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Effect of irrigation, seeding date and fertilizer on growth and yield of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted during the winter season of 1992–93 and 1993–94 on sandy loam soil of Ranchi, to study the effect of irrigation, seeding date and fertilizer on growth and yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Wheat crop receiving 4 irrigation maintaining higher leaf-area index (LAI), dry matter, crop-growth rate (CGR) and net assimilation rate (NAR) resulted in 43 and 14% more grain yield than 2 (22.32 q/ha) and 3 irrigations (27.86 q/ha) respectively. Timely-seeded crop (24 November) also recorded higher LAI, dry matter and CGR and gave 39% more grain yield than late seeding 18 December (22.85 q/ha). Seeding beyond 24 November reduced the grain yield by 37.5 kg/ha/day. Similarly, crop grown with 100% recommended fertilizer having higher LAI, NAR and dry-matter accumulation rate gave 35% more grain yield than 50% recommended fertilizer (23.31 q/ha).

Productivity of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) depends on the prevailing environmental conditions during the crop growth which cannot be modified to a great extent under field condition. However, with the adoption of modern agronomic management, favourable soil-moisture regime can be created by timely scheduling of irrigation (McDonald *et al.*, 1984). Similarly, soil fertility can be maintained with the use of recommended fertilizer (Singh and Verma, 1990). Temperature, one of the major determinants of wheat growth, cannot be manipulated in the field but seeding time can be adjusted to fit the existing temperature best suited to different gowth stages (Tewary and Singh, 1993). Hence the present experiment was undertaken to study the effect of irrigation, seeding date and fertilizer on growth and yield of wheat.

MATERIALS AND METHODS

The field experiment was conducted during the winter season of 1992–93 and 1993–94 in randomized block design. with the treatments consisting combinations of 3 irrigation schedules (crown-root-initiation and boot stages; crown-root-initiation, boot and milk stages and crown-root-initiation, maximum tillering, boot and milk stages); 2 seeding dates (24 November and 18 December) and 2 fertilizer levels (recommended fertilizer, 100, 50, and 25 kg/N : P_2O_5 : K_2O/ha and 50% recommended fertilizer) and replicated thrice at the University Farm, Ranchi. The experimental soil was sandy loam (20% silt and 19.6% clay) with low water-retention capacity (160 mm available water/m soil depth), slightly acidic in reaction (pH 6.4), low in available N (190 kg/ha) and medium in available P_2O_5 (25 kg/ha) and available K_2O (205 kg/ha). 'UP

262' wheat was sown 20 cm apart using 120 kg seed/ha. Timely-sown crop faced conducive temperature during pre (16 to 20°C)- and post-anthesis period (20 to 22°C), whereas late-sown crop faced low temperature during early growth period (13 to 15°C) and high temperature (22 to 26°C) during post-anthesis period during both the years. The crop received irrigation, 5 ± 1 cm each as per treatment apart from 25 and 30 mm rainfall during first and second year of experiment respectively.

RESULTS AND DISCUSSION

Crop growth

Crop receiving 4 irrigations produced 37 and 62% more green leaf area at 50 and 70 days after sowing (DAS) respectively and consequently produced more dry matter (31 to 51%) than 2 irrigations (Table 1). Crop-growth rate (CGR) gradually increased with crop age and reached its peak during 70–90 days and thereafter it declined (Table 2). Crop with 4 irrigations also maintained highe CGR throughout the crop growth period than the crop receiving 2 or 3 irrigations. Similarly, crop grown with 4 irrigations had more net assimitation rate (NAR) (3.31 g/m^2/day) during 50–70 days after sowing than the crop with 2 irrigations. Higher CGR and NAR associated with frequent irrigations (4) was mainly due to high leaf-area index (LAI) which accumulated dry matter at a faster rate per unit leaf area per unit time by reducing death of tiller and senescence of leaf (McDonald. 1984).

Timely-seeded crop (24 November) produced 22 and 43% more green leaf area at 50 and 70 days after sowing respectively and acccumulated more dry matter and maintained higher CGR throughout the crop-growth period than late-seeded crop (18 December). Consequently timely-seeded crop accumulated 33% more dry matter than late-seeded crop at maturity. Low temperature during early growth period under late seeding delayed germination, hampered tillering which produced less number of leaves and consequently lead to poor LAI and dry-matter accumulation than timely-seeded crop. However, higher NAR (3.41 g/m^2/day) during 50–70 DAS of late-seeded crop was probably due to accelerated rate of photosynthesis at high temperature causing more dry-matter accumulation per unit leaf area per unit time than the timely-seeded crop (Matsumura *et al.*, 1988).

