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Studies on post-emergence herbicides in *Rabi* onion (*Allium cepa* L.)

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Abstract
Onion is a slow growing crop, shallow rooted, narrow, upright leaves and non-branching habit. Due to this type of growing habit, onion crop cannot compete well with weeds. A field experiment was conducted at Research farm, Department of Agronomy, College of Agriculture, Parbhani. The soil was vertisol, low in nitrogen, medium in phosphorus and alkaline in reaction. The experiment was laid out in Randomized block design with three replications and eight treatments including hand weeding, weed free and weedy check. Weed free treatment recorded significantly lowest number of monocot weed count (m^{-2}), dry weight of weeds and the highest weed control efficiency. Among the herbicidal treatments, application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) recorded significantly least number of weed count and dry weight of weeds it was at par with the application of Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4). Gross monetary returns, net monetary returns and B:C ratio was recorded significantly higher with the application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2).

Keywords: *Allium cepa* L., nitrogen, phosphorus

Introduction
Onion has culinary, dietary and medicinal importance in daily life of Indian people and due to its export trade, it is also a major vegetable crop to gain foreign currency. India is the second largest producer of onion in the world, next to China. Onion is an important and indispensable item in every kitchen as condiment and vegetable and hence, commands an extensive internal market. It is a commercial vegetable crop grown from ancient times in India. Onion (*Allium cepa* L.) can be grown under a wide range of climatic conditions, but mild season with optimum temperature is the best suited for it.

In India, the area under onion cultivation is 1177.6 lakh ha with a production of 20333.1 MT. The average yield of onion in India is reported to be around 16.1 MT ha^{-1}. The major onion growing states are Maharashtra, Karnataka, Andhra Pradesh, Gujarat and Madhya Pradesh. Maharashtra is the leading state in the onion production and trade in India. The area under onion cultivation was 441.9 lakh ha with production 5361 MT followed by Karnataka (3227 MT), Madhya Pradesh (2842 MT), Bihar (1247.3 MT), Gujarat (1126.6 MT) and Andhra Pradesh (575.6 MT) and In Maharashtra major area being concentrated in Nashik, Ahmadnagar, Satara and Pune District (Anonymous, 2016) [1].

The average yield of onion in India is very low as compared to other leading countries due to many factors. One of the limiting factors is weed infestation. Its poor competitive ability with its slow initial growth and lack of adequate foliage makes onion weak against weeds. In addition, their cylindrical upright leaves do not shade the soil to smother weed growth. Reduced bulb yield from 48 to 85% depending upon the weed competition and intensity of weeds (Bhalla, 1978) [2]. Onion is slow growing, shallow rooted, narrow upright leaves and non-branching habit. The conventional method of weed control is laborious, expansive and sometime cause's damages to the crop. Non-availability of labourers during critical period of crop makes hand weeding difficult leading to heavy yield losses. Spraying of post-emergence herbicides helped to minimize the crop weed competition during such critical growth stages resulted in higher crop yields. Improved weed control practices that include chemical weed control with newer formulations and cultural methods. Types of weed flora associated with onion are, Dicot weeds like, *Acalypha indica*, *Phyllanthus maderaspatensis*, *Euphorbia geniculate*, *Amaranthus polygamous*, *Digera arvensis*, *Tridax procumbens* and monocots like, *Cynodon dactylon*, *Cyprus rotundus*, *Brachiaria eruciformis.*

The critical period of crop-weed competition in onion lies between 15-60 days after transplanting (Singh and Singh, 1994) [10]. 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. The effective weed control involves identification of weed flora, method of weed control and judicious combination of effective weed control methods. Hand weeding in onion is a common practice in India, but it is a tedious, expensive and time consuming task due to closer spacing and shallow root system. Non-availability of labourers during critical period of crop makes hand weeding difficult leading to heavy yield losses. If the weeds are present throughout the crop growth period, there may be complete loss of marketable yield. Yield loss due to weed infestation in onion is 48 to 80 per cent depending upon the duration, intensity of weed growth and weed competition (Channapagoudar and Biradar, 2007) [5]. Chemical weed management practices for weed control in onion which is practically effective and economically feasible for farmers.

Material and Methods

The experiment was conducted during *rabi* season of the year 2015 at Department of Agronomy, College of Agriculture, Parbhani. The soil of the experimental site was deep, black in colour with good drainage. The topography of experimental field was uniform and levelled. The experiment was laid out by using randomized block design with eight treatments and three replications. The treatments included are *viz.*, Haloxyfop 10.8% EC @ 81 g a.i. ha^{-1} at 15 DAT (T_1), Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3), Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4), Quizalfop ethyl 5% EC @ 40 g a.i. ha^{-1} at 15 DAT (T_5), Two hand weeding at 30 and 45 DAT (T_6), Weed free (T_7), Weedy check (T_8). Six week old seedlings of onion were transplanted manually on raised beds with spacing of 20 cm x 15 cm. The crop was fertilized with 100 kg nitrogen, 50 kg phosphorus and 50 kg potash per hectare. Biometric observations were recorded periodically which includes crop and associated weed in onion. Weed studies includes identification of weed flora, number of monocot weed count (m^{-2}), dry weight of weeds (m^{-2}), weed control efficiency. The data collected for all the characters were statistically analysed as described by Panse and Sukhatme (1978).

