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Performance of Different Herbicides on Weed Control in Onion (*Allium cepa L.)* and Its Effect on Economics

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Onion is one of the most important vegetable in India. However, yields are generally low due to weeds problem which reduce onion yields. In order to evaluate various herbicides for weed control in onion, an experiment was conducted at Agricultural Research Institute, Patna under Bihar Agricultural University, Sabour, Bhagalpur during two consecutive rabi Season 2016-17 and 2017-2018.The experiment comprised 3 herbicides and were applied alone , their combinations ,hand weeded plot and a weedy check was also included. Thus the eight different treatments were: weed free throughout the all crop period, two hand weeding at 20 and 40 days after transplanting, glyphosate at the rate 1kg active ingredient /ha 15 days before transplanting, pendimethalin at the rate 1 kg active ingredient/ha as pre emergence i.e., 3 days after transplanting, oxyfluorfen at the

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rate 250 g active ingredient /ha as post emergence i.e. 30 days after transplanting, pendimethalin followed by oxyfluorfen, glyphosate followed by pedimethalin followed by oxyfluorfen and the control.

Statistical analysis of the data showed that the hand weeded treatment had the lowest total dry weight of weeds (10.3g) and total fresh weight of weeds (29.4g) followed by combined application of glyphosate, pendimethalin and oxyfluorfen treated plot (12.7g) and (24.5g) as compared to the weedy check (45.8g) and (159.0g) respectively. Similarly, the maximum size of onion bulbs (62.5g), yield (281q/ha) was recorded in the hand weeded plots followed by the combined application of glyphosate, pendimethalin and oxyflurfen treated plot (61.9g and 268q/ha) as compared to weedy check (13.3g and 49q/ha). The highest cost benefit ratio was obtained in the treatment (where combinations of the 3 herbicides were applied i.e., (T_7) due to low labour consumption as compared to weed free treatment (T_1).

Keywords: Onion; yield; herbicides; economics.

1. INTRODUCTION

Onion (*Allium cepa L*) is an important vegetable crop grown throughout the world. Onion is regarded as a highly export oriented crop and earns a valuable foreign exchange for the country. It is considered to be the second most important vegetable crop grown in the world next to tomato. In the world, India stands first in area and ranks second to China in production; the total area in India under onion cultivation during 2012-13 was 10.51 lakh hectare with a production of 168.13lakh tones and productivity of 16 000 tonnes per hectare [1]. One reason for lower than expected yields is weed competition.

Onion crop has poor competitive ability with weeds due to inherent characteristics such as short stature, non branching habits, shallow root system and extremely slow growth in initial stage. In addition to this frequent irrigation water and fertilizer application allows for successive flushes of weeds in onion. Yield loss due to weed infestation in onion is to the tune of 40-80 % [2]. Controlling weed development during the onion crop cycle is essential to obtain high yields and marketable products.

Weeds are mostly managed manually and therefore huge amount of the money are invested for the control of weeds. Herbicides can be an alternative method for the control of weeds prior to transplanting and also after transplanting of this crop because usage of herbicides has become popular in onion crop as it is grown on large scale both for internal consumption and for export purposes. Spraying of pre –emergence herbicides keeps the crop in weed free condition during early stages. Then at later stages application of post emergence herbicides helps to reduce the cost of weeding and keep the weed population below economic threshold level through the crop growth period. However, onion production is seriously affected by price fluctuation every year.

2. MATERIALS AND METHODS

The experiment was conducted at agricultural Research Institute, Patna under Bihar Agricultural University, Sabour, Bhagalpur. A Randomized Block Design (RBD) was used with three replications. The soil being clayey loam in texture, it was ploughed by tractor and then harrowed. The plot size was 3mx3m and the plants being planted at a distance of 15cmx10cm. NPK were applied at recommended rates just before transplanting and half of the nitrogan was applied after four weeks of transplanting. The specific treatments details during the course of experiment has been mentioned below-

2.1 Treatment Details

T_1 - Weed free throughout the crop period.
T_2 - Two hand weedings at 20 and 40 DAT.
T_3 - Applications of glyphosate at the rate of 1 Kg active ingredient /ha 15 days before transplanting.
T_4 - Application of pendimethalin at the rate of 1 Kg active ingredient/ha 3 days within transplanting.
T_5 - Application of oxyfluorfen at the rate of 250 g active ingredient /ha 30 days after transplanting.
T_6 - Application of pendimethalin followed by oxyfluorfen.
T_7 - Application of Glyphosate followed by pendimethalin and oxyfluorfen.
T_8 - Weed Control.

