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Production and Economics of Wheat (*Triticum aestivum* L.) Under Drip Fertigation

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Abstract: ***A field study was conducted at Irrigation Water Management Farm, Post Graduate Institute, M.P.K.V., Rahuri, Maharashtra, India during rabi season of 2013-2014. The experiment was laid out in randomize block design with nine treatments and three replications. The treatment consisted of five fertiliser application rates as 100 % recommended dose with foliar sprays, 100 %, 80%, 60% and 0% under drip fertigation and compared with conventional irrigation and fertilisation. The treatment of 100% drip fertigation with foliar sprays was found to be more beneficial than conventional method of irrigation and fertilization in respect of increase in yield (25.6%) with 44.5% water saving which brought 0.8 ha more area under irrigation. In terms of economics, the same treatment was found more profitable with net extra income of Rs. 61,933 as compared to conventional method.***

Keyword: Drip irrigation, Economics, Fertigation and Productivity

1.Introduction

Food security in the world is challenged by increasing food demand and threatened by declining water availability (Zwart and Bastiaanssen, 2004). In order to increase food production and to meet the increasing demand of vast growing population of our country, Indian farmer needs to be trained to adopt modern technologies in which fertilizers and irrigation management play major role. Adoption of drip irrigation is one of the most efficient methods of scheduling of irrigation having more than 90 percent irrigation efficiency. As water is applied very frequently and uniformly, usually there is no moisture stress in crop root zone and it results into 25 to 30 per cent increase in crop yield as compared to surface irrigated crop (Wang *et al*., 2013 and Pawar *et al*., 2014). Among the agronomic practices that influence the efficiency of applied fertilizer, time and method of application are critically important. Fertigation is one of the techniques which enable the application of water soluble fertilizers and other chemicals along with irrigation water, uniformly and more efficiently. It is recommended that, fertilizer should be applied regularly and timely in small amounts, in order to increase the use efficiency of added nutrients and reduced leaching losses. Due to this, nutrient application through drip, fertigation, is gaining popularity among farmers for several crops (Pawar *et al*., 2013). Wheat grain yield is affected by the number of tillers per plant and thousand seed weight (Frederick *et al*. 2001) which is mainly influenced by water and nutrient availability in root zone. Nutrients applied through drip fertigation at grain development stage results into maximum number of spikelets per spike (Jabran *et al*., 2011). In irrigated crops, high level of management techniques and skills related to water and nutrients application are required for achieving higher yields and better crop quality. As the water and nutrients are costlier inputs, scientific means need to be developed for its efficient utilization.

2.Materials and Methods

A field experiment was conducted during *Rabi* season 2013-2014 at Experimental Farm of Interfaculty Department of Irrigation Water Management, M.P.K.V., Rahuri, Ahmednager, Maharashtra, India. Agro-climatically, the area falls under the scarcity zone of Maharashtra with annual rainfall of 520 mm which is mostly erratic and uncertain in nature. The soil was clayey in texture with 80 cm in depth and alkaline in reaction with pH as 8.10. The available nitrogen, phosphorus and potassium were 158.42, 17.40 and 610.0 kg ha^{-1}, respectively. The soil was well drained with moisture content at field capacity, permanent wilting point and available water content as 39.22, 19.27 and 19.95%, respectively. The experiment consisted of nine treatments replicated thrice with randomized block design as 100% fertigation (T_1), 100% fertigation with foliar sprays (T_2), 80% fertigation (T_3), 60% fertigation (T_4), 100% N and K fertigation (T_5), 100% conventional fertilisers (CF) under drip irrigation (DI) (T_6), no fertilizer under DI (T_7), 100% CF under surface irrigation (SI) (T_8) and 100% CF with foliar sprays under SI (T_9).

In fertigation treatments (T_1 to T_4) the fertilizers were applied in 12 splits apportioned as per crop growth stages (Table 1), in N and K fertigation (T_5), the entire N and K was applied through urea and muriate of potash (MOP) in 12 equal weekly splits and P as basal dose through soil. In conventional practice of fertilizer application (T_6, T_8 and T_9), 50% N, full dose of P and K was applied as basal dose and remaining 50% N was applied on 30 days after sowing. The recommended dose of fertilizer for wheat was applied (120:60:40 N: P_2O_5: K_2O hg ha^{-1}). The fertigation was done using water soluble fertilizers *viz.* Urea (46:0:0), urea phosphate (17:44:0) and MOP (0:0:60).

