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Integrated weed management in winter onion (*Allium cepa*) under mid-hill conditions of north-western Himalayas

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ABSTRACT

A field experiment was conducted during winter (*rabi*) season of 1996–97 and 1997–98 to study the effect of herbicides (fluchloralin, oxyfluorfen, pendimethalin and alachlor) alone and in combination with hand-weeding (45 days after transplanting) on weeds and onion (*Allium cepa* L.). Season-long crop–weed competition reduced the bulb yield by 81.2% compared to weed-free condition. All the weed-control treatments significantly reduced the population and dry weight of weeds and in turn increased the bulb yield significantly except oxyfluorfen 0.15 kg/ha compared to weedy check. Alachlor 2.0 kg/ha + hand-weeding 45 days after transplanting being at par with pendimethalin 1.5 kg/ha + hand-weeding at 45 days and weed-free proved to be the superior integrated weed-control approach to control weeds and increased the plant height, bulb diameter, bulb weight, weed-control efficiency. These treatments also registered higher additional net returns. But highest additional returns/rupee invested were obtained with alachlor 2.0 kg/ha.

Key words : Integrated weed management, Onion, *Allium cepa*, Herbicide, Yield

Onion has an important place in commercial vegetables and spices and is widely grown as a cash crop in different parts of country. Slow initial growth and inherent characteristics of onion such as short stature, non-branching habit, sparse foliage, shallow root-system coupled with frequent irrigation and fertilizer application at high doses cause severe crop–weed competition. Uncontrolled weed growth reduces the bulb yield to the tune of 40–80%, depending on types of weed flora, their intensity and duration of crop–weed competition (Patel *et al.*, 1983; Mishra *et al.*, 1986). Due to closer planting and shallow root system of onion, manual weeding is tedious, expensive and time consuming. Moreover, non-availability of sufficient labour at critical period of crop–weed competition and some time field conditions do not permit the manual weeding. Under such situations, chemical

weed control can only be the best alternative. However, an integrated weed-management approach involving herbicide at low doses and cultural practices, not only provides economically acceptable weed control but eco-friendly in nature as well. An information on this aspect, particularly in hills of Uttar Pradesh, is meagre. Hence the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was carried out during the 1996-97 and 1997-98 winter (*rabi*) seasons at Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora (29°36′ N, 79° 40′E, longitude with an elevation of 1,250 m amsl). The soil of the experimental field was sandy loam in texture, neutral in reaction (pH 6.7) and medium in available N (425.6 kg/ha), P (20.8 kg/ha) and K (205.4 kg/ha). Eighteen treatments (Table 1) were laid out in randomized block design with 4 replications. Fluchloralin and oxyfluorfen were incorporated into the soil before transplanting, whereas pendimethalin and alachlor were applied on the next day of the transplanting. Four hand-weedings (25, 50, 75 and 100 days after transplanting) were done in weed-free treatment. One light-irrigation was given just after transplanting and others were given as and when required. Herbicides were applied with a manually operated foot sprayer using flat-fan nozzle.

Two-month-old healthy seedlings of onion cv. 'VL Piaz 3' were transplanted in the flat beds at distance of 15 cm × 10 cm on 11 and 12 December during 1996–97 and 1997–98 respectively. The recommended cultural practices and plant-protection measures were adopted to raise a healthy crop. Well-decomposed FYM @ 20 tonnes/ha was applied uniformly at the time of field preparation. In addition, the crop was fertilized with 100 kg N, 80 kg P_2O_5 and 60 kg K_2O/ha. Half the N and full quantity of P and K were applied at the time of transplanting and remaining N was top-dressed in 2 equal splits, 40 and 60 days after transplanting. Observations were recorded on weed population and dry weight at harvest with the help of 0.25 m × 0.25 m quadrate at 2 randomly selected places in each plot. Effect of treatments on yield attributes, yield and comparative economics was also recorded.

RESULTS AND DISCUSSION

Weed flora

The predominant weed species infesting the experimental plots were *Galinsoga parviflora* Cav., *Brachiaria ramosa* L., *Cyperus rotundus* L., *Cannabis sativa* L., *Polygonum plebjum* L., *Fumaria parviflora* L., *Phalaris minor* Retz. and *Oxalis latifolia* H.B.K.

