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Production of weed-free mother bulb of onion (*Allium cepa*) through integration of herbicides and weeding

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ABSTRACT

A field experiment was carried out during winter season of 2004 and 2005 to find out the appropriate and economic weed-management practice for production of weed-free mother bulb of onion (*Allium cepa* L.) required subsequently for seed production. There was reduction in the bulb yield (64.8%) and bulb diameter (24.8%) due to uncontrolled weed growth in the weedy check. Pre-emergence application of oxyfluorfen integrated with one hand-weeding at 35 days after transplanting (DAT) was significantly superior to pendimethalin, fluchloralin and alachlor when applied alone and also when supplemented with one hand-weeding at 35 DAT. All the weed-control treatments significantly reduced the weed density and dry weight of weeds, and in turn increased the bulb yield compared with the weedy check. Significantly lower bulb yield was recorded with alachlor (1.5 kg/ha) compared with pendimethalin, fluchloralin and oxyfluorfen at higher doses due to its inability to control broad-leaf weeds, which had the maximum density in the experimental field. Maximum additional monetary returns (Rs 42,990 and 36,850 ha) and net monetary returns (Rs 37,350 and 31,750/ha) were recorded by oxyflurofen 0.15 kg/ha integrated with one hand-weeding at 35 DAT and oxyfluorfen 0.30 kg/ha, respectively.

Key words : Mother bulb, Herbicide, Weed density, Onion, Monetary returns

Onion (*Allium cepa* L.) has an important place as a commercial crop in Indian agriculture, grown on a large area throughout the country. It is a biennial crop that forms bulbs during the first year and seed in the second year under the bulb-to-seed method. Production of optimum size of mother bulb is an important factor that influences the growth and yield of seed crop. The bulb size and bulb yield are reduced under weedy conditions (Sharma *et al.*, 2001). Onion bulb is planted in January in north-west India. The increase in temperature during February-March along with irrigation favours the luxurious growth of weeds in this crop. Onion is a poor competitor with weeds due to its inherent characteristics like sparse foliage, non-branching habit, shallow root system and slow initial growth. Uncontrolled weed growth reduces the blub yield up to 40-80 per cent, depending upon the nature, intensity and duration of weed competition (Prakash *et al.*, 2000). Closer planting and shallow root system of onion makes manual weeding tedious, time consuming, cumbersome and often uneconomical. Under such situations chemical weed control can alone be the alternative. Use of herbicide and cultural practices as an integrated approach may provide economically acceptable weed control. Hence the present study was conducted to study the effect of herbicides and weeding alone and in combination on weeds, mother-bulb size, yield and economics of onion.

MATERIALS AND METHODS

The field experiment was conducted during 2004 and 2005 at the research farm of Regional Station, Indian Agricultural Research Institute, Karnal. The soil was sandy loam, with pH 7.9. The available soil N, P and K were 180, 212 and 301 kg/ha respectively. The experiment was laid out in randomized block design with four replications. Fluchloralin was incorporated in soil before transplanting. Pendimethalin, alachlor and oxyfluorfen were applied a day after transplanting with knapsack sprayer using 600 litres water/ha. The seedlings at 55 to 58 days were transplanted in flat beds at a distance of 15 cm × 10 cm on 21 January 2004 and 23 January 2005. The recommended cultural practices and plant-protection measures were adopted to raise a healthy crop. The crop was fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg K_2O. One-third the nitrogen and full quantity of phosphorus and potassium were applied at the time of transplanting and the remaining two-thirds nitrogen was applied in two equal splits at 35 and 55 days after transplanting. Observations on total

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weed density, density of individual weeds and dry weight of weeds were recoded at 60 days after transplanting (DAT) from two randomly selected quadrates of 50 cm × 50 cm in each plot.

RESULTS AND DISCUSSION

Weed flora

In the experimental field the weeds observed were : *Cyperus rotundus* (28%), *Coronopus didymus* (48%), *Anagallis arvensis* (6%), *Spergula arvensis* (6%) and other weeds (20%) which included *Convolvulus arvensis*, *Chenopodium album*, *Melilotus* spp. and *Poa annua*. *Coronopus didymus* was the dominant broad-leaf weed, and *Cyperus rotundus* was dominant among sedges and grasses.

