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EFFICACY OF DIFFERENT HERBICIDES FOR CONTROLLING WEEDS IN ONION IN HIGHER ALTITUDES*

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ABSTRACT

To study the efficacy of different herbicides for controlling weeds in onion (variety Swat-1), an experiment was conducted at Agriculture Research Station (North), Mingora during rabi 2003–04, using Randomized Complete Block (RCB) design, having eight treatments and four replications. The treatments were seven herbicides including pendimethalin @ 1.32, trifluralin @ 1.2, s-metolachlor @ 1.92 kg ha^{-1} used as pre-emergence, while post-emergence herbicides were 2,4-D @ 1.13, bromoxynil+ MCPA @ 1.3, clodinafop @ 0.05 kg ha^{-1} and terbutryn + triasulfuron @ 0.3 kg a.i ha^{-1} and a weedy check. The effect of all these herbicides was studied on weeds kill percentage, fresh weed biomass (kg ha^{-1}), size of onion bulbs (ml), onion bulbs m^{-2}, plant height (cm), onion diameter (cm), onion yield (kg ha^{-1}) and cost-benefit ratio. The parameters that significantly affected by different herbicides were weed kill percentage, size of onion bulbs (ml), onion diameter (cm) and onion yield (kg ha^{-1}). Maximum weeds kill percentage (88.6 %), size of onion bulbs (78.25 ml), onion diameter (5.49 cm) and onion yield (29950 kg ha^{-1}) were recorded in pendimethalin treatment as compared to weedy check 00.0 %, 47.75 ml, 4.06 cm and 13700 kg ha^{-1}, respectively. The cost-benefit ratio was also highest (1:29.81) in pendimethalin followed by s-metolachlor (1:19.32) and trifluralin (1:17.05) while, it was the lowest was in terbutryn + triasulfuron (1:3.90). It is concluded that the performance of pendimethalin was the best among all the herbicidal treatments followed by s-metolachlor. Therefore, pendimethalin is recommended @ 1.32 kg a.i ha^{-1} for significantly reducing the weeds population and enhancing the bulb yield in onion.

Key words: Onion, weed control, pendimethalin, s-metolachlor, trifluralin

INTRODUCTION

Onion (*Allium cepa* L.) belonging to family Alliaceae is one of the important vegetable crops not only in Pakistan but also all over the world. It is one of the oldest vegetable mentioned in the Bible as well as in the Holy Quran. It is a condiment crop and consumed as fresh in salads or added in cooking dishes as a spice. Apart from furnishing nutrition, it also provides relishing flavors to our diets. Research has suggested that onions in the diet may play a part in preventing heart diseases by reducing blood

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cholesterol level and triglycerides (Bakhsh and Khan, 1990). Onion bulb is rich in phosphorus, calcium and carbohydrates. Onion has diuretic properties and is beneficial to the digestive tract. It is good for eyes and acts as a heart stimulant and is useful as anti-rheumatic remedies (Shanmugavelu, 1990).

Onion can be grown on all classes of soils i. e. sandy loam to clay loams but clays need lightening with humus application. Onion plant is sensitive to high acidity and produce maximum yield over a fairly narrow range of soil reactions i. e. pH 5.8-6.5 on sandy loam soil. Good yields of onion are produced on muck soils (organic in nature, rich in nitrogen and have high water holding capacity) over a wide range of soil reactions than on mineral soils (Haliburton, 1956). Onion is highly sensitive to temperature and photoperiod. Bulb formation is favored by relatively high temperature and longer photoperiod (Thompson and Kelley, 1957).

In Pakistan onion was grown on area of 108 thousands hectares during 2002-2003, with a total production of 1427.5 thousand tons at an average yield of 13.2 tons ha^{-1}, while in NWFP, with the total production of 193.6 thousand tons @ 19.3 tons ha^{-1} on an area of 10,000 ha (Anonymous, 2003).

The onion yield in Pakistan is lower as compared to the potential yield of the cultivars. This gap could mainly be attributed to the weed competition, because onion has poor canopy structure to compete with weeds. At young stage the onion leaves are very small and cannot shade the ground even in advanced stages of growth of the bulb crop. The period from emergence to 4 weeks is the most critical in the direct seeded onion (Ghafoor, 2000, and Shadbolt and Holm 1956), while in the transplanted onion the critical stage is from the time of transplantation up to nine weeks and yield reduction estimates ranged between 4.45 and 70.5% (Garcia *et al.* 1994).

