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INFLUENCE OF TILLAGE PRACTICES AND HERBICIDE REGIMES ON WEED FLORA AND PRODUCTIVITY OF WHEAT

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ABSTRACT

The performance of different broadleaf weed killing herbicides and tillage practices were evaluated on weed dynamics, yield attributes and yield of wheat (*Triticum aestivum* L.) during two successive *Rabi* seasons of 2018-19 and 2019-20 at Varanasi, U.P. The findings revealed that zero tillage recorded significantly minimum number of weeds and weed dry matter resulting into higher weed control efficiency (74.54 % in 2018-19 and 73.62 %) in 2019-20) at 60 days after sowing (DAS) over rest other tillage treatments. Among the weed management practices, carfentrazone-ethyl 30 g /ha accumulated significantly minimum weed population, weed dry matter and improved weed control efficiency (82.68 % in 2018-19 and 81.07 % in 2019-20) next to hand weeding applied at 25 and 45 DAS, however it was at par with carfentrazone-ethyl 40 g/ha (85.33 % in 2018-19 and 83.59 % in 2019-20) and carfentrazone-ethyl 20 g/ha (79.68% in 2018-19 and 78.76 % in 2019-20). The yield determining attributes (effective tillers, earhead length, grain count, spikelet/earhead, 1000- grain weight) and grain yield (4.03 t/ha in 2018-19 and 4.10 t/ha in 2019-20) and straw yield (6.18 t/ha in 2018-19 and 6.10 t/ha in 2019-20) of wheat were significantly higher under carfentrazone-ethyl 30 g /ha over rest other treatments next to hand weeding (25 and 45 DAS). However, it was comparable to that of carfentrazone-ethyl 20 g /ha, metsulfuron-methyl 8 g/ha and metsulfuron-methyl 6 g /ha during both the years of study.

Keywords : Broadleaf weeds, Carfentrazone-ethyl, Conventional tillage, Hand weeding, Metsulfuron-methyl, Wheat, Zero tillage.

Introduction

Wheat (*Triticum aestivum* L.), the highest protein containing cereal, is consumed as the second primary food following rice across India. Among the wheat producing states, the highest wheat production of 32.74 and 32.59 million tonnes from an area of 9.54 and 9.50 million ha was contributed by Uttar Pradesh which is about 31.60 and 30.29% of total nationwide wheat production during the recent past 2018-19 and 2019-20, respectively with a constant productivity of 3432 kg/ha in both the years (Anonymous 2020). This stagnation in wheat productivity is mainly due to ill-effects caused by weeds, excessive tillage and soil health deterioration (Choudhary *et al.,* 2010). The anticipated year-to-year drop of wheat production may also be attributed to the adverse climate change, water scarcity, diseases and weeds infestation *etc.* Weeds are a major issue in wheat farming, and their unchecked growth can cut crop yield by up to 66% (Singh *et al.,* 2015). Indirectly, weeds cause damage to the crops while harboring pests and disease agents. Weed management represents a significant expense in the cultivation of crops within the wheat-producing regions of our subcontinent, particularly in the plains of Uttar Pradesh which is the leading producer of wheat in India (Singh 2018). In the Gangetic plains raising wheat under zero tillage is now being practiced to advance the sowing time and economize the energy use. This helps in utilizing the residual moisture after rice harvest and in many situations pre-sowing irrigation can be avoided and the water used in first irrigation in zero tillage (ZT) fields is much less than in conventionally tilled (CT) fields (Singh *et al.,* 2004).

A single herbicide application is insufficient to control all weed species, and repeated use of the same herbicide may cause weed shift and herbicide resistance (Kaur *et al.,* 2017). When ZT wheat was compared to CT wheat, a significant amount of narrow leaf weed (*Phalaris minor* Retz.) control was seen; however, at the same time, the population of broad leaf weeds rose (Singh *et al.,* 2002). About 73-82% of weed flora in the wheat field comprised of broad leaf weeds and this weed shift can be attributed to selective control of grasses with narrow leaf herbicides in the rice-wheat sequence. There has been 20-50% or even greater grain yield loss on account of heavy weed influx (Balyan and Malik 2000). However, broad leaf weeds found in industrial, utility, and agricultural fields can be effectively controlled with the post-emergence herbicide carbentrazone-ethyl (Victor and Ilango 2003). Similarly the other broad leaf herbicides like 2,4-D and metsulfuron-methyl also controls broad leaf weeds infesting the crops. In agricultural fields and cultivated regions, traditional methods are being employed to control these broadleaf weeds. This practice has detrimental effects on the environment and the financial wellbeing of the farmers, as 90% of the herbicide is wasted due to volatilization, runoff, and erosion, which harms the ecosystem and increases application expenses. On account of the above reasons the present study was undertaken to examine the performance of broad leaf herbicides on the weed mortality and crop productivity.

