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RESEARCH ARTICLE

Weed management in *Rabi* onion

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ABSTRACT

A field experiment was conducted to evaluate the efficacy of different herbicides for controlling weeds in onion (*Allium cepa* L.) during *Rabi* 2019 and 2020. The experiment was laid out in randomized complete block design with seven weed control treatments, *viz*. pre-emergence application (PE) of oxyfluorfen 199.75 g/ha, post-emergence application (PoE) of quizalofop-ethyl 50 g/ha, quizalofop-ethyl + oxyfluorfen 50 g/ha PoE, quizalofop-ethyl + oxyfluorfen 75 g/ha PoE, quizalofop-ethyl + oxyfluorfen 100 g/ha PoE, hand weeding twice 30 and 60 days after transplanting (DAT) and unweeded control. Quizalofop-ethyl + oxyfluorfen 100 g/ha PoE provided effective weed control with highest bulb yield (31.13 t/ha), highest net returns (Rs. 184.90 $\times 10^3$/ha) and B: C ratio (2.48). The un-weeded control recorded the lowest net returns (Rs. 80.03 $\times 10^3$/ha) and benefit: cost ratio (1.63).

Keywords: Economics, Onion, Quizalofop-ethyl + oxyfluorfen, Weed management

INTRODUCTION

The bulbous vegetable onion (*Allium cepa* L var. *aggregatum*) is the most important species of *Allium* group and is regarded as the single most important vegetable spices as it forms an indispensable part of many diets, both vegetarianand non-vegetarian. Onion is valued for its bulbs having characteristic odour, flavor and pungency. Onion is regarded as a highly export oriented crop and earns a valuable foreign exchange for India.It is also a good source of minerals phosphorus and calcium. Besides this, it is also good source of proteins, carbohydrates, fats, thiamine, niacin and ascorbic acid. India is the second largest onion growing country with average yield of 16.2 t/ha. India is the second largest producer of onion in the world, next to China with an area of 1.43 million hectares and production of 26.15 million tones, but the productivity is low (16.2 t/ha) as compared to other countries (Anonymous 2020).

Weeds are one of the most important factors known to causesignificant reduction in onion yield which has direct correlation with weed competition. Onion exhibits greater susceptibility to weed competition as compared to other crops due to its inherent characteristics such as their slow growth, small stature, shallow roots and lack of dense foliage (Dhananivetha *et al.* 2017). In addition, their long growing season allows several successive flushes of weeds. Weeds compete with the crop plants for nutrients, water, space and light resulting in losses in yield, quality and value of the crop through increased production and harvesting cost. A loss in yield due to weed infestation ranged from49-86 % in onion (James and Harlen 2010).

Hand weeding, a conventional method of weed control is effective but it is time consuming, cumbersome and under many situations becomes uneconomical. The predominant choice for weed control in onion is the use of herbicides. Currently herbicides with greater efficacy and environmental safety are becoming available for effective control of weeds in field crops. Hence, the present study was planned to evaluate the efficacy of pre- and post-emergence herbicides on weed growth and yield in onion toidentify practically effective and economically feasible weed management method to suit to needs of farmers.

MATERIALS AND METHODS

The field experiment was conducted at Krishi Vigyan Kendra, Nurmahal, Jalandhar, Punjab to study the efficacy of different herbicides for controlling weeds in onion during the year 2019 and 2020 in *Rabi* season. Krishi Vigyan Kendra, Nurmahal, Jalandhar is geographically situated at 31°09'N latitude, 75°59' E longitude and at an altitude of about 237 m above

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mean sea level. The experimental site was sandy loam in texture, low in organic carbon (0.31) with available nitrogen (195 kg/ha), high in available phosphorus (28.7 kg/ha) and medium in available potassium (151 kg/ha) in 0-15 cm soil depth. Experiment was laid out in randomized complete block design and replicated thrice. The treatments consists of: pre-emergence application (PE) of oxyfluorfen 199.75 g/ha; post-emergence application (PoE) of quizalofop-ethyl 50 g/ha, quizalofop-ethyl + oxyfluorfen 50 g/ha PoE; quizalofop-ethyl +oxyfluorfen 70 g/ha PoE, quizalofop-ethyl +oxyflourfen100 g/ha PoE, hand weeding twice 30 and 60 days after transplanting (DAT) and unweeded control.

