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Effect of depth of irrigation and level and time of nitrogen application on growth, yield and nutrient uptake by wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted on sandy-loam soil during the winter season of 1992–93 and 1993–94 at Kalyani, West Bengal, to study the effect of different depths of irrigation, viz. ¾ field capacity (FC), 1 FC, ½ FC and 2 FC (i.e. 4.5, 6, 9 and 12 cm water), levels of nitrogen (50 and 100 kg/ha) and its time of application (before irrigation and after irrigation) on plant height, yield attributes, yield and uptake of N, P and K by wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Irrigation level up to 1 FC resulted in significantly higher plant height, yield attributes, as well as grain and straw yields of wheat over the other levels of irrigation. Nitrogen @ 100 kg/ha when half of N top-dressed after irrigation recorded greater grain and straw yields and yield components. The highest uptake of N, P and K in grain and straw and total uptake of N, P and K were also recorded with 1 FC irrigation. Similarly, 100 kg N/ha and its top-dressing just after irrigation resulted in maximum N, P and K uptake in straw as well as grain of wheat crop. Total uptake of N, P and K by wheat crop showed the similar trend as in case of grain and straw with nitrogen application.

Key words : Wheat, Irrigation, Nitrogen level and time, yield attributes, Yield, Nutrient concentration and uptake

Productivity of wheat crop is improved due to judicious application of irrigation and nitrogenous fertilizer. Under and over-irrigation caused lower fertilizer-use efficiency of crop. Over-irrigation not only enhances deep percolation of costly irrigation water but also accelerates the movement of nitrogen fertilizer beyond the crop root zone. Time of nitrogen top-dressing also has a significant role in higher productivity of the crop. Nitrogen application before irrigation of higher quantity reduces the availability of N, resulting low yield of crop which is the

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usual practice. Since information on these aspects is lacking for alluvial region of West Bengal, the present experiments was conducted to assess the optimum depth of irrigation and nitrogen application for yield of wheat and fertilizer-use efficiency of the crop.

MATERIALS AND METHODS

A field experiment was conducted during the winter season of 1992–93 and 1993–94 at District Seed Farm, BCKV, Kalyani, West Bengal, on sandy-loam soil, having 222.94, 23.63 and 189.20 kg/ha of available N, P and K, respectively, with organic carbon content 0.53% and pH 6.7. The treatments consisted of 4 levels of irrigation [up to ¾, 1, 1½ and 2 FC (field capacity), i.e. 4.5, 6, 9 and 12 cm irrigation water], 2 levels of N, viz. 50 and 100 kg/ha, where half of N was applied basal and rest half N at crown-root initiation (CRI) stage at 2 different times, viz. before irrigation and just after irrigation. These treatments were tested in split-plot design with 3 replications, allotting irrigation levels in the main plots, N levels in subplot and time of nitrogen application in subplots. Wheat 'UP 262' was sown 23 cm apart in rows on 2 December and 18 November with a seed rate of 100 kg/ha and harvested on 19 March and 10 March during 1992–93 and 1993–94 respectively. Half dose of N and full dose of 50 kg P_2O_5 and 50 kg K_2O/ha were applied basal in the form of urea, single superphosphate and muriate of potash respectively. Each level of irrigation was applied at CRI, maximum tillering, flowering and dough stages of crop with the help of 90°V notch. Concentrations (%) of N, P and K of grain and straw were analysed separately after harvesting the crop on dry-weight basis. The uptake of nutrients was calculated by multiplying the concentration of nutrients with the respective yield of wheat in kg/ha.

Uptake (kg/ha) = Concentration (%) × dry weight, i.e. yield (kg/ha)

The crop received 49.0 and 54.0 mm rainfall during 1992–93 and 1993–94 respectively during the growing period.

RESULTS AND DISCUSSION

Plant height and yield attributes

Irrigation levels increased plant height significantly. Application of 1 FC quantity of irrigation water produced maximum plant height and it was the lowest under ¾ FC level.

Application of 100 kg N/ha and when it was applied just after irrigation produced higher plant height over 50 kg N/ha and top-dressed before irrigation (Table 1). Balyan (1992) also reported similar increase in plant height with an increase level of N.

Yield attributes, viz. effective tillers/m^2, grains panicle and 1,000-grain weight, influenced markedly by irrigation treatment. The highest number of effective tillers, grains/panicle and 1,000-grain weight were observed under 1 FC irrigation depth. The results clearly indicate that the application of irrigation water to an optimum level (1 FC) was beneficial for improvement of all the yield components, whereas insufficient irrigation water and over-irrigation were not conducive for proper crop growth and development.