Materials and Methods

The current study was conducted at the Institute of Agricultural Sciences' Agricultural Research Farm, Varanasi, Uttar Pradesh, India, throughout the course of two consecutive *Rabi* seasons in 2018–19 and 2019–20.

The soil in the experimental field had a texture of sandy clay loam, exhibited a neutral pH (7.32 and 7.27), and possessed a medium level of accessible potassium (190.39 and 193.74) and phosphorus (17 and 18.4), and had low organic carbon (0.319 and 0.327) and nitrogen (208 and 219.6) during the experimental years of 2018-19 and 2019-20, respectively.

Experimental treatments comprised of different crop establishment methods viz. conventional, reduced and zero tillage which were assigned in the main plot and different weed management practices viz. carfentrazone- ethyl 10 g/ha , carfentrazone- ethyl 20 g /ha, carfentrazone- ethyl 30 g /ha, carfentrazone- ethyl 40 g/ha, 2,4-D Amine salt 750 g/ha, metsulfuron-methyl 4 g /ha, metsulfuron-methyl 6 g/ha, metsulfuron-methyl 8 g/ha, hand weeding at 25 & 45 DAS and weedy check were assigned in sub plot which remained same for both the years under Split Plot Design (SPD) in this experiment which were replicated thrice.

The weather conditions were more favorable for the growth and development of the wheat crop in the second year hence giving better yield as compared to first year of experimentation. The growth parameters, weed studies, yield and yield attributes was observed for all the treatments in the current experimentation. Statistical analysis of variance method of Split Plot Design (SPD) was used as per Gomez and Gomez (2003) to obtain the effect of different treatments as well as treatment effect of different combination in all the above observations.

Results and Discussion

Weed density (No. /m^2)

A significant influence of the crop establishment methods and weed management practices was observed on weed density at 30, 60 and 90 DAS during both the investigating years (Table 1). Zero tillage documented significantly minimum weeds (30.57 and 29.84/m^2) than conventional and reduced tillage during 2018-19 and 2019-20, respectively at 30 DAS (Figure 1). However weed density under conventional was observed to be statistically at par with reduced tillage during the two consecutive years of experimentation. When compared to other tillage systems, ZT's lack of soil disturbance explains reduced weed populations and plays a significant role in breaking dormancy (Yenish *et al.,* 1992) therefore zero tilled wheat planting is a new integrated weed management technique (Mehla *et al.,* 2000). The reduction in tillage intensity also resulted in reduced weed count per unit area (Khaliq *et al.,* 2013).

Among the weed management practices significantly minimum weed population (30.54 and 31.80/m^2) was recorded by carfentrazone- ethyl 30 g/ha after hand weeding at 25 & 45 DAS and was significantly at par with carfentrazone- ethyl 20 g/ha , carfentrazone- ethyl 40 g/ha and metsulfuron-methyl 8 g/ha during the two years of study, respectively at 30 DAS. Also weed population under metsulfuron-methyl 8 g/ha was at par with metsulfuron-methyl 6 g/ha at all the growth periods during both years of the research conducted. On the other hand, statistically higher weed density at 30 DAS was documented under weedy check (58.44 and 56.03/m^2) over rest other treatments during the two years of research work, respectively. This can be discussed in the light that carfentrazone-ethyl 20 g/ha, metsulfuron-methyl 4 g/ha and 2,4-D amine salt 750 g/ha alone could not control the weeds as effectively as their higher doses (Paswan *et al.,* 2012). There was significant interactions effect of crop establishment methods and the weed management practices on the weed density at various growth stages during both the investigating years.

Weed dry matter accumulation (g/m^2)

Wheat established through different tillage practices and the weed management strategies had statistically significant effect on the weed dry matter accumulation at 30, 60 and 90 DAS during both the investigating years (Figure 1). Among the tillage practices significantly minimum dry matter accumulation was seen in weeds observed under zero tillage over rest of the tillage practices. However, dry matter accumulated by weeds under conventional tillage was significantly higher and in turn was at par with reduced tilled wheat in the entire course of study conducted. Conventional tillage has a higher density of weeds and hence the weed dry matter because it provides an ideal growing habitat with adequate moisture and pulverized soil that is deep enough to feed the whole of weed flora. Weed seeds are incorporated into the soil by CT, which breaks their dormancy and may account for greater weed densities and dry weight accumulation under CT (Yenish *et al.,* 1992; Barros *et al.,* 2007).

