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Effect of Weed Control Methods on Weeds and Wheat under *Eucalyptus tereticornis* Based Agroforestry System

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A B S T R A C T

A field experiment was conducted during winter season to find out the effect of herbicides on weed dynamics and yield performance of wheat (*Triticum aestivum* L.) variety LOK-1 in randomized complete block design with three replications under eucalyptus based agroforestry system. An experiment was conducted at the farmer field village- Majitha, District- Jabalpur during the rabi season of 2016-17 and 2017-18. The field was infested with 5 major weed species *Phalaris minor*, *Rumex dentatus* (L.), *Melilotus indicus* (L.), *Chenopodium album* (L.) *and Launaea nudicaulis* (L.) during both the year. The hand weeding showed minimum total weed density and dry weight and proved more effective than all weed control treatments and over weedy check. Among chemical weed control treatment 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}, Metribuzin 0.250 Kg ha^{-1} have control both broad leaf and grassy weed and Clodinafop-propargyl 0.140 kg ha^{-1} control grassy weed over weedy check. The application of 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 77.03 and 80.41%), 2, 4-D 0.5 lit ha^{-1} (T1: 75.15 and 83.00%), and 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 75.18 and 77.60%) was found higher weed control efficiency during both the year under wheat- *Eucalyptus tereticornis* based agroforestry system. The hand weeding showed maximum weed control efficiency (T9: 86.73 and 95.51%) and proved superior over herbicidal treatments. The higher grain yield and straw yield was found under hand weeding 30 DAS (T9; 19.75, 18.20 and 46.54, 39.72 q ha^{-1}) during both the year.

Introduction

Agroforestry is a sustainable land use system where two or more component is growing simultaneously on the same unit of land. Agroforestry may be one of the solutions to increase area outside the forest to one third of the total geographical area of our country.

The importance of agroforestry land use for food, fuel, fodder, fruits, fertilizer, timber, etc. and also in conservation of natural resources have been well recognized. The agrisilviculture (tree + crop) system is more productive and sustainable than agriculture.

India is the first country in the world to adopt the National Agroforestry Policy in 2014, under its Ministry of Agriculture and Farmers Welfare. It objective is to expand tree plantation in combination with crops and/or livestock to improve overall productivity,

reducing unemployment, generating additional source of income and livelihood support to small landholders (Verma *et al.,* 2017).

Wheat (*Triticum aestivum* L.) is the major cereal crop in many dry areas of the world and a basic food for more than one third of the world population. It is a prime source of carbohydrates and protein which has served as a staple diet for mankind (Nural-lslam and Johanson, 1987). Ecologically, wheat is adapted to a variety of climates and stressed environments including salinity. However, different biotic and abiotic stresses cause reduction in grain yield to various extents depending upon their nature and intensity. In agroforestry systems, reduction in yield of wheat is generally observed under the shade of tree crown and weeds due to resource competition (Puri and Bangarwa, 1992 and Awan *et al.,* 2015).

Weed infestation is one of the major factor limiting crop productivity. For realizing full genetic yield potential of the crop, the proper weed control is one of the essential management practices. Weeds not only reduce the yield but also make the harvesting operation difficult. Therefore, for sustaining food grain production to feed ever-increasing population and ensuring food security, effective weed management is very essential. Uncontrolled weeds are reported to cause upto 66% reduction in wheat grain yield (Angiras *et al.,* 2008, Kumar *et al.,* 2010 and Kumar *et al.,* 2011) or even more depending upon the weed density, type of weed flora and duration of infestation. In wheat growing bowl of the country, infestation of grassy weeds likes *P. minor* and *Avena ludoviciana* L. and broadleaf weeds like *Chenopodium album* L., *Chichorium intybus* L. and *Rumex dentates* L. etc are increasing at an alarming rate thus culminating wheat yield reduction by 18 to 73%. To manage the dynamics of weed flora, there is a need to evaluate a range of herbicides to have broad spectrum weed control. Chemical weed control is a preferred practice due to scarce, costly labour and time consuming as well as lesser feasibility of mechanical or manual weeding especially in broadcast wheat (Dixit and Singh, 2008). Hence, an experiment was conducted to evaluate the effect of weed control treatments, herbicides and their mixtures on weeds and wheat yield under *Eucalyptus tereticornis* based agroforestry system.

