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Effect of irrigation levels and weed management on yield attributes and yield of wheat (*Triticum aestivum* L.) in Northern-Hill zone of Chhattisgarh

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Abstract
A field experiment was carried out for two consecutive years in *rabi* seasons of 2017-18 and 2018-19 at Research Cum Instructional Farm, IGKV, Lt. Dr. Ramchanra Singh Dev College of Agriculture and Research Station, Baikunthpur, Korea, Chhattisgarh. The soil of experimental field was (*Vertisols*), neutral in reaction, low in available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in Split Plot Design with three replications. The main plot treatment consisted of 03 Irrigation levels I_1: 0.8 IW/ CPE, I_2: 1.0 IW/ CPE, I_3: 1.2 IW/ CPE and Sub-plot treatment consisted of 06 Weed management *i.e.* W_1: Sulfosulfuran (20 g ha^{-1}), W_2: Clodinofop (60 g ha^{-1}), W_3: Metsufuron (4 g ha^{-1}), W_4: Clodinofop + Metsulfuran (60 g + 4 g ha^{-1}), W_5: Sulfosulfuran + Metsulfuran (20 g + 4 g ha^{-1}), W_6: Unweeded Control. The finding revealed that the irrigation in wheat at I_3: 1.2 IW/CPE recorded significantly highest yield attributes and grain and straw yields and harvest index were also found significantly highest under this treatment. As regards to weed management practices in wheat, treatment W_4: Clodinofop + metsulfuron (60 g+4 g ha^{-1}) registered significantly highest yield attributes and grain and straw yields and harvest index as compared to others. Interaction between I_3: 1.2 IW/CPE ratio and W_4: Clodinofop + Metsulfuran (60 g + 4 g ha^{-1}) registered significantly highest number of tillers m^{-2}, dry matter accumulation $plant^{-1}$ grain and straw yields and harvest index.

Keywords: Wheat, irrigation levels, weed management, yield attributes, grain yield

Introduction

Wheat is one of the most important cereal crops of the world occupying around 217 million hectares holding with a production of 713 million tonnes and productivity of 3371kg ha^{-1}. Nearly 55 per cent of the world population depends on wheat for about 20 per cent of calories intake. India is second largest producer of wheat in the world after China with about 12 per cent share in total world production. In India, wheat is second most important food crop, next to rice, with an area of 31.62 million hectares and production of 109.52 million tons (Anonymous, 2021) [1]. In Chhattisgarh, wheat is cultivated in an area of 3.6 million hectare with the productivity of the state ranging between 1.2 to 1.6 t ha^{-1} depending upon the rainfal. In the Northern-Hills Zone of Chhattisgarh especially Baikunthpur, Surajpur, Ambikapur and other in other districts wheat is a major cereal crop of *rabi* season in rice based cropping system under irrigated condition and maximum farmers grow wheat crop after harvesting of rice in midland condition. The climatic condition is quite favorable for wheat cultivation due to prolong & cold winter. The productivity of the wheat depends upon on several factors like crop establishment techniques, irrigation; weed management, sowing methods, seed rate, fertilizers management and other cultural practices. Irrigation plays an important role in wheat plant development at any critical stage from seed germination to plant maturation. Efficient irrigation management of water permits better utilization of all other production factor which leads to increased yield per unit area and time. It requires study of climate, plant water relationship, agronomic practices and economic assessment. The judicious application of water needs immediate attention and this is possible only by application of water to the crop with water practices. A number of approaches have been investigated for scheduling irrigation in wheat; however, irrigation based on climatological approach has been most widely accepted. Earlier studies have shown that moisture stress to wheat crop at spike emergence and antithesis stages reduced yield from 3.3 to 7 t ha^{-1} (Yousaf *et al.*, 2014) [15].