Spraying of broadleaf herbicide carfentrazone-ethyl 30 g/ha accumulated minimum weed dry matter (4.69 and 4.82 g/m^2) over rest other treatments next to weed managed through hand weeding at 25 & 45 DAS and was at par with , carfentrazone-ethyl 20 g/ha, carfentrazone-ethyl 40 g/ha and metsulfuron-methyl 8 g/ha during 2018-19 and 2019-20, respectively at 30 DAS. Further, metsulfuron-methyl 8 g/ha produced weed dry matter significantly at par with that of metsulfuron-methyl 6 g/ha (Figure 1). Whereas maximum weed dry matter (8.56 and 8.12 g/m^2) was accumulated under weedy check as compared to rest other treatments in both the years of 2018-19 and 2019-20, respectively. When compared to weedy check herbicide treatments with varied management approaches also showed a significant drop in the dry weight of weeds since their population decreased (Nichols *et al.,* 2015). The interactions effect of the crop establishment methods and the weed management practices on the weed dry matter build up was statistically significant during both the investigating years.

Weed control efficiency (%)

A significant effect of the treatments assigned in the main and sub-plots were observed on the weed control efficiency (Table 2). Among the wheat establishment through different tillage practices zero tilled wheat reported significantly highest weed control efficiency (74.54 and 73.62%) over other treatments however weed management under conventional tillage was statistically at par with reduced tilled wheat during both the years of research conducted during both the years of 2018-19 and 2019-20, respectively.

Further, weed control efficiency was significantly higher under carfentrazone- ethyl 30 g/ha (82.68 and 81.07%) after hand weeding at 25 & 45 DAS but was at par with that recorded by carfentrazone- ethyl 20 g/ha, carfentrazone- ethyl 40 g/ha and metsulfuron-methyl 8 g/ha. During both the years of investigation it was observed that the weed control efficiency under the experimental plots treated with metsulfuron-methyl 8 g /ha (80.16 and 78.09%)was statistically at par with that of metsulfuron-methyl 6 g /ha (77.33 and 75.10 %). However, application of 2,4-D Amine salt 750 g/ha recorded significantly lowest weed control efficiency (51.67 and 52.01%) after weedy check in comparison with rest other treatments during the research work carried out in 2018-19 and 2019-20, respectively . Weeds treated with different doses of broad leaf herbicides showed a significant increase in weed control efficiency over weedy check on account of decreased population and dry weight (Nichols *et al.,* 2015). The interactions effect of the crop establishment methods and the weed management practices on the weed control efficiency was statistically significant during both the investigating years.

Weed index (%)

The observations related to weed index after statistical analysis reflects that it differed significantly under the influence of wheat establishment methods and the weed management practices while carrying out the investigation in *Rabi* 2018-19 and 2019-20 (Table 2). However no significant effect of crop establishment methods was reported on the weed index in the entire course of experimentation during both the year.

Among the treatments for effective weed management, the application of broadleaf herbicide carfentrazone- ethyl 30 g/ha reported lower weed index (2.30 and 1.47 %) in comparison with other treatments next to hand weeding at 25 & 45 DAS and was at par with carfentrazone- ethyl 20 g/ha and metsulfuron-methyl 8 g /ha in 2018-19 and 2019-20, respectively. Further, metsulfuron-methyl 8 g /ha produced weed index (4.50 and 3.20%) at par with that of metsulfuron-methyl 6 g /ha (6.36 and 5.11 %) 2018-19 and 2019-20, respectively. Whereas maximum weed index was accumulated under weedy check as compared to rest of weed management practices in the trial years of 2018-

19 and 2019-20. The interactions effect of the crop establishment methods and the weed management practices on the weed index was statistically significant during both the investigating years.

Yield attributes

Wheat established through different tillage practices and weed management treatments had marked influence on the effective tillers, ear length, grains/ear head, spikelet/ear head in the experimental seasons of 2018-19 and 2019-20 (Figure 2). Conventionally grown wheat recorded significantly maximum effective tillers (74.73 and 76.99/m), longer ear length (9.78 and 9.91cm), maximum grains/earhead (39.59 and 40.02), higher spikelet/ear (15.01 and 15.17) over zero tilled wheat but was at par with reduced tilled wheat during the current investigations of 2018-19 and 2019-20, respectively .

