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Abhishek Gowda CS
Department of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Narayana S Mavarkar
Department of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

O Kumar
Department of Agronomy, AHRS, Kathalagere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Corresponding Author:
Abhishek Gowda CS
Department of Agronomy, College of Agriculture, Shivamogga, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India

Effect of weed management practices on growth and yield of direct seeded rice (*Oryza Sativa* L.) under Bhadra command area of Karnataka

Abhishek Gowda CS, Narayana S Mavarkar and O Kumar

Abstract
A field experiment entitled "Weed Management in Direct Seeded Rice (*Oryza sativa* L.) under Bhadra command area of Karnataka" was conducted during *kharif* 2018 in Agricultural and Horticultural Research Station, Kathalagere with twelve treatments combination viz., inter cultivation, pre-emergent (pre em.) herbicides viz., pretilachlor 30.7 EC, pendimethalin 38.7 CS, oxadiargyl 80% WP and post-emergent (Post em.,) herbicides *viz.,* bispyribac sodium 10% SC, chlorimuron ethyl + metsulfuron methyl 20 WP and Ethoxysulfuron 15 WDG. Four hand weeding practices at 15 days interval and weedy check were included. The experiment was laid out in RCBD and replicated thrice.The experimental results revealed that Inter cultivation *fb* Hand weeding at 20 and 40 DAS recorded higher growth and growth attributes. Higher grain yield (5212 kg ha^{-1}), straw yield (5928 kg ha^{-1}) and major nutrients uptake by crop also recorded in above mentioned treatment. These results are on par with inter-cultivation at 20 DAS *fb* bispyribac sodium10 % SC @ 20 g a.i ha^{-1}. Among herbicide combination treatments, pendimethalin 38.7 CS @0.75 kg a.i ha^{-1} (Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1}(Post. em.) recorded higher growth and yield attributes without being phytotoxic to the crop. There was no residual effect of herbicides on soil microbial population and succeeding crop.

Keywords: Direct Seeded Rice, Pre –emergent, Post- emergent and Yield

Introduction
Rice (*Oryza sativa* L.) is the most important cereal crop of the World as it forms the staple diet of 70 per cent of the world's population. Globally, it is grown on approximately 160.60 m ha and a total production of 738.20 m t with a productivity 3424.41 kg ha^{-1} (Anon, 2016) [1]. In Asia Ninety per cent of the World's rice is produced and consumed (Solunke *et al*., 2006) [7]. In India, the area under rice is 43.4 m ha with annual production of 104.3 m t next to china among rice growing countries of the world with productivity of 2.4 t ha^{-1} (Anon, 2016) [1]. It is one of the most important food crops of India which is evident from the fact that 29.9 per cent of the total calories come from this crop (Timmer and Peter, 2010) [8]. Weeds pose a major threat for increasing productivity (Shilpa Sree *et al.* 2014) [6]. Uncontrolled weed growth caused 33-45% reduction in grain yield of rice (Manhas *et al.* 2012) [4].

Weed management in rice is one area that still needs attention for effectively using resource conservation technologies. Experiences have shown that a shift to direct seeded rice has resulted in weed flora changes towards more difficult-to-control and competitive grasses and sedges and appearance of weedy rice in various parts of the rice growing regions in the world The use of only one method of weed control in direct seeded rice crop may not be successful for raising a good crop. Manual weeding has become difficult because of labour scarcity and increasing cost of cultivation. Herbicide use becomes more important when weeds and rice emerge simultaneously in direct seeded rice, and some of the weeds have morphological similarity to rice like *Echinocloa colona* and *Echinocloa crusgalli*, which are difficult to be differentiated at early stages of growth. The use of herbicides ensures effective weed control throughout crop growth period under labour shortage condition when weeding coincides with other farm activities. Rice being important cereal food crop in most of the command areas. Among different commands in Karnataka, Bhadra is also one of the important rice bowls in Southern Karnataka occupied more than 1.02 lakh hectares with average production of 2.55 lakh tons. In command areas, there is lot of scope for introduction of direct seeded rice. Keeping these points in view, an experiment was conducted on "Effect of weed management practices on growth and yield of direct seeded rice (*Oryza Sativa* L.) under Bhadra command

area of Karnataka". The experiment was carried out at Agricultural and Horticultural Research Station, Kathalagere, University of Agricultural and Horticultural sciences, Shivamogga, Karnataka.