Irrigation applied at a sensitive stage, would be a valuable management practice for improving yield. In general, irrigation is being scheduled on the basis of climatologically approach (IW: CPE ratio) during entire period of crop irrespective of stage of growth proper scheduling of irrigation of irrigation is necessary at both vegetative and reproductive phases to maintain the optimum moisture regime for better growth and development of crop in the changing climatic scenario where abrupt variation in temperature take place. Irrigation levels from 0.5 to 1.25 IW/CPE recorded increases in weed dry matter (Yaghobi, 2008) [14]. Weed population is one of the major barriers, responsible for low productivity of crop because, weed compete with the crop for moisture, nutrients, space, light etc. In wheat crop, studies revealed that weeds causes up to 90 per cent failure of the crop. The presence of weeds like *Phalaris minor, Circium spp., Avena spp., Cynodan dactylon, Convolvulus spp.,* etc. Weeds compete with crop species for water, nutrients and light and ultimately reduce crop yield. Chemical weed control method is popularizing day by day among the farmers because weed control through hand weeding is time consuming and tedious and become very costly due to unavailability of labor in peak period and high labor charges due to shifting of agricultural labor to industries for better and assured wages. The recent advances in weed management showed that single application of chemical may not cover the entire weed flora, But if the mixture of two herbicides is used the total flora can be managed. Therefore, it is important to control weed to minimize the competition between weeds and the crop.

Material and Methods

A field experiment was carried out for two consecutive years in *rabi* seasons of 2017-18 and 2018-19 at Research Cum Instructional Farm, IGKV, Lt. Dr. Ramchanra Singh Dev College of Agriculture and Research Station, Baikunthpur, Korea, Chhattisgarh. The soil of experimental field was (*Vertisols*), neutral in reaction, low in available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in Split Plot Design with three replications. The treatments were comprised of three different irrigation levels (main-plot) and six different herbicides (sub-plot). The climate of Korea district is basically tropical wet and dry. The temperature of Korea district remains moderate throughout the year, except from March to June, in this month temperature remains extremely hot. The maximum weekly temperature of Korea district goes up to 45.2 ºC in the month of May. Whereas, minimum temperature falls up to 9 ºC in the month of January. Winters starts from November to January and are mild. The average annual rainfall varies between 1200-1400 mm, which is mostly received during a span of four months *i.e.* between June to September through south-western monsoon. The wheat variety GW-366 was sown as test crop during 27th November, 2017-18 and 30th November 2018-19. Harvesting was done during 18th April in the first year (2018) and 20th April in the second year (2019), respectively. Observations on various growth and yield attributes, grain and straw yields, economics were recorded and data were analyzed statistically.

Result and Discussion

Yield attributes

Number of effective tillers m^{-2}

Number of effective tillers per unit area is one of the important yield attributing components which affects the photosynthetic efficiency of the plant. As the number of effective tillers per plant increases, the yield per hectare also increases. The data regarding number of effective tillers m^{-2} are presented in Table 1.

The number of effective tillers m^{-2} was significantly affected due to different irrigation levels during both the years and on mean basis. The significantly highest number of effective tillers m^{-2} was recorded in treatment I_3**:** 1.2 IW/CPE as compared to others however, significantly the lowest number of effective tillers m^{-2} was recorded in treatment I_1: 0.8 IW/CPE during both the years and on mean basis. This might be attributed to constant supply of moisture and which may have lead to maximum supply of nutrients to plant from root zone, all these factors enforced to exhibit the potentiality of crop variety to attain more number of effective tillers. The results are in conformity with the findings of Bandyopadhyay (1997) [2], Singh and Jain (2000) [11], As regards to weed management practices in wheat, treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) registered significantly higher number of effective tillers m^{-2} as compared to other treatments but it was statistically at par to treatment W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during both the years and on mean basis. However, significantly the lowest number of effective tillers m^{-2} was noted under W_6: unweeded control during both the years and on mean basis. This might be due to the weed free environment provided by these treatments which minimized the weed crop competition to the extent of their efficacy in weed control which led to better growth of the crop in term of effective tillers. Similar result were reported by Malik *et al.* (2008) [5], Singh *et al.* (2010) [12]

The interaction effect between irrigation levels and weed management practices on number of effective tillers m^{-2} of wheat was found significant during both the years and on mean basis and data are presented in Table 2. The findings revealed that the interaction between I_3: 1.2 IW/CPE and W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) registered significantly highest number of effective tillers m^{-2} as compared to other interactions. However, it was statistically at par to treatment I_3: 1.2 IW/CPE and W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during both the years and on mean basis as well as interaction between I_3: 1.2 IW/CPE and W_1: Sulfosulfuron (20 g ha^{-1}) during 2017-18 and interaction between I_2: 1.0 IW/CPE and W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) during 2017-18 and on mean basis and also I_2: 1.0 IW/CPE W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during 2017-18.

