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EFFECTS OF INTEGRATED WEED MANAGEMENT ON GREEN FORAGE YIELD OF OATS (AVENA SATIVA L.)

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Abstract

This research under the title of effects of integrated weed management on green forage yield of Oats (*Avena sativa* L.) had carried out in the research farm of Lovely Professional University during winter season 2019-2020 to insure the effects of integrated weed management on the growth, yield and quality parameters of Oats.

This research work was carried out in Randomized Block Design (RBD) which contained nine treatments replicated three times. The treatments included of various weed control techniques like weedy check (control), weed free check, hand weeding at 25 days after sowing, hand hoeing at 25 days after sowing, pre-emergence application of Pendimethalin @ 0.75 kg a.i. ha^{-1} + one hand weeding at 40 days after sowing, post emergence application of 2-4-D @ 0.75 kg a.i. ha^{-1} at 21 days after sowing + one hand weeding at 35 days after sowing, post emergence metsulfuron methyl @ 0.004 kg a.i. ha^{-1} at 21 days after sowing + one hand weeding at 35 days after sowing, post emergence application of 2-4-D @ 0.75 kg a.i. ha^{-1} at 21 days after sowing + one hand hoeing at 35 days after sowing and post emergence metsulfuron methyl @ 0.004 kg a.i. ha^{-1} at 21 days after sowing + hand hoeing at 35 days after sowing. During this research the variety of oats was Kent which was sown by drilling method in the rows with the space of 30 cm and depth of 1-2 cm on a flatbed in plot size of 5m x 3m.

Weed free check was considered preferable in all of the growth and yield parameters traced by Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one hand weeding at 35 DAS and post emergence application of Atrazine @ 0.75 kg a.i ha^{-1} at 21 DAS + one hand weeding at 35 DAS.

The above detailed treatments in that regularity seize the maximum to minimum weed control efficiency and minimum to maximum weed index corresponding to dry matter of the weeds and forage product, respectively.

According to green forage yield, weed free check confirmed highest among all the treatments and traced by Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS.

Key words: Green forage yield, Weed index, Weed Control Efficiency, Plant height, and plant count.

1. Introduction

Oats (*Avena sativa* L.) is sowing from very ancient period of time in various European countries of the west, the red oat was grown as a fodder in Asia Minor in the tropics Major oat producing countries are USA, ex-USSR, Canada, Poland, France, Germany and the UK. The total world area under Oat cultivation is approximately 30 million hectares. As a winter crop, oats are grown in the northern, western and central India. It is presently cultivated on a large scale in Punjab, Haryana, and Uttar Pradesh and to a limited extent in certain parts of Himachal Pradesh, Maharashtra, Gujrat, Madhya Pradesh, Orissa, Bihar, and West Bengal (Chandy 2002).

Oat is the major cereal forage crop of Rabi season in India because of quick growing savory and nutritious for the livestock. The alimentary value of forage oat in case of dry matter digestibility in more than 75 percent while fed to dairy cattle.

Other cereals which have some chemical composition like oats are not that much rich in term of digestibility organic matter as oats is (Cudd ford 1995).

In case of metabolic energy spring oats straw is rich as compare to winter oats but by considering available energy both types are better than other cereals.

The straw which is produced from oats is softer, savory and much more acceptable for livestock feeding compare to the other cereals (Stevens *et al*., 2004).

Being a Rabi irrigated and long durational crop, the oat is massively infested with various species of annual and perennial weeds, some of those are not preferred by animals e.g. *Kharbathua (Chenopodium murale)*, Carrot grass (*parthenium hysterophorous*), Hariyali (*cynodon dactylon*)

And wild hollyhock (*althaea ludwigri*)

This contamination cases degradation of fodder productivity since it is a forage crop, only cultural practices (weeding and hoeing) are adopted to control the weeds. However, sue to scarcity of laborers, it becomes very difficult to manage the weeds in time under irrigated condition resulting in to more crop weed competition for nutrient, light, moisture, and space thus, causing substantial reduction in green forage yield and quality of oat (Anonymous 2010).