Material and Methods

The present investigation entitled Effect of weed management practices on growth and yield of direct seeded rice (*Oryza Sativa* L.) under Bhadra command area of Karnataka was carried out at Agricultural and Horticultural Research Station, Kathalagere, University of Agricultural and Horticultural sciences, Shivamogga, Karnataka under irrigated condition during *kharif* 2018. The detailed account of materials used and methods employed during the course of investigation have been described in this chapter. The experimental site was located at Agricultural and Horticultural Research Station, Kathalagere which comes under Southern Transition Zone of Karnataka in Bhadra command area. Experimental site was situated in 14 0 26' North latitude and 750 82' East longitude with an altitude of 561.6 meters above mean sea level. The station was located 4.5 km away towards south of Kathalagere village and 30 km from south of Davanagere city. The results of soil analysis revealed that the experimental site was acidic in reaction (pH-6.20) having low salt load (0.05 dS m-1). The organic carbon content was medium (0.53 %) with medium status of available nitrogen and potassium (273 kg ha-1 and 216.4 kg ha-1, respectively) and was low in available phosphorus (25.4 kg ha-1). The Rice crop selected for present study with twelve treatments combination viz., inter cultivation, pre-emergent (pre em.) herbicides viz., pretilachlor 30.7 EC, pendimethalin 38.7 CS, oxadiargyl 80% WP and post-emergent (Post em.,) herbicides *viz.*, bispyribac sodium 10% SC, chlorimuron ethyl + metsulfuron methyl 20 WP and Ethoxysulfuron 15 WDG. Four hand weeding practices at 15 days interval and weedy check were included and the experiment was laid out in RCBD with three replication. Data collected included growth and yield attributes of Rice crop.

Results and Discussion

The data pertaining to plant height (cm), number of tillers per hill and total dry matter (g hill^{-1}) was recorded at harvest as influenced by different weed management practices are presented in Table 1.

At harvest, plant height varied significantly due to different weed management practices. Inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_3) recorded significantly higher plant height (78.94 cm) followed by inter cultivation at 20 DAS *fb* bispyribac sodium10% SC @ 20 g a.i ha^{-1}(T_6; 77.52 cm) and pretilachlor 30.7 EC @ 0.3 kg a.i ha^{-1} with safener (Pre. em.) *fb* inter-cultivation at 40 DAS (T_5; 76.83 cm) which was statistically on par with other. Pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1} (Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1} (Post. em.) (T_7) recorded higher plant height (75.96 cm) which were on par with all other herbicide treatment except oxadiargyl 80 WP @ 0.10 kg a.i ha^{-1}(Pre. em.) *fb* chlorimuron ethyl + metsulfuron methyl 20 WP @ 4 g a.i ha^{-1}(Post. em.) (T_{10}; 67.52 cm). While significantly higher plant height (84.60 cm) observed in four hand weeding at 15 days interval (T_2). However, lower plant height (65.81 cm) was recorded under weedy check (T_1).

At harvest, number of tillers per hill recorded by Inter cultivation *fb* hand weeding at 20 and 40 DAS (T_3) recorded higher number of tillers per hill (24.18) which was on par with inter cultivation at 20 DAS *fb* bispyribac sodium10% SC @ 20 g a.i ha^{-1} (T_6; 23.24) and pretilachlor 30.7 EC @ 0.3 kg a.i ha^{-1} with safener (Pre. em.) *fb* inter-cultivation at 40 DAS (T_5; 22.42). In the group of sequential application of pre and post-emergent herbicidal treatments, higher number of tillers per hill noticed in pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1}(Post. em.) (T_7; 21.68), pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* ethoxysulfuron15 WG @ 12 g a.i ha^{-1} (Post. em.) (T_{11}; 20.97) and pendimethalin 38.7 CS @0.75 kg a.i ha^{-1}(Pre. em.) *fb* chlorimuron ethyl + metsulfuron methyl 20 WP @ 4 g a.i ha^{-1}(Post. em.) (T_9; 20.60) which were on par with other. While significantly higher number of tillers per hill (25.39) observed in four hand weeding at 15 days interval (T_2). However, lower number of tillers per hill (12.01) was recorded under weedy check (T_1).