Earhead length (cm)

The length of ears is one of the yield attributes of wheat that contribute to grain yield. Crops with lengthier ears could have higher grain yield. The data on earhead length as influenced by irrigation levels and weed management practices during both the years and on mean basis are presented in Table 1.

Among the irrigation levels, significantly highest earhead length was recorded under treatment I_3: 1.2 IW/CPE as compared to other treatments, whereas, the significantly lowest earhead length was recorded under treatment I_1: 0.8 IW/CPE during both the years and on mean basis. Earhead length (cm) is more or less governed by the genetically constitution of crop but it is little modified by environmental fiction and that is called G x E intrection, that may be cause of increase in length because of congenial condition in term of moisture provided in treatment $I_{3:}$ 1.0 IW/ CPE. Similar finding were also reported by Patel and Upadhayay (1993) [7].

As regards to weed management practices in wheat, significantly highest earhead length was recorded under treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) as compared to other treatments but it was at par to treatment W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during both the year and on mean basis. However, the minimum earhead length was registered under treatment W_6: unweeded control during both the years and on mean basis. Effective control of weeds during critical crop-weed competition period might have helped in uptake of water and nutrients, which turned into better growth and development and thereby result in better yield attribute. Similar result were reported by Patel (2011) [8].

Interaction effects between irrigation levels and weed management practices on earhead length remained unaffected during both the years and on mean basis.

Number of grains earhead^{-1}

Number of grains earhead^{-1} has been considered as a main yield component which defines the yield potential of crop. Data recorded on the number of grains earhead^{-1} as influenced by irrigation levels and weed management practices have been presented in Table 1.

The number of grains earhead^{-1} was significantly affected due to different irrigation levels during both the years and on mean basis. The significantly highest number of grains earhead^{-1} was recorded in treatment I_3**:** 1.2 IW/CPE whereas, the significantly lowest number of grains earhead^{-1} was recorded in treatment I_1: 0.8 IW/CPE during both the years and on mean basis.

Among the weed management practices in wheat, significantly the maximum number of grains earhead^{-1} was recorded under treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) but it was at par to treatment W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during both the year on mean basis. However, significantly the lowest number of grains earhead^{-1} was registered under treatment W6: unweeded control during both the years and on mean basis.

Interaction effects between irrigation levels and weed management practices in wheat was found non – significant with respect to number of grains earhead^{-1} during both the years and on mean basis.

Grain weight earhead^{-1} (g)

The data on grain weight earhead^{-1} was significantly influenced by irrigation levels and weed management practices during both the years and on mean basis and presented in Table 3.

A glance at the data revealed that grain weight earhead^{-1} enhanced prominently up to the increases in irrigation levels and declined thereafter with further reduced irrigation levels during both the years and on mean basis. Among different irrigation levels, I_3: 1.2 IW/CPE gave maximum grain weight earhead^{-1} during both the years and on mean basis. Significantly the minimum grain weight earhead^{-1} was recorded under treatment I_1: 0.8 IW/CPE during both the years and on mean basis.

The data further speaks that different weed management practices caused significant variation in the grain weight earhead^{-1} of wheat during both the years and on mean basis. Among the treatment, W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) gave significantly higher grain weight earhead^{-1} as compared to other treatment, however, it was statistically at par to treatment W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}) during both the year and on mean basis. The lowest grain weight earhead^{-1} was recorded under treatment W_6: unweeded control during both the years and on mean basis.

