

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.907.032>

Efficacy of Pre and Post Emergence Herbicides against Weed Flora in Onion (*Allium cepa* L.)

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ABSTRACT

A field investigation entitled efficacy of pre and post emergence herbicides against weed flora in onion (*Allium cepa* L.) was carried out at AICRP on weed management field of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the Rabi season of 2018-19. The investigation was carried out to evaluate the efficacy of different pre and post emergence herbicides against weed flora, as well as to study the phytotoxic effect on the crop, yield of onion and to study the economics of different method of weed control in onion. The experiment was laid out in randomized block design with nine treatment replicated thrice. The treatment comprised of different pre-emergence, post-emergence herbicides in different doses and were compared with cultural method. The soil of experimental field was fairly uniform and leveled and characterized as clayey in texture, having slightly alkaline reaction with pH (7.7) low organic carbon status (0.41%), low nitrogen content (197.21 kg ha⁻¹), medium available phosphorus (18.76 kg ha⁻¹) and rich in available potassium (366.49 kg ha⁻¹). Onion (Variety- Akola Safed) was transplanted on 14th December 2018 at 20×10 cm spacing with fertilizer dose of 100:50:50 NPK kg ha⁻¹. The results revealed that among the various treatments under study weed free recorded significantly higher values of major parameters where as, in the herbicidal treatments, the maximum yield attributes were recorded with application of pendimethalin 24% + oxyfluorfen 4% ZE @600+102.5 g a.i./ha which was at par with treatment Oxyfluorfen 23.5% EC@ 200 g a.i./ha. Among the herbicidal treatment, reduction in weed population, weed dry matter, higher weed control efficiency (85.86%) and lowest weed index (4.29%) was found with pendimethalin 24% + oxyfluorfen 4% ZE @600+102.5 g a.i./ha and higher weed index in weedy check (54.33). Pendimethalin 24% + oxyfluorfen 4% ZE @600+102.5 g a.i./ha was found most economical with maximum value of GMR (188290 Rs ha⁻¹), NMR (126520 Rs ha⁻¹) and B: C ratio (3.04). The net return per hectare was more under cultural practice i.e. two hand weeding at 25 and 45 DAT but the difference was not much when compared to effective pre emergence herbicide (Pendimethalin 24% + oxyfluorfen 4% ZE @600+102.5 g a.i./ha).

Keywords

Onion, Hand weeding, Weeds, Pendimethalin + Oxyfluorfen, Pre-emergence

Article Info

Accepted:

05 June 2020

Available Online:

10 July 2020

Introduction

Onion is one of the most important commercial bulbous vegetable crop belonging to family Amaryllidaceae grown from ancient times having more demand in domestic market as well as in export market due to its ability to fetch handsome foreign exchange. India ranks second in area and production of onion in world after china. Major contributing

states in onion production are Maharashtra, Karnataka, Madhya Pradesh, Bihar and Gujrat. In India onion occupies about 1.20 million hectare area having 19.40 million metric tonnes of production and average productivity of 16.13 metric tonnes ha⁻¹.

In Maharashtra, it is grown over an area of 0.9 million hectare with total production of 2.06 million metric tonnes with average

productivity of 16.51 metric tonnes ha⁻¹ (Anonymous, 2017). Among various constraints faced by onion growing farmer community, weed pose serious problem in onion cultivation which reduces bulb yield production to the extent of 40-80% (Vishnu *et al.*, 2014). The conventional or cultural method of weed control i.e. hoeing, hand weeding is no doubt beneficial but it is cumbersome, time consuming, labour consuming and uneconomical under certain condition due to higher labour wages. Due to industrial development, most of the labours migrate to the urban area and hence there is scarcity of labour. Moreover inherent characteristics of onions such as short stature, non- branching habit, sparse foliage, close planting of transplant, shallow root system of seedling, extremely slow initial growth frequent irrigation provide congenial condition for weed growth and conventional method weed control quite ineffective against uprooting of weed (Ibrahim *et al.*, 2011). Under such circumstances application of herbicides offer appropriate suitable and reliable option of weed control (Uygur *et al.*, 2010). Keeping this factor in view, the present investigation was planned with a objective to study the efficacy of pre and post emergence herbicide against weed flora in onion, phytotoxicity on crop and profitability in onion.