The selection of the herbicides for the experiment was based on the frequent availability at purchasable rates for the local farming community. The pre transplanted herbicide (glhyphosate) was applied 15 days prior to transplanting and the pre and post transplanted herbicides ie; pendimethalin was applied 3 days within transplanting and oxyflourfen at 30 days after transplanting. All the herbicide applications were made with a knapsack sprayer. The weed community in the experiment site comprised of *Physalis micrantha, Cyperus, rotundus* L*, Vicia sativa L, Chenopodium album, Blumea wightiana, Crotalaria, retusa L, Trianthema portutalastrum, Nicotiana plumbaginifolia, Cynodon dactylon, Melilotus spp.*

3. RESULTS AND DISCUSSION

3.1 Growth and Yield Parameters

All the weed management treatments were superior over control in respect of all growth and yield attributes and also the bulb yield (Table 1). The highest growth attributes (plant height, collar thickness) and yield attributes (polar and equatorial diameter and weight of per bulb) and bulb yield were observed in weed free plot. However spray of the combinations of the 3 different herbicides was at second place in respect of all these attributes. Whereas, the lowest all growth and yield attributes and bulb yield were reported under control plot (without hand weeding and chemical herbicides).

It might be due to less weed crop competition throughout crop growth period by manual weeding i.e., in T_1 ,which in turn maintain the soil fertility status by way of removing less plant nutrients through weeds and ultimately have favourable effect on growth parameters and yield attributes. These findings are in close proximity with the reports of [3,4,5] and [6] who worked with different crops.

Increased Crop growth and bulb weight in need free plot (T_1) was favorable environment received to the Crop to express better plant growth. This increased in Crop growth was due to less Crop weed Completion at the earlier stage of Crop growth.

3.2 Crop Yield

Among all the treatments, the highest bulb yield (281 q/ha) was obtained in weed free plot (T_1) followed by treatment (T_7) i.e Combined application of herbicides as pre- plant, pre-emergence and post emergence form (glyphosate @ 1 kgai/ha 15 days before transplanting, followed by pendimethalin 1 kg ai/ha 3 days within transplanting and oxyflourfen 250 g ai/ha 30 days after transplanting). The lowest bulb yield of 49 q/ha was observed in the control plots. Combinations of herbicides treated plots fetched better result due to the efficient weed control which provided an opportunity for the crop to utilize the available resources efficiently to produce good yield. The lowest yield (49 q/ha) in control plot may be due to weed competition. Thus reducing availability of moisture, light and nutrients to the crop resulting loss of yield in the unwedded plot. This supports the findings of [7] in onion.

Table 1. Effect of integrated weed management practices on growth and yield attributed of onion Crop. (Pooled data of two years)

Treatments	Plant height (cm)	Collar thickness (cm)	Polar diameter (cm)	Equatorial diameter (cm)	Weight/bulb (cm)	Yield (q/ha)
T_1	24.3	2.9	7.9	5.46	62.5	281.00
T_2	20.7	1.85	6.6	4.56	59.0	182.00
T_3	19.7	1.45	5.7	3.89	57.3	126.00
T_4	21.6	1.82	6.1	5.04	58.1	226.00
T_5	22.5	1.88	5.9	4.38	59.0	247.00
T_6	22.0	2.6	6.5	5.20	61.4	258.00
T_7	23.5	2.85	7.6	5.46	61.4	268.00
T_8	18.0	0.92	2.2	2.0	13.3	49.00
$SE_m(\pm)$	0.44	0.05	0.14	0.12	0.60	0.61
CD (5%)	1.33	0.16	0.43	0.35	1.29	1.83
CV (%)	3.54	4.62	4.1	4.1	1.36	17.34

Weed free plot reduced the competition from the weeds to a greater extent and thus helped in faster growth and development of onion bulb crop, resulting in obtaining higher values of all yield attributing characters. The findings are in closely vicinity of those reported by many researchers [8] and [9] with respect to onion yield.