Among different weed management strategies, carfentrazone-ethyl 30g/ha documented maximum effective tillers (84.02 and 89.58/m), longer ear length (10.62 and 10.79 cm), maximum number of grains/ ear head (39.95 and 40.24), maximum spikelet/ ear (16.04 and 16.01) after hand weeding at 25 & 45 days after sowing and in turn was significantly at par with carfentrazone -ethyl 20 g/ha and metsulfuron-methyl 8 g/ha. Further, effective tillers (83.53 and 86.75/m), longer ear length (10.58 and 10.64 cm), maximum number of grains/ ear head (39.62 and 39.72), maximum spikelet/ear (15.68 and 16.11) observed in metsulfuron-methyl 8 g/ha was significantly at par with that of metsulfuron-methyl 6 g /ha. Weedy check reported significantly least effective tillers(53.63 and 54.45/m), shortest ear length (6.95 and 7.04 cm), minimum grains/ ear head(37.22 and 36.70) poorer number of spikelet/ ear (11.84 and 11.39) than rest other conducts and was at par with carfentrazone- ethyl 10 g /ha during study of 2018-19 and 2019-20, respectively.

Efficacy of crop establishment methods and weed management strategies on the test weight of grains was reported to be non-significant during entire course of investigations of 2018-19 and 2019-20.

Grain and straw yield (t /ha)

Wheat establishment methods and weed management practices had a significant impact on the grain and straw yield for the period of two years of investigations (Table 3). Conventionally grown wheat recorded grain yield (3.81 and 3.90 t/ha) which was statistically at par with wheat grown by reduced tillage and by 4.46 and 4.61% significantly higher than zero tilled wheat but during the entire course of investigations of 2018-19 and 2019-20, respectively. Further in zero tilled wheat the grain yield recorded was found to be statistically at par with that of wheat raised on reduced tilled plots during both the *Rabi* seasons of 2018-19 and 2019-20. The grain yield was impacted by the tillage techniques as the higher grain production was observed with conventional tillage over zero tillage. This may be the result of the soil being ground to a much finer texture over a longer period of time using traditional tillage, which produced greater yield attributes and hence maximum grain yield (Khanali *et al.,* 2012).

The application of broadleaf herbicide carfentrazone-ethyl 30 g/ha documented maximum grain yield (4.03 and 4.10 t/ha) over rest other treatments after manual weeding conducted at 25 & 45 DAS and was at par with carfentrazone-ethyl 20 g/ha (3.93 and 3.98 t/ha) and metsulfuron-methyl 8 g /ha(3.94 and 4.03 t/ha) during both the *Rabi* seasons of 2018-19 and 2019-20, respectively. This could be linked to the reduced weed growth, increased crop dry matter, more ears of the crop that were observed throughout the therapy. An additional explanation could be that the photosynthetic food material that the plants synthesize accumulates in various plant parts, causing the tissues to enlarge and develop. This, in turn, leads to a consequent increase in dry matter with an increase in number of effective tillers, spike length, grains per spike, and test weight, all of which ultimately result in a higher grain yield (Dhillan *et al.,* 2005). Also metsulfuron-methyl 8 g/ha produced grain yield which was reported to be at par with that of metsulfuron-methyl 6 g/ha (3.85 and 3.95 t/ha) during the entire course of investigations of 2018-19 and 2019-20, respectively. Lowest yield in metsulfuron-methyl 4 g/ha (3.78 and 3.63 t/ha) can be due to less number of effective tillers and lower weed control efficiency in the year 2018-19 and 2019-20, respectively. However metsulfuron-methyl 8 g /ha significantly increased seed yield over unweeded control as the growth of grassy weeds it checked for a month and gave excellent control of broadleaf weeds (Chopra *et al.,* 2001). The significantly poorer grain yield was recorded in weedy check (3.14 and 3.42 t/ha) over rest of other treatments during the entire course of investigations of 2018-19 and 2019-20, respectively.

According to the observations straw yield produced by conventional tillage (5.90 and 5.84 t/ha) was statistically at par with reduced tilled wheat and had a significant higher edge by 3.05 and 3.08% over zero tillage in 2018-19 and 2019-20, respectively. Further the straw produced by zero tilled wheat was at par with reduced tillage (5.8 and 5.77t/ha) during the entire course of investigations of 2018-19 and 2019-20, respectively. This increase in straw yield under conventional tillage may be mostly the result of improved root development, quicker growth, and increased aeration because there is more available free space for healthier plant growth (Majeed *et al.,* 2015).

When the weed management practices were applied it was observed that carfentrazone-ethyl 30 g/ha recorded higher straw yield (6.18 and 6.10t/ha) after manual weeding by hand at 25 & 45 DAS but was at par with carfentrazone-ethyl 20 g/ha (5.97 and 5.95 t/ha) and metsulfuron-methyl 8 g/ha (6.13 and 6.04 t/ha) during the current investigations of 2018-19 and 2019-20, respectively. Carfentrazone-ethyl 20 g /ha did not show any phytotoxicity on wheat plants in terms of yellowing, stunting and necrosis, hyponasty and epinasty and therefore resulted in higher yield attributes and yield over rest of the treatments and was at par with that of carfentrazone ethyl 30 g/ha.

