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EFFECT OF DATE OF SOWING AND IRRIGATION LEVELS ON WATER REQUIREMENT OF WHEAT CULTIVARS

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ABSTRACT

A field experiment was conducted during winter season of 1995-97 at Ranchi on sandy loam soil to estimate the daily consumptive water use, moisture-extraction pattern, crop-co-efficient and water-use efficiency of wheat cultivars under dates of sowing and irrigation levels. Timely sown wheat (21 November) used 3.27 mm water day to produce 3301 kg/ha /ha with water the efficiency of 8.35 kg grain/ha-mm Peak water-use rate (mm/day) coincided with flowering stage of wheat, which was attained during second week of February in timely-sown and during second week of March in very late sown wheat (7 January) crop. Highest crop co-efficient was recorded in January (1.12) for timely sown and in February (0.82) for very late sown crop. The crop irrigated at crown-root initiation, maximum tillering, boot and milk stages consumed 384.5 mm water to produce 2671 kg grain/ha with water-use efficiency of 6.95 kg grain/ha-mm water. Daily water use and surface soil-moisture extraction increased with increase in irrigation frequency. The crop receiving four irrigations had higher seasonal (0.71) as well as month-wise crop coefficient with its peak (0.96) in February than that receiving either 2 (crown-root initiation and boot) or 3 (crown-root initiation, boot and milk) irrigations. Wheat cultivar (HUM 234 consumed 11.4 mm less water than K 9006 (352.5 mm) to produce 2372 kg grain/ha with water use efficiency of 6.95 kg grain/ha-mm water.

Key words: Irrigation, water requirement, wheat.

Water, a key component of crop production system governs realization of full potential of high yielding wheat cultivars. Under limited availability of water, scheduling of irrigation at the most critical stages increases crop productivity and water use efficiency (Prihar, 2000). To increase the productivity of wheat in plateau region of Jharkhand, where availability of irrigation water is meagre, knowledge of daily water use is necessary for timely scheduling of irrigation and efficient utilization of applied water. Therefore, present study was undertaken to determine consumptive water use, consumptive water use rate, crop coefficient, moisture extraction pattern and water use efficiency of wheat cultivars under different date of sowing and irrigation levels.

MATERIALS AND METHODS

The field experiment was conducted during the winter season of 1995-96 and 1996-97 a Birsa Agricultural University Farm, Ranchi (Jharkhand) on sandy loam soil with pH 6.2. The soil was low in organic carbon (0.39%), available nitrogen (198 kg/ha) and medium in available phosphorus (17.2 kg/ha) and potassium (139.2 kg/ha). The soil was having low water retention capacity (95.6 mm/60 cm soil depth). The treatments were set out in split - plot design, keeping 4 dates of sowing *viz.* timely (November 21), moderately late (December 7), late (December 21), very late (January 7) and 3 irrigation levels *viz.* crown-root initiation and boot (CRI + BT), crown-root initiation, boot and milk (CRI + BT + MK), crown-root initiation, maximum tillering, boot and milk (CRI + MT + BT + MK) in main plots, two wheat cultivars *viz.* HUW 234 and K 9006 in sub plots with three replications. Wheat was sown 20 cm apart at 5 cm soil depth with a seed rate of 125 kg/ha. The crop was fertilized with 80 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha in form of Urea, SSP and MOP, respectively. Half of the nitrogen and full doses of phosphorus and potash were applied as basal at the time of sowing. The remaining dose of nitrogen was applied after first irrigation at crown-root initiation stage. Crop received 5±1 cm depth of water for each irrigation as per treatment, apart from 86.7 mm and 45.2 mm rainfall during first and second year of experimentation respectively. Periodic soil sample (0-60 cm. depth) from sowing to harvesting at 15 days intervals and before and after 24 hr of each irrigation was taken to determine consumptive water use. Crop

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Table 1. Periodic consumptive water use, grain yield and water-use efficiency of wheat cultivars under different date of sowing and irrigation levels (Pooled data of 2 years)

