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Effect of sowing methods and weed management on growth yield attributes and yield of wheat in Chhattisgarh plains

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Abstract
A field experiment was carried during the *rabi* season of 2018-19 at National Institute of Biotic Stress Management (ICAR-NIBSM), Baronda farm, Raipur (C.G.) with a view to study the "Effect of sowing methods and weed management on growth yield attributes and yield of wheat in Chhattisgarh plains" to find out the best seeding method and weed management practice in wheat. The wheat variety GW-273 was used for the research and the treatments were replicated three times in a split plot design. The treatment was made of three sowing methods in the main plot *i.e.* S1 (broadcasting), S2 (line sowing) and S3 (criss-cross sowing) with five weed management treatments in sub plot *viz*., T1 (clodinafop 15% + metsulfuron 1% at (64 g ha-1), T2 (sulfosulfuron 75% and metsulfuron 5% (32 g ha-1)), T3 (weedy check), T4 (hand weeding at 25 & 45 DAS) and T5 (weed free). Wheat was sown with a spacing of 20 cm (line to line distance) for line sowing and 20 cm × 20 cm for criss-cross method in a gross plot size of 5 m × 5m and net plot size we m 4.2 × 4.2 m. The outcome of the research revealed that among the different sowing methods, S3 (criss-cross sowing) produced significantly highest seed yield (4993.33 kg ha-1) as compared to S2 line sowing (4506.67 kg ha-1) and S1 Broadcasting (3773.33 kg ha-1). The weed management treatment i.e., weed free (T5) produced highest grain yield (5033.33 kg ha-1 followed by T1 (clodinafop + metsulfuron + surfactant) with 4777.78 kg ha-1 followed by hand weeding (T4) with 4577.78 kg ha-1 followed by the application of sulfosulfuron + metsulfuron + surfactant(T2) with 4533.33 kg ha-1. The weedy check treatment produced the lowest of grain yield (3200.00 kg/ha) among all treatments. The results of the investigation reveal that in overall performance in weed management, growth parameters, yield attributes and economics of the crop were observed to be significantly higher under treatment S3T1 i.e., criss-cross along with clodinafop + metsulfuron + surfactant in crop cultivated under Chhattisgarh plain conditions. The treatment T3 (weedy check) showed lower values for all of the above mentioned parameters. The treatment T5 (weed free) of criss-cross sowing(S3) resulted in the higher grain yield (5033.33 kg ha-1) and straw yield (5433.33 kg ha-1) and it was recorded at par with T1, T2 and T4. Treatment S3T5 (weed free of criss-cross sowing) also came up with highest gross return (1,01,200 Rs ha-1) and but due to higher cost of cultivation, the net return was highest for S3T1 (66,402.27 Rs ha-1) among the treatments with maximum B:C ratio (2.09).

Keywords: Wheat, criss-cross, clodinafop+ metsulfuron, broadcasting, Chhattisgarh plain

Introduction
Wheat (*Triticum aestivum* L.) is an important cereal crop belongs to family "Graminae" and genus "Triticum" after harvest of paddy in Chhattisgarh. Wheat is World's widely cultivated and most important cereal crop, it ranks first in the world among the cereal, both in respect area and production. Globally wheat is cultivated over an area of 223.67 million hectares with a production of 735.30 million metric tonnes and having a productivity of 3.29 metric tonnes ha-1 (USDA, 2015-16). Wheat is a nutritious food of all, used for manufacturing of bread, cakes, bakeries, flakes, biscuits, alcohol etc. and in India it is mostly eaten as chapaties. The availability of wheat has increased from about 79 g capita-1 day-1 to more than 185 g capita-1 day- 1 despite the doubling of the population since 1961 (Bhardwaj *et al*., 2010)
In India, wheat occupies an area of 30.72 million hectares with a production of 98.51 million tonnes with an average national productivity of 30.93 q/ha (Project Director report, DWR, 2016-17).

In Chhattisgarh, wheat occupies 0.177 (m ha) with a production of 0.261 (million tonnes) and average productivity of 13.37 q/ha (Ministry of Agriculture and farmers welfare, India, 2017). In Chhattisgarh, major wheat growing regions are Chhattisgarh plains and Northern hills region of Chhattisgarh.

In Chhattisgarh, wheat is grown in typical semi-arid climate which is characterized by high temperature during crop growth. Major wheat growing regions in the state are Chhattisgarh plains and Northern hills region of Chhattisgarh. Productivity of wheat is much lower compared to national average because of high temperature and low humidity coupled with rain-fed cultivation of the crop (Tomar *et al*., 2010) [7].

