*Indian Journal of Agronomy* **50** (1) : 35–37 (March 2005)

# Effect of weed-management practices on direct-seeded rice (*Oryza sativa*) under puddled lowlands

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Received : November 2003

## ABSTRACT

A field experiment was conducted during the rainy season of 2001 and 2002 at the Crop Research Station, Ghaghraghat (Bahraich), to find out the most effective weed-control method in controlling weeds in direct-seeded rice (*Oryza sativa* L.) under puddled condition. Pre-emergence application of anilophos + 2, 4-D (0.3+0.5 kg a.i./ha) supplemented by 1 hand-weeding 40 days after sowing (DAS) provided a broad-spectrum weed control throughout the crop season. The highest weed-control efficiency (85.2%) was also recorded under this treatment. The grain yield and nutrient uptake of the crop were highest in 2 hand-weeding treatments which was comparable with treatment of anilophos + 2,4-D (0.3+0.5 kg a.i./ha)+ 1 hand-weeding 40 days after sowing (DAS). Both formulations of fenoxaprop-P-ethyl and almix + 0.2% surfactant as post-emergence resulted in the poorest control of weeds, lower grain yield and higher phytotoxicity to rice crop.

***Key words :*** Weed management, Direct-seeded rice, Puddled, Lowlands

Direct-seeded rice is becoming popular and alternative to transplanted one in Uttar Pradesh, as it reduces the cost of labour, and grain yield is oftenly higher than the transplanted rice under good weed-management practices, and it is more remunerative if the crop is managed properly (Madhu and Nanjappa, 1996). Dhiman and Nandal (1996) reported 30–35% reduction in yield of direct-seeded rice under puddled condition during wet season. Though hand-weeding effective, it is highly expensive. Moreover, heavy demand of labour during peak period and its scarcity necessitates the use of alternative method of weed control. Chemical weed control being cost effective and less labour dependent, is recommended to overcome this constraint under direct-seeded puddled rice. Broad spectrum of weed flora may not be controlled by herbicides alone, as flushes of weeds come up at different stages. In view of the above, the present investigation was undertaken to study the effectiveness of herbicides to control weeds in direct-seeded rice under puddled situation.

## MATERIALS AND METHODS

A field experiment was carried out during the rainy (*kharif*) seasons of 2001 and 2002 at the Crop Research Station, Ghaghraghat (Bahraich), in sandy-loam soil. The soil had pH 8.1, organic carbon 0.42%, available N 235, $P_2O_5$ 20.14 and $K_2O$ 182 kg/ha. 'Mahsuri' rice received uniform fertilizer dose of 100 N + 50 $P_2O_5$ + 40 $K_2O$ + 20 $ZnSO_4$ kg/ha. The entire quantity of phosphorus, potash, zinc sulphate and half dose of nitrogen were applied basal and remaining nitrogen was top-dressed in 2 equal splits– at tillering (45 days after sowing) and panicle initiation (80–85 days after sowing).

Pre-germinated seeds of rice were sown in puddled field in the last week of June during both years. The seed rate was kept 100 kg/ha. The experiment was laid out in randomized block design with 12 treatments replicated 4 times. The herbicides application was made as per schedule (Table 1).

The density and dry weight of weeds were taken at 4 stages, i.e. 30, 6, 90 days after sowing and at harvesting stage of crop using a quadrate of 0.25 $m^2$ from 2 places in each plot. Data were transformed using $\sqrt{X + 0.5}$. The phytotoxicity of treatment was measured by using 0–10 scale. Crop and weed samples were analysed for uptake of nitrogen, phosphorus and potash as per standard laboratory procedures. The total rainfall received during the crop season was 895 and 650 mm in 2001 and 2002 respectively.

