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Effect of pre-emergence herbicides on weed control of kharif onion (*Allium cepa* L.) in vindhyan plateau of Madhya Pradesh

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Abstract
An experiment was conducted to find out practically convenient and economically feasible weed management practice in onion at the Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P). The experiment comprised of ten treatments of pre-emergence herbicides with hand weeding and unweeded control. The experiment was laid out in randomized block design with three replications. Hand weeding treatment (three hand weeding at 25, 50, and 75 DAT) recorded significantly the lowest dry matter of weeds and the highest weed control efficiency. All the growth and yield attributes of onion *viz*., plant height (64.93 cm),leaves width (1.51 cm), no. of leaves (8.67), neck thickness (1.11 cm), fresh bulb weight (70 g),polar diameter (5.48 cm),equatorial diameter of bulb (6.34 cm) and bulb yield (545.75 q ha-1) were recorded maximum in hand weeding plots. The highest cost: benefit ratio was found with T_{10} (Oxyfluorfen 23.5% EC @ 1.25kg a.i. /ha (PE) (1:6.88) followed by T_9 (Oxyfluorfen 23.5% EC @ 1kg a.i./ha (PE) (1:6.78).

Keywords: Bulb yield, Herbicide, Onion, Pre emergence herbicide, weed control

Introduction
Onion belongs to the family Alliaceae is an important vegetable crop grown all over the world. Onion is regarded as a highly export oriented crop and earns a valuable foreign exchange for the country. India ranks second in area and production of onion in the world followed by China. In India major onion growing states are Maharashtra, Karnataka, Madhya Pradesh, Bihar and Gujarat. Onion is cultivated in an area of 1320130 hectare with a production of 20931250 MT and productivity 15.86 Tonnes/ha in India. In Madhya Pradesh, it is grown in about 118200 ha with a production of 2848000 MT and productivity 24.09 Tones/ha (N.H.R.D.F., 2015-16). Weeds are of great menace as they interfere with production of crop and add to the cost of cultivation. The reduction in crop yield has direct correlation with weed competition. Onion exhibits greater susceptibility to weed competition as compared to other crops due to its inherent characteristics such as their slow growth, small stature, shallow roots and lack of dense foliage. Generally, the bulb yield of onion reduced by 30-60% due to weed infestation. As weeds decrease the profitability of onion crop, therefore, weed must be controlled well in time. This situation makes it necessary to use herbicides for effective and timely control of weeds in this crop. Proper and timely weed control measures essential for good bulb development in onion. It is thus highly imperative to schedule suitable method of weed control by application of different herbicides for enhancing profits to onion growers of the country.

Materials and methods
The experiment was conducted at the Horticulture Research Farm, R.A.K College of Agriculture, Sehore (M.P) during kharif season of 2016-17. The soil in the study area belongs to a textural class of medium black and low in nitrogen relative to available phosphorus with a pH of 7.2 which is slightly alkaline.The experiment was laid out in randomized block Design with three replications and ten treatments (Table 1). The treatments included pre-emergence application of herbicides *viz.*
T_1- Weedy check
T_2- Hand weeding (at 25, 50, and 75 DAT)
T_3- Pendimethalin 30% EC 1 kg a.i./ha PE
T_4 Pendimethalin 30% EC 1.5 kg a.i./ha PE

T_5- Pendimethalin 30% EC 2 kg a.i./ha PE
T_6- Pendimethalin 30% EC 2.5 kg a.i./ha PE
T_7- Oxyfluorfen 23.5% EC 0.5 kg a.i./ha PE
T_8- Oxyfluorfen 23.5% EC 0.75 kg a.i./ha PE
T_9- Oxyfluorfen 23.5% EC 1 kg a.i./ha PE
T_{10}- Oxyfluorfen 23.5%EC 1.25 kg a.i./ha PE
Seven week old seedlings of onion (cv.Agrifound Dark Red) with a spacing of 15×10 cm were transplanted manually in 12th September of during the year of 2016. Observations were recorded on growth and yield parameters. The data so generated was statistically analysed.