Result and Discussion

All treatments reported significant reduction in dry weight of weeds, number of monocot weed count (m^{-2}) as compared to weedy check (Table 1). Significantly lower dry weight of weeds and higher weed control efficiency were observed under weed free closely followed by treatments of the application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 days after transplanting (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 days after transplanting (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 days after transplanting (T_4). All the weed management treatments were significantly superior over weedy check in respect of all weed studies and yield parameters (Table 1.). Mean number of monocot weed count (m^{-2}) was recorded (0.00 m^{-2}) with weed free treatment (T_7) which was followed by post-emergence herbicide treatments of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) (9.00 m^{-2}), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) (9.67 m^{-2}) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4) (10.00).

Mean dry weight of monocot weeds (m^{-2}) was resulted nothing with weed free treatment (T_7) which was followed by post-emergence herbicide treatments of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4). Significantly the higher weed control efficiency of monocot weeds was observed in weed free (T_7) (100%) which was significant over Quizalfop ethyl 5% EC @ 40 g a.i ha^{-1} (T_5) (60.83%) and was at par with Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) (82.67%), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) (82.50%) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4) (79.54%). Highest mean weight of cured bulb was recorded with the weed free (T_7) (105.77 g) which was at par with the Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 days after transplanting (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4). Similar findings were also reported by Nandal *et al.* (2002) [8], Channapagoudar and Biradar (2007) [5], Kumar *et al.* (2014) [7] and Vishnu *et al.* (2014) [11].

In table 2. From the economics point of view, highest gross return was obtained from the weed free (T_7) (346800 Rs. ha^{-1}) and the application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) recorded higher gross monetary returns of 335730 Rs. ha^{-1} over rest of the treatments. But it was at par with Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4). The application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) recorded higher net monetary returns of 231392 Rs. ha^{-1} over rest of the treatments. Benefit: cost ratio was higher with the application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) (3.2). Bulb yield was higher with weed free (T_7) (34.68 t ha^{-1}) but which was at par with the treatments of post-emergence herbicide of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4). Application of weedy check (T_8) recorded significantly lower gross monetary returns, net monetary returns and B:C ratio. Similar results were reported by Bhutia *et al.* (2005) [4], Kathepuri *et al.* (2007) [6], Bharathi *et al.* (2011) [3], and Vishnu *et al.* (2014) [11].

Conclusion

The effect of different treatment was noticed on weed studies and yield of onion. The weed free (T_7) treatment recorded significantly lower number of monocot weed count (m^{-2}) and dry weight of weed. Higher Weed control efficiency were reported in weed free (T_7). Among post-emergence chemical treatments application Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2), Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT (T_3) and Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT (T_4) was significantly superior over rest of the treatments and weedy check (T_8). Application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) was found most effective and economical to control monocot weeds in onion thereby increasing productivity of rabi onion. Application of Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT (T_2) produced higher net monetary returns and B:C ratio and most profitable and economical in onion.

Table 1: No. of monocot Weeds (m^{-2}), Dry weight of weeds (m^{-2}), Weed control efficiency (%), Weight of cured bulb (g) and No. of bulbs (kg^{-1}) of onion as influenced by different treatments

Treatments	No. of monocot Weeds (m^{-2})	Dry weight of weeds (m^{-2})	Weed control efficiency (%)	Weight of cured bulb (g)	No. of bulbs (kg^{-1})
T_1- Haloxyfop 10.8% EC @ 81 g a.i. ha^{-1} at 15 DAT	17.67	13.44	62.02	95.11	10.18
T_2- Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT	9.00	6.13	82.67	99.02	8.03
T_3- Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT	9.67	6.19	82.50	98.99	8.07
T_4- Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT	10.00	7.24	79.54	95.20	8.12
T_5- Quizalfop ethyl 5% EC @ 40 g a.i. ha^{-1} at 15 DAT	19.00	13.86	60.83	86.41	10.74
T_6- Two hand weeding at 30 and 45 DAT	25.00	20.25	42.78	79.03	11.72
T_7- Weed free	0.00	0.00	100	105.77	8.23
T_8- Weedy check	58.00	35.39	0.00	48.00	15.13
S.Em ±	1.32	1.38	-	2.30	1.36
C.D at 5%	3.99	4.18	-	6.98	NS

Table 2: Gross monetary returns (Rs. ha^{-1}), Net monetary returns (Rs. ha^{-1}), B:C ratio and bulb yield of onion at harvest as influenced by different treatments.

Treatments	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio	Bulb yield (t ha^{-1})
T_1- Haloxyfop 10.8% EC @ 81 g a.i. ha^{-1} at 15 DAT	291470	195690	3.0	29.15
T_2- Haloxyfop 10.8% EC @ 108 g a.i. ha^{-1} at 15 DAT	335730	231392	3.2	33.57
T_3- Haloxyfop 10.8% EC @ 135 g a.i. ha^{-1} at 15 DAT	322760	220012	3.1	32.28
T_4- Haloxyfop 10.8% EC @ 270 g a.i. ha^{-1} at 15 DAT	321556	21731	3.0	32.13
T_5- Quizalfop ethyl 5% EC @ 40 g a.i. ha^{-1} at 15 DAT	265690	171614	2.8	26.57
T_6- Two hand weeding at 30 and 45 DAT	244820	106234	1.7	24.48
T_7- Weed free	346800	153986	1.8	34.68
T_8- Weedy check	143213	76186	2.1	14.32
S.Em ±	930	1236	-	0.85
C.D at 5%	2823	3749	-	2.58

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