Among the other broadleaf herbicides applied, metsulfuron-methyl 8 g /ha produced straw yield which was at par with that of metsulfuron-methyl 6 g /ha (6.00 and 5.92 t/ha) on account of excellent control of broadleaf weeds under metsulfuron-methyl 8 g /ha (Panwar *et al.,* 1996). However, significantly lower straw yield was recorded in weedy check (5.18 and 5.15 t/ha) as compared to rest other treatments during the investigations of 2018-19 and 2019-20, respectively. The interactions effect of the crop establishment methods and the weed management practices was statistically non-significant on the grain and straw yield during both the investigating years. The wheat establishment methods and weed management practices failed to produce marked influence on the harvest index during two *Rabi* seasons of investigations (Table 3).

It can be inferred from the experimental findings of the current investigation that zero tillage outperformed the other treatments in terms of weed dynamics. The weed management practices including spraying of carfentrazone-ethyl 20 g /ha, carfentrazone-ethyl 30 /ha, Metsulfuron-methyl 8g /ha and Metsulfuron-methyl 6g /ha were comparable to other treatments but these broad leaf herbicides were found to be significantly superior in terms of wheat crop growth, weed studies, yield attributes and the grain and straw yield.

Table 1: Effect of different establishment methods and weed management practices on weed density (No./m^2) at various growth stages

Treatments	Weed density (No. /m^2)					
	30 DAS		60 DAS		90 DAS	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Crop establishment methods						
CT	5.90(38.65)	6.09(40.62)	5.01 (29.03)	5.01 (28.95)	3.62 (17.61)	3.71(17.95)
RT	5.87(37.27)	5.94(38.33)	4.93 (28.15)	4.91 (27.84)	3.53(17.00)	3.51 (17.00)
ZT	5.32(30.57)	5.25(29.84)	3.77 (17.07)	4.02 (20.48)	2.81 (12.40)	2.73(12.15)
SEm±	0.08(0.85)	0.03(0.50)	0.04(0.41)	0.04(0.34)	0.05(0.06)	0.05(0.11)
C.D.(P=0.05)	0.31(3.35)	0.14(1.96)	0.14 (1.59)	0.15(1.34)	0.21 (0.23)	0.21 (0.42)
Weed management practices						
Carfentrazone-ethyl @ 10 g a.i. /ha	6.25(38.87)	6.72(44.88)	5.02 (25.92)	4.98 (24.63)	3.43 (11.61)	3.51(12.33)
Carfentrazone-ethyl @ 20 g a.i. /ha	5.82(33.89)	5.82(33.59)	4.08 (16.75)	4.03 (16.35)	2.57(6.28)	2.46(5.90)
Carfentrazone-ethyl @ 30 g a.i. /ha	5.56(30.54)	5.68(31.80)	3.91 (15.05)	3.91 (14.89)	2.26 (4.67)	2.22(4.99)
Carfentrazone-ethyl @ 40 g a.i. /ha	5.36(28.53)	5.51(29.96)	3.69(13.36)	3.71 (13.44)	2.09 (3.96)	1.98(3.47)
2,4-D Amine salt @ 750 g a.i. /ha	6.97(49.29)	7.22(51.98)	6.18 (37.96)	6.36 (40.08)	4.01 (15.77)	4.32(18.45)
Metsulfuron-methyl @ 4 g a.i. /ha	6.87(46.80)	6.96(48.17)	5.15 (27.12)	5.41 (29.64)	3.56 (13.11)	3.67(13.93)
Metsulfuron-methyl @ 6 g a.i. /ha	6.05(36.20)	5.82(33.57)	4.12 (16.85	4.07 (18.08)	2.70 (7.19)	2.64(6.70)
Metsulfuron-methyl @ 8 g a.i. /ha	5.73(32.43)	5.71(32.63)	3.94 (15.19)	4.04 (16.02)	2.43 (5.63)	2.32(5.07)
Hand weeding at 25 & 45 DAS	0.71(0.00)	0.71(0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71(0.00)
Weedy check	7.62(58.44)	7.48(56.03)	8.91 (79.30)	9.22 (84.44)	9.43 (88.46)	9.31(86.19)
C.D. (P=0.05)	0.33(3.83)	0.22(2.71)	0.23 (1.74)	0.22 (2.07)	0.37 (1.91)	0.33(1.82)
Interaction	S	S	S	S	S	S