Results and discussion

Effect on weeds: All treatments caused significant reduction in dry matter of weeds as compared to unweeded control (Table 1). Significantly lower dry matter of weeds and higher weed control efficiency were observed under hand weeding treatment followed by treatments Oxyfluorfen 23.5%EC 1.25 kg a.i./ha (PE) and Oxyfluorfen 23.5% EC 1 kg a.i./ha (PE). This is attributed to the effective control of weeds under these treatments, which reflected on less number of weeds and ultimately lower weed biomass. The Control plot (without hand weeding and chemical herbicides) recorded the highest dry matter of weeds and the lowest weed control efficiency, where is due to uncontrolled condition favoured luxurious weed growth leading to increased dry matter accumulation. These results are in line with those reported by chattopadhyay *et al.* (2016) [4]. Vishnu *et al.* (2015) [12], Kalhapure and Shete (2013) [6], Bharathi *et al.* (2011) [2], and Ushakumari *et al.* (2001) [10].

Effect on crop: All the weed management treatments were significantly superior over control in respect of all growth and yield attributes (Table 2 and 3) and bulb yield (Table 1).Significantly the highest growth attributes (*viz*., plant height, no. of leaves, neck thickness, bolters and yield attributes (bulb diameter and fresh bulb weight) and bulb yield were observed in hand weeding treatment. However, spray of Oxyfluorfen 23.5%EC 1.25 kg a.i./ha (PE) and Oxyfluorfen 23.5% EC 1 kg a.i./ha (PE) was at second place in respect of all these attributes. Whereas, significantly the lowest all growth & yield attributes and bulb yield were reported under Control plot (without hand weeding and chemical herbicides) followed by the under application of Pendimethalin 30% EC 1 kg a.i./ha (PE). It might be due to less weed crop competition throughout crop growth period by manual weeding, 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 conformity with those reported by Bharathi *et al.* (2011) [2], Kalhapure *et al.* (2013) [7]. Bhutia *et al.* (2005) [3], Vashi *et al.* (2011) [11], Gandolkar *et al.* (2015) [5] and Kumar *et al.* (2014) [8].

Economics: From the economic point of view**,** the highest cost of cultivation was recorded under hand weeding treatment (at 25, 50, 75DAT), with all the treatments. The highest gross income 408750₹/ha was obtained in treatment hand weeding (at 25, 50, 75DAT). Where highest net return was recorded in treatment Oxyfluorfen 23.5% EC @ 1.25 kg a.i./ha (PE) 343604 ₹/ha followed by hand weeding treatment (at 25, 50, 75DAT) which has net return ₹341381. The highest cost: benefit ratio was found with Oxyfluorfen 23.5% EC @ 1.25kg a.i./ha (PE) closely followed by Oxyfluorfen 23.5% EC @ 1kg a.i./ha (PE) and T_6 (Pendimethalin 30% EC @ 2.5kg a.i./ha (PE). This is attributed to lower cost of cultivation in these treatments compared to other treatments. The lowest cost: benefit ratio was found with control plot (without hand weeding and use of chemical herbicides) over rest of the treatments due to lower bulb yield. Looking to the economics results, chemical weed control in onion is significantly effective and beneficial. Similar findings were also reported by chattopadhyay *et al.* (2016) [4], Vishnu *et al.* (2015) [12] and Saini and Walia (2012) [9].

Table 1: Effect of different weed management treatments on dry matter of weeds, weed control efficiency, bulb yield and economics

Treatment	Dry matter of weeds (g/0.25m^2)	WCE (%)	Bulb Yield (q)	Gross return	Net Return (ha-1)	B:C ratio
T_1=Control plot (without hand weeding and chemical herbicides)	86.67	0.00	306.82	229500	180137	1:4.64
T_2=Three hand weeding at 25, 50 and 75 DAT	6.00	100	545.75	408750	341381	1:6.06
T_3=Pendimethalin 30% EC 1 kg a.i./ha (PE)	70.67	17.08	366.77	274500	223899	1:5.42
T_4=Pendimethalin 30% EC 1.5 kg a.i./ha (PE)	54.33	27.12	409.97	306750	255531	1:5.98
T_5=Pendimethalin 30% EC 2 kg a.i./ha (PE)	51.67	30.84	462.87	346500	294667	1:6.68
T_6=Pendimethalin 30% EC 2.5 kg a.i./ha (PE)	50.00	49.07	472.57	354000	301549	1:6.74
T_7=Oxyfluorfen 23.5% EC 0.5 kg a.i./ha (PE)	38.33	34.19	470.81	352500	299527	1:6.65
T_8=Oxyfluorfen 23.5% EC 0.75 kg a.i./ha (PE)	36.33	42.38	484.03	363000	308208	1:6.62
T_9=Oxyfluorfen 23.5% EC 1 kg a.i./ha (PE)	32.00	50.92	512.25	384000	327406	1:6.78
T_{10}=Oxyfluorfen 23.5%EC 1.25 kg a.i./ha (PE)	28.67	57.61	536.05	402000	343604	1:6.88
SEm±	2.47	0.00	21.80	-	-	-
C.D. at 5% level	7.34	100	64.77	-		-

