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Effect of irrigation and weed management practice on available nutrients, nutrient concentration and their uptake by weeds and wheat

Kairovin Lakra and Karam HusainDOI: <https://doi.org/10.22271/chemi.2020.v8.i5h.10350>**Abstract**

A field experiment was conducted in sandy loam soil during winter season of 2017-18 and 2018-19. Significantly the lowest weed biomass production, highest available nutrients in soil and the maximum N and K content in weeds and crop was recorded with the application of irrigation at CRI+ active tillering stage. Whereas, irrigation at CRI+jointing+ booting+ flowering+milking stage was recorded maximum P content. Application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) 100 g *a.i.* ha⁻¹ at 35 DAS recorded significantly lowest weed biomass and the highest nutrient content in weeds and crop. Application of irrigation at CRI+jointing+ booting+ flowering+milking stage was recorded significantly the highest nutrients depletion by weeds and their uptake by crop. Significantly the lowest nutrients depletion by weed and their highest uptake of crop and the maximum available nutrients in soil were recorded with the application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) 100 g *a.i.* ha⁻¹ at 35 DAS. Grain (9.79 kg ha⁻¹) and straw yield (4.54 kg ha⁻¹) will be reduced by an increased in unit of nutrients depletion by weeds.

Keywords: Available nutrients, irrigation, herbicides, nutrient content, weed**Introduction**

Wheat (*Triticum aestivum* L.) is dominant crop in the temperate countries not only for human food, but also for livestock feed. Productivity of wheat is governed by many factors, but one of the most serious and less noticed causes of low yield is the presence of weeds (Kaur and Singh, 2019) ^[1]. Among various factors that affect the yield of wheat, availability of water and weed management are of supreme importance. Water is a key input for all recommended agronomic practices and therefore efficient utilization of irrigation water is essential (Verma *et al.*, 2015) ^[21]. Weeds compete with crops for water, nutrients and other growth factors, and in absence of an effective control measures, weeds remove considerable quantity of applied nutrients resulting loss in yield and conditions become severe under its scarcity (Sangwan *et al.*, (2019) ^[12] and Zargar *et al.*, (2020) ^[22]. The yield increases significantly with increase in the level of irrigations (Verma *et al.*, 2017 ^[20] and Maurya *et al.*, 2017) ^[8]. Nadeem *et al.* (2010) ^[10] reported increase in weed population and their dry weight with increase in irrigation levels. Singh *et al.* (2019) ^[13] found that the nutrients uptake by the crop was reduced significantly when the weeds are allowed to grow throughout the crop growing season. Available nutrients in soil were increased under weed management treatments than weedy condition (Singh *et al.*, 2017) ^[15]. Necessity of adequate weed control treatments and timely water supply in crop production through irrigation scheduling is present demand to save water, increases water productivity, nutrients uptake and their availability in soil. Keeping above facts in mind, the present study entitled 'effect of irrigation and weed management practice on available nutrients, nutrient concentration and their uptake by weeds and wheat' was undertaken.

Materials and Methods

The field experiment was conducted during winter (*Rabi*) season of 2017-18 and 2018-19 at Students Instructional Farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. (U.P).

