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Effect of different weed management practices on onion (*Allium cepa* L.)

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Abstract
The field experiment was conducted during Rabi season of 2016-17 at the Horticulture Research cum Instructional farm, BTC CARS, Bilaspur (C.G.). The treatments consisted of ten combination of different agro input management practices viz., T1 (control weedy check),T2 (weed free),T3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)),T4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)), T5 (Quizalofop-ethyl @1 kg/ha (Post-emergence)), T6 (Pendimethalin @ 1.750 kg/ha (Pre emergence) + Quizalofop-ethyl @ 1 kg/ha (Post-emergence)), T7 (Oxyfluorfen @ 1 kg/ha (Pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (Postemergence)), T8 (Two hand weeding at 25 and 45 DAT), T9 (Black polythene mulch), T10 (Organic mulch with paddy straw @ 20 q/ha). The weed population weed fresh weight and weed dry matter, varied significantly with all the stages of crop. It showed increasing trend with lowest at 20 DAT and highest at 60 DAT. Conidering the weed control strategies significantly lower weed population. Weed fresh weight, weed dry matter, weed index and relatively higher weed control efficiency were recorded in weed free plot (T2) then rest of all the treatments and in herbicidal treatments T7 (Oxyfluorfen @ 1 kg/ha (Pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (Postemergence)), was attribute to the effective control of weeds and in terms of alone apploication of herbicide Oxyfluorfen @ 1 kg/ha (pre-emergence) control weed effectively than other treatments.

Keywords: Pendimethalin, oxyfluorfen, quizalofop-ethyl, and onion

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops grown all over the world. It is native of Central Asia and Mediterranean region. It belongs to family Alliaceae and the plant is either biennial or perennial. Its semi-cylindrical leaves emerge from a subterranean bulb, which bears fascicled, short and scarcely branched roots. The stem is erect and an umbel-like inflorescence composed of white or greenish-white small flowers grow at the tip of the stem. The fruit is capsule, which contain black flat seeds. The edible bulb is composed of several overlapping layers on a central core. Onion possess as culinary, dietary and medicinal importance in daily life of people in the whole world, it is also a major vegetable crop to gain foreign currency.

It becomes a major cash crop with higher market demand and price. It is popularly known as "Queen of kitchen" because of its characteristic flavour and taste of food. Onion is a condiment crop, which is consumed fresh in salads or added in cooking dishes as a spice. Apart from furnishing nutrition, onion also provides relishing flavours to our diets. Recent research has suggested that onion in the diet may play a part in preventing heart diseases and other aliments (Sangha and Baring, 2003).

In Chhattisgarh, it is being grown on an area of 20.06 ('000 ha) with a production of 308.10 ('000) mt and the productivity is 15.36 ton/ha (NHRDF, Nashik). The maximum cultivated area and production of onion is Mahasamund followed by Durg, Kanker, and Raipur district (Anon, 2013) [2]. Onion is very rich in various nutrients and vitamins like vitamin „A" thiamine, riboflavin, niacin and ascorbic acid and rest are the carbohydrates which make up the dry matter of the bulb. Under such circumstances application of herbicides offer a suitable method for weed control by producing maximum sized bulbs and higher yield.

The conventional method of weed control (hoeing and manual weeding) is very labourious, expensive and insufficient Weed infestation is the important constraint in onion production, which causes reduction in bulb and seed yield to the tune of 40 to 80% (Channapagoudar and Biradar, 2007). Onion is slow growing, shallow rooted crop with narrow upright leaves and non-branching habit. Due to this type of growing habit, it cannot compete well with weeds. In addition to this, frequent irrigation and fertilizer application allows for successive flushes of

weeds in onion.

Material and methods

1. Weed population at 20, 40, and 60 DAT

Weeds density in the experimental plots was recorded at three times *i.e*. 20, 40 and 60 DAT. Species wise weed count was made by four quadrates of 0.25 m2 in each plot randomly.

2. Weed fresh weight at 20, 40 and 60 DAT

Weeds fresh weight in the experimental plots was collected at three times *i.e*. 20, 40 and 60 DAT. Fresh weed sample was collected by four quadrates of 0.25 m2 in each plot randomly.