Materials and Methods

The field experiment was conducted at farmer's field during Rabi season 2016 -17 and 2017-18 at Village - Majitha, Block – Shahpura, District – Jabalpur. The experiment was laid out in randomized block design with three replications and consisted of ten weed control treatment [2, 4-D 0.5 lit ha^{-1}, Metribuzin 0.250 Kg ha^{-1}, Butachlor 1 lit ha^{-1}, Clodinafop-propargyl 0.140 kg ha^{-1}, 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}, 2, 4-D 0.5 lit ha^{-1} *fb* Butachlor 1 lit ha^{-1}, Metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1}, 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS, Hand weeding 30 DAS and Weedy check]. Wheat variety LOK-1 was sown with 25 cm row spacing at a depth of 4 cm from the top of the soil by opening furrows through a Kudal. The weed control treatments and herbicides were applied as post emergent at crop tillering stage i.e. about 30 DAS. Weed population was counted with the help of quadrate (0.25cm X 0.25cm) thrown randomly at four places in each plot and converted in to m^2 area. The aboveground weed dry matter was also recorded from the above thrown quadrates after cutting weeds from the ground level and then oven dried at 70^0C and converted to m^2. The yield of crop was recorded in all the treatments at the time of harvest. Harvest index was calculated as the ratio of grain yield to the biological yield. It was calculated as per the formula proposed by Nichiporovich (1967).

$$\text{Harvest Index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Weed control efficiency (WCE)

Weed control efficiency (WCE) of the treatments against weedy check was calculated on the basis of weed dry weight as suggested by Mani *et al.,* (1973).

$$\text{WCE (\%)} = \frac{WD_c - WD_t}{WD_c} \times 100$$

Where,

WCE = Weed control efficiency

WD_c = Dry weight of weeds in unweeded control plot

WD_t = Dry weight of weeds in treated plot

Weed count were subjected to square root transformation, (√X+0.5).

Weed index

Weed index of each treatment was calculated by using following formula (Gill and Kumar, 1969).

$$\text{Weed Index (\%)} = \frac{X - Y}{X} \times 100$$

Where,

X - Yield from hand weeded plot.

Y – Yield from the treatment for which weed index is to be worked out.

Weed count were subjected to square root transformation, √X+0.5. All the experimental data were statistically analyzed and critical difference (CD) was worked out by the procedure as described by Gomez and Gomez (1984).

Results and Discussion

Weed flora

The weed community comprised both broadleaved and grass weeds. The experiment field consisted with 5 weed species belonging to 5 families in the experimental plot.

Effect on individual weeds

Phalaris minor

The perusal of data showed that hand weeding found lower weed density (T9: 2.00 and 0.67 m^2) over all the weed control treatment and weedy check during both the year. Among chemical weed control treatment Clodinafop-propargyl 0.140 kg ha^{-1} showed lowest weed density (T4: 2.00 and 1.00 m^2) followed by Metribuzin 0.250 Kg ha^{-1} (T2: 3.33 and 2.00 m^2) 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 3.33 and 2.67 m^2) and 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 3.67 3.50 m^2) over weedy check which recorded significantly higher weed control treatment (T10: 9.33 and 11.33 m^2) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 1). The perusal of statistical data reported that highest weed control efficiency was found under hand weeding 30DAS (T9: 77.50 and 94.10 %) followed by clodinafop-propargyl 0.140 kg ha^{-1} (T4: 77.50 and 91.84 %) over weedy check (T10- 0 %), 2, 4-D 0.5 lit ha^{-1} (T1:13.33 and 52.03 %) and butachlor 1 lit ha^{-1} (T3: 32.50 and 58.70 %) during both the year (Table 2) Similar views have also been reported by, Singh *et al.,* (2005), Amare *et al.,* (2014), Saini and Chopra (2015) and Singh *et al.,* (2015).