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It is situated at an elevation of 125.9 meter above mean sea level 26°20' 35" North latitude and 80°18'35" East longitude of Indo-Gangetic Plain in the Central part of Uttar Pradesh. The soil of experimental site is sandy loam, pH (7.1), low in OC (0.35%), available nitrogen (172.4 kg ha⁻¹), sulphur (15.7 kg ha⁻¹) and zinc (0.456 ppm), and medium in available phosphorus (12.8 kg ha⁻¹) and potassium (156.5 kg ha⁻¹). The experiment was laid out in Split Plot Design and replicated four times having 32 treatment combinations. The wheat variety 'K-9423' was sown at row distance of 22.5 cm by opening slits with seed-drill machine. Treatments consisted of four irrigation schedule *viz.* irrigation at CRI and active tillering stage (I₁), irrigation at CRI + jointing + booting (I₂), CRI + active tillering + booting + flowering stage (I₃) and irrigation at CRI + jointing + booting + flowering + milking stage (I₄) were assigned to main plots and weed management practices *viz.* W₁-weedy check, W₂-two hand weeding at 20 and 40 DAS, W₃-sulfosulfuron 25 g ha⁻¹ at 35 DAS, W₄-pendimethalin (pre-em) *fb* WCPL-15, 400 g ha⁻¹ at 35 DAS, W₅-broadway (carfentrazone ethyl 20% + sulfosulfuron 25%WG) 100 g *a.i.* ha⁻¹ at 35 DAS, W₆-halauxafen + penxasulam 23.5%, 75 g *a.i.* ha⁻¹ at 35 DAS, W₇-halauxafen-methyl 1.21% w/w + fluroxypyr at 35 DAS and W₈-clodinafop-propargyl 15% + metsulfuron 1% 400 g *a.i.* ha⁻¹ 35 DAS were allocated to sub plots. The experimental crop was sown in lines 22.5 cm apart using 100 kg ha⁻¹ seed by opening slits with seed-drill machine. A uniform recommended dose of 150 kg N, 75 kg P₂O₅ and 75 kg K₂O ha⁻¹ was applied to crop through urea, DAP and murate of potash, respectively. Half amount of nitrogen and full dose of phosphorus and potash were applied as basal at the time of sowing, ¼ part of nitrogen was top dressed after first irrigation and remaining ¼ part of nitrogen was top dress at spike initiation stage. Weed management practices and irrigations were applied as per treatment. General crop management practices were followed. Data on weed was recorded from an area enclosed in the quadrat of 0.25 m² randomly selected at three places in each plot. Oven dry weight of weeds was recorded. Grain and straw yield was recorded at harvest were studied. The nutrients content and their depletion by weeds were worked out at 60 days after sowing. Available nutrients in soil and nutrient contents in crop were determined as per the standard procedures at harvest and the uptake values were worked out. Nutrient uptake (kg ha⁻¹) was calculated by multiplying their nutrient concentration with weed biomass and crop yield. The experimental data were analyzed statistically and were interpreted.

Results and Discussion

Weed dry weight

Dry weight of weeds significantly affected by irrigation and weed management practices (Table 1). Significantly the lowest dry weight of weed was recorded with application of irrigation at CRI+ active tillering stage (I₁) over irrigation at CRI+ active tillering+ booting+ flowering (I₃) and irrigation CRI+jointing+booting+flowering+milking stage (I₄) and it was at par with irrigation at CRI+ jointing+booting (I₂). The decrease in dry weight of weeds at lower rate of irrigation resulted from the least availability of moisture (Verma *et al.*, 2015) [21], which provides inadequate growing environment to weeds (Verma *et al.*, 2008) [17]. Application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25%WG) 100 g *a.i.* ha⁻¹ at 35 DAS caused significant reduction in dry weight of

weeds over other herbicidal treatments. These results are corroborated with findings of Singh *et al.* (2009) [14].

Grain and straw yield

Irrigation at CRI+jointing+booting+flowering+milking stage resulted into significantly the highest grain and straw yield followed by I₃, I₂ and I₁, respectively. The better development of crop under irrigated treatments was a result of better moisture availability, which maintained the internal water balance of the plant (Verma *et al.*, 2013 [18], Kumar *et al.*, 2019 [7] and Dhaliwal *et al.*, 2020) [1]. Among weed management practices, application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25%WG) 100 g *a.i.* ha⁻¹ at 35 DAS resulted significantly the highest grain and straw yield as compared to rest of the herbicidal treatments. The reason for higher values on growth parameter can be discussed in the light of fact that crop under this treatment had comparatively less weed competition. The reduction in weed competition in wheat by the use of herbicides or hand weeding not only favoured the crop growth with abundant availability of moisture, nutrients, light and space, but also reduced the overall weed interference, facilitating vigorous growth and development of crop plants and finally produce more grain and straw yield of wheat (Singh *et al.*, 2017) [16].

