Indian Journal of Agronomy **48** (4) : 282–286 (December 2003)

Growth analysis of wheat (*Triticum aestivum*) cultivars under different seeding dates and irrigation levels in Jharkhand

SHIVANI[1], U.N. VERMA, SANJEEV KUMAR[2], S.K. PAL AND R. THAKUR

Birsa Agricultural University, Kanke, Ranchi, Jharkhand 834 006

Received : April 2001

ABSTRACT

A field experiment was conducted during the winter season of 1995–96 and 1996–97 on sandy-loam soil of Ranchi, to study the growth behaviour of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cultivars under different dates of sowing and irrigation levels. Timely seeded wheat (21 November) recorded more tillers/m², higher dry-matter accumulation, plant height, leaf-area index (LAI), net assimilation rate (NAR) and crop-growth rate (CGR) as well as gave more grain yield (3,301 kg/ha) than delayed seeded crops. Wheat crop, which received 4 irrigations, maintained taller plants, more tillers per unit area, dry-matter accumulation, LAI, NAR, CGR and RGR and resulted in 13.7 and 29% more grain yield over 3 irrigations (2,349 kg/ha) and 2 irrigations (2,071 kg/ha) respectively. There was no significant difference between both the cultivars ('HUW 234' and 'K 9006') for growth pattern and grain yield but cultivar 'HUW 234' (7.54 kg grain/ha-mm) had higher water-use efficiency over cultivar 'K 9006' (7.14 kg grain/ha-mm).

Key words : Wheat, Cultivars, Growth characters, Seeding date, Irrigation, Water-use efficiency, Yield

Wheat an energy-rich winter cereal contributes 35% to the foodgrain basket of the country from about 25.5 m ha area, with a production of 68.7 million tonnes. In order to meet the projected wheat demand of 109 million tonnes for the growing population of about 1.3 billion by 2020 AD, it is essential to sustain the productivity at much higher level (Nagarajan, 1998). In fact, productivity of wheat genotypes depends largely on the prevailing weather conditions and soil-moisture regime during the crop-growth period. Variation in the seeding date and temperature interact to influence growth, development and yield of wheat. Water, one of the major determinants of wheat growth governs realization of full potential of high-yielding wheat cultivars. Actually adequate soil moisture is required for normal development of wheat crop at all stages of growth which can be created by timely scheduling of irrigation. Being a thermo-sensitive crop, choice of suitable cultivar for different seeding time further gets prime importance. However, there is paucity of information on this aspect in the region and, therefore, keeping above points in view the present investigation was carried out to study the growth behaviour of wheat cultivars under different dates of seeding and irrigation levels.

MATERIALS AND METHODS

The field experiment was conducted during 1995-96 and 1996-97 at Birsa Agricultural University farm, Ranchi (Jharkhand), on sandy-loam soil, low in available N (198 kg/ha) and medium in available P (17.2 kg/ha) and K (129.23 kg/ha), with pH 6.2. The experiment was replicated thrice in split plot design with 4 seeding time, viz. timely (21 November), moderately late (7 December), late (21 December), very late (7 January), and 3 irrigation levels, viz. irrigation at crown-root initiation (CRI) and boot (BT) stage; irrigation at crown-root initiation, boot and milk (MK) stages and irrigation at crown-root initiation, maximum tillering (MT), boot and milk stage as main plot treatments while subplot treatments consisted of 2 wheat cultivars ('HUW 234' and 'K 9006'). Wheat crop was sown 20 cm apart at 5 cm soil depth with a seed rate of 125 kg/ha. The crop received an uniform dose of plant nutrients @ 80 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha through urea single superphosphate and muriate of potash respectively. Half of the nitrogen and full doses of phosphorus and potash were applied as basal at the time of sowing. The remaining nitrogen was applied after first irrigation at crown-root initiation. The crop received 5 ± 1 cm water during each irrigation as per treatment apart from 86.7 mm. and 45.2 mm rainfall during first and second year of experimentation respectively. Timely seeded crop faced gradually decreasing mean temperature up to boot stage, whereas moderately late seeded and late

Present address : [1,2]ICAR Research Complex for Eastern Region, Patna, Bihar 801 505

seeded crop faced decreasing mean temperature up to maximum tillering and very late seeded crop up to crown-root initiation and thereafter temperature started rising. Thus timely seeded crop faced conducive temperature well suited to different stages of growth, whereas delayed seeded crops (December-January) faced adverse temperature in early and later stages of crop growth. The observations on growth parameters like tillers per unit area, dry-matter accumulation, crop-growth rate (CGR), relative growth rate (RGR), leaf-area index (LAI) and net assimilation rate (NAR) were recorded at different growth stages of wheat crop. The observations on plant height, yield and yield attributes like effective tillers/m², grains/spike, grain weight/spike and 1,000-grain weight were recorded at maturity and seasonal consumptive water use was calculated to determine water-use efficiency of wheat cultivars.