The perusal of data (Table 3) showed that the lowest dry weight of *Phalaris minor* was recorded in hand weeding 30 DAS (T9: 4.00 and 1.33 gm^{-2}) at par with clodinafop-propargyl 0.140 kg ha^{-1} (T4: 4.00 and 2.00 gm^{-2}). The weedy check recorded higher weed dry weight (T10: 18.67 and 22.67 gm^{-2}) during both year. Similar finding was also reported by Pradhan and Chakraborti (2010), Tiwari *et al.*, (2011), Pisal and Sagarka (2013), Amare *et al.*, (2014) and choudhry *et al.*, (2016).

Chenopodium album

The result showed that hand weeding recorded lower weed density (T9: 1.33 and 0.67 m^2) whereas weedy check recorded significantly higher weed density (T10: 9.67 and 8.67 m^2). Among chemical weed control treatment 2, 4-D 0.5 lit ha^{-1} showed lower weed density (T1: 1.33 and 1.00 m^2) followed by 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 2.00 and 2.00 m^2) and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 2.33 and 2.5 m^2) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 1).

The application of weed management practices the highest weed control efficiency was found under hand weeding 30 DAS (T9: 86.11 and 93.94 %). The application of 2, 4-D 0.5 lit ha^{-1} (T1: 84.26 and 87.45 %), 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 79.17 and 79.74 %), 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 74.54 and 76.34 %), metribuzin 0.250 Kg ha^{-1} (T2: 65.28 and 66.23 %) recorded higher weed control efficiency over the weedy check (T10: 0 %) during both the year(Table 2) Similar views have also been reported by, Singh *et al.*, (2005), Amare *et al.*, (2014), Saini and Chopra (2015) and Singh *et al.*, (2015).

The minimum dry weight of *Chenopodium album* was recorded in hand weeding 30 DAS (T9: 4.00 and 2.00 g m^{-2}) which was significantly superior over weedy check which recorded higher dry weight (T10: 29.00 and 26.00 g m^{-2}).

The application of 2, 4-D 0.5 lit ha^{-1} (T1: 4.00 and 3.00 g m^{-2}), 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 6.00 and 4.67 g m^{-2}) and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 7.00 and 5.67 g m^{-2}) were also at par with hand weeding which rerecorded minimum dry weight of *Chenopodium album* during both the year(Table 3). Similar find also reported by Tiwari *et al.*, (2011), Pisal and Sagarka (2013), Amare *et al.*, (2014) and choudhry *et al.*, (2016).

Table.1 Floristic composition of weeds of the experimental field

Botanical name	Common name	Family	Habit and characteristics
Grasses			
Phalaris minor	Canary grass	Poaceae	Tufted annual bunch grass, spike like panicle.
Broad leaved weeds			
***Rumex dentatus* (L.)**	Toothed dock, Aegean dock	Polygonaceae	Annual, erect with long taproots.
***Meliotus indica* (L.) All.**	Sweet clover, Indian sweet clover	Fabaceae	Annual herb of 10-50cm, yellow flowers.
***Chenopodium album* (L.)**	Lambsquarters, goosefoot	Chenopodiaceae	Annual, many branches, dull green flowers.
Launaea nudicaulis (L.)	Broad leaf launaea	Asteraceae	Perennial herb with a taproot and often shoot bearing lateral roots, up to 40-50 cm high.

