Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2012, 4(11):4941-4945

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Response of bed planted wheat (*Tritcum aestivum L.*) under the different moisture regime on water use and it's efficiency

Lakhapati Singh[1], C. M. Singh[3] and G. R. Singh[2]

[1]Department of Agronomy, Institute of Agricultural Sciences, B.H.U., Varanasi-221005(U.P.)
[2]Department of Agronomy, NDUA&T, Kumarganj, Faizabad, 224 229 (U.P.)
[3]Department of Soil Sciences & Agrilcultural Chemistry, Institute of Agricultural Sciences, B.H.U., Varanasi-221005(U.P.)

ABSTRACT

An experiment was conducted at Research Farm, NDUA&T, Kumarganj, Faizabad, during winter season 2007-08, to evaluate the performance of wheat under different moisture regime, water use and it's efficiency. It was found that irrigation supplementation at 1.0 Irrigation water/Cumulative Pan Evaporation (IW/CPE) Ratio is significantly influence the growth and yield of wheat crop, while application of 125.0 % nitrogen significantly affected the growth and yield of crop, highest water use efficiency under the 4.0 cm irrigation at 1.0 IW/CPE ratio and 150 kg N ha^{-1}.

Key words: Wheat, IW/CPE Ratio, moisture regime, water use and water use efficiency

---

INTRODUCTION

Irrigated wheat is grown in rotation with rice on 2.6 Mha in the intensive rice–wheat system in north India (GOP,2006). However, the sustainability of the rice–wheat system is threatened by declining soil fertility and groundwater depletion (Humphreys *et al.,* 2010; Ladha *et al.,* 2007).

Nearly 60% of arable land worldwide is dedicated to cereal production. Fertilizers are constrain factor limiting crop productions such as wheat (Camara *et al.*, 2003, Derksen *et al.*, 2002, Mohammaddoust *et al.*, 2006). The demand for wheat by 2020 has been projected to be between 105-109 million tonnes. Most of this increase in production will have to manage from increase productivity as the land area under wheat is not expected to expand.

About one third of the developing world's wheat (*Triticum aestivum* L.) area is located in environments that are regarded as marginal for wheat production because of drought, heat and edaphic factors. Despite these limitations, the world's dry and difficult cropping environments are increasingly crucial to food security in the developing world. For example, it has been reported that 32% of the 99 million hectares of wheat grown in developing countries experiences varying levels of drought stress (Rajaram *et al.,* 1996).

It is well known that water management is one of the major factors responsible for achieving better harvest in crop production. As more than 90% of the water is used for irrigation. Priority should be fixed for higher WUE in the field. Since water is a precious and scare input and hence it must be judiciously used. It plays a vital role for assured crop production. Without water either through irrigation or rain, plant growth and development will be adversely affected. Since it is essential for the maintenance to turgidity, absorption of nutrients and the metabolic process of the plants. Therefore, it becomes imperative to find out appropriate irrigation schedule in order to maintain the availability of soil moisture throughout the growing season for exploiting yield potential. Among the several recognized criteria of irrigation scheduling, the climatological approach is very scientific and has been identified widely among the scientists and research workers throughout the world. It is well known that evapo-transpiration by a full crop cover is closely associated with the evaporation from an open pan (Dastane, 1967). Parihar *et al.* (1974) suggested a relatively more practical meteorological approach of IW/CPE, the ratio between a fixed amount of irrigation water (IW) and cumulative pan evaporation minus rains since previous irrigation (CPE) as a basis for irrigation scheduling to crops. This IW/CPE approach merits special consideration on account of its simplicity of operation and high water use efficiency. Therefore, IW/CPE is taken for applying water to wheat and for comparative study treatments on critical growth stage are also taken.

Aggarwal and Goswami (2003) and Aggarwal *et al.* (2006) reported that bed-planting system was superior to conventional planting system as it improved water and nutrient use efficiency and also reduced mechanical impedance and enhanced root growth. Fahong and Sayre (2004) also found that nitrogen use efficiency (NUE) could be improved by 10% or more in furrow irrigated bed-planting systems because of improved microclimate due to the reduction in canopy humidity within the field which reduced crop lodging and decreased the incidence of some wheat diseases. Sweeney and Sisson (1998) reported that on poorly drained soils, wheat yields increased when grown on 75 cm raised beds. These researchers also found that soil temperature tended to be higher on the raised beds early in the growing season. Therefore, the main objective of this study was to evaluate the effect of different moisture regimes on the grain yield, WU and WUE of bed planted wheat cultivars. The groundwater table is falling steadily at the rate of about 1 m/year and the main factors leading to this decrease are the expansion of the wheat area to be irrigated with groundwater and the low water-use efficiency (Zhang *et al.*, 2006).

