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Studies on integrated weed management in Onion (*Allium cepa* L.)

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Abstract
The present investigation entitled "Studies on integrated weed management in onion (*Allium cepa* L.)" was carried out at the Vegetable Research Farm, Department of Vegetable Science, Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) during rabi, 2012-13 and 2013-14 with the objective to study the effect of different weed management practices on growth and yield of onion cv. Palam Lohit. In this study, 12 treatment *viz*. preplant application of pendimethalin, preplant application of oxyfluorfen, hand weeding at 40,60 and 90 DAT, weed free plot, preplant application of pendimethalin + hand weeding at 40 DAT, preplant application of pendimethalin + hand weeding at 60 DAT, preplant application of oxyfluorfen + hand weeding at 40 DAT, preplant application of oxyfluorfen + hand weeding at 60 DAT, mulching with black polythene, mulching with pine needles, mulching with local grass and Unweeded check were compared in a Randomized Complete Block Design (RCBD) having three replications with a plot size of 3 x 1.5 m and a plant spacing of 30 cm x 10 cm. All the treatments were found significant for different characters like maximum value for number of leaves per plant, leaf length, Average weight of bulb (132.37) in this study. Use of black polythene mulch, therefore was found most effective for most of the character studied.

Keywords: *Allium cepa* L., growth, integrated nutrient management

1. Introduction
Onion (*Allium cepa* L.) is one of the most important vegetable crops in all over the world including India. It is most widely grown and popular vegetable crop among the alliums, globally it is considered to be the second most important vegetable after tomatoes. It is an indispensible item in every kitchen as vegetable. It is consumed as fresh salad and / or added as a spice while cooking dishes. Apart from furnishing nutrition, it also provides relishing flavors to our dietes. Therefore, onion is popularly referred as 'Queen of the kitchen'. Onion contains carbohydrates (11.0g), proteins (1.2g), fiber (0.6 g), moisture (86.8 g) and several vitamin like vitamin A (0.012 mg), vitamin C (11 mg), thiamin (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg) and also some minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) (Rahman *et al*., 2013) [1].
Weeds poses production problems in onion fields. The weeds problem is becoming worse in irrigated areas where cropping intensity is rapidly increasing and weed management through cultivation practices has become a challenge. Weeds compete with onion for light, nutrient, water space and also host plant of several harmful insects and pathogens and considerably reduce the yield, quality and value of the crop through increased production and harvesting cost (Uygur *et al*., 2010) [2]. Weed interferes development of onion bulbs thereby reducing bulbs yield to the extent of 40-80% (Singh *et al*., 1992) [3].
Onion has very poor competitive ability with weeds due to its inherent characteristics such as short stature, non-branching habit, sparse foliage, shallow root system and extremely slow growth in initial stages which cause rapid growth of weeds. In addition, their cylindrical upright leaves do note shade the soil to block weed growth (Ramalingam *et al*., 2013) [4].
Weeds reduce crop yield because they compete with the crop plants for nutrients, water and

light. In addition, weed also hinder with the crops harvesting and increase the cost of production (Khatam *et al*., 2012) [5].
Weeds can be controlled by cultural, mechanical, chemical methods and the use of organic and inorganic mulch. It becomes necessary to control the weed during the later period of crop growth. Use of herbicide and cultural practices as an integrated approach may provide economically acceptable weed control.
Mulches can be used to prevent weeds germination and their growth, which ultimately reduce time and labour required to control weeds. Mulch provides many advantages for the user, such as higher yield, better moisture retention, reduce fertilizer leaching, decrease soil compaction, reduce weed infestation, thus offering environment friendly control of weeds (Karimi *et al*., 2012) [6]. One of the main objectives of using plastic mulch is to increase soil temperature in root and bulb zone.
Keeping in view the significance of above aspects the studies on integrated weed management in onion (*Alium cepa* L.) has been conducted.

