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Effect of sowing methods and weed management practices on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
An agronomic investigation to study the response of various sowing methods and different weed management practices was conducted during *Rabi* season of year 2020-21 an agricultural Farm at Rama University, Kanpur 209217 (U.P) India. The experiment was laid out in split plot design with three replications. The experiment was laid out in split plot design with three replications. Three sowing methods treatments *viz.* S_1- Line sowing, S_2- Cross sowing, S_3- Broadcasting were allocated in main plots; whereas sub plots consisted five weed control practices *viz.* T_1- Clodinafop @ 60g/ha, T_2- Metribuzin @ 200g/ha, T_3- Sulfosulfuron @ 25g/ha, T_4- Weedy check and T_5- Weed free check. The minimum total weed density and dry weight of weed at 30 DAS, 60 and 90 DAS was recorded under Line sowing (S_1) with Metribuzin @ 200g/ha of wheat crop. Higher growth attributing characters at different crop stages and yield attributing characters at harvest *viz.* plant height, number of tillers, leaf area index, plant dry matter, length of spike, number of spike, number of grains per spike and test weight were produced in cross sowing with application of Metribuzin @ 200g/ha. Similarly, recorded higher grain yield, straw yield and harvest index under the treatment.

Keywords: Sowing, growth attribute, cross, wheat and yield

Introduction
Wheat (*Triticum aestivum* L.) is one of the most abundant food crop worldwide and in India, its production was augmented from 11.0 million tons during 1960-61 to 109.52 million tons during 2020-21. However, this is more than eleven-time increase in wheat production was mainly due to the adoption of short duration and high yielding wheat crop varieties, increased the application of synthetic fertilizers and other inputs like irrigation and herbicides. These not only a little inputs requirements along with less competitive nature of these high yielding dwarf varieties of crop have to be provided the compatible environment which has increased weed infection in field. The weeds are considered as a most defamation to crop production and account to be about one third of total losses that caused by all type pests. The rice-wheat is general cropping system in India. Among the various wheat crop-based cropping system, its occupying about 26.58 million hectare in India and area in worldwide occupies about 220 million hectare.

Introducing of the high yielding dwarf varieties for the rehabilitated spectrum of weed flora of wheat crop of broadleaf weeds in the 1960s to mixed flora of broadleaf and grassy weeds. In early of the 1970s, the effect of grass weeds in wheat crop field especially, *Phalaris minor* in late 1970s. The chemical weed control became a requirement in late 1970s with introduction of herbicides in the1979-80s, the weed flora changed that the favor of complex weeds species in late 1980s and then again in favor of *P. minor* during in wheat crop (Malik and Singh, 1995) [7]. Weeds has most harmful effect over the crop basically poor agronomic management of farm. With introduction of good agronomic practices and the ecology, so it is necessary to understand that the interaction among weeds and the wheat crop.

The competition exists among weed with crop plants for nutrients, light, moisture and space, in that way despoil the crop of critical inputs. Therefore, competition of weed is one of the most important in crop production. The weed- crop competition initiated when crop plants and weeds grow in together and their roots or shoots system could be overlaps. The competition become more severe due to greater smothering effect, when weeds emerge before the crop seed germination. Among the rice-wheat cropping system, due to availability of sufficient soil

moisture after harvesting of rice crop, the weeds come out from soil earlier than wheat seed germination. Losses in wheat crop yield are mainly due to reduction in tillering and growing of weeds.

