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# Effect of Cultural and Chemical Weed Management Practices on Yield, Economics and Nutrient Uptake Under Zero-till Direct Seeded Rice (*Oryza sativa* L.)

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**An field experiment was conducted during kharif seasons of 2013-14 at Varanasi, UP to evaluate the effect of weed management practices in zero-till direct seeded rice. Results revealed that weed free treatment resulted the highest yield; however, it was not economical due to high cost of cultivation. Pre-emergence application of pendimethalin (1.0 kg ha$^{-1}$) fb (followed by) early post-emergence application of bispyribac (0.025 kg ha$^{-1}$) at 18 days after sowing (DAS) was recorded significantly the highest number of effective tillers, grain yield (4290 kg ha$^{-1}$) and straw yield (5750 kg ha$^{-1}$), biological yield, harvest index (42.71 %) and NPK uptake as compared to Sesbania co-culture + residue incorporation, Sesbania co-culture fb 2, 4-D and pretilachlor fb hand weeding at 30 DAS and it were at par with the application of pendimethalin fb hand weeding at 30 DAS and pretilachlor fb bispyribac. Application of pretilachlor fb bispyribac at 18 DAS recorded maximum net returns (₹ 45586) and benefit cost ratio (2.7). None of the treatment as effective as weed free with respect to reduction of density and dry weight of weeds, crop growth, yield attributes and yield, and nutrients uptake.**

**Keywords:** Rice, NPK uptake, Net return, Pendimethalin, Pretilachlor.

Rice (*Oryza sativa* L.) is the world's most important crop and is a staple food for more than half of the world's population. In India, rice is grown in an area of 43.9 m ha with a total production of 104.80 mt and average productivity of 2390 kg ha$^{-1}$ (Anonymous, 2015). DSR occupies 26 per cent of the total rice area in South Asia. (Gupta *et al*., 2006), to meet the global rice demand, it is estimated that about 114 million tons of additional milled rice need to be produced by 2035, which is equivalent to an overall increase of 26% in the next 25 years. The possibility of expanding the area under rice in the near future is limited. Due to resource constraints, especially water and labours, direct seeding under dry condition is now emerging new trend in rice cultivation. In recent years, due to severe water and labour scarcity, farmers are changing their rice establishment method from transplanting to direct seeding (Walia *et al*., 2012). Direct seeding offers such advantages as faster and easier planting, reduced labour and less drudgery, earlier crop maturity by 7-10 days, more efficient water use and higher tolerance of water deficit, less methane emission and often higher profit in areas with an assured water supply (Singh *et al*., 2014). Low productivity of direct seeded rice is mainly due to heavy crop-weed competition due to early emergence of weeds along with crop

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seedling due to favorable soil conditions and their rapid growth result in severe competition for nutrients, space, and light. Thus, integration of herbicides and cultural practices, controlled weeds effectively and made available more nutrients to crop and consequently resulted in higher yield (Kumar *et al.,* 2010). Herbicide use becomes more important because weeds and rice seedling emerge simultaneously in DSR and start crop weed competition (Raj *et al*., 2013). Post-emergence application (15-25 DAS) of bispyribac 25 g $ha^{-1}$ is effective in controlling of grasses, sedges and broadleaved weeds. Brown manuring in DSR reduces weed population by nearly half without any adverse effect on rice yield. Also, *Sesbania* surface mulch decomposes very fast to supply N and other re-cycled nutrients (Gopal *et al*., 2010). Thus, keeping the above facts in view the present investigation was undertaken to study the effect of integrated cultural and chemical weed management practices on yield, economics and nutrient uptake under zero-till direct seeded rice (*Oryza sativa* L.)

## MATERIALS AND METHODS

An experiment was conducted in *kharif* seasons of 2013-4 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The soil of the experimental field was Gangetic alluvial having sandy clay loam in texture with pH 7.51, respectively. It was moderately fertile, being low in available organic carbon (0.57 %) and available nitrogen (175.55 kg $ha^{-1}$), and medium in available phosphorus (21.2 kg $ha^{-1}$) and potassium (225.6 kg $ha^{-1}$). The experiment was laid out in RBD design with three replication. The treatments comprised eight weed management methods *viz*., weedy, weed free, *Sesbania* co-culture + cutting and residue incorporation, *Sesbania* co-culture fb 2,4 D 0.5 kg $ha^{-1}$at 35 DAS, pendimethalin 1.0 kg $ha^{-1}$ (pre-emergence) fb hand weeding at 30 DAS, pretilachlor 0.5 kg $ha^{-1}$fb hand weeding at 30 DAS, pendimethalin 1.0 kg $ha^{-1}$ (pre-emergence) fb bispyribac-Na 0.025 kg $ha^{-1}$ (early post-emergence) at 18 DAS and pretilachlor 0.5 kg $ha^{-1}$fb bispyribac-Na 0.025 kg $ha^{-1}$ (early post-emergence) at 18 DAS. A uniform dose of 120 kg N, 60 kg P2O5 and 60 kg K2O $ha^{-1}$a was applied to all the treatments. Half dose of N and full dose of P and K were applied as basal at sowing. Remaining dose of N was top-dressed in two equal splits at active tillering and panicle initiation stage. The sources of N, P and K were urea, di- ammonium phosphate and murate of potash, respectively. Seeds of paddy were placed in moist soil with the help of zero-til- drill at a spacing of 20 cm between rows. Rice variety 'MTU-7029' was sown at the rate of 30 kg $ha^{-1}$during the last week of June. *Sesbania* was sown in between rows of rice at the rate of 20 kg $ha^{-1}$. At 25 DAS, it was knock down by using 2, 4-D for brown manuring. The required quantity of pre-emergence and post-emergence herbicides were applied as per treatment with spray volume 600 l $ha^{-1}$ using knap sack sprayer fitted with flat fan nozzle. Total weed population ($m^2$) and their dry weight were recorded at 60 DAS under each treatment with the help of 0.25 $m^2$ quadrate randomly from three places. Data on weed density and weed biomass were transformed using "X+0.5 for comparison of treatments. Growth parameters were recorded at 60 DAS, yield attributes and yield was recorded at the harvest of crop. Collected data was statistically analyzed as per standard procedure to draw a valid conclusion.