Weed population and weed biomass

All the weed-control treatments caused significant reduction in population and dry weight of weeds compared with the weedy check (Table 1). However, magnitude of reduction in density and biomass of weeds varied, depending on control measures adopted. Inclusion of hand-weeding at 45 days after transplanting in herbicide treatments further significantly reduced weed dry weight and remarkably decreased weed density compared with respective herbicide

Table 1. Effect of weed-control measures on weed population, dry weight of weeds and weed-control efficiency (pooled data of 1996–97 and 1997–98)

Treatment	Weed population (No./m²)	Weed dry weight (g/m²)	Weed-control efficiency (WCE)
T_1, Fluchloralin 1.0 kg/ha (PPI)	194.5	396.6	31.1
T_2, Fluchloralin 1.5 kg/ha (PPI)	184.0	380.6	33.8
T_3, Fluchloralin 2.0 kg/ha (PPI)	161.0	344.6	40.6
T_4, T_1 + HW 45 DAT	116.0	236.9	59.6
T_5, T_2 + HW 45 DAT	110.5	224.9	61.5
T_6, T_3 + HW 45 DAT	101.5	224.5	61.8
T_7, Oxyfluorfen 0.15 kg/ha (PPI)	270.5	458.2	19.8
T_8, Oxyfluorfen 0.25 kg/ha (PPI)	216.0	438.1	23.2
T_9, T_7 + HW 45 DAT	148.0	204.6	64.3
T_{10}, T_8 + HW 45 DAT	89.0	211.7	63.3
T_{11}, Pendimethalin 1.0 kg/ha (PE)	170.5	284.4	49.4
T_{12}, Pendimethalin 1.5 kg/ha (PE)	168.0	273.9	51.2
T_{13}, T_{11} + HW 45 DAT	100.0	168.8	70.5
T_{14}, T_{12} + HW 45 DAT	90.5	146.3	74.5
T_{15}, Alachlor 2.0 kg/ha (PE)	96.0	179.9	68.3
T_{16}, T_{15} + HW 45 DAT	78.5	133.9	76.6
T_{17}, Weed-free	17.5	11.5	98.0
T_{18}, Weedy check	370.5	572.1	
CD (P = 0.05)	87.4	72.9	

PPI, Pre-plant incorporation; HW, hand-weeding; DAT, days after transplanting; PE, pre-emergence

alone. Pre-emergence spray of alachlor at 2.0 kg/ha, followed by hand-weeding at 45 days after transplanting being at par with weed-free check recorded significantly lower weed population and weed biomass. Alachlor 2.0 kg/ha was found statistically at par with pendimethalin 1.0 or 1.5 kg/ha in reducing weed population. However, former proved significantly superior to latter in reducing the weed dry weight. Higher concentration of herbicides was more effective, though non-significant in reducing the population and dry weight of weeds compared with their lower concentrations. This might be due to longer persistence of herbicides in soil. Patel *et al.* (1983) and Singh (1996) also reported similar results. Weed-control efficiency due to herbicides alone ranged from 19.8 to 68.3%, maximum being in alachlor 2.0 kg/ha and minimum under oxyfluorfen 0.15 kg/ha. Inclusion of hand-weeding with herbicides improved the weed-control efficiency by 8.3–40.4%.

Yield and yield attributes

Plant height, bulb diameter, bulb weight and bulb yield were significantly influenced due to weed-control measures. Highest plant height, bulb diameter and

Table 2. Plant height, bulb diameter, bulb weight and bulb yield and monetary returns as influenced by weed-control treatments (pooled data of 1996–97 and 1997–98)