The grain weight earhead^{-1} of wheat remained unaffected due to the interaction between irrigation levels and weed management practices during both the years and on mean basis.

Test weight (g)

The data on test weight (g) of wheat as influenced by different treatments have been presented in Table 3. The test weight of wheat was significantly influenced by irrigation levels and weed management practices.

Irrigation levels had significantly influenced the test weight during both the years and on mean basis. The significantly higher test weight was produced under treatment I_3**:** 1.2 IW/CPE whereas, significantly the lighter test weight was noted under I_1**:** 0.8 IW/CPE during both the years and on mean basis. The increase in test weight might be due to luxurious growth of the crop in terms of plant height and total tillers may have provided a better quality and quantity of photosynthates and well transportation due to optimum water pressure in plant system and as a result more deposition of food grains. The results of the present study is in agreement with Parihar and Tripathi (1989) [6].

As regards to weed management practices in wheat, treatment W4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) registered significantly highest test weight as compared to other treatments, however, it was statistically at par to treatment W_5: sulfosulfuron + metsulfuron (20 g+4 g ha^{-1}), W_1: sulfosulfuron (20 g ha^{-1}) and W_2: clodinofop (60 g ha^{-1}) during both the years and on mean basis. The lighter test weight was recorded under W_6: unweeded control during both the years and on mean basis. This might be associated with lower crop weed competition. Similar results were also reported by Sepat (2006) [9].

Interaction effects between irrigation levels and weed management practices on test weight remained unaffected during both the years and on mean basis.

Grain yield (q ha^{-1})

The data pertaining to grain yield of wheat as influenced by irrigation levels and weed management practices are presented in Table 4.

Irrigation levels had significantly influenced the grain yield of wheat during both the years and on mean basis. The significantly highest grain yield was recorded in treatment I_3**:** 1.2 IW/CPE and the lowest grain yield were registered in treatment I_1: 0.8 IW/CPE during both the years and on mean basis. This may be due to favorable effect of increasing irrigation frequency, which may be due to more conversion of sources to sink for the formation of seed. In case wheat grain yield, similar results have been reported by Bandyopadhyay and Mallick (2003) [3] and Verma *et al.* (2011) [13].

As regard to weed management practices in wheat, significantly highest grain yield was recorded under treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) and the minimum grain yield were recorded under W_6: unweeded control during both the years and on mean basis. The increase in grain and straw yield under weed control was owing to reduced state of crop-weed competition and thereby increase in nutrient availability to the crop plants resulting in improvement in the yield attributing characters. This result was supported by Sharma and Sharma, 1997 [10].

The interaction effect between irrigation levels and weed management practices in wheat was found significant during both the years and on mean basis and data are presented in Table 5. The findings revealed that the interaction between I_3:

1.2 IW/CPE and W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) registered significantly highest grain yield as compared to other interactions, however, interaction between I_1**:** 0.8 IW/CPE and W_6: unweeded control was noted significantly the lowest grain yield during both the years and on mean basis. These findings are in agreement with the results reported by Choubey *et al*. (1998) [4].

Table 1: Yield attributes of wheat as influenced by different irrigation levels and weed management practices

Treatment	Number of effective tiller m^{-2}			Earhead length (cm)			Grains $earhead^{-1}$ (no.)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
Irrigation levels									
I_1: 0.8 IW/CPE	318.02	323.93	320.98	8.59	9.16	8.87	36.62	37.58	37.10
I_2: 1.0 IW/CPE	348.23	355.43	351.83	9.45	9.96	9.71	40.72	42.06	41.39
I_3: 1.2 IW/ CPE	355.86	364.41	360.13	9.83	10.30	10.07	44.23	45.20	44.72
S.Em±	1.23	1.40	1.30	0.08	0.08	0.08	0.43	0.51	0.46
CD (P=0.05)	4.96	5.66	5.26	0.35	0.34	0.35	1.73	2.03	1.83
Weed management									
W_1: Sulfosulfuron (20 g ha^{-1})	356.13	362.60	359.37	9.18	9.74	9.47	39.36	41.04	40.20
W_2: Clodinofop (60 g ha^{-1})	348.96	357.71	353.33	9.28	9.83	9.55	39.56	40.89	40.22
W_3: Metsulfuron (4 g ha^{-1})	337.18	343.87	340.52	9.20	9.74	9.47	39.44	40.38	39.91
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	367.24	376.89	372.07	9.92	10.41	10.17	44.29	44.89	44.59
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	364.89	372.56	368.72	9.83	10.32	10.08	43.44	44.40	43.92
W_6: Unweeded Control	269.82	273.93	271.88	8.34	8.80	8.57	37.07	38.07	37.57
S.Em±	1.50	1.26	1.28	0.16	0.15	0.16	1.00	0.99	0.99
CD (P=0.05)	4.35	3.66	3.70	0.49	0.45	0.47	2.89	2.88	2.87
Interaction (I X W)	S	S	S	NS	NS	NS	NS	NS	NS