Based on above facts, following inquiry was suggested for the following purposes;

1. To assess the effect of integrated weed management on growth, yield and quality of oat.
2. To study the efficacy of herbicides in controlling weeds in oat.
3. To study the economics of integrated weed management in oat.
4. To assure the most effective method for weed control in Oat.

Materials and methods

The mentioned research project had been carried out in the research farm of LPU Lovely Professional University Jalandhar-Punjab India at Rabi season of 2019-20 which was known by the title of (Effects of integrated weed management on oats *Avena sativa* L.).

In the current chapter we have enlisted the materials and methodology used during the research which includes the following sub topics.

Experimental design and Details

Crop and variety: Oat (*Avena sativa* L.) Kent

Working season: Rabi November 2019-20

Date of sowing: 30/Nov/2019

Method of sowing: Line sowing

Seed Rate: 100 kg ha $^{-1}$

Spacing: 30 cm

Total area: 450 m^2

Total number of plots: 27

Per plot size: 15 m^2

Design: Randomized Block Design (R.B.D)

Number of treatments: 9

Number of replications: 3

Recommended Dose of fertilizer: 75:20:0 (N: P2O5:K2O) kg ha^{-1}

Details of treatments

Symbol	Treatment Details
T1	Weedy check (Control).
T2	Weed free check.
T3	Hand weeding at 21 DAS.
T4	Hand hoeing at 21 DAS.
T5	Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.
T6	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.
T7	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS.
T8	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.
T9	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand hoeing at 35 DAS.

Field Layout

R1T1	Irrigation channel	R2T5	R3T3	Irrigation channel
R1T2		R2T7	R3T6	
R1T3		R2T1	R3T2	
R1T4		R2T9	R3T8	
R1T5		R2T2	R3T4	
R1T6		R2T8	R3T9	
R1T7		R2T3	R3T1	
R1T8		R2T6	R3T7	
R1T9		R2T4	R3T5	

Statistical analysis and interpretation of data

The data recorded were statistically analyzed by using technique of analysis of variance (Fisher, 1970) and significance was determined as given by Panase and Sukhatme (1985) for randomized block design. Standard error of the means (S.E.m.±) was worked out. Wherever the results were significant, the critical difference (C.D) at 5% significance level was also worked out and presented. Graphical illustrations of data have been given at appropriate places.

Result and discussion

The field investigation under the title of "effects of integrated weed management on green forage yield and quality of Oats (*Avena sativa* L.)" was carried out in Rabi season of 2019-20 at the research farm of lovely professional university LPU. In this chapter the details and result insured from the investigation were discussed.

Initial and final plant population

all the figures about the initial and final plant counts as influenced by different treatments are presented in table 7.

Initial plant counts which were recorded 10 days after sowing was at the range of 3061000 to 3197000 ha $^{-1}$ which indicates xxx % to xxx % of the wanted plant populations, but the final plant population which were counted at the time of harvest was at the range of 3029000 to 3142000 ha $^{-1}$ which indicated xxx % to xxx % of the expected plant population.

Table 7. Mean initial and final plant population per hectare as influenced by different treatments

Treatments	Initial plant counts ha $^{-1}$ (000)	Final plant counts ha $^{-1}$ (000)
Weedy check (control)	3061	3029
Weed free check.	3197	3174
Hand weeding at 21 DAS.	3039	3038
Hand hoeing at 21 DAS.	3057	3035
Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.	3100	3098
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.	3090	3090
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS.	3120	3142
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.	3053	3024
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand hoeing at 35 DAS.	3073	3029
S.E.m. ±	49.41	55.81
C.D. P=(0.05)	NS	NS

Plant height

The data of mean plant height which was periodically influenced by various treatments is shown in table 8 and as well as graphically indicated in fig. 4.

