International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(2): 2326-2329

Received: 19-01-2020
Accepted: 21-02-2020

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Effect of chemical weed management and sowing method practices in late sown wheat (*Triticum aestivum* L.)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i2ai.9096

Abstract
A field experiment was conducted during *rabi* seasons of 2015-16 and 2016-17 at Instructional Farm (SIF), Department of Agronomy, C S Azad University of Agriculture and Technology, Kanpur in alluvial tract of gangetic plains in Central part of Uttar Pradesh. The treatments consisted three sowing methods and five weed management practices. The experiment was laid out in split plot design with three replications. The results showed that plant height was increasing with increasing days after sowing in the relevant crop of wheat, respectively. The tallest plants were obtained in S_3 : Cross sowing followed by S_2 : Line sowing. The application of weed management practices on W_4 : Two hand weeding (25 and 45 DAS) W_2 : Clodinofop (60g ha^{-1}) fb 2,4-D (500 g ha^{-1}), significantly improved the growth and yields of Two hand weeding (25 and 45 DAS) followed by Clodinofop (60g ha^{-1}) fb 2,4-D (500 g ha^{-1}), amongst different cropping systems during the two years of experimentation.

Keywords: Sowing methods, weed management practices, plant height, yield, harvest index, B:C ratio

Introduction
Wheat (*Triticum aestivum* L.) is the second most important cereal crop next to rice and accounts for 36.2% of total food grain basket of the country. It is grown under diverse agro climatic conditions. The total area of wheat in the world is 221.12 million hectare with annual production of 697.8 million tonnes and productivity of 31.55 q ha^{-1}. The largest producer of wheat in the world is the European Union followed by China, India and United States of America. The consumption of wheat in the world is 667 million tonnes but is kept satisfied with an equally high production figures. Consumption has been constantly increasing during the last 15 years with the increase in population and is prepared to shoot up further to 780 million tonnes in 2020. It has been estimated that India will need at least 109 million tonnes of wheat by 2020 as against present production of 93.5 million tonnes. The wheat production has increased manifold from 6.60 million tonnes at the time of independence to 97.44 million tons (Anonymous, 2017) [1].

The productivity has witnessed an increase by 473 per cent *i.e.* from 670 kg ha^{-1} to 3172 kg ha^{-1} during the above period. Despite delayed sowing, the country recorded 30.71 million hectares. The clearly indicates the strength of systematic and planned wheat research in the country. It may be recalled that the total wheat production of the country during 1947-48 was just 5.6 million tons with average productivity of less than one t ha^{-1}. India has witnessed a record yield breaking increase in total wheat production *i.e.* 93.50 million tons from an area of 30.60 m ha^{-1} with the productivity of 30.93 q ha^{-1} during 2015-16. Out of total area of wheat in India, Uttar Pradesh alone contributes area 9.65 million hectare and production near about 26.87 million tons with productivity of 27.72 q ha^{-1}. Wheat consumption in India estimated to surpass 110 million tons of wheat will be needed by 2020.

Wheat is the backbone of food security of India. It is utilized for bread, cakes, cookies, noodles, petri-products and chapatti etc. Wheat grains contains starch 60-68%, protein 8-15%, fat 1.5-2.0%, cellulose 2.0-2.5%, and minerals 1.5-2.0% (Rathore, 2001) [6]. Wheat crop contributes substantially to the national food security by providing more than 50 % of the calories to the people who mainly depend on it. The effects of weeds on wheat crop, the impact of weed competition on quantity and quality of wheat yield, allelopathic effects of

certain weeds on crop growth and development and the poison effect of other weed species to humans and animals. Weeds usually found in wheat fields and associate with crop plants were identified and grouped based on their morphology. Studies on the determination of the critical weed-free period in wheat were reviewed and the importance of this period in weed management was discussed. Chemical and none-chemical weed control methods were reviewed. Certain agricultural and management practices aimed at promoting early canopy crop development and reduce weed growth are mentioned. Importance of plant factors, timing of farm operations, and selection of proper herbicide are discussed. Most recent research findings on weed management in wheat fields are incorporated. Herbicides recommended and practiced in wheat, their type, method of action, method and time of application, physiological effects on crop plants and weeds, and recent research findings on this aspect were included. Some suggestions and recommendations that sustain weed management and aimed at increasing crop productivity and minimizing weed effects are discussed Sharma & Saroa, 2017 [5].

