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Integrated weed management practices in onion under agro climatic condition of Chhattisgarh plains

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Abstract
The experiment was conducted at College of Agriculture and Research Station, Janjgir-Champa, IGKV, Raipur (C.G.) during *rabi* season 2016-17 and 2017-18 to find out the effect of integrated weed management practices on growth and yield of onion, weed dynamics and economics. The 14 treatments comprised of pendimethalin @ 1.5 kg ha^{-1} as PE, pendimethalin @ 1.5 kg ha^{-1} as PE fb one hand weeding at 45 DAT, pendimethalin @ 1.5 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT, oxyfluorfen @ 0.25 kg ha^{-1} as PE, oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT, oxyfluorfen @ 0.25 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 g ha^{-1} as PoE at 45 DAT, oxadiargyl @ 0.080 kg ha^{-1} as PE, oxadiargyl @ 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT, oxadiargyl @ 0.080 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT, propaquizafop 5% + oxyfluorfen 12% @ 0.15 kg ha^{-1} PE, pendimethalin @ 1.0 kg ha^{-1} PE fb propaquizafop 0.05 kg ha^{-1} PoE at 45 DAT, oxadiargyl @ 0.070 kg ha^{-1} PE fb propaquizafop 0.05 kg ha^{-1} PoE at 45 DAT, Two hand weeding at 20 and 50 DAT and weedy check. The experiment was laid out in randomized block design with three replications. Onion variety "Agrifound Light Red" was grown as a test crop.
In the experimental field weeds, such as *Parthenium hysterophorus, Physalis minima, Chenopodium album, Cyperus rotundus, Cynodon dactylon, Melilotus indica and Medicago denticulata* were the predominant weeds. At initial period of crop growth, broad leaf weeds contributed more as compared to grasses and sedges. The weed density and biomass of weeds were found minimum under two hand weeding at 20 and 50 DAT. Whereas, weed control efficiency was found maximum under two hand weeding at 20 and 50 DAT. All the herbicides treatments improved crop growth viz. plant height, Number of leaves, dry weight of leaves, leaf area index, fresh weight of bulb and minimum weed index, economics and reduced weed density and their weed biomass as compared to weedy check. Significantly highest bulb yield of onion (322.17 q ha^{-1}) was noted under hand weeding twice at 20 and 50 DAT, however, it was statistically followed by oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT (291.95 q ha^{-1}), pendimethalin @ 1.5 kg ha^{-1}as PE fb one hand weeding at 45 DAT (288.77 q ha^{-1}) and oxadiargyl 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT (285.66 q ha^{-1}). Hand weeding twice at 20 and 50 DAT gave maximum gross return (Rs.281500.00 ha^{-1}) and B:C (2.93), whereas, net return (Rs.185465.00 ha^{-1}) and benefit cost ratio (3.07) was highest under oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT. All these economic parameters were found minimum under weedy check.

Keywords: Onion, growth, bulb yield, pre and post herbicides

Introduction
Onion (*Allium cepa* L.) is one of the most important vegetable crops grown throughout the world. According to Vavilov (1951), the primary center of origin lies in Central Asia. The near east and Mediterranean are the secondary centre of origin. Globally it is considered to be the second most important vegetable after tomatoes. Therefore, onion is popularly referred as 'Queen of the kitchen.
It is an indispensible item in every kitchen as vegetable. Onion bulb and green leaves both are rich in minerals, protein and ascorbic acid. The pungency in onion odour is formed by enzymatic reaction only when tissues are damaged. The pungency in onion is due to volatile oil as allyl-propyl disulphide. The colour of the outer skin of onion bulbs is due to quercetin.
The major onion producing countries are China, India, USA, Turkey, Japan, Iran, Pakistan, Spain and Brazil. India is the second largest producer of onion in the world and occupies 12.85 lakh hectares area under the cultivation with a production of 232.62 lakh tonnes and productivity of 18.10 t ha^{-1}. Maharashtra is leading state in area and production but in productivity Gujarat is the leading state followed by Haryana, Andhra Pradesh and Madhya Pradesh (*Anonymous*, 2018) [1].