As it is known from the table 8 and fig.2, the mean plant height was influenced at all growth stages of the crop. At 30 DAS Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS, Hand hoeing at 21 DAS and weedy free check recorded the highest plant height as compare to other treatments and the lowest plant height was recorded in weedy check followed by Hand weeding at 21 DAS.

As per the measurement of the plant height the plot in which we have applied Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS was having the highest plant height as compare to other treatments and weedy free check was stand in second position according to plant height and in the list of lowest plant height Hand weeding at 21 DAS was at first rank which was followed by Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS.

Table 8. Periodically recorded mean plant height (cm) as influenced by different treatments.

Symbol	Treatments	At 30 DAS	At 60 DAS	At Harvest
T1	Weedy check (Control).	41.113	82.070	114.333
T2	Weed free check.	43.690	93.077	139.500
T3	Hand weeding at 21 DAS.	41.333	86.333	115.900
T4	Hand hoeing at 21 DAS.	44.813	90.343	124.033
T5	Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.	47.587	93.787	128.100
T6	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.	42.000	90.700	118.333
T7	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS.	41.590	83.543	124.600
T8	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.	41.520	84.367	127.500
T9	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS.	41.613	83.983	119.100
	S.E.m.±	0.366	0.661	0.557
	C.D (P=0.05)	1.106	1.997	1.684
	General Mean	42.806	87.578	123.488

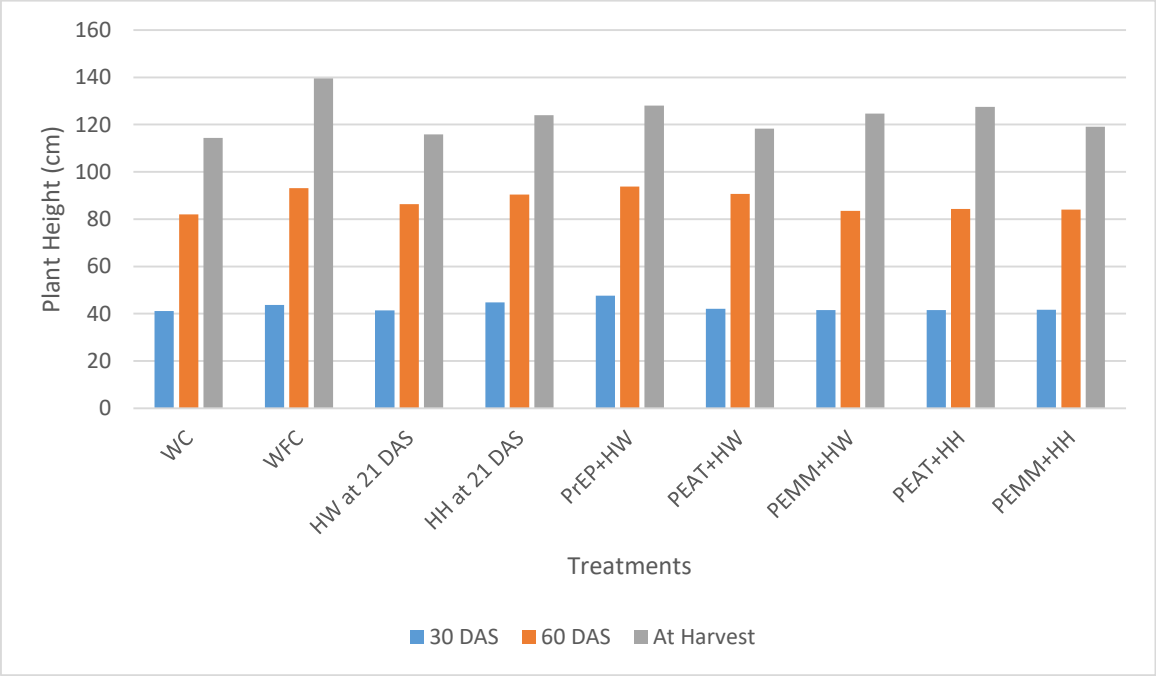

Fig.4. Mean plant height as influenced by different treatments.