RESULTS AND DISCUSSION

Seeding time

Seeding time significantly influenced the growth characters, yield attributes and yield of wheat. Plant height of timely seeded wheat was 11.47, 29.25 and 54.06% higher in the first year, while 15.08, 33.44 and 44.06% higher in second year compared to moderately late, late and very late seeded wheat respectively (Table 1). Timely seeded crop produced significantly more number of tillers per unit area than delayed seeded wheat crop at all growth stages. Although temperature was favourable for tiller production in delay seeded crops but sudden rise in post-January temperature had reduced the tillering phase duration in proportion of delay in seeding time. This result confirms the findings of Verma *et al.* (1997). Crop-growth rate (CGR) increased with increase in crop age, and attained its peak at 90 days after sowing and thereafter decreased till maturity. The CGR of timely seeded crop was significantly higher than all other dates of seeding in both years (Table 1).

Total dry-matter accumulation per plant gradually increased with crop age and attained maximum at maturity. Further, dry-matter accumulation (Table 2) decreased with delay in sowing from timely (21 November) to very late (7 January). This may be due to reduction in duration of tillering phase with delayed seeding which produced lesser number of leaves and lead to poor leaf-area index coupled with lower net assimilation rate (NAR) and CGR as well as dry-matter accumulation in both the years. Contrary to dry-matter accumulation and CGR, relative growth rate (RGR) gradually decreased with advanced growth phase (Table 2). Leaf-area index and net assimilation rate was highest in November seeded crop and lowest in very late seeded crop.

Timely seeded crop produced maximum spike-bearing tillers/m², grains/spike and 1,000-grain weight (Table 3). All these parameters decreased by progressive delay in seeding time. Grain and straw yields of wheat were significantly affected due to its seeding time. Delay in seeding beyond timely seeding reduced the grain yield by 16.2, 37.4 and 59.9% under moderately late, late and very late sown condition, respectively, in pooled mean (Table 4). This is expected because most of the growth and yield attributes that determine the biological yield were adversely affected when seeding was delayed beyond 21 November.

Table 1. Plant height and other growth characters of wheat cultivars as influenced by seeding time and irrigation

Treatment	Plant height (cm) at maturity			Tillers/m² at maturity			CGR (g/m²/day) at 90 DAS–maturity		
	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	1995–97	1996–97	Pooled
Seeding time									
Timely	85.0	76.9	81.3	360.7	345.3	353.0	7.5	6.9	7.2
Moderately late	77.0	66.9	71.9	296.1	303.4	299.7	5.6	5.3	5.4
Late	66.4	57.7	62.0	256.7	276.0	266.3	4.9	5.3	5.1
Very late	55.7	53.4	54.5	205.9	241.3	223.6	4.4	5.2	4.8
CD (P=0.05)	1.26	2.02	1.86	19.5	6.89	15.2	0.5	1.0	0.7
Irrigation									
CRI + BT	67.2	60.4	63.8	248.3	266.5	257.4	4.2	4.5	4.3
CRI + BT + MK	70.0	63.0	66.5	271.9	287.6	279.7	5.7	5.6	5.6
CRI + MT +BT + MK	76.5	67.7	72.1	319.6	320.3	319.9	6.8	6.8	6.8
CD (P=0.05)	1.09	1.75	1.67	16.9	5.97	13.3	0.4	0.8	0.5
Cultivar									
'HUW 234'	70.6	62.9	66.7	277.1	290.7	283.9	5.2	5.3	5.2
'K 9006'	71.9	64.5	68.2	282.7	292.3	287.5	6.0	6.0	6.0
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.4	NS	0.5

CRI, Crown root initiation; BT, boot; MK, milk; MT, maximum tillering

Table 2. Growth characters of wheat cultivars as influenced by seeding time and irrigation