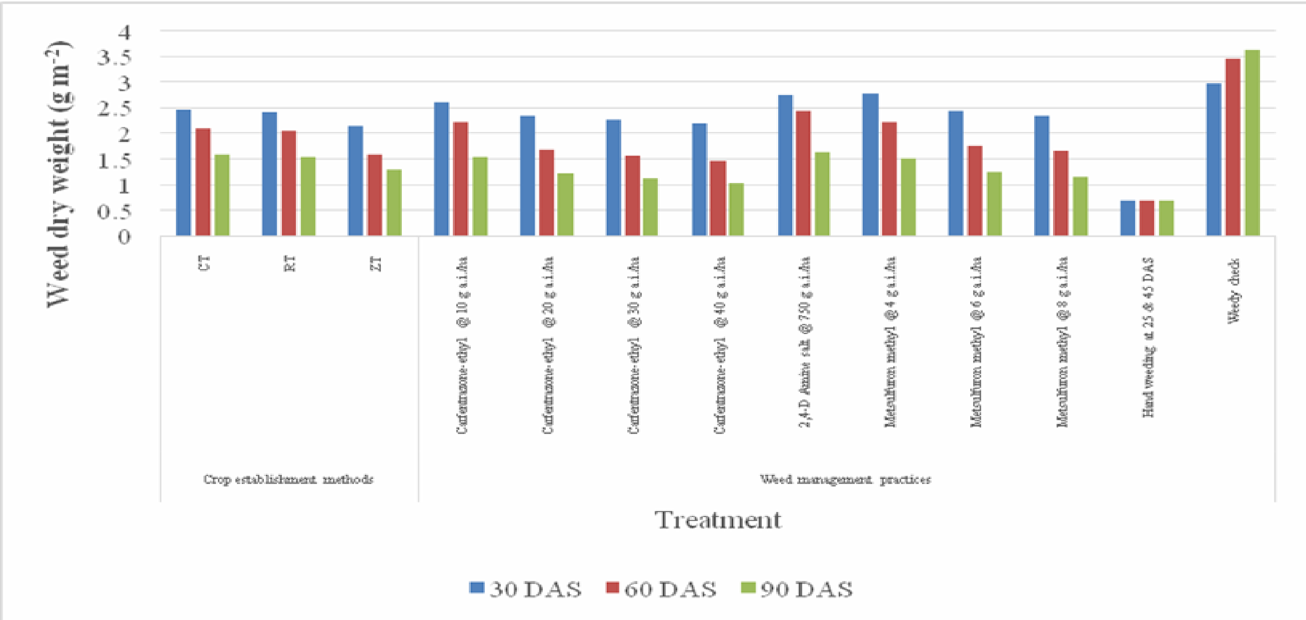
Original data in parentheses was subjected to square root transformation √x+0.5 before analysis.

Table 2: Effect of different establishment methods and weed management practices on weed control efficiency and weed index in wheat at various growth stages