3. Weed dry matter at 20, 40 and 60 DAT

For dry weight matter of weeds, the fresh weed sample collected at 20, 40 and 60 DAT. The weeds were kept for drying in oven at 50oC for 48 hours. After complete drying, the dry matter production of weeds was recorded for different treatments.

4. Weed control efficiency (WCE)

The weed control efficiency was calculated on the basis of reduction in dry matter production in treated plot in comparison with the control plot and expressed in percentage.
WEC%: DWC-DWT/DWC×100

5. Weed index (%)

It is a measure of the efficacy of a particular treatment when compared with a weed free treatment. It is expressed as percentage of yield potential under weed free. Higher weed index means greater loss due to weeds. Weed index was calculated by the formula outlined by Gill and Vijaya Kumar (1969).

Weed index = X-Y/X×100

Results and discussion

1. Weed population at 20, 40, and 60 DAT

The data presented in table 1 show the effect of various herbicidal treatments on weed density at 20 days after transplanting.

At 20 DAT the weed population ranged from (4.04 to 9.21), the weed density at 20 days after transplanting was found to be significantly affected by different weed management treatments. The lowest weed population (4.04/m^2) was recorded under T_2 (Weed free), it was significantly lowest weed population than all the other treatments. Among the treatments T_6 (Pendimethalin @ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (6.81/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (6.75/m²), T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (6.49/m²), T_9 (Black polythene mulch) (6.39/m²) and T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (6.38/m²), were significantly at par to each other and the lower weed population than rest of the treatments. Treatment T_{10} (Organic mulch with paddy straw @ 20 q/ha) (8.29/m²) and T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (9.16/m²), were recorded lower weed population over T_8 (Two hand weeding at 25 and 45 DAT) (9.21/m²), and T_1 (Control weedy check plot) (9.21/m^2). Treatment T_1, T_8 and treatment T_{10} recorded the maximum weed population.

Table 1: Effect of different weed management practices on weed population (Number of weed/m²) of onion at 20, 40 and 60 DAT*

Treatment	Treatment detail	Weed population (Number of weed/m²)		
		20 DAT	40 DAT	60 DAT
T_1	Control (weedy check)	9.21 (84.84)	19.50 (380.22)	29.82 (889.07)
T_2	Weed free	4.04 (16.40)	3.51 (12.53)	3.78 (14.53)
T_3	Pendimethalin @ 1.75 kg/ha (pre-emergence)	6.75 (45.64)	8.22 (67.62)	14.11 (199.29)
T_4	Oxyfluorfen @ 1 kg/ha (pre-emergence)	6.38 (40.80)	8.07 (65.21)	14.06 (197.60)
T_5	Quizalofop-ethyl @ 1 kg/ha (post-emergence)	9.16 (83.90)	7.98 (63.73)	13.46 (181.28)
T_6	Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	6.81 (46.40)	7.66 (58.67)	13.33 (177.60)
T_7	Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	6.49 (42.27)	6.80 (46.40)	13.11 (171.95)
T_8	Two hand weeding at 25 and 45 DAT	9.21 (84.93)	4.79 (23.04)	9.74 (95.00)
T_9	Black polythene mulch	6.39 (40.81)	9.31 (86.80)	10.67 (113.80)
T_{10}	Organic mulch with paddy straw @ 20 q/ha	8.29 (68.80)	13.35 (178.44)	14.82 (219.68)
	SEm±	0.17	0.20	0.16
	CD (P=0.05)	0.49	0.59	0.49

*DAT= Days after transplanting **The data in the parentheses have been subjected to square root transformation

At 40 DAT the weed population ranged from (3.51/m² to 19.50/m²), the weed population at 40 days after transplanting was recorded to be significantly affected by different weed management treatments. The lowest weed population (3.51/m^2) was found under T_2 (Weed free), it was significantly lowest weed population than all the treatment. Treatment (T_8) Two hand weeding at 25 and 45 DAT (4.79/m²) and (T_7) Oxyfluorfen @ 1 kg /ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence) (6.80/m²), were reported lower weed population. Treatment Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence) (T_6) (7.66/m²), Quizalofop-ethyl @1 kg/ha (post-emergence) (T_5) (7.98/m²), Oxyfluorfen @ 1 kg/ha (pre-emergence) (T_4) (8.07/m²) and Pendimethalin @ 1.75 kg/ha (pre-emergence) (T_3) (8.22/m²), were significantly at par with each other. Treatment Black polythene mulch (T_9) (9.31/m²), Organic mulch with paddy straw @ 20 q/ha (T_{10}) (13.35/m²), also produced lower weed population than the weedy check plot (T_1) in which weed population was recorded (19.50/m^2).

