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# Influence of Different Weed Management Practices on Broad Leaf Weeds and their effect on economics of Wheat (*Triticum aestivum* L.).

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**ABSTRACT: A field experiment was conducted during *rabi,* season of 2016-17 at Crop Research Station, Masodha, Ayodhya (U.P.). The experiment consisting of Eleven treatments was laid out in randomized block design with three replications. The crop was infested with the divergent type of weed flora e.g. *Phalaris minor, Fumaria parviflora* and *Cynodondactylon* of grassy, *Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus alba* and *Solanum nigrum* of broad-leaved and *Cyperus rotundus, Cyprus iria* and *Cyprus difformis* of sedges group. The sowing of wheat variety NW-5054 (Narendra wheat 5054) was done on 22$^{th}$ November 2016, and harvesting was done on 10$^{th}$ April, 2017. The results revealed that Metsulfuron + Carfentrazone @ 4 + 20 g ha$^{-1}$ and Halauxifen-methyl Ester +Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g ha$^{-1}$ gave higher weed control efficiency (85.51%, 84.30%), lower weed index (3.75%, 5.85%) respectively. Among of all treatments recorded higest Benefit Cast ratio in Metsulfuron + Carfentrazone @ 4 + 20 g ha$^{-1}$ fallowed by Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g ha$^{-1}$ (1.37 and 1.34). The minimum weeds density of *Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus alba* was also noticed under Metsulfuron + Carfentrazone @ 4 + 20 g ha$^{-1}$ fallowed by Halauxifen-methyl Ester +Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g ha$^{-1}$ at different stages. And also total weeds density as well as total weeds dry matter was found low in Metsulfuron + Carfentrazone @ 4 + 20 g ha$^{-1}$ followed by Halauxifen-methyl Ester +Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g ha$^{-1}$ at all stage except 30 days. Based on all the observations recorded, Metsulfuron + Carfentrazone @ 4+20 g ha$^{-1}$ fallowed by Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g ha$^{-1}$ PoE has performed better in all respects amongst all the herbicide applied treatment.**

**Keywords:** Benefit-cost ratio, post-emergence herbicides application, total weed density, weed control efficiency and weed index.

## INTRODUCTION

Wheat (*Triticum aestivum* L.) in India's is second most important cereal crop after rice, and accounts for 31.5% of the country's total food grain basket.Wheat is generally infested by both grassy weeds viz., *Phalaris minor* and *Avena* spp. and broad leaf weeds i.e. *Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus alba*. Hence, weed control is essential for increasing the wheat production. It has been reported that with production of each kilogram of weeds, one-kilogram of wheat grains are reduced (Chaudhary *et al*., 2008). Weed infestation is one of the main causes of low wheat yield not only in India but all over the world, as it reduces wheat yield by 37-50% (Waheed *et al.*, 2009). Rice-wheat are one of the most important cropping systems in northern part of the country. Weeds are considered as one of the major constraints in wheat cultivation. The prominent weeds noted in wheat fields are *Phalaris minor, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis, Lathyrus aphaca, Cyperus rotundus* and *Cynodon dactylon* etc. which alone cause 33% reduction in wheat yield. Rice-wheat is one of the most important cropping systems in northern part of the country (Chhokar and Sharma 2008). Broad-leaved weeds (BLWs) like *Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus*