Table 2: Efficiency of different weed management treatments on growth parameters of onion at harvest

Treatment	Plant height (cm)	No. of leaves per plant	Neck thickness (cm)	Yield of unmarketable bulbs/ha (q)	Yield of marketable bulbs/ha (q)
T_1=Control plot (without hand weeding and chemical herbicides)	59.93	7.20	0.92	17.48	289.34
T_2=Three hand weeding at 25, 50 and 75 DAT	64.93	8.67	1.11	10.83	534.91
T_3=Pendimethalin 30% EC 1 kg a.i./ha (PE)	62.27	7.33	0.97	13.17	353.60
T_4=Pendimethalin 30% EC 1.5 kg a.i./ha (PE)	62.40	7.40	0.98	12.33	397.97
T_5=Pendimethalin 30% EC 2 kg a.i./ha (PE)	62.53	7.93	0.99	12.00	451.21
T_6=Pendimethalin 30% EC 2.5 kg a.i./ha (PE)	62.73	8.33	1.05	11.67	460.24

T_7=Oxyfluorfen 23.5% EC 0.5 kg a.i./ha (PE)	61.47	7.93	1.00	11.92	458.89
T_8=Oxyfluorfen 23.5% EC 0.75 kg a.i./ha (PE)	62.13	8.20	1.01	11.83	472.20
T_9=Oxyfluorfen 23.5% EC 1 kg a.i./ha (PE)	62.20	8.23	1.07	11.67	500.58
T_{10}=Oxyfluorfen 23.5%EC 1.25 kg a.i./ha (PE)	62.87	8.27	1.09	11.33	524.72
SEm±	0.61	0.30	0.03	0.39	21.69
C.D. at 5% level	1.81	0.89	0.11	1.16	64.44

Table 3: Growth parameters and yield attributes as influenced by different weed management treatments in onion.

Treatment	**No. of Bolting /plot**	**Bolting (%)**	**Equatorial diameter of bulb (cm)**	**Polar diameter of bulb(cm)**	**weight of bulb /plant (g)**	**weight of bulbs /plot (kg)**
T_1=Control plot (without hand weeding and chemical herbicides)	22.67	8.97	5.31	4.83	59.20	11.60
T_2=Three hand weeding at 25, 50 and 75 DAT	14.33	5.67	6.34	5.48	96.53	20.63
T_3=Pendimethalin 30% EC 1 kg a.i./ha (PE)	21.00	8.31	5.51	4.86	71.47	13.87
T_4=Pendimethalin 30% EC 1.5 kg a.i./ha (PE)	20.00	7.92	5.71	4.96	72.47	15.50
T_5=Pendimethalin 30% EC 2 kg a.i./ha (PE)	18.67	7.39	5.80	4.99	78.40	17.50
T_6=Pendimethalin 30% EC 2.5 kg a.i./ha (PE)	15.67	6.20	6.27	5.17	96.53	17.87
T_7=Oxyfluorfen 23.5% EC 0.5 kg a.i./ha (PE)	19.00	7.52	5.99	4.86	77.87	17.80
T_8=Oxyfluorfen 23.5% EC 0.75 kg a.i./ha (PE)	18.67	7.39	6.02	5.21	89.07	18.30
T_9=Oxyfluorfen 23.5% EC 1 kg a.i./ha (PE)	18.33	7.26	6.31	5.27	92.80	19.37
T_{10}=Oxyfluorfen 23.5%EC 1.25 kg a.i./ha (PE)	13.67	5.42	6.33	5.28	96.00	20.27
SEm±	1.81	0.69	0.20	0.11	5.96	0.82
C.D. at 5% level	5.40	2.05	0.58	0.33	17.71	2.45

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