Numbers of tillers per meter row

Among the treatments the number of tillers per meter row were significantly different. At 60 DAS the highest number of tillers per meter row was measured in weedy free check (113) traced by Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (106) and Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (97). Other treatments were almost at par and the recorded number of tillers were lower.

The highest number of tillers per meter row at harvest were recorded in weedy free check (120) which was almost at par with Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (118) and Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (118). The weed free condition might have the positive effects on number of tillers due to sufficient nutrients, sunlight, space, water and other growth affecting factors in these treatments compare to weedy check (control), Hand hoeing at 21 DAS and (101) and Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS(103), were recorded the lowest number of tillers.

Table 9. Mean number of tillers per meter row as influenced by different treatments and Leaf: stem ration at harvest

Treatments	Number of tillers		Leaf: stem ratio at harvest
	At 60 DAS	**At Harvest**	
Weedy check (Control).	80	102	0.790
Weed free check.	113	120	1.133
Hand weeding at 21 DAS.	96	116	1.213
Hand hoeing at 21 DAS.	86	101	1.193
Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.	97	118	0.967
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.	92	110	0.693
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS.	106	118	1.193
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.	90	103	1.067
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS.	95	104	1.267
S.E.m.±	0.878	1.182	0.014
C.D (P=0.05)	2.656	3.573	0.043
General Mean	**95.000**	**110.222**	**1.057**

Weed control efficiency (WCE)

Different weed control treatments were affecting the weed control efficiency, by observing table 14 we can say that the weedy free check was superior among all the treatments and it recorded 100 % weed control efficiency (WCE) take a while weedy check (control) treatment recorded 0 % of WCE.

Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (92.061 %) was the second treatment among the highest WCE % and it was followed by Post emergence

application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS (87.212 %) which was at par with Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (87.152 %) and Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS (85.091 %). The higher weed control efficiency in these treatments could be due the appropriate methods of the weed control. Hand hoeing at 21 DAS (53.455 %) recorded the lowest weed control efficiency and it was followed by Hand weeding at 21 DAS (73.939 %) which indicates that a single method of weed control could not be that much effective as a combination of two or more methods is. The similar results were also reported by Tiwari *et al*. (2011).