Nitrogen resulted significant increase in

Table 1. Effect of irrigation, nitrogen and its time of application on height and productivity of wheat

Treatment	Height of plant (cm)		Effective tillers/m^2		Grains/ panicle		1,000-grain weight (g)		Grain yield (q/ha)		Straw yield (q/ha)	
	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94
Levels of irrigation												
¾ FC	82.02	86.95	270.6	308.3	44.1	38.8	46.18	45.01	30.42	35.27	50.14	52.60
1 FC	84.80	93.87	331.5	330.1	48.1	39.7	47.43	45.50	41.01	38.31	62.50	55.47
$^3/_2$ FC	83.81	93.02	309.0	324.6	45.7	40.8	45.80	46.01	33.53	35.38	51.93	52.63
2 FC	83.15	91.24	298.6	315.9	45.5	38.5	45.25	44.73	32.28	32.96	54.15	52.77
CD (P=0.05)	1.78	4.60	21.37	NS	2.11	NS	NS	NS	4.712	1.824	8.635	NS
Nitrogen (kg/ha)												
50	79.29	87.02	263.8	292.4	44.1	37.2	45.51	44.90	30.23	30.31	48.27	44.71
100	87.35	95.52	341.1	347.5	47.6	41.8	46.84	45.72	38.40	40.65	61.09	62.02
CD (P = 0.05)	1.13	1.97	10.47	22.4	0.66	2.01	0.563	NS	1.089	1.357	4.462	1.484
Time of N application												
Before irrigation	82.48	91.24	291.3	315.6	45.4	38.9	45.70	45.27	33.25	34.55	53.47	52.36
After irrigation	84.17	91.29	313.6	324.3	46.3	40.0	46.64	45.35	35.37	36.41	55.90	54.37
CD (P = 0.05)	1.13	NS	10.47	NS	0.66	NS	0.563	NS	1.089	1.357	NS	1.484

all the yield attributes (Table 1). Maximum tillers/m^2, grains/panicle and 1,000-grain weight were observed under 100 kg N/ha. Nitrogen 50 kg/ha did not meet the requirement of nitrogen for wheat and consequently wheat plants experienced N deficiency which resulted poor yield attributes. Similar results were reported by Kumar *et al.* (1994) and Singh and Singh (1995).

Time of nitrogen application also influenced markedly by irrigation treatment. The highest number of effective tillers, grains/panicle and 1,000-grain weight were observed under 1 FC irrigation depth. The results clearly indicate that the application of irrigation water to an optimum level (1 FC) was beneficial for improvement of all the yield components, whereas insufficient irrigation water and over-irrigation were not conducive for proper crop growth and development.

Time of nitrogen application also influenced the yield attributes greatly. Nitrogen top-dressed after irrigation (at CRI stage) showed better result than top-dressed before irrigation. This might be owing grater availability of nitrogen in this method of nitrogen application. This observation supports the finding of Rajput and Verma (1994).

Yield

Both grain and straw yields of wheat were significantly influenced by irrigation levels except straw yield obtained during 1993–94 (Table 1). Maximum yields of grain and straw were produced with irrigation levels up to 1FC. Both under irrigation, i.e. ¾ FC and over-irrigation, i.e. ½ and 2 FC resulted in reduction of yield of wheat. The 1 FC irrigation improved all the yield components and growth of wheat which contributed to significantly greater grain and straw yields. Similar observation was made by Reddy and Dakshnamurti (1976).

Nitrogen levels and its time of application influenced grain and straw yields markedly. Nitrogen 100 kg/ha and half of nitrogen when top-dressed just after irrigation recorded greater grain and straw yields. A lower level of nitrogen (50 kg/ha) was insufficient for optimum growth and dvelopment of wheat crop caused decreased yield of wheat. Nitrogen top-dressed before irrigation enhances leaching loss of nitrogen with irrigation water beyond the crop root-zone depth resulted reduced crop yield. Availability of N increased when it was applied just after irrigation and also improved plant growth and development and hence higher grain and straw yields were recorded under this treatment. The results are in accordance with Singh and Singh (1995).

Nutrient uptake

Irrigation significantly influenced N, P and K uptake in grain in both the years, whereas in straw during 1993–94 only (Table 2). The highest uptake of N, P and K in grain and straw recorded with irrigation up to 1 FC and the lowest observed under ¾ FC irrigation. Reduction in N, P and K uptake with over- and under-irrigation were due to decreased yields of grain and straw. Yadav (1991) also made similar observation.