EXPERIMENTAL SECTION

The experiment was conducted during the *Rabi* season 2007-08 at Agronomy research farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad. The experimental site is situated at 26^0 47' N latitude, 82^0 12' E longitudes and on altitude of 113 meters above mean sea level. The whole experiment conducted in split-spit plot design with three replication. The moisture regime located in main plot treatment. The moisture level maintain by the supplementation of irrigation water as per required treatment *i.e.* 0.8 and 1.0 Irrigation water/Cumulative Pan Evaporation (IW/CPE) Ratio respectively, I_3 irrigation at CRI, late jointing and milking andI_4 irrigation at CRI, maximum tillering, late jointing, flowering and milking stage of wheat with three nitrogen level @ 75%, 100% and 125% of recommended dose of nitrogen. The recommended dose of nitrogen is 120 kg/ha. Irrigation was scheduled on the basis of IW/CPE

$$IW/CPE = \frac{\text{Irrigation water depth (mm)}}{\text{Cumulative pan evaporation (mm)}}$$

Water used by the crop was determined with the following formula

$$CU = \sum_{i=1}^{n} = \frac{M_{1i} - M_{2}i}{100} bdi \times di + ER + \sum_{i=1}^{n} ET$$

Where,
CU =Consumptive use of water (cm)

$\sum_{i=1}^{n}$ =Summation of n-number of soil layers sampled in the root zone depth ‘d’

M_{1i} =Soil moisture percentage on oven dry weight basis at the time of second sampling in the i^{th} layer.
M_{2i} =Soil moisture percentage on the oven dry weight basis at the time of first sampling in the i^{th} layer.
bdi =Bulk density of i^{th} layers of soil (g cm^{-3})
di =depth of i^{th} layer of the soil (cm)
ER =Effective rainfall (cm)

$\sum_{i=1}^{n}$ ET= Summation of evapotranspiration (ET) for two days of concerned irrigation period (ET = Evaporation x 0.6)

Water use efficiency (W.U.E.) was calculated by following formula

$$WUE\ (kg\ ha^{-1} - cm) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Consumptive use (cm)}}$$

RESULTS AND DISCUSSION

The data pertaining to initial plant population and plant height presented in table no.1. The initial plant population (15 days after sowing) did not significantly influenced due to moisture regime, nitrogen level.

Water is the fundamental basis of life. Growth of plant is controlled by rates of cell division, their enlargement and by the supply of organic and inorganic compounds required for the synthesis of new protoplasm and cell wall. Cell enlargement is particularly dependent on least minimum degree of cell turgor. Stem and leaf elongation is quickly checked by water deficit. Thus decreasing water content is accompanied by loss of turgor and wilting, cessation of cell enlargement, closure of stomata, reduction in photo synthesis and interference with many basic metabolic processes (Kramer, 1969).

Initial plant population did not change by different moisture regime because there was enough and uniform moisture at the time of sowing which lead proper germination. This was mainly due to the effect that initial plant population was counted at 15 days after sowing (DAS) and irrigation treatments were not applied upto this period.

Different irrigation schedules were showed significant response on the growth characters *viz*., plant height, number of shoots as well as leaf area index at 70 DAS and 90 DAS. The plant height, number of shoots m^{-2} and leaf area index did not influence by different moisture regime at initial growth stages (30 DAS and 50 DAS) because variable irrigation was received after this stage under different moisture regime.