Nutrient content and their depletion by weeds

The main effect of irrigation and weed management practices on N, P and K concentration in weeds was not significant (Table 1). The N and K content in weeds were decreased with increasing number of irrigation and moisture availability was mainly due to dilution effect of these nutrients. Whereas, P content was increased with increasing levels of irrigation. The N, P and K content in weeds are increased with the application of herbicides as compared to weedy check. The highest nutrient content in weeds was observed under broadway (carfentrazone ethyl 20% + sulfosulfuron 25%WG) 100 g *a.i.* ha⁻¹ at 35 DAS treated plot followed by clodinafop-propargyl 15% + metsulfuron 1%, 400 g *a.i.* ha⁻¹ 35 DAS. This may be due to lower dry weight of weed, which reduces the partitioning of nutrients. Weeds consume more nutrients than they need for their growth, and may accumulate higher mineral nutrient concentrations than crop plants (Kaur *et al.*, 2018) [3].

The N, P and K depletion by weeds increased with increasing level of irrigation and significantly the highest depletion of nutrients (N, P and K) by weeds were recorded under irrigation at CRI+jointing+booting+flowering+milking stage (Table 2). It could be attributed to the better soil moisture conditions, which helped in better utilization of nutrient by weeds, thereby resulting in highest weed dry weight and nutrient uptake (Verma *et al.*, 2008 and Verma *et al.*, 2015) [17, 21]. Weed management practices significant influenced on the N, P and K depletion by weeds. It was significantly the highest under halauxafen-methyl 1.21% w/w + fluroxypyr at 35 DAS followed by sulfosulfuron 25 g ha⁻¹ at 35 DAS. The increase in the depletion of N, P and K by weeds under this treatment was due to poor control of weeds resulted highest dry weight of weed, which corroborated with the findings of Singh *et al.* (2009) [14], Kumar *et al.* (2017) [6] and Singh *et al.* (2019) [13].

Nutrient content and their uptake by crop

Increased irrigation frequency increased P content in grain and straw and it was the highest with irrigation at CRI+jointing+booting+flowering+milking stage due to the

dilution effect (Table 1). Whereas, N and K content in grain and straw decreased with increased irrigation frequency and it was found the highest wheat crop was irrigated at CRI+ active tillering stage (I₁). Results are in close conformity with the findings of Verma and Idnani (2012),^[19] Verma *et al.* (2013)^[18] and Kumar *et al.* (2017)^[7]. An application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) 100 g a.i. ha⁻¹ at 35 DAS recorded significantly the highest N, P and K content in grain and straw of wheat followed by clodinafop- propargyl 15% + metsulfuron 1%, 400 g a.i. ha⁻¹ 35 DAS, respectively.

Irrigation at CRI+jointing+booting+flowering+milking stage significantly influenced the N, P and K uptake in grain and straw as well as total uptake of these nutrients by wheat (Table 2). It could be attributed to the better soil moisture conditions during plant growth which helped in better utilization of nutrient by the plant, thereby resulting in highest yield and nutrient uptake. It could be attributed to the better soil moisture conditions during growth period which helped in better utilization of nutrient by the plants, thereby resulting in highest yield and nutrient uptake. The similar results were also reported by Verma *et al.* (2015)^[21].

Weed management practices significantly influenced the total N, P and K uptake by wheat. It was significantly highest with post-emergence application of broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) 100 g a.i. ha⁻¹ at 35 DAS over other herbicidal treatments. The increase in the uptake of nutrients by crop was due to the fact that lower dry weight of weeds under these treatments which helps in the better utilization of N, P and K, and other elements. The higher uptake of these nutrients was due to the higher yield, higher dry matter production and higher nutrient content in different parts of plants, which corroborated with the findings of Kumar *et al.* (2017)^[7], Singh *et al.* (2017)^[16] and Singh *et al.* (2019)^[13]. Significantly the highest nutrients uptake was

recorded under weed free situation due to higher grain and straw yield of wheat (Verma *et al.*, 2015 and Paswan *et al.*, 2017)^[21, 11]. This was due to reduced depletion of nutrients by weeds and concomitant increase in the absorption and translocation of these nutrients to different plant parts for enhanced photosynthetic efficiency (Khokhar and Nepalia, 2010^[4] and Verma *et al.*, 2017)^[20]. Herbicides application brought about significant reduction in N, P and K uptake by weeds and enhanced their uptake by crop (Kumar *et al.* 2017)^[6]. Monsefi *et al.* (2016)^[9] and Singh *et al.* (2017)^[15] reported that the nutrient uptake by crop decreased linearly with increase in nutrient removal by weeds.