Table.2 Effect of weed control treatment on weed density (m^{-2}) at harvest during both the year under wheat- *Eucalyptus tereticornis* based agroforestry system

Treatments	*Phalaris minor*		*Chenopodium album*		*Rumex dentatus*		*Launaea nudicaulis*		*Melilotus indicus*	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1 - 2, 4-D 0.5 lit ha^{-1}	2.91 (8.00)*	2.42 (5.33)	1.29 (1.33)	1.17 (1.00)	1.29 (1.33)	1.00 (0.67)	1.46 (1.67)	1.34 (1.00)	1.47 (2.00)	1.34 (1.33)
T_2 - Metribuzin 0.250 Kg ha^{-1}	1.95 (3.33)	1.56 (2.00)	1.95 (3.33)	1.81 (2.83)	1.77 (2.67)	1.68 (2.33)	1.77 (2.67)	1.47 (1.83)	1.77 (2.67)	1.46 (1.67)
T_3- Butachlor 1 lit ha^{-1}	2.61 (6.33)	2.27 (4.67)	2.20 (4.33)	1.95 (3.33)	1.76 (2.67)	1.73 (2.50)	2.11 (4.00)	1.94 (3.33)	1.90 (3.17)	1.77 (2.67)
T_4- Clodinafop-propargyl 0.140 kg ha^{-1}	1.48 (2.00)	1.17 (1.00)	2.48 (5.67)	2.34 (5.00)	2.26 (4.67)	2.00 (3.50)	2.04 (3.67)	1.78 (2.83)	1.86 (3.00)	1.68 (2.33)
T_5- 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}	1.95 (3.33)	1.77 (2.67)	1.68 (2.33)	1.72 (2.5)	1.46 (1.67)	1.46 (1.6)	1.39 (1.67)	1.29 (1.33)	1.29 (1.33)	1.34 (1.33)
T_6- 2, 4-D 0.5 lit ha^{-1} *fb* butachlor 1 lit ha^{-1}	2.27 (4.67)	2.11 (4.00)	2.11 (4.00)	1.91 (3.17)	1.77 2.67	1.63 (2.17)	1.86 (3.00)	1.74 (2.60)	1.76 (2.67)	1.66 (2.27)
T_7- Metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1}	2.24 (4.67)	2.04 (3.67)	2.48 (5.67)	2.22 (4.5)	2.26 (4.67)	2.02 (3.67)	1.77 (2.67)	1.58 (2.33)	1.86 (3.00)	1.77 (2.67)
T_8- 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS	2.03 (3.67)	1.98 (3.50)	1.48 (2.00)	1.56 (2.00)	1.56 (2.00)	1.29 (1.33)	1.56 (2.00)	1.48 (2.00)	1.68 (2.33)	1.68 (2.33)
T_9- Hand Weeding 30 DAS	1.48 (2.00)	1.05 (0.67)	1.27 (1.33)	1.00 (0.67)	1.05 (0.67)	0.71 (0.00)	1.17 (1.00)	0.88 (0.33)	1.00 (0.67)	1.05 (0.67)
T_{10}- Weedy check	3.13 (9.33)	3.43 (11.33)	3.18 (9.67)	3.02 (8.67)	2.80 (7.33)	2.74 (7.00)	2.97 (8.33)	2.80 (8.33)	3.01 (8.67)	3.13 (9.33)
SEm±	0.22	0.14	0.22	0.19	0.18	0.18	0.18	0.16	0.21	0.11
Treatment (T) CD (P=0.05)	0.66	0.42	0.64	0.55	0.53	0.51	0.54	0.47	0.62	0.33

*(Data subjected to square root x+0.5 transformation and figures in parenthesis are original value)

Table.3 Effect of weed control treatment on weed control efficiency (%) under wheat-*Eucalyptus tereticornis* based agroforestry system