Table 1: Nutrients to be applied in 12 weekly splits

Days after sowing	% nutrients		
	N	**P**	**K**
1-21days (3 weeks)	25	15	24
22-43 days (3 weeks)	47	20	48
44-63 days (3 weeks)	20	35	16
64-84 days (3 weeks)	8	30	12

In drip irrigation system, single lateral per six rows of wheat with 4 lph inline drippers at 0.50 m was provided. The spacing between two rows of wheat was 15 cm and the spacing between two adjacent laterals was 1.20 m. In conventional method of irrigation, 67 mm depth of irrigation was applied at 75 mm cumulative pan evaporation. In drip method, the water requirement was calculated using reference evapo- transpiration (FAO 56) and crop coefficients (Allen *et al*. 1998). The total cost of cultivation was calculated as cost of cultivation plus fixed cost on irrigation systems which was more in drip irrigated treatments due to more cost of water soluble fertilizers and drip system installation. Net seasonal income was returns from grain and straw yield, total net income was net seasonal returns plus returns from additional area that can be brought under irrigation due to water saving in drip. The soil samples were air dried, processed and analysed for available N (Subbiah and Asija, 1956), available P (Olsen *et al*., 1954) and available K (Hanway and Heidal, 1967). The statistical analysis was performed by using analysis of variance (ANOVA) for randomized block design as per Panse and Sukhatme (1985).

3.Results and Discussion

3.1 Yield and Water Saving

The highest yield of grain and straw was observed in treatment T_2 (100% fertigation with foliar sprays) as 41.1 q ha^{-1} and 70.1 q ha^{-1}, respectively, due to split application of fertilizers at appropriate time through drip and foliar sprays. Treatment T_7 showed lowest yield of grain and straw might be due to no application of fertilizers. In conventional method, the foliar sprays showed increased yield of grain and straw in T_9 (35.0 q ha^{-1} and 58.8 q ha^{-1}, respectively) than grain and straw yields in treatment T_8 (32.8 q ha^{-1} and (55.4 q ha^{-1}, respectively).

Water requirement in drip was very less as compared with conventional method of irrigation in wheat (Table 2). The drip method recorded lowest water use of 222 mm as compared 400 mm in surface method and thus resulted in 44.5% water saving. In drip, the water is applied directly in root zone which increases water application efficiency and decreases water loss through percolation, infiltration, evaporation thereby saving large quantity of water.

The term of water use efficiency denotes the production of crops per unit of water applied, the maximum water use efficiency (WUE) was obtained in T_2 (18.5 kg/ha-mm) followed by T_1 (17.6 kg/ha-mm) and T_3 (17.2 kg/ha- mm). Among the drip treatments, lowest water use efficiency was recorded in treatment T_7 as 7.8 kg/ha-mm; however, in surface method of irrigation, lowest WUE was recorded in T_8 where, 100% fertilisers were applied conventionally with surface irrigation method.

Table 2: Wheat production, total water applied and water use efficiency in different treatments

Sr. No.	Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Total water applied (mm)	Water use efficiency (kg/ha-mm)	Water saved (%)
T_1	100% fertigation	39.1	66.4	222	17.6	44.5
T_2	100% fertigation with foliar sprays	41.1	70.1	222	18.5	44.5
T_3	80% fertigation	38.1	65.8	222	17.2	44.5
T_4	60% fertigation	34.3	57.9	222	15.4	44.5
T_5	100% N and K fertigation	36.7	59.6	222	16.5	44.5
T_6	100% CF under DI	36.1	61.3	222	16.3	44.5
T_7	No fertilizer under DI	17.3	31	222	7.8	44.5
T_8	100% CF under SI	32.8	55.4	400	8.2	0
T_9	100% CF with foliar sprays under SI	35	58.8	400	8.8	0
C.D. at 5%		3.4	5.6	-	-	-

Note.
DI = drip irrigation CF = conventional fertilizer SI = surface irrigation

3.2 Economic Parameters of Wheat

The cost of cultivation was higher in drip fertigation treatments than conventional irrigation treatments due to the cost of installation of drip irrigation system and higher costs of WSF as compared to conventional application fertilizers. Treatment T_2 gave highest net seasonal income of Rs. 66,022 ha^{-1} due to higher grain yields by fertigation and foliar spray, total net returns due to 0.80 ha additional area under irrigation due to water saving in drip as Rs. 119,038 ha^{-1} (Table 3), net extra income over conventional practice as Rs.61,933 ha^{-1} and water productivity (Fig.1) of Rs. 298 per ha-mm of water as compared to conventional irrigation (T_8) which recorded net seasonal income, total net income and water productivity as Rs. 57105 ha^{-1}, Rs. 57105 ha^{-1} and Rs. 143 ha-mm, respectively. The treatment T_7 gave lowest values of all economical parameters than all other treatments might be due lowest grain and straw yields as a result of no fertilizer application. B:C ratio was observed higher in surface irrigated treatment (T_9) due to low cultivation cost. The B:C ratio was profitable in all the treatments (Fig. 2).

Table 3: Economics of wheat influenced by different treatments

Sr. No.	Treatments	Total cost of cultivation (Rs. ha^{-1})	Net