Onion is short duration, shallow rooted bulb vegetable crop commonly cultivated throughout the India and it is more prone to weed menace and usually infested by wide spectrum of broad leaf and grassy weeds. Weeds are undesirable plants which compete with crop for available space, nutrients and water and thereby cause considerable losses in crop yield. The weeds infestation is problematic especially at early stage of crop growth. The problem of weeds in onion is aggravated due its initial slow growth, shallow root system, heavy nutrients and farm yard manure application and frequent irrigations. Weeds compete with the crop for water, soil nutrient competitive ability with its initial slow growth and lack of adequate foliage makes onions weak against weeds (Wicks *et al*., 1973). In addition, their cylindrical upright leaves do not shade the soil to block weed growth.

Weed infestation is the one of the limiting factors in quality bulb production in onion. Weed competition reduced the bulb yield of onion to the extent of 2.35 – 61.8 per cent depending upon the duration of crop weed competition and intensity (Sankar *et al* 2011) [11]. Removal of weeds through hand weeding method is laborious, costly and time consuming. This situation makes it necessary to use herbicides for effective and timely management of weeds in this crop. Proper and timely weed control measures are essential for good bulb development in onion. It is thus highly imperative to schedule suitable method of weed management by application of different herbicides for enhancing profits to onion growers of the country. It is essential to evaluate the effects of herbicides in weed control in onion that can have positive effects on development of onion crop.

Materials and Methods

The experiment carried out during the year 2016-17 and 2017-18 in *rabi* season at College of Agriculture and Research Station, Farm, Janjgir-Champa, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Jangir is situated in central parts of Chhattisgarh and lies at latitude, longitude and altitude of 22º1′ N, 82º39′ E and 253 meter above mean sea level, respectively. The region fall under the Eastern Plateau and Hill Region Agro-Climatic Zone-7 of India. The experiment consists of 14 treatments viz. T_1: pendimethalin @1.5 kg ha^{-1} as PE, T_2 : pendimethalin @1.5 kg ha^{-1}as PE fb one hand weeding at 45 DAT, T_3 : pendimethalin @ 1.5 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT, T_4 : oxyfluorfen @ 0.25 kg ha^{-1} as PE, T_5 : oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT, T_6 : oxyfluorfen @ 0.25 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT, T_7 : oxadiargyl 0.080 kg ha^{-1} as PE, T_8 : oxadiargyl @ 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT, T_9 : oxadiargyl @ 0.080 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT, T_{10} : propaquizafop 5% + oxyfluorfen 12% @ 0.15 kg ha^{-1}PE, T_{11} : pendimethalin @ 1.0 kg ha^{-1} PE fb propaquizafop 0.05 kg ha^{-1} PoE at 45 DAT, T_{12} : oxadiargyl @ 0.070 kg ha^{-1}PE fb propaquizafop 0.05 kg ha^{-1} PoE at 45 DAT, T_{13} : Two hand weeding at 20 and 50 DAT and T_{14} : Weedy check. The experiment was laid out in Randomized Block Design with three replications. Onion variety "Agrifound Light Red" was grown as a test crop. Onion was transplanted 1st December 2016 and 2nd 2017 with spacing 15x10 cm. The crop was fertilized with 75, 60 and 100, N_2, P_2O_5 and K_2O kg ha^{-1}, respectively. Whole quantity of phosphorus and potash were applied as basal before transplanting and nitrogen in two equal splits 50% as basal and 50% as top dressing 3o days after transplanting. The pre-emergence herbicides were sprayed within 48 hours after transplanting of seedlings by knapsack sprayer using flat fan nozzle with 600 liter of water and post harvest emergence as per treatments were applied at 45 DAT. Other packages of practices were followed as per recommendations made for the onion crop. Growth, yield and quality parameters were recorded from each plot by randomly selected five plants and same were used for analyzing purpose.

Result and Discussion

Effect on growth, Yield and economics parameters

The data presented on growth parameters in onion (Table.1) revealed significant variations among the treatments. Significantly highest pooled plant height was recorded in two hand weeding at 20 and 50 DAT (58.36 cm) followed by oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT (56.83 cm), pendimethalin @1.5 kg ha^{-1}as PE fb one hand weeding at 45 DAT (56.55 cm) and oxadiargyl 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT (55.97 cm). Significantly shortest pooled plant height of (42.88 cm) was observed in weedy check plots. Similar trend was also recorded in pooled number of leaves plant^{-1} significantly maximum in two hand weeding at 20 and 50 DAT (7.38) followed by T_2 (7.38), T_5 (6.88) and T_8 (7.20). However, minimum Number of leaves plant^{-1} observed in weedy check (4.85). Significant variation was observed in pooled dry weight of leaves and leaf area index maximum in two hand weeding at 20 and 50 DAT (14.21 q ha^{-1}) and (3.41) which were significantly at par with oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT, pendimethalin @ 1.5 kg ha^{-1}as PE fb one hand weeding at 45 DAT and oxadiargyl 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT. Lowest pooled leaf area index (1.18) and dry weight of leaves (5.45 q ha^{-1}) were recorded in weedy check.