Available nutrients in soil

The availability of N, P, K, S and Zn in soil was higher with irrigation at CRI+ active tillering stage which was closely followed by irrigation at CRI + jointing + booting stage and it were significantly superior over (I₄) and (I₃), respectively. This may be due to fact that lower number of irrigation not fully utilized the available nutrients resulted increase in the availability of nutrients in soil. Similar results were also observed by reported by Verma *et al.* (2017)^[20] and Maurya *et al.* (2017)^[8].

All the weed management treatments recorded significantly the highest N, P, K, S and Zn availability in soil than the weedy check. Weed free had more N, P, K, S and Zn availability in soil which was closely followed by broadway (carfentrazone- ethyl 20% + sulfosulfuron 25% WG) 100 g a.i. ha⁻¹ at 35 DAS, clodinafop- propargyl 15% + metsulfuron 1% 400 g a.i. ha⁻¹ at 35 DAS, pendimethalin (pre-em) *fb* WCPL-15 400 g ha⁻¹ at 35 DAS, halauxafen + penxasulam 23.5% 75 g a.i. ha⁻¹ at 35 DAS, sulfosulfuron 25 g ha⁻¹ at 35 DAS and halauxafen 1.21% w/w + fluroxpyr at 35 DAS (37.1 and 38.0 g), respectively. Results are corroborated with the research results of Singh *et al.* (2017)^[16].

Fig 1: Relationship between nutrients depletion by weeds and yield

Table 1: Effect of irrigation and weed management on weed dry weight, yield and nutrient concentration weeds and crop

Treatments	Dry weight of weed (kg ha ⁻¹)	Grain Yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)	Nutrient concentration in weeds (%)			Nutrient concentration in wheat grain (%)			Nutrient concentration wheat straw (%)		
				N	P	K	N	P	K	N	P	K
Irrigation schedule												
I ₁	264.4	2737	3481	1.873	0.319	1.982	1.724	0.330	0.659	0.495	0.130	1.533
I ₂	317.4	2900	3613	1.872	0.319	1.982	1.722	0.332	0.659	0.491	0.132	1.532
I ₃	368.0	3037	3685	1.868	0.320	1.981	1.712	0.336	0.662	0.485	0.136	1.527
I ₄	389.7	3151	3748	1.868	0.321	1.980	1.710	0.337	0.659	0.483	0.138	1.525
SEm±	24.9	46	30	0.003	0.002	0.001	0.017	0.005	0.007	0.020	0.002	0.009
CD(P=0.05)	70.1	146	97	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed management												
W ₁	729.7	2506	3261	1.851	0.310	1.954	1.726	0.341	0.668	0.504	0.132	1.535
W ₂	000.0	3402	4068	1.878	0.325	1.993	1.696	0.339	0.659	0.494	0.146	1.530
W ₃	362.2	2856	3544	1.869	0.319	1.984	1.722	0.334	0.661	0.486	0.135	1.530
W ₄	322.2	2911	3592	1.874	0.322	1.986	1.723	0.332	0.662	0.487	0.134	1.527
W ₅	276.3	3193	3815	1.876	0.323	1.984	1.705	0.328	0.652	0.483	0.130	1.523
W ₆	321.2	2946	3635	1.872	0.321	1.985	1.722	0.332	0.660	0.482	0.132	1.530
W ₇	365.5	2749	3433	1.868	0.318	1.982	1.725	0.338	0.665	0.492	0.134	1.533
W ₈	301.9	3093	3705	1.874	0.322	1.981	1.716	0.331	0.655	0.482	0.133	1.527
SEm±	8.49	36	33	0.002	0.003	0.002	0.015	0.004	0.004	0.010	0.001	0.004
CD(P=0.05)	24.6	102	92	0.006	0.008	0.005	NS	NS	NS	NS	NS	NS

