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Effect of cultural and chemical weed control on productivity of fodder oat *(Avena sativa)* in arid Rajasthan

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ABSTRACT

A field experiment was conducted during winter *(rabi)* season of 2002-03 and 2003-04 to find out the effective and economical weed-control measure in fodder oats *(Avena sativa* L.). The different weed-control treatments significantly controlled the weed flora and recorded 69.2 to 97.6% weed-control efficiency (WCE) at 45 days after sowing (DAS) and 59.3 to 98.0 per cent at 50% flowering stage. However, post-emergence application of 2,4-D proved phytotoxic by stunting the crop growth and narrowing the leaf area. Among weed-control treatments, weed-free treatment proved superior and produced highest fodder yields (GFY 42.9 t/ha DFY 11.05 t/ha), followed by post-emergence application of metsulfuron methyl @ 0.008 kg/ha + 1 hand-weeding. Economical analysis showed that application of metsulfuron methyl @ 0.008 kg/ha gave the maximum net returns (Rs 14,647) and benefit: cost ratio (1.79), followed by metsulfuron methyl 0.012 kg/ha+1 hand-weeding. Computation of energy relationship revealed that weed-free treatment was more energy efficient, recording highest energy ratio (9.46) and energy productivity (525.7 g/MJ), followed by post-emergence application of metsulfuron methyl @ 0.012 kg/ha (9.42 and 523.3 g/MJ).

Key words : Oats, Weed control, 2, 4-D, Metsulfuron methyl, Economics, Energy relationships

Oats *(Avena sativa* L.) is an important winter *(rabi)* season-fodder crop of India, rich in energy, protein, vitamin B, phosphorus and iron (Mehra, 1978). In arid region of Rajasthan the introduction of Indira Canal and the resultant increase in number of tubewells for irrigation provided an opportunity for farming community to grow fodder oats in large areas. Since it is grown under irrigated conditions, weed infestation is generally high; the severe crop-weed competition leads to major constraints in achieving higher fodder-productivity potential. The weed species associated with fodder oats like *Kharbathua (Chenopodium murale)* and wild hollyhock *(Althaea ludwigii)* are generally disliked by the animals. They not only decrease the fodder yield by 20% but also impair the fodder quality. Earlier studies indicate that no single weed-control practice is effective to control the weed density. The better strategy would be an integrated approach of weed control. The present study was undertaken to find out the effective, economical and energy-efficient weed-control practice for fodder oats by using some post-emergence herbicides and cultural practices as also their combination.

MATERIALS AND METHODS

The field experiment was conducted at research farm of the institute at Bikaner. The soil was sandy and low in organic carbon (0.23%), available nitrogen (146.8 kg/ha), available phosphorus (7.8 kg P/ha) and available potassium (84.4 kg K_2O/ha), with pH 8.54 and electrical conductivity (EC) 0.58 dS/m. Treatments consisted of: T_1, one hand-weeding (HW) at 30 days; T_2, two hand-weedings each at 20 and 40 days; T_3, post-emergence application of 2,4-D @ 0.50 kg/ha; T_4, 2,4-D @ 0.75 kg/ha; T_5, 2,4-D @ 0.50 kg/ha, + 1 HW, T_5, metsulfuron methyl @ 0.008 kg/ha, T_6, metsulfuron methyl @ 0.012 kg/ha; T_7, metsulfuron methyl @ 0.008 kg/ha + 1 HW; T_9, weedy check; and T_{10}, weed-free treatment. This trial was undertaken in randomized block design (RBD) with three replications. Both the herbicides were sprayed at post emergence stage at 4 weeks of crop age (at tillering after 5-leaf stage) with a manually operated foot-spray using flat fan nozzle and one hand-weeding in treatment T_5 and T_8 was done at 40 days after sowing. Metsulfuron methyl was sprayed along with recommended quantity of the surfactant. The crop was sown on 2 December 2002 and 6 December 2003. Oat 'Kent' was sown 30 cm apart in rows. Sheep manure @ 10 t/ha was applied uniformly at the time of field preparation and the crop was fertilized with 90 kg N/ha through urea and 40 kg P and K/ha each through single superphosphate and muriate of potash respectively. The crop was irrigated as and when required and a total 6 irrigations

each were applied in both the years. All other recommended packages of practices was adopted to raise a healthy crop. The crop was harvested at 50% flowering. At the time of harvest the weed samples were collected from 1 m^2 quadrate from each plot to determine weed density and dry weight at 45 days after sowing and 50% flowering stage. The energy relationships were computed as suggested by Panesar and Bhatnagar (1987).