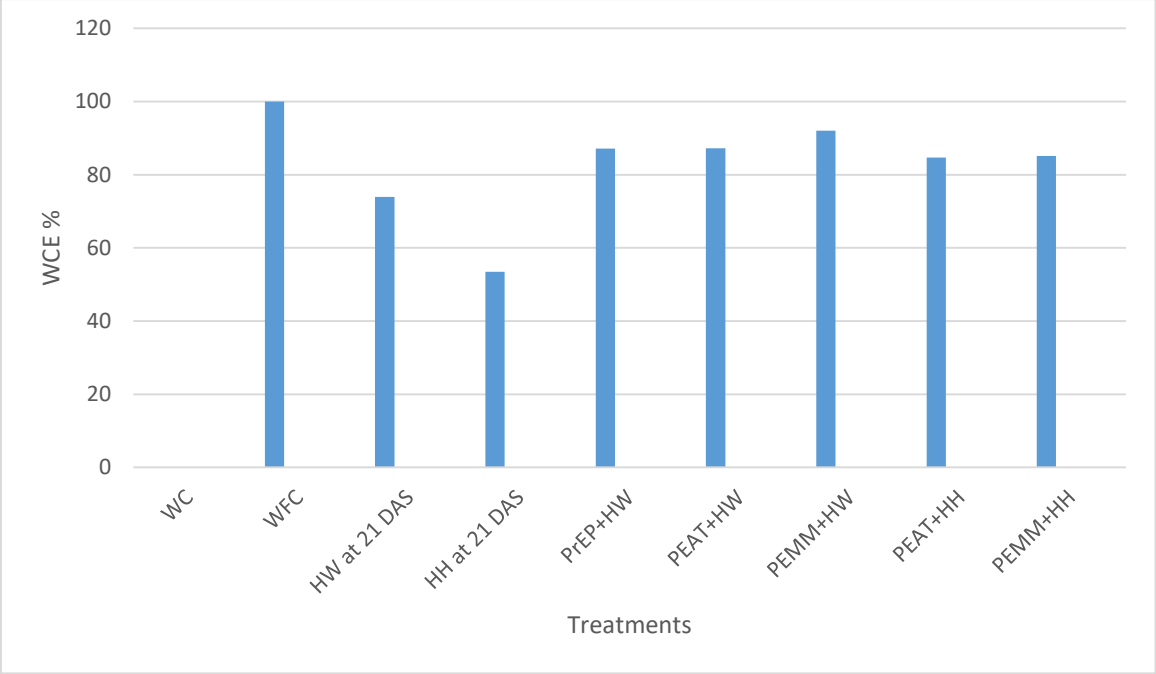

Fig. 7. WCE % as influenced by different treatments

Weed Index (WI)

Likewise the WCE, WI was significantly influenced by various treatments. The lowest WI (0 %) was recorded in weedy free check which indicates that there was not any negative effect of weeds population on the yield. It was followed by Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (3.647 %) which was at par with Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (7.231 %).

Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS (12.710 %), Hand weeding at 21 DAS (17.230 %), Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS (25.386 %). weedy check (45.426 %) recorded the highest WI due to no control of the weeds during the investigation period which could lead to the lowest yield among all the treatments. These results are in conformity with the results which had been reported by Pandey *et al*. (2001) who stated the use of Metsulfuron methyl alone or with combination of 2-4-D could be much effective in control of the broad leaf weeds in the field of wheat.