Treatment	Plant height (cm)	Bulb diameter (cm)	Bulb weight (g)	Bulb yield (q/ha)	Additional gross return (Rs/ha)	Treatment cost (Rs/ha)	Additional returns (Rs/ha)	Additional net returns/ rupee invested
T_1, Fluchloralin 1.0 kg/ha (PPI)	45.6	4.8	41.0	243.3	57,960	1,981	55,979	28.3
T_2, Fluchloralin 1.5 kg/ha (PPI)	46.0	4.8	45.0	246.3	59,600	2,561	57,039	22.3
T_3, Fluchloralin 2.0 kg/ha (PPI)	46.2	5.0	47.5	267.7	68,160	3,141	65,019	20.7
T_4, T_1 + HW 45 DAT	47.0	5.3	62.0	355.1	103,120	10,531	92,589	8.8
T_5, T_2 + HW 45 DAT	47.0	5.4	64.0	357.4	104,040	11,111	92,929	8.4
T_6, T_3 + HW 45 DAT	47.1	5.4	63.0	363.5	106,480	11,691	94,789	8.1
T_7, Oxyfluorfen 0.15 kg/ha (PPI)	41.8	4.3	31.0	166.7	27,760	1,673	26.087	15.6
T_8, Oxyfluorfen 0.25 kg/ha (PPI)	42.5	4.6	34.5	189.9	37,040	2,241	34,799	15.5
T_9, T_7 + HW 45 DAT	46.3	5.3	61.5	365.0	107,200	10,223	96,977	9.5
T_{10}, T_8 + HW 45 DAT	47.6	5.7	68.0	351.0	101,840	10,791	91,049	8.4
T_{11}, Pendimethalin 1.0 kg/ha (PE)	45.5	5.1	56.0	330.2	93,160	2,520	90,640	36.0
T_{12}, Pendimethalin 1.5 kg/ha (PE)	45.6	5.2	59.0	338.0	96,280	3,370	92,910	27.6
T_{13}, T_{11} + HW 45 DAT	48.8	6.1	73.0	427.4	132,053	11,070	120,983	10.9
T_{14}, T_{12} + HW 45 DAT	50.6	6.2	78.5	465.7	147,360	11,920	135,440	11.4
T_{15}, Alachlor 2.0 kg/ha (PE)	49.4	6.0	69.0	407.4	124,040	1,841	122,199	66.4
T_{16}, T_{15} + HW 45 DAT	50.9	6.3	80.5	487.9	156,240	10,391	145,849	14.0
T_{17}, Weed-free	51.4	6.5	92.5	522.2	169,960	34,200	135,760	4.0
T_{18}, Weedy check	40.3	3.4	20.5	97.3				
CD (P = 0.05)	5.0	0.9	10.5	84.9				

DAT, Days after transplanting; HW, hand-weeding
Price (Rs/litre) : Fluchloralin, 580; oxyfluorfen, 1,420; pendimethalin, 515; alachlor, 255
Labour cost : Rs 68.4/day; cost of 1 HW, Rs 8,550/ha
Selling price of onion : Rs 400/q

bulb weight were recorded under weed-free condition, followed by alachlor 2.0 kg/ha + hand-weeding (HW) 45 days after transplanting and pendimethalin 1.5 kg/ha + HW 45 days after transplanting. However, differences were not significant among themselves except for bulb weight in pendimethalin 1.5 kg/ha + HW 45 days after transplanting which was significantly inferior to weed-free. Malik *et al.* (1982) and Verma and Singh (1996) also reported similar results. Superimposition of HW 45 days after transplanting over herbicide treatments brought further significant improvement in all the yield attributes except bulb diameter due to fluchloralin and plant height for all herbicides. This may be attributed to proper aeration, reduced crop–weed competition and better utilization of resources (space, light, moisture and nutrients etc.) by the crop. Our results corroborate the findings of Mishra *et al.* (1986) and Singh *et al.* (1998).

Except oxyflourfen 0.15 kg/ha, all the weed-control treatments resulted in significantly higher bulb yield over weedy check. Among the treatments involving herbicides, pre-emergence spray of alachlor 2.0 kg/ha + 45 days after transplanting being at par with pendimethalin 1.5 kg/ha + HW 45 days after transplanting and weed-free check resulted in significant higher yield. Alachlor 2.0 kg/ha alone yielded at par with pendimethalin 1.0 or 1.5 kg/ha, alachlor 2.0 kg/ha, fluchloralin at all rates and oxyfluorfen at both rates, each followed by HW 45 days after transplanting. Hand-weeding 45 days after transplanting in combination with herbicides in general, further enhanced the bulb yield compared to herbicides alone. These results are in accordance with the findings of Malik *et al.* (1982), Patel *et al.* (1983), Singh *et al.* (1987) and Singh (1996). Better performance of herbicides + hand-weeding treatments over respective alone herbicide treatments was owing to effective control of weed through herbicides during initial stage and later on by hand-weeding.

Monetary returns

Alachlor 2.0 kg/ha + HW 45 days after transplanting recorded the maximum additional net returns, followed by weed-free and pendimethalin 1.5 kg/ha + HW 45 days after transplanting. Oxyfluorfen alone either 0.15 or 0.25 kg/ha gave lower additional net returns. Additional net returns/rupee invested ranged from 4.0 to 66.4 under different weed-control measures, being highest under alachlor 2.0 kg/ha alone and lowest under weed-free. It was mainly due to higher cost involved in repeated manual weeding to keep field free from weeds. Control of weeds either through herbicide alone or in combination with HW 45 days after transplanting registered higher net returns/rupee investment compared to weed-free.

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