Treatments	*Phalaris minor*		*Chenopodium album*		*Rumex dentatus*		*Launaea nudicaulis*		*Melilotus indicus*	
	2016-17	2017-18	2016-17	2017-18	2016-17		2016-17	2017-18	2016-17	2017-18
T_1 - 2, 4-D 0.5 lit ha^{-1}	13.33	52.03	84.26	87.45	84.26	91.67	79.63	86.90	79.37	81.39
T_2 - Metribuzin 0.250 Kg ha^{-1}	64.17	82.45	65.28	66.23	65.28	66.17	67.59	77.86	67.86	75.00
T_3- Butachlor 1 lit ha^{-1}	32.50	58.70	53.70	59.96	53.70	63.10	51.85	59.29	61.71	71.94
T_4- Clodinafop-propargyl 0.140 kg ha^{-1}	77.50	91.84	38.42	41.94	38.42	50.00	56.02	65.60	65.08	69.72
T_5- 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}	63.33	75.78	74.54	76.34	74.54	76.59	80.09	82.14	80.95	86.94
T_6- 2, 4-D 0.5 lit ha^{-1} *fb* butachlor 1 lit ha^{-1}	49.17	64.59	58.33	63.48	58.33	68.65	64.35	68.33	69.84	76.53
T_7- Metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1}	50.83	67.24	39.81	46.16	39.81	49.01	68.06	72.14	65.08	68.33
T_8- 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS	60.83	68.44	79.17	79.74	79.17	80.56	75.46	75.71	70.63	76.11
T_9- Hand Weeding 30 DAS	77.50	94.10	86.11	93.94	86.11	100.00	87.96	95.83	94.44	93.06
T_{10}- Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEm±	7.68	4.30	7.03	4.94	7.03	6.07	6.45	6.28	6.68	4.26
Treatment (T) CD (P=0.05)	22.42	12.54	20.52	14.41	20.52	17.72	18.82	18.33	19.50	12.43

Table.4 Effect of weed control treatment on weed dry weight (g m^{-2}) under wheat - *Eucalyptus tereticornis* based agroforestry system

Treatments	*Phalaris minor*		*Chenopodium album*		*Rumex dentatus*		*Launaea nudicaulis*		*Melilotus indicus*	
	2016-17	2017-18	2016-17	2017-18	2016-17	2016-17	2017-18	2016-17	2017-18	2016-17
T_1 - 2, 4-D 0.5 lit ha^{-1}	4.06 (16.00)	3.34 (10.67)	1.90 (4.00)	1.71 (3.00)	2.57 (8.00)	1.65 (4.00)	3.17 (10.00)	2.27 (6.00)	2.23 (6.00)	2.27 (5.00)
T_2 - Metribuzin 0.250 Kg ha^{-1}	2.67 (6.67)	2.08 (4.00)	3.23 (10.00)	2.97 (8.50)	4.50 (20.00)	3.81 (14.00)	4.03 (16.00)	3.39 (11.00)	2.90 (8.00)	2.82 (7.50)
T_3- Butachlor 1 lit ha^{-1}	3.61 (12.67)	3.13 (9.33)	3.63 (13.00)	3.23 (10.00)	5.10 (26.00)	3.93 (15.00)	4.90 (24.00)	4.48 (20.00)	3.10 (9.50)	2.90 (8.00)
T_4- Clodinafop-propargyl 0.140 kg ha^{-1}	1.94 (4.00)	1.47 (2.00)	4.13 (17.00)	3.93 (15.00)	5.83 (34.00)	4.63 (21.00)	4.70 (22.00)	4.18 (17.00)	3.03 (9.00)	3.06 (9.00)
T_5- 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}	2.67 (6.67)	2.41 (5.33)	2.70 (7.00)	2.45 (5.67)	3.77 (14.00)	3.21 (10.00)	2.83 (10.00)	2.60 (8.00)	1.90 (4.00)	2.10 (4.00)
T_6- 2, 4-D 0.5 lit ha^{-1} *fb* butachlor 1 lit ha^{-1}	3.13 (9.33)	2.90 (8.00)	3.50 (12.00)	3.15 (9.50)	4.90 (24.00)	3.67 (13.00)	4.23 (18.00)	4.00 (15.60)	2.83 (8.00)	2.70 (6.80)
T_7- Metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1}	3.09 (9.33)	2.80 (7.33)	4.17 (17.00)	3.71 (13.50)	5.83 (34.00)	4.67 (22.00)	4.03 (16.00)	3.79 (14.00)	3.03 (9.00)	3.12 (9.50)
T_8- 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS	2.78 (7.33)	2.71 (7.00)	2.30 (6.00)	2.17 (4.67)	3.10 (12.00)	2.60 (8.00)	3.43 (12.00)	3.10 (12.00)	2.70 (7.00)	2.73 (7.00)
T_9- Hand Weeding 30 DAS	1.94 (4.00)	1.29 (1.33)	1.90 (4.00)	1.32 (2.00)	2.50 (8.00)	0.71 (0.00)	2.23 (6.00)	1.32 (2.00)	1.30 (2.00)	1.48 (2.00)
T_{10}- Weedy check	4.37 (18.67)	4.81 (22.67)	5.37 (29.00)	5.13 (26.00)	7.63 (58.00)	6.51 (42.00)	7.13 (50.00)	7.09 (50.00)	5.07 (26.00)	5.50 (30.00)
SEm±	0.35	0.22	0.44	0.39	0.66	0.46	0.55	0.66	0.43	0.27
Treatment (T) CD (P=0.05)	1.01	0.65	1.29	1.14	1.94	1.36	1.61	1.91	1.25	0.79