The different grassy weeds in wheat crop *viz*; *Phalaris minor* and among broad-leaved weeds *viz*; *Rumex dentatus* L. and *Medicago denticulata* are of major apprehension under irrigated wheat crop in rice-wheat cropping system in India. The major problem of *P. minor* weeds in heavy soils, however, wild oat could be high prevalent in light textured soil. The weeds *viz*: *Rumex dentatus* and

P. minor both are highly competitive weeds and it can cause drastic losses of wheat yield under heavy weed infestation. The development of resistance in *P. minor* against isoproturon made. It is a single weed species that limiting wheat productivity in the North Western plains of India. Manual weeding is the common practice in wheat but very costly and availability of labour for this operation is problem especially during peak period Timely control of weeds is essential which in most of the cases is cannot be achieved by manual weeding on large scale. The narrow row spacing and predominance of weeds in wheat further limit the use of mechanical means. It is also limit to control the grassy weeds like *Phalaris minor* and *Avena spp*. Due to their morphological similarity with wheat in early stage use of herbicides under such condition seems to be promising. But at present no herbicide is available which alone can provide desired degree of weed control continuous and indiscriminate use of single herbicides may lead to man problems such as resistance in weeds residue in crop and soil pollution hazards, health hazards to non-target organisms (Singh *et al*. 2012) [10, 11]. The problem of complex weed flora in wheat was successfully solved through application of pre and post emergence herbicide. So, there is need to evaluate alternate herbicides with different mode of action and broad spectrum for the control of complex weed flora in wheat.

Materials and Methods

The field experiment was conducted during *Rabi* season of 2020-2021 at Agricultural Research Farm, of Rama University, Mandhana, Kanpur Nagar (U.P.) which is situated in the alluvial tract of Indo - Gangatic Plain in central part of Uttar Pradesh between $25^0$26′ to $26^0$58' North latitude, $79^0$31′ to $31^0$34' East longitude and on the altitude of 125.9 meters. The irrigation facilities are adequately available on this farm. The farm is situated in the main campus of the university. During the cropping season maximum temperature ranges from 17 to 35.1^{0}C, while the lowest temperature ranges from 6 to 21.7^{0}C. During the cropping period, relative humidity ranged from 24 to 94 percent. During the trial, average wind speeds ranged from 1.3 to 6.3 km hr^{-1}. During the testing period, the trail location got a total of 43.2 mm of rain in one wet day, providing favourable conditions for crop development. The experiment was laid out in split plot design with three replications. Three sowing methods treatments *viz.* S_1- Line sowing, S_2- Cross sowing, S_3- Broadcasting were allocated in main plots; whereas sub plots consisted five weed control practices *viz.* T_1- Clodinafop @ 60g/ha, T_2- Metribuzin @ 200g/ha, T_3- Sulfosulfuron @ 25g/ha, T_4- Weedy check and T_5- Weed free check. All plots of experiment was equally fertilized with recommended dose of fertilizers (150:60:40 kg ha^{-1} NPK). The source of nitrogen, phosphorus and potassium were urea, di-ammonium phosphate and murate of potash respectively. The soil of the experimental site was clay loamy in texture, low in organic carbon (0.40%), available nitrogen (166.53 kg ha^{-1}) and medium in available phosphorus (18.73 kg ha^{-1}) and potash (266.27 kg ha^{-1}) with slightly alkaline in reaction (8.2 pH). The wheat variety DBW 550 was sown in line at 20 cm row to row distance and seed rate 120.0 kg ha^{-1} was used for sowing of experimental crop and before sowing seed was treated with vitavax @ 2.5 g kg^{-1} of seed. Experimental crop was herbicide use as per treatments.

Results and Discussion

Response to sowing method

The maximum total weed density and dry weight of weed at 30 DAS, 60 and 90 DAS was recorded in broadcasting method of sowing. However, the minimum total weed density at was recorded under method of Line sowing (S_1) of wheat crop. It might be due to difficult control in broadcasting sowing methods; similar finding have been also reported by Chopra *et al*. (2006) [3].