In Pakistan, weeds are mostly managed manually costing about Rs. 1000 ha^{-1}. Whereas, in USA hand weeding costs have been reported to the tune of $9259 ha^{-1} (Bannaon *et al.* 1988). Good selective and economical weed control was obtained with the use of herbicides (Suso *et al.* 1993). Yield increased in the herbicidal treatments which ranged between 8.89 and 37.92 ton ha^{-1} compared with the yield in the treatments of mechanical cultivation + hoeing which ranged from 5.49 to 12.49 ton ha^{-1} (Halmagean *et al.* 1993). Srivastava *et al.* (1986) obtained significantly higher yield than the weedy check using herbicides and twice of the manual hand weeding in the onion crop.

Keeping in view the importance of different herbicides for controlling weeds in onion, the present experiment was carried out with the objectives: firstly, to evaluate different herbicides for controlling weeds in onion. Secondly, to figure out the effect of different herbicides on the yield of onion. Thirdly, to find out the most effective and economical herbicide for weed control in onion under the agro-climatic condition of Swat and finally to quantify the phytotoxicity of herbicides if any on the crop.

MATERIALS AND METHODS

In order to study the effect of different herbicides for controlling weeds in onion an experiment was conducted at Agriculture Research Station, Mingora. The variety Swat-1 was transplanted during rabi 2003–04 in the month of February. The fertilizers were used as per standard recommendation. The experiment was laid out in randomized complete block (RCB) design with four replications. Each replication consisted of eight treatments. Each treatment consisted of 5 rows with row-row distance of 20 cm and

plant-plant distance of 8 cm. The detail of the treatments during the study were as shown in Table-1:

Table-1. Detail of treatments used in the trial.

S. No.	Treatments	Common name	Time of application	Rate (kg ai ha^{-1})
1.	Stomp 330 EC	pendimethalin	Pre-transplantation	1.32
2.	Dual Gold 960 EC	s-metolachlor	Pre-transplantation	1.92
3.	Treflan 4 EC	trifluralin	Pre-transplantation	120
4.	2,4-D 70 SL	2,4-D	Post-transplantation	1.13
5.	Buctril M 40 EC	bromoxynil + MCPA	Post-transplantation	1.30
6.	Topik 15 WP	clodinafop	Post-transplantation	0.05
7.	Logran Extra 64 WG	terbutryn + triasulfuron	Post-transplantation	0.30
8.	Weedy check		-	-

The data were recorded on weed kill percentage, Fresh weed biomass (kg ha^{-1}), Onion bulbs m^{-2}, Size of onion bulbs (water displaced)(ml), Plant height (cm),Onion diameter (cm), Onion yield (kg ha^{-1}) and Cost-Benefit Ratio (CBR).

The data recorded for each trait were individually subjected to the ANOVA Technique by using MSTATC computer software and means were separated by using Fisher's LSD test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The data recorded on weeds kill percentage, fresh weed biomass, onion count m^{-2}, plant height, size of onion bulbs, onion diameter, onion yield and cost-benefit ratio in onion variety Swat-1 at Agricultural Research Station, Mingora were statistically analyzed and the results are presented and discussed as under:

Weeds kill percentage

The statistical analysis of the data showed that there was significant ($P<0.05$) effect of different herbicides on the weeds kill percentage (Table-2). The weed species infesting the experiment were *Echinochloa crus-galli*, *Paspalum* sp., *Digitaria sanguinalis*, *Chenopodium album*, *Coronopus didymus*, *Sinapis arvense*, *Fumaria indica*, *Ranunculus* sp., *Polygonum* sp., *Setaria* sp., *Rumex* sp., *Poa annua*, *Sisymbrium irio*, *Amaranthus viridis*, *Eleusine indica*, *Cuscuta* sp., *Leptochloa* sp. and *Alternanthera* sp. The maximum weed kill percentage (88.6 %) was recorded in the plots treated with Stomp 330 EC pre-em., followed by Dual gold 960 EC (85.0 %), Treflan 4 EC (76.7 %) and Topik 15 WP (76.7 %), while minimimum weed kill was recorded in Logran extra 64 WG (19.4 %) treated plots (Table-2). The variability in weeds kill percentage in different treatments can be attributed to the fact that pre-emergence herbicides are more effective for weed control than the others particularly from broad leaf killer herbicides i. e. Logran Extra and Buctril M 40 EC. These results are in similarity with those reported by Orkwor *et al.* (1983) who stated that herbicides applied prior to transplanting, gave excellent weed control for at least 12 weeks and resulted maximum onion yield comparable with herbicides applied after transplanting.