The increase in plant height was eventual due to more absorption of plant nutrients from the soil and increased root-shoot growth, increased number of greener leaves which produced greater amount of food material (photosynthates), resulting in more cell division, cell enlargement and finally rapid vegetative growth with the lapse of time. While, weedy check were lower plant height due to stunted growth of the plants due to severe weed competition (14.59, 39.5, 63.60 and 65.81 cm, at 30, 60, 90 DAS and at harvest, respectively). These findings are in agreement with that of Walia *et al.* (2011) [10].

Total dry matter (g hill^{-1}) at harvest, recorded with treatment inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_3) noticed higher total dry matter production (68.01 g hill^{-1}) which was on par with treatments such as inter cultivation at 20 DAS *fb* bispyribac sodium10% SC @ 20 g a.i ha^{-1}(Post. em.) (T_6; 66.98 g hill^{-1}) and pretilachlor 30.7 EC @ 0.3 kg a.i ha^{-1} with safener (Pre. em.) *fb* inter-cultivation at 40 DAS (T_5; 65.10 g hill^{-1}). Among sequential application of pre and post-emergent herbicidal treatments, higher total dry matter production noticed in pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1}(Post. em.) (T_7; 63.25 g hill^{-1}) which was on par with pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1} (Pre. em.) *fb* ethoxysulfuron15 WG @ 12 g a.i ha^{-1}(Post. em.) (T_{11}; 60.88 g hill^{-1}) and pendimethalin 38.7 CS @0.75 kg a.i ha^{-1} (Pre. em.) *fb* chlorimuron ethyl + metsulfuron methyl 20 WP @ 4 g a.i ha^{-1}(Post. em.) (T_9; 58.26 g hill^{-1}). Whereas higher total dry matter production (69.93 g hill^{-1}) observed with plot receiving four hand weeding at 15 days interval (T_2). While, lower total dry matter production (42.77 g hill^{-1}) was recorded under weedy check (T_1).

The higher dry matter of rice plants in above treatments might be due to the reduction in crowding effect or weed population among the crop plants, which facilitate more space, nutrients, light and moisture for their proper growth and development leads to maximum accumulation of dry matter per unit area of rice plant. The lowest dry matter of rice under weedy check (T_1) might be due to adverse effect of excessive crop-weed competition as evident from maximum dry matter production of weeds which resulted in reduction of nutrient uptake and dry matter accumulation by crop. Similar report was made by Choudhary and Anil Dixit (2018) [2].

The data pertaining grain yield and straw yield (kgha^{-1}) was recorded at harvest as influenced by different weed management practices are presented in Table 2.

Grain yield (kgha^{-1})

Inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_3) recorded highest grain yield (5212 kg ha^{-1}) which was

statistically on par with inter cultivation at 20 DAS *fb* bispyribac sodium10% SC @ 20 g a.i ha^{-1}(T_6; 4699 kg ha^{-1}). In plots receiving herbicidal treatments, pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1}(Post. em.) (T_7) noticed highest grain yield (4427 kg ha^{-1}) which was on par with pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* ethoxy sulfuron 15 WG @ 12 g a.i ha^{-1} (Post. em.) (T_{11}; 4006 kg ha^{-1}). While, highest (5308 kg ha^{-1}) and lowest (1515 kg ha^{-1}) grain yield was recorded in four hand weeding at 15 days interval (T_2) and weedy check (T_1), respectively.

Straw yield (kg ha^{-1})

Different weed management treatment significantly influenced on straw yield, Where, higher straw yield (5928 kg ha^{-1}) was obtained in inter cultivation *fb* Hand weeding at 20 and 40 DAS (T_3) which was on par with inter cultivation at 20 DAS *fb* bispyribac sodium10 % SC @ 20 g a.i ha^{-1}(T_6; 5388 kg ha^{-1}). Pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1}(Post. em.) (T_7) recorded highest straw yield (5019kg ha^{-1}) among other herbicide combination treatments which was on par with pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* ethoxy sulfuron 15 WG @ 12 g a.i ha^{-1} (Post. em.) (T_{11}; 4723 kg ha^{-1}). However, highest (6047 kg ha^{-1}) and least (1974 kg ha^{-1}) straw yield was recorded with four hand weeding at 15 days interval (T_2) and weedy check (T_1), respectively. However, harvest index of paddy did not vary significantly due to different weed management treatments.