Data presented in (Table 2 and 3) revealed that maximum pooled fresh weight of bulb was obtained in T_{13} (77g) closely followed by T_2 (75g), T_5 (74g) and T_8 (73.67g).Significantly maximum bulb equatorial and polar diameter obtained in T_{13} (6.66 and 5.23 cm) followed by T_5 (6.32 and 4.68 cm), T_2 (6.30 and 4.64 cm) and T_8 (6.26 and 4.60 cm). Which were significantly at par with each other However, minimum fresh weight of bulb equatorial and polar diameter of bulbs recorded in weedy check (30.16g, 3.65 and 3.25cm). Significantly highest total bulb yield was recorded in T_{13} (322.17 q ha^{-1}) followed by T_5 (291.95q ha^{-1}), T_2 (288.77q ha^{-1}), and T_8 (285.66 q ha^{-1}) than the rest of treatments.. 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 favorable effect on crop growth parameter and yield attributes. The results clearly indicated the effect of weed management in onion. Similar results were reported by Yumnam *et al.* (2009) [17], Baraathi *et al.* (2011) Tripathy *et al*. (2013) [13] and Sahoo *et al.* (2017) [10].

However, significantly lowest pooled total bulbs yield 101.35 q ha^{-1}was recorded in weedy check as the presences of more weed which interfered with growth and development of the crop and compete for the nutrients, moisture, light and space. The similar results were reported by Vashi *et al.* (2011) [14], Patel *et al*. (2012) [6] and Thakare *et al*. (2018) [12]

The results on BC ratio (Table 3) showed variability among different weed management application onion the pooled BC ratio obtained in weed management practice over control indicated maximum BC ratio of 3.07 in T_5 followed by 3.06

in T_8 and minimum 0.85 in T_{14}. Similar results were also reported by Chopra and Chopra (2007) [4], Kalpapure and Shete (2012) and Sahoo *et al*. 2017 [10].

Effect on weeds: The experimental field was infested with mixed flora of dicot and monocot weeds, such as *Parthenium hysterophorus, Physalis minima, Chenopodium album, Cyperus rotundus, Cynodon dactylon, Melilotus indica and Medicago denticulata* were the predominant weeds. At initial period of crop growth, broad leaf weeds contributed more as compared to grasses and sedges. All treatments caused significant reduction in weed biomass as compared to weedy check. (Table.3) Significantly lower weed biomass and maximum weed control efficiency were registered in two hand weeding at 20 and 50 DAT followed by oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT, pendimethalin @ 1.5 kg ha^{-1} as PE fb one hand weeding at 45 DAT and oxadiargyl 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT. These results might be due to owing to less weed density and production of biomass by weeds in the treated plots. 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 weedy check recorded the highest weed biomass of weeds and the lowest weed control efficiency, where is due to uncontrolled condition favored luxurious weed growth leading to increased weed biomass accumulation. The finding was in conformity with those reported by Channappagour and Biradar (2017) [3], Barathi *et al*. (2011) and Vishnu *et al*. (2015) [15].

Data on weed index as in Table.3 showed the least yield reduction in treatment with application of oxyfluorfen @ 0.25 kg ha^{-1} as PE fb one hand weeding at 45 DAT (9.38%) followed by pendimethalin @ 1.5 kg ha^{-1} as PE fb one hand weeding at 45 DAT (10.36%), oxadiargyl 0.080 kg ha^{-1} as PE fb one hand weeding at 45 DAT (11.33%) and pendimethalin @ 1.5 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT (16.69%). However, maximum weed index was registered in weedy check (68.16%) due to presence of weeds throughout crop growth period. Lower is the weed index in chemical treatments better the efficiency of that herbicide in controlling weeds, which provided favorable conditions for the crop growth which ultimately increased the bulb yield of onion as compared to weedy check. This result corroborate with finding of Sable *et al*. (2015) [8] and Thakare *et al*. (2020) [12].