The nursery of onion (cv. PRO-6) was sown on raised beds using seed rate 10 kg/ha in last week of October in both the experimental years. The onion seedlings were transplantedin first fortnight of January during both the years following row to row and plant to plant spacing of 15cm and 7.5 cm, respectively. The crop was raised as per the recommended package of practices by Punjab Agricultural University, Ludhiana except weed control treatments. Oxyfluorfen 199.75 g/ha was applied within three days of transplanting as pre-emergence, while other treatments were post-emergence applied after 25 days after transplanting (DAT). The gross plot size for each treatment was 25 m^2. The data on weed density (number/m^2), and weeds biomass (dry matter) (g/m^2) were recorded atharvest. Weed control efficiency (WCE) was determined by followingformula.

$$WCE = \frac{(WD_C - WD_T) \times 100}{WD_C}$$

Where WD_C = Weed density (no./m^2) in control plot

WD_T = Weed density (no./m^2) in treated plot.

The number of weeds from one square meter were counted using quadrat of 1 m^2 randomly placed in each plot at 60 DAT. Later weeds were uprooted from sampling area from each treatment; sun dried for about 9–10 days and the dry weight (biomass) of the weeds was recorded. The data on fresh bulb weight (g), plant height (cm), bulb diameter (cm) and onion yield (t/ha) were recorded at harvest. The bulbs were uprooted manually in the first week of May during 2020 and last week of April during 2021. The data was statistically analyzed by standard analysis of variance technique for RBD described by (Gomez and Gomez 1984) comparisons were made at 5 per cent level of significance.

RESULTS AND DISCUSSION

Effect on weeds

Grassy and broad-leaved weeds were predominant weed flora in onion.Relative composition of weed species varied with the growth stages of onion. The weeds infested the experimental plots were: *Poa annua, Cyperus rotundus, Anagallis arvensis, Convolvulus arvensis, Lepidium sativum* and *Medicago denticulata* (**Table 1**). Relative proportion *Poa annua* in total weeds was high (48.0 %) *Cyperus rotundus* (17.0%), *Anagallis arvensis* (11.0%) and *Coronopus didymus* (9.0%), *Convolvulus arvensis* (7.0%), *Rumex dentatus* (5.0%) and *Medicago denticulata* (3.0%). The lowest weed density was recorded in weeding twice (30 and 60 DAT) followed by quizalofop-ethyl + oxyflourfen100 g/ha PoE. The maximum weed density was recorded in unweeded control plot followed by quizalofop-ethyl + oxyfluorfen 50 g/ha PoE and quizalofop-ethyl 50 g/ha PoE which are statistically at par quizalofop-ethyl + oxyfluorfen 70 g/ha PoE. It showed that some herbicidal treatments were found more effective than others. Similar results were reported by Sraw *et al.* (2016) in rabi onion. Highest weed control efficiency was recorded in hand weeded twice (90.0%) followed by treatment quizalofop-ethyl + oxyfluorfen 100 g/ha PoE (88.9%). It might be due to lack of competition for resources between crop and weeds due toeffective weed control. It was also observed that weed control efficiency varied from 77.5-88.9% in post-emergence application of quizalofop-ethyl 50 g/ha, quizalofop-ethyl + oxyfluorfen 50 g/ha, quizalofop-ethyl + oxyfluorfen70 g/ha and quizalofop-ethyl + oxyfluorfen 100 g/ha while it was 68.8% with oxyfluorfen 199.75 g/ha PE. Similar results were also recorded by Ganesh *et al. (*2022). Though weeds were controlled more efficiently and bulb yield production was highest hand weeding twice but its cost of cultivation was also higher because of the higher human labour requirement and their higher wages. Similar results were also recorded by Kalapure *et al.* (2013).

Table 1. Weed flora at experimental site

Scientific name	Weed category	Proportion of total weeds (%)
Poa annua	Grass	48
Cyperus rotundus	Sedge	17
Anagallis arvensis	Broad-leaved	11
Coronopus didymus	Broad-leaved	9
Convolvulus arvensis	Broad-leaved	7
Rumex dentatus	Broad-leaved	5
Medicago denticulata	Broad-leaved	3

Table 2. Effect of different weed control treatments on weed density, weed biomass and weed control efficiency at harvest (pooled data of two years)

Treatment	Weed density (no./m^2)	Weed biomass (g/m^2)	Weed control efficiency (%)
Oxyfluorfen 199.75 g/ha PE	40.3	38.8	68.8
Quizalofop-ethyl 50 g/ha PoE	45.0	27.9	77.5
Quizalofop-ethyl + oxyfluorfen 50 g/ha PoE	47.0	24.3	80.4
Quizalofop-ethyl + oxyfluorfen70 g/ha PoE	44.7	20.7	83.4
Quizalofop-ethyl + oxyfluorfen 100 g/ha PoE	30.3	13.8	88.9
Hand weeding twice at 30 and 60 DAT	13.7	12.4	90.0
Unweeded control	87.7	124.5	-
LSD (p=0.05)	3.3	4.8	4.9

