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Barkha
Regional Research Station, Anand Agricultural University, Anand, Gujarat, India

AS Bhanvadia
Regional Research Station, Anand Agricultural University, Anand, Gujarat, India

SN Dholiya
Regional Research Station, Anand Agricultural University, Anand, Gujarat, India

Correspondence
Barkha
Regional Research Station, Anand Agricultural University, Anand, Gujarat, India

Effect of irrigation scheduling with drip irrigation and nitrogen levels on growth and yield of wheat (*Triticum aestivum* L.)

Barkha, AS Bhanvadia and SN Dholiya

Abstract
A field experiment was conducted at the Regional Research Station, Anand Agricultural University, Anand, Gujarat during *rabi* season of 2015-16. The experiment comprised of eight treatment combinations with four irrigation schedules under drip irrigation(0.6, 0.8 and 1.0 ADPEF and conventional method) and two levels of nitrogen (100% and 75% RDN). The field experiment was laid out in a split plot design with four replications. The growth and yield attributes were significantly higher in irrigation scheduled at 1.0 ADPEF as compared to rest of the treatments but it remained at par with 0.8 ADPEF. Irrigation schedules showed similar response for grain and straw yield. Varying nitrogen levels had non-significant effect on growth and yield attributes except for spike length and number of spikelets spike^{-1} where, significantly higher spike length and spikelets spike^{-1}were observed with 100% RDN. Grain and straw yields of wheat were not influencedbynitrogen levels.

Keywords: wheat, drip irrigation, irrigation scheduling, nitrogen

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important staple food grains of human race contributing substantially to the national food security. With increasing demand of wheat, it is important for us to work towards maximizing the productivity as there is no scope for increasing the area under production. Irrigationscheduling plays a very significant role in enhancing yield. Considering the present scenario of water scarcity, emphasis should be given on use of more efficient methods of irrigation like drip irrigation. Along with increased irrigation efficiency, it is also important to provide optimum amount of nutrients to the crop. Nitrogen is the key element for plant growth and development, as it is a constituent of chlorophyll and proteins. Keeping this in view, the present investigation was undertaken to study the growth and yield attributes of wheat (*Triticum aestivum* L.) as influenced by irrigation scheduling with drip irrigation and nitrogen levels.

Materials and Methods
A field experiment was carried out during *rabi* season of the year 2015-2016 at the Regional Research Station farm, Anand Agricultural University, Anand (22^0 - 35' N, 72^0 - 55' E and 45.1 m above the mean sea level), Gujarat. The soil was sandy clay with bulk density 1.43Mg m^{-3}, 0.24dSm^{-1} EC and 7.7 soil pH, having good drainage. It was low in available nitrogen (237 kg ha^{-1}), medium in available phosphorus (50.34 kg ha^{-1}) and potassium (347 kg ha^{-1}). The experiment was laid out in split-plot design with four replications and eight treatment combinations with four irrigation schedules under drip irrigation(0.6, 0.8 and 1.0 ADPEF and conventional method) as well as two levels of nitrogen (100% and 75% RDN).Irrigation schedules were relegated as main plot treatments and two nitrogen levels were allotted as sub-plot treatments. Wheat variety GW-496 was sown on 23 November, 2015 with seed rate of 120 kg ha^{-1} at 20 cm row spacing. The plots were of size 4.8 m × 6 m and crop was raised with recommended package of practices. Irrigations were applied through drip irrigation based on alternate day pan fraction evaporation (ADPEF) approach. The daily pan evaporation values were measured with the help of USWB class ‘A’ open pan evaporimeter installed in the experimental field. Laterals with emitters of 4 lph discharge capacity were installed at a spacing of 80 cm and the distance between two emitters was 37.5 cm. Total 42 irrigations of 246, 328 and 372 mm water were applied under 0.6, 0.8 and 1.0 ADPEF treatments respectively whereas, in the conventional method 8 irrigations of 430 mm were applied through irrigation channels at critical growth stages. The entire quantity of phosphorus

(60 kg ha^{-1}) in the form of SSP along with 40 percent of nitrogen (as per treatment) in the form of urea was applied uniformly in the furrows as basal dose. The remaining 60 percent of nitrogen was applied in two equal splits as top dressing at 30 and 60 DAS. The annual rainfall recorded during the year in *kharif* season was 539 mm. However, there was no rain during experimental period. The biometric observations were recorded from five randomly selected plants tagged within each plot. Plant population at 20 DAS and periodical plant height at 15, 30, 60, 90 DAS and at harvest were recorded. Yield attributing characters like tiller conversion index, spike length, number of spikelets spike^{-1}, number of grains spike^{-1} were calculated at the time of harvest. The crop was harvested manually with sickle when grains were matured and straw had turned yellow and data on test weight, grain yield, straw yield and harvest index were recorded. The sun-dried bundles were threshed and winnowed and grains obtained were weighed. The straw yield was obtained by subtracting the grain yield from the biological yield.