Yield, which is the final product of growth, development and resultant of the yield attributes, is controlled by dry matter accumulation during the ripening phase. All the herbicidal treatments significantly influenced grain yield compared with weedy check. The differences noticed in yield attributes reflected in grain and straw yield recorded by different treatments. Large variations in grain yield ranged from 1515 kg ha^{-1} to 5308 kg ha^{-1} were noticed across the treatments showing the scope for increase in yield with the better weed management options and best agronomic practices. The highest grain yield was observed with treatment, inter cultivation *fb* hand weeding at 20 and 40 DAS (T_3) (5212 kg ha^{-1}) which was 60.61 per cent increment in yield compare to package of practices treatment i.e Pretilachlor (Pre.em.) 30.7 EC @ kg a.i ha^{-1} with safener *fb* bispyribac sodium (Post.em.) 10 % SC @ 20 g a.i ha^{-1}. In plots receiving pure herbicidal treatments pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1} (Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1} (Post. em.) (T_7) noticed highest grain yield (4427 kg ha^{-1}) which was on par with pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* ethoxy sulfuron 15 WG @ 12 g a.i ha^{-1} (Post. em.) (T_{11}; 4006 kg ha^{-1}) these treatments have 36.42 and 23.45 per cent higher yield compare to package of practices treatment respectively. The lowest yield (1515 kg ha^{-1}) was noticed in weedy control. The variation in the yield could be explained in terms of yield attributes. The excellence of these herbicide combination treatments could be ascribed to higher values of yield attributing characters such as number of panicle, panicle length, number of filled grains *etc.*, reduced weed density, weed biomass, better weed control efficiency, better plant growth and dry matter accumulation supported for higher yield attributes observed with those treatments increased yield. These findings are in agreement with that of Mahajan and Timsina (2011) [3] and Walia *et al.* (2011) [10].

Straw yield also differed significantly due to weed management practices (Table 4.18). Higher straw yield was recorded with treatments consists of inter cultivation *fb* hand weeding at 20 and 40 DAS (T_3; 5928 kg ha^{-1}) and inter cultivation at 20 DAS *fb* bispyribac sodium10 % SC @ 20 g a.i ha^{-1}(T_6; 5388 kg ha^{-1}) did not differ significantly and were on par with each other. In the group of herbicidal based weed management practices, higher straw yield was recorded with application of pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1} (Post. em.) (T_7) which is on par with pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em.) *fb* ethoxy sulfuron 15 WG @ 12 g a.i ha^{-1} (Post. em.) (T_{11}; 4723 kg ha^{-1}). The increasing straw yield in the above treatments is evidenced by better growth of the plant during initial stages of the crop growth is mainly due to non-competition from the weeds, which resulted in increased leaf area and efficient utilization of resources and resulted in better growth component and dry matter production. The treatment weedy check (T_1) recorded lowest straw yield (1974 kg ha^{-1}). The lower straw yield was mainly due to higher competition of weeds for the available resources. These findings are in agreement with that of Sandeep *et al.* (2014) [6].

Table 1: Plant height (cm), number of tillers and total dry matter (g hill^{-1}) of Rice as influenced by different weed management practices at different growth stages of direct seeded rice

Treatment	*K.* Plant height at harvest (cm)	Number of tillers at harvest	Total dry matter At harvest (g hill^{-1})
T_1= Weedy check.	65.81	12.01	42.77
T_2= 4 Hand weeding at 15 days interval.	84.60	25.39	69.93
T_3= Inter cultivation *fb* Hand weeding at 20 and 40 DAS.	78.94	24.18	68.01
T_4= Pretilachlor (Pre.em.-3 DAS) 30.7 EC @ 0.3 kg a.i ha^{-1} with safener *fb* bispyribac sodium (Post.em.,-30 DAS) 10% SC @20 g a.i ha^{-1}	71.93	16.74	54.27
T_5= Pretilachlor (Pre.em.-3 DAS) 30.7 EC @ 0.3 kg a.i ha^{-1} with safener + inter-cultivation at 40 DAS	76.83	22.42	65.10
T_6= Inter-cultivation at 20 DAS *fb* bispyribac sodium (Post.em.-30 DAS,) 10% SC @20 g a.i ha^{-1}	77.52	23.24	66.98
T_7= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @ 0.75 kg a.i ha^{-1}*fb* bispyribac sodium (Post.em.,30 DAS) 10% SC @ 20 g a.i ha^{-1}	75.96	21.68	63.25
T_8= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10 kg a.i ha^{-1}*fb* bispyribac sodium (Post.em., 30 DAS)10%SC @ 20 g a.i ha^{-1}.	73.67	20.12	57.06
T_9= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @ 0.75 kg a.i ha^{-1}*fb* chlorimuron ethyl + metsulfuronmethyl (Post.em.,30 DAS) 20 WP @ 4 g a.i ha^{-1}	74.31	20.60	58.26
T_{10}= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10 kg a.i ha^{-1}*fb* chlorimuron ethyl + metsulfuron methyl (Post.em.,30 DAS) 20 WP @ 4 g a.i ha^{-1}	67.52	16.19	53.19
T_{11}= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @0.75 kg a.i ha^{-1}*fb* ethoxy sulfuron (Post.em.,30	75.33	20.97	60.88