The data pertaining to yield attribute and Harvest index presented in table no.2 respectively. The yield attributes character *viz.* Number of spike, length of spike, number of spikelet per spike, number of grain per spike weight of 1000 seed and harvest index were significantly influenced by with application of irrigation at irrigation at 1.0 IW/CPE ratio(I_2),Nitrogen supply @150Kg/ha(F_3)

In the early stage of crop growth, various moisture regime could not produce significant changes in plant height but affected significantly at later stages. This might be due to start of differential treatment at 50 DAS. The driest moisture regime i.e. irrigation at CRI, late jointing and milking stage was not received any variable irrigation even upto 70^{th} days stage produce significantly shorter plants then those of other moisture regime. There was no significant difference in plant height between irrigation at 1.0 IW/CPE ratio, irrigation at 0.8 IW/CPE ratio and 5 irrigations at CRI, maximum tillering, late jointing, flowering and milking stage. At 70 and 90 DAS, under wettest moisture regime (1.0 IW/CPE ratio) plants were provided with adequate moisture to meet there various requirements, which resulted into higher plant height in comparison to other moisture regime. Increase in plant height at higher level of moisture regime has been positively due to maintenance of constant water supply to the plants, which maintained various metabolic processes. Minimum plant height was recorded under I_3 irrigation at CRI, late jointing and milking stage at 70 and 90 DAS due to poor growth caused by moisture deficit condition. Significant reduction in plant height due to decrease in moisture availability was also reported by Yadav and Verma (1991), Bandyopadhyay (1997) Rehman *et al.*(2000) and Saren *et al*.(2004).

Yield attributes which determined yield, is the resultant of the vegetative development of the plant. All the attributes of yield *viz.*, number of spike per running meter, length of spike, number of spikelets per spike, number of grains per spike and test weight influenced significantly due to different moisture regime (Table-2). Maximum number of spikes per running meter, length of spike, number of spikelets per spike, number of grains per spike and test weight were recorded under 1.0 IW/CPE ratio followed by 0.8 IW/CPE ratio, 5 irrigations given at CRI, maximum tillering, late jointing, flowering and milking stage. Under wettest moisture regime 1.0 IW/CPE ratio due to favorable vegetative growth and development because it received adequate moisture during entire period of growth. As under adequate moisture, the plant height, leaf area index were highest contributed to highest yield attributes increased photosynthetic activity of leaves. Besides, translocation of photosynthetes from source to sink also increased under wettest condition through higher uptake of potassium lead to better yield attributed. Minimum yield attributes were recorded where 3 irrigation were given at CRI, late jointing and milking because of plant were unable to extract more water and nutrients under moisture deficit condition which resulted in poor growth and yield attributes. This result is close proximity to those obtained by Khola *et al*. (1989a), Kumar *et al.* (1995a), Dubey and Sharma (1996), Bandyopadhyay (1997), Khatri *et al.* (2001).

The yield attributes *viz*. number of spike m^{-2}, spike length, number of spikelets per spike, number of grain per spike and test weight increased with increasing doses of nitrogen upto 125% recommended dose of nitrogen (150 kg N ha^{-1}) (Table 2). Application of fertility level increased the dry matter accumulation in assimilation organs that in term brought about increase yield attributes. Increased in yield attributing characters with increasing doses of nitrogen was also supported by Khola *et al.* (1989a), Dubey and Sharma (1996), Azad *et al.* (1998), Ali *et al.* (2003) and Rajput *et al.* (2004).

Consumptive use of water showed an increasing trend with increase in moisture regime. The highest consumptive use (32.83 cm) were recorded under moisture regime of 1.0 IW/CPE ratio followed by 0.8 IW/CPE ratio, 5-irrigations given at CRI, maximum tillering, flowering and milking stages. This was mainly due to the fact that greater loss of applied water through evopotranspiration because of more available of water result into better leaf area foliage and plant growth. The lowest consumptive use of water (28.80 cm) was computed under lowest moisture availability to plant under three irrigations due to combination of lower surface evaporation and reduce transpiration. These finding was supported by Khola *et al.*, (1988 b), Singh and Uttam (1993 b) and Saren et al. (2004).

Water use efficiency (WUE) markedly influenced by different moisture regime. The highest water use efficiency was (119.67 kg ha^{-1}- cm recorded under irrigation applied at 1.0 IW/CPE ratio followed by moisture of 0.8 IW/CPE ratio, 5 irrigations given at CRI, maximum tillering, late jointing, flowering and milking stages and 3 irrigation given at CRI, late jointing and milking stage. This might be due to higher yield obtained with less amount of water used. Chavan and Pawar (1988) recorded that the water use efficiency increased with increase in the IW/CPE ratio. Our findings were supported by findings of Rathore and Patel (1991).