Treatment	Dry-matter accumulation (g/m^2) at maturity			Relative growth rate (g/g/day) at 90 DAS–maturity			Leaf-area index at 70 DAS			Net assimilation rate (g/m^2/day) at 50–70 DAS)		
	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled
Seeding time												
Timely	1,135.8	1,058.4	1,097.1	0.007	0.007	0.007	4.37	4.20	4.28	4.02	3.97	3.99
Moderately late	945.5	911.8	928.6	0.006	0.006	0.006	4.03	3.82	3.92	3.61	3.64	3.62
Late	821.3	763.0	792.1	0.006	0.007	0.006	3.50	3.26	3.38	3.52	3.54	3.53
Very late	708.9	624.4	666.6	0.006	0.009	0.007	2.98	2.87	2.92	3.39	3.39	3.39
CD (P=0.05)	49.12	48.44	49.01	0.0006	0.0013	0.0007	0.20	0.09	0.13	0.33	0.14	0.29
Irrigation												
CRI+BT	766.8	710.9	738.8	0.006	0.007	0.006	3.28	3.20	3.24	3.41	3.42	3.41
CRI+BT+MK	883.8	820.6	852.2	0.007	0.007	0.007	3.44	3.40	3.42	3.70	3.74	3.72
CRI+MT+BT+MK	1,058.0	986.7	1,022.3	0.007	0.008	0.007	4.44	4.01	4.22	3.80	3.76	3.78
CD (P=0.05)	42.55	41.95	42.35	0.0005	NS	0.0006	0.17	0.08	0.11	0.29	0.12	0.26
Cultivar												
'HUW 234'	906.7	834.0	870.3	0.006	0.007	0.006	3.75	3.56	3.65	3.64	3.62	3.63
'K 9006'	899.0	844.8	871.9	0.007	0.008	0.007	3.69	3.52	3.60	3.63	3.66	3.64
CD (P=0.05)	NS	NS	NS	0.0005	NS	0.0006	NS	NS	NS	NS	NS	NS

CRI, Crown root initiation; BT, boot; MK, milk; MT, maximum tillering

Table 3. Yield-attributing characters of wheat cultivars as influenced by seeding time and irrigation

Treatment	Effective tillers/m^2			Grains/spike			Grain weight/spike (g)			1,000-grain weight (g)		
	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled
Seeding time												
Timely	333.6	324.2	328.9	42.9	37.0	39.9	1.74	1.61	1.68	44.8	42.5	43.7
Moderately late	278.7	271.6	275.1	38.6	34.4	36.5	1.53	1.52	1.53	41.4	40.3	40.3
Late	242.3	231.3	236.8	35.5	31.5	33.5	1.10	1.09	1.10	37.1	35.3	35.3
Very late	189.1	196.2	192.7	31.2	30.6	30.9	0.90	0.83	0.87	33.8	32.0	32.0
CD (P=0.05)	15.5	6.5	14.2	4.8	0.7	4.1	0.09	0.05	0.08	1.7	1.5	1.5
Irrigation												
CRI + BT	231.5	230.4	230.9	33.7	30.9	32.3	1.10	1.09	1.10	37.6	36.2	36.2
CRI+BT+MK	250.4	251.0	250.7	36.9	33.1	35.0	1.26	1.24	1.25	39.3	37.7	37.7
CRI + MT + BT + MK	300.8	286.1	293.5	40.5	36.2	38.3	1.59	1.46	1.53	41.0	39.6	39.6
CD (P=0.05)	13.4	5.6	12.3	4.1	0.6	3.5	0.09	0.04	0.05	1.5	1.3	1.3
Cultivar												
'HUW 234'	263.2	254.9	259.1	37.8	33.4	35.6	1.33	1.26	1.30	39.7	38.1	38.1
'K 9006'	258.6	256.8	257.7	36.3	33.4	34.8	1.30	1.27	1.29	38.9	37.6	37.6
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

CRI, Crown root initiation; BT, boot; MK, milk; MT, maximum tillering

These finding are in conformity with the reports of Verma *et al.* (1997).

Water-use efficiency of timely seeded wheat was maximum and decreased with delay in seeding, as it decreased by 4.6, 25.8 and 45.4% in moderately late, late and very late seeded wheat respectively.

Irrigation

There was a progressive and significant increase in plant height with increasing number of irrigation. Plant

Table 4. Grain yield, straw yield and water-use efficiency of wheat cultivars as influenced by seeding time and irrigation

Treatment	Grain yield (kg/ha)			Straw yield (kg/ha)			Water-use efficiency (kg grain/ha-mm) (pooled)
	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled	
Seeding time							
Timely	3,505	3,096	3,301	4,473	4,554	4,514	8.87
Moderately late	3,040	2,493	2,767	3,904	3,872	3,888	8.46
Late	2,201	1,928	2,065	3,269	3,216	3,243	6.58
Very late	1,442	1,205	1,324	2,282	2,138	2,210	4.84
CD (P=0.05)	258.0	66.0	225.0	375.0	104.0	330.0	
Irrigation							
CRI + BT	2,257	1,885	2,071	2,988	3,022	3,005	7.27
CRI + BT + MK	2,525	2,173	2,349	3,438	3,366	3,402	7.31
CRI + MT + BT + MK	2,858	2,484	2,671	4,020	3,947	3,984	7.43
CD (P=0.05)	223.0	57.0	195.0	326.0	90.0	285.0	
Cultivar							
'HUW 234'	2,576	2,168	2,372	3,490	3,422	3,456	7.54
'K 9006'	2,517	2,193	2,355	3,475	3,468	3,472	7.14
CD (P=0.05)	NS	NS	NS	NS	NS	NS	