*alba* are causing a serious problem in wheat crop because they are highly competitor of nutrient, water, sunlight and spacing at enitial stage but their management is possible with the help of hand weeding and herbicides. In hand weeding more labour are required at peack of weed infestation but and requirement of labour are not complete at that time due to scare and costly labour as well as lesser feasibility of mechanical or manual therefore we have one option go for herbicide application and other advantage of herbicide they manage the both weeds inter row as well as intra row weeds. This crop has competition with several grassy and broad-leaf weeds during its growth period depending upon the adopted agronomic practices, soil types, underground water quality, weed control techniques and cropping system followed. The losses caused by weeds depend on their type, abundance and environmental factor which may be minimized to a greater extent simply by adopting an appropriate weed management practices. The crop rotations, tillage and herbicides have pronounced effect on the type of weed flora (Anderson and Beck 2007). For control of broad-leaf weeds in wheat, three major herbicides used in India are metsulfuron, 2, 4-D and carfentrazone (Chhokar and Sharma 2008). Halauxifen methyl is a novel arylpicolinate herbicide with an auxinic mode of action. Halauxifen-methyl 7.5 g $ha^{-1}$ EC alone achieved a high control effect of 96.5-100% and 81.1-94.1% to *Galium aparine* and *Descurainia sophia*, at the dosage of 7.5 g $ha^{-1}$ when applied during spring or autumn in winter wheat, but failed to control *Lithospermum arvense*, and *Silene conoidea* Li Mei, (2016). During the surveys and meet with farmers, it was found that the herbicide resistance in weeds evolved due to non-following of herbicides rotation, wrong time and method of herbicide application. If one herbicide stops working therefore farmers only change the brand of herbicides, not the group of the herbicides. This indicated the need for intervention of herbicides with different mode of action in the rotation or sequential application for managements of complex weed flora in wheat crop. Tank-mix or pre-combination of different herbicide application. Keeping all the above facts in view, an attempt was made to find out the efficacy of different herbicides against different complex of weed flora to improve the productivity of wheat crop.

## MATERIALS AND METHODS

The experimentwas conducted during *rabi* season of 2016-17 at Crop Research Station, Masodha, Ayodhya (U.P.). The experimental site is situated at Crop Research Station, Masodha, about 6 km away from Faizabad city on Sultanpur road, which is working under A.N.D. University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The geographical position of this farm is 26°43′N latitude, 82°8′E longitude and an altitude of 113 meters above mean sea level. The average annual rainfall of this locality is 1109.0 mm, about 75 to 80% of which precipitates during middle of June to middle of October (about 120 days) and there is very scanty rainfall during the remaining period (245 days). But the total rainfall during course of experimentation was 17.50 mm. During crop season Nov. 2016-April 2017, minimum in January and maximum in April month, temperature ranged between 4.9 to 20.6°C and 19.3 to 39.6°C, respectively. While the mean relative humidity was in the ranges of 84.9 to 88.20% at 7:00 AM and 55.73 to 75.41% at 2:00 PM respectively. The range of average sun shine hour and evaporation were 1.1 hr. to 8.9 hr. and 0.4 mm to 8.5 mm, respectively. The soil of experimental field was slightly alkaline in reaction (7.6 *p*H), Electrical conductivity (0.22 $dSm^{-1}$), organic C (0.42%), available nitrogen (180.0 kg $ha^{-1}$) was low and phosphorus (17.5 kg $ha^{-1}$) and potassium (224.0 kg $ha^{-1}$) was in medium range. Eleven weed management practices viz, $T_1$: Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g $ha^{-1}$, $T_2$.Metsulfuron methyl + surfactant @ 4 g $ha^{-1}$, $T_3$:Carfentrazone @ 20 g $ha^{-1}$, $T_4$: 2,4-D Na (80WP) @ 500 g $ha^{-1}$, $T_5$: 2,4-D E 38 EC @ 500 g $ha^{-1}$, $T_6$: Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$, $T_7$: 2,4-D Na + Carfentrazone @ 400+20 g $ha^{-1}$, $T_8$: 2,4-D E + Carfentrazone @ 400+20 g $ha^{-1}$, $T_9$: Halauxifen-methyl +Florasulam + Carfentrazone@ 10.21+20 g $ha^{-1}$, $T_{10}$: Weed free(two hand weeding at 20 and 45 DAS), $T_{11}$:Weedy check, respectively in a randomized block design (RBD) with three replications. The size of the experimental plot was 9.8 $m^{-2}$. The wheat variety NW-5054 (Narendra wheat 5054) were sown in row to row spacing of 20 cm, on November 22, 2016, using seed-rate @ 100 kg $ha^{-1}$. Urea, DAP and muriate of potash were used to supply 120 kg N, 60 kg $P_2O_5$ and 40 kg $K_2O$ respectively. Half dose of nitrogen and full dose of phosphorus potassium were applied as basal dressing in the field at the time of sowing. Remaining half dose of nitrogen through urea was top-dressed after first irrigation. The herbicides were sprayed with the help of a hand-operated Knapsack sprayer fitted with flat fan nozzle using 600 liters of water $ha^{-1}$. Nitrogen content were estimated by using micro-kjeldahl distillation method, phosphorus by vanado-molybdo-phosphoric acid yellow colour method, potassium by flame photometer method. Since the data transformation is the most appropriate remedial measure for variance heterogeneity where the variance and mean values are functionally related into a new scale resulting in a new data set that is expected to satisfy the condition of homogeneity of variance. The data on population of individual weed species and their dry matter were analysed after square root transformation by

$\sqrt{x+1}$, the treatment comparisons were made at 5% level of significance.