The result of experiment furnished indicate that the maximum plant height, dry matter accumulation, no. of tillers and leaf area index (LAI) at 60 and 90 DAS was recorded from cross sowing which was statistically superior than line sowing of wheat crop. This could be happened that line and cross sowing method provide enough space to the plant. Therefore, the horizontal along with vertical utilization of space have to be increase the growth and development of plant Khan *et al.* (2007) [5] and El-Temsah (2017) [4]. Increases in growth-related characters eventually showed up in yield-related characters *viz.* ear length (cm), number of ear m^{-1}, number of grains per ear and test weight (Table. 3); which were recorded higher with cross sowing method planning on different yield-contributing traits such as *viz*. ear length (cm), number of ear m^{-1}, number of grains per ear and test weight and growth characters (plant height, number of tillers, LAI, dry matter accumulation) resulted in Higher grain yield, straw yield, biological yield and harvest index; similar findings have been also reported by Malik *et al*. (2013) [8] and Khan *et al.* (2007) [5]

Response to weed control practices

The application of Metribuzin @ 200g/ha (T_2) at 30, 60 and 90 DAS was recorded minimum total weed density followed by application of Sulfosulfuron @ 25g/ha (T_3). This could be due to the pre-emergence Metribuzin herbicide prohibited the germination of weed at least 30 DAS. However, the maximum total weed density and weed dry weight at 30, 60 and 90 DAS has been recorded in weedy check plot. It may be due to the residual effect of pre-emergence herbicide could be declined after crop progressed and weed have to be germinated in later stage of crop growth. Similar finding has been reported by Saquib *et al.* (2012) and Nanher *et al.* (2015) [9].

The maximum plant height, dry matter accumulation and leaf area index (LAI) at 60 and 90 DAS was depicted with application of Sulfosulfuron @ 25g/ha (T_3) which were statistically superior over both with application of Metribuzin @ 200g/ha (T_2) and clodinafop @ 60g/ha (T_1). This could be happened that because Sulfosulfuron act on both narrow and broad leaf weed while clodinafop have to kill only narrow leaf weeds. This similar result has been found by scientist Pal *et al.* (2012) and Singh *et al.* (2013). Among weed control

practices, the maximum grain yield, straw yield, biological yield and harvesting index was recorded with application of Sulfosulfuron @ 25g/ha (T3) which were statistically at par with application of clodinafop @ 60g/ha (T1) but superior than metribuzin @ 200g/ha. It might be due to weed create competition between wheat plant for nutrient, light, water and some weed having allelopathic effect. Therefore, yield could be reduced ultimately. Similar result has found by many scientists Bhullar *et al.* (2004), Malik *et al.* (2013) [8] and Kumar *et al.* (2003) [6].

Table 1: Effect of sowing methods and weed management practices on weed studies

S.N	Treatments	Total weed density			Total weed dry weight		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
Main plot (Sowing methods)							
1.	Line sowing (S1)	10.962	23.472	22.258	10.962	24.176	28.626
2.	Cross sowing (S2)	10.860	23.038	22.150	10.860	24.110	29.922
3.	Broadcasting (S3)	11.844	26.040	25.042	11.844	26.270	33.514
	C.D.	0.571	1.125	1.088	0.337	1.002	1.341
	SE(m)	0.196	0.386	0.374	0.116	0.487	0.461
	SE(d)	0.277	0.546	0.528	0.164	0.344	0.651
Sub plot (Weed control)							
1.	Clodinafop @ 60g/ha (T1)	11.473	16.113	15.053	8.887	26.087	27.907
2.	Metribuzin @ 200g/ha (T2)	3.507	20.810	19.533	3.760	22.523	24.477
3.	Sulfosulfuron @ 25g/ha (T3)	4.480	11.963	11.147	4.400	15.803	18.067
4.	Weedy check (T4)	33.273	63.393	61.617	18.033	51.200	73.110
5.	Weed free check (T5)	3.377	8.637	8.400	3.613	8.647	9.877
	C.D.	0.737	1.452	1.404	0.435	1.294	1.731
	SE(m)	0.253	0.499	0.682	0.149	0.444	0.595
	SE(d)	0.358	0.705	0.482	0.211	0.628	0.841
	Interaction (AxB)						
	SE(d)±	N/A	N/A	N/A	N/A	N/A	N/A
	C.D at 5%	1.494	1.222	1.222	1.222	1.222	1.222

Table 2: Effect of sowing methods and weed management practices on growth attributing characters of wheat.