Materials and Methods

A field experiment was conducted during *rabi* seasons of 2014-15 and 2015-16 at Instructional Farm (SIF), Department of Agronomy, C S Azad University of Agriculture and Technology, Kanpur in alluvial tract of gangatic plains in Central part of Uttar Pradesh. The soil of the experimental field was sandy loam in texture and slightly calcareous having organic carbon 0.28%, total nitrogen 0.032%, available P_2O_5 13.0 kg ha^{-1}, available K_2O 180 kg ha^{-1}, pH 7.5, electrical conductivity 0.20 dS m^{-1}, wilting point 6.0%, field capacity 19.2%, water holding capacity 28.3%, Bulk density 1.43 Mg m^{-1}, Particle density 2.60 Mg m^{-1} and porosity 45.6%. The field experiment was conducted in Split plot design with three replications. keeping cropping systems in main plot and sub plot in subplots. *A : Sowing methods (Main-plot)* S_1 : Broad cast sowing, S_2 : Line sowing and S_3 : Cross sowing *B : Weed-management practices (Sub-plot)* W_1 : Pendimethaline (1kg ha^{-1}) fb Sulfosulfuron (25 g ha^{-1}) W_2 : Clodinofop (60g ha^{-1}) fb 2,4-D (500g ha^{-1}), W_3 : Pinoxaden (50 g ha^{-1}) fb Carfentrazone (30 g ha^{-1}), W_4 : Two hand weeding (25 and 45 DAS) and W_5 : Weedy check. Clean seed of wheat variety Halna-K7903 was sown at 20 cm rows distance at the sowing method of Line sowing, Cross sowing and Broad cast sowing seed rate with the help of seed drill. Crop was sown on December 15 and 17, during 2015 and 2016 growing seasons, respectively. Weeds were removed manually in two hand weeding at 25 and 45 days after sowing as per treatments during both years. Available moisture at sowing time up to 100 cm soil profile was measured which was 163.2 and 144.0 mm. The amount and distribution of rainfall received during cropping season was 212.0 and 243.4 mm in 2014-15 and 2015-16, respectively against the average annual rainfall of about 800 mm. Recommended package of practices and fertilizers doses were applied in different treatments.

The cost of cultivation was calculated by taking in to account the prevailing prices of the input and application cost of the relevant treatments. Economics of different treatments was worked out to assess the most viable and remunerative water harvesting technique.

Results and Discussion

It is evident from the data that plant height of wheat was increasing with increasing DAS up to maturity (Table-1). The tallest plants were observed in S_3 : Cross sowing followed by the treatment of S_2 : Line sowing. The lowest plant height was recorded under S_1: Broad cast sowing during the two different years of study. Further, the application of weed management practices the plant height and tallest plants were found when W_4 : Two hand weeding (25 and 45 DAS) was applied and minimum height was obtained from W_5 : Weedy check when it was applied only through weed management practices has been also reported by Pal *et al.,* (2012) [10] and Chaudhary *et al.* (2016) [3].

The seed yield of wheat under different treatments varied significantly and maximum values of these parameters in first and second year was S_3 : Cross sowing. The maximum yield of stover/straw yield was obtained from S_3 : Cross sowing during two different years. Among weed management practices treatments highest seed yield was obtained from W_4 : Two hand weeding (25 and 45 DAS) followed by W_2 : Clodinofop (60 g ha^{-1}) fb 2,4-D (500 g ha^{-1}) and lowest under W_5 : Weedy check during both the years. Further, the combined effect of weed management practices was found to be significantly superior over sowing methods. The result indicate better growth in terms of seed yield, straw/stover yield in combined use supplemented with Two hand weeding (25 and 45 DAS). The harvest index did not showed significant variations during the two years of observation Kumar *et al.,* (2012) [7], Paighan *et al.,* (2013) [9] and Singh *et al.* (2016) [3, 4]

The maximum net return of S_3 : Cross sowing followed by S_2 : Line sowing under different treatments of sowing methods (Table–3). It may be attributed due to polled yield in different row crop adjustments during the two years of study. Subsequently, B:C ratio varied from 1.73, 1.79 & 1.76 and 1.64, 1.67 & 1.65 during the two years of experimentation, highest and lowest values were recorded in S_3 : Cross sowing and S_1 : Broad cast sowing, respectively. The application of weed management practices further influenced the B:C ratio and values ranged from 1.73, 1.76 & 1.74 and 1.64, 1.66 & 1.65 highest and lowest values were observed in W_4 : Two hand weeding (25 and 45 DAS) and W_1 : Pendimethaline (1kg ha^{-1}) fb Sulfosulfuron (25 g ha^{-1}), respectively during the two different years Nizamani *et al.,* (2014) [8] and Anjum *et al.,* (2017) [2].

Table 1: Effect of plant height (cm) under different treatments.

