50 and (S3)-60 kg/ha which were assigned to main plots and five weed control methods viz., weedy check (W1), weed free (W2), pendimethalin (W3) 1.0 kg/ha pre-

emergence (PE), bispyribac-sodium (W4) 25 g/ha and ready-mix chlorimuron-ethyl (W5) 4 g/ha post-emergence (POE) at 30 days after sowing (DAS) one hand weeding 60 DAS were allotted to sub-plots. Treatment combinations were **(**S_1W_1) 40 Kg and weedy check, (S_1W_2) 40 Kg and weed free, (S1W3) 40Kg with pendimethalin (PRE @1.0 kg a.i./ha), (S1W4) 40 Kg with bispyribac-sodium (POE @25g/ha), (S_1W_5) 40 Kg with ready-mixchlorimuron ethyl @4g/ha, (S2W1) 50 Kg and weedy check, (S2W2) 50 Kg and weed free (S2W3), 50Kg with pendimethalin (PE @1.0kg a.i./ha), (S2W4) 50 Kg with bispyribac-sodium (POE @25g/ha), (S2W5) 50 Kg with ready-mixchlorimuron ethyl @4g/ha (S3W1), 60 Kg weedy check, (S3W2) 60 Kg weed free, (S3W3) 60 Kg with pendimethalin (PE @1.0kg a.i./ha), (S3W4) 60 Kg with bispyribac-sodium (POE @25g/ha) and (S3W5) 60 Kg with ready-mixchlorimuron ethyl @4g/ha. Rice variety 'NDR-97' was seeded on 25th June, 2013. Seeds were soaked in water and pre-germinated before sowing. The sprouted seeds with radicle length of one to two millimeters were uniformly sown by hand in the puddled field and in rows 20 cm apart. The recommended dose of fertilizers for rice i.e Urea, Diammonium phosphate & muriate of potash were used to supply 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1}, respectively. Generally, 1000 liters of water volume was used for pre-emergence herbicides & 800 liters of water volume was used for post-emergence herbicides per ha respectively. Herbicides were applied with the help of manually operated Knapsack sprayer fitted with flat fan nozzle.

RESULT AND DISCUSSION

Weed flora

The predominant weed flora of the rice at experimental field was *Echinochloa colona* (L.) Link., *Echinochloa crusgalli* (L) Beauv., *Panicum maximum* L., *Commelina benghalensis* L., *Trianthema monogyna* L., *Caesulia axillaris* (L) Roxb., *Cyperus rotundus* L., *Cyperus iria* L. The weeds were not uniformly distributed in all the plots.

weed density and weed dry weight

The density of total weeds was influenced significantly due to seed rate and weed control methods. Total weed density was increased up to 60 DAS and reduced in later stages irrespective of treatments, seed rate or weeds control methods. Among the seed rate, minimum density of total weeds was recorded with seed rate of 60 kg ha^{-1} being at par with 50 kg ha^{-1} significantly lower than 40 kg ha^{-1} at all the stages of crop growth. Lowest total weed density was observed in weed free plots, which is obvious. Among the weed control treatment, minimum density of total weeds were recorded from pre emergence application of Pendimethalin @ 1.0 kg ha^{-1} at 30 DAS , which was found significantly lower than rest of the treatments. Weed density was observed lower with post-emergence application of Bispyribac-sodium @ 25g ha^{-1} at 60 DAS, which is significantly lower than other chemical treatments and same trend was found at 90 DAS and at harvest. The density of all these weeds decreased subsequently in 60 kg ha^{-1} seed rate sown plots due to canopy development of crop. Similar results found by Walia *et al.*[11] and Singh *et al*[8].

