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Study on Different Methods of Weed Management in Onion (*Allium cepa* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A weed management study on onion (*Allium cepa* L.) was conducted at Birsa Agricultural University, Jharkhand, India during winter season of 2016-17 and 2017-18 in a randomized block design comprised of nine weed control treatments consisting plastic mulch, available weeds mulch, straw mulch, cover crops (Fenugreek), oxyfluorfen 0.5 kg/ha pre-emergent (PE), pendimethalin 1.0 kg/ha PE, mechanical weeding by Dutch hoe, hand weeding at 20, 40, 60 days after transplanting (DAT) and weedy check. Hand weeding at 20, 40 and 60 DAT was most effective in reducing weed dry matter however it was similar to plastic mulch at all the growth stages of crop during 2016-17, 2017-18 as well as in pooled except at 60 DAT in 2016-17. Hand weeding reduced weed dry matter to the extent of 75.83 and 84.83 percent during 2016-17, 100 and 89.21 percent during 2017-18, 98.64 and 88.62 percent under pooled data at 30 and 60 DAT respectively and the corresponding reduction in weed dry matter due to application of plastic mulch was 70.73 and 40.32 percent during 2016-17, 100 and 93.64 percent during 2017-18, 98.37 and 86.52 percent under pooled data at 30 and 60 DAT respectively, compared to weedy check. Application of plastic mulch recorded 300 and 38 percent higher onion yield during 2016-17, 1959 and 117 percent during 2017-18, 576 and 70 percent higher under pooled data compared to weedy check and hand weeding respectively. Plastic mulch also recorded maximum net return ₹364136, 380185 and 372160 /ha during 2016-17, 2017-18 and under pooled data similar to net return with application of

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oxyfluorfen 0.25 kg/ha PE, pendimethalin 1 kg/ha PE and hand weeding during 2016-17 while under pooled data maximum B:C ratio was with plastic mulch and was similar to oxyfluorfen 0.25 kg/ha PE, pendimethalin 1 kg/ha PE and hand weeding.

Keywords: Plastic mulch; hand weeding; weed dry matter; net return.

1. INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops grown all over the world. It is mainly used for cuisine and culinary purpose and also preventing coronary heart diseases and other aliments [1]. In India onion occupies about 1.06 million hectare area having 15.12 million metric tons of production and average productivity of 14.2 tons per hectare [2]. Onions are slow-growing, shallow-rooted crops that can suffer severe yield loss from weed competition. Their narrow, upright leaves and non branching habit do not compete well with weeds. In addition, their long growing season, frequent irrigation water and fertilizer application allows for successive flushes of weeds. Due to this type of growing habit, onion crop cannot compete well with weeds; yield loss due to weed infestation in onion has been recorded to the tune of 40 to 80% [3]. Singh et al. [4] also reported un-controlled weed growth reduces the bulb yield up to 40-80% depending upon the nature of intensity and duration of weed competition in onion field. In the last few decades different herbicides were used alone or in combination to eliminate the weeds but their efficiency differ because of their narrow spectrum of weed control [5]. Severe labour crisis makes weed control very difficult at the critical period and causing huge yield gap. The conventional methods of weed control (hoeing and weeding) are laborious, expensive and insufficient. Hence, an attempt was made to find out the appropriate weed management practices for weed control in onion which is practically effective and economically feasible for farmers.

2. MATERIALS AND METHODS

A field experiment was conducted during winter season of 2016-2017 and 2017-18 at agronomical research farm of Birsa Agricultural University, Jharkhand, India, situated at 23º17' N latitude and longitude of 85º10' E with an altitude of 625 m above mean sea level, to find out the effect of weed control methods on productivity and economics of onion. The experimental soil was poor in nitrogen (243 kg/ha), medium in phosphorus (19.15 kg/ha), potassium (188.16 kg/ha) and organic carbon (4.2 g/kg soil). The pH of soil was 5.9. The experiment was laid out in a randomized block design with three replications. The treatments comprised of nine weed control methods consisting plastic mulch, available weeds mulch, straw mulch, cover crops (Fenugreek), oxyfluorfen 0.5 kg/ha PE, pendimethalin 1.0 Kg /ha PE, mechanical weeding by Dutch hoe, hand weeding at 20, 40, 60 DAT and weedy check. The onion variety Nasik N-53 has been taken for the experiment. Bulbs of this variety are flattish round in shape with red colour, medium to large in size and mildly pungent. Total soluble solids (TSS) is 11-12%. The seedlings have been raised on October 27, 2016 and November 4, 2017 and transplanted on 17th and 27th December during 2016 and 2017 at spacing of 15 x 10 cm. FYM 10 t/ha and Karanj (*Derris indica*) cake 2.5 t/ha were applied 15 days prior to transplanting. The experiment was done under irrigated condition. Weed mulches of locally available sources were applied @ 10 t/ha. Relative composition of weeds (%) of an individual weed species was calculated by the formula:

$$Relaitve\ composition\ of\ a\ species\ (\%) = \frac{No.\ of\ individual\ species}{Total\ no.\ of\ all\ weeds} x100$$

3. RESULTS AND DISCUSSION

3.1 Effect on Weeds

Weed flora: Relative composition of weed species differed with growth stages of onion. Two years pooled data of weed species revealed that *Coronopus dydimus Anagalis arvensis*, *Ageratum conyzoides, Stellaria media* and *Polygonum plebejum* were found as major weeds at 30 DAT with average relative composition of 36.24, 15.49, 15.43, 6.43, 6.21% and under weedy check condition it was 33.84, 24.80, 10.84, 7.45, 4.99% respectively (Table 1). While at 60 DAT *Coronopus didymus, Ageratum conyzoides, Dactiloctanium aegyptium, Anagalis arvensis, Stellaria media, Polygonum plebejum,* and *Chenopodium album* were the major weeds with average relative composition of 24.57, 16.99, 13.03, 8.72, 5.42, 5.70 and 6.50% while under weedy check condition relative composition was 32.71, 11.44, 13.10, 11.44, 6.13, 5.81 and 4.41% respectively (Table 2).

Table 1. Relative composition of weeds (%) at 30DAT as affected by weed management practices (Pooled of 2016-17 and 2017-18)

Treatments	Weed species (number /m^2)								
	Ageratum conyzoides	***Stellaria media***	***Alternanthera pungens***	***Anagalis arvensis***	***Chenopodium album***	***Polygonum plebejum***	***Coronopus dydimus***	***Cyperus rotundus***	**Others**
Plastic mulch (black)	59	37	8	32	8	35	53	0	13
Available weeds mulch	64	29	19	91	8	16	331	0	34
Straw mulch	104	32	19	99	13	29	163	40	34
Cover crops (fenugreek)	96	53	16	93	24	80	336	0	91
Oxyfluorfen 0.25 kg/ha PE	21	13	0	5	0	3	56	45	41
Pendimethalin 1.0 kg/ha PE	117	0	0	11	0	0	109	61	27
Mechanical weeding (Dutch hoe)	37	16	11	53	29	40	200	8	67
Hand weeding (20, 40, 60 DAS)	109	29	29	16	24	32	51	0	65
Weedy check	163	112	109	373	59	75	509	8	96
Average number of weeds	86	36	23	86	18	34	201	18	52
Mean relative weed composition (%)	15.43	6.43	4.23	15.49	3.31	6.21	36.24	3.25	9.41
Weedy relative weed composition (%)	10.84	7.45	7.25	24.80	3.92	4.99	33.84	0.53	6.38

Table 2. Relative composition of weeds (%) at 60 DAT as affected by weed management practices (Pooled of 2016-17 and 2017-18)

Treatments	Weed species (number/m^2)										
	Ageratum conyzoides	***Stellaria media***	***Alternanthera pungens***	***Medicago polymorpha***	***Anagalis arvensis***	***Chenopodium album***	***Polygonum plebejum***	***Coronopus dydimus***	***Dactyloctenium aegyptium***	***Cynodon dactylon***	**Others**
Plastic mulch (black)	61	35	21	13	75	16	32	187	64	77	43
Available weeds mulch	61	64	19	40	109	27	24	245	83	51	66
Straw mulch	205	24	11	16	61	16	53	141	61	19	76
Cover crops (fenugreek)	104	61	16	29	43	96	51	96	96	32	83
Oxyfluorfen 0.25 kg/ha PE	32	24	0	19	24	8	5	83	104	11	42
Pendimethalin 1.0 kg/ha PE	296	0	0	27	8	120	3	83	35	5	12
Mechanical weeding (Dutch hoe)	40	21	16	16	16	29	83	64	48	13	65
Hand weeding (20, 40, 60 DAS)	51	3	3	13	13	13	3	77	93	29	38
Weedy check	179	96	64	27	179	69	91	512	205	72	71
Average number of weeds	114	36	17	22	59	44	38	165	88	34	55
Average relative weed composition (%)	16.99	5.42	2.48	3.30	8.72	6.50	5.70	24.57	13.03	5.10	8.19
Weedy relative weed composition (%)	11.44	6.13	4.09	1.72	11.44	4.41	5.81	32.71	13.10	4.60	4.56