CRI, Crown root initiations; BT, Boot; MK, Milk; MT, Maximum tillering

growth depends on cell-division and cell expansion for which adequate water supply is essential (Singh and Singh, 1977). Hence plants were taller due to increase in irrigation level (Hooda and Agrawal, 1987). Crop receiving irrigation at crown-root initiation, maximum tillering, boot and milk stages produced more tillers/unit area throughout the growth period than the crop which received only 2 or 3 irrigations which further increased with increase in crop age and attained its peak at 60 DAS and thereafter, it declined gradually during both the years. At later growth stages, increasing the frequency of irrigation increased the number of tillers/unit area which led to higher leaf-area index, net assimilation rate, crop-growth rate and also dry-matter production. This is in conformity with the findings of Pal *et al.* (1996). Crop with 4 irrigations had higher RGR than the crop which received 2 irrigations during later growth phases (90 DAS – maturity) in first year and early growth phases (30 – 50 DAS and 50 – 70 DAS) in the second year.

Crop receiving irrigation at crown-root initiation, maximum tillering, boot and milk stages produced significantly more spike-bearing tillers/m^2, grains/spike, weight of grains/spike and 1,000-grain weight (Table 3) than those which received 2 and 3 irrigations only. Higher availability of moisture might have helped in better nutrient removal by the crop which in turn resulted in assimilation of photosynthates and better development of yield attributes.

Grain yield as well as straw yield increased with increasing irrigation level (Table 4). Crop which received 4 irrigations (at CRI, maximum tillering, boot and milk stages) gave 13.7 and 29% more grain yield than the crop grown with 3 irrigations (CRI, boot and milk) and 2 irrigations (CRI and boot). Likewise, the crop raised with 3 irrigations had significant edge over 2 irrigations, which may be due to beneficial effect of soil-moisture regime on growth and yield components (Bhan *et al.,* 1990).

Water-use efficiency increased with increasing irrigation frequency. Wheat crop with 4 irrigations at CRI, MT, Boot and milk stage showed 7.43 kg grain/ha-mm of water use, which was higher than that of 2 or 3 irrigations (Table 4). Higher WUE with increased irrigation level can be attributed to the fact that there was relatively more increase in grain yield than crop water use at 2 and 3 irrigation levels.

Performance of cultivars

Both the cultivars 'HUW 234' and 'K 9006' did not differ in plant height and other growth characters like crop growth rate, dry-matter accumulation, relative growth rate, leaf-area index and net assimilation rate during both the years. However, 'HUW 234' accumulated more dry matter than 'K 9006' at DAS in the first year which led to differences in crop growth rate and relative growth rate (90– maturity). Further, both the cultivars did not differ in respect of grain and straw yields. It may be due to similar leaf-area index, spike-bearing tillers/m^2, grains/spike, grain weight/spike and 1,000-grain weight.

Wheat cultivar 'K 9006' consumed more water than cultivar 'HUW 234', while water-use efficiency of 'HUW 234' was higher than cultivar 'K 9006'.

It was concluded that for obtaining higher yield, both the cultivars should be seeded in time (21 November) and the crop whether timely or late should be irrigated at crown-root initiation, maximum tillering, boot and milk stages, as they exhibited equal flexibility with seeding time.

REFERENCES

Bhan, S.C., Bishnoi, O.P. and Rao, V.U.M. 1990. Influence of water stress in wheat crop yield. *Mausam* **41** : 593–596.

Hooda, I.S. and Agrawal, S.K. 1987. Studies on irrigation, weed control and fertility levels on growth and yield of wheat. *Indian Journal of Agronomy* **32** : 261–264.

Nagarajan, S. 1998. Perspectives on wheat demand and research needs. (In) *Wheat Research Needs Beyond* 2000 AD. Nagarajan, S., Singh, G. and Tyagi, B.S. (Eds). Narosa Publication, pp. 13–27.

Pal, S.K., Kaur, J., Thakur, R., Verma, U.N. and Singh, M.K. 1996. Effect of irrigation, seeding date and fertilizer on growth and yield of wheat. *Indian Journal of Agronomy* **41**(3) : 386–389.

Verma, U.N., Pal, S.K., Singh, M.K. and Thakur, R. 1997. Fertilizer requirement of late sown wheat (*Triticum aestivum* L.) under condition of Bihar plateau. *Indian Journal of Agricultural Sciences* **68** (5) : 204–207.

Singh, S.K. and Singh, N.P. 1977. Monograph 4. Water Technology Centre, Indian Agricultural Research Institute, New Delhi.