## RESULTS AND DISCUSSION

### Density and dry weight of weed

The weed population was significantly reduced by adoption of weed management treatments over weedy (Table 1). Among weed management practices, pre-emergence application of pendimethalin fb bispyribac recorded significantly the lowest density and dry weight of weeds over *Sesbania* co-culture + residue incorporation, *Sesbania* c-o-culture *fb* 2, 4-D and pretilachlor *fb* hand weeding at 30 DAS and it was at par with the application of pendimethalin *fb* hand weeding at 30 DAS and pretilachlor *fb* bispyribac, respectively. Pre- and post-emergent herbicides in sequential herbicide application were more effective in controlling initial as well as later flushes of weeds, respectively. This is the main reason of reducing weed density under sequential application of herbicides (Mahajan *et al*., 2009 and Gaurav *et al*., 2015). Pendimethalin have been reported to be effective against most of grassy weeds and up to some extant to other weeds also. *Sesbania* co-

**Table 1.** Yield and economics of direct seeded rice as influenced by integrated weed management practices under zero-till condition

| Treatment | Effective tillers (No. $m^{-1}$) | Grain yield (kg $ha^{-1}$) | StrawYield (kg $ha^{-1}$) | Biological yield (kg $ha^{-1}$) | Harvest index(%) | Cost of cultivation (₹ $ha^{-1}$) | Net return ($ha^{-1}$) | B:C ratio |
|---|---|---|---|---|---|---|---|---|
| Weedy | 42.40 | 1593.33 | 3340.00 | 4933.33 | 32.25 | 23698 | 7034 | 1.3 |
| Weed free | 60.00 | 4920.00 | 6650.00 | 11570.00 | 42.55 | 40198 | 43711 | 2.1 |
| Sesbania co-culture + cutting residue incorporation at 35 DAS | 48.70 | 3180.00 | 4600.00 | 7780.00 | 40.87 | 25098 | 30041 | 2.2 |
| Sesbania co-culture *fb* 2, 4 D 0.50 kg $ha^{-1}$ at 35 DAS | 48.80 | 3360.00 | 4723.33 | 8083.33 | 41.61 | 24563 | 33286 | 2.4 |
| Pendimethalin 1 kg $ha^{-1}$ *fb* hand weeding at 30 DAS | 53.60 | 3888.27 | 5400.00 | 9288.27 | 41.92 | 27397 | 39350 | 2.4 |
| Pretilachlor 0.5 kg $ha^{-1}$ *fb* hand weeding at 30 DAS | 52.40 | 3570.00 | 5050.00 | 8620.00 | 41.42 | 26838 | 34721 | 2.3 |
| Pendimethalin 1 kg $ha^{-1}$ *fb* bispyribac 0.025 kg $ha^{-1}$ at 18 DAS | 55.40 | 4290.00 | 5750.00 | 10040.00 | 42.71 | 27852 | 45167 | 2.6 |
| Pretilachlor 0.5 kg $ha^{-1}$ *fb* bispyribac 0.5 kg $ha^{-1}$ at 18 DAS | 54.75 | 4280.00 | 5740.00 | 10020.00 | 42.67 | 27273 | 45586 | 2.7 |
| SEm ± | 1.62 | 158.01 | 231.64 | 328.25 | 1.17 | - | - | - |
| C.D. (P=0.05) | 4.73 | 462.34 | 677.76 | 960.44 | 3.43 | - | - | - |

