Int.J.Curr.Microbiol.App.Sci (2019) *8*(6): 2519-2526

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 06 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.806.302

Response of Wheat (*Triticum aestivum* L.) under Drip Fertigation System

B.A. Karangiya*, H.H. Mashru and H.M. Vadher

Department of Soil and Water Conservation Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, India

**Corresponding author*

Keywords

Drip Irrigation, Fertigation, FUE, Wheat, WUE

Article Info

Accepted:
20 May 2019
Available Online:
10 June 2019

A B S T R A C T

The experiment was carried out in winter season of 2017-18 (November-March) at Instructional Farm, College of Agricultural Engineering and Technology, JAU, Junagadh to study the response of wheat (*Triticum aestivum* L.) under drip fertigation system. The experiment was undertaken with four fertigation levels viz., 40% RDF-N (F_1), 60% RDF-N (F_2), 80% RDF-N (F_3) and 100% RDF-N (F_4) and three irrigation level viz., 0.6 IW/ETc (I_1), 0.8 IW/ETc (I_2) and 1.0 IW/ETc (I_3). Large plot technique was adopted with three replications of each treatment. Fertigation levels and irrigation levels were taken as a main and sub factor respectively. Higher plant height at harvesting, grain yield, straw yield and yield attributes were observed at fertigation level 100% RDF-N and irrigation level 1.0 IW/ET_C but, it was found that 0.8 IW/ET_C statistically at par with 1.0 IW/ET_C. So, optimum irrigation level for wheat under drip irrigation system is 0.8 IW/ET_C. Higher fertilizer use efficiency of 84.58 kg/kg was observed at fertigation level 40% RDF-N (F_1) combination with irrigation level 1.0 IW/ETc (I_3). Higher water use efficiency 17.12 kg/ha-mm was observed at irrigation level 0.6 IW/ETc (I_1) combination with fertilizer level 100 % RDF-N (F_4).

Introduction

Wheat (*Triticum aestivum* L.) is one of the most important staple food grains of human race. India stands 2nd both in area 29.65 M ha and production 86.5 MT with average productivity of 3 tons per hectare in the world. India's share in world wheat area is about 12.5 % whereas it occupies 12.05 % share in the total world wheat production.

It is the second largest producer of wheat in the world. In India, most of the area under wheat crop is irrigated by flood irrigation with very poor water use efficiency. Available estimates indicate that water use efficiency under flood method of irrigation is only about 35 to 40 per cent because of huge conveyance and distribution losses (Rosegrant, 1997; INCID, 1994). India's water resources, particularly in the context of agriculture, are facing extreme stress.

In India, availability of irrigation water is the major limiting factor in improving wheat productivity. India has the largest irrigated area in the world, two decades ago, more than 60 per cent of wheat in India was grown

under rain fed situation. At present, more than 60 per cent of wheat area is under irrigated condition, of which about 50 per cent receive only one or two irrigations (Chouhan and Yadav, 2012). One of the main reasons for the low coverage of irrigation is the predominant use of flood (conventional) method of irrigation, where water use efficiency is very low. There is need to improve irrigation efficiency through optimization of irrigation water under conditions of limited water availability.

Considering the water availability for future use and the increasing demand for water from different sectors, a number of demand management strategies and programmes have been introduced since late seventies in India to increase the water use efficiency, especially in the use of surface irrigation water. One of the demand management strategies introduced recently to control water consumption in Indian agriculture is micro irrigation (MI), which includes mainly drip and sprinkler irrigation method. Among all the irrigation methods, the drip irrigation is the most efficient.

With increasing demand of irrigation water, the irrigation efficiency and water use efficiency can be enhanced by replacing surface irrigation with micro irrigation methods especially in arid and semi-arid region.

The overall irrigation efficiency of micro irrigation system normally ranges from 70-90% as compare to 30-45% in case of surface irrigation owing to reduce loss of moisture through evaporation/runoff. Drip irrigation is considered the most efficient method because it applies water precisely and uniform at high frequency and maintained high soil metric potential in the root zone, additionally well aerated condition can be maintaining in drip irrigation.

