Indian Journal of Agronomy **46** (4) : 659–664 (December 2001)

Production potential and water-use efficiency of wheat (*Triticum aestivum*) cultivars under different dates of seeding and irrigation levels

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

Birsa Agricultural University, Kanke, Ranchi, Jharkhand 834 006

Received : October 2000

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 production potential and water–use efficiency of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) cultivars under different dates of seeding and irrigation level. Yield, yield attributes and water-use efficiency of 'HUW 234' and 'K 9006' were significantly higher when crop was sown timely on 21 November. The crop which received 4 irrigations showed maximum grain yield and water-use efficiency. Both the above cultivars did not show any significant difference in for yield and yield-attributing characters, but cultivar 'HUW 234' showed higher water-use efficiency (7.54 kg grain/ha-mm) than cultivar 'K 9006' (7.14 kg grain/ha-mm).

Key words **:** Wheat, Irrigation, Seeding time, Cultivar, Yield, Water-use efficiency

Wheat is the most accomodating crop in different cropping systems, as it can be grown after rice, maize, cotton, grain legumes, *toria*, groundnut, sugarcane and potato etc. However, productivity of wheat genotypes depends largely on the prevailing weather conditions and soil-moisture regime during crop-growth period. Temperature affects growth and development of wheat to a great extent and decides production potential and optimum seeding time in each agro-ecological region of the country. Higher temperature at critical plant-development stages limits productivity at later sowings (Mahajan and Nayeem, 1990). 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 (Prihar, 2000). Choice of crop cultivar is also a vital production input as all the cultivars of wheat cannot perform equally well under timely and late-sown condition (Singh *et al.* 1998). Since there is lack of information on these aspects in the region, the present investigation was undertaken to

Present address: [1,2]ICAR Research Complex for Eastern Region, Patna, Bihar 801 805

study the production potential and water-use efficiency of wheat cultivars under different dates of sowing and irrigation level.

MATERIALS AND METHODS

The field experiment was conducted during 1995–96 and 1996–97 at Birsa Agricultural University farm, Ranchi (Jharkhand), having sandy-loam soil, low in available N (198 kg/ha), medium in available P (17.2 kg/ha) and K (129.23 kg/ha) and low in water-retention capacity (95.6 mm available water/60 cm soil-depth), with 6.2 pH. The experiment was carried out in split-plot design with 3 replications and 24 treatment combinations. The main plot consisted of 4 seeding times, 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 stages (BT); irrigation at crown-root initiation, boot and milk stages (MK); and irrigation at crown-root initiation, maximum tillering (MT), boot and milk stages, 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 uniform doses 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 basal at the time of sowing. The remaining nitrogen was applied after first irrigation at crown-root initiation. The crop had received 5 ± 1 cm water during each irrigation as per treatment apart from 86.7 cm and 45.2 mm rainfall during the first and second year of experimentation respectively. The mean monthly thermal index was 18.6 ± 1.28, 15.53 ± 1.45, 15.17 ± 1.17, 17.79 ± 2.37, 23.19 ± 2.46 and 26.04 ± 2.42 °C in the first year and 17.48 ± 0.37, 14.65 ± 2.23, 13.78 ± 1.55, 16.78 ± 2.48, 23.13 ± 2.06 and 24.19 ± 1.92°C in the second year during November, December, January, February, March and first fortnight of April respectively. Thus, wheat crop experienced gradually decreasing mean temperature up to boot stage in timely seeded condition, up to maximum tillering stage in moderately late and late-seeded crop and up to crown-root-initiation stage in very late-seeded crop and thereafter temperature starts rising.

RESULTS AND DISCUSSION

Yield and yield attributes

Seeding time significantly influenced the number of spike-bearing tillers, spike length, fertile spikelets/spike and 1,000-grain weight (Table 1). Timely seeded wheat crop showed the maximum spike bearing tillers/m^2, grain/spike and 1,000-grain weight and resulted in highest grain and straw yields. All these parameters were decreased by progressive delay in seeding time. Timely seeded crop took more days to complete its life-cycle (seeding to physiological maturity) compared with later-seeded crops (Tables 1, 2). Each day delay in seeding beyond timely seeding to moderately late, late and very late seeding reduced the grain yield by 35.6, 41.2 and 43.9 kg/ha day respectively in pooled mean. Significantly higher yield and yield-attributing characters of timely seeded