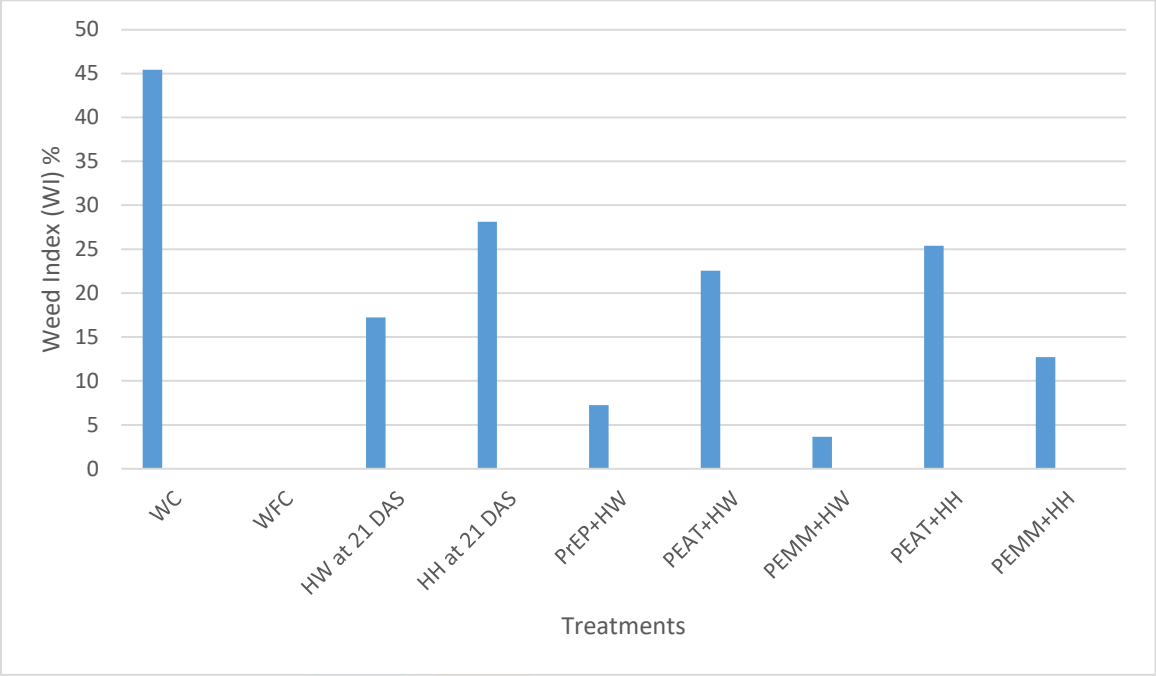

Fig. 8. Weed Index as influenced by different treatments

Yield Studies

Green forage yield of the Oats was varied significantly between the different treatments. The highest green forage yield (449.60 q ha -1), and highest dry matter yield (97.280 q ha -1) were recorded in weedy free check which is due to the complete removal of the weeds during the growth period of crop and it was almost equal with Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS which recorded (433.01 q ha -1) and (92.283 q ha -1) in terms of green forage yield and dry matter yield. After these treatments, Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (416.90 q ha -1) of green forage yield and (87.083 q ha -1) of dry matter yield was the highest among all the treatments. The pre-emergence application of the herbicides could lead to efficient control of the weeds and might help the plant to get regular sun light, nutrients and other essentials for the life which is finally leading to higher yield.

Table 15. Green forage and dry matter yield of oat (q ha-1) as influenced by different treatments.

Symbol	Treatment	Green Forage Yield q ha $^{-1}$	Dry Matter Yield q ha $^{-1}$
T1	Weedy check (Control).	245.253	45.360
T2	Weed free check.	449.600	97.280
T3	Hand weeding at 21 DAS.	371.966	73.840
T4	Hand hoeing at 21 DAS.	322.933	61.300
T5	Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.	416.903	87.083
T6	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.	348.106	66.773
T7	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS.	433.010	92.283
T8	Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.	335.316	63.807
T9	Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand hoeing at 35 DAS.	392.283	81.453
S.E.m.±		29.140	0.037
C.D (P=0.05)		88.115	0.111
General Mean		368.374	74.353