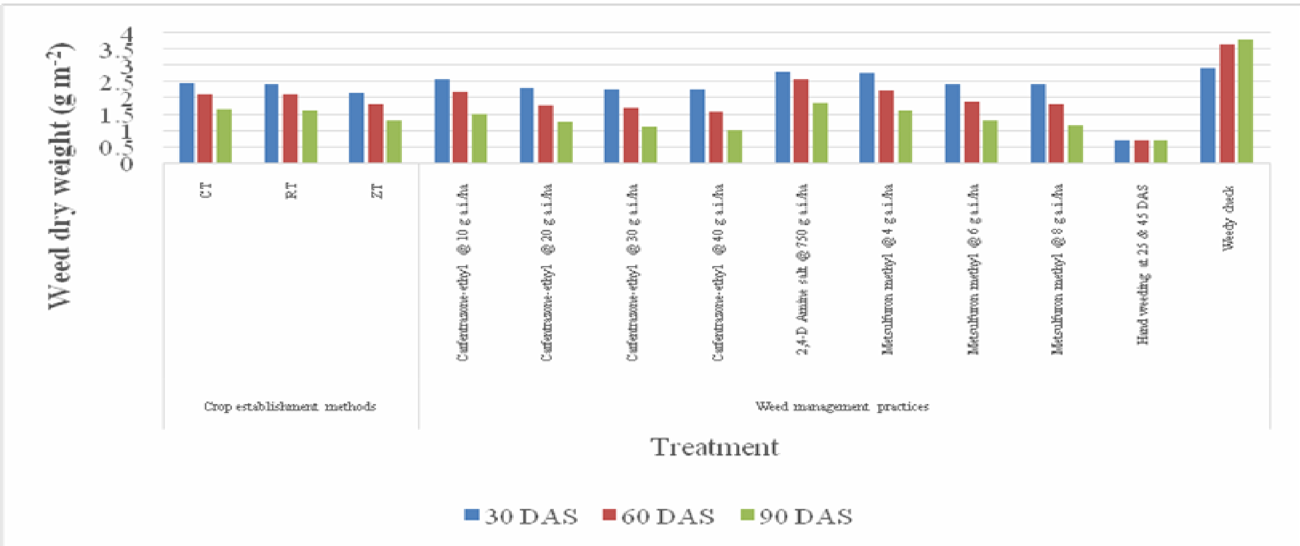
Treatments	Weed control efficiency (%) 60 DAS		Weed Index (%)	
	2018-19	2019-20	2018-19	2019-20
Crop establishment methods				
CT	64.93	66.57	9.83	9.28
RT	64.26	62.95	9.27	5.75
ZT	74.54	73.62	9.82	10.65
SEm±	0.99	1.72	2.30	2.15
C.D.(P=0.05)	3.88	6.74	NS	NS
Weed management practices				
Carfentrazone-ethyl @ 10 g a.i. /ha	61.21	64.63	15.25	17.31
Carfentrazone-ethyl @ 20 g a.i. /ha	79.68	78.76	4.59	4.50
Carfentrazone-ethyl @ 30 g a.i. /ha	82.68	81.07	2.30	1.47
Carfentrazone-ethyl @ 40 g a.i. /ha	85.33	83.59	8.98	9.32
2,4-D Amine salt @ 750 g a.i. /ha	51.67	52.01	22.55	14.04
Metsulfuron-methyl @ 4 g a.i. /ha	61.03	63.90	8.22	13.03
Metsulfuron-methyl @ 6 g a.i. /ha	77.33	75.10	6.36	5.11
Metsulfuron-methyl @ 8 g a.i. /ha	80.16	78.09	4.50	3.20
Hand weeding at 25 & 45 DAS	100.00	100.00	0.00	0.00
Weedy check	0.00	0.00	23.62	17.61
C.D. (P=0.05)	3.32	3.43	5.08	4.46
Interaction	S	S	S	S

Table 3: Effect of different establishment methods and weed management practices on yield of wheat

Treatments	Yield							
	Grain yield (t /ha)		Straw yield (t /ha)		Biological yield (t /ha)		Harvest Index (%)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Crop establishment methods								
CT	3.81	3.90	5.90	5.84	9.70	9.74	39.16	39.99
RT	3.72	3.81	5.80	5.77	9.51	9.58	39.03	39.78
ZT	3.64	3.72	5.72	5.66	9.36	9.38	38.89	39.55
SEm±	0.03	0.03	0.04	0.03	0.06	0.06	0.25	0.13
C.D.(P=0.05)	0.11	0.13	0.17	0.12	0.22	0.24	NS	NS
Weed management practices								
Carfentrazone-ethyl @ 10 g a.i. /ha	3.49	3.44	5.55	5.28	9.04	8.72	38.62	39.47
Carfentrazone-ethyl @ 20 g a.i. /ha	3.93	3.98	5.97	5.95	9.90	9.93	39.68	40.08
Carfentrazone-ethyl @ 30 g a.i. /ha	4.03	4.10	6.18	6.10	10.20	10.20	39.44	40.22
Carfentrazone-ethyl @ 40 g a.i. /ha	3.75	3.78	5.81	5.79	9.56	9.57	39.14	39.46
2,4-D Amine salt @ 750 g a.i. /ha	3.19	3.57	5.08	5.38	8.28	8.95	38.62	39.82
Metsulfuron-methyl @ 4 g a.i. /ha	3.78	3.63	5.93	5.82	9.71	9.46	38.92	38.32
Metsulfuron-methyl @ 6 g a.i. /ha	3.85	3.95	6.00	5.92	9.85	9.87	39.10	40.04
Metsulfuron-methyl @ 8 g a.i. /ha	3.94	4.03	6.13	6.04	10.06	10.08	39.10	40.03
Hand weeding at 25 & 45 DAS	4.13	4.17	6.22	6.13	10.35	10.30	39.87	40.49
Weedy check	3.14	3.42	5.18	5.15	8.32	8.57	37.79	39.80
C.D. (P=0.05)	0.21	0.18	0.23	0.15	0.33	0.22	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