These may be due to the reason that application of initial pendimethelin, oxyflorfen and oxadiargyl control the germination of weed seeds satisfactorily. In integrated weed management practices at 45 DAT control the weed flora completely. There was less competition from weeds was observed with the crop among the integration of herbicides. Among the combined application of herbicide, pendimethalin @ 1.50 kg ha^{-1}PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT and oxyfluorfen @ 0.25 kg ha^{-1} as PE fb fenoxaprop-p-ethyl 0.080 kg ha^{-1} as PoE at 45 DAT gave satisfactory results in comparison with other combined applications.

Pre and post application of herbicides was found to be more effective than sole application which confirms integrated weed management as better alternative herbicides for suppressing the different weed flora integration of hand weeding. The result may be attributed to higher persistence of the herbicides in the soil there by suppressing the weed flora for longer duration resulting in less crop weed competition and for this reason higher bulb yield was obtained. Hence the treatment recorded highest bulb yield than other treatments

Table 1: Effect of weed management on growth parameters in onion

Treatments	Plant height (cm)			No. of leaves			Dry weight of leaves (q ha^{-1})			Leaf area index		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	47.77	47.43	47.60	6.30	5.93	6.11	10.80	10.77	10.78	3.03	3.07	3.05
T_2	57.00	56.10	56.55	7.43	6.93	7.18	13.63	13.60	13.61	3.33	3.40	3.36
T_3	49.17	48.43	48.80	7.23	6.13	6.68	12.43	12.57	12.50	3.20	3.10	3.15
T_4	47.50	47.67	47.58	6.47	6.00	6.23	10.63	10.80	10.71	3.07	3.00	3.03
T_5	57.33	56.33	56.83	6.80	6.97	6.88	13.47	13.50	13.48	3.37	3.40	3.38
T_6	49.47	49.67	49.57	6.17	6.12	6.14	11.97	12.33	12.15	3.20	3.13	3.16
T_7	47.67	47.83	47.75	6.37	6.33	6.35	10.83	10.40	10.61	3.03	3.00	3.01
T_8	56.37	55.57	55.97	7.50	6.90	7.20	13.97	13.53	13.75	3.33	3.37	3.35
T_9	49.73	48.40	49.06	6.57	5.97	6.27	11.17	10.97	11.07	3.12	3.13	3.13
T_{10}	48.27	47.33	47.80	6.40	6.17	6.28	10.80	10.33	10.56	3.10	3.07	3.08
T_{11}	48.23	48.70	48.46	6.97	5.63	6.30	11.63	11.40	11.51	3.10	3.13	3.11
T_{12}	48.10	49.50	48.80	6.67	5.70	6.18	11.50	11.80	11.65	3.11	3.12	3.12
T_{13}	58.33	58.40	58.36	7.63	7.13	7.38	13.90	14.53	14.21	3.40	3.43	3.41
T_{14}	42.53	43.23	42.88	5.17	4.53	4.85	5.53	5.37	5.45	1.20	1.17	1.18
SEM-+	0.70	0.95	0.82	0.26	0.27	0.26	0.28	0.33	0.30	0.03	0.04	0.03
CD 5%	2.02	2.77	2.39	0.75	0.79	0.77	0.82	0.96	0.89	0.08	0.11	0.09

PE-Pre emergence, PoE- Post emergence, DAT-Days after transplanting, HW- hand weeding, fb-followed by

Table 2: Effect of weed management on fresh weight, bulb yield, Equatorial diameter and Polar diameter parameters in onion

Treatments	Fresh weight of bulb (g)			Bulb yield (q ha^{-1})			Equatorial diameter (cm)			Polar diameter (cm)		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	56.00	54.00	55.00	213.67	218.56	216.11	5.23	5.33	5.28	3.38	3.50	3.44
T_2	74.00	75.00	74.50	289.33	288.22	288.77	6.33	6.27	6.30	4.60	4.68	4.64
T_3	59.00	58.67	58.83	264.33	274.67	269.50	5.50	5.63	5.57	4.26	4.13	4.19
T_4	53.67	54.33	54.00	212.33	213.67	213.00	5.23	5.30	5.26	3.33	3.53	3.43
T_5	76.00	74.00	75.00	291.67	292.23	291.95	6.35	6.30	6.32	4.63	4.73	4.68
T_6	56.33	57.67	57.00	269.33	267.44	268.38	5.53	5.37	5.45	4.10	4.20	4.15
T_7	54.00	53.67	53.83	209.33	207.67	208.50	5.23	5.20	5.21	3.30	3.40	3.35