*PE=pre-emergence application; PoE= post-emergence application; DAT=days after transplanting

Table 3. Effect of different weed control treatments on growth and yield contributing characters and bulb yield of onion (pooled data of two years)

Treatment	Plant height (cm)	Bulb weight (g)	Bulb diameter (cm)	Bulb yield (t/ha)		
				2019	2020	Pooled
Oxyfluorfen 199.75 g/ha PE	62.1	64.7	4.5	29.49	29.51	29.50
Quizalofop-ethyl 50 g/ha PoE	63.5	71.5	5.3	29.97	29.77	29.87
Quizalofop-ethyl + oxyfluorfen 50 g/ha PoE	65.5	70.4	4.4	29.92	29.78	29.85
Quizalofop-ethyl + oxyfluorfen 70 g/ha PoE	67.1	70.3	5.7	29.99	30.30	30.11
Quizalofop-ethyl + oxyfluorfen 100 g/ha PoE	69.4	73.5	5.8	31.08	31.18	31.13
Hand weeding twice at 30 and 60 DAT	70.8	72.4	4.7	30.87	31.27	31.07
Unweeded control	43.5	39.3	3.1	20.41	20.03	20.22
LSD (p=0.05)	2.8	3.7	0.4	0.21	0.23	0.22

*PE=pre-emergence application; PoE= post-emergence application; DAT=days after transplanting

Table 4. Economics analysis of different weed control treatments

Treatment	Gross income (Rs×10^3/ha)	Net returns (Rs×10^3/ha)	B:C ratio
Oxyfluorfen 199.75 g/ha PE	285.0	145.59	2.04
Quizalofop ethyl 50 g/ha PoE	298.5	171.31	2.34
Quizalofop-ethyl + oxyfluorfen 50 g/ha PoE	298.5	172.67	2.37
Quizalofop-ethyl + oxyfluorfen 70 g/ha PoE	301.1	175.06	2.46
Quizalofop-ethyl + oxyfluorfen 100 g/ha PoE	311.3	184.90	2.48
Hand weeding twice at 30 and 60 DAT	310.7	129.53	1.80
Unweeded control	202.2	80.03	1.65

*PE=pre-emergence application; PoE= post-emergence application; DAT=days after transplanting

Effect on onion

Maximum onion plant height and higher bulb yield was recorded in hand weeded twice followed quizalofop-ethyl + oxyfluorfen 100 g/ha PoE and quizalofop-ethyl + oxyfluorfen 70 g/ha PoE (**Table 3**) In the present study, bulb diameter did not show significant difference amongst all the treatments. Bulb yield is final adjective from farmers point to fetch better price in market. During both the year of significantly higher bulb yield (31.13 t/ha) was recorded in quizalofop-ethyl + oxyfluorfen 100 g/ha PoE which was at par with hand weeding twice at 30 and 60 DAT. Minimum onion bulb yield was recorded in untreated control. Sraw *et al.* (2016) also reported that the efficacy of post emergence herbicides in term of yield and monetary return which is ultimate goal of all vegetable growers. Similar findings were observed by Barla and Upasani (2019), Sahoo and Tripathy (2019) and Hembrom *et al.* (2023).

Gross income was calculated from average price of onion prevailing market from which net returns per season were calculated in both experimental seasons. The highest net returns (Rs. 311300) and B:C ratio (2.48) was recorded with quizalofop-ethyl + oxyfluorfen at 70 g/ha PoE while minimum B:C ratio (1.65) was with un-weeded plot. Kalhapure *et al* (2014) also reported that post-emergence application of premix of oxyfluorfen + quizalofop-ethyl effectively control important grass and broad-leaved weeds in seed production onion with higher yield and monetary returns. These results also support findings of Kumari*et al.* (2019) and Singla and Singh (2020).

The application of quizalofop-ethyl + oxyfluorfen 100 g/ha gave the highest bulb yield and highest net returns of Rs 184.90 ×10^3/ha with B:C ratio 2.48 due to effective weed management. Hand weeding twice although gave better control of weeds, but it can only be practiced at small holder farmers onion fields and not on large scale cultivation in the state like Punjab, as the labour is very scarce, expensive and limited.

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