The different weed management treatments marked significant effect on weed population recorded at 60 DAT, the ranged from (3.78/m² to 29.82 /m²), Further, among the different treatments, significantly less weed population (3.78/m^2) was observed under weed free (T_2) than all other treatments, followed by treatment T_8 (two hand weeding at 25 and 45 DAT) (9.74/m²) and T_9 (Black polythene mulch) (10.67/m²) which produced lower weed population. Treatment T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-

ethyl @ 1 kg/ha (post-emergence)) (13.11/m²), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (13.33/m²) and T_5 (Quizalofop-ethyl @1 kg/ha (post-emergence)) (13.46/m²) were at par with each other and lower weed population than rest of the treatments. Treatment T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (14.06/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (14.11/m²), were also significantly at par to each other and the treatment T_{10} (Organic mulch with paddy straw @ 20 q/ha) (14.82/m²), was recorded lower weed population than the Weedy check plot (T_1) (29.82/m²).

All the weed management practices caused significant reduction in weed population compared with the weedy check. However, magnitude of reduction in population varied depending on the control measures adopted. The periodical weed density varied at different stages of the crop. Lowest weed population recorded in weed free (T_2) at 20 DAT (4.04/m^2), 40 DAT (3.51/m^2) and 60 DAT (3.78/m^2), population of weeds was more as compared to one stage to the other stages. Though, the herbicide treated plots has low population of weed due to mortality of weeds by herbicides, than T_1 control weedy check. The findings were in conformity with those reported by Ramalingam *et al.* (2013) [12], Sharma and Khandwe (2008) [13], Marwat *et al.* (2005) [10].

2. Weed fresh weight at 20, 40 and 60 DAT

Table 2 reveals that different weed management practices showed significant effect on total dry matter of weeds.

At 20 DAT the weed fresh weight ranged from (1.98 g/m² to 4.84 g/m²), the weed fresh weight at 20 days after transplanting was found to be significantly affected by different weed management treatments. T_2 (Weed free) treatment was produced significantly lower fresh weight (1.98 g/m²). Among the treatment T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (3.67 g/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (3.66 g/m²), T_7 (Oxyfluorfen @ 1 kg /ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (3.60 g/m²), T_9 (Black polythene mulch) (3.40 g/m²) and T_4 (Oxyfluorfen @ 1 kg /ha (pre-emergence)) (3.53 g/m²), were significantly at par to each other. Treatment T_{10} (Organic mulch with paddy straw @ 20 q/ha) (4.54 g/m²), T_1 (Weedy check plot) produced (4.83 g/m^2), T_5 (Quizalofop-ethyl @1 kg/ha (post-emergence)) (4.84 g/m²), and T_8 (Two hand weeding at 25 and 45 DAT) (4.84 g/m²) were similar to produced maximum fresh weight of weed in initial stage at 20 DAT.

At 40 DAT the it ranged from (2.22 g/m² to 34.39 g/m²), at 40 DAT, weed free treatment exhibited significantly minimum fresh weight of weeds (2.22 g/m²)

Table 2: Effect of different weed management practices on fresh weight (g) of weed in onion at 20, 40 and 60 DAT*