## RESULTS AND DISCUSSION

*A. Effect on Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus alba of wheat crop*

Divergent weed flora like *Phalaris minor, Cynodon dactylon, Avena fatua* of grassy weeds, *Chenopodium album, Convolvulus arvensis, Anagallis arvensis, Melilotus alba, Rumex* spp. and *Vicia hirsuta* of broad leaf weed and *Cyperus rotundus* of sedges were noted. Similar weed flora of wheat crop under normal as well as late sown condition have also reported by Bharat *et al.,* (2012); Bhullar *et al*., (2012); Singh *et al*., (2017).

The observation recorded periodically on the population of *Chenopodium album* is summarized in (Table 1), indicate that all the weed management practices had significant effect on density of weeds $m^{-2}$ at all stages of plant growth. The data further revealed that all weed management practice reduced density of *Chenopodium album* significantly over weedy check at all stages of crop growth except at 30 DAS where only weed free treatment reduced weed density significantly over rest of the weed management practices. At 60 and 90 DAS minimum weed density recorded with weed free which was significantly lesser than rest of the weed management practices. Herbicide combination Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$ was found most effective for reduced the population of weed being at par with Halauxifen - methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g $ha^{-1}$ both are comparable to weed free while significantly superior than rest of the weed management practices at all stages except 30 DAS due herbicides are used as post emergence application. These findings were in conformity with those reported by Shivran *et al.,* (2020).

**Table 1: Effect of various weed management practices on *Chenopodium album, Convonvulus arvensis, Anagallis arvensis, Melilotus alba* density ($m^{-2}$) at different growth stages of wheat.**