I₁-Two irrigation (CRI+active tillering), I₂-Three irrigation (CRI+ jointing+booting), I₃- Four irrigation (CRI+active tillering+ booting+flowering), I₄-Five irrigation (CRI+jointing+booting+flowering+milking), W₁-Weedy check, W₂- Two hand weeding (20 and 40 DAS), W₃-Sulfosulfuron @25 g ha⁻¹ at 35 DAS, W₄- Pendimethalin (pre-em) fb WCPL-15@400 g ha⁻¹ at 35 DAS, W₅- Broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) @ 100 g a.i. ha⁻¹ at 35 DAS, W₆- Halaxafen + penxasulam 23.5% @ 75 g a.i. ha⁻¹ at 35 DAS, W₇- Halaxafen - methyl 1.21% w/w + fluroxypyr @ at 35 DAS, W₈- Clodinafop- propargyl 15% + metsulfuron 1% @ 400 g a.i. ha⁻¹ 35 DAS

Table 2: Effect of irrigation and weed management on weed dry weight, yield and nutrient concentration weeds and crop

Treatments	Nutrients depletion by weeds (kg ha ⁻¹)			Nutrient uptake by crop (kg ha ⁻¹)			Available nutrient in soil				
	N	P	K	N	P	K	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)	S (kg ha ⁻¹)	Zn (mg kg ⁻¹)
Irrigation schedule											
I ₁	4.94	0.84	5.22	63.1	13.15	67.10	168.35	11.82	153.40	15.77	0.561
I ₂	5.93	1.01	6.27	66.2	14.00	69.75	167.50	11.75	152.80	15.70	0.559
I ₃	6.86	1.17	7.27	68.3	14.80	71.55	166.35	11.62	151.45	15.68	0.556
I ₄	7.26	1.24	7.70	70.7	15.40	73.70	166.30	11.65	151.65	15.66	0.557
SEm±	0.47	0.08	0.49	0.9	0.22	0.68	0.30	0.03	0.25	0.02	0.001
CD(P=0.05)	1.30	0.22	1.37	2.7	0.66	2.03	0.93	0.08	0.80	0.06	0.003
Weed management											
W ₁	13.50	2.26	14.25	57.6	12.30	60.60	165.10	11.51	150.50	15.54	0.553
W ₂	0.00	0.00	0.00	76.2	17.00	79.75	169.65	11.93	154.15	15.89	0.564
W ₃	6.77	1.16	7.18	64.9	13.92	68.40	166.30	11.63	151.55	15.65	0.555
W ₄	6.03	1.04	6.39	66.7	14.22	71.25	167.25	11.73	152.45	15.69	0.559
W ₅	5.18	0.90	5.48	71.6	15.07	74.80	168.05	11.81	153.35	15.75	0.562
W ₆	6.01	1.03	6.37	67.1	14.28	71.60	166.85	11.69	152.15	15.68	0.557
W ₇	6.83	1.16	7.24	62.5	13.40	65.30	166.10	11.61	151.35	15.69	0.555
W ₈	5.66	0.97	5.98	69.7	14.78	72.70	167.70	11.77	153.00	15.72	0.561
SEm±	0.26	0.05	0.28	0.6	0.10	0.69	0.28	0.02	0.21	0.02	0.001
CD(P=0.05)	0.83	0.15	0.89	2.0	0.31	2.06	0.79	0.06	0.57	0.05	0.002
Initial value	-	-	-	-	-	-	172.45	12.85	156.50	15.75	0.547

I₁-Two irrigation (CRI+active tillering), I₂-Three irrigation (CRI+ jointing+booting), I₃- Four irrigation (CRI+active tillering+ booting+flowering), I₄-Five irrigation (CRI+jointing+booting+flowering+milking), W₁-Weedy check, W₂- Two hand weeding (20 and 40 DAS), W₃-Sulfosulfuron @25 g ha⁻¹ at 35 DAS, W₄- Pendimethalin (pre-em) fb WCPL-15@400 g ha⁻¹ at 35 DAS, W₅- Broadway (carfentrazone ethyl 20% + sulfosulfuron 25% WG) @ 100 g a.i. ha⁻¹ at 35 DAS, W₆- Halaxafen + penxasulam 23.5% @ 75 g a.i. ha⁻¹ at 35 DAS, W₇- Halaxafen - methyl 1.21% w/w + fluroxypyr @ at 35 DAS, W₈- Clodinafop- propargyl 15% + metsulfuron 1% @ 400 g a.i. ha⁻¹ 35 DAS

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