Treatment	Treatment detail	Fresh weight (g) of weed		
		20 DAT	40 DAT	60 DAT
T_1	Control (weedy check)	4.83 (23.34)	34.39 (1183.00)	52.50 (2756.37)
T_2	Weed free	1.98 (3.92)	2.22 (4.93)	2.84 (8.15)
T_3	Pendimethalin @ 1.75 kg/ha (pre-emergence)	3.66 (13.38)	10.20 (104.00)	29.53 (871.87)
T_4	Oxyfluorfen @ 1 kg/ha (pre-emergence)	3.53 (12.54)	10.06 (101.20)	29.23 (854.53)
T_5	Quizalofop-ethyl @ 1 kg/ha (post-emergence)	4.84 (23.41)	10.70 (114.53)	27.36 (748.51)
T_6	Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	3.67 (13.46)	8.80 (77.47)	19.39 (375.87)
T_7	Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	3.60 (12.94)	8.54 (73.03)	18.45 (340.27)
T_8	Two hand weeding at 25 and 45 DAT	4.84 (23.56)	4.86 (23.71)	15.58 (242.77)
T_9	Black polythene mulch	3.40 (11.54)	12.40 (153.87)	27.96 (782.00)
T_{10}	Organic mulch with paddy straw @ 20 q/ha	4.54 (20.58)	16.25 (264.13)	45.64 (2083.00)
	SEm±	0.12	0.17	0.14
	CD (P=0.05)	0.37	0.49	0.41

*DAT= Days after transplanting **The data in the parentheses have been subjected to square root transformation

And it was significantly lower than all the treatments. Among the herbicidal treatments T_7 (Oxyfluorfen @ 1 kg /ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (8.54 g/m²) and T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (8.80 g/m²), were at par with each other, similarly these were also significantly at par with T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (10.20 g/m²) and T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (10.06 g/m²) and recorded lower fresh weight. The treatment T_5 (Quizalofop-ethyl @1 kg/ha (post-emergence)) (10.70 g/m²), T_9 (Black polythene mulch) (12.40 g/m²) and T_{10} (Organic mulch with paddy straw @ 20 q/ha) (16.25 g/m²), produced lower weed fresh weight than Weedy check plot which was recorded maximum fresh weight (19.50 g/m^2).

At 60 DAT the ranged from (2.84 g/m² to 52.50 g/m²) fresh weight was recorded. At 60 DAT, T_2 (Weed free) treatment presented significantly minimum fresh weight of weeds (2.84 g/m²) than all the treatments, followed by the treatment T_8 (Two hand weeding at 25 and 45 DAT) (15.58 g/m²) found lower fresh weight of weed than rest of the treatment. Treatment T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (18.45 g/m²), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (19.39 g/m²), T_5 (Quizalofop-ethyl @1 kg/ha (post-emergence)) (27.36 g/m²), T_9 (Black polythene mulch) (27.96 g/m²), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (29.23 g/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (29.53 g/m²), and T_{10} (Organic mulch with paddy straw @ 20 q/ha) (45.64 g/m²) were also recorded significantly lower than the weedy check in which maximum fresh weight of weed is (52.50 g/m^2).

Significantly lower fresh weight was noted in (T_2) Weed free at 20 DAT and the highest fresh weight was observed in (T_1) Weedy check plot at 20 DAT 40 DAT and 60 DAT, respectively. The lower fresh weight was found in all the herbicides treatments plot than weedy check (T_1). It is due to mortality of weed by herbicides. Similar result found by Rahman *et al.* (2012) [11].

3. Weed dry matter at 20, 40, and 60 DAT

Table 3 reveals that different weed management practices showed significant effect on total dry matter of weeds.

At 20 DAT the weed dry weight ranged from (0.99 g/m² to 3.68 g/m²). The treatment (T_2) Weed free treatment produced significantly lowest dry weight than the all other treatment. Among, the treatment T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (1.86 g/m²), T_6 (Pendimethalin´@ 1.75 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (1.88 g/m²), T_9 (Black polythene mulch) (1.75 g/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (1.95 g/m²) and T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (1.85 g/m²) were found significantly at par in respect to dry weight of weed at 20 DAT. Similarly the treatment (T_{10}) Organic mulch with paddy straw @ 20 q/ha was also recorded lower dry weight of weeds than the (T_1) Weedy check (3.68 g/m²), T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (3.62 g/m²) and T_8 (Two hand weeding at 25 and 45 DAT) (3.64 g/m²), and in turn produced almost similar dry weight of weeds.

At 40 DAT the dry matter weight ranged from (1.71 g/m² to 15.56 g/m²). The treatment (T_2) Weed free treatment found significantly lower dry matter of weeds (1.71 g/m²) than all other treatments. However, the treatment T_8 (Two hand weeding at 25 and 45 DAT) (4.26 g/m²) was reported lower dry matter than the rest of treatments and the treatment T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (4.70 g/m²), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (4.91 g/m²) were at par with each other and produced lower dry weight than T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (5.30 g/m²), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (5.37 g/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (5.84 g/m²), T_9 (Black polythene mulch) (8.43 g/m²), T_{10} (Organic mulch with paddy straw @ 20 q/ha) (11.55 g/m²) and (T_1) Weedy check plot recorded maximum dry matter (15.56 g/m^2).