Treatments	Consumptive water use (mm)							water-use	
	Nov	Dec	Jan	Feb	Mar	Apr	Seasonal	Grain yield (kg/ha-mm)	efficiency (kg/ha-mm)
Sowing Time									
Timely	8.2	60.1	127.7	127.3	72.0	-	395.3	3301	8.35
Moderately late		34.0	120.0	123.0	82.5	-	359.4	2767	7.70
Late		10.3	111.9	120.4	87.4	4.5	334.5	2065	6.17
Very late		-	35.0	114.6	121.5	27.0	398.1	1324	4.44
C.D. (P=0.05)		-	-	-	-	-		225	-
Irrigation									
CRI+BT		38.4	95.5	111.7	65.1	-	310.6	2071	6.67
CRI+BT+MK		36.2	97.6	118.3	93.2	-	345.4	2349	6.80
CRI+MT+BT+MK		36.1	102.8	133.9	109.7	-	384.5	2671	6.95
C.D. (P=0.05)		-	-	-	-			195	-
Cultivars									
HUW 234		38.0	97.2	117.4	90.4	-	341.1	2372	6.95
K 9006		39.1	100.0	125.2	88.2	-	352.5	2355	6.68
C.D. (P=0.05)		-	-		-	-	-	NS	-

Note: Detials of treatments are discussed under materials and methods section.

Table 2. Crop coefficient and rate of consumptive water use of wheat cultivars under different date of sowing and irrigation levels

Treatments	Crop coefficient						
	Nov	Dec	Jan	Feb	Mar	Apr	Seasonal
Sowing Time							
Timely	0.23	0.61	1.12	0.91	0.50	-	0.74
	(0.82)	(1.94)	(4.12)	(4.39)	(3.60)	-	(3.27)
Moderately late		0.43	1.05	0.88	0.40	-	0.67
		(1.36)	(3.87)	(4.24)	(3.17)	-	(3.24)
Late		0.29	0.98	0.86	0.39	0.22	0.63
		(0.94)	(3.61)	(4.15)	(2.82)	(2.24)	(3.22)
Very late		-	0.38	0.82	0.54	0.24	0.54
		-	(1.40)	(3.95)	(3.92)	(2.45)	(3.11)
Irrigation							
CRI + BT		0.67	0.84	0.80	0.29	-	0.58
		(2.13)	(2.13)	(3.85)	(2.10)	-	(2.96)
CRI+BT+MK		0.63	0.86	0.85	0.42	-	0.65
		(2.01)	(2.01)	(4.08)	(3.01)	-	(3.20)
CRI+MT+BT+MK		0.66	0.90	0.96	0.49	-	0.71
		(2.11)	(2.11)	(4.62)	(3.54)	-	(3.46)
Cultivars							
HUW 234		0.63	0.86	0.84	0.40	-	0.64
		(2.00)	(3.14)	(4.05)	(2.92)	-	(3.22)
K 9006		0.68	0.88	0.90	0.39	-	0.64
		(2.17)	(3.23)	(4.32)	(2.84)	-	(3.20)

Note : Details of treatment are discussed under materials and methods section.

co-efficient was calculated by dividing consumptive water use for a particular period with corresponding value of pan evaporation.

Results and Discussion

Effect of date of sowing

Date of sowing influenced the amount and rate of consumptive water use. Timely sown wheat consumed maximum amount of water (395.3 mm) and produced highest yield (3301 kg/ha) with a water use efficiency of 8.35 kg grain/ha-mm water (Table 1). Seasonal consumptive water use, its rate and water use efficiency decreased in proportion with delay in sowing time. Consequently timely sown crop consumed 10, 18.2 and 32.6 per cent more water than that used by moderately late and late (359.4mm), late (334.5) and very late (2.98.1 mm) crop respectively (Fig.1). Timely, moderately late wheat used major share of their respective seasonal water use in January and February while very late wheat in February and March which coincides with boot to flowering stage of wheat crop. Further timely sown wheat utilized water at its maximum rate while late and very late wheat utilized water at lower rate during crop growth period (Table 2). Consumptive water use rate increased with crop age, reached its peak during February and declined sharply in the month of March in timely, moderately late and late sown wheat while it was more or less same during February and March in very late sown wheat. This may be due to the fact that later sown crop was March in very late sown wheat. This may be due to the fact that later sown crop was transpiring actively while former was proceeding towards physiological maturity (Pal *et al.* 1996). Timely sown wheat extracted maximum amount of water (40.77%) from surface soil (0-15 cm) and it reduced slightly with delay in sowing as it was 37.87 per cent in very late sown crop, whereas the reverse was true from sub-surface soil i.e. 30-60 cm (Fig. 1). Crop coefficient also increased with crop age and was maximum when the crop was in vigorous vegetative growth phase with maximum transpiration and thereafter declined (Agarwal *et al.* 1997). It was maximum value during January in Timely sown wheat while very late sown whet attained maximum value during during February (Table 2). Higher seasonal and month-wise crop coefficient of timely sown wheat led to higher water requirement compared with that of later sown crops.