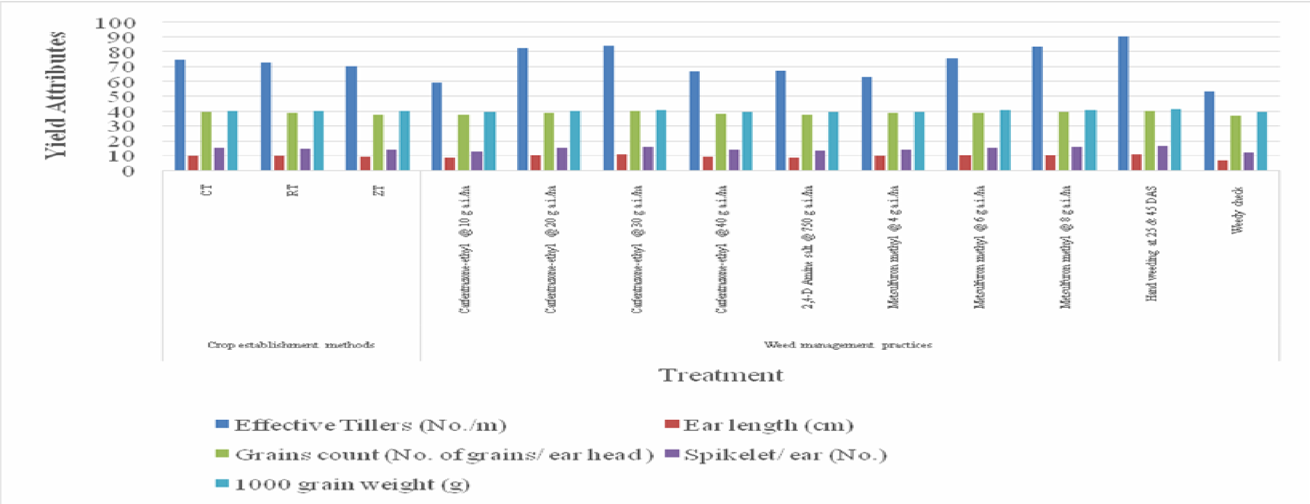


2018-2019

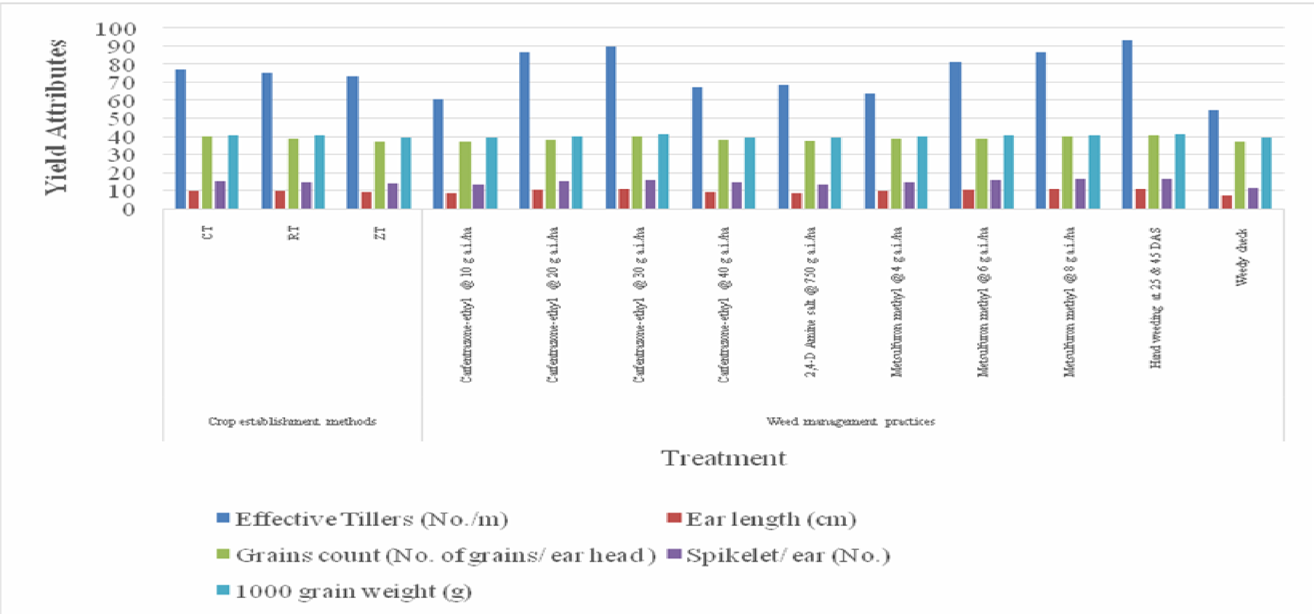


2019-2020

Fig. 1: Effect of crop establishment methods and weed management practices on weed dry weight of wheat at various growth stages



2018-19



2019-20

Fig. 2: Effect of crop establishment methods and weed management practices on yield attributes of wheat

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