Table 1. Yield-attributing characters of wheat cultivars under different seeding dates and irrigation levels (pooled data of 1995–96 and 1996–97

Treatment	Effective tillers/m^2	Spike length (cm)	Fertile spikelets/ spike	Grains/ spike	1,000-grain weight (g)
Seeding time					
Timely	328.9	10.0	17.5	39.9	43.7
Moderate late	275.1	9.5	16.4	36.5	10.3
Late	236.8	9.1	14.7	33.5	35.3
Very late	192.7	8.7	12.6	30.9	32.0
CD (P=0.05)	14.2	0.5	0.6	4.1	1.5
Irrigation level					
CRI + BT	230.9	9.0	14.4	32.3	36.2
CRI + BT + MK	250.7	9.3	15.2	35.0	37.7
CRI + MT + BT + MK	293.5	9.7	16.3	38.3	39.6
CD (P=0.05)	12.2	0.3	0.5	3.5	1.3
Cultivar					
'HUW 234'	259.1	9.2	15.4	35.6	38.1
'K 9006'	257.7	9.5	15.3	34.8	37.6
CD (P=0.05)	NS	NS	NS	NS	NS

CRI, Crown-root initiation; BT, boot; NK, milking; MT, maximum tillering

wheat was owing to relatively more favourable temperature experienced by the crop during its crop season. Gradually increasing temperature from timely seeding to delayed seeding proportionately reduced the vegetative growth duration while ascending post - January temperature accelerated transition from vegetative to generative phase, consequently reduced the duration of tillering which inturn decreased the spike-bearing tillers in moderately late to very late-seeded crop. Tewari and Singh (1993) and Verma *et al.* (1997) also reported similar findings from their study.

Crop which received 4 irrigations (at CRI, maximum tillering, boot and milk stages) produced significantly more spike-bearing tillers/m^2, spike length, fertile spikelets/spike, grains/spike and 1,000-grain weight than those which received 2 and 3 irrigations only. Crop raised with 4 irrigations also gave significantly more grain yield than the crop raised with 2 or 3 irrigations. Similar trend was recorded for straw yield. This increase in grain yield was owing to beneficial effect of soil-moisture regime with 4 irrigations (Bhan *et al.*, 1990).

'HUW 234' and 'K 9006' did not differ significantly in respect of grain and straw yields. It may be due to similar number of spike-bearing tillers/m^2, spike length, fertile spikelets/spike, grains/spike and test weight.

Interaction effect

Grains/spike : Interaction of seeding time and irigation was significant during 1996–97. Late-seeded wheat with 4

Table 2. Yield, crop duration, consumptive water use and water-use efficiency of wheat cultivars under different seeding dates and irrigation levels

Treatment	Grain yield (q/ha)			Straw yield (q/ha)			Crop duration (days)	Consumptive water use (kg grain/ mm)	Water-use effieiency (kg grain/ ha-mm)
	1995–96	1996–97	Pooled	1995–96	1996–97	Pooled			
Seeding time									
Timely	35.0	31.0	33.0	44.7	45.5	45.1	120.1	395.3	8.87
Moderately late	30.4	24.9	27.7	39.0	38.7	38.9	111.0	359.4	8.46
Late	22.0	19.3	20.7	32.7	32.2	32.4	104.6	334.5	6.58
Very late	14.4	12.1	13.2	22.8	21.4	22.1	95.2	298.1	4.84
CD (P=0.05)	2.6	0.7	2.2	3.7	1.0	3.3			
Irrigation level									
CRI + BT	22.6	18.9	20.7	29.9	30.2	30.1	104.8	310.6	7.27
CRI +BT + MK	25.3	21.7	23.5	34.4	33.7	34.0	107.0	345.4	7.31
CRI + MT + BT + MK	28.6	24.8	26.7	40.2	39.5	39.8	111.3	384.5	7.43
CD (P=0.05)	2.2	0.6	1.9	3.3	0.9	2.8			
Cultivar									
'HUW 234'	25.8	21.7	23.7	34.9	34.2	34.6	105.9	341.1	7.54
'K 9006'	25.2	21.9	23.6	34.8	34.7	34.7	109.5	352.5	7.14
'CD (P=0.05)	NS	NS	NS	NS	NS	NS			

CRI, Crown-root initiation; BT, boot; MK, milking; MT, maximum tillering irrigations produced equal number of grains/spike as that of timely seeded wheat with 2 irrigations and moderately late seeded wheat with 3 irrigations. Similarly, moderately late-seeded wheat with irrigations produced as much grains/spike as that of timely-seeded wheat with 3 irrigations (Table 3).