Effect of irrigation levels

Wheat irrigated at crown root initiation and boot stages utilized 310.6 mm water to attain maturity and produced grain yield of 2071 kg/ha with water use efficiency of 6.67 kg grain/ha-mm (Table 1.) One extra irrigation at milk stage increased the water requirement of wheat cultivars by 34.8 mm, with additional grain yield of 278 kg/ha and water use efficiency of 6.80 kg/ grain ha-mm than 2 irrigations. Further, one additional irrigation at maximum tillering stage increased the consumptive water use and grain yield by 39.1 mm and 322 kg/ha respectively, with further increased in water use efficiency of 6.95 kg/ha-mm than irrigation at crown root initiation, boot and milk stages. Periodic consumptive water use and its rate increased with crop age and reached its peak, during February (boot to flowering period) indicating that these stages must be matched with adequate irrigation supply. Water use rate at different growth stages depends not only on the transpiration but also on the evaporative demand of the atmosphere (Pal *et al.* 1996). The rate of consumptive water use increased with increase in irrigation frequency beyond crown root initiation stage (Pratibha, *et al.* 1994). The pattern of soil moisture extraction revealed that maximum utilization of moisture was form surface soil (0-15 cm) and it gradually decreased with increasing depth of soil (Fig. 1). This might be due to maximum concentration of roots in the upper (0-15 cm) layer (Bandyopadhyay, 1997). Wheat cultivars raised with four irrigations extracted more moisture from surface soil (0-15 cm) than 2 or 3 irrigations where as reverse was true with sub-surface soil. Crop coefficient increased with crop age and was heigher during January - February then December and March (Table 2). During January - February crop was at vigorous vegetative growth phase with maximum transpiration without remarkable increase in evaporative demand of the atmosphere but it declined thereafter probably due to decreased in transpiration along with increased evaporative demand. Increase in irrigation frequency also influenced the crop coefficient. Wheat receiving four irrigations had higher seasonal as well as monthly crop coefficient than the crop receiving 2 or 3 irrigations.

Effect of cultivar

Wheat cultivar K 9006 consumed more water throughout the growth period and had more seasonal consumptive water use (352.5mm) than HUW 234 (341.1 mm) (Table 1). Contrarily consumptive water

use, water use efficiency and seasonal consumptive water use rate of cultivar HUW 234 was higher than cultivar K 9006. However, no significant difference was observed in respect of grain yield between cultivars K 9006 and HUW 234. Wheat cultivar HUW 234 extracted more moisture than K 9006 from top 0-30 cm soil depth. Monthly crop co-efficient value of both cultivars increased with increase in crop age and reached the peak value of both cultivars increased with increase in crop age and reached the peak value during January (HUW 234) and February (K 9006) and declined thereafter till maturity (Table 2).

REFERENCES

Agarwal, M.C., Dhindwal, A.S., Jaiswal, C.S., Prabhakar, A. and Ahuja, M.S. 1997. Status of Research on Agricultural Water Management of Northern Region. *All India Coordinated Project for Research on Water management*. Directorate of Water Management, Patna pp 138.

Pal, S.K., Thakur, R. Verma, H.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): 328-332.

Prabhu, 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.

Prihar, S.S. 2000. Alleviating soil physical constraints for sustainable crop production. *Int. International Conference of Managing Natural Resources for Sustainable Agricultural Production in 21st century, Extended summaries* Vol. (1): 38.