Fresh weed biomass (kg ha^{-1})

Statistical analysis of the data showed that different herbicidal treatments had non-significant effect on weed biomass. The data in Table-2 indicated that minimum weed biomass (2666 kg ha^{-1}) was found in Stomp 330 EC treated plots. However, it was statistically at par with Dual Gold 960 EC (2916 kg ha^{-1}), Treflan 4 EC (3166 kg ha^{-1}), 2,4-D 70 SL (3874 kg ha^{-1}), Buctril M 40 EC (3791 kg ha^{-1}), Topik 15 WP (3691 kg ha^{-1}) and Logran Extra 64 WG (4208 kg ha^{-1}). This might be attributed to the fact that the data for fresh weeds biomass were taken at the end of the season, where almost all of the weeds were present. By this time the persistence/effect of pre-emergence herbicides has finished, while, the post-emergence herbicides were selective and only controlled either grassy or broadleaf weeds. As a result the tolerant or resistant species flourished well. So at the end of the season maximum weeds were present in all the treatments and were not more different than the weedy check in terms of weeds biomass. These results are in line with those reported by Malik *et al.* (1981) and Sinha and Ratohore (1993).

Onion bulbs m^{-2}

The statistical analysis of the data showed that the onion bulbs count was not significantly affected by different herbicidal treatments (Table-2). The means shown in the Table-2 indicated the highest bulb count was recorded in Stomp 330EC (49.97) treated plots, while the lowest bulb count (39.95) was observed in the Weedy check. The variability can be attributed to the fact that the presence of weeds in certain treatments although affected the size of the bulb but did not prevent the transplants to establish. As a result we got approximately similar number of bulbs from different treatments. These results agree with the findings of Sarivastava *et al.* (1986).

Size of onion bulbs (ml)

Analysis of variance of the data revealed that the size of onion bulb was significantly ($P<0.05$) affected by different herbicidal treatments (Table-2). The data shown in Table-2 indicated the largest bulb size was recorded in Stomp 330EC (78.25 ml). However, it was statistically at par with Dual gold (70.0 ml), Treflan 4 EC (67.50 ml) and Topik 15 WP (63.75 ml), while minimum bulb size (50.0 ml) was observed in Logran Extra and weedy check (50.0 ml). The largest size in different treatments is due to the effectiveness of different herbicides, which controlled weeds and ultimately increased the nutrient availability for the crop. Thus the treatments, which remained weed free for the maximum time, produced larger bulbs. These results are in line with the results reported by Keeling *et al.* (1990).

Table-2. Effect of different herbicides on weed kill fresh wed biomass, onion count and size of onion bulbs.

Treatments	Weed kill percentage	Fresh weed biomass (kg ha^{-1})	Onion count m^{-2}	Size of onion bulbs (ml)
Stomp 330 EC (pendimethalin)	88.60 a*	2666 b	49.97	78.25 a*
Dual Gold 960 EC (s-metolachlor)	84.96 ab	2916 b	48.58	70.00 ab
Treflan 4 EC (trifluralin)	76.69 ab	3166 ab	48.77	67.50 abc
2,4-D 70 SL (2,4-D)	67.22 bc	3874 ab	46.13	51.50 bc
Buctril M 40 EC (bromoxynil + MCPA)	52.57 c	3791 ab	46.13	53.75 bc
Topik 15 WP (clodinafop)	76.68 ab	3791 ab	42.08	63.75 abc
Logran Extra 64 WG (terbutryn + triasulfuron)	19.44 d	4208 ab	44.63	50.00 c
Weedy check	00.00 e	4875 a	39.95	47.75 c
LSD at $\alpha_{0.05}$	18.61	1740	10.39	19.79

*Means followed by different letters in the respective column are significantly different at 5% probability level according to LSD test.