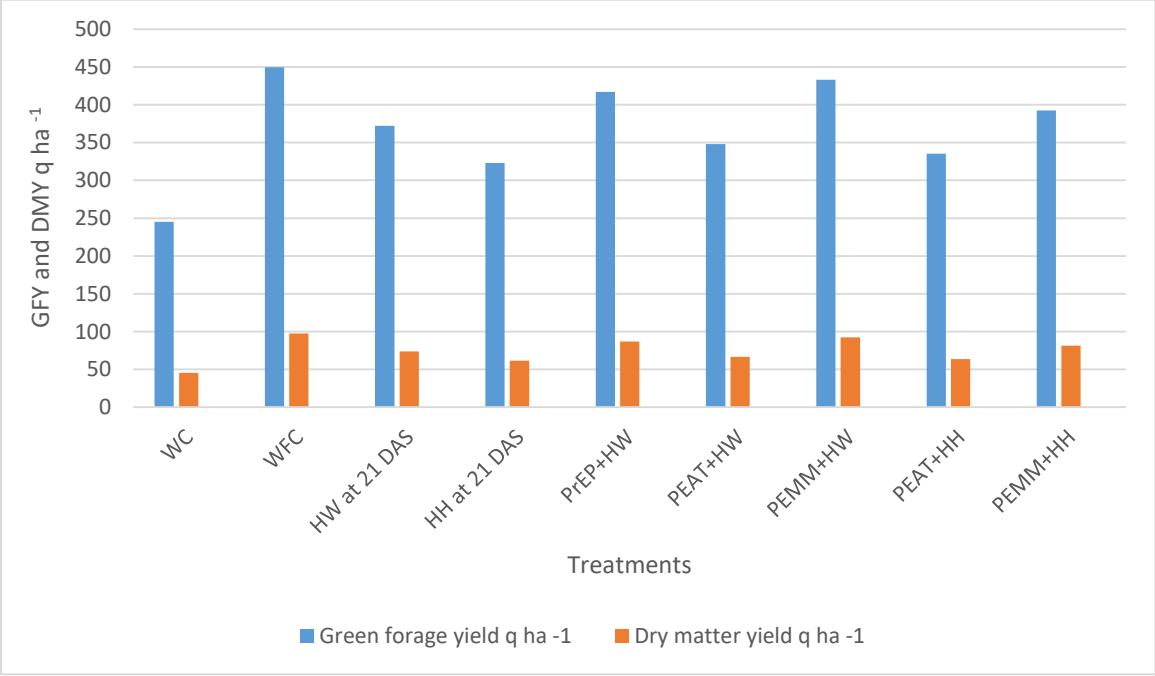

Fig. 8. Green forage and dry matter yield (q ha-1) as influenced by different treatments.

Economics of weed control

Gross monetary returns

By observing table 17 we can understand that gross monetary returns were highest in weedy free check (Rs. 49537.8 ha -1) and it was almost equal with Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (Rs. 47620.9 ha -1) and these treatments were followed by Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (Rs. 45934.4 ha -1) which was at par with Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS (Rs. 43117.9 ha -1). The lowest gross monetary returns (Rs. 27018.7 ha -1) was recorded in weedy check (control) treatment because there was minimum amount of green forage yield and dry matter yield.

Cost of cultivation

Cost of cultivation was highest in weedy free check (Rs. 34082 ha -1) among all the treatments. This could be contributed with the long working manual of the treatment which contained many periods of weed removal which required more labors and time compare to the other treatments. Kumar *et al* (2001) stated similar data. It was followed by Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS (Rs. 22992 ha -1) and it could be due to higher cost of the herbicides which had been used. The lowest cost of cultivation (Rs. 15392 ha -1) was recorded in weedy check and since there was no requirement of labors and herbicides for weed control. It was following by Hand hoeing at 21 DAS (Rs. 19592 ha -1) which was at par with Hand weeding at 21 DAS (Rs. 21692 ha -1).

Net monetary returns

According to the net monetary returns, Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS (Rs. 25531.9 ha -1) was higher than the other treatments. It was followed by Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS (Rs. 22977.4 ha -1) which was almost equal with Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS (Rs. 21208.9 ha -1) and Hand weeding at 21 DAS (Rs. 19302.9 ha -1). Sharma *et al*. (2006) stated the same results and more ever they had reported that the higher net returns and benefit: cost ratio could be due to cost effective weed control techniques. The lowest net monetary returns were observed in weedy check (Rs. 11626.7 ha -1).

Table 17. Economics of weed control in oat (Rs. ha-1) as influenced by different treatments.

Treatments	Gross monetary returns (Rs ha-1)	Cost of cultivation (Rs ha-1)	Net monetary returns (Rs ha-1)	B: C Ratio
Weedy check (Control).	27018.7	15392	11626.7	1.75
Weed free check.	49537.8	34082	15455.8	1.45
Hand weeding at 21 DAS.	40994.9	21692	19302.9	1.88
Hand hoeing at 21 DAS.	35582.5	19592	15990.5	1.81
Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS.	45934.4	22957	22977.4	2.00
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand weeding at 35 DAS.	38384.6	22992	15392.6	1.66
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS.	47620.9	22089	25531.9	2.15
Post emergence application of Atrazine @ 0.75 kg a.i. ha-1 at 21 DAS + One hand hoeing at 35 DAS.	37034.3	22152	14882.3	1.67
Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand hoeing at 35 DAS.	43117.9	21909	21208.9	1.96
S.E.m.±	--	--	--	--
C.D (P=0.05)	--	--	--	--
General Mean	40580.6	22539.6	18041.0	1.81