## RESULTS AND DISCUSSION

The major weed species recorded in rice crop were: *Cynodon dactylon* (L.) Pers. *Echinochloa crus-galli* (L.) P. Beauv.; *E. colonum* Link and *Laptochloa chinensis* L. among grassess; *Cyperus rotundus* L., *Cyperus iria* (L.);

*Fimbristlis miliacea* (L.) Vahl among sedges; and *Caesulia axillaris* Roxb., *Cynotis axillaris* and *Commelina benghalensis* L. among the broad-leaf weeds.

### *Effect on weeds*

The density of weeds increased up to 60 days after sowing (DAS) and thereafter reduced in all the treatments. However, the dry weight of weeds increased up to 90 DAS and reduced at harvesting. Application of anilophos + 2,4-D (0.3+0.5 kg a.i./ha) supplemented with 1 hand-weeding at 40 DAS ($T_{10}$) recorded the lower weed density and dry weight of weeds at 30, 60, 90 DAS and at harvesting which was followed by 2 hand-weeding treatment ($T_{11}$). Among the butachlor + propanil applied treatment, butachlor + propanil (1.05 + 1.05 kg a.i./ha) applied at 10 DAS reduced the both density and dry weight of weeds at all stages (30, 60, 90 DAS and at harvest stage). The poor control of weeds was recorded by fenoxaprop - P - ethyl and almix + 0.2% surfactant-applied treatments (Table 2). All treatment resulted in significantly lower weed population and dry weight than the weedy check (Table 2). Application of anilophos + 2, 4-D (0.3+0.5 kg a.i./ha) as pre-emergence supplemented with 1 hand-weeding at 40 DAS recorded the highest weed-control efficiency (85.21%), followed by 2 hand-weeding treatment (83.26%). The lowest weed-control efficiency (20.62%) was recorded against fenoxaprop - P- ethyl treatment owing to higher weed dry weight because of poor weed control. The highest phytotoxicity to crop was recorded with almix + 0.2% surfactant, and fenoxaprop - P- ethyl treatment. Both formulations of anilophos + 2, 4-D resulted in the lower phytotoxicity to crop.

Weedy check resulted in the highest uptake of nutrients by weeds, However, among the herbicidal treatments, the lowest uptake of nutrients through weeds was recorded by anilophos + 2,4-D (0.3+0.4 kg a.i./ha) + 1 hand-weed-

**Table 1.** Details of treatments used in experiment

| Treatment | Concentration (%) | Dose (kg a.i./ha) | Time of application (DAS) |
|---|---|---|---|
| $T_1$, Butachlor + Safener | 47.6 EC | 1.0 | 3 |
| $T_2$, Butachlor + Propanil | 28 + 28EC | 0.84+0.84 | 10 |
| $T_3$, Butachlor + Propanil | 28 + 28 + EC | 1.12+1.05 | 10 |
| $T_4$, Butachlor + Propanil | 27.5 + 27.5 EW | 1.05+1.05 | 10 |
| $T_5$, Fenoxaprop-P-ethyle | 9 EC | 0.056 | 15 |
| $T_6$, Fenoxaprop-P-ethyle | 9 EC | 0.075 | 15 |
| $T_7$, Alimix + 0.2% surfactant | 20 WP | 0.004 | 20 |
| $T_8$, Alimix + 0.2% surfactant | 20 WP | 0.004 | 25 |
| $T_9$, Anilofos + 2,4-D EE | 24 + 32 EC | 0.4±0.6 | 3 |
| $T_{10}$, Aniloplos +2,4-D EE + HW | 24 + 32 EC | 0.3±0.5 | 3, 40 |
| $T_{11}$, 2 hand-weedings | | | 20, 40 |
| $T_{12}$, Weedy check | | | |