Plant height (cm)

The analysis of variance of the data regarding plant height revealed that the effect of different herbicides was non-significant. Data in Table-3 indicate that all the treatments were statistically similar to one another. The highest onion height was recorded in unweeded check and pendimethalin treated plots. This may be attributed to the fact that in case of weeds free conditions the plants developed to full size with out any stress conditions or competition with weeds for nutrients space and light. But in case of weed infestation the competition between plants tended to invest more photosynthate into structural tissue to harvest light. Similar results have been reported by Markovic (1983) who stated that there was no significant effect of herbicides on plant height.

Onion diameter (cm)

The statistical analysis of the data showed that the effect of different herbicides on onion diameter was significant ($P<0.05$). Data concerning the effect of different herbicides on onion diameter are given in the Table-3. Maximum onion diameter was recorded in the Stomp 330EC treated plots (5.24 cm). However it was statistically similar with Dual gold 960 EC (5.085), Treflan 4 EC (4.965), Topik 15 WP (4.727) and Buctril-M 40 EC (4.463). Minimum bulb diameter was noted in the weedy check (4.057 cm) followed by Logran extra 64 WG (4.27). The possible reason for increase in onion diameter by Stomp 330EC, Dual gold 960 EC and Treflan 4EC could be the best control of weeds and consequently increased nutrients availability to the crop while the reason for minimum bulb diameter in weedy check could be attributed to weed competition for nutrients, light, moisture and space. These results are in conformity with Gill *et al.* (1982) and Manjunath *et al.* (1989) who reported that weeds infestations highly reduced crop vigor, leaf production, and bulb diameter and consequently bulb yield in onion crop.

Onion yield (kg ha^{-1})

The statistical analysis of the data exhibited that different herbicides had significant effect ($P<0.05$) on onion yield. Data regarding the effect of different herbicides on onion yield are given in the Table-3. Maximum yield was produced by Stomp 330EC treated plots (29950 kg ha^{-1}) and Dual Gold (29400 kg ha^{-1}). However, it was statistically at par with Treflan 4 EC (27620 kg ha^{-1}) and Topik 15 WP (24320 kg ha^{-1}), while minimum bulb yield was recorded in the weedy check (13700 kg ha^{-1}) and Logran extra 64 WG (16920 kg ha^{-1}). Pre-emergence herbicides as a whole produced better results. This could be due to the fact that pre-emergence herbicides were more effective than the post-emergence herbicides. Pre-emergence herbicides controlled the weeds throughout the critical stage of the onion. Thus, increased the availability of the nutrients to the crop. These results are in line with those reported by Singh *et al.* (1992) and Halmagean *et al.* (1993).

Cost-Benefit Ratio (CBR)

The effect of different herbicides on cost-benefit ratio was significant. Data regarding the effect of different herbicides on cost-benefit ratio are given in the Table-3. Maximum cost-benefit ratios were recorded for Stomp 330 EC (1: 29.81), Dual gold 960 EC (1:19.32), and Treflan 4 EC treated plots (1: 17.05). The lowest cost-benefit ratio was recorded for Logran extra 64 WG treated plots (1: 3.90). However, it is also acceptable. These values indicated that all the herbicidal treatments gave optimum cost-benefit ratio as compared to the yield in the weedy check. The possible reason for the highest return of herbicides might be their cost and timely weed control as compared to other weed control methods. Similar results have been reported by Warade *et al.* (1995) and Saikia *et al.* (1997).

Table-3. Effect of different herbicides on onion height, diameter, bulb yield and cost benefit ratio.

Treatments	Plant height (cm)	Onion diameter (cm)	Onion yield (kg ha^{-1})	Cost-Benefit Ratio (CBR)
Stomp 330 EC (pendimethalin)	59.70	5.49 a*	29950 a*	29.81
Dual Gold 960 EC (s-metolachlor)	56.10	5.08 ab	29400 a	19.32
Treflan 4 EC (trifluralin)	54.25	4.96 ab	27620 ab	17.05
2,4-D 70 SL (2,4-D)	55.05	4.32 bc	18700 cde	8.88
Buctril M 40 EC (bromoxynil + MCPA)	55.80	4.46 abc	21520 bcd	7.67
Topik 15 WP (clodinafop)	55.80	4.73 abc	24320 abc	9.32
Logran Extra 64 WG (terbutryn + triasulfuron)	54.85	4.28 bc	16920 de	3.90
Weedy check	59.65	4.06 c	13700 e	-----
LSD at $\alpha_{0.05}$	8.171	0.891	6558	

*Means followed by different letters in the respective column are significantly different at 5% probability level according to LSD test.

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