T_8	73.67	73.67	73.67	288.33	283.00	285.66	6.20	6.33	6.26	4.50	4.70	4.60
T_9	57.67	55.33	56.50	265.33	266.33	265.83	5.47	5.38	5.43	3.77	3.87	3.82
T_{10}	56.67	54.33	55.50	213.67	214.33	214.00	5.37	5.30	5.34	3.63	3.77	3.70
T_{11}	57.00	56.33	56.66	265.67	266.56	266.11	5.43	5.40	5.42	4.23	4.03	4.13
T_{12}	55.33	56.67	56.00	257.44	257.34	257.39	5.40	5.43	5.41	3.60	3.63	3.61
T_{13}	76.67	77.33	77.00	322.67	321.67	322.17	6.60	6.73	6.66	4.97	5.50	5.23
T_{14}	30.33	30.00	30.16	62.11	60.67	61.39	3.57	3.73	3.65	3.20	3.30	3.25
SEM-+	1.27	1.36	1.31	1.56	0.84	1.20	0.19	0.15	0.17	0.17	0.30	0.23
CD 5%	3.68	3.94	3.81	4.52	2.45	3.48	0.54	0.42	0.48	0.49	0.87	0.68

PE-Pre emergence, PoE- Post emergence, DAT-Days after transplanting, HW- hand weeding, fb-followed by

Table 3: Effect of weed management on, dry weight of weed, weed index, Weed control efficiency and economics parameters in onion

Treatments	Dry weight of weeds (kg ha^{1})			Weed index (%)			Weed control efficiency (%)			Net return			B:C Ratio		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T_1	525.67	527.00	526.00	33.78	32.05	32.92	54.94	54.17	54.56	93082	96798	94940.00	2.24	2.28	2.26
T_2	120.38	123.33	121.86	10.33	10.39	10.36	89.68	89.28	89.48	168982	162408	165695.00	2.95	2.85	2.90
T_3	286.67	288.67	287.67	18.08	14.61	16.35	75.43	74.90	75.17	144638	143214	143926.00	2.91	2.87	2.89
T_4	513.33	509.67	511.50	34.19	33.57	33.88	56.00	55.68	55.84	98852	101498	100175.00	2.34	2.37	2.36
T_5	120.67	119.33	120.00	9.60	9.15	9.38	89.66	89.62	89.64	178082	177798	177940.00	3.08	3.06	3.07
T_6	285.67	282.00	283.84	16.53	16.85	16.69	75.51	75.48	75.50	148608	138332	143470.00	2.99	2.84	2.92
T_7	523.67	522.67	523.17	35.12	35.44	35.28	55.11	54.55	54.83	93002	97782	95392.00	2.88	2.83	2.86
T_8	120.33	125.67	123.00	10.64	12.02	11.33	89.69	89.07	89.38	176342	172182	174262.00	3.10	3.03	3.06
T_9	418.67	415.33	417.00	17.77	17.20	17.49	64.11	63.88	64.00	147758	144288	146023.00	3.00	2.94	2.97
T_{10}	515.00	511.67	513.34	33.78	33.37	33.58	55.85	55.51	55.68	102574	98808	100691.00	2.41	2.34	2.38
T_{11}	422.33	427.00	424.67	17.66	17.13	17.40	63.80	62.87	63.34	146592	142510	144551.00	2.94	2.87	2.91
T_{12}	416.67	413.00	414.84	20.21	19.20	19.70	64.28	64.09	64.18	135512	135824	135668.00	2.85	2.83	2.84
T_{13}	50.67	49.67	50.17	0	0	0	95.66	95.68	95.67	185002	185928	185465.00	2.93	2.92	2.93
T_{14}	1166.6	1150.0	1158.3	67.83	68.49	68.16	0	0	0	-9578	-11652	-10615.00	0.86	0.83	0.85
SEM-+	0.04	0.06	0.05	-	-	-	-	-	-	-	-	-	-	-	-
CD 5%	0.12	0.20	0.16	-	-	--				-	-	--	-	-	-

PE-Pre emergence, PoE- Post emergence, DAT-Days after transplanting, HW- hand weeding, fb-followed by

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