2. Materials and Methods

The present investigation on "Studies on integrated weed management in onion *(Allium cepa* L.)" was carried out at the experimental farm of Department of Vegetable Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) in the rabi season of 2012-13 and 2013-14 to measure the number of leaves per plant, Leaf length (cm), number of bulbs per plot by applying below mentioned treatments in Palam Lohit variety of onion (*Allium cepa* L.) with plot size 3 x 1.5 m, spacing 30 x 10 cm with number of plants per plot 150.by applying the Randomized Complete Block Design (RCBD). The experiment consisted of ten 10 combinations of weeding practices which were laid out in randomized complete block design with three replications (Table 1).

Table 1: Treatments applied

Symbol used	Treatments
T_1	Preplant application of Pendimethalin @ 1.0 kg a.i./ha
T_2	Preplant application of Oxyfluorfen @ 0.25 kg a.i./ha
T_3	Hand weeding at 40,60 and 90 days after transplanting (DAT)
T_4	Weed free plot (weeding at 10 days interval)
T_5	T_1 + Hand weeding at 40 days after transplanting (DAT)
T_6	T_1 + Hand weeding at 60 days after transplanting (DAT)
T_7	T_2 + Hand weeding at 40 days after transplanting (DAT)
T_8	T_2 + Hand weeding at 60 days after transplanting (DAT)
T_9	Mulching with black polythene
T_{10}	Mulching with pine needles
T_{11}	Mulching with local grass
T_{12}	Unweeded check

The methodology used in present work is represented as under

2.1 Weed Management Practices

2.1.1 Application of herbicides

The herbicides dissolved in water @ 600 litre ha^{-1} were sprayed as pre emergence application with the help of knap sack sprayer using flat fan type nozzle before three days of transplanting. Details of the herbicides are given in table 2.

Table 2: Details of the herbicides used in present studies

Common Name	Trade Name	a.i. (%)	Manufacturer
Pendimethalin	Stomp	30 EC	BASF
Oxyfluorfen	Goal	23.5 EC	Dow Agro Science

Where a.i. = Active Ingredient

2.1.2 Hand weeding

Weeding was done at 40, 60 and 90 days after transplanting (DAT) with the help of local hand tool called 'Khunti'.

2.1.3 Mulching of plots

The plots were mulched with black polythene, pine needles and local grass as per the layout plan one week after the transplanting. The mulching of the plots was done in such a way that the soil would be covered completely. About 5 kg of pine needle and grass were required per plot for mulching. Black polythene sheet of 5 m^2 per plot of thickness 25 µ was used for mulching the plot as per the plan of the experimental layout.

2.1.4 Weed free plot

Hand weeding was done every 10 day interval from 20 to 90 DAT

2.1.5 Weedy check

Weedy check plots remained infested with the native weed population throughout the cropping season

2.2 Experimental Plantings

Onion (*Allium cepa* L.) cv. Palam Lohit was used for the study. The nursery was raised two month before transplanting. Healthy seedlings were transplanted at a spacing of 30 cm x 10 cm. The below mentioned observations had been recorded

2.2.1 Number of leaves per plant

The numbers of leaves were counted at 60 and 90 DAT from ten plants in each plot and then averages were worked out**.**

2.2.2 Leaf length (cm)

The length of leaves was recorded from the base to tip of the tallest leaf in centimeters at 60 and 90 DAT. Ten plants were taken at random in each plot for this purpose.

2.2.3 Number of bulbs per plot

The total numbers of bulbs per plot were recorded at the time of harvest of the crop.

2.4 Statistical Analysis

All the data related to studies on integrated weed management were analysed statistically by the procedure described by Panse and Sukhatme (1987) [7]. The data of weed fresh biomass weight (g m^{-2}) 60 DAT and dry biomass weight (g m^{-2}) was subjected to $\sqrt{x} + 1$ (square root transformation), weed fresh biomass weight (g m^{-2}) 90 DAT subjected to log transformation (X+1) while weed count data were brought to arc sign transformation before analysis. The results have been interpreted on the basis of 'F' test and critical difference (CD) at 5 per cent level of significance.

