I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS) Rating : 3.03

Effect of Tillage System, Irrigation Scheduling and Depth on Growth, Yield Attribute, Yield and Water Use in Wheat (Triticum Aestivum)

Yashwant Kumar Singh* and T. P. S. Katiyar**

ABSTRACT: *An experimental field trial was conducted at student instruction form at N. D. U. A. & T., Kumarganj, Faizabad during 2003-04 to 2004-05 with sowing of wheat in two patterns namely, zero tillage and conventional tillage and, three irrigation schedules (0.8, 1.0 and 1.2 IW/CPE ratio) in main plot and two depth of irrigation (4cm and 6 cm) as subplot conventional tillage planted wheat had lower water consumption fire water use efficiency and grain yield then zero tilled wheat. At 30 to 60 day after sowing the intact root length, root volume and root dry weight under conventional tillage were higher than zero tillage. The highest water consumption and water use efficiency was observed when subsequent irrigation were applied at 1.0 IW/CPE ratio at 4 cm depth.*

INTRODUCTION

Wheat crop is planted on preparing good tilth with 4-8 tillage operations after rice crop. The land preparation requires high input energy and increase cost of cultivation. Secondly, wheat sown with conventional tillage system also requires irrigation of 7.5 cm depth. To cope the problems of high cost of cultivation, fast depleting ground water resource and to sustain the productivity of rice-wheat cropping system, the adoption of new tillage and crop establishment technologies like zero tillage, bed planting (Furrow irrigated raised beds) direct seeded rice, crop residue recycling and crop diversification could answer the major constraints to the sustainability issues of rice-wheat cropping (Gupta *et al*., 2006). Zero tillage reduces cost of cultivation, saves fuel, energy, facilitate timely planting of crop, reduces weed population and wear and tear of tractor (Fahong, 2004). Optimizing irrigation schedule and depth of water play an important role in obtaining maximum yield. However, such as information is lacking about irrigation schedule and depth of water in zero till and conventional tilled wheat. With this background, present study was undertaken to workout the irrigation schedule for zero- till and conventional tilled wheat with the objectives to know subsequent irrigation and depth of irrigation water in zero till and conventional tilled wheat.

MATERIAL AND METHODS

Field trial on wheat were conducted over two growing seasons (2003-04 to 2004-05) at N. D. U. A. & T., Kumarganj, Faizabad. The soil of experimental field was silty loamy in texture with pH 8.2 , low organic carbon (0.38), low in available N (175 $kgha^{-1}$), medium in available P (15.4 $kgha^{-1}$) and available K (268.4 $kgha^{-1}$). Initial bulk density was 1.41, 1.43, 1.50 and 1.53 (gcm^{-3}) in the soil layers of 0-15, 15-30 , 30-60 and 60-90cm,. The experiment was laid out in split plot design having two tillage system viz. Zero tillage machine (ZT) and conventional method (CT) with three irrigation schedules viz. 0.8 (I_1),1.0 (I_2) and1.2 (I_3) IW/CPE ratio as main plot and two depths of irrigation viz. 4 (D_1) and 6 (D_2) cm as sub plot treatment 12 treatment combination with three replication. The wheat ' was planted and the irrigation was applied as per treatment.. The wheat was planted on 1st weak of December in both years using seed rate of 125 $kgha^{-1}$ in zero tillage and conventional tillage and N: P: K ratio is 120: 60:40. The rainfall was 52.60 and 36.80 mm during the season in 2003-04 and 2004-05, respectively. Average number of irrigation was

* Department of Soil Science & Agricultural Chemistry (Soil and Water Conservation), Rajeev Gandhi South Campus, Banaras Hindu University, Barkachha, Mirzapur 231001

** Department of Soil Science, N. D. U. A. & T., Kumarganj, Faizabad 224229

applied CRI+4 ,CRI+5 , CRI+7 ; CRI+3 ,CRI+4 , CRI+4 and CRI+3 ,CRI+4 , CRI+5 and CRI+2 ,CRI+3 , CRI+3 in zero and conventional tillage at 4 and 6 cm depth with 0.8,1.0and 1.2 IW:CPE ratio; including first irrigation at 3 weeks after sowing during 2003-04 and, 2005-06 respectively. For measuring root length, soil blocks upto 60 cm depth and 30 cm width with plant root were taken out from five random places during the croup duration (cylinder monolith method). Then root volume and root dry weight were observed soil moisture was determined gravimetrically by taking soil sample at sowing time, before and after each irrigation and at harvest from 0 -15, 15-30, 30-60 and 60-90 cm soil depths and calculation of consumptive use of water and water use efficiency was done by Dastane method (1972).