**Table 2.** Effect of weed-control treatments on weed density, weed dry weight and weed-control efficiency (WCE) at 90 days after sowing

| Treatment | Weed density no./m² | | | | Weed dry weight (q/ha) | | | | Phytotoxicity rating on crop | WCE (%) | Nutrient uptake (kg/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | Harvest | 30 DAS | 60 DAS | 90 DAS | Harvest | | | Nitrogen | Phosphorus | Potash |
| $T_1$ | 93 | 154 | 146 | 143 | 4.9 | 8.1 | 14.1 | 12.7 | 3.0 | 50.6 | 11.9 | 5.7 | 16.1 |
| $T_2$ | 101 | 168 | 159 | 155 | 4.0 | 6.6 | 11.4 | 10.2 | 2.0 | 60.3 | 9.2 | 4.6 | 12.5 |
| $T_3$ | 109 | 176 | 165 | 162 | 3.8 | 6.7 | 10.9 | 9.2 | 2.5 | 64.2 | 8.1 | 4.2 | 11.5 |
| $T_4$ | 92 | 149 | 140 | 136 | 2.3 | 3.8 | 6.5 | 5.8 | 2.5 | 77.4 | 5.1 | 2.7 | 7.5 |
| $T_5$ | 89 | 144 | 135 | 132 | 7.9 | 13.2 | 22.3 | 18.9 | 4.0 | 26.4 | 18.7 | 8.5 | 24.6 |
| $T_6$ | 67 | 107 | 101 | 98 | 9.4 | 15.7 | 26.5 | 20.4 | 4.5 | 20.2 | 20.2 | 9.4 | 28.6 |
| $T_7$ | 106 | 172 | 162 | 158 | 6.2 | 10.4 | 17.5 | 14.7 | 5.0 | 42.8 | 14.2 | 20.9 | 19.1 |
| $T_8$ | 107 | 174 | 165 | 160 | 6.0 | 10.0 | 16.9 | 14.2 | 5.5 | 44.7 | 14.1 | 6.2 | 17.9 |
| $T_9$ | 76 | 123 | 116 | 112 | 3.3 | 5.6 | 9.4 | 8.1 | 1.5 | 68.4 | 7.0 | 3.7 | 9.7 |
| $T_{10}$ | 75 | 25 | 22 | 19 | 1.6 | 2.7 | 4.5 | 3.8 | 1.5 | 85.2 | 3.3 | 1.5 | 4.2 |
| $T_{11}$ | 75 | 32 | 27 | 24 | 1.7 | 2.8 | 4.7 | 4.3 | 1.0 | 83.3 | 3.7 | 1.6 | 4.3 |
| $T_{12}$ | 190 | 322 | 305 | 294 | 10.5 | 17.4 | 29.5 | 25.7 | 1.0 | | 24.9 | 11.0 | 28.3 |
| CD (P=0.05) | | | | | 0.8 | 0.9 | 1.0 | 1.1 | | | 0.9 | 0.9 | 1.1 |

DAS, Days after sowing

**Table 3.** Effect of weed-control treatments on yied attributes, grain yield, nutrients uptake and weed index

| Treatment | Yield attributes | | | | Nutrient uptake (kg/ha) | | | Grain yield (tonnes/ha) | | | Weed index* (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Effective panicles/ $m^2$ | Panicle weight (g) | Grains/ panicle | 1,000-grain weight (g) | N | $P_2O_5$ | $K_2O$ | 2001 | 2002 | Pooled | |
| $T_1$ | 285 | 3.2 | 119 | 15.5 | 37.4 | 8.3 | 7.5 | 3.0 | 2.3 | 2.8 | 20.6 |
| $T_2$ | 291 | 3.3 | 124 | 15.7 | 39.4 | 8.7 | 7.8 | 3.2 | 2.6 | 2.9 | 16.9 |
| $T_3$ | 299 | 3.4 | 127 | 15.9 | 41.7 | 9.7 | 8.1 | 3.2 | 2.8 | 3.0 | 13.5 |
| $T_4$ | 317 | 3.6 | 130 | 16.3 | 46.2 | 11.0 | 9.3 | 3.7 | 2.9 | 3.3 | 4.6 |
| $T_5$ | 292 | 2.9 | 112 | 15.0 | 33.6 | 6.8 | 6.3 | | 2.5 | 2.5 | 27.5 |
| $T_6$ | 294 | 2.9 | 114 | 15.1 | 34.2 | 7.1 | 6.3 | | 2.5 | 2.5 | 26.9 |
| $T_7$ | 275 | 2.9 | 118 | 15.3 | 35.8 | 7.9 | 6.9 | 2.8 | 2.4 | 2.6 | 24.1 |
| $T_8$ | 271 | 2.9 | 112 | 14.9 | 33.0 | 6.5 | 6.2 | 2.7 | 2.4 | 2.5 | 28.4 |
| $T_9$ | 3.6 | 3.5 | 128 | 16.1 | 44.3 | 10.2 | 8.6 | 3.5 | 2.8 | 3.2 | 8.6 |
| $T_{10}$ | 321 | 3.7 | 132 | 16.4 | 47.5 | 11.2 | 9.9 | 3.9 | 2.9 | 3.4 | 3.0 |
| $T_{11}$ | 331 | 3.8 | 133 | 16.5 | 50.2 | 11.9 | 10.1 | 3.9 | 3.0 | 3.5 | |
| $T_{12}$ | 190 | 2.1 | 65 | 14.7 | 20.8 | 4.3 | 4.0 | 1.8 | 1.5 | 1.7 | 51.9 |
| CD (P=0.05) | 11 | 0.4 | 10 | 0.4 | 2.8 | 0.7 | 0.2 | 0.2 | 0.2 | 0.2 | |