| Tretments | *C. album* (No. $m^{-2}$) | | | *C. arvensis* (No. $m^{-2}$) | | | *A. arvensis* (No. $m^{-2}$) | | | *M. alba* (No. $m^{-2}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| Halauxifen-methyl Ester +Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g $ha^{-1}$ | 5.27 (26.80) | 2.54 (5.50) | 2.80 (6.87) | 4.59 (20.10) | 2.15 (3.67) | 2.31 (4.40) | 3.61 (12.06) | 1.78 (2.20) | 2.07 (3.33) | 3.00 (8.04) | 1.59 (1.57) | 1.88 (2.57) |
| Metsulfuron methyl + surfactant @ 4 g $ha^{-1}$ | 5.11 (25.20) | 3.00 (8.03) | 3.19 (9.20) | 4.46 (18.90) | 2.24 (4.03) | 2.46 (5.13) | 3.51 (11.34) | 1.85 (2.43) | 2.16 (3.70) | 2.92 (7.56) | 1.63 (1.67) | 1.96 (2.87) |
| Carfentrazone @ 20 g $ha^{-1}$ | 5.15 (25.60) | 3.38 (10.43) | 3.58 (11.87) | 4.48 (19.20) | 2.32 (4.40) | 2.58 (5.67) | 3.53 (11.52) | 2.10 (3.43) | 2.33 (4.47) | 2.94 (7.68) | 1.79 (2.21) | 2.05 (3.23) |
| 2,4-D Na (80WP) @ 500 g $ha^{-1}$ | 5.23 (26.40) | 3.47 (11.07) | 3.63 (12.20) | 4.56 (19.80) | 2.38 (4.67) | 2.64 (6.00) | 3.58 (11.88) | 2.11 (3.48) | 2.40 (4.80) | 2.98 (7.92) | 1.81 (2.30) | 2.09 (3.40) |
| 2,4-D E 38 EC @ 500 g $ha^{-1}$ | 5.30 (27.20) | 3.53 (11.50) | 3.67 (12.50) | 4.61 (20.40) | 2.47 (5.13) | 2.68 (6.20) | 3.63 (12.24) | 2.20 (3.85) | 2.43 (4.93) | 3.02 (8.16) | 1.83 (2.37) | 2.12 (3.50) |
| Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ | 5.27 (26.80) | 2.32 (4.40) | 2.55 (5.53) | 4.59 (20.10) | 1.97 (2.87) | 2.04 (3.17) | 3.61 (12.06) | 1.68 (1.83) | 1.82 (2.33) | 3.00 (8.04) | 1.51 (1.15) | 1.74 (2.03) |
| 2,4-D Na + Carfentrazone @ 400 + 20 g $ha^{-1}$ | 5.11 (25.20) | 3.08 (8.53) | 3.28 (9.80) | 4.46 (18.90) | 2.25 (4.07) | 2.49 (5.20) | 3.51 (11.34) | 2.04 (3.17) | 2.27 (4.17) | 2.92 (7.56) | 1.65 (1.72) | 1.94 (2.77) |
| 2,4-D E + Carfentrazone @ 400+20 g $ha^{-1}$ | 5.04 (24.40) | 3.16 (9.03) | 3.43 (10.77) | 4.39 (18.30) | 2.28 (4.20) | 2.53 (5.43) | 3.45 (10.98) | 2.06 (3.29) | 2.30 (4.33) | 2.87 (7.32) | 1.72 (1.97) | 2.03 (3.13) |
| Halauxifen-methyl +Florasulam+ Carfentrazone@ 10.21 + 20 g $ha^{-1}$ | 5.11 (25.20) | 2.94 (7.67) | 3.10 (8.67) | 4.46 (18.90) | 2.23 (4.00) | 2.39 (4.73) | 3.51 (11.34) | 1.82 (2.34) | 2.09 (3.40) | 2.92 (7.56) | 1.60 (1.58) | 1.89 (2.60) |
| Weed free (two hand weeding at 20 and 45 DAS) | 2.64 (6.00) | 1.00 (0.00) | 1.00 (0.00) | 2.36 (4.67) | 1.00 (0.00) | 1.00 (0.00) | 2.11 (3.49) | 1.00 (0.00) | 1.00 (0.00) | 2.13 (3.57) | 1.00 (0.00) | 1.00 (0.00) |
| Weedy check | 5.07 (24.80) | 5.40 (28.23) | 5.68 (31.33) | 4.42 (18.60) | 4.33 (17.73) | 4.08 (15.70) | 3.48 (11.16) | 3.56 (11.67) | 3.68 (12.60) | 2.90 (7.44) | 2.80 (6.89) | 2.93 (7.63) |
| SEm ± | 0.06 | 0.08 | 0.08 | 0.12 | 0.06 | 0.09 | 0.08 | 0.03 | 0.09 | 0.05 | 0.03 | 0.04 |
| CD (P = 0.05) | 0.19 | 0.25 | 0.25 | (0.36) | 0.18 | 0.27 | 0.24 | 0.11 | 0.28 | 0.15 | 0.10 | 0.14 |

Figures in parentheses are original values, while outside are transformed values ($\sqrt{x+1}$)

The data recorded on *Convolvulus arvensis* at various stage of crop growth presented in (Table 1), indicate that all the weed management practices had significant effect on density of *Convolvulus arvensis* $m^{-2}$ at all stages of crop growth. Density of *Convolvulus arvensis* tended to decline with advancement in crop age irrespective of the treatments. Data further revealed that all weed management practice reduced density of *Convolvulus arvensis* significantly over weedy check at all stages of crop growth except 30 DAS where only weed free treatment reduced the weed population significantly over rest of the treatment. Weed free treatment gave most effective management and reduced the density of *Convolvulus arvensis* significantly over rest of the weed management practices. Herbicide combination Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ found most effective for reduced the population of weed being at par with Halauxifen- methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2 N @ 12.76 g $ha^{-1}$ both are comparable to weed free while significantly superior than other herbicide combination at all stage of crop growth except 30 DAS. Maximum weed density recorded under weedy check situation at all stages except 30 DAS.

The observation recorded periodically on the population of *Anagallis arvensis* is summarized in (Table 1), indicate that the density of *Anagallis arvensis* influenced significantly by different weed management

practices at all stage of crop growth. Data further revealed that all weed management practice reduced density of *Anagallis arvensis* significantly over weedy check at all stages except at 30 DAS where only weed free treatment reduced weed density significantly over rest of the weed management practices. At 60 and 90 DAS weed free condition recorded minimum weed density which was significantly lesser than rest of the weed management practices. Herbicide combination Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ found most effective for reduced the population of *Anagallis arvensis* being at par with Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g $ha^{-1}$ both are comparable to weed free while significantly superior than rest of the herbicide. almost similar finding reported by Raj *et al*., (2020). Maximum density of *Anagallis arvensis* recorded under weedy check situation at all stage except 30 DAS.