RESULTS AND DISCUSSION

Growth Parameters

The conventional tillage of wheat had significantly higher plant height (100.05cm) then zero tillage (93.35cm). Irrigation scheduling at 1.0 IW/CPE have significantly higher plant height (101.69 cm) then.0.8 (91.14 cm) IW:CPE ratio and at par with 1.2 (97.24 cm) IW:CPE ratio and at 4cm depth plant height was (98.63 cm) and 6 cm (94.26 cm) but the difference were not significant. It also could be due to better environment for growth and development, where water was used more efficiently and caused an increase in photosynthetic potential (Wang, 2004). The average dry matter accumulation at maturity were significantly observed in conservation tillage (1059.70 **g m-^{2}**) then zero tillage (964.18 **g m-^{2}**) Irrigation scheduling at 1.0 IW/CPE have significantly higher dry matter accumulation (1058.01 **g m-^{2}**) then.0.8 (968.48 **g m-^{2}**) IW/CPE ratio and at par with 1.2 IW/CPE ratio (1008.90 **g m-^{2}**) . Significantly higher dry matter accumulation (1037.07 **g m-^{2}**) at 4 cm depth then. (986.52 **g m-^{2}**) at 6 cm depth (Table 1). Conventional tillage wheat had significantly higher average leaf area index (4.03) than zero (3.71). Irrigation scheduling at 1.0 IW/CPE have significantly higher leaf area index (4.10) then.0.8 IW:CPE ratio (3.71) and at par with1.2 IW/CPE ratio (3.84) and at 4cm depth plant height was (3.96) and 6 cm (3.79).

Yield attributes average No of spike m^{-2}, spike length (cm), no of grain spike^{-1}, grain yield, significantly influenced by tillage practices (Table 1). Conventional tillage gave significantly higher no of spike m-2 (386.11), spike length (12.61 cm), no of grain spike^{-1} (41.93), grain yield (41.79qha-^{1}) then zero tillage, no of spike m-^{2} (363.65), spike length (10.81 cm), no of grain spike-^{1} (37.32), grain yield (35.88qha-^{1}) respectively. Higher yield might be due to better growth and yield parameters such as effective tillers per meter row length, ear length and leaf area index (Dhillon. 2004).

maximum grain yield was obtained when irrigation scheduled at IW:CPE ratio of 1.0 (41.20qha-^{1}) which was significantly higher than that of 0.8 IW:CPE ratio (36.30qha-^{1}) and was at par with IW/CPE ratio of 1.2 (39.01qha-^{1}).However, the average higher grain yield was also recorded under the treatments where irrigation was applied at IW:CPE ratio of 1.0 and at 4cm depth grain yield was (39.90qha-^{1}) and 6 cm (37.78qha-^{1}) but the difference were not significant.

Root Length, Root Volume and Root Dry Weight

Average root length, root volume and root dry weight of two years was varied under different tillage system, irrigation scheduling and depth (Table 2) the significantly higher length (4.43 and 26.77 cm), root volume (7.97 and 46.35 **cm3/1000cm^{-2}) and root dry weight (3.47 and 17.38 g/1000cm-2)** was recorded under conventional tillage (2358.9 gm) as compared to zero l (3.79 and 19.59 cm), (6.62 and 32.69 **cm3/1000cm^{-2}**) and (3.17 and11.46 **g/1000cm-^{2}**) respectively at 30cn and 60 cm depth of soil.. It could be due to the higher bulk density at the top surface which restricted the proliferation of roots at the upper surface. However, the highest root length, root volume and root dry weight was recorded under conventional tillage than at zero tillage. It could be due to lower penetration resistance in soil layers. Singh, (2002). reported higher root length, root volume and root dry weight under conventional tillage than at zero tillage. The differences in rooting behaviour under different tillage levels could be attributed to bulk density variation in the soil profile. The crop received irrigation scheduled at IW:CPE ratio of 1.0 had the higher root length (4.15 and 24.28cm) ,root volume (7.60 and 38.70 **cm3/1000cm^{-2}**) and root dry weight (3.47 and15.11 **g/1000cm-^{2}**) as compared to 1.2 root length (4..10 and 23.20cm), root volume (7.33 and 36.86 **cm3/1000cm^{-2}**) and root dry weight (3.27 and14.41 **g/1000cm-^{2}**) and 0.8 IW:CPE ratio root length (4..07 and 22.15cm) ,root volume (6.96 and 35.51 **cm3/1000cm^{-2}**) and root dry weight (3.22 and13.73 **g/1000cm-^{2}**) at 30 and 60 cm respectively. However, higher root length (4.10 and 23.52cm), root volume (7.39 and 37.69 **cm3/1000cm^{-2}**) and root dry weight (3.36 and14.76 **g/**