Table 3: Analysis of Variance

Source of Variation	d.f.	Sum of Square	Mean Sum of Square	Variance Ratio ('F' value)
Replication (r)	(r-1)	S_r	$S_r/(r-l) = M_r$	M_r/M_e M_t/M_e
Treatments (t)	(t-1)	S_t	$S_t/(t-l) = M_t$	
Error	(r-1) (t-1)	S_e	$S_e/(r-l)(t-l) = M_e$	

Where

r = Number of replications,
t = Number of treatments
M_e = Error variance,
d.f. = Degree of freedom

The standard error of mean SE (m) and critical differences (CD) for comparing the means of any two treatments were computed as follows

SE (m) = $\pm (M_e/r)^{1/2}$
SE (d) = $\pm (2M_e/r)^{1/2}$
CD at 5% = S_e (d) X 't' values at error degree of freedom

3. Results and Discussion

The results of the experiment found clear support for the effects of integrated weed management on important growth characteristics. The data recorded on different characteristics were analyzed as per design of the experiment for individual years. The mean value of individual years were interpreted and analyzed for both the year and pooled analysis for different characteristics have been given. Data on different parameters was analyzed statistically.

Analysis of variance showed significant effect of treatments on growth parameters viz., number of leaves per pant, leaf length, Number of bulbs at harvest

3.1 Number of leaves per plant at 60 and 90 DAT

The examination of data indicated that there was significant increase in number of leaves per plant. Observation of number of leaves at 60 DAT. Maximum number of leaves per plant (4.03) in the year 2012-13 were recorded with the use of mulching with black polythene (T_9) being statistically at par with all other treatment except T_1 (Preplant application of pendimethalin @ 1.0 kg a.i.ha^{-1}), T_2 (Preplant application of oxyfluorfen @ 0.25 kg a.i. ha^{-1}), T_6 (T_1 + Hand weeding at 60 DAT), T_{11} (Mulching with local grass) and T_{12} (Unweeded check). Minimum number of leaves (3.07) per plant were recorded in T_{12} (Unweeded check). During 2013-14, maximum number (4.47) of leaves were recorded in T_9 which was at par with T_4, where as minimum number of leaves (3.40) were recorded in control (Unweeded check) and observations at 90 DAT (Table 4) indicated that number of leaves per plant were influenced significantly with the treatments under investigation. Highest number of leaves per plant (6.77) were recorded in the year 2012-13 with the use of black polythene mulch (T_9) being statistically at par with T_4 (Weed free plot), T_5 (T_1 + Hand weeding at 40 DAT), T_6 (T_1 + Hand weeding at 60 DAT), T_7 (T_2 + Hand weeding at 40 DAT) and T_8 (T_2 + Hand weeding at 60 DAT). During 2013-14, Maximum number (7.37) of leaves per plant were recorded in T_9 which was at par with T_4 (Weed free plot), T_5 (T_1 + Hand weeding at 40 DAT) and T_7 (T_2 + Hand weeding at 40 DAT). The pooled data also showed highest number of leaves i.e. 7.07 in T_9 (Mulching with black polythene). This treatment was statistically at par with T_4 (Weed free plot) and significantly higher than other treatments. The lowest number of leaves per plant (4.30 pooled value) were recorded in unweeded check (T_{12}).