The dry matter produced by total weeds was increased with the advancement of crop age and it was highest at harvesting stage. The total weed dry weight decreased as the rate of seed increased at all growth stages. Among the weed control treatments, significant reduction in weed dry weight was observed under all the treatments over unweeded check at all the stages of crop growth. Total weeds dry weight was recorded lowest from pre-emergence application of Pendimethalin @ 1.0 kg ha^{-1} at 30 DAS, and at 60 DAS lowest total weeds dry weight was recorded from post-emergence application of Bispyribac-sodium @ 25g ha^{-1}, which,was found significantly lower than rest of the treatments. Same trend was found recorded at later stages of crop growth. The total dry matter of weeds was 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.*

Yield attributes and Yield

Among the seed rate, maximum number of effective tillers (m^{-2}) were recorded from seed rate of60 kg ha^{-1}, which was statistically at par with 50 kg ha^{-1} and significantly higher than 40 kg ha^{-1} seed. Among the weed control treatments, maximum number of effective tillers (m^{-2}) were recorded from weed free plots, post-emergence application of bispyribac-sodium @ 25g ha^{-1} at 30 DAS produced highest effective tillers (No.m^{-2}) being at par with pendimethalin @1.0 kg ha^{-1} and ready-mixchlorimuron-ethyl @ 4g ha^{-1} and significantly superior weedy check.

Among the seed rate, the longest panicles were recorded from 60 kg ha^{-1} seed rate, which was at par with 50 kg ha^{-1} and significantly longer than 40 kg ha^{-1} seed rate. All the weed control treatments produced significantly longer panicle than weedy check plots .The panicle length was recorded significantly higher in application of pendimethalin @1.0 kg ha^{-1} over post-emergence application of Bispyribac-sodium @ 25 g ha^{-1}at 30 DAS, and ready mix chlorimuron @ 4g ha^{-1}. Among the seed rate, maximum number of grains per panicle were recorded from 40 kg ha^{-1} being at par with 50 kg ha^{-1} and significantly higher than 60 kg ha^{-1} seed rate. Weed free plots produced the highest number of grains $panicle^{-1}$ and the lowest number was observed with weedy check. In weed control methods higher number of $panicle^{-1}$ was recorded with the application of Bispyribac-sodium @ 25g ha^{-1} at 30 DAS being at par with pendimethalin @ 1.0 kg ha^{-1} and ready mix chlorimuron-ethyl @ 4g ha^{-1} significantly superior over weedy check treatment. Test weight was not affected significantly with the seed rate. The maximum and minimum was recorded with weed free and weedy check plots respectively under weed control methods. Highest test weight was noted with application of Bispyribac-sodium @ 25g ha^{-1} being on par with pendimethalin @ 1.0kg ha^{-1} and ready-mix chlorimuron@ 4g ha^{-1} and significantly superior over weedy check treatment.

The grain yield is the ultimate result for final assessment of treatments in any agronomical investigation. The grain yield of rice was influenced due to seed rate and weed control treatments. Among the seed rate, highest grain yield was recorded from 60 kg ha^{-1} seed rate being at par with 50 kg ha^{-1} and significantly higher than 40 kg ha^{-1}.In weed control methods maximum and minimum grain yield *i.e.* 25.38 and 20.68 q ha^{-1} was recorded under weed free and weedy check treatments. Under chemical control methods higher grain yield *i.e.*24.52 qh^{-1} was noted with Bispyribac-sodium being at par with pendimethalin@ 1.0 kg ha^{-1} and ready mix chlorimuron-ethyl @ 4g ha^{-1} and significantly superior over weedy check plots. Among the seed rate, highest straw yield was recorded from 60 kg ha^{-1} which was at par with 50 kg ha^{-1} and significantly higher over 40 kg ha^{-1} seed rate. Under the weed control methods straw yield was recorded maximum *i.e.* 41.75q ha^{-1} with weed free plots. In chemical control, application of Bispyribac-sodium @ 25g ha^{-1} recorded higher straw yield *i.e.* 40.58q ha^{-1} being on par with Pendimethalin @1.0kgha^{-1} and ready mix chlorimuron-ethyl @ 4g ha^{-1} and significantly superior over weedy check plots. The population of *E. colona, E. crusgalli, Commelina benghalensis* and *Cyperus rotundus* reduced with the post-emergence application of Bispyribac-sodium @25g ha^{-1} and produced significantly higher grain and straw yield as compared to Pendimethalin @ 1.0 kg ha^{-1} and ready-mixchlorimuron-ethyl @ 4 g ha^{-1} at 30 DAS. The finding was supported by, Chauhan *et al.*[2] and Bahar and Singh[1]. Harvest index was not affected significantly due to seed rate and weed control treatments.