*(Data subjected to square root x+0.5 transformation and figures in parenthesis are original value)

Table.5 Grain yield, straw yield and harvest index of wheat as influenced by different treatments under wheat- *Eucalyptus tereticornis* based agroforestry system

Treatment		Grain Yield (q ha^{-1})		Straw Yield (q ha^{-1})		Harvest Index (%)	
		2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T_1	2, 4-D 0.5 lit ha^{-1}	16.67	15.17	39.92	31.21	29.45	32.73
T_2	Metribuzin 0.250 Kg ha^{-1}	17.04	15.32	40.10	31.85	29.83	32.48
T_3	Butachlor 1 lit ha^{-1}	13.97	12.85	35.41	28.94	28.27	30.79
T_4	Clodinafop-propargyl 0.140 kg ha^{-1}	17.63	16.18	41.36	34.52	29.89	31.89
T_5	2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}	15.84	15.23	38.82	32.64	28.97	31.82
T_6	2, 4-D 0.5 lit ha^{-1} *fb* butachlor 1 lit ha^{-1}	15.27	14.17	37.67	31.95	28.84	30.70
T_7	Metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1}	15.00	13.70	36.50	27.99	29.14	32.84
T_8	2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS	17.19	16.04	40.22	30.56	29.95	34.69
T_9	Hand Weeding 30 DAS	19.75	18.20	46.54	39.72	29.80	31.41
T_{10}	Weedy check	13.07	12.07	34.99	28.67	27.23	29.68
SEm±		**0.40**	**0.54**	**0.82**	**1.37**	**0.71**	**0.91**
Treatment (T) CD (P=0.05)		**1.17**	**1.57**	**2.39**	**3.99**	**2.08**	**2.64**
Year (Y) CD(P=0.05)		-	-	-	-	-	-
Interaction (YxT) CD (P=0.05)		-	-	-	-	-	-

Rumex dentatus

The perusal of data (Table 1) showed that hand weeding recorded lower weed density (T9: 0.67 and 0.00 m^2) whereas weedy check recorded significantly higher weed density (T10: 7.33 and 7.00 m^2). Among chemical weed control treatment 2, 4-D 0.5 lit ha^{-1} showed lower weed density (T1: 1.33 and 0.67 m^2) followed by 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 2.00 and 1.33 m^2) and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 1.67 and 1.60 m^2) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system.