Table 2: Interaction effect of irrigation levels and weed management practices on effective tillers (No. m^{-2}) of wheat

Treatment	Effective tillers (No. m^{-2})								
	2017-18			2018-19			Mean		
	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE
W_1: Sulfosulfuron (20 g ha^{-1})	336.67	360.20	371.53	342.13	367.47	378.20	339.40	363.83	374.87
W_2: Clodinofop (60 g ha^{-1})	323.53	357.67	365.67	331.87	365.53	375.73	327.70	361.60	370.70
W_3: Metsulfuron (4 g ha^{-1})	295.87	352.07	363.60	302.53	358.07	371.00	299.20	355.07	367.30
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	347.00	375.20	379.53	353.33	384.53	392.80	350.17	379.87	386.17
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	343.13	373.47	378.07	348.80	381.87	387.00	345.97	377.67	382.53
W_6: Unweeded Control	261.93	270.80	276.73	264.93	275.13	281.73	263.43	272.97	279.23
S.Em±									
2 SP at same MP	3.01			3.44			3.20		
2MP at same SP	2.67			2.44			2.40		
				CD (P=0.05)					
2 SP at same MP	8.18			7.15			7.17		
2MP at same SP	8.39			7.99			7.79		

Table 3: Grain weight $earhead^{-1}$ and test weight of wheat as influenced by different irrigation levels and weed management practices

Treatment	Grain weight $earhead^{-1}$(g)			Test weight (g)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean
Irrigation levels						
I_1: 0.8 IW/CPE	2.10	2.35	2.23	40.27	40.45	40.36
I_2: 1.0 IW/CPE	2.66	2.95	2.81	41.84	41.84	42.84
I_3: 1.2 IW/ CPE	3.09	3.36	3.23	43.59	43.80	43.70
S.Em±	0.08	0.08	0.08	0.36	0.36	0.36
CD (P=0.05)	0.33	0.31	0.30	1.46	1.44	1.46
Weed management						
W_1: Sulfosulfuron (20 g ha^{-1})	2.58	2.84	2.72	41.95	42.09	42.02
W_2: Clodinofop (60 g ha^{-1})	2.56	2.85	2.71	41.90	42.10	41.98
W_3: Metsulfuron (4 g ha^{-1})	2.52	2.79	2.66	41.60	41.68	41.64
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	2.90	3.17	3.04	43.15	43.39	43.27
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	2.89	3.17	3.03	43.06	43.17	43.12
W_6: Unweeded Control	2.27	2.52	2.39	39.75	39.86	39.81
S.Em±	0.10	0.10	0.10	0.45	0.46	0.45
CD (P=0.05)	0.29	0.30	0.29	1.32	1.33	1.32
Interaction (I X W)	NS	NS	NS	NS	NS	NS

Table 4: Grain, straw yield and harvest index of wheat as influenced by different irrigation levels and weed management practices