Table 3. Effect of weed management practices on weed dry matter and weed control efficiency % in onion (2016-17 and 2017-18)

Treatments	Total weed dry matter (g/m^2)						Weed control efficiency %					
	2016-17		2017-18		Pool		2016-17		2017-18		Pool	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
Plastic mulch (black)	1.34 (1.32)	3.57 (13.26)	0.71 (0)	3.01 (9.17)	1.07 (0.66)	3.35 (11.22)	69.19	42.85	100.00	93.37	97.83	86.94
Available weeds mulch	1.34 (1.41)	2.56 (7.7)	3.24 (10.29)	3.26 (10.35)	2.49 (5.85)	3.02 (9.02)	72.03	72.38	81.43	92.74	80.88	89.67
Straw mulch	1.18 (0.89)	3.23 (10.6)	3.37 (11.04)	2.96 (8.37)	2.52 (5.97)	3.14 (9.49)	77.60	54.78	80.22	93.71	81.12	88.49
Cover crops (fenugreek)	2.03 (4.22)	3.33 (11.33)	4.39 (20.21)	3.67 (13.01)	3.51 (12.22)	3.53 (12.17)	19.39	51.90	74.50	90.55	68.31	85.38
Oxyfluorfen 0.25 kg/ha PE	1.05 (0.63)	3.02 (10.33)	3.01 (9.23)	3.98 (15.52)	2.27 (4.93)	3.58 (12.93)	86.98	61.35	87.46	89.21	87.12	85.19
Pendimethalin 1.0 kg/ha PE	1.12 (0.76)	3.25 (11.93)	3.14 (10.45)	2.86 (8)	2.38 (5.61)	3.19 (9.96)	81.10	54.72	87.58	93.76	87.09	88.29
Mechanical weeding (Dutch hoe)	1.4 (1.49)	3.12 (10.1)	4.69 (23.15)	3.21 (10.67)	3.48 (12.32)	3.30 (10.38)	65.45	57.43	71.37	91.50	70.82	86.64
Hand weeding (20, 40, 60 DAS)	1.26 (1.09)	1.83 (3.37)	0.71 (0)	4.00 (15.57)	1.02 (0.55)	3.13 (9.47)	72.26	87.43	100.00	88.97	98.39	88.68
Weedy check	2.2 (4.51)	4.69 (22.22)	8.58 (76.64)	11.95 (144.27)	6.29 (40.58)	9.08 (83.24)	0.00	0.00	0.00	0.00	0.01	0.00
SEm±	0.17	0.23	0.62	0.52	0.42	0.25	10.43	7.44	5.33	1.59	5.03	1.47
CD (P=0.05)	0.51	0.70	1.86	1.55	1.25	0.74	31.25	22.31	15.97	4.78	15.09	4.41

Data in parenthesis (original value) was subjected to √(X + 0.5) transformation

Table 4. Effect of weed management practices yield and economics of onion (2016-17 and 2017-18)