The application of 2, 4-D 0.5 lit ha^{-1} (T1: 84.26 and 91.67 %), hand weeding 30 DAS *fb* 2, 4-D 0.5 lit ha^{-1} (T8: 79.17 and 80.56), 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 kg ha^{-1} (T5: 74.54 and 76.59 %) were found higher weed control efficiency over weedy check (0%), chlodinafop-propargyl 0.140 kg ha^{-1} (T4: 38.42 and 50.00 %) and metribuzin 0.250 kg ha^{-1} *fb* butachlor 1 lit ha^{-1} (T7: 39.81 and 49.01 %) during both the year (Table 2) Similar views have also been reported by Saini and Chopra (2015) and Singh *et al.*, (2015).

Lowest weed dry weight of *Rumex dentatus* was found under hand weeding 30 DAS (T9: 8.00 g m^{-2}) followed by 2, 4-D 0.5 lit ha^{-1} (T1: 8.00 g m^{-2}), hand weeding 30 DAS + 2, 4 D 0.5 lit ha^{-1} (T8: 12.00 g m^{-2}) and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 14.00 g

m^{-2}) over Weedy check which found significantly higher (T10: 58.00 g m^{-2}) *Rumex dentatus* dry weight. During second year 2017-18 hand weeding showed signicantly lower weeds dry weight over weedy check and all the management practices.

The application of 2, 4-D @ 0.5 lha^{-1} (T1: 4.00 g m^{-2}) followed by 2, 4 D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 8.00 g m^{-2}) were also reduced the dry weight of *Rumex dentatus* (Table 3). Similar finding also reported by Amare *et al.,* (2014) and choudhry *et al.,* (2016).

Launaea nudicaulis

The perusal of data (Table 1) showed that hand weeding recorded lower weed density (T9: 1.00 and 0.33 m^2) whereas weedy check recorded significantly higher weed density (T10: 8.33 and 8.33 m^2).

Among chemical weed control treatment 2, 4-D 0.5 lit ha^{-1} showed lower weed density (T1: 1.67 and 1.00 m^2) followed by 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 2.00 and 2.00 m^2) and 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 1.67 and 1.33 m^2) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system.

The application of weed management practices the highest weed control efficiency was found under hand weeding 30 DAS (T9: 87.96 and 95.83 %) followed by 2, 4-D 0.5 lit ha^{-1} (T1: 79.63 and 86.90), 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 80.09 and 82.14 %) and 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 75.46 and 75.71 %) over weedy check (T10: 0.00 %) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 2). Similar views have also been reported by Saini and Chopra (2015) and Singh *et al.,* (2015).

Among weed control practices the hand weeding had found lowest weed dry weight (T9: 6.00 and 2.00 g m^{-2}) at par with 2, 4-D 0.5 lit ha^{-1} (T1: 10.00 and 6.00 g m^{-2}), 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 kg ha^{-1} (T5: 10.00 and 8.00 g m^{-2}) and 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8:12.00 and 12.00 g m^{-2}) over weedy check which found significantly higher Weed dry weight (T10: 50.00 and 50.00 gm^{-2}) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 3). Similar finding also reported by Amare *et al.,* (2014) and choudhry *et al.,* (2016).

Melilotus indicus

The result showed that hand weeding recorded lower weed density (T9: 0.67 and 0.67 m^2) whereas weedy check recorded significantly higher weed density (T10: 8.67 and 9.33 m^2). Among chemical weed control treatment 2, 4-D 0.5 lit ha^{-1} showed lower weed density (T1: 2.00 and 1.33 m^2) followed by 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 1.33 and 1.33 m^2) and 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 2.33 and 2.33 m^2) during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 1).

The application of weed management practices the highest weed control efficiency was found under hand weeding 30 DAS (T9: 94.44 and 93.06%) followed by 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} (T5: 80.95 and 86.94 %) and 2, 4-D 0.5 lit ha^{-1} (T1: 79.37 and 81.39 %) over Weedy check (T10: 0 %) (Table 2). Similar views have also been reported by, Saini and Chopra (2015) and Singh *et al.,* (2015).