Material and Methods

The field experiment was conducted during *rabi* season (2018-19) at the ICAR-National Institute of Biotic Stress Management (NIBSM) is located at Baronda, Raipur (Chhattisgarh). The institute is about 30 km away from the Raipur city en-route to Baloda Bazar. The experimental field lies between 21º38 North latitude and 81º82 East longitude with an altitude of

291 m above Mean sea level. The field selected was uniform in topography with fairly infestation of location specific weeds representative of this area. The experiment was conducted during *rabi* season of 2018-19 at Research Farm of BTC College of Agriculture and Research Station, Bilaspur, Chhattisgarh. The Research Farm is situated at 22˚09 N′ latitude and 82˚15 E′ longitude and at an altitude of 298 m above mean sea level. The climate of the region is sub- humid to semi arid. The source of rainfall is South-Western monsoon. The average rainfall is about 1320 mm. The wheat variety GW-273 was used for the research and the treatments were replicated three times in a split plot design. The treatment was made of three sowing methods in the main plot *i.e.* S1 (broadcasting), S2 (line sowing) and S3 (criss-cross sowing) with five weed management treatments in sub plot *viz*., T1 (clodinafop 15% + metsulfuron 1% at (64 g ha-1), T2 (sulfosulfuron 75% and metsulfuron 5% (32 g ha-1)), T3 (weedy check), T4 (hand weeding at 25

& 45 DAS) and T5 (weed free). Wheat was sown with a spacing of 20 cm (line to line distance) for line sowing and 20 cm × 20 cm for criss-cross method in a gross plot size of 5 m × 5m and net plot size we m 4.2 × 4.2 m.

Results and Discussion

Growth parameters

Data pertaining to plant height affected by sowing methods and weed management was recorded at 30 DAS, 60 DAS, 90 DAS and at harvesting are given in Table 1.

Effect of sowing methods

The plant height of wheat reported that the sowing method has significantly influence on plant height at all the stage.

At 30 DAS, the plant height of S2 (line sowing) at was recorded highest *i.e*. 30.45 cm, followed by sowing method S3 (criss-cross sowing) *i.e*. 30.15 cm plant height. The lowest plant height was observed in S1 (Broadcasting) *i.e.* 28.79 cm. At 60 DAS, the plant height recorded shows S3 has the highest plant height (67.97 cm), followed by S2 with 64.97 cm and the lowest plant height recorded was S1 (63.09 cm). At 90 DAS, the plant height of wheat crop shows that S3 (91.35 cm) which is highest among the S2 (89.00 cm) and S1 (86.49 cm) and sowing method S3 is at par with S2. At the time of harvest, the plant height recorded was that S3 (92.80 cm) which was at par with S2 (89.81 cm) and S1 recorded the lowest plant height *i.e*. 87.51 cm.

Effect of weed management

The weed management has significantly influence on plant height at all the stage. The plant height of wheat at 30 DAS observed that the treatment T4 (hand weeding) has highest plant height *i.e.* 30.15 cm. amongst the other treatment. It was at par with T2 (Sulfosulfuron + metsulfuron) *i.e.* 30.05 cm and T2 was at par with T5 (weedy free), T1 (Clodinafop + metsulfuron) and T3 (Weedy check) which were 29.88 cm, 29.73 cm and 29.21 cm respectively. At 60 DAS, T5 had significantly higher plant height (67.99 cm) as compared to all other treatments. At 90 DAS, it was noted that T5 (92.43 cm) has significantly higher height among all the treatments. All treatments T1, T2, T3, T4 and T5 plant height was recorded at the time of harvesting, which was 92.62 cm, 89.70 cm, 81.36 cm, 92.77 cm and 93.76 cm respectively.

Interaction effect

The association between the methods of sowing and weed management was found insignificant.

Yield parameters

The effect of different sowing methods and weed management on grain yield (kg/ha), straw yield (kg/ha) and harvest index (%) of wheat crop are presented in Table 2.

Effect of sowing methods

The grain yield of wheat crop indicated that sowing methods have significant influence on crop yield. The sowing method S3 (criss-cross) produced significantly higher yield (4993.33 kg/ha) as compared to S2 (line sowing) which produced 4506.67 kg/ha. The broadcasting method of sowing had significantly lower yield producing 3773.33 kg/ha than the other two sowing methods.

Effect of weed management

The perusal of the yield data reveals that the grain yield varied from 3200.00 to 5033.33 kg/ha. Among the weed management treatments, weed free produced highest grain yield (5033.33 kg/ha) followed by the post emergence application of clodinafop + metsulfuron + surfactant (T1) exhibited significantly higher grain yield (4777.78 kg/ha). However, hand weeding (T4) was next best in grain yield (4577.78 kg/ha) followed by the application of sulfosulfuron + metsulfuron + surfactant (T2) was the next best herbicidal treatment (4533.33 kg/ha). The weedy check treatment produced the lowest of grain yield (3200.00 kg/ha) among all treatments.