Treatments	Plant height (cm) 30 DAS			Plant height (cm) 60 DAS			Plant height (cm) 90 DAS		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
A : Sowing methods									
S_1	7.65	7.91	7.78	47.68	49.26	48.47	82.44	84.94	83.69
S_2	7.79	8.05	7.92	48.44	50.34	49.39	83.57	86.42	85.00
S_3	7.92	8.21	8.06	50.32	52.11	51.21	86.70	89.84	88.27
SE (m)	0.21	0.39	0.21	0.51	0.52	0.37	0.68	0.76	0.51
CD (P=0.05)	N.S.	N.S.	0.62	1.99	2.10	1.21	2.65	2.99	1.67
B : Weed management practices									
W_1	7.62	7.91	7.76	47.90	49.56	48.73	82.63	85.42	84.02
W_2	7.96	8.23	8.10	49.92	51.59	50.75	86.08	88.92	87.50
W_3	7.82	8.09	7.96	49.04	50.74	49.89	84.57	87.49	86.03
W_4	8.35	8.62	8.48	52.15	54.04	53.10	89.82	93.18	91.50
W_5	7.19	7.43	7.31	45.07	46.92	45.99	78.09	80.33	79.21
SE (m)	0.28	0.31	0.18	0.56	0.54	0.39	1.00	1.17	0.77
CD (P=0.05)	N.S.	N.S.	N.S.	1.63	1.57	1.16	2.92	3.40	2.29

Table 2: Effect of Grain Yield (q ha^{-1}), Straw Yield (q ha^{-1}) and Biological Yield (q ha^{-1}) under different treatments.

Treatments	Grain Yield (q ha^{-1})			Straw Yield (q ha^{-1})			Biological Yield (q ha^{-1})		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
A : Sowing methods									
S_1	24.58	26.17	25.43	44.31	45.67	44.99	68.88	70.86	69.87
S_2	24.98	26.29	25.58	44.72	45.84	45.28	69.36	71.94	70.65
S_3	26.42	27.40	26.91	46.20	47.19	46.70	72.66	74.54	73.60
SE (m)	0.40	0.23	0.18	0.30	0.31	0.22	0.52	0.58	0.39
CD (P=0.05)	1.33	0.89	0.60	1.17	1.21	0.69	2.04	2.25	1.24
B : Weed management practices									
W_1	24.88	25.83	25.36	45.21	46.31	45.76	70.11	72.09	71.10
W_2	26.14	27.82	26.65	45.31	46.65	45.93	71.11	73.53	72.49
W_3	25.19	27.15	26.50	45.21	46.53	45.92	69.84	72.75	71.29
W_4	27.84	28.90	28.37	46.90	48.05	47.46	74.74	76.91	75.82
W_5	22.58	23.40	22.99	42.77	43.62	43.19	65.36	66.96	66.16
SE (m)	0.28	0.26	0.19	0.24	0.31	0.20	0.56	0.56	0.39
CD (P=0.05)	0.82	0.76	0.55	0.71	0.89	0.22	1.62	1.62	1.12

Table 3: Effect of Cost of Cultivation (Rs ha^{-1}), Gross Return (Rs ha^{-1}), Net Return (Rs ha^{-1}) and B:C Ratio under different treatments**.**

Treatments	Cost of Cultivation (Rs ha^{-1})			Gross Return (Rs ha^{-1})			Net Return(Rs ha^{-1})			B:C Ratio		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
A : Sowing methods												
S_1	35891	37291	36591	59560.4	62234.4	60897.4	23269.4	23326.73	23298.07	1.64	1.67	1.65
S_2	36291	37091	36691	59783.4	62384.4	61084.4	23492.4	23792.4	23642.4	1.65	1.68	1.66
S_3	36591	36891	36741	62803.87	64879.2	63841.5	25512.2	26512.2	26012.2	1.73	1.79	1.76
SE (m)	-	-	-	553.52	526.98	382.13	421.38	413.9	324.41	0.01	0.02	0.01
CD (P=0.05)	-	-	-	2161.13	2057.52	1246	1645.22	1616.02	1057.8	0.03	0.07	0.03
B : Weed management practices												
W_1	35150	35816	35483	59737.33	61925	60831.2	24587.33	25064	24825.67	1.64	1.66	1.65
W_2	36015	37015	36515	62014.00	65306	63660	25612	25912	25762	1.71	1.74	1.72
W_3	35905	36905	36405	61463.33	64207	62835.2	25448.33	25115	25281.67	1.70	1.73	1.71
W_4	39935	40935	40435	65547.00	67826.33	66686.7	26109	26505.67	26307.34	1.73	1.76	1.74
W_5	34450	34783	34617	54817.78	56567.33	55692.6	20366.67	19922.22	20144.44	1.59	1.63	1.61
SE (m)	-	-	-	703.57	461.02	420.49	510.08	594.78	219.07	0.02	0.02	0.01
CD (P=0.05)	-	-	-	2054.12	1345.97	1195.68	1736.51	1736.51	622.93	0.05	0.07	0.03

Conclusion

Based on two years of experiment it may be inferred that S_3: Cross sowing supplemented with W_4 : Two hand weeding (25 and 45 DAS) in soil showed good potential for sustainable production and proved to be quite remunerative in irrigated alluvial tract of Uttar Pradesh.

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