Materials and Methods

The present field experiment was conducted during *Rabi* season of the year 2018-19 at the research farm of AICRP-Weed Management, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) in Randomized Block Design with three replication having nine different treatments of weed management including Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE (T₁), Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE (T₂), Pendimethalin 24% +

Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃), Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE (T₄) are the herbicide with combine (pre-mix) formulation with different concentration of active ingredient, Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE (T₅), Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T₆), Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE(T₇), 2 Hand weeding 25 & 45 DAT (T₈) and weedy check (T₉).

The soil of the experimental field characterized as fairly uniform and leveled. clay loam in texture, having slightly alkaline pH (7.7), moderate organic carbon status (0.41%), low nitrogen content (197.21 kg ha⁻¹), medium available phosphorus content (18.76 kg ha⁻¹) and high available potassium (366.49 kg ha⁻¹). From the very beginning, the field was prepared to obtain a best possible fine tillage for the better survival of young onion seedlings.

Approximately six to seven weeks old onion seedlings of variety “Akola safed” were treated for 10 minutes with a solution of bavistine @ 0.5gm lit⁻¹ of water to protect the crop from the threat of various fungal diseases. Then the seedlings were manually transplanted on 14th December 2018 with a spacing of 20 cm in between lines and 10 cm within the line in a plot size of 6.5 m x 5 m with 100:50:50 NPK kg ha⁻¹. Soon after transplanting, light irrigation was given for the quick seedling establishment.

The application of herbicide was done as per the treatments with manually operated knapsack sprayer attached with a flood jet nozzle. After calibrating the sprayer, water volume used was 700 lit. per ha. for pre emergence herbicides and 500 lit. per ha. for post emergence herbicides. For hand weeding, weeds were removed manually by using the *khurpi* with female manpower as per the

scheduled dates in treatment details. Every possible package of practices was adapted uniformly with an utmost care to raise a high-quality crop. Five plants were randomly selected from each replication per treatment for recording the yield attributing traits after harvesting. The crop was harvested on 9th April, 2019.

The observations on weed density and weed biomass were taken at 20 days interval upto harvest from four randomly selected spots by using a quadrat of 50 cm x 50 cm quadrat from net plot area. Then weeds were grouped as monocot species and dicot species. Weed control efficiency (WCE) was calculated by using standard formula suggested by Maity and Mukherjee (2011).

Phytotoxicity symptoms due to herbicides on crop was recorded by using a visual score scale of 0-10 scale method as proposed by Rao (2000). Visual assessment of herbicide toxicity on crop was monitored 10 days after application of herbicide in respective treatment. Data on various yield attributing characters were statistically analysed as per the standard procedure.

Results and Discussion

Weed flora

The selected experimental site was a weed prone area with wide diversities of monocot and dicot weeds but dominance of monocot weeds was observed in entire field. Weed flora observed in the experimental field, mainly comprised of *Datura stramonium*, *Parthenium hysterophorus*, *Euphorbia hirta* L., *Commelina benghalensis*, *Alternanthera triandra*, *Digera arvensis* Forst., *Tridax procumbens* L., *Euphorbia geniculata* Orteg., *Argemone mexicana* L., *Xanthium strumarium* L., *Chenopodium album* L., *Phyllanthus niruri* L., *Portulaca oleracea* L., *Lagasca mollis* and

Acalypha indica these were dicot weeds and among monocot *Cyprus rotundus*, *Cynodon dactylon*, *Eleusin indica* L. and *Dactyloctenium aegyptium* L. Among the different weed species, *Datura stramonium* was the most dominant weed, while *Parthenium hysterophorus* was second in weed density and other weeds were followed by them. Similar types of weeds in onion field were also reported by Patel *et al.*, (2011), Kalhapure *et al.*, (2014), Gaharwar *et al.*, (2017) and Thakare *et al.*, (2018).

Effect on weeds

The data presented in Tables 1 revealed that the weed control treatments significantly reduced the total (monocot + dicot) weed population and total dry weed biomass as compared with unweeded control. Initially at 20 DAT significantly lowest total weeds density and ultimately lowest dry matter was recorded in treatment Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE (T₄) than rest of the weed management treatments due to its higher concentration but from 40 DAT and onwards its higher concentration restrict plant growth by showing slight retardation in plant growth as compared to other and hence from 40 DAT onwards upto harvest significantly lowest total weeds density and weed dry matter was recorded in the treatment of cultural practice of two hand weeding at 25 and 45 DAT (T₈) than rest of the weed management treatments.