The higher values of grain yield with these treatments may be ascribed to excellent control of mixed weed flora with marked decrease in weed population and weed dry weight and thereby better growth and increased productive tillers and yield attributes. Similar results were found in by Chaudhari *et al.*, (2017) Among the different treatments, weed free treatment (T5) recorded the highest grain yield

(5033.33 k/ha) which was significantly superior over to rest of the treatment under investigation. Weedy check (T3) was observed to be the significantly most inferior for grain yield (3200.00 k/ha) compared to other treatment taken for study. Unchecked weed growth decreased the yield to the tune of 63.58% compared to weed free plots and to an extent 66.98% compared to the treatment where clodinafop + metsulfuron +

surfactant was applied The probable reasons for recording higher grain yield may be due to greater number of ear bearing tillers, wheat grains per ear and 1000 grain weight. Herbicide treatments also influenced grain yield significantly which may be due to higher yield attributing components and weed control efficiency. An increase in grain yield in herbicide mixture sulfosulfuron + metsulfuron could be attributed to poor weed growth, higher crop dry matter, a greater number of ears and test weight of plants recorded under the treatment. Other reason may be due to the fact that photosynthetic food material synthesized in the plants gets deposited in different plants parts resulting in enlargement and development of plant tissues which cause gradual increment in dry matter and a greater number of effective tillers, spike length, grains per spike and test weight ultimately producing higher grain yield. Similar results were also observed by Bhardwaj *et al*., 2004 [2].

Interaction

The association between the different methods of sowing and weed management was found insignificant.

Straw yield (kg/ha)

Straw wheat yield is the function of accumulated growth parameter influences such as tillers per unit area and final plant height. Data pertaining to straw yield (kg/ha) was significantly influenced by different sowing methods and weed management practices which has been presented in table given below.

Effect of sowing methods

The maximum straw yield was recorded under the method of criss-cross sowing (S3) 5553.33 kg/ha which was then followed by line sowing (S2) 5180.33 kg/ha and then with 4593.33 kg/ha broadcasting (S1) had the lowest straw yield.

Effect of weed management

The maximum straw yield of 5433.33 kg/ha was obtained where weed free condition was maintained throughout crop growth period (T5) although at par result (5388.89 kg/ha) was shown by the treatment where clodinafop + metsulfuron + surfactant (T1) was applied. Significantly lower straw yield was recorded under weedy check treatment (4277.78 kg/ha). This treatment produced 78.73% lower straw yield compared to weed free plots.

This may be due to the major fraction of photosynthates assimilated during growth phase is translocated to the storage organs, yet because of the increased plant height as well as number of tillers in wheat on account of better weed management through integrated use of herbicides, might have helped in improving the growth and development of the crop and thereby straw yield of wheat. Straw yield is the result of total plant dry matter per unit area and the trend may be supported by the findings of Kumar *et al*. (2008) [5].

Interaction

The association between the different methods of sowing and weed management was found insignificant.

A crop's capacity to transform complete dry matter into economic productivity is indicated by its index value for harvest. The higher the harvest index, the higher the physiological potential to convert the total dry matter into grain yield. Data pertaining to harvest index as influenced by various weed control treatment are presented in table 4.6 and depicted in figure 4.6 A data perusal indicates that there were no important variations in the harvest index caused by varying weed control methods.

Effect of sowing methods

The maximum harvest index was recorded under the criss-cross sowing (S3) method (47.19) which was followed by line sowing (S2) with 46.20 and lowest was recorded under broadcasting (S1) with 44.84.

Effect of weed management

The maximum harvest index was recorded under weed free treatment (T5) with 47.93 and lowest harvest index was recorded in the weedy check treatment (T3) with 42.55. The reason may be due to environmental variables such as humidity, space, sunshine, etc. that had greater economic yield, resulting in greater harvest indexes. Similar results have been recorded by Soltani (2015) [6].

Table 1: Effect of sowing methods and weed management on plant height (cm) at different stages of wheat crop

Treatment	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
A. Dates of sowing (S)				
S1 - Broadcasting	28.79	63.09	86.49	87.51
S2 - Line sowing	30.45	64.97	89.00	89.81
S3 – Criss cross sowing	30.15	67.97	91.35	92.80
S. Em. ±	0.38	1.02	0.44	0.56
C.D. at 5%	1.48	4.00	1.75	2.18
B. Weed management (T)				
T1 – Clodinafop + metsulfuron	29.73	65.15	91.50	92.62
T2 - Sulfosulfuron + metsulfuron	30.01	65.04	89.18	89.70
T3 - Weedy check	29.21	60.87	80.36	81.36
T4 - Hand weeding (25 & 45 DAS)	30.15	67.63	91.27	92.77
T5 - Weed free	29.88	67.99	92.43	93.76
S. Em. ±	0.41	1.15	0.52	0.58
C.D. at 5%	1.21	3.36	1.51	1.69
Interaction (S×T)				
S. Em. ±	2.10	2.00	0.89	1.00
C.D. at 5%	NS	NS	NS	NS