Wheat is very sensitive to insufficient nitrogen and very responsive to nitrogen fertilization. Insufficient N availability to wheat plants results in low yields and significantly reduced profits compared to a properly fertilized crop (Singh *et al.,* 2010). Fertigation has the potential to supply a right mixture of water and nutrients to the root zone, and thus meeting plants' water and nutrient requirements in most efficient possible manner.

The introduction of simultaneous micro-irrigation and fertilizer application (fertigation) opens new possibilities for controlling water and nutrient supplies to crops besides maintaining the desired concentration and distribution of nutrients and water into the soil (Bar-Yosef, 1999). By introducing drip with fertigation, it is possible to increase the yield of crops by 3 times from the same quantity of water. When fertilizer is applied through drip, it is observed that beside the increase in yield, about 30 per cent of the fertilizer could be saved (Sivanappan and Ranghaswami, 2005).

Materials and Methods

To achieve the objectives of the study, field experiment was carried out in winter season of 2017-18 (November-March) at Instructional Farm, College of Agricultural Engineering and Technology, JAU, Junagadh located at 21.5 °N latitude and 70.1 °E longitude with an altitude of 60 meter above mean sea level. The study area having typically subtropical and semi-arid climate. The soil of the experimental plot was clay in texture and slightly alkaline in reaction. The soil had organic carbon content of 0.90 %, and it had 23.77 % field capacity and 2.5 g/cc specific gravity. It had dry bulk density of 1.37 g/cc. Sowing of wheat seed at a seed rate of 120 kg/ha and 22.5 cm row to row spacing was done on 17th November, 2017 by tractor

mounted seed cum fertilizer drill. The recommended dose of phosphorus @ 60 kg P_2O_5 ha^{-1} and potassium @ 60 kg K_2O ha^{-1} were applied as basal dose in the form of single super phosphate and muriate of potash, respectively. Nitrogen (urea) was applied at weekly interval up to 64 days as per treatments. The weekly dose of nitrogen was applied as per following percentage during various growth stage.

The experiment was undertaken with four fertigation levels viz; 40% RDF-N (F_1), 60% RDF-N (F_2), 80% RDF-N (F_3) and 100% RDF-N (F_4) and three irrigation level viz; 0.6 IW/ET_c (I_1), 0.8 IW/ET_c (I_2) and 1.0 IW/ET_c (I_3) (Table 1). Large plot technique was adopted with three replications of each treatment. Irrigation frequency was kept as 3 days' interval. Adjusted FAO K_C was determined for different growth stages and multiplied by evapotranspiration from reference vegetation (ET_0) to compute ET_C. Adjusted crop coefficient was calculated from tabulated crop coefficient as per FAO 56 method and $ET_0$was calculated by using Penman-Monteith equation.

$$ET_0 = \frac{0.408\,\Delta(R_n - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34\,u_2)}$$

Where,

ET_0 is reference evapotranspiration [mm day^{-1}],

R_n is net radiation at the crop surface [MJ m^{-2} day^{-1}],

G is soil heat flux density [MJ m^{-2} day^{-1}],

T is mean daily air temperature at 2 m height [°C],

u_2 is wind speed at 2 m height [m s^{-1}],

e_s is saturation vapour pressure [kPa],

e_a is actual vapour pressure [kPa],

$e_s - e_a$ is saturation vapour pressure deficit [kPa],

Δ is slope vapour pressure curve [kPa $°C^{-1}$],

γ is psychrometric constant [kPa $°C^{-1}$].

Results and Discussion

Effect of N levels and irrigation levels on the yield and yield contributing characters of wheat are presented in Table 2. The result showed that, the effect of fertigation level and irrigation levels gave a significant effect on plant height, ear length, number of grains per ear, number of tiller per sq. m., number of ear per sq. m., test weight, grain yield, biological yield and straw yield.