Lower weed count resulted into lower dry matter. Among herbicidal treatment, Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃) produced lower weed count but were statistically at par with Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE(T₆). The Weedy check (T₉) treatment recorded significantly higher weed population at all the growth stages during the experimentation.

From 40 DAT upto harvesting stage, treatment weed free (T₈) found significantly superior in reducing the total weeds population than rest of the weed management treatments. The combination of pre mixed herbicide Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃) showed its superiority in lowering down the weed population and dry matter over all other herbicidal treatments. Total weed density and weed dry biomass was reduced significantly due to various weed control treatments at all stages of crop growth.

This might be due to the herbicidal application alone and in combinations which were effective in timely reducing total weed population which result in lower weed dry matter accumulation. Pendimethalin inhibits germination of weed seed and oxyfluorfen disrupt cell membrane by lipid peroxidation. Similar results were reported by Bharathi *et al.*, (2011), Kalhapure *et al.*, (2013) and Gupta *et al.*, (2019).

Weed control efficiency of onion was significantly influenced by weed management treatments, where all the treatments resulted in increase of weed control efficiency over the weedy check. The sequential application of pre and post emergence herbicides was found superior. The highest weed control efficiency was observed in treatment Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE (T₄) at 20 DAT but from 40 DAT up to at harvest, highest WCE was observed in treatment with two HW (25 & 45 DAT) because of keeping weed free environment and found superior over rest of all herbicidal treatments.

Among the herbicides at harvest ,the highest weed control efficiency (85.86%) was found with Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃) followed by Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE

(85.29%) (T₆) and Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE (T₄) (84.73%). This showed that all the pre-emergence and post emergence herbicides used in this experiment were compatible, which increased their efficiency without any phytotoxic effect causing adverse effect on onion.

Data on weed index as indicated in Table 2 showed the least yield reduction (4.29%) in treatment with application of Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃) followed by the treatments Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (12.25%) (T₆) and Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE(T₄) (14.78%). Whereas yield reduction varied from 4.29% to 33.35 % in the herbicide applied plots as compared to weed free treatment.

Weedy check (T₉) treatment recorded maximum weed index i.e. 54.33% indicating the reduction in onion bulb yield due to presence of weeds throughout crop growth period. Lower is the weed index in chemical treatments, better the efficiency of that herbicide in controlling weeds, which provided favorable conditions for crop growth which ultimately increased the bulb yield of onion crop as compared to weedy check treatment. This result corroborate with finding of Kolse *et al.*, (2010), Shinde *et al.*, (2012), Jangre *et al.*, (2014) and Sable *et al.*, (2015).

Crop phytotoxicity

Phytotoxicity symptoms due to herbicide on onion crop was recorded by using visual score scale of 0 - 10. Visual assessment of herbicide toxicity on crop was monitored 10 days after application of herbicide in respective treatment. Data presented in Table 2 revealed that none of the herbicides under study shown any phytotoxicity symptoms on crop growth

during the experimentation only with the exception of treatment (T₄) pendimethalin 24% + oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha as PE where leaf injury on tips and necrosis observed which was upto the easily recoverable extent was observed. The phytotoxicity was seen initially but the onion plants that were injured were recovered upto harvest. The results are in accordance with the finding of Yadav *et al.*, (2009) and Uygur *et al.*, (2010).

Effect on yield attributing traits

The data of yield attributing characters presented in Table 3 revealed that, the weed control treatments showed significant influence on average bulb weight, equatorial diameter, polar diameter and total bulb yield which significantly influenced by different herbicidal treatments. Different weed control treatments registered significant increase in all the yield attributing characters compared to unweeded control. The Hand weeding twice i.e. 25 and 45 days after planting produced significantly highest onion bulb yield as compared to other treatments and remain at par with application of Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃).