Table 1
Effect of Different Treatment on Growth, Yield Component and Grain Yield of Wheat (Average Data of Two Year)

Treatment	*DMA (g m-2)*	*LAI at90 DAS*	*No of spike m-2*	*Spike length (cm)*	*No of grain spike -1*	*Test weight (g1000 grain-1*	*Grain yield (qha-1)*
Tillage System							
ZT	964.18	3.71	363.65	10.81	37.32	42.99	35.88
CT	1059.70	4.03	386.11	12.61	41.93	43.56	41.79
SEm±	16.52	0.06	5.57	0.23	0.64	0.77	0.62
C.D.	52.04	0.18	17.55	0.72	2.02	NS	1.96
Irrigation schedule (IW: CPE)							
I1	968.48	3.71	357.92	10.59	37.14	41.53	36.30
I2	1058.01	4.10	389.95	13.08	42.19	45.12	41.20
I3	1008.90	3.84	376.77	11.46	39.54	43.19	39.01
SEm±	20.23	0.07	6.83	0.28	0.79	0.59	0.76
C.D.	63.75	0.23	21.50	NS	NS	NS	2.41
Irrigation depth							
D1	1037.07	3.96	383.11	12.51	42.58	43.89	39.90
D2	986.52	3.79	366.65	10.91	36.66	42.66	37.78
SEm±	14.71	0.05	5.06	0.16	0.59	0.70	0.58
C.D.	45.31	0.16	15.61	0.47	1.79	NS	NS

Table 2
Effect of Different Treatment on Root Length, Root Volume, Root Dry Weight, Consumptive use of Water and Water use Efficiency (Average Data of Two Year)

Treatment	*Root length*		*Root volume (cm3/1000cm-2)*		*Root dry weight (g/1000cm-2)*		*Consump-tive water use (cm)*	*Water use efficiency kgha-1cm-1*	*Moisture depletion*			
	30 DAS	*60 DAS*	*30 DAS*	*60 DAS*	*30 DAS*	*60 DAS*			*0-15*	*15-30*	*30-60*	*60-90*
Tillage System												
ZT	3.79	19.59	6.62	32.69	3.17	11.46	27.42	132.81	9.12	6.95	2.86	1.73
CT	4.43	26.77	7.97	46.35	3.47	17.38	29.68	143.68	10.04	7.57	3.34	1.86
SEm±	0.06	0.44	0.14	0.66	0.06	0.28						
C.D.	0.18	1.39	0.43	2.06	0.20	0.90						
Irrigation schedule (IW: CPE)												
I1	4.07	22.15	6.96	35.51	3.22	13.73	26.72	138.28	8.98	6.74	2.80	1.71
I2	4.15	24.28	7.60	38.70	3.47	15.11	28.73	145.51	9.69	7.30	3.09	1.80
I3	4.10	23.20	7.33	36.86	3.27	14.41	30.19	130.93	10.07	7.73	3.41	1.88
SEm±	0.07	0.54	0.17	0.80	0.08	0.40						
C.D.	NS	NS	NS	NS	NS	NS						
Irrigation depth												
D1	4.10	23.52	7.39	37.69	3.36	14.76	28.94	140.22	9.61	7.31	3.32	1.81
D2	4.11	22.84	7.20	36.35	3.28	14.08	28.14	136.76	9.55	7.21	3.06	1.78
SEm±	0.06	0.38	0.09	0.45	0.06	0.28						
C.D.	NS	NS	NS	NS	NS	NS						

1000cm-2) was recorded at 4 cm depth then at 6 cm depth of water root length (4..11 and 22.84cm), root volume (7.20 and 36.35 **cm3/1000cm-2**) and root dry weight (3.28 and14.08 **g/1000cm-2**) at 30 and 60 cm respectively .

Soil Moisture Depletion Pattern

Soil moisture depletion by wheat decrease with increase in soil depth, relative higher from 0-15cm soil layer (Table 2) this was mainly due to greater proliferation and spread of the roots in conventional

tillage in upper soil layer because of less water was available in deeper soil layers then zero tillage. Soil moisture depletion (cm) in profile under conventional tillage (10.04,7.57,3.34 and 1.86 cm) was higher than zero tillage (9.12, 6.95, 2.86 and 1.73) at 1-15,15-30,30-60 and 60-90 cm respectively. Among irrigation scheduling maximum Soil moisture depletion was observed in1.2 IW/CPE is (10.07, 7.73, 3.41 and 1.99 cm) then 1.0 IW/CPE (9.69, 7.30, 3.09 and 1.80) and 0.8 IW/CPE (8.89, 6.74, 2.80 and 1.71) respectively. However, higher Soil moisture depletion was recorded at 4 cm depth (9.61, 7.31, 3.32 and 1.81) then at 6 cm depth of water (9.55, 7.21, 3.06 and1.78cm).