Treatments	Yield (t/ha)			Cost of cultivation (₹/ha)	Gross return (₹/ha)			Net return (₹/ha)			B:C		
	2016-17	2017-18	Pool		2016-17	2017-18	Pool	2016-17	2017-18	Pool	2016-17	2017-18	Pool
Plastic mulch(black)	24.69	25.33	25.01	253148	617284	633333	625309	364136	380185	372160	1.44	1.50	1.47
Available weeds mulch	9.35	11.00	10.18	156897	233796	275000	254398	76900	118103	97501	0.49	0.75	0.62
Straw mulch	14.94	8.00	11.47	165960	373457	200000	286728	207497	34040	120769	1.25	0.21	0.73
Cover crops (fenugreek)	6.94	10.33	8.64	156523	173611	258333	215972	17088	101810	59449	0.11	0.65	0.38
Oxyfluorfen 0.25 kg/ha PE	18.98	11.33	15.16	156139	474531	283333	378932	318392	127194	222793	2.04	0.81	1.43
Pendimethalin 1.0 kg/ha PE	19.44	9.00	14.22	159690	486111	225000	355556	326421	65310	195866	2.04	0.41	1.23
Mechanical weeding (Dutch hoe)	13.21	6.67	9.94	155022	330241	166667	248454	175219	11644	93431	1.13	0.08	0.60
Hand weeding (20, 40, 60 DAS)	17.84	11.67	14.75	166268	445988	291667	368827	279719	125399	202559	1.68	0.75	1.22
Weedy	6.17	1.23	3.70	153148	154321	30833	92577	1173	-122315	-60571	0.01	-0.80	-0.40
SEm±	1.48	1.09	0.93		36988	27344	23354	36988	27344	23354	0.22	0.15	0.13
CD (P=0.05)	4.44	3.28	2.80		110878	81969	70007	110878	81969	70007	0.66	0.46	0.38

Price of onion=Rs.25.00/kg

Different weed management methods had different number of weed species, minimum weed was recorded under application of oxyfluorfen 0.5 kg/ha PE followed by plastic mulch at 30 DAT whereas at 60 DAT hand weeding at 20, 40 and 60 DAT recorded minimum weeds followed by application of oxyfluorfen 0.5 kg/ha PE. Singh et al. [4] also reported similar finding.

Weed dry matter and weed control efficiency: Hand weeding at 20, 40 and 60 DAT was most effective in reducing weed dry matter however it was similar to plastic mulch at all the growth stages of crop (Table 3) during 2016-17, 2017-18 as well as under pooled data except at 60 DAT in 2016-17. Hand weeding reduced weed dry matter to the extent of 75.83 and 84.83 percent during 2016-17, 100 and 89.21 percent during 2017-18, 98.64 and 88.62 percent under pooled data at 30 and 60 DAT respectively, and the corresponding reduction in weed dry matter due to application of plastic mulch was 70.73 and 40.32 percent during 2016-17, 100 and 93.64 percent during 2017-18, 98.37 and 86.52 percent under pooled data at 30 and 60 DAT respectively, compared to weedy check. At 30 DAT weed control efficiency was maximum with application of oxyfluorfen 0.25 kg/ha PE and was similar to all weed control methods except cover crop during 2016-17,while hand weeding recorded maximum weed control efficiency at 60 DAT during 2016-17 and at 30 DAT during 2017-18 as well as in pooled and was similar to plastic mulch. Kalhapure et al. [6] have also reported three hand weeding at 20, 40 and 60 DAT reduced weed density significantly.

Growth, yield and economics: Maximum onion yield and net return was recorded with plastic mulch (Table 4). The increase in yield due to application of plastic mulch was to the extent of 300 and 38 percent during 2016-17, 1959 and 117 percent during 2017-18, 576 and 70 percent under pooled data compared to weedy check and hand weeding respectively. Pramanick et al. [7] have also reported plastic mulch recorded effective weed control and increased onion yield. The advantages of mulching are also reported by Smolikowski et al. [8] and Erenstein [9]. Plastic mulch also recorded maximum net return 364136, 380185 and 372160 ₹ per ha during 2016-17, 2017-18 and under pooled similar net return was recorded with application of oxyfluorfen 0.25 kg/ha PE, pendimethalin 1 kg/ha PE and hand weeding during 2016-17 while under pooled data maximum B:C ratio was with plastic mulch and was similar to oxyfluorfen 0.25 kg/ha PE, pendimethalin 1 kg/ha PE and hand weeding. Whereas, minimum net return and BC ratio was recorded in weedy check. Minz et al. [10] also reported similar finding.

4. CONCLUSION

Thus it can be concluded that for harvest of higher onion yield application of pendimethalin 1 kg/ha PE oroxyfluorfen 0.25 kg/ha PE or plastic mulch can be practiced for effective weed control and higher monetary return.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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