The observation recorded periodically on the population of *Melilotus alba* is presented in (Table 1), the data indicate that weed management practices had significant effect on density of *Melilotus alba* at all stage of crop growth. All weed management practices reduced density of *Melilotus alba* significantly over weedy check at all stages except at 30 DAS where only weed free treatment reduced weed density significantly over rest of the weed management practices. At 60 and 90 DAS weed free situation reduced the density of *Melilotus alba* significantly lesser than rest of the weed management practices. Herbicide combination Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ reduced population of *Melilotus alba* being at par with Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2 N @ 12.76 g $ha^{-1}$ both are comparable to weed free while significantly superior than rest of the herbicide. almost similar finding reported by Raj *et al*. (2020). Maximum density of *Melilotus alba* recorded under weedy check situation at all stage except 30 DAS.

*B. Effect on total weed density, total weed dry matter, weed control efficiency and weed index*

The total weed population is presented in (Table 2), at 30 DAS only weed free recorded minimum population of weeds significantly lesser than rest of the weed management practices, this might be due to the fact only one hand weeding was applied at 20 DAS in experimental field therefore this treatment found best in all weed management practices reduced the Broad leaf weeds population significantly over weedy check, At $60^{th}$, $90^{th}$ DAS and at harvest stages of crop growth, weed free treatment recorded lowest weeds at all stages due to slow pace of growth by first flush of weeds at 20 DAS (By hand weeding) after that the emergence of new flushes of weed could not attain full growth under the shade of wheat crop. Next to weed free, post emergence application has Metsulfuron + Carfentrazone @ 4+20 $gha^{-1}$ has been found most effective to manage the Broad leaf weeds as compared to other herbicide at all the growth stages. While statistically at par with Halauxifen - methyl ester + Florasulam + Polyglycol @ 12.76 g $ha^{-1}$ and both were significantly superior to rest of the weed management practices. Almost similar finding reported by Singh *et al*., (2011); Chhokar *et al*., (2015).

In case of total weed dry matter accumulation is presented in (Table 2), Synonymous to weed density, weed dry weight was also reduced significantly by the different weed management practices as compared to un-weeded control at all the stages of crop growth.

The weed dry weight recorded at harvest stage was lower than $90^{th}$ day stage due to senescence of weed plants with the advancement of age. Weed free recorded lowest weed dry weight which was significantly lowest than rest of the weed management practices. Next to weed free, Post emergence application of Metsulfuron + Carfentrazone@ 4 + 20 g $ha^{-1}$ was found most effective to reduce the weed dry weight (g) $m^{-2}$ which remained at par with Post emergence application of Halauxifen - methyl ester + Florasulam + Polyglycol @12.76 g $ha^{-1}$, it might be due to minimum weed density under these treatments have resulted in reduced weed dry weight. These results may be corroborated by Singh *et al*., (2010); Singh *et al*., (2011); Meena and Singh (2011); Hou *et al*., (2012); Chhokar *et al*., (2015).

The spectrum of Broad leaf weeds has a bearing on the efficiency of the management practices adopted. The Weed control efficiency is presented in (Table 2), Next to weed free (100%), Post emergence application of Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ provided the highest weed control efficiency (85.51%) followed by Post emergence application of Halauxifen - methyl ester + Florasulam + Polyglycol @12.76 g $ha^{-1}$ **(**84.30%**).** This was mainly due to lowest weed dry weight under the effects of above treatments. Also reported by Meena and Singh (2011); Li *et al*., (2016); Su *et al*., (2016).

Weed index is the measure of reduction in yield caused by weed infestation and directly related with weed density and weed dry matter. The Weed Index is presented in (Table 2), Next to weed free (0%), Post emergence application of Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$ recorded lowest weed index of (3.75%**)** followed by post emergence application of Halauxifen - methyl ester + Florasulam + Polyglycol @ 12.76 g $ha^{-1}$ of (5.82**)** as compared to weedy check (39.66). This might be mainly due to lesser crop weed competition in herbicidal treatment as compared to weedy check within term resulted higher yield vice-versa reduce weed index.

