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Response of late-sown wheat (*Triticum aestivum*) to irrigation schedules

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ABSTRACT

A field experiment was conducted during the winter seasons of 1995–97 on acidic sandy-loam soil at Ranchi, to find out the critical growth stages for irrigations as per availability of water for higher and profitable production of late-sown wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Wheat receiving 4 irrigations at crown-root-initiation, maximum tillering, boot and milk stages gave maximum grain (2,707 kg/ha) and straw (4,164 kg/ha) yields, with net return of Rs 11,855/ha and net benefit of Rs 1.31 on each rupee investment. This treatment showed significant edge over all other irrigation schedules except the crop receiving 3 irrigations at maximum tillering, boot and milk stages (2,523 kg/ha grain yield, and Rs 10,474/ha net return with 1.23 benefit : cost ratio). Among 2 irrigation schedules, wheat irrigated at maximum tillering and milk stages gave the maximum grain (2,011 kg/ha) and straw (2,823 kg/ha) yields, with net return of Rs 7,328/ha and net benefit of Rs 0.92/rupee investment.

***Key words*:** Late wheat, Limited irrigation, Productivity, Irrigation scheduling

A considerable area of wheat is sown late due to delay in harvesting of rainy-season crops. In such a situation, wheat crop is exposed to high temperature coupled with high evaporating demand of the atmosphere during the reproductive phase which consequently reduceds growth and productivity. However, profitability of cropping systems still makes it a common and popular practice with the farming community. In fact, its productivity can be boosted under favourable soil-moisture regime, which can be created by proper scheduling of irrigation (Mc Donald *et al.*, 1984), as it not only takes care of the deleterious effect of high temperature but also increases the input-utilization efficiency of the crop. The deleterious effect of water deficit is not equally pronounced over all the growth stages of wheat crop. Accordingly critical growth stages based on the availability of irrigation must be worked out for late-sown wheat, as its water need differs from timely sown crop (Pal *et al.*, 1996a). Hence an investigation was undertaken to find out the critical growth stages for irrigation as per availability of water for late-sown wheat.

MATERIALS AND METHODS

A field experiment was conducted during the winter season of 1995–96 and 1996–97 at the university farm, Ranchi, on sandy-loam soil. The soil was low in water-retention capacity (148 mm/m soil depth, FC 20.2%, PWP 11.4% and BD 1.68 mg/kg), slightly acidic in reaction (pH 6.2), low in available N (196 kg/ha), medium in available P (15.3 kg/ha) and K (120.3 kg/ha). The experiment was laid out in randomized block design, replicated 3 times, consisting of 11 different irrigation scheduled based on critical growth stages of wheat and availability of irrigation water, viz. 4 irrigations at (*i*) crown-root initiation, maximum tillering, boot and milk; 3 irrigations at (*ii*) crown-root initiation, maximum tillering and boot, (*iii*) crown-root initiation, boot and milk, (*iv*) crown-root initiation, maximum tillering and milk, (*v*) maximum tillering, boot and milk; and 2 irrigations at (*vi*) crown-root initiation and maximum tillering, (*vii*) crown-root initiation and boot, (*viii*) crown-root initiation and milk, (*ix*) maximum tillering and boot, (*x*) maximum tillering and milk, and (*xi*) boot and milk. 'HD 2285' wheat was sown 20 cm apart using 125 kg seed/ha in the third week of December, during both the years. The crop was uniformly fertilized with 80 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha. The crop received 5 ± 1 cm water during each irrigation as per treatment apart from 87.3 and 67.8 mm rainfall during first and second year of experimentation respectively.

RESULTS AND DISCUSSION

Productivity

Wheat receiving 4 irrigations at crown-root-initiation, maximum tillering, boot and milk stages gave the maximum grain and straw yields, owing to higher spikes/m^2, spike length, fertile spikelets/spike, grains/spike as well as grain and biomass production rate (Tables 1,2). This treatment showed its superiority to all other levels and time of irrigation except the crop grown with 3 irrigations at maximum tillering, boot and milk stages. Crop receiving 3 irrigations at crown-root initiation, maximum tillering and milk stages also gave significantly higher grain and straw yields than the crops raised with 3 irrigations given at crown-root initiation, boot and milk stages and was on a par either irrigations given with crown-root-initiation, maximum tillerging and boot or the crop receiving 2 irrigations at maximum tillering and milk stages. Wheat with 4 irrigations showed 32.95 and 65.0% more grain and 30.2 and 55.8% more straw yield than those of the crop grown with 3 and 2 irrigations, respectively, irrespective of irrigation timings. Similarly, crop with 3 irrigations 24.14% more grain yield than that of the crop with 2 irrigations. The results conform the findings of Pal *et al.* (1996 b). Water stress at the maximum tillering drastically reduced the grain yield by 34.72% as compared to the crop productivity obtained with 4 irrigations. In fact water stress at maximum tillering not only reduced the spikes/m^2 but also influenced the sink size, as it coincided with the spike-initiation stage during which number of spikelets/spike was determined.