The lowest weed dry weight of *Melilotus indicus* was found under hand Weeding 30 DAS (T9: 2.00 and 2.00 g m^{-2}) at par with 2, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1}

(T5: 4.00 and 4.00 g m^{-2}) and 2, 4-D 0.5 lit ha^{-1} (T1: 6.00 and 5.00 g m^{-2}) which was significantly superior over weedy check (T10: 26.00 and 30.00 g m^{-2}) during both the year (Table 3). Similar finding also reported by Pradhan and Chakraborti (2010), Tiwari *et al.,* (2011) Pisal and Sagarka (2013), Amare *et al.,* (2014) and choudhry *et al.,* (2016).

Grain yield

The significantly higher grain yield was found under hand weeding 30 DAS (T9; 19.75 and 18.20 q ha^{-1}) which was significantly superior over weedy check (T10: 13.07 and 12.02 q ha^{-1}) during both the year. Among herbicidal treatments the higher grain yield was found under chodinafop-propargyl 0.140 kg ha^{-1} (T4: 17.63 and 16.18 q ha^{-1}) followed by 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 17.19 and 16.04 q ha^{-1}), metribuzin 0.250 Kg ha^{-1} (T2: 17.04 and 15.32 q ha^{-1}) and 2, 4-D 0.5 lit ha^{-1} (16.67 and 15.32 q ha^{-1}) over control (T10: 13.07 and 12.07 q ha^{-1}), followed by butachlore 1 lit ha^{-1} (13.97 and 12.85 q ha^{-1}) during both the year. The 33.82% and 33.68% yield reduction was found under weedy check treatments over hand weeding 30 DAS during both the year under wheat – *Eucalyptus tereticornis* based Agroforestry system (Table 4). The findings are in close conformity to the findings of Brar *et al.,* (2002), Yadav *et al.,* (2009) and Chander *et al.,* (2014).

Straw yield

The significantly higher straw yield was found under hand weeding 30 DAS (T9; 46.54 and 39.72 q ha^{-1}) which was significantly superior over weedy check (T10: 34.99 and 28.67 q ha^{-1}) and rest of the weed control treatments. Among herbicidal treatment the higher straw yield was found under chodinafop-propargyl 0.140 kg ha^{-1} (T4: 41.36 and 34.52 q ha^{-1}) over weedy check (T10: 34.99 and 28.67 q ha^{-1}), followed by butachlor 1 lit ha^{-1} (T3: 35.41 and 28.94 q ha^{-1}). The 24.81% and 11.05 % straw yield reduction was found under weedy check over hand weeding 30 DAS during both the year (Table 4).

Harvest index

The higher harvest index was found under 2, 4-D 0.5 lit ha^{-1} + Hand weeding 30 DAS (T8: 29.95%) over weedy check (T10: 27.23%) during first year (2016-17) and During second year (2017-18), higher straw yield was found under 2, 4-D 0.5 lit ha^{-1} + hand weeding 30 DAS (T8: 34.69%) followed by metribuzin 0.250 Kg ha^{-1} *fb* butachlor 1 lit ha^{-1} (T7: 32.84%), 2, 4-D 0.5 lit ha^{-1} (T1: 32.73%) and metribuzin 0.250 Kg ha^{-1} (T2: 32.48%) over weedy check (T10: 29.68%) (Table 5).

From the two year experiment result concluded that, the hand weeding was superior to control all type of weed under wheat – *Eucalyptus tereticornis* based Agroforestry system. Among the weed management practices concluded that clodinafop-propagyl at 0.140 kg ha^{-1} reduce *Phalaris minor* and 2, 4 – D 0.5 lit ha^{-1} reduce weed density of broad leaved weed whereas, 2,4D+ hand weeding 30 DAS and, 4-D 0.5 lit ha^{-1} *fb* metribuzin 0.250 Kg ha^{-1} reduce weed density and dry weight of both broad leaved and narrow leaf weed at all stage of crop growth. These treatments also increase grain yield and straw yield over weedy check plot under wheat – *Eucalyptus tereticornis* based Agroforestry system.

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