Treatment	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean	2017-18	2018-19	Mean
Irrigation levels									
I_1: 0.8 IW/CPE	23.90	24.98	24.44	36.30	37.46	36.88	39.67	39.96	39.81
I_2: 1.0 IW/CPE	28.27	29.75	29.01	40.39	41.25	40.82	40.99	41.69	41.34
I_3: 1.2 IW/ CPE	31.28	32.91	32.09	43.07	44.37	43.72	41.84	42.33	42.09
S.Em±	0.11	0.10	0.10	0.11	0.10	0.10	0.03	0.02	0.03
CD (P=0.05)	0.46	0.40	0.42	0.41	0.38	0.38	0.10	0.08	0.11
Weed management									
W_1: Sulfosulfuron (20 g ha^{-1})	27.80	29.30	28.55	39.58	41.03	40.30	41.19	41.59	41.39
W_2: Clodinofop (60 g ha^{-1})	27.01	28.50	27.75	39.14	40.38	39.76	40.76	41.28	41.02
W_3: Metsulfuron (4 g ha^{-1})	26.38	27.69	27.04	38.81	39.74	39.27	40.42	40.99	40.71
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	33.41	35.29	34.35	45.54	46.75	46.14	42.12	42.81	42.47
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-})	31.54	33.28	32.41	43.41	44.74	44.07	41.92	42.50	42.21
W_6: Unweeded Control	20.77	21.23	21.00	33.05	33.52	33.28	38.59	38.77	38.68
S.Em±	0.12	0.11	0.10	0.17	0.17	0.16	0.04	0.04	0.03
CD (P=0.05)	0.34	0.31	0.31	0.51	0.49	0.46	0.10	0.11	0.08
Interaction (I X W)	S	S	S	S	S	S	S	S	S

Table 5: Interaction effect of irrigation levels and weed management practices on grain yield of wheat

Treatment	Grain yield (q ha^{-1})								
	2017-18			2018-19			Mean		
	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE
W_1: Sulfosulfuron (20 g ha^{-1})	24.99	27.28	31.12	26.07	28.79	33.03	25.53	28.03	32.07
W_2: Clodinofop (60 g ha^{-1})	23.58	26.76	30.68	24.61	28.30	32.59	24.10	27.53	31.63
W_3: Metsulfuron (4 g ha^{-1})	23.27	26.27	29.60	24.24	27.72	31.10	23.76	27.00	30.35
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	25.86	36.01	38.35	27.37	37.90	40.61	26.62	36.95	39.48
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	25.52	32.38	36.71	26.97	34.43	38.44	26.25	33.40	37.57
W_6: Unweeded Control	20.19	20.90	21.21	20.63	21.37	21.70	20.41	21.13	21.45
S.Em±									
2 SP at same MP	0.28			0.25			0.26		
2MP at same SP	0.21			0.20			0.20		
CD (P=0.05)									
2 SP at same MP	0.66			0.59			0.59		
2MP at same SP	0.70			0.63			0.64		

Table 6: Interaction effect of irrigation levels and weed management practices on straw yield of wheat

Treatment	Straw yield (q ha^{-1})								
	2017-18			2018-19			Mean		
	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE
W_1: Sulfosulfuron (20 g ha^{-1})	37.60	38.82	42.33	38.47	40.09	44.53	38.03	39.45	43.43
W_2: Clodinofop (60 g ha^{-1})	35.64	38.66	43.10	37.05	39.69	44.42	36.35	39.18	43.76
W_3: Metsulfuron (4 g ha^{-1})	35.51	38.91	41.99	36.70	39.74	42.77	36.11	39.32	42.38
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	38.54	48.69	49.39	39.96	49.29	51.00	39.25	48.99	50.19
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	38.11	43.97	48.14	39.76	44.99	49.46	38.93	44.48	48.80
W_6: Unweeded Control	32.38	33.27	33.48	32.84	33.70	34.02	32.61	33.49	33.75
S.Em±									
2 SP at same MP	0.30			0.23			0.23		
2MP at same SP	0.31			0.28			0.27		
CD (P=0.05)									
2 SP at same MP	0.81			0.88			0.84		
2MP at same SP	0.88			0.85			0.82		

Table 7: Interaction effect of irrigation levels and weed management practices on harvest index of wheat