DAS)15 WG @ 12 g a.i ha^{-1}			
T_{12}= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10 kg a.i ha^{-1} *fb* ethoxy sulfuron (Post.em.,30 DAS) 15 WG @ 12 g a.i ha^{-1}	72.24	17.98	55.18
S.Em ±	2.64	0.82	2.08
CD (P=0.05)	7.75	2.40	6.11

DAS: days after sowing; a.i: active ingredient; Pre. em. – Pre Emergence, Post. em. – Post Emergence

Table 2: Grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) and harvest index as influenced by different weed management practices in direct seeded rice

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index
T_1= Weedy check.	1515	1974	0.43
T_2= 4 Hand weeding at 15 days interval.	5308	6047	0.47
T_3= Inter cultivation *fb* Hand weeding at 20 and 40 DAS.	5212	5928	0.47
T_4= Pretilachlor (Pre.em.-3 DAS) 30.7 EC @ 0.3 kg a.i ha^{-1} with safener *fb* bispyribac sodium (Post.em.,-30 DAS) 10 % SC @ 20 g a.i ha^{-1}	3245	3998	0.45
T_5= Pretilachlor (Pre.em.-3 DAS) 30.7 EC @ 0.3 kg a.i ha^{-1} with safener + inter-cultivation at 40 DAS	4491	5159	0.45
T_6= Inter-cultivation at 20 DAS *fb* bispyribac sodium (Post.em.-30 DAS,) 10 % SC @ 20 g a.i ha^{-1}	4699	5388	0.47
T_7= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @0.75 kg a.i ha^{-1} *fb* bispyribac sodium (Post.em.,30 DAS) 10% SC @ 20 g a.i ha^{-1}	4427	5019	0.46
T_8= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10 kg a.i ha^{-1} *fb* bispyribac sodium (Post.em.,30 DAS) 10%SC @ 20 g a.i ha^{-1}.	3627	4238	0.46
T_9= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @ 0.75 kg a.i ha^{-1} *fb* chlorimuron ethyl + metsulfuronmethyl (Post.em.,30 DAS) 20 WP @ 4 g a.i ha^{-1}	3718	4437	0.45
T_{10}= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10 kg a.i ha^{-1} *fb* chlorimuron ethyl + metsulfuron methyl (Post.em.,30 DAS) 20 WP @ 4 g a.i ha^{-1}	2941	3667	0.45
T_{11}= Pendimethalin (Pre.em.-3 DAS) 38.7 CS @ 0.75 kg a.i ha^{-1} *fb* ethoxy sulfuron (Post.em.,30 DAS)15 WG @ 12 g a.i ha^{-1}	4006	4723	0.46
T_{12}= Oxadiargyl (Pre.em.-3 DAS) 80 WP @ 0.10kg a.i ha^{-1} *fb* ethoxy sulfuron (Post.em.,30 DAS) 15 WG @ 12 g a.i ha^{-1}	3262	4150	0.44
S.Em ±	176.79	193.25	0.02
CD (P=0.05)	518.30	566.83	NS

DAS: days after sowing; a.i: active ingredient; Pre. em. – Pre Emergence, Post. em. – Post Emergence

Conclusion

Inter cultivation *fb* hand weeding at 20 and 40 DAS was effective in influencing the growth and yield of rice. The other good method of weed control was inter cultivation at 20 DAS *fb* bispyribac sodium10% SC @ 20 g a.i ha^{-1}. Among herbicidal combination treatment, pendimethalin 38.7 CS @ 0.75 kg a.i ha^{-1}(Pre. em,-3 DAS) *fb* bispyribac sodium 10% SC @ 20 g a.i ha^{-1} (Post. em.-30DAS) was effective in enhancing the growth and yield of rice.

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