Weed density and weed biomass

Both weed density and dry weight of weeds were significantly reduced on the application of pendimethalin, fluchloralin, oxyfluorfen and alachlor compared with the weedy check. The first three herbicides supplemented with one weeding at 35 DAT recorded lower weed density and dry weight of weeds and increased the weed-control efficiency compared with their sole application, alachlor alone and oxyfluorfen applied 20 DAT (Table 1 and 2). The lower dry matter of weeds and higher weed-control efficiency under these treatments compared with their application at higher doses were owing to the removal of left-out weeds by subsequent hand-weeding at 35 DAT. Kohle (2001) reported similar findings. Oxyflourfen 0.15 kg/ha + hand-weeding (HW) at 35 DAT recorded significantly lower weed density and dry weight of weeds compared with higher doses of pendimethalin, fluchloralin and alachlor; but these were on a par with those at their higher dose of 0.30 kg/ha. Alachlor integrated with one hand-weeding recorded significantly lower weed population than when applied alone. It proved less effective on *Anagallis arvensis*, *Coronopus didymus*, *Spergula arvensis* and other broad-leaf weeds, leading to increased weed density when applied alone (Table 1). However, it was the only herbicide effective against *Cyperus rotundus*. Pendimethalin, fluchloralin and oxyfluorfen showed effective control of *Anagallis arvensis*, *Coronopus didymus* and *Spergula arvensis* as well as other broad-leaf weeds compared with *Cyperus rotundus* (Table 1).

Bulb size and yield

The bulb diameter was significantly reduced in weedy check compared with weed-control treatments. There was reduction of 24.8 per cent in weedy check compared with oxyfluorfen at 0.15 kg/ha supplemented with hand-weeding at 35 DAT. Sharma *et al.* (2001) also reported lower diameter of bulb under uncontrolled weedy conditions. There was reduction of 8.0 and 12.1 per cent in bulb diameter with alachlor 1.0 kg/ha + one hand-weeding and alachlor 1.5 kg/ha respectively compared with oxyfluorfen 0.15 kg/ha + hand-weeding at 35 DAT, perhaps owing to competition provided by broad-leaf weeds that alachlor failed to control.

Pendimethalin, fluchloralin, oxyfluorfen alone and when supplemented with one hand-weeding, HW twice and thrice proved significantly superior to the unweeded check. There was reduction of 60.1, 55.0, 64.8, 57.3 and 49.6 per cent in yield under weedy check compared with pendimethalin, fluchloralin and oxyfluorfen supplemented with one hand-weeding, hand weeding twice and hand-weeding thrice (Table 2). Mondal *et al.* (2005) reported 61 per cent reduction in yield in the weedy check com-

Table 1. Effect of integrated weed management on different weed species at 60 DAT

Treatment	*Cyperus rotundus*	*Coronopus didymus*	*Anagallis arvensis*	*Spergula arvensis*	Other weeds	Weed density (0.25 m²)	Weed dry weight (g/0.25 m²)
Pendimethalin @ 1.0 kg/ha + HW	(16.8) 4.2	(18.2) 3.9	(0.12) 1.6	(1.6) 1.6	(6.0) 2.5	(42.8) 6.6	10.7
Pendimethalin @ 1.5 kg/ha	(25.7) 5.1	(18.6) 4.0	(0.12) 1.1	(2.2) 1.7	(4.5) 2.2	(51.3) 7.1	15.8
Fluchloralin @ 1.0 kg/ha + HW	(22.0) 4.7	(9.1) 2.8	(0.62) 1.2	(1.3) 1.5	(4.5) 2.1	(31.8) 5.6	11.4
Fluchloralin @ 1.5 kg/ha	(29.2) 5.3	(116) 3.1	(1.1) 1.4	(2.5) 1.8	(3.5) 2.1	(48.0) 6.9	15.7
Oxyfluorfen @ 0.15 kg/ha + HW	(24.5) 5.0	(5.1) 2.2	(0.0) 1.0	(0.9) 1.3	(4.4) 2.2	(26.6) 5.0	8.7
Oxyfluorfen @ 0.30 kg/ha	(25.1) 5.0	(2.6) 1.6	(0.0) 1.0	(1.5) 1.6	(3.9) 2.1	(33.1) 5.8	11.8
Alachlor @ 1.0 kg/ha + HW	(11.3) 3.5	(44) 6.2	(2.6) 1.9	(4.3) 2.3	(2.5) 1.8	(64.9) 8.1	19.2
Alachlor @ 1.5 kg/ha	(10.7) 3.4	(43) 6.2	(7.7) 2.9	(7.5) 2.9	(6.1) 2.6	(75.1) 8.7	25.9
Oxyfluorfen at 20 DAT	(29.8) 5.4	(22.2) 4.7	(5.2) 2.3	(7.7) 3.0	(11.1) 3.5	(78.5) 8.9	24.9
HW at 20, 40 and 60 DAT	(19.2) 4.4	(12.0) 3.0	(1.5) 1.6	(0.7) 1.3	(3.8) 2.8	(26.6) 4.9	7.3
HW at 30 and 60 DAT	(31.7) 5.6	(9.8) 3.3	(3.5) 2.1	(3.5) 2.1	(8.1) 3.0	(56.8) 7.5	16.0
Weedy check	(32.6) 5.6	(54.8) 7.1	(12.7) 3.6	(9.6) 3.2	(20.8) 4.4	(128.4) 11.3	46.7
CD (P=0.05)	(8.5) 0.8	(12.6) 1.0	(2.3) 0.4	(1.4) 0.4	(6.5) 0.8	(20.59) 1.5	5.0