Results and Discussion

Growth and yield attributes

The varying irrigation schedules could not affect plant population at 20 DAS and plant heights at 15 and 30 DAS significantly, whereas, height increased significantly under 1.0 ADPEF which remained at par with 0.8 ADPEF at 60 and 90 DAS and at harvest (Table 1). Irrigation schedules showed significant influence on yield attributes *viz.*, tiller conversion index, spike length, number of spikelets spike^{-1}, number of grains spike^{-1} and test weight of grains. Yield attributes were significantly higher with irrigation scheduled at 1.0 ADPEF as compared to rest of the treatments but it remained at par with 0.8 ADPEF (Table 2). This might be due to adequate availability of water and better conducive rhizosphere for higher uptake of nutrients which in turn boost the growth, leading to the development of higher yield attributes through supply of more photosynthates towards the sink. Stress during the reproductive phase might have hampered the supply of photosynthates towards the sink resulting in poor yield attributes recorded in irrigation at 0.6 ADPEF. These results are in close conformity with Patel and Patel (2016) [3] and Narolia *et al.* (2016) [2].

The effect of varying nitrogen levels was non-significant on growth and yield attributes *viz.* periodical plant heights, number of grains spike^{-1}, tiller conversion index and test weight but was significant on spike length and number of spikelets spike^{-1} where, significantly higher spike length and spikelets spike^{-1}were observed with 100% RDN which might be due to higher photosynthetic activity of the plant as a result of higher level of nitrogen applied (Table 1 and 2). The non-significant influence maybe because when water is applied by drip irrigation, leaching losses of the nutrient was less and better utilization of applied nitrogen occurs. However, higher attributes with higher nitrogen dose was reported by Singh and Agarwal (2001) [4] and Tripathi *et al.* (2013) [5].

Yields

Grain and straw yield were registered maximum under irrigation schedule 1.0 ADPEF and 0.8 ADPEF remained at par. Treatment 0.6 ADPEF recorded the lowest grain and straw yield. Irrigation schedules 1.0 and 0.8recorded 14.6 and 12.5 % higher grain yield and 12.8 and 8.6 % higher straw yield than conventional method, respectively (Table 2). Harvest index of wheat was obtained significantly higher under 1.0 ADPEF which was at par with 0.8 ADPEF. Higher grain yield was due to the cumulative effect of improvement in growth and yield attributes. It was also found that with sufficient moisture in the soil profile under higher irrigation frequency with drip irrigation, plant nutrient particularly nitrogen, phosphorus and potash were more available and might have translocated to produce more dry matter. Secondly, increase in yield might be due to more irrigations providing constant wetting of root zone which might have favoured greater release of nutrients from soil. Other reason might be due to increase in numbers of irrigation applied at shorter intervals and total consumptive use of water. These results are in conformity with the results of Narolia *et al.* (2016) [2] and Patel and Patel (2016) [3].

There was no significant effect of different nitrogen levels on grain and straw yields of wheat (Table 2). The reason for this might be due to better utilisation of even lesser quantity of applied nitrogen as a result of reduced leaching losses under drip irrigation system. Similar results were reported by Kachroo and Razdan, (2006) [1].

Conclusion

In the light of the results obtained from the study conducted, it can be concluded that drip irrigation was found to be superiorto conventional method. Irrigating wheat at 0.8 ADPEF along with 75% RDN is better in terms of water saving along with better yieldas it saves 24% water and gives 12.5% higher yield over conventional method.

Table 1: Plant population and growth attributes of wheat as influenced by treatments

Treatments	**Plant population metre^{-1} row length**	**Periodical plant height (cm)**				
Irrigation (I)	**(20 DAS)**	**15 DAS**	**30 DAS**	**60 DAS**	**90 DAS**	**Harvest**
I_1 : 0.6ADPEF	20.25	13.96	27.85	52.11	68.51	80.58
I_2 : 0.8 ADPEF	23.25	14.18	29.84	60.58	79.07	89.06
I_3 : 1.0 ADPEF	25.00	15.03	31.26	65.43	83.30	93.05
I_4 : conventional method	23.25	14.35	28.56	54.14	74.81	84.40
S.Em. ±	1.01	0.45	0.93	1.65	1.96	2.50
C.D. (P=0.05)	NS	NS	NS	5.29	6.28	7.99
Nitrogen (N)						
N_1: 100 % RDN	23.56	14.51	29.76	58.87	77.39	87.77
N_2: 75 % RDN	22.31	14.25	28.99	57.26	75.45	85.77
S.Em. ±	1.85	0.67	1.32	2.97	4.16	4.02
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS
I×N	Non-significant					

Table 2: Yield attributes and yields of wheat as influenced by treatments

Treatments	Tiller conversion index (%)	Spike length (cm)	Spikelets spike^{-1}	Grains spike^{-1}	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Irrigation (I)								
I_1 : 0.6ADPEF	61.24	9.29	12.13	32.50	37.17	3948	5079	42.48
I_2: 0.8 ADPEF	71.36	10.69	14.25	44.63	40.60	4955	5952	45.51
I_3: 1.0 ADPEF	74.82	11.53	14.63	47.13	41.59	5050	6180	46.26
I_4: conventional method	64.54	10.13	14.00	39.75	39.32	4405	5480	44.29
S.Em. ±	2.19	0.47	0.52	1.46	0.59	171.15	205.05	0.58
C.D. (P=0.05)	7.02	1.52	1.66	4.68	1.89	54.55	655.98	1.87
Nitrogen (N)								
N_1:100% RDN	69.12	10.68	14.06	41.63	40.07	4623	5725	44.85
N_2: 75% RDN	66.85	10.13	13.44	40.38	39.27	4556	5621	44.42
S.Em. ±	3.65	0.17	0.14	2.33	1.20	233.97	292.46	0.56
C.D. (P=0.05)	NS	0.51	0.43	NS	NS	NS	NS	NS
I×N	Non-significant							

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