The consumptive use of water (CU) and water use efficiency (WUE) increased with increasing N level upto 125% of recommended dose of nitrogen (150 kg N h^{-1}). Application of more nitrogen favoured the growth of plants, as they consumed more amount of water for their metabolic processes and transpiration which in tern led to higher consumptive use. The increase in water use efficiency with increasing N level was mainly due to proportionately higher increase in grain yield than consumption of water. These results were reported by Khola *et al.* (1989b), Rathore and Patel (1991) and Limon *et al.* (2000).

Table No.01: Initial plant population and plant height of wheat influenced by moisture regime, nitrogen level.

Treatments	Initial plant population (m^{-2}) (15 DAS)	Plant height (cm.)			
		30 DAS	50 DAS	70 DAS	90 DAS
Moisture regime					
I_1	162.5	24.74	55.78	82.80	88.47
I_2	164.0	24.87	55.92	83.36	92.40
I_3	162.7	24.88	55.48	80.12	83.23
I_4	163.0	24.87	55.63	82.62	87.91
SEm ±	3.8	0.50	1.73	0.98	1.55
CD at 5%	NS	NS	NS	3.19	5.35
Nitrogen level					
F_1	162.32	23.80	52.58	77.99	83.83
F_2	163.62	24.75	56.22	82.28	88.21
F_3	163.03	25.97	58.30	86.63	91.77
SEm ±	2.81	0.40	0.97	1.33	1.21
CD at 5%	NS	NS	2.92	3.99	3.63

Table No.02: Yield attributes of wheat as affected by moisture regime, nitrogen level.

Treatments	No. of spike running^{-1}	Length of spike (cm)	No. of spikelet spike^{-1}	No. of grain spike^{-1}	1000 grain weight (g)
Moisture regime					
I_1	89.0	8.11	12.1	36.2	39.18
I_2	92.0	8.31	13.1	38.7	40.21
I_3	78.0	7.33	11.2	33.0	38.21
I_4	88.2	8.09	12.0	35.8	38.29
SEm ±	0.44	0.08	0.25	0.74	0.26
CD at 5%	1.52	0.28	0.86	2.56	0.86
Nitrogen level					
F_1	79.8	6.93	10.0	29.8	36.23
F_2	87.5	7.99	12.1	36.1	38.82
F_3	93.0	8.91	14.1	41.9	41.87
SEm ±	0.38	0.06	0.20	0.60	0.18
CD at5%	1.14	0.18	0.60	1.79	0.53

Table-3 Consumptive use of water (cm) and water use efficiency as influenced by moisture regime, nitrogen level.

Treatments	Consumptive use of water (cm)	Water use efficiency (kg ha-1 – cm)
Moisture regime		
I1	31.34	114.20
I2	32.63	120.41
I3	28.21	108.57
I4	31.18	112.12
Nitrogen level		
F1	29.01	101.34
F2	30.10	114.08
F3	32.74	124.55

CONCLUSION

Suitable moisture regime for wheat crop grown on raised bed was found to be 4.0 cm irrigation at 1.0 IW/CPE ratio. The suitable nitrogen dose for bed planted wheat was found to be 150 kg N ha-1. The yield attributes character *viz.* Number of spike, length of spike, number of spikelet per spike, number of grain per spike and 1000 seed weight were significantly influenced by 125% recommended dose of nitrogen. Highest water use fficiency was recorded under the treatment combination of 4.0 cm irrigation at 1.0 IW/CPE ratio.