Total N, P and N uptake of wheat was also greatest with 1 FC irrigation level. The highest total N, P and K uptake at 1 FC was

Table 2. Effect of irrigation, nitrogen and its time of application on N, P and K uptake (kg/ha) by wheat

Treatment	Uptake of N (kg/ha)						Uptake of P (kg/ha)						Uptake of K (kg/ha)					
	Straw		Grain		Total		Straw		Grain		Total		Straw		Grain		Total	
	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94	1992–93	1993–94
Levels of irrigation																		
¾ FC	22.71	28.92	54.87	64.92	77.58	93.84	9.82	10.01	10.21	14.11	20.03	24.12	80.06	88.66	12.35	14.41	92.42	103.07
1 FC	36.64	34.57	88.34	82.78	124.98	117.35	12.65	10.37	14.10	15.70	26.74	26.07	106.02	92.32	16.50	15.32	122.54	107.64
$^3/_2$ FC	26.45	27.27	67.05	67.36	93.50	94.66	10.47	9.04	11.02	13.28	21.49	22.31	89.57	91.10	13.28	13.22	102.85	104.25
2 FC	25.02	32.31	66.54	70.38	91.56	102.68	9.92	9.22	11.44	14.28	21.36	23.50	86.26	89.75	14.76	15.64	101.02	105.39
CD (P=0.05)	7.20	NS	13.06	4.30	10.20	15.83	3.23	NS	1.14	1.04	3.56	1.14	17.16	NS	1.98	1.57	NS	NS
Levels of nitrogen (kg/ha)																		
50	18.36	18.63	49.93	49.19	68.25	67.82	10.10	9.17	10.58	12.76	20.69	21.93	76.06	71.63	13.46	13.60	89.54	85.16
100	37.08	42.90	88.48	93.53	125.56	136.43	11.33	10.15	12.80	15.92	24.12	26.07	104.86	109.29	14.99	15.69	119.87	125.02
CD (P=0.05)	5.17	4.53	5.42	4.22	7.44	6.57	NS	0.63	0.63	0.84	1.27	0.92	11.70	7.04	0.61	1.16	11.65	7.05
Time of N application																		
Before irrigation	26.52	29.86	65.91	69.12	92.43	98.98	10.22	9.31	11.51	14.11	21.73	23.42	87.70	88.79	13.97	14.67	101.68	103.50
After irrigation	28.89	31.67	72.49	73.60	101.38	104.27	11.20	10.01	11.88	14.58	23.08	24.58	93.24	92.13	14.48	14.62	107.73	106.67
CD (P=0.05)	NS	NS	5.42	4.22	7.44	6.57	NS	0.63	NS	0.84	1.27	0.92	NS	NS	NS	NS	NS	NS

attributed owing to an improvement in yield and N, P and K uptke of straw and grain.

Uptake of N, P and K were significantly affected by nitrogen levels except P uptake in straw during 1993–94. However, 100 kg N/ha enhanced N, P and K uptake compared with 50 kg N/ha possibly with increased yields of grain and straw.

Total N, P and K uptake of wheat followed the same trend as N, P and K uptake in grain and straw due to nitrogen levels. Maximum total uptake of N, P and K were observed with 100 kg N/ha due to its significant effect of N, P and K uptake of grain and straw. Similar observation was made by Parihar and Tripathi (1990).

Time of nitrogen application did not have significant effect on nutrients uptake of wheat except N uptake in grain and P uptake in straw and grain during 1993–94 (Table 2). However, nitrogen top-dressed just after irrigation recorded higher N, P and K uptake with nitrogen applied after irrigation, was mainly due to increased yield of grain and straw of wheat. The result is in confirmity with the finding of Parihar and Tripathi (1990).

Effect of nitrogen application time on total uptake of N, P and K by wheat was significant, except total uptake of K in both the years. Nitrogen top-dressed after irrigation resulted in the highest total uptake of N, P and K by wheat crop. Lower uptake of N, P and K in grain and straw with nitrogen applied before irrigation resulted the lowest total N, P and K uptake by wheat crop in this treatment. Similar results were also made by Yadav (1991) and Dubey and Sharma (1996).

It could be concluded that application of 1 FC irrigation and 100 kg N/ha, of which 50% top-dressed just after irrigation, showed beneficial effect in optimizing the growth, yield and nitrogen-use efficiency of wheat crop in alluvial sandy-loam soils of West Bengal.

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