RESULTS AND DISCUSSION

Weed flora

The major weed species were mainly broad-leaf weeds, viz. *kasani (Chicorium intybus), khartua* or *kharbathua (Chenopodium murale)*, wild hollyhock *(Althaea ludwigii), piajee (Asphodelus tenufolius),* badi duddhi *(Euphorbia hirta)* and *gokhru (Tribulus terrestris).* The density of grasy weeds, viz. *Motha (Cyperus rotundus)* and doob grass *(Cynodon dactylon)* was found to be much less in the experimental field. *C. intybus, C. murale* and *A. ludwigii* were the most predominant weed species, with average density of 58, 29 and 11% respectively.

Weed dynamics

The density and dry weight of weeds were significantly reduced due to all weed-control practices in both the years compared with the weedy check (Table 1) at both the stages. Mean data over 2 years showed that weed-control efficiency (WCE) was 71.3 to 96.9% at 45 days after sowing (DAS), being maximum with two hand-weedings. This was followed by application of mesulfuron methyl @ 0.008 kg/ha + 1 HW. However, at 50% flowering stage the latter treatment recorded the highest WCE (97.5%), followed by application of 2,4-D @ 0.50 kg/ha + 1 HW. Application of 2,4-D at both the doses proved phytotoxic and stunted the plant growth and narrowed the leaf area (Table 2). Weed index varied from1.3 to 25.8% during the study. Application of metsulfuron methyl at different doses recorded the lowest weed index, and a similar position was obtained from one or two hand-weedings. However, application of 2,4-D at both the doses recorded higher weed index due to phyto-oxicity, which was almost similar to or more than the weedy check. Pandey *et al.* (2001) also reported that mesulfuron methyl alone or in combination with 2,4-D Na gave excellent control of broad-leaf weed species in wheat.

Growth and fodder yield

The weed-free environment gave the maximum green-fodder and dry-matter yields (GFY 42.9 t/ha and DMY

Table 1. Weed dynamics at 45 days after sowing and at 50% flowering as affected by different weed-control practices in oats

Treatment	At 45 days after sowing							At 50% flowering			Weed index	
	No. of weeds*/ m^2		Dry weight of weeds* (g/m^2)		WCE (%)			WCE (%)				
	2002–03	2003–04	2002–03	2003–04	2002–03	2003–04	Mean	2002–03	2003–04	Mean	2002–03	2003–04
T_1 One HW at 30 DAS	6.78 (46.2)	7.53 (56.80)	6.02 (35.80)	6.17 (39.70)	74.8	73.9	74.3	85.9	78.9	82.4	3.3	9.2
T_2 Two HW at 20, 40 DAS	2.66 (6.70)	2.40 (5.30)	2.78 (7.30)	3.02 (8.70)	96.3	97.6	96.9	95.9	95.5	95.7	3.1	8.3
T_3 2, 4-D @ 0.5 kg	5.28 (27.80)	7.99 (63.80)	4.49 (19.80)	4.68 (21.50)	84.8	70.8	77.8	90.1	59.3	74.7	14.4	24.2
T_4 2, 4-D @ 0.75 kg	4.32 (18.50)	7.38 (54.30)	3.43 (11.30)	3.77 (13.70)	89.9	75.1	82.5	94.4	69.5	81.9	20.2	25.8
T_5 2, 4-D @ 0.5 kg + 1 HW	2.48 (5.70)	3.48 (4.70)	2.49 (5.70)	2.50 (5.90)	96.9	94.6	95.7	97.3	96.3	96.8	18.8	21.9
T_6 MM @ 0.008 kg	7.01 (48.70)	8.23 (67.30)	4.55 (20.30)	4.71 (21.80)	73.4	69.2	71.3	93.6	83.1	88.3	5.5	8.9
T_7 MM @ 0.012 kg	6.75 (45.30)	7.11 (50.70)	3.19 (9.70)	4.44 (19.30)	75.3	76.8	76.0	95.1	87.1	91.1	1.3	10.7
T_8 MM @ 0.008 kg+1 HW	2.64 (6.50)	2.94 (8.30)	2.68 (6.90)	3.02 (8.70)	96.4	96.2	96.3	98.0	97.1	97.5	2.7	8.1
T_9 Weedy check	13.54 (183.30	14.78 (218.30)	9.38 (87.80)	9.83 (96.30)							21.7	22.2
T_{10} Weed-free treatment	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	100	100	100	100	100	100	-	-
CD (P=0.05)	1.05	1.05	0.58	0.60								

Number and dry weight of weeds are transformed values $\sqrt{x+0.5}$, and figures in parentheses are actual number and weights
HW=Hand-weeding; PoE=post-emergence; WCE=weed-control efficiency; and MM=metsulfuron methyl

11.05 t/ha). This treatment was statistically on a par with that of post-emergence application of metsulfuron methyl at both the doses and one or two hand-weedings, but significantly higher than that of weedy check and application of 2,4-D (Table 2). Application of 2,4-D at both the doses significantly decreased the fodder yield and recorded similar yields with the weedy check treatment. Higher yield under weed-free treatment on application of metsulfuron methyl was the function of higher plant height and number of plants per unit area. However, lower fodder yield in the plot treated with 2,4-D was the function of lower number of plants, tiller height and leaf-area index (Table 2) due to phytotoxicity. Higher fodder yield in weed-free treatment may be ascribed to the lower crop-weed competition for air, light, nutrients and water, where the crop plants performed well under stress-free environment and produced higher yield. Kumar *et al.* (2001) also reported similar results.