Table 2: Effect of sowing methods and weed management on at different stages of wheat crop

Treatment	Grain yield per plot (Kg)	Grain yield (kg/ha)	Straw yield per plot (kg)	Straw yield (kg/ha)	Harvest Index (%)
A. Sowing methods (S)					
S1- Broadcasting	6.65	3773.33	8.07	4593.33	44.84
S2- Line sowing	7.95	4506.67	9.13	5180.33	46.20
S3- Criss cross sowing	8.80	4993.33	9.78	5553.33	47.19
S. Em. ±	0.13	77.04	0.14	82.44	0.19
C.D. at 5%	0.53	302.50	0.55	323.70	0.75
B. Weed management (T)					
T1- Clodinafop + metsulfuron	8.42	4777.78	9.46	5388.89	46.98
T2- Sulfosulfuron + metsulfuron	7.99	4533.33	9.27	5266.67	46.15

T3- Weedy check	5.64	3200.00	7.54	4277.78	42.55
T4- Hand weeding (25 & 45DAS)	8.07	4577.78	9.13	5177.78	46.79
T5 - Weed free	8.87	5033.33	9.58	5433.33	47.93
S. Em. ±	0.09	48.88	0.11	60.91	0.16
C.D. at 5%	0.25	142.66	0.32	177.78	0.47
Interaction (S×T)					
S. Em. ±	0.15	84.66	0.39	105.50	0.28
C.D. at 5%	NS	NS	NS	NS	NS

Weed Parameter

Weed flora

It is evident from the data in the experiment that there was predominance of *Medicago denticulata* L. (36.70%) followed by *Chenopodium album* L (23.27%), *Vicia sativa* L. (19.33%) and *Melilotus alba (*6.80%) in wheat as higher relative density whereas the dicot weeds whereas *Echinochloa colona* L (13.90%) was dominant among the monocot seed.

Weed index

The weed index among the sowing methods was found to be lowest (9.21%) in the criss- cross method (S3) compared to the line sowing (S2) (11.77%).

The weed index was significantly lowest (5.17%) in the herbicidal application of clodinafop + metsulfuron + surfactant (T1) followed by (9.56%) in hand weeding (T4). The weed control index recorded in treatment sulfosulfuron + metsulfuron + surfactant (T2) was 10.19%, and the highest weed index 36.87% was recorded in weedy check treatment (T3). Their interaction on weed index was found to be non-significant.

Table 3: Weed flora at the experimental field in weedy check plot at 25 DAS

Botanical Name	Common Name	Family	Weed Density (m-2)	Relative density (%)
A. Monocot weeds				
1. *Echinochloa colona* L.	Jungle rice	Poaceae	11.66	13.90
B. Dicot weeds				
1. *Medicago denticulate* L.	Rough medic	Fabaceae	32.33	36.70
2. *Chenopodium album* L.	lambs quarter	Chenopodiaceae	18.33	23.27
3. *Melilotus alba*	White sweetclover	Fabaceae	5.33	6.80
4. *Vicia sativa* L.	Common vetch	Fabaceae	17.33	19.33
Total			84.98	100.00

Table 4: Weed index of wheat crop as influenced by different sowing methods and weed management practices

Treatment	Weed Index (%)
A. Sowing methods (S)	
S1- Broadcasting	16.09
S2- Line sowing	11.77
S3- Criss cross sowing	9.21
S. Em. ±	1.73
C.D. at 5%	6.81
B. Weed management (T)	
T1- Clodinafop + metsulfuron	5.17
T2- Sulfosulfuron + metsulfuron	10.19
T3- Weedy check	36.87
T4- Hand weeding(25 & 45 DAS)	9.56
T5- Weed free	0.00
S. Em. ±	1.00
C.D. at 5%	2.92
Interaction(S×T)	
S. Em. ±	1.73
C.D. at 5%	NS

Conclusion

1. Sowing method S3 (criss-cross sowing) produced significantly highest seed yield (4993.33 kg ha-1) as compared to S2 line sowing (4506.67 kg ha-1) and S1 Broadcasting (3773.33 kg ha-1).
2. Weed management practice T1 (clodinafop + metsulfuron + surfactant) was significantly found to be the overall best in terms of yield attributing parameters and yield (4777.78 kg ha-1), Cost of cultivation (31731 Rs ha-1), Gross return (98,133.27 Rs ha-1), Net return (66,402.27 Rs ha-1) leading ultimately to higher B:C ratio (2.09).

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