*Average of 2 years data

ing at 40 DAS which was followed by 2 hand-weeding treatments (3.74 kg N, 1.54 kg $P_2O_5$ and 4.26 kg $K_2O$ kg/ha). The lowest amount of weed dry weight owing to better control of weeds under anilophos + 2,4-D supplemented with 1 hand-weeding treatment resulted in the lower nutrient uptake. Butachlor + proponil-applied treatments were found better in controlling weeds and removed the lower amount of nutrient among the herbicides treatments. The lowest uptake of nutrient (5.10 kg N, 2.67 kg $P_2O_5$/ha + 7.54 kg $K_2O$ kg/ha) by weeds was recorded with butachlor + propanil (1.05 + 1.05 kg a.i./ha).

### *Effect on crop*

The grain yield was higher in 2001 than that in 2002 because of lower rainfall and unfavourable weather conditions during 2002. However, the trends of various treatments with regards to yield was similar during both years. The highest grain yield was recorded with 2 hand weeding treatment. Amongst herbicides treatments, anilophos + 2,4-D (0.3+0.5 kg a.i./ha) supplemented with 1 hand-weeding resulted in significantly highest grain yield over rest of the treatments except butachlor+propanil (1.05+1.05 kg a.i./ha) and anilophos + 2,4-D (0.4+0.5 kg a.i./ha). This could be attributed to efficient control of weeds which reduce the nutrients uptake by weeds and resulted in better growth yields and attributes to rice crop (Table 2). Similar results were reported by Singh *et al.* (2000).

The highest reduction in grain yield due to weeds (51.9%) was registered in weedy check treatment (Table 3). Application of anilophos + 2,4-D (0.3+0.5 kg a.i./ha) supplemented with 1 hand-weeding at 40 DAS resulted in the lowest reduction in yield (2.9%) due to weeds which was followed by butachlor + propanil (1.05+1.05 kg a.i./ha) applied at 10 DAS (4.6%).

The higher yield and more nutrient uptake by rice crop with 2 hand-weeding and anilophos + 2,4-D supplement with 1 hand-weeding at 40 DAS treatments were mainly owing to more effective panicles/$m^2$, higher panicle weight and 1,000-grain weight and more grains/panicle (Table 2).

The lowest nutrient depletion by crop was recorded under weedy check treatment because of poor grain yield of crop. However, 2 hand-weedings resulted in the highest depletion of nutrient by crop which was on par with anilophos + 2,4-D supplement with 1 hand-weeding at 40 DAS. The higher uptake of nutrients by crop with above treatments could be attributed to more availability of nutrients in soil owing to less depletion of nutrients by weeds (Singh *et al.*, 2000).

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