Economics

On the basis of prevalent market prices of different inputs and outputs, economic analysis of oats cultivation was done (Table 2). Higher net returns were realized with the application of metsulfuron methyl @ 0.008 kg/ha, followed by its higher dose @ 0.012 kg/ha and weed-free treatment. Similarly, highest B:C ratio was recorded with metsulfuron methyl @ 0.008 kg/ha, followed by that @ 0.012 kg/ha and the treatment of one hand-weeding only. Higher net returns and B:C ratio found with the application of mesulfuron methyl treatment might be due to cost-effective weed-control technique. But weed-free treatment in spite of higher fodder yields could not achieve the similar level of net returns and B:C ratio values of as obtained with metsulfuron methyl due to increased cost on repeated manual weeding. These results are in close agreement with the findings of Naik *et al.* (2001).

Energy relationships

Energy used in oats cultivation under different weed-control treatments was computed to augment the energy-use efficiency (Table 2). As per computation, input energy differed due to difference in energy use under different weed-control techniques. The output energy, however, is dependent on dry-fodder yield (DFY) under different treatments and higher fodder yields registered greater output energy. Hence energy ratio (output : input ratio) and energy productivity per unit of energy used (in Mega Joule) may be considered for energy relationships. Among weed-control practices, weed-free treatment recorded the maximum energy ratio and energy productivity, followed by higher dose of metsulfuron methyl, i.e. 0.012 kg/ha. Higher energy ratio and energy productivity might be caused by higher production of output energy due to higher fodder yields and lower input energy use in comparison to other treatments.

On the basis of 2 years data, it is inferred that weed-free environment holds promise to provide higher and energy-efficient fodder production, but application of metsulfuron methyl @ 0.008 kg/ha produced more economical fodder. Hence in the condition of costly or unavailability of manual labour, application of metsulfuron methyl @ 0.008 kg/ha at 4 weeks of crop age (at tillering) may be recommended for farmer's use to control weeds in fodder oats in arid region of Rajasthan.

Table 2. Growth, fodder yield, energy relationship and economics as affected by different weed-control treatments in oats

Treatment	Green fodder (t/ha)		Dry matter and growth attributes (pooled analysis of 2 years)				Energy productivity				Economics	
	2002-03	2003-04	Dry matter (t/ha)	Tiller hight (cm)	Tiller number (m row)	Leaf-area index	Energy input ('000 MJ/ha)	Energy output ('000 MJ/ha)	Energy ratio	Energy productivity (g/MJ)	Net returns Rs/ha)	B:C ratio
T_1 : One HW	43.8	38.7	10.33	118.2	108.8	11.55	20.23	185.9	9.19	510.5	14,103	1.75
T_2 : two HW	43.5	39.5	10.42	118.6	112.2	11.65	20.63	187.6	9.09	505.2	13,103	1.65
T_3 : 2,4-D @ 0.5 kg	38.6	31.6	8.92	109.6	102.2	8.55	19.91	160.6	8.07	448.1	10,013	1.55
T_4 : 2,4-D @ 0.75 kg	35.8	30.6	8.51	108.1	101.5	8.15	20.00	153.2	7.66	425.5	8,349	1.46
T_5 : 2,4-D @ 0.5 kg + 1 HW	36.7	32.8	8.80	108.6	103.2	9.05	20.46	158.4	7.74	430.1	8,533	1.44
T_6 : MM @ 0.008 kg	42.5	40.4	10.25	118.7	107.4	11.75	19.85	184.5	9.30	516.4	14,647	1.79
T_7 : MM @ 0.012 kg	44.3	39.3	10.39	115.7	110.1	11.50	19.86	187.0	9.42	523.3	14,577	1.77
T_8 : MM @ 0.008 kg + 1 HW	43.8	40.8	10.45	119.5	108.6	11.50	20.25	188.1	9.29	516.0	14,127	1.72
T_9 : Weedy check	35.6	33.8	8.62	133.3	105.0	11.25	19.84	155.2	7.82	434.4	10,063	1.57
T_{10} : Weed-free treatment	44.8	41.0	11.05	120.9	113.0	11.90	21.02	198.0	9.46	525.7	13,023	1.61
CD (P=0.05)	5.3	4.0	0.88	3.9	6.0	0.71					2,565	0.14

MM=Metsulfuron methyl

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