3.3 Dry Weight of Weeds

The significant effect on total dry weight of weeds (Table 2) was found due to different herbicides treatments. The maximum dry weight was found in T_8 (weedy check). The lowest dry weight however, was found in T_1. Other herbicides resulted higher weeds dry weight than the T_1 treatment. The dry weight of weeds may be due to the increased weed population and continuous growth and may also be due to the higher amount of nutrient uptake [10].

The variability in weed population between the different treatments could be attributed to differences in the spectrum of weeds present, and differences in the spectrum of control by each herbicide. These results agreed with those of [11] and [12].

3.4 Effect on Economic Returns

It is evident from Table 3 that the highest net monetary return of Rs 275420.00 with cost benefit ratio 2.92 was reported with weed management treatment (T_7). Pre-plant application of glyphosate at the rate of 1 kg active ingredient /ha was done 15 days before transplanting. Pre-emergence application of pendimethalin was done at the rate of 1 Kg active ingredient /ha and post emergence application of oxyfluorfen was done at the rate of 250 g active ingredient /ha at 30 days after transplanting. The highest yield (281 q/ha) was obtained in weed free plot (T_1). Due to labour consumption, raised cost of cultivation, tedious weeding job, and other time consuming factors, this leads to less monetary returns (Rs 268280 q/ha) in weed free plot (T_1) when compared with

Table 2. Effect of different treatments on weed biomass, total fresh weight of weed, total dry weight of weeds (g)

Treatments	Weed biomass/m^2	Total fresh weight of weeds (g)	Total dry weight of weeds (g)
T_1	315.8	29.4	10.3
T_2	619.0	56.9	24.4
T_3	411.0	60.1	22.8
T_4	382.3	42.8	17.4
T_5	304.0	38.2	15.3
T_6	300.4	31.0	13.8
T_7	285.7	24.5	12.7
T_8	1313.3	159.0	45.8
$SE_m(\pm)$	87.39	11.46	5.11
LSD (0.05)	187.46	24.58	10.97

Table 3. Economics of onion as affected by different weed management practices

Treatments	Cost of cultivation (Rs/ha)	Yield (q/ha)	Gross realization (Rs/ha)	Net realization	B:C ratio
T_1	125120	281	393400	268280	2.14
T_2	116390	182	254800	138410	1.18
T_3	96022	126	176400	80378	0.83
T_4	96648	226	316400	219752	2.27
T_5	97210	247	345800	248590	2.51
T_6	98808	258	361200	262392	2.66
T_7	99780	268	375200	275420	2.92
T_8	94080	48.88	63000	-310080	-0.33
$SE_m(\pm)$		0.61			
CD (5%)		1.83			
CV (%)		17.34			

combined effect of herbicide treated plot (T_7). Reflection of the highest net return (Rs.275420 q/ha) in treatment (T_7) could be attributed to lowest cost of cultivation in these herbicide treatment as compared to weed free treatment.

The results regarding gain of highest monetary returns and cost benefit ratio with integrated weed management practices are supported with the results of [13] and [14] who have studied the economic returns parameters in INM in onion crop under various climatic conditions. The lowest cost benefit ratio was found with control plot (without hand weeding and chemical herbicides) over rest of the treatments due to lower bulb yield.

4. CONCLUSION

The results of this trial showed that the herbicide glyphosate at the rate of 1 kg active ingredient /ha followed by pendimethalin 1kg active ingredient /ha and oxyfluorfen 250 g active ingredient /ha is the best option for chemical weed control in onion crop to gain desirable yields.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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