Significantly maximum values for yield attributing traits were recorded in weed free plots (Two hand weedings) followed by others herbicidal treatments due to the favorable environmental conditions created by the clean crop culture resulted in more absorption of solar radiation and plant nutrients which ultimately resulting in more photosynthetic rates and dry matter accumulation. Among the herbicidal treatments highest yield contributing traits values such as average bulb weight (101.77 g), equatorial and polar diameter (67.64 and 54.01) and total bulb yield (188.29 qha⁻¹) were recorded in treatment with application of

Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃), which is closely followed by pre emergence application of Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE (T₆) and Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha (T₄) as pre-emergence were significantly at par with each other. The findings are in close proximity to that of Tripathy *et al.*, (2013);Thakare *et al.*, (2018) and Gupta *et al.*, (2019). The lowest yield attributes were recorded in weedy check plots owing to low chlorophyll content and photosynthetic rate due to unchecked weed growth there by reducing the availability of moisture, light and nutrients to the crop thus resulting in loss of yield (Channappagoudar and Biradar, 2007).

Economics

The data related to cost of cultivation, gross return, net return, benefit:cost ratio under various weed management practices are presented in Table 3. The highest net monetary return of Rs 126870 ha⁻¹ was obtained with application of (T₃) Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE with benefit: cost ratio of 3.04. Though weeds were controlled more efficiently and bulb yield production was highest in treatment of two hand weeding at 25 and 45 DAT, its cost of cultivation was also higher (Rs 69870 ha⁻¹) because of the higher human labour requirement and their higher wages. The cost of human labours for controlling weeds was reduced with application of pre emergence herbicides , which was responsible for reduction in total cost of cultivation, resulting maximum B:C in treatment Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE (T₃). Similarly economical parameters of onion in respect of methods of weed control were also studied earlier by Gupta *et al.*, (2019).

Table.1 Weed density (No./m²) and weed dry matter (g/m²) as influenced by different weed control treatments in onion

Treatment	Total weed density					Weed dry matter				
	20 DAT	40 DAT	60 DAT	80 DAT	At harvest	20 DAT	40 DAT	60 DAT	80 DAT	At harvest
T₁ - Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE	4.21 (17.23)	4.97 (24.20)	6.36 (40.40)	7.59 (57.67)	8.14 (66.23)	2.93 (8.08)	3.27 (10.31)	3.63 (12.69)	3.88 (14.70)	4.28 (17.93)
T₂ - Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE	3.62 (12.90)	4.60 (20.63)	5.51 (30.13)	6.75 (45.11)	7.18 (51.03)	2.61 (6.52)	2.93 (8.13)	3.27 (10.30)	3.58 (12.37)	4.04 (15.83)
T₃ - Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE	3.06 (9.07)	4.23 (17.43)	4.89 (23.43)	5.75 (32.80)	6.49 (41.67)	2.28 (5.00)	2.53 (6.03)	2.82 (7.47)	3.23 (9.96)	3.72 (13.37)
T₄- Pendimethalin 24% +Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE	3.03 (8.90)	4.38 (19.67)	4.99 (24.47)	5.92 (34.87)	6.64 (43.67)	2.22 (4.50)	2.58 (6.27)	2.84 (7.60)	3.27 (10.17)	3.85 (14.33)
T₅- Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE	4.00 (15.50)	4.92 (23.70)	5.90 (34.67)	6.64 (43.70)	7.54 (56.33)	2.86 (7.70)	3.07 (8.94)	3.47 (11.51)	3.76 (13.64)	4.44 (19.23)
T₆- Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE	3.37 (10.90)	4.39 (18.80)	4.96 (24.13)	5.91 (34.57)	6.61 (43.37)	2.35 (5.34)	2.57 (6.10)	2.85 (7.72)	3.24 (10.00)	3.75 (13.80)
T₇- Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE	7.58 (56.97)	7.26 (52.30)	8.36 (70.23)	9.20 (84.17)	10.17 (104.47)	4.42 (19.23)	3.32 (11.11)	3.92 (15.26)	4.49 (19.77)	5.02 (26.27)
T₈- Two HW (25 & 45 DAT)	7.45 (55.07)	3.43 (11.23)	3.86 (14.80)	4.35 (18.67)	4.81 (22.88)	3.98 (15.37)	2.26 (4.73)	2.80 (7.33)	2.98 (8.36)	3.35 (10.80)
T₉-Weedy Check	7.86 (61.30)	13.06 (171.27)	15.03 (225.83)	16.18 (263.20)	17.04 (291.73)	6.67 (44.03)	7.89 (62.27)	8.65 (75.30)	9.06 (83.53)	9.68 (93.86)
S.E(m)±	0.23	0.27	0.40	0.46	0.50	0.23	0.26	0.30	0.34	0.39
C.D. at 5%	0.70	0.83	1.21	1.39	1.51	0.69	0.80	0.92	1.02	1.17