Table 4: Effect of different treatments on number of leaves per plant at different stages of crop growth in onion

Treatment		60 DAT			90 DAT		
		2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_1	Preplant application of Pendimethalin @ 1.0 kg a.i.ha^{-1}	3.30	3.77	3.53	5.97	6.43	6.20
T_2	Preplant application of Oxyfluorfen @ 0.25 kg a.i. ha^{-1}	3.33	3.90	3.62	6.13	6.43	6.28
T_3	Hand weeding at 40,60 and 90 DAT	3.80	4.13	3.97	6.27	6.70	6.48
T_4	Weed free plot (weeding at 10 days interval)	3.90	4.40	4.15	6.60	7.13	6.87
T_5	T_1 + Hand weeding at 40 DAT	3.70	4.03	3.87	6.40	6.80	6.60
T_6	T_1 + Hand weeding at 60 DAT	3.63	3.97	3.80	6.33	6.70	6.52
T_7	T_2 + Hand weeding at 40 DAT	3.70	4.00	3.85	6.50	6.83	6.67
T_8	T_2 + Hand weeding at 60 DAT	3.73	3.90	3.82	6.33	6.67	6.50
T_9	Mulching with black polythene	4.03	4.47	4.25	6.77	7.37	7.07
T_{10}	Mulching with pine needles	3.80	4.07	3.93	5.83	5.93	5.88
T_{11}	Mulching with local grass	3.67	4.10	3.88	5.60	5.87	5.73
T_{12}	Unweeded check	3.07	3.40	3.23	4.17	4.43	4.30
$CD_{0.05}$		0.36	0.32	0.31	0.47	0.58	0.37

The pooled analysis also revealed significant differences among treatments for this trait. Maximum number of leaves per plant (4.25) were found with the treatment T_9 (Mulching with black polythene) which was significantly higher to all other treatments except T_3 and T_4.

3.2 Leaf length of onion at 60 and 90 DAT (cm)

The data presented in table 5 revealed that leaf length in onion was significantly affected by the treatments in the experiment. In the year 2012-13 maximum leaf length (23.45 cm) was found with treatment T_9 (Mulching with black polythene) which was statistically at par with T_4 (Weed free plot), T_5 (T_1 + Hand weeding at 40 DAT), T_7 (T_1 + Hand weeding at 60 DAT) and T_8 (T_2 + Hand weeding at 60 DAT). Minimum leaf length (17.32 cm) was observed in the plots where weeds were not removed (T_{12}). The leaf length increased to 30.55 cm in the year of 2013-14 in T_9 treatment was statistically at par with T_4, T_7 and T_{10}. The pooled data also indicated the similar results. Maximum leaf length (27.00 cm) was found with the treatment T_9 (Weed free plot) which was statistically at par with T_4 and T_7 whereas, minimum leaf length (20.58 cm) was observed in T_{12} (Unweeded check) which is at par with T_6 (T_1 + Hand weeding at 60 DAT) and observations taken at 90 DAT revealed that maximum leaf length 52.70 cm was obtained during 2012-13 in T_9 (Mulching with black polythene) which was statistically at par with T_3 (HW at 40,60 and 90 DAT), T_4 (Weed free plot), T_5 (T_1 + HW at 40 DAT) and T_7 (T_2 + HW at 40 DAT). Lowest length of leaf (40.23 cm) was recorded in T_{12}. During 2013-14 maximum leaf length (55.33 cm) was found in treatment of black polythene

mulch (T_9) which was statistically at par with T_4 (Weed free plot). Minimum leaf length (39.90 cm) was found in T_{12} (Unweeded check) and T_{11} (Mulching with local grass). The pooled data also showed that maximum length of leaf (54.07 cm) found in T_9 (Mulching with black polythene) which was statistically at par with T_4 (Weed free plot) and shortest leaves (40.07 cm) were recorded in T_{12} (unweeded check).