Treatment	Harvest index (%)								
	2017-18			2018-19			Mean		
	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE	I_1: 0.8 IW/ CPE	I_2: 1.0 IW/ CPE	I_3: 1.2 IW/ CPE
W_1: Sulfosulfuron (20 g ha^{-1})	39.92	41.27	42.36	40.40	41.79	42.58	40.16	41.53	42.47
W_2: Clodinofop (60 g ha^{-1})	39.82	40.89	41.58	39.92	41.62	42.31	39.87	41.26	41.95
W_3: Metsulfuron (4 g ha^{-1})	39.62	40.30	41.34	39.77	41.09	42.10	39.70	40.70	41.72
W_4: Clodinofop + Metsulfuron (60 g + 4 g ha^{-1})	40.16	42.51	43.71	40.65	43.46	44.33	40.40	42.99	44.02
W_5: Sulfosulfuron + Metsulfuron (20 g + 4 g ha^{-1})	40.11	42.40	43.26	40.42	43.35	43.73	40.26	42.87	43.49
W_6: Unweeded Control	38.40	38.58	38.78	38.58	38.80	38.94	38.49	38.69	38.86
S.Em±									
2 SP at same MP	0.06			0.06			0.05		
2MP at same SP	0.06			0.04			0.05		
CD (P=0.05)									
2 SP at same MP	0.19			0.20			0.16		
2MP at same SP	0.18			0.19			0.17		

Straw yield (q ha^{-1})

The straw yield of wheat is the function of an accumulated effect of growth parameters like tillers per unit area and final plant height. Data on straw yield (q ha^{-1}) of wheat as influenced by different treatments during both the years have been presented in Table 4. An appraisal of the data showed that similar to seed yield, significant variations in straw yield of wheat also occurred due to irrigation levels and weed management practices during both the years and on mean basis.

The straw yield of wheat was significantly affected due to different irrigation levels during both the years and on mean basis. The significantly highest straw yield was recorded in treatment I_3**:** 1.2 IW/CPE and the significantly minimum straw yield were recorded in treatment I_1: 0.8 IW/CPE during both the years and on mean basis.

Among the weed management practices in wheat, significantly highest straw yield was recorded under treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) and the lowest straw yield were recorded in treatment W_6: unweeded control during both the years and on mean basis.

The interaction effect between irrigation levels and weed management practices on straw yield was found significant during both the years and on mean basis (Table 6). The findings revealed that the interaction between I_3: 1.2 IW/CPE and W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) recorded significantly highest straw yield as compared to other interactions, however, the lowest straw yield was noted under interaction between I_1**:** 0.8 IW/CPE and W_6: unweeded control during both the years and on mean basis.

Harvest index (%)

The ability of the crop to convert the total dry matter into economic yield is indicated by its harvest index value. Highest the harvest index value, greater is the physiological potential for converting the total dry matter in to grain yield. The data on harvest index as influenced by irrigation levels and weed management practices during both the years and on mean basis are presented in Table 4.

The harvest index in wheat varied significantly due to irrigation levels during both the years and on mean basis. The significantly highest harvest index value was recorded in treatment I_3: 1.2 IW/CPE and the least harvest index value was recorded in treatment I_1**:** 0.8 IW/CPE during both the years and on mean basis. Similar results have been reported by Verma *et al.* (2011) [13].

Different weed management practices in wheat had significant effect on harvest index during both the years and on mean basis. The significantly higher harvest index was registered in treatment W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) as compared to other treatments, whereas, the lowest harvest index was noted in treatment W_6: unweeded control during both the years and on mean basis.

The interaction effects between irrigation levels and weed management practices exert significant effects during both the years and on mean basis of investigation (Table 7). The interaction between I_3: 1.2 IW/CPE and W_4: clodinofop + metsulfuron (60 g+4 g ha^{-1}) recorded significantly highest harvest index value as compared to others, whereas, the significantly lowest harvest index value was registered under interaction between I_1**:** 0.8 IW/CPE and W_6: unweeded control during both the years and on mean basis.

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