Table 3: Effect of different weed management practices on dry matter (g) of weed in onion at 20, 40 and 60 DAT*

Treatment	Treatment detail	Dry matter (g) of weed		
		20 DAT	40 DAT	60 DAT
T_1	Control (weedy check)	3.68 (13.57)	15.56 (242.03)	26.76 (716.19)
T_2	Weed free	0.99 (0.98)	1.71 (2.98)	1.40 (2.06)
T_3	Pendimethalin @ 1.75 kg/ha (pre-emergence)	1.95 (3.88)	5.84 (34.16)	11.99 (143.71)
T_4	Oxyfluorfen @ 1 kg/ha (pre-emergence)	1.85 (3.41)	5.37 (28.80)	11.05 (122.13)
T_5	Quizalofop-ethyl @ 1 kg/ha (post-emergence)	3.62 (13.17)	5.30 (28.05)	10.87 (118.17)
T_6	Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	1.88 (3.63)	4.91 (24.15)	8.16 (66.61)
T_7	Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	1.86 (3.48)	4.70 (22.16)	7.72 (59.72)
T_8	Two hand weeding at 25 and 45 DAT	3.64 (13.27)	4.26 (18.24)	7.27 (52.88)
T_9	Black polythene mulch	1.75 (3.10)	8.43 (71.21)	13.60 (185.08)
T_{10}	Organic mulch with paddy straw @ 20 q/ha	2.32 (5.40)	11.55 (133.51)	14.96 (223.96)
	SEm±	0.11	0.14	0.14
	CD (P=0.05)	0.34	0.41	0.43

*DAT= Days after transplanting **The data in the parentheses have been subjected to square root transformation

At 60 DAT the dry matter weight ranged from (1.40 g/m² to 26.76 g/m²), At 60 DAT all the weed management practices significantly lower the dry matter of weeds than (T_1) Weedy check. The treatment T_2 (Weed free) observed significantly minimum dry matter of weeds (1.40 g/m²) than all other treatment. The treatment T_8 (Two hand weeding at 25 and 45 DAT) (7.27 g/m²), T_7 (Oxyfluorfen @ 1 kg /ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (7.72 g/m²), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (8.16 g/m²) which was at par with each other, and found significantly lower dry matter over rest of the treatment. Treatment T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (10.87 g/m²), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (11.05 g/m²), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (11.99 g/m²), T_9 (Black polythene mulch) (13.60 g/m²) and T_{10} (Organic mulch with paddy straw @ 20 q/ha) (14.96 g/m²) were also recorded lower dry matter than T_1 (Weedy check plot) and found maximum dry matter weight (26.76 g/m^2).

Significantly lower dry weight was recorded which (T_2) Weed free and maximum dry weight was noted (T_1) Weedy check. All the weed management practices caused significant reduction in weed population compared with the weedy check. However, magnitude of reduction in dry weight varied depending on the control measures adopted. The periodical weed density varied at different stages of the crop. At 20, 40 and 60 DAT, dry weight of weeds was increase but it was lower as compared to (T_1) Weedy check in all stages. This might be due to the combined action of pre-planting and post-emergence herbicides used in onion. The primary mode of action of pendimethalin is to inhibit microtubule formation in cells of sus-ceptible monocot and dicot weeds which are an important part of the cell division process. As a result of restricted cell division, growth of the emerging weed seedling is prevented, eventuating in death due to lack of food reserves.

Similar results were reported by Hussain *et al.* (2008) [7] and Ghadage *et al.* (2006) [6].

4. Weed control efficiency (%)

Data recorded on weed control efficiency are presented in Table 4

At 20 DAT, maximum weed control efficiency (73.11%) was obtained under T_2 (Weed free) than the rest of treatments and treatment T_9 (Black polythene mulch) (52.45%), T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (49.33%), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (49.83%), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (48.80%), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (46.86%), T_{10} (Organic mulch with paddy straw

@ 20 q/ha) (36.84%), T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (1.52%), T_8 (Two hand weeding at 25 and 45 DAT) (1.01%) were recorded higher weed control efficiency than control weedy check.