Highest plant height was observed in treatment T_{12} (100 % RDF-N @1.0 ETc) (81.47 cm) and the lowest plant height was observed in treatment T_1 (40 % RDF-N @0.6 ETc) (67.53 cm) as shown in figure 1. Highest number of grains per ear was observed in treatment T_{12} (100 % RDF-N @1.0 ETc) (33.4) and the lowest number of grains per ear was observed in treatment T_1 (40 % RDF-N @0.6 ETc) (21.8) as shown in figure 2. Adequate moisture availability and fertilizer application during the whole season results the higher grains per ear in treatment combination F_4I_3.

Highest number of tiller per $m^2$was observed in treatment T_{12} (100 % RDF-N @1.0 ETc) (413) and the lowest number of tiller per $m^2$was observed in treatment T_1 (40 % RDF-N @0.6 ETc) (287.33) as shown in figure 3. Highest grain yield was observed in treatment T_{12} (100 % RDF-N @1.0 ETc) (5407.41 kg/ha) and the lowest grain yield was observed in treatment T_1 (40 % RDF-N @0.6 ETc) (3374.89 kg/ha) as shown in figure 4.

Fig.1 Effect of fertigation levels and irrigation levels on plant height at harvest

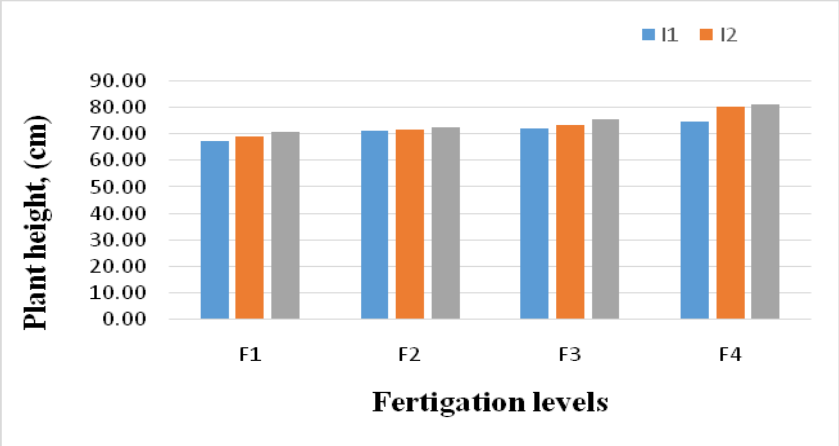

Fig.2 Effect of fertigation levels and irrigation levels on number of grains per ear

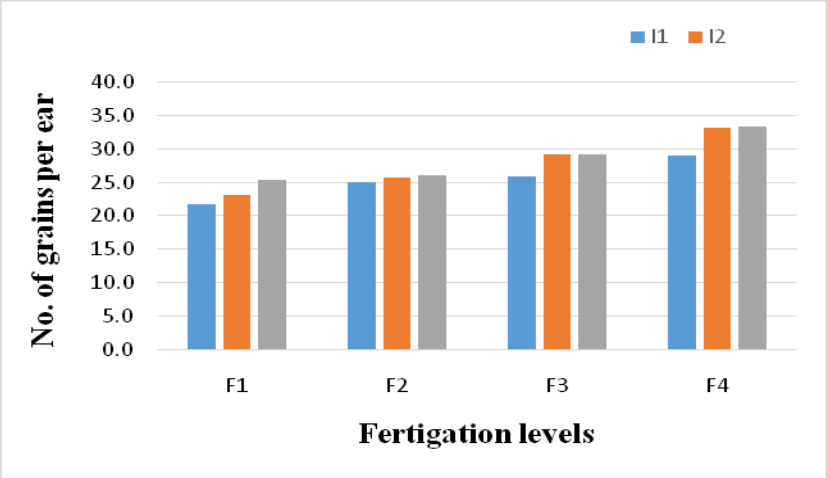

Fig.3 Effect of fertigation levels and irrigation levels on number of tiller per m^2