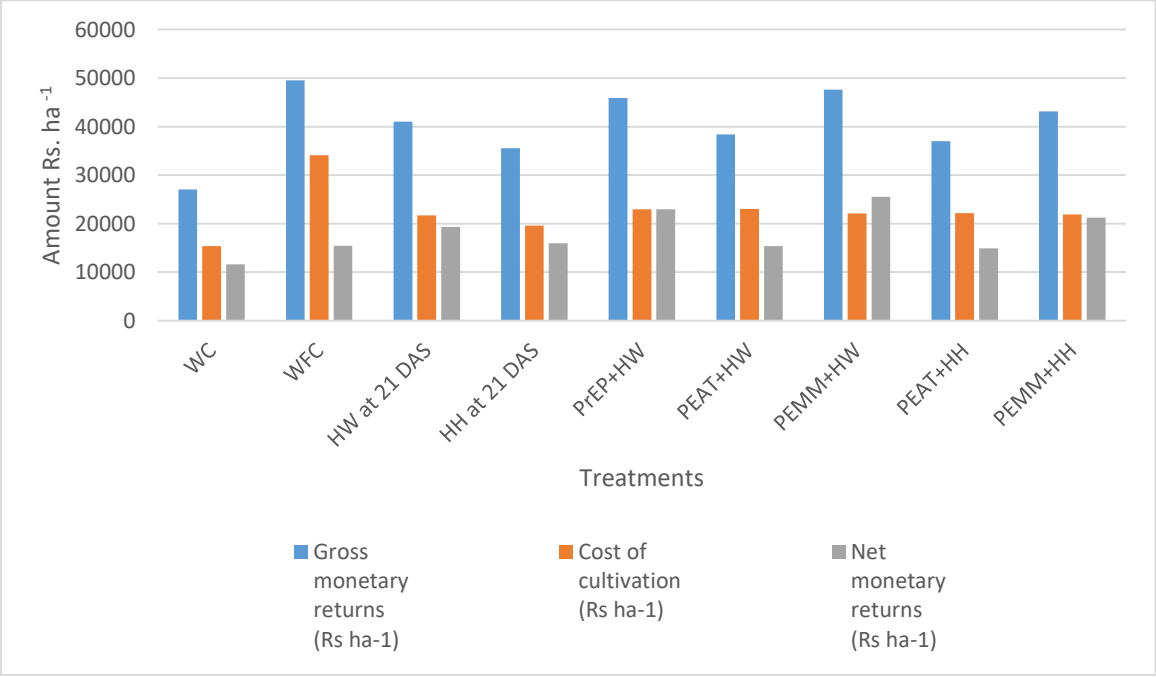

Fig. 10. Economics of weed control (Rs. ha-1) as influenced by different treatments.

Conclusion

Weeds are included in major pests of the crop which decreases the crop yield by a high percentage. Oat yield might decrease with a big percentage whenever weeds are competing with the crop for light, water, space and nutrients. There are many herbicides and chemicals to control weeds but they should be used as an additional tools not as main treatment. When one control method chemical or mechanical is used for a while it may causes weed resistance against that method. The following conclusions were achieved from the investigation.

i. Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS recorded the highest green forage and dry matter yield which was almost level with weedy free check.
ii. Pre-emergence application of pendimethalin @ 0.75 kg a.i. ha-1 + one Hand weeding at 35 DAS was the most effective treatment for weed control in the early stages of the crop growth.
iii. Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha-1 at 21 DAS + one hand weeding at 35 DAS insured the highest weed control efficiency (WCE) as well as the lowest weed index (WI), compare to the other treatments in which herbicides or other methods are used.
iv. Different weed control treatments were not affecting crude protein and crude fibre contents but their yield was varied with green forage and dry matter yield.
v. Post emergence application of metsulfuron methyl @ 0.004 kg a.i. ha- 1 at 21 DAS + one hand weeding at 35 DAS recorded highest net monetary returns among all the treatments and the Benefit: cost ratio was (2.00).

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