3.3 Number of bulbs per plot at harvest

Observations on number of bulbs per plot as affected by various weed management practices have been presented in table 6. During the year 2012-13, maximum number of bulbs per plot (137.33) were recorded in T_4 (Weed free plot) which was statistically at par with T_5 (T_1 + HW at 40 DAT), T_6 (T_1 + HW at 60 DAT), T_7 (T_2 + HW at 40 DAT), T_8 (T_2 + HW at 60 DAT) and T_9 (Mulching with black polythene). Minimum number of bulbs per plot (127.33) were recorded in T_{12} which was statistically at par with T_1 (Preplant application of pendimethalin @ 1.0 kg a.i.ha^{-1}), T_2 (Preplant application of oxyfluorfen @ 0.25 kg a.i. ha^{-1}), T_3 (HW at 40,60 and 90 DAT), T_{10} (Mulching with pine needles) and T_{11} (Mulching with local grass) where as in 2013-14 maximum number of bulbs per plot (137.00) were found in T_4 and T_5 which was statistically at par with all other treatment except T_2, T_3, T_{10}, T_{11} and T_{12}. Minimum number of bulbs (126.67) were recorded in pine needle mulched plots. Pooled data also indicated the similar results. Maximum and minimum numbers of bulbs were found in T_4 (137.17) and T_{12} (127.50) respectively.

Table 5: Effect of different treatments on leaf length (cm) of onion at different stage of crop growth in onion

Treatment		60 DAT			90 DAT		
		2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
T_1	Preplant application of Pendimethalin @ 1.0 kg a.i.ha^{-1}	19.94	26.40	23.17	46.67	47.13	46.90
T_2	Preplant application of Oxyfluorfen @ 0.25 kg a.i. ha^{-1}	20.77	27.81	24.29	45.87	45.30	45.60
T_3	Hand weeding at 40,60 and 90 DAT	20.67	26.48	23.58	48.97	48.47	48.73
T_4	Weed free plot (weeding at 10 days interval)	23.32	30.12	26.72	52.57	55.13	53.87
T_5	T_1 + Hand weeding at 40 DAT	21.50	27.60	24.55	49.45	50.87	50.17
T_6	T_1 + Hand weeding at 60 DAT	19.69	23.83	21.76	48.50	50.23	49.40
T_7	T_2 + Hand weeding at 40 DAT	22.14	28.84	25.49	49.13	49.30	49.23
T_8	T_2 + Hand weeding at 60 DAT	21.55	26.67	24.11	48.27	48.87	48.60
T_9	Mulching with black polythene	23.45	30.55	27.00	52.70	55.33	54.07
T_{10}	Mulching with pine needles	20.17	29.17	24.67	44.93	44.20	44.60
T_{11}	Mulching with local grass	20.30	27.39	23.85	44.73	43.77	44.27
T_{12}	Unweeded check	17.32	23.83	20.58	40.23	39.90	40.07
$CD_{0.05}$		2.09	2.18	1.82	3.78	4.140	2.74

Table 6: Effect of different treatments on number of bulbs per plot at harvesting in onion

Treatment		Year		Pooled
		2012-2013	2013-2014	
T_1	Preplant application of Pendimethalin @ 1.0 kg a.i.ha^{-1}	130.67	131.00	130.83
T_2	Preplant application of Oxyfluorfen @ 0.25 kg a.i. ha^{-1}	129.67	129.67	129.67
T_3	Hand weeding at 40,60 and 90 DAT	129.00	129.33	129.17
T_4	Weed free plot (weeding at 10 days interval)	137.33	137.00	137.17
T_5	T_1 + Hand weeding at 40 DAT	136.33	137.00	136.67
T_6	T_1 + Hand weeding at 60 DAT	134.67	131.67	133.17
T_7	T_2 + Hand weeding at 40 DAT	135.00	135.33	135.17
T_8	T_2 + Hand weeding at 60 DAT	133.33	135.33	134.33
T_9	Mulching with black polythene	135.33	134.00	134.67
T_{10}	Mulching with pine needles	129.33	126.67	128.00
T_{11}	Mulching with local grass	128.33	128.00	128.17
T_{12}	Unweeded check	127.33	127.67	127.50
$CD_{0.05}$		6.40	7.14	5.13

4. Conclusion

On the basis of experiment conducted, it is concluded that use of black polythene mulch was found superior among all other treatments including unneeded check for growth characters of onion. Use of black polythene mulch depicted the reduction in weed density, crop-weed competition and ultimately resulted in better growth, development of onion.

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