Grain yield: Interaction between seeding dates and irrigation level on grain yield was significant during 1996–97. Moderately late-seeded crop grown with 4 irrigations at crown-root initiation, maximum tillering, boot and milk stages gave similar grain yield as that of timely seeded crop raised with 2 irrigations at crown-root initiation and boot stages (Table 4).

Water requirement and water-use efficiency

Timely seeded crop consumed maximum water (395.3 mm), which was 10, 18.2 and 32.6% more than the water used by moderately late, late and very late-seeded crop respectively (Table 2). Seasonal consumptive water use decreased in proportion with delay in seeding time and increased with increase in irrigation frequency. Pratibha *et al.* (1994) also observed similar results.

Water-use efficiency of timely-seeded wheat was the maximum and decreased by 4.6, 25.8 and 45.4% in moderately late, late and very late-seeded sheat respectively (Table 2). Wheat crop which recieved 4

Table 3. Interaction effect of seeding time and irrigation levels on number of grains/spike of wheat cultivar (1996–97)

Irrigation level	Seeding time			
	Timely	Moderately late	Late	Very late
CRI + BT	33.7	31.9	29.5	28.6
CRI + BT + MK	36.3	34.0	31.4	30.5
CRI + MT + BT + MK	40.9	37.4	33.8	32.8
CD (P=0.05)		1.1		

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

Table 4. Interaction effect of seeding time and irrigation levels on number of grain yield (q/ha) of wheat cultivar.(1996–97)

Irrigation level	Seeding time			
	Timely	Moderately late	Late	Very late
CRI + BT	28.3	21.7	15.9	9.5
CRI + BT + MK	31.3	25.1	18.4	12.2
CRI + MT + BT + MK	33.4	28.0	23.5	14.4
CD (P=0.05)		1.1		

CRI, Crown-root initiation; BT, boot; MK, milking; MT, maximum tillering irrigations at the crown-root initiation, maximum tillering, boot and milk stages recorded the maximum water-use efficiency and was higher than that of 2 and 3 irrigations. Pal *et al.* (1996) also reported similar increase in water-use efficiency with increase in irrigation frequency. Wheat cultivar 'K 9006' consumed more water than 'HUW 234' , but water-use efficiency of 'HUW 234' was higher than that 'K 9006'.

It was concluded that timely seeding and irrigation at crown-root initiation, maximum tillering, boot and milk stages favourably influences the grain yield and water-use efficiency of wheat cultivars to a great extent.

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.

Mahajan, A.R. and Nayeem, K.A. 1990. Effect of date of sowing on test weight, protein content and yield in wheat and triticale genotype. *Journal of Research, Haryana Agricultural University, Hisar* **15** : 69–71.

Pal, S.K., Thakur,R., Verma, U.N. and Singh, M.K. 1996. Water requirement of wheat as influenced by irrigation, seeding date and fertilizer. *Indian Journal of Agricultural Sciences* **66**(6) : 177–179.

Pratibha, G., Ramaiah, N.V. and Satyanarayana, V. 1994. Studies on consumptive water use, WUE, soil-moisture extraction pattern by wheat genotypes under varying irrigations applied at different physiological stages. *Journal of Research, Andhra Pradesh Agricultural University* **22** (1-2) : 33–34.

Parihar, S.S. 2000. Alleviating soil physical constraints for sustainable crop production. (In) *Proceedings of International Conference of Managing Natural Resources for Sustainable Agricultural Production in 21st Century. Extended Summaries* **1** : 38.

Singh, Dhananjya, Kumar, Agarawal, R.L. and Ahuja, K.N. 1998. Response of wheat varieties to different seeding dates for agroclimatic conditions of Agra region. *Annals of Agricultural Research* **19**(4) : 496–498.

Tewari, S.K. and Singh, Mahendra. 1993. Yielding ability of wheat (*Triticum aestivum* L.) at different dates of sowing–a temperature dependent performance. *Indian Journal of Agronomy* **38** (2) : 204–209.

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.