**Table 2: Effect of various weed management practices on total weed density (No. $m^{-2}$) weed dry matter (g $m^{-2}$) at different growth stages, weed control efficiency and weed index of wheat.**

| Tretments | Total weed density (No. $m^{-2}$) | | | | Weed dry matter (g $m^{-2}$) | | | | W.C.E. (%) | W.I. (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | At harvest | 30 DAS | 60 DAS | 90 DAS | At harvest | | |
| Halauxifen-methyl Ester + Florasulam 40.85% WG + Polyglycol 26-2N @ 12.76 g $ha^{-1}$ | 9.28 (85.20) | 4.36 (18.03) | 4.93 (23.47) | 4.33 (17.92) | 5.76 (32.35) | 5.43 (28.67) | 5.99 (35.00) | 5.19 (26.00) | 84.30 | 5.82 |
| Metsulfuron methyl + surfactant @ 4 g $ha^{-1}$ | 9.10 (81.87) | 4.72 (21.37) | 5.32 (27.37) | 4.80 (22.13) | 5.91 (34.17) | 6.33 (39.13) | 6.75 (44.67) | 6.00 (35.20) | 78.75 | 8.96 |
| Carfentrazone @ 20 g $ha^{-1}$ | 9.21 (83.87) | 5.30 (27.15) | 5.74 (32.10) | 5.26 (26.82) | 5.56 (30.13) | 6.69 (43.87) | 7.11 (49.73) | 6.37 (39.67) | 76.05 | 15.03 |
| 2,4-D Na (80WP) @ 500 g $ha^{-1}$ | 9.27 (85.00) | 5.40 (28.21) | 5.85 (33.33) | 5.38 (27.96) | 5.73 (31.90) | 6.83 (45.83) | 7.30 (52.33) | 6.55 (42.00) | 74.64 | 15.41 |
| 2,4-D E 38 EC @ 500 g $ha^{-1}$ | 9.41 (87.67) | 5.54 (29.79) | 5.93 (34.33) | 5.49 (29.27) | 5.52 (29.57) | 6.85 (46.28) | 7.36 (53.23) | 6.66 (43.50) | 73.74 | 18.79 |
| Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$ | 9.29 (85.43) | 3.95 (14.65) | 4.35 (18.08) | 3.75 (13.16) | 5.87 (33.50) | 5.31 (27.33) | 5.79 (32.67) | 4.99 (24.00) | 85.51 | 3.75 |
| 2,4-D Na + Carfentrazone @ 400 + 20 g $ha^{-1}$ | 9.05 (81.00) | 4.94 (23.49) | 5.42 (28.45) | 4.89 (23.01) | 5.89 (33.83) | 6.56 (42.23) | 6.99 (48.00) | 6.27 (38.33) | 78.86 | 9.77 |
| 2,4-D E + Carfentrazone @ 400 + 20 g $ha^{-1}$ | 8.92 (78.67) | 5.06 (24.64) | 5.58 (30.25) | 5.10 (25.10) | 5.75 (32.27) | 6.67 (43.67) | 7.14 (50.00) | 6.32 (39.00) | 76.45 | 13.15 |
| Halauxifen-methyl +Florasulam+ Carfentrazone@ 10.21+20 g $ha^{-1}$ | 9.05 (81.00) | 4.65 (20.72) | 5.16 (25.73) | 4.62 (20.47) | 5.63 (30.83) | 6.30 (38.73) | 6.57 (42.23) | 5.94 (34.33) | 79.87 | 8.83 |
| Weed free (two hand weeding at 20 and 45 DAS) | 5.10 (25.09) | 1.00 (0.00) | 1.00 (0.00) | 1.00 (0.00) | 3.61 (12.10) | 1.00 (0.00) | 1.00 (0.00) | 1.00 (0.00) | 100 | 0 |
| Weedy check | 9.10 (81.90) | 9.49 (89.11) | 10.05 (100.07) | 9.00 (80.05) | 5.48 (29.17) | 9.49 (89.33) | 13.5 (181.3) | 12.90 (165.67) | 0 | 39.66 |
| SEm ± | 0.13 | 0.15 | 0.20 | 0.20 | 0.18 | 0.22 | 0.13 | 0.10 | - | - |
| CD (P =0.05) | 0.38 | 0.45 | 0.61 | 0.60 | 0.55 | 0.67 | 0.41 | 0.31 | - | - |