Table 1. Grain and straw yields, harvest index, grain and biomass production rate, net return and benefit : cost ratio of late-sown wheat as influenced by different irrigation schedules (mean data of 2 years)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index	Grain production rate (kg/ha/day)	Biomass production rate (kg/ha/day)	Net return (Rs/ha)	Net benefit : cost
CRI + MT+ B+M	2,707	4,164	0.394	76.94	58.73	11,855	1.31
CRI + MT + B	2,006	3,460	0.367	60.78	47.95	7,270	0.85
CRI + B + M	1,767	2,629	0.402	50.48	40.33	5,052	0.59
CRI + M + M	2,214	3,522	0.386	59.84	50.76	8,672	1.02
MT + B + M	2,523	3,264	0,436	72.09	50.32	10,474	1.23
CRI + MT	1,670	3,115	0.349	52.19	43.90	5,345	0.67
CRI + B	1,469	2,480	0,372	47.39	37.25	3,531	0.44
CRI + M	1,239	2,352	0.345	39.96	34.53	1,933	0.24
MT + B	1,836	3,307	0,357	57.38	46.33	6,578	0.82
MT + M	2,011	2,823	0,416	57.46	44.76	7,328	0.92
B + M	1,647	2,400	0.407	51.47	37.82	4,624	0.58
CD (P=0.05)	346	653	NS	11.52	7.28	2,422	0.28

CRI, Crown-root initiation; MT, maximum tillering; B, boot; M, milk

Table 2. Yield-attributing characters of late-sown wheat as influenced by different irrigation schedule (mean data of 2 years)

Treatment	Spikes/ m^2	Spike length (cm)	Total spikelets/ spike	Fertile spikelets/ spike	Grains/ spike	1,000-grain weight (g)
CRI + MT+ B + M	273	16.1	17.0	16.4	35.4	42.8
CRI + MT + B	198	15.3	16.1	13.7	30.3	39.1
CRI + B + M	178	14.8	16.3	12.8	27.1	36.2
CRI + MT + M	223	15.4	16.1	14.5	31.7	38.5
MT + B + M	266	15.8	16.8	16.2	32.5	39.6
CRI + MT	160	14.8	16.7	12.2	27.5	37.5
CRI + B	152	14.2	15.4	11.9	24.2	37.0
CRI + M	132	13.7	15.5	11.5	23.2	35.2
MT + B	185	15.0	15.5	13.6	28.3	38.5
MT + M	221	14.8	15.7	14.4	27.6	37.6
B + M	175	14.5	15.1	12.8	25.6	36.6
CD (P = 0.05)	34	0.4	NS	2.1	4.1	NS

CRI, Crown-root initiation; MT, maximum tillering; B, boot; M, milk

Similarly, water stress at milk stage also reduced the grain yield by 25.89% compared to productivity with 4 irrigations as it influenced the source by reducing not only the rate of photosynthesis but also the net photosynthate accumulation by increasing the rate of respiration (Singh and Patel, 1995).

Economics

Wheat grown with 4 irrigations at crown-root initiation, maximum tillering, boot and milk stages had the maximum net return, being 61.0 and 147.0% more than the crop raised with 3 as well as 2 irrigations, respectively, irrespective of time of application. Consequently, net benefit/rupee investment in the crop with 4 irrigations was 50.2 and 188.3% higher than that of 3 and 2 irrigations respectively. Among 3 irrigations-schedules, crop irrigated at maximum tillering, boot and milk stages had maximum net return and net benefit : cost ratio, while in 2-irrigation schedules crop irrigated at maximum tillering and milk stage recorded the maximum net return and net benefit : cost ratio. Omission of irrigation at maximum tillering, boot and milk stages reduced the net return by 57.38, 26.85 and 38.67%, respectively, compared with the crop irrigated at crown-root initiation, maximum tillering, boot and milk stages indicating the importance of irrigation at maximum tillering and milk stages.

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