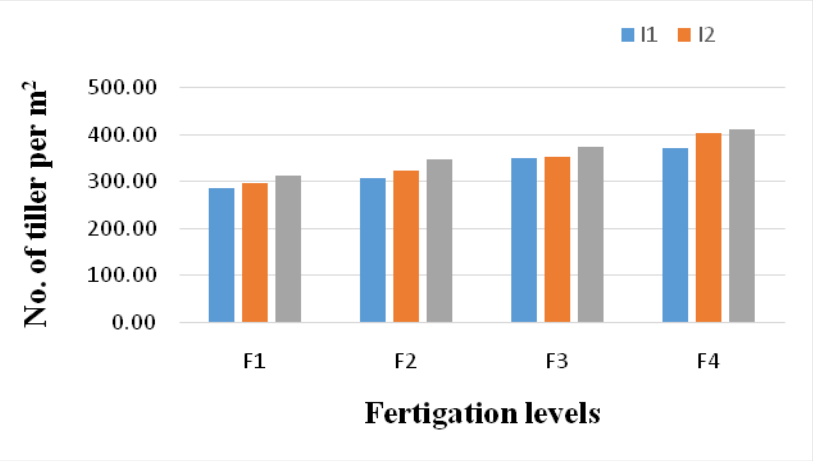

Fig.4 Effect of fertigation levels and irrigation levels on grain yield (kg/ha)