**Table 2.** Nitrogen, phosphorus and potassium uptake (kg ha$^{-1}$) by crop and associated weeds of direct seeded rice under zero-till condition

| Treatment | Nitrogen uptake (kg ha$^{-1}$) | | Phosphorus uptake (kg ha$^{-1}$) | | Potassium uptake (kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| | Crop at harvest | Weed at 60 DAS | Crop at harvest | Weed at 60 DAS | Crop at harvest | Weed at 60 DAS |
| Weedy | 41.06 | 5.97 | 19.71 | 4.73 | 46.07 | 6.10 |
| Weed free | 125.13 | 0.00 | 35.9 | 0.00 | 131.78 | 0.00 |
| Sesbania co-culture + cutting residue incorporation at 35 DAS | 67.96 | 2.43 | 20.26 | 1.73 | 69.01 | 2.10 |
| Sesbania co-culture *fb* 2,4 D 0.50 kg ha$^{-1}$ at 35 DAS | 72.43 | 1.27 | 21.47 | 1.40 | 76.57 | 1.70 |
| Pendimethalin 1 kg ha$^{-1}$ *fb* hand weeding at 30 DAS | 92.93 | 1.93 | 24.84 | 0.73 | 94.77 | 1.27 |
| Pretilachlor 0.5 kg ha$^{-1}$ *fb* hand weeding at 30 DAS | 84.64 | 1.90 | 22.45 | 0.67 | 87.63 | 1.30 |
| Pendimethalin1 kg ha$^{-1}$ *fb* bispyribac 0.025 kg ha$^{-1}$ at 18 DAS | 105.31 | 1.48 | 28.22 | 0.53 | 107.39 | 1.13 |
| Pretilachlor 0.5 kg ha$^{-1}$ *fb* bispyribac 0.025 kg ha$^{-1}$ at 18 DAS | 103.82 | 1.63 | 27.05 | 0.57 | 104.15 | 1.97 |
| SEm± | 3.0 | 0.05 | 2.64 | 0.03 | 2.11 | 0.03 |
| C.D. (P=0.05) | 9.01 | 0.15 | 8.66 | 0.09 | 8.29 | 0.11 |

culture + cutting residue incorporation was not effective in reducing the population of grasses, sedges and broadleaf which were the dominant weed species in DSR, thus resulting in highest weed population over other weed management practices (Jabran *et al*., 2012).

**Yield attributes and yield**

Among the weed management treatment, application of pendimethalin *fb* bispyribac recorded significantly the highest number of effective tillers $m^{-1}$ (55.40), grain yield (4290 kg $ha^{-1}$) and straw yield (5750 kg $ha^{-1}$), biological yield (10040 kg $ha^{-1}$) and harvest index (42.71 %) as compared to *Sesbania* co-culture + residue incorporation, *Sesbania* co-culture *fb* 2, 4-D and pretilachlor *fb* hand weeding at 30 DAS and it was at par with the application of pendimethalin *fb* hand weeding at 30 DAS and pretilachlor *fb* bispyribac, respectively. This result could be attributed due to lower density and dry weight of weeds under sequential herbicide application which reduces crop weed competition and consequently led to enhanced growth, development and yield of rice. None of the treatments were comparable to weed free in respect to yield and harvest index of rice. However, all the weed management treatment were significantly superior over weedy. These results are in accordance with findings of walia *et al* (2008).

**Nutrient uptake by crop**

The maximum uptake of NPK by crop varied significantly due to weed control practices. The maximum uptake of NPK by crop was recorded in weed free and minimum in weedy. Among weed management practices, application of pendimethalin *fb* bispyribac recorded significantly the highest NPK uptake (105.31 kg $ha^{-1}$), (84.22 kg $ha^{-1}$) (90.39 kg $ha^{-1}$) respectively, in comparison to *Sesbania* co-culture + residue incorporation, *Sesbania* co-culture *fb* 2, 4-D and pretilachlor *fb* hand weeding at 30 DAS and it was at par with the application of pendimethalin *fb* hand weeding at 30 DAS and pretilachlor *fb* bispyribac, respectively. None of the treatments were comparable to weed free in increasing total NPK uptake by crop. However, all the herbicidal treatment was significantly superior in increasing NPK uptake over weedy. This is owing to lower nutrient depletion by weeds under these treatments. These were in close conformity with the research findings of Prakash *et al.* (1995) and Brar and Bhullar (2013).

**Nutrient depletion by weeds**

Significantly the lowest NPK depletion by weeds was recorded with the application of pendimethalin *fb* bispyribac and pretilachlor *fb* bispyribac as compared to other weed management practices. The maximum NPK depletion by weeds was observed in weedy due to maximum weed growth and their dry weight. Among weed management treatment, the highest NPK depletion by weeds was recorded under *Sesbania* co-culture + cutting residue incorporation treatment. It was due to maximum total weed dry matter under the treatment as nutrient depletion is positively correlated with weed dry matter accumulation. Maity and Mukherjee (2011) and Brar and Bhullar (2013) also recorded similar findings.

**Economics**

A perusal of data on economic analysis of different weed management practices in direct seeded rice suggested that the maximum and minimum cost of cultivation and net returns were noted under weed free and weedy, respectively. The treatment pretilachlor + bispyribac recorded highest net returns (₹ 45586) followed by pendimethalin + bispyribac ( 45167). The benefit cost ratio was maximum with pretilachlor + bispyribac (2.7) followed by pendimethalin + bispyribac (2.6). Highest net returns among these treatments was primarily due to better plant stand as a result highest yield with low toxicity and effective weed control.

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