Consumptive Use of Water

The average (2years) consumptive use of water by the crop was maximum under conventional tillage (29.68 cm) followed by zero tillage (27.42 cm) due to the well distributed rainfall in the growing seasons and less irrigation frequency (Table 2). A progressive increase in consumptive use (26.72 to 30.19 cm) of water was recorded with increasing IW: CPE ratio from 0.8 to 1.2. It could be due to better availability of soil water content and more aboveground dry matter under higher frequency of irrigation. Parihar and Tiwari, (2003). reported that consumptive use of water by the wheat crop increased with the increase inIW: CPE ratio from 0.6 to 1.2. 0 and at 4cm depth consumptive use of water was (28.94 cm) and 6 cm (28.14cm) but the difference were not significant.

Water Use Efficiency

The average water use efficiency (WUE) was higher in the conventional tillage (143.68 kgha-^{1}cm-^{1}) then zero tillage (132.81 kgha-^{1}cm-^{1}) might be due to the higher consumptive use of water resulted in higher WUE. the highest WUE recorded when first irrigation was applied at 21 days after sowing (Singh, 2000). The maximum WUE was observed where irrigation scheduled at IW:CPE ratio of 1.0 (145.51 kgha-^{1}cm-^{1}) than IW:CPE ratio of 0.8 (138.28 kgha-^{1}cm-^{1}) and 1.2 IW:CPE ratio (130.13 kgha-^{1}cm-^{1}) could be due to the prolonged availability of soil water content resulted in higher grain yield. Bandyopadhyay, (1997). reported that highest was obtained with IW: CPE ratio of 1.0 and decreased with the decrease in frequency of irrigation. The maximum WUE was observed at 4 cm depth of water applied(140.22 kgha-^{1}cm-^{1}) then at 6 cm depth of water (136.74 kgha-^{1}cm-^{1})

CONCLUSIONS

This study showed that first irrigation at 3 weeks after sowing (CRI) and irrigation scheduled at 1.0 IW:CPE ratio and at 4 cm depth of water to be applied in conventional tillage to obtain the higher grain yield of wheat in comparison to zero tillage.

REFERENCES

Bandyopadhyay, P. K. (1997), Effect of irrigation schedule on evapotranspiration and water use efficiency of winter wheat. 42(1): 90-93.

Dastane, N. G. (1972), A practical manual for research in agricultural, 2 edn. Navbharat Pakistan, Puna.

Dhillon, S. S., Prashar, A. and Thaman, S. (2004), Studies on bed planted wheat under different nitrogen levels and tillage methods. 5(1): 253-256.

Fahong, W., Xuqing, W. and Sayre, K. (2004), Comparison of conventional, flood irrigated, flat planting with furrow irrigated, raised bed *Triticum aestivum Indian J. Agron. Triticum aestivum Curr. Sci.* planting for winter in China. 87: 35-42.

Gupta, R. K., Jat, M. L. and Gill, M. S. (2006), Alternate tillage and crop establishment options for resource conservation in Indo-Gangetic plains of India. , October 26-28, BHU,Varanasi, U.P. India 3-7.

Mahey, R. K., Singh, O., Singh, A., Brar, S. S., Virk, A. S. and Singh, J. (2002), Influence of first and subsequent irrigations under varying tillage levels on weed control and grain yield of wheat. 23(1): 7-11.

Parihar, S. S. and Tiwari, R. B. (2003), Effect of irrigation and nitrogen levels on yield, nutrient uptake and water use of late-sown wheat. 48(2): 103-07.

Singh, M. (2000), Studies on seed rate requirement and time of first irrigation in no-till wheat following rice. , Punjab Agricultural University, Ludhiana. 67-69.

Singh, S. (2001), Studies on irrigation, fertilizer and plant population on growth, yield and water use in bed planted wheat. PAU, Ludhiana. 52-55.

Singh, S., Yadav, A., Malik, R. K. and Singh, H. (2002), Furrow-irrigated raised bed planting system-A resource conservation technology for increasing wheat productivity in rice-wheat sequence. March 4-6 at CCSHAU, Hisar, India. 198-200.

Wang, F. H.,Wang, X. Q. and Sayre, K. (2004), Conventional, flood irrigated, flat planting with furrow irrigated, raised bed planting for winter wheat in China., 87: 35-42.

Zhang Jiyang, Sun Jingsheng, Duan Aiwang, Wang Jinglei, Shen Xiaojun and Liu Xiaofei. (2007), Effects of different planting patterns on water use and yield performance of winter wheat in the Huang-Huai-Hai plain of China. 92: 41-47.