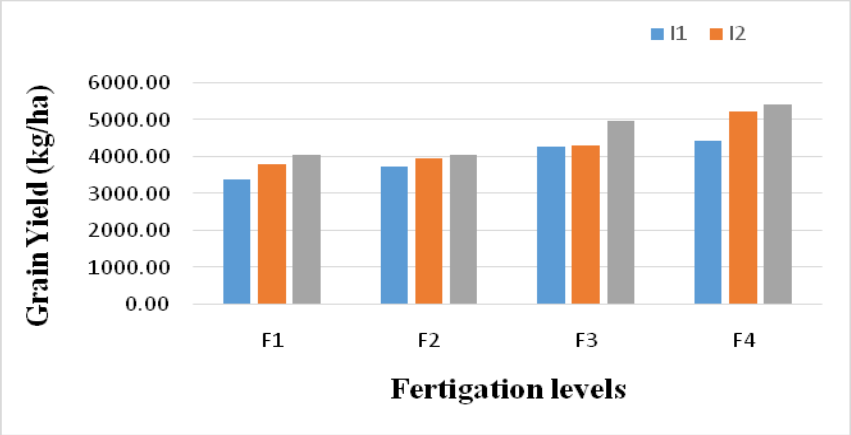

Fig.5 Fertilizer use efficiency under different treatments

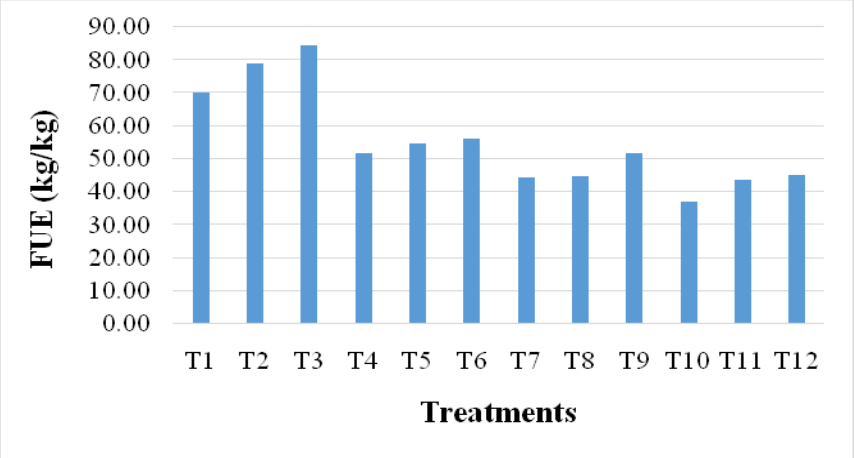

Fig.6 Water use efficiency under different treatments

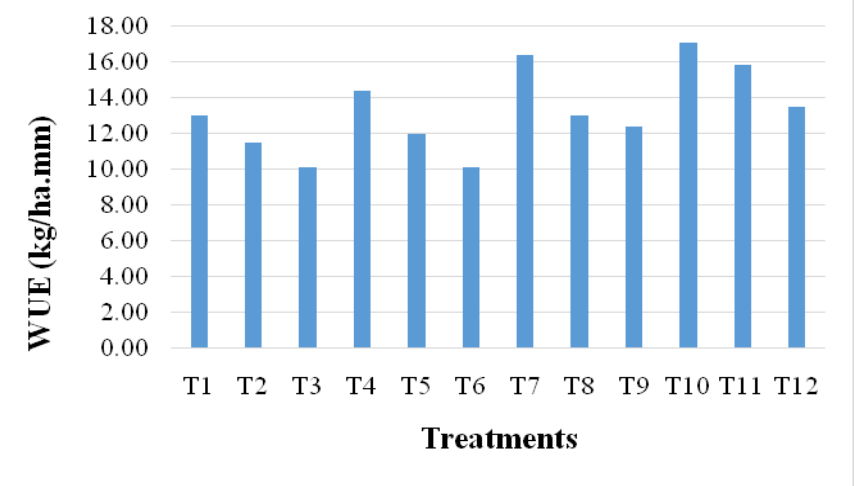

Table.1 Nitrogen schedule for wheat crop

DAS	Nitrogen (%)	Recommended dose of N-fertilizer							
		40% RDF -N		60% RDF-N		80% RDF-N		100% RDF-N	
		N kg/ha	Urea kg/ha	N kg/ha	Urea kg/ha	N kg/ha	Urea kg/ha	N kg/ha	Urea kg/ha
Basal	10	4.8	10.4	7.2	15.6	9.6	20.8	12	26
15	15	7.2	15.6	10.8	23.4	14.4	31.2	18	39
16-22	15	7.2	15.6	10.8	23.4	14.4	31.2	18	39
23-29	15	7.2	15.6	10.8	23.4	14.4	31.2	18	39
30-36	15	7.2	15.6	10.8	23.4	14.4	31.2	18	39
37-43	10	4.8	10.4	7.2	15.6	9.6	20.8	12	26
44-50	10	4.8	10.4	7.2	15.6	9.6	20.8	12	26
51-57	5	2.4	5.2	3.6	7.8	4.8	10.4	6	13
58-64	5	2.4	5.2	3.6	7.8	4.8	10.4	6	13
	100	48	104	72	156	96	208	120	260

Table.2 Effect of different treatment combination on yield and yield attributing characteristics of wheat

Treatment		Fertigation levels	Irrigation levels	Plant height	Ear length	Number of grains per ear	Number of tiller per m2	Number of ear per m2	Test weight	Grain yield	Biological yield	Straw yield	Harvest index
T_1	F_1I_1	40% RDF-N	0.6 ETc	67.53	6.40	21.8	287.33	242.75	48.27	3375	8764	5389	38.51
T_2	F_1I_2	40% RDF-N	0.8 ETc	69.13	7.01	23.0	296.67	252.04	49.46	3792	9856	6065	38.62
T_3	F_1I_3	40% RDF-N	1.0 ETc	71.07	7.09	25.4	313.33	275.26	50.10	4060	10403	6343	39.06
T_4	F_2I_1	60% RDF-N	0.6 ETc	71.4	6.73	25.1	307.67	273.88	49.15	3736	10495	6759	35.61
T_5	F_2I_2	60% RDF-N	0.8 ETc	71.8	7.17	25.8	323.00	282.70	49.95	3949	10819	6870	36.71
T_6	F_2I_3	60% RDF-N	1.0 ETc	72.6	7.29	26.1	348.33	285.52	50.27	4046	12134	8088	33.35
T_7	F_3I_1	80% RDF-N	0.6 ETc	72.07	7.01	26.0	349.33	287.07	49.63	4259	10931	6671	38.78
T_8	F_3I_2	80% RDF-N	0.8 ETc	73.43	7.43	29.1	354.00	288.05	50.62	4296	12509	8213	34.47
T_9	F_3I_3	80% RDF-N	1.0 ETc	75.87	7.78	29.2	373.67	315.26	50.92	4963	13019	8056	38.52
T_{10}	F_4I_1	100% RDF-N	0.6 ETc	74.87	7.42	29.0	370.67	297.94	50.18	4444	13125	8681	34.04
T_{11}	F_4I_2	100% RDF-N	0.8 ETc	80.60	7.93	33.1	404.67	322.57	52.03	5227	14028	8801	37.27
T_{12}	F_4I_3	100% RDF-N	1.0 ETc	81.47	8.13	33.4	413.00	337.98	52.59	5407	14843	9435	36.43