Wheat grown with recommended fertilizer maintained 33–35% more green leaf area, accumulated dry matter at a faster rate and also had high NAR throughout the crop-growth period and consequently produced 39% more dry matter at maturity than half of the recommended fertilizer. This confirms the findings of Awasthi and Bhan (1993).

Yield

Crop receiving irrigation at the CRI, maximum tillering, boot and milk stages gave 43 and 14% more grain yield than the crop receiving 2 (CRI and boot) and 3 (CRI, boot and milk) irrigations respectively (Table 2). Straw production also followed the similar pattern owing to high LAI and dry-matter accumulation rate. Crop receiving 2 irrigations faced moisture stress during heading and grain development which caused maximum yield reduction (30%) than the crop receiving 4 irrigations (31.87 q/ha). Timely-seeded crop gave 39 and 25% more grain and straw yields than late-seeded one. As timely sown crop faced conducive temperature during pre- and post-anthesis periods which resulted in high leaf area and CGR, whereas late-sown crop

Table 1. Leaf-area index and dry-matter accumulation of wheat as influenced by irrigation, seeding date and fertilizer (mean of 2 years)

Treatment	Leat-area indiex at days afte sowing		Dry-matter accumulation (g/m^2) at days after sowing			Maturity
	50	70	50	70	90	
Irrigation						
CRI + boot	2.29	2.90	113.0	254.5	544.6	649.4
CRI + boot + milk	2.43	3.37	111.8	291.2	597.7	731.4
CRI + maximum tillering + boot + milk	3.15	4.71	128.8	385.6	715.3	932.9
CD (P = 0.05)	0.64	0.86	NS	40.4	86.8	143.2
Seeding date						
24 November	2.89	4.31	125.7	326.9	660.7	879.9
18 December	2.36	3.01	110.1	294.0	577.7	662.6
CD (P = 0.05)	0.52	0.71	13.9	33.0	70.9	116.9
$N : P_2O_5 : K_2O$ (kg/ha)						
100 : 50 : 25	2.96	4.12	138.6	343.7	703.5	895.8
50 : 25 : 12.5	2.29	3.20	97.2	277.2	534.9	646.7
CD (P = 0.05)	0.52	0.71	13.9	33.0	70.9	116.9

Table 2. Crop-growth rate (CGR), net assimilation rate (NAR), grain and straw yields of wheat as influenced by irrigation, seeding date and fertilizer level (mean data of 2 years)

Treatment	CGR (g/m^2/day) at day after sowing			NAR (g/m^2 leaf/ day) at days after sowing	Yield (q/ha)	
	50–70	70–90	90– maturity	70–90	Grain	Straw
Irrigation						
CRI + boot	7.07	14.50	5.24	2.74	22.32	32.38
CRI + boot + milk	8.97	15.32	6.68	3.22	27.86	38.95
CRI + maximum tillering + boot + milk	12.84	16.48	10.88	3.31	31.87	43.65
CD (P = 0.05)	1.98	1.07	1.36	0.46	3.75	4.45
Seeding date						
24 November	10.06	16.69	10.96	2.81	31.85	42.56
18 December	9.19	14.18	4.24	3.41	22.85	34.09
CD (P = 0.05)	NS	0.88	1.67	0.37	3.05	3.55
$N : P_2O_5 : K_2O$ (kg/ha)						
100 : 50 : 25	10.36	17.99	9.61	3.30	31.40	44.26
50 : 25 : 12.5	8.90	12.88	5.59	2.92	23.31	32.39
CD (P = 0.05)	1.55	0.88	1.67	0.37	3.05	3.55

faced low temperature during early growth period which restricted its vegetative growth and high temperature during post-anthesis period accelerated the rate of dry-matter accumulation but reduced the duration of grain development, consequently reduced the grain yield by 37.5 kg/ha/day. Crop grown with recommended fertilizer gave 35 and 37% more grain and straw yields respectively than the crop with 50% recommended fertilizer due to significant increase in growth and development characteristics of wheat (Singh and Verma, 1990).

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