Figures in parenthesis are original value

Table.2 Crop phytotoxicity score, Weed control efficiency (%) and weed index (%) as Influenced by different weed control treatments in onion

Treatment	Crop phytotoxicity visual rating score		Weed control efficiency (%)				Weed index (%)
	Rate	Effect on crop	40 DAT	60 DAT	80 DAT	At Harvest	
T₁ - Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE	0	No injury, normal	83.44	83.14	82.40	80.89	25.30
T₂ - Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE	0	No injury, normal	86.94	86.32	83.53	83.13	22.53
T₃ - Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE	0	No injury, normal	90.31	90.07	88.70	85.86	4.29
T₄- Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE	1	Slight stunting, injury discolouration	89.77	89.90	87.82	84.73	14.78
T₅- Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE	0	No injury, normal	85.64	84.71	83.67	79.51	33.35
T₆- Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE	0	No injury, normal	90.20	89.74	88.02	85.29	12.25
T₇- Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE	0	No injury, normal	82.15	79.73	76.33	72.01	27.93
T₈- Two HW (25 & 45 DAT)	0	Normal	92.40	90.26	89.99	88.49	-
T₉-Weedy Check	0	Normal	-	-	-	-	54.33

Table.3 Yield attributes and onion bulb yield (q/ha) as influenced by different weed control treatments

Treatment	Average Bulb weight (g)	Equatorial Diameter (mm)	Polar Diameter (mm)	Total bulb yield (q/ha)	Gross monetary returns (Rs ha ⁻¹)	NMR (Rs ha ⁻¹)	B:C ratio
T₁ - Pendimethalin 24% + Oxyfluorfen 4% ZE @480+82 g a.i./ha PE	88.87	56.48	45.92	146.95	146950	85480	2.39
T₂ - Pendimethalin 24% + Oxyfluorfen 4% ZE @541.80+92.56 g a.i./ha PE	98.50	61.69	48.69	152.40	152400	90776	2.47
T₃ - Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE	101.77	67.64	54.01	188.29	188290	126870	3.04
T₄- Pendimethalin 24% + Oxyfluorfen 4% ZE @1083.60+185.12 g a.i./ha PE	91.60	64.49	50.92	167.66	167660	103142	2.59
T₅- Pendimethalin 38.7% CS@ 677.25 g a.i./ha PE	77.70	59.88	45.79	131.11	131110	69318	2.12
T₆- Oxyfluorfen 23.5% EC@ 200 g a.i./ha PE	100.87	66.77	53.91	172.63	169381	107986	2.76
T₇- Quizalofop ethyl 5% EC@ 50 g a.i./ha PoE	75.37	54.18	44.44	141.79	141791	80371	2.30
T₈- Two HW (25 & 45 DAT)	107.60	68.06	56.30	196.74	196740	126520	2.81
T₉-Weedy Check	60.03	49.84	40.57	89.84	89740	29950	1.50
S.E(m)±	4.45	3.51	2.71	9.42	6869	6869	-
C.D. at 5%	13.34	10.52	8.12	28.25	20595	20595	-

It was concluded that application of pre emergence herbicides Pendimethalin 24% + Oxyfluorfen 4% ZE @600+102.5 g a.i./ha PE found to be suitable and economical herbicide in onion . The conventional cultural method of weed control is effective, however due to labour scarcity and high cost of human labour weeding during the critical stage of the crop is a problem. As an alternative option, pre-mix herbicide application as a pre-emergence method of weed control can be the good option for management of weeds in onion.

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How to cite this article:

Akanksha Thakare, S. U. Kakade, J. P. Deshmukh, N. D. Parlawar and S. S. Thakare. 2020. Efficacy of Pre and Post Emergence Herbicides against Weed Flora in Onion (*Allium cepa* L.). *Int.J.Curr.Microbiol.App.Sci.* 9(07): 301-310. doi: <https://doi.org/10.20546/ijemas.2020.907.032>