S.N	Treatments	Leaf area index			Plant height at harvest	No. of tillers at harvest	Dry matter accumulation at harvest
		30 DAS	60 DAS	90 DAS			
Main plot (Sowing methods)							
1.	Line sowing (S1)	1.612	1.732	1.890	87.862	80.472	210.108
2.	Cross sowing (S2)	1.668	1.828	2.108	90.432	83.956	214.860
3.	Broadcasting (S3)	1.606	1.636	1.806	83.360	80.042	206.136
	C.D.	N/A	0.059	0.066	3.00	2.943	0.94
	SE(m)	0.019	0.020	0.023	1.03	1.429	2.488
	SE(d)	0.027	0.029	0.032	1.45	1.011	3.519
Sub plot (Weed control)							
1.	Clodinafop @ 60g/ha (T1)	1.633	1.763	1.963	87.860	85.750	215.203
2.	Metribuzin @ 200g/ha (T2)	1.630	1.733	1.937	87.063	84.900	210.490
3.	Sulfosulfuron @ 25g/ha (T3)	1.620	1.697	1.900	86.717	83.833	205.313
4.	Weedy check (T4)	1.617	1.667	1.867	85.550	82.867	202.170
5.	Weed free check (T5)	1.643	1.800	2.007	88.900	86.767	218.663
	C.D.	N/A	0.077	0.085	0.52	0.52	9.354
	SE(m)	0.025	0.026	0.029	2.33	2.845	3.213
	SE(d)	0.035	0.037	0.041	2.88	2.305	4.543
	Interaction (AxB)						
	SE(d)±	N/A	N/A	N/A	N/A	N/A	N/A
	C.D at 5%	0.061	0.064	0.064	3.261	3.196	7.869

Table 3: Effect of sowing methods and weed management practices on yield and yield attributing characters

S.N	Treatments	Length of ear (cm)	No. of spikelet's /ear	No. of grain per ear	Test weight (g)	Grain yield (Kg/ha)	Straw yield (Kg/ha)	Biological yield (Kg/ha)	Harvest index (%)
Main plot (Sowing methods)									
1.	Line sowing (S1)	11.292	21.144	40.518	40.492	49.542	75.262	123.974	39.668
2.	Cross sowing (S2)	11.696	22.008	41.566	41.566	51.524	74.074	125.304	41.014
3.	Broadcasting (S3)	10.604	19.860	39.622	39.622	48.102	74.820	123.494	39.086
	C.D.	0.385	0.721	1.399	1.398	1.712	0.221	0.399	1.376
	SE(m)	0.132	0.248	0.480	0.679	0.588	0.891	1.472	0.472
	SE(d)	0.187	0.350	0.679	0.480	0.832	1.261	2.081	0.668
Sub plot (Weed control)									
1.	Clodinafop @ 60g/ha (T1)	11.450	21.250	40.827	40.783	51.310	74.100	126.713	40.867

2.	Metribuzin @ 200g/ha (T2)	11.370	21.037	40.620	40.620	47.983	75.480	125.213	38.857
3.	Sulfosulfuron @ 25g/ha (T3)	11.140	20.757	40.207	40.207	50.057	74.477	124.067	40.200
4.	Weedy check (T4)	10.450	20.517	39.790	39.790	46.347	75.413	123.533	38.053
5.	Weed free check (T5)	11.577	21.460	41.400	41.400	52.917	74.123	121.760	41.637
	C.D.	0.497	0.10	0.100	0.12	2.210	0.30	0.230	1.776
	SE(m)	0.171	0.452	0.620	0.620	0.759	1.151	1.900	0.610
	SE(d)	0.241	0.320	0.877	0.877	1.074	1.628	2.687	0.863
	Interaction (AxB)								
	SE(d)±	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C.D at 5%	0.418	0.783	1.519	1.519	1.519	2.819	2.819	1.494

Conclusion

It can be concluded from the present investigation that cross sowing practice with Metribuzin @ 200g/ha increases the growth & yield attributes and yield of wheat. The minimum total weed density was recorded under Line sowing (S_1) method with Metribuzin @ 200g/ha of wheat crop.

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