DAT = Days after transplanting
The data in parentheses indicate original values

Table 2. Effect of integrated weed management on weed density, dry weight of weeds weed control efficiency (WCE) bulb yield and economics of onion

Treatment	WCE (%)	Bulb diameter (cm)	Bulb yield (q/ha)	Returns over control (Rs/ha)	Cost of treatment (Rs/ha)	Net returns (Rs/ha)
Pendimethalin @ 1.0 kg/ha + HW	77.1	3.8	99.2	31,550	5,131	26,419
Pendimethalin @ 1.5 kg/ha	66.2	3.6	82.7	23,300	3,100	20,200
Fluchloralin @ 1.0 kg/ha + HW	75.6	3.6	92.3	28,100	4,422	23,678
Fluchloralin @ 1.5 kg/ha	66.4	3.5	81.8	22,850	2,033	20,817
Oxyfluorfen @ 0.15 kg/ha + HW	81.4	4.0	121.9	42,900	4,334	38,566
Oxyfluorfen @ 0.30 kg/ha	74.7	3.8	109.8	36,850	2,468	34,382
Alachlor @ 1.0 kg/ha (HW	58.8	3.6	80.3	22,100	3,800	18,300
Alachlor @ 1.5 kg/ha	44.5	3.5	59.7	11,800	1,100	10,700
Oxyfluorfen at 20 DAT	46.7	3.7	36.1	16,400	1,434	14,966
HW at 20, 40 and 60 DAT	84.3	3.9	104.8	34,350	9,000	25,350
HW at 30 and 60 DAT	65.7	3.7	89.3	26,600	6,000	20,600
Weedy check		3.0	68.9			
CD (P=0.05)		0.3	21.6			

HW = Hand weeding; Original values are given in parentheses

Bulb price: Rs 500/q; price of herbicide (trade product): Stomp (pendimethalin), Rs 580/litre; Basalin (fluchloraLin), Rs 550/litre; Oxygold (oxyfluorfen), Rs 1,800/litre, Lasso (alachlor), Rs 300/litre, hand-weeding, 3,000/ha

*Cost of herbicide spray: Rs 200/ha

pared with oxyflourfen + HW. Oxyfluorfen 0.15 kg/ha supplemented with one hand-weeding 35 DAT was found significantly superior to all the other herbicidal treatments and hand-weeding twice, but remained on a par with three hand-weedings treatment. Alachlor (1.5 kg/ha) and oxyfluorfen (20 DAT) were found significantly inferior to pendimethalin and oxyfluorfen supplemented with hand-weeding (Table 2). Alachlor alone at higher dose (1.5 kg/ha) remained inferior to pendimethalin, fluchloralin and oxyfluorfen at higher doses due to its ineffectiveness in controlling broad-leaf weeds. Better performance of herbicide + hand-weeding treatments over their individual application was owing to the effective control of weeds through herbicides during initial stages and later on by hand-weeding. Bulb yields with oxyfluorfen 0.15 kg/ha supplemented with one hand-weeding 35 DAT and hand-weeding thrice remained at par.

Threat assessment in bulb production due to weeds

The relationship between weed density, dry weight of weeds and bulb yield of onion fitted well with linear regression. Bulb yield reduced substantially with increase in the density of weeds due to competition for available resources. Bulb yield was negatively correlated with weed density and dry weight of weeds. The negative correlation is due to the depletion of various inputs by weeds and thereby decrease in their availability to the onion crop for bulb production. Reduction in bulb yield could be predicted up to 0.751 and 2.001 q/ha with increase in weed density and dry weight of weeds by one number and 1 g/0.25 m^2. These results are in conformity with the findings of Kohle (2001).

Monetary returns

All the herbicides either alone or in combination with hand-weeding recorded higher monetary returns over the weedy check. Among the weed-control treatments, oxyfluorfen + HW and higher dose of oxyfluorfen at 0.30 kg/ha gave the maximum monetary returns over the weedy check, followed by pendimethalin + HW (Table 3). Among the herbicide + HW combinations, alachlor + HW gave the least monetary returns, perhaps due to differential efficacy towards the complex weed flora in onion. Three hand-weedings remained on a par with pendimethalin + HW. But it gave lower returns than oxyfluorfen + HW and higher dose of oxyfluorfen (0.30 kg/ha), mainly due to the high cost involved in repeated manual weedings to keep the crop weed free (Table 3).

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