Table 1: Effect of seed rate and weed control method on weed density and weed dry weight

Treatment	weeds density (No.m^{-2})				Weed dry weight			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
Seed rate (kg ha^{-1})								
S_1	9.00 (101.96)	10.61 (141.84)	9.27 (107.38)	7.59 (72.00)	5.86 (41.99)	14.91 (282.30)	17.30 (381.68)	18.32 (428.17)
S_2	8.83 (98.10)	10.41 (136.50)	9.09 (103.27)	7.44 (69.06)	5.75 (40.41)	14.63 (271.56)	16.97 (367.16)	17.97 (411.87)
S_3	8.53 (91.30)	10.05 (127.00)	8.80 (96.72)	7.19 (64.42)	5.55 (37.61)	14.12 (252.72)	16.38 (341.69)	15.72 (304.12)
SEm±	0.11	0.13	0.11	0.09	0.07	0.19	0.23	0.23
C.D. (P=0.05)	0.34	0.39	0.33	0.28	0.22	0.55	0.67	0.68
Weed control methods								
W_1	14.56 (211.77)	16.86 (284.00)	14.61 (213.20)	12.24 (149.47)	9.22 (84.55)	23.65 (559.70)	27.66 (765.53)	26..52 (723.42)
W_2	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
W_3	8.76 (76.43)	11.33 (123.13)	9.88 (97.23)	7.98 (63.20)	5.72 (32.22)	16.39 (268.50)	18.86 (355.82)	19.97 (398.92)
W_4	9.67 (93.20)	10.49 (109.60)	9.19 (84.02)	7.32 (53.13)	6.25 (38.62)	14.72 (216.60)	17.16 (294.50)	18.11 (328.00)
W_5	10.23 (104.20)	12.41 (153.83)	10.87 (117.83)	8.78 (76.67)	6.71 (44.63)	17.31 (299.50)	20.04 (401.70)	21.37 (456.60)
SEm±	0.10	0.11	0.10	0.08	0.06	0.16	0.20	0.20
C.D. (P=0.05)	0.29	0.34	0.29	0.28	0.19	0.48	0.58	0.59

Table 2: Effect of seed rate and weed control method on yield attributes and yield

Treatment	Effective tillers at harvest (m^{-2})	Length of panicle (cm)	Number of grain panicle^{-1}	Test weight (g)	Grain yield q ha^{-1}	Straw yield q ha^{-1}
Seed rate (kg ha^{-1})						
S_1	296.42	20.90	157.04	22.33	21.15	36.26
S_2	315.46	20.30	152.50	21.90	23.98	40.58
S_3	324.46	19.10	143.44	21.46	25.39	41.56
SEm±	7.38	0.53	3.87	NS	059	0.94
C.D. (P=0.05)	21.39	1.54	11.22	NS	1.73	2.72
Weed control methods						
W_1	274.60	18.30	132.87	19.27	20.68	35.07
W_2	336.90	21.10	163.07	23.64	25.38	41.75
W_3	315.70	25.30	152.53	22.12	23.74	40.20
W_4	324.50	20.90	157.00	22.78	24.45	40.58
W_5	308.87	19.90	149.50	21.68	23.28	39.40
SEm±	6.39	0.46	3.35	NS	0.51	0.81
C.D. (P=0.05)	18.52	1.34	9.72	NS	1.50	2.35

CONCLUSION

On the basis of the findings of the experiment conducted over the past year, the following conclusions may be drawn: Application of Bispyribac-sodium @ 25g ha^{-1} at 30 DAS was found the most effective weed control method under direct-seeded rice. The losses to crop yield was observed maximum with *Commelina benghalensis* (66.7) and minimum with *Cyperus rotundus* (29.22).

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