Figures in parentheses are original values, while outside are transformed values ($\sqrt{x+1}$)

*C. Effect on Economics of wheat crop*

The economics are presented in (Table 3), The highest cost of cultivation of (Rs. 55468 $ha^{-1}$) was incurred under weed free against the lowest cost of cultivation of weedy check (Rs. 44468 $ha^{-1}$). In all weed management practices recorded higher gross return, net return and benefit cost ratio over weedy check. The maximum gross return of (Rs. 113250 $ha^{-1}$) was obtained with weed free closely followed by Metsulfuron + Carfentrazone @ 4 + 20 $gha^{-1}$ (Rs. 109068 $ha^{-1}$) against lowest gross income (Rs.71590 $ha^{-1}$) in weedy check. Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$ recorded the highest net return of (Rs. 63150 $ha^{-1}$) closely followed by and Halauxifen-methyl ester + Florasulam+ Polyglycol @ 12.76 g $ha^{-1}$ (Rs. 61312) and against lowest net return of (Rs. 27122 $ha^{-1}$) noted with weedy check. Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ treatments also recorded highest benefit cost ratio of (1.37), as compared to weedy check of (0.60). The weed free was not found to be economical in comparison to other herbicidal treatments because of its high labours expenditure involved in keeping the plots free from weeds. In the herbicides the better net return and net return per rupee investment was mainly due to lesser increase in cost of cultivation with these treatments compare to weed free. Almost similer result was reported by Singh & Saha, (2009).

**Table 3: Effect of various weed management practices on economics of wheat.**

| Treatments | Total cost of cultivation (Rs $ha^{-1}$) | Gross return (Rs $ha^{-1}$) | Net return (Rs $ha^{-1}$) | B-C ratio |
|---|---|---|---|---|
| Halauxifen-methyl Ester +Florasulam 40.85% WG +Polyglycol 26-2N @ 12.76 g $ha^{-1}$ | 45568 | 106880 | 61312 | 1.34 |
| Metsulfuron methyl + surfactant @ 4 g $ha^{-1}$ | 45418 | 103630 | 58212 | 1.28 |
| Carfentrazone @ 20 g g $ha^{-1}$ | 45668 | 97078 | 51410 | 1.12 |
| 2,4-D Na (80WP) @ 500 g $ha^{-1}$ | 45368 | 97033 | 51665 | 1.13 |
| 2,4-D E 38 EC @ 500 g g $ha^{-1}$ | 45344 | 94092 | 48748 | 1.07 |
| Metsulfuron + Carfentrazone @ 4+20 g $ha^{-1}$ | 45918 | 109068 | 63150 | 1.37 |
| 2,4-D Na + Carfentrazone @ 400+20 g $ha^{-1}$ | 45908 | 102800 | 56892 | 1.23 |
| 2,4-D E + Carfentrazone @ 400+20 g $ha^{-1}$ | 45889 | 99015 | 53126 | 1.15 |
| Halauxifen-methyl +Florasulam + Carfentrazone@ 10.21+20 g $ha^{-1}$ | 46068 | 103892 | 57824 | 1.25 |
| Weed free (two hand weeding at 20 and 45 DAS) | 55468 | 113250 | 57782 | 1.04 |
| Weedy check | 44468 | 71590 | 27122 | 0.60 |

## CONCLUSION

Based on the results obtained from this research that application of Metsulfuron + Carfentrazone @ 4 + 20 g $ha^{-1}$ followed by post emergence application of Halauxifen - methyl ester + Florasulam + Polyglycol @ 12.76 g $ha^{-1}$ 30 DAS was the best herbicide combination and can be recommended for wheat in enhancing grain yield in terms of lower weed population, lower weed dry matter, high weed control efficiency and low in weed index ultimately resulting in higher benefit cost ratio.

## FUTURE SCOPE

Cultivation of wheat without proper weed management is not possible because they compete to crop at all stage. Due to continuous application of sigle herbicide or same type of herbicides, there may be chances of weed shift or growth of resistant weeds agaist herbicides. So further research should also be carried out to manage these adverse circumstances.

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