At 40 DAT, maximum weed control efficiency (89.03%) was obtained under T_2 (Weed free) which is superior than the rest of treatments. However, the treatment T_8 (Two hand weeding at 25 and 45 DAT) (72.61%), T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (69.76), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (68.42%), T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (65.96%), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (65.51%), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (62.45%), T_9 (Black polythene mulch) (45.78%), T_{10} (Organic mulch with paddy straw @ 20 q/ha) (25.76%) of different management of weed control were higher weed control efficiency over the control plot (weedy check).

At 60 DAT, maximum weed control efficiency (94.77%) was obtained under T_2 (Weed free) treatment than the rest of treatments. The treatment T_8 (Two hand weeding at 25 and 45 DAT) (72.84%), T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (71.13%), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (69.51%), T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (59.38%), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (58.71%), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (55.21%), T_9 (Black polythene mulch) (49.17%) and T_{10} (Organic mulch with paddy straw @ 20 q/ha) (44.09%) were also higher weed control efficiency than control weedy check plot and comparable with each other.

Weed control efficiency of different treatments ranged from (1.01-73.11%) at 20 days after transplanting and (89.03-25.76%) at 40 DAT and (94.77- 44.09%) at 60 DAT. These results are in conformity with the studies conducted by Ghadage *et al.*, (2006) [6], Dalavai *et al.*, (2009) and Kalhapure and Shete (2013) [9].

5. Weed index (%)

Data recorded on weed index are presented in Table 5

Maximum weed index (%) was recorded under (T_1) weedy check (71.11%) than the all other treatments. Treatments T_{10} (Organic mulching with paddy straw @ 20 q/ha) (65.36%), T_9 (Black polythene mulch) (40.72%), T_5 (Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (31.72%), T_3 (Pendimethalin @ 1.75 kg/ha (pre-emergence)) (23.10%), T_4 (Oxyfluorfen @ 1 kg/ha (pre-emergence)) (21.80%), T_8 (Two hand weeding at 25 and 45 DAT) (17.78%), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (10.64%), and T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) (8.76%) were also higher and remarkable weed index and comparable with each other.

Weed index is the indicator the reduction in the yield due to presence of the weeds. It was recorded lowest in weed free plots followed by T_7 (Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)), T_6 (Pendimethalin´@ 1.750 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)) and maximum was in T_1 (weedy check plots) due to prominent weed-crop competition, suppression of crop plants by the emerging weeds and more utilization of nutrients and moisture by the weed canopy. Similar results were also reported by Kalhapure *et al*. (2014) [8], Ramalingam *et al.* (2013) [12]. They reported that weed free treatment provided the maximum weed index.

Table 5: Effect of different weed management practices on weed control efficiency (%) and Weed index (%) of onion at 20, 40 and 60 DAT*

Treatment	Treatment detail	Weed control efficiency (%)			Weed index
		20 DAT	40 DAT	60 DAT	
T_1	Control (weedy check)	-	-	-	71.11
T_2	Weed free	73.11	89.03	94.77	0.00
T_3	Pendimethalin @ 1.75 kg/ha (pre-emergence)	46.86	62.45	55.21	23.10
T_4	Oxyfluorfen @ 1 kg/ha (pre-emergence)	49.83	65.51	58.71	21.80
T_5	Quizalofop-ethyl @ 1 kg/ha (post-emergence)	1.52	65.96	59.38	31.72
T_6	Pendimethalin´@ 1.75 kg/ha (pre emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	48.80	68.42	69.51	10.64
T_7	Oxyfluorfen @ 1 kg/ha (pre-emergence) + Quizalofop-ethyl @ 1 kg/ha (post-emergence)	49.33	69.76	71.13	8.76
T_8	Two hand weeding at 25 and 45 DAT	1.01	72.61	72.84	17.78
T_9	Black polythene mulch	52.45	45.78	49.17	40.72
T_{10}	Organic mulching with paddy straw @ 20 q/ha	36.84	25.76	44.09	65.36

*DAT=Days after transplanting

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