REFERENCES

[1] Aggarwal, P. and Goswami, B. (**2003**) *Indian J. Agric. Sci*. 73, 422–425.
[2] Aggarwal, P., Choudhary, K.K., Singh, A.K. and Chakraborty, D. (**2006**) *Geoderma* 136, 353–363.
[3] Ali, L.; Qarnar Mohy,U.P.D.N. and Ali, M. (**2003**). *International Journal of Agriculture and Biology*. **5** (4) : 438-439.
[4] Azad, B.S.; Bhagwat, B.D.; Bali, S.V.; Kachroo, Dileep and Gupta, S.C. (**1998**). *Indian J. Agron*. 43 (4) : 653-656.
[5] Bandyopadhyay, P.K. (**1997**). *Indian J. Agron*. 42 (1) : 90-93.
[6] Chamara, K.M., Payne, W. A and Rasmussen, P. E. (**2003**) *Agron. J*. 95: 828_835.
[7] Chavan, D.A. and Pawar, K.R. (**1988**). *Journal of Maharashtra Agricultural Universities* 13 (2) : 209-210.
[8] Dastane, N.G. (**1967**). *A practical manual for water use research*. Navabharat Prakashan, Pune. pp. 13-16.
[9] Derksen, D. A., Anderson, R. L., Blackshaw, R. E. and Maxwell, B. (**2002**) *Agron. J*. 94: 174– 185.
[10] Dubey, Y.P. and Sharma, S.K. (**1996**). *Indian J. Agron.* **41** (1) : 48-51.
[11] Fahong, W.X. and Sayre, K.D. (**2004**) *Field Crops Res*. 87, 35–42.
[12] GOP (**2006**) Agriculture at a glance. Dept. of Agriculture, GOP, Chandigarh, India.
[13] Humphreys, E., Kukal, S.S., Christen, E.W., Hira, G.S., Balwinder-Singh, Yadav, S., Sharma, R.K. (**2010**) *Adv. Agron.* 109, 155–217.
[14] Khatri, R.S.; Goel, K.C. and Malik, P.K. (**2001**). *Crop Research*, **21** (1) : 20-23.
[15] Khola, O.P.S.; Rao, D.S.; Ram Mohan; Singh, Harbir and Faroda, A.S. (**1988b**). *Indian J. Agron.* **34** (4) : 467-477.
[16] Khola, O.P.S.; Rao, D.S.; Ram Mohan; Singh, Harbir and Faroda, A.S. (**1989a**). *Indian J. Agron.* **34** (1) : 114-116.
[17] Kramer, P.J. (**1969**). *Plant and soil water relationship*. A modern synthesis. Edn. 8th Tata Mc Grow Hill Publishing Company Ltd., New Delhi, 482 pp.
[18] Kumar, A.; Sharma, D.K. and Sharma, H.C. (**1995a**). *Indian J. Agron*. **40** (1) : 38-42.
[19] Ladha, J.K., Pathak, H., Gupta, R.K. (**2007**) *J. Crop Improv*. 19, 125–136.
[20] Limon, Ortega. A.; Sayre, K.D. and Francis, C.A. (**2000**). *Agronomy Journal*, **92** (2) : 303-309.
[21] Mohammaddoust, H.R., Tulikov, A.M. and Baghestani M.A. (**2006**) *Pak. J. Weed Sci. Res.* 12: 221-234.
[22] Prihar, S.S.; Gajri, P.R. and Rarang, R.S. (**1974**). *Indian J. Agric. Sci.* **44** : 567-571.
[23] Rahman, M.A.; Karim, AJMS; Haque, M.M. and Eqashira, K. (**2000**). *Journal of the faculty of Agriculture*, **45** (1) : 301-308.
[24] Rajaram S., Braun H.J. and Ginkel M. V. (**1996**). *Euphytica*. 92, (1/2), 147-153.
[25] Rajput, M.I.; Soomro, Z.A. and Siddiqui, S.A. (**2004**). *Asian Journal of Plant Sciences*, **3** (1) : 143-144.
[26] Rathore, A.L. and Patel, S.L. (**1991**). *Indian J. Agron*. **36** (2) : 184-187.
[27] Saren, B.K.; Dey, S. and Mandal, D. (**2004**). *Indian J. of Agricultural Sciences*. **74** (5) : 257-261.
[28] Singh, V.P.N. and Uttam, S.K. (**1993** b). *Indian J. Agron*. **38** (3) : 386-338.
[29] Sweeney, D.W. and Sisson, J.B. (**1998**) *Soil Tillage Res*. 12, 187–196.
[30] Yadav, G.L. and Verma, J.K. (**1991**). (Supplement). *Indian J. Agron*. **36** : 50-56.
[31] Zhang, X.Y., Pei, D., Chen, S.Y., Sun, H.Y. and Yang, Y.H. (**2006**) *Agron. J*. 98, 1620–1626