The highest plant height, ear length, number of grains per ear, number of tiller per m^2, number of ear per m^2, test weight, grain yield, biological yield and straw yield were observed under treatment T_{12} (100 % RDF-N @1.0 ETc). The lowest plant height, ear length, number of grains per ear, number of tiller per m^2, number of ear per m^2, test weight, grain yield, biological yield and straw yield were observed in treatment T_1 (40 % RDF-N @0.6 ETc).

Higher fertilizer use efficiency of 84.58 kg/kg was observed at fertigation level 40% RDF(F_1) combination with irrigation level 1.0 ETc (I_3) and the lowest fertilizer use efficiency of 37.04 kg/kg was observed at fertigation level 100% RDF (F_4) with irrigation level 0.6 ETc (I_1) as shown in figure 5.

Higher water use efficiency 17.12 kg/ha-mm was observed at irrigation level 0.6 ETc (I_1) combination with fertilizer level 100 % RDF (F_4). And the lowest water use efficiency of 10.14 kg/ha-mm was observed at irrigation level 1.0 ETc with fertigation level 60% RDF-N (F_2) as shown in figure 6.

In conclusions, the highest plant height, ear length, number of grains per ear, number of tiller per m^2, number of ear per m^2, test weight, grain yield, biological yield and straw yield were observed under treatment T_{12} (100 % RDF-N @1.0 ETc). Considering the performance of drip irrigation system at fertigation level 100% RDF and 1.0 ETc irrigation level which gave higher grain yield, straw yield, yield attributes and net return, this combination may be adopted for wheat cultivation under drip fertigation for increasing the farmers' income.

References

Bar-Yosef, B. 1999. Advances in fertigation. *Advances in Agronomy*. 65: 1–77.

Chauhan, R. P. S. and Yadav, B.S. 2012. Studies on crop yield responses to deficit irrigation and levels of nitrogen in wheat, water, energy and food security: call for solutions. India Water Week, New Delhi.

INCID. 1994. Drip Irrigation in India, *Indian National Committee on Irrigation and Drainage*. New Delhi.

Rosegrant, W. M. 1997. Water resources in the twenty-first century: challenges and implications for action, food, agriculture and the environment discussion paper 20. International Food Policy Research Institute. Washington D.C., U.S.A.

Singh, B. N., Vishwakarma, S.R and Singh, V. K. 2010. Character association and Path analysis in elite lines of wheat (*Triticum aestivum* L.). *Plant Archives*. 10: 845 – 847.

Sivanappan, R. K. and Ranghaswami, M. V. 2005. Technology to take 100 tonnes per acre in Sugarcane. *Kisan World*. 32(10): 35-38.

How to cite this article:

Karangiya, B.A., H.H. Mashru and Vadher, H.M. 2019. Response of Wheat (*Triticum aestivum* L.) under Drip Fertigation System. *Int.J.Curr.Microbiol.App.Sci.* 8(06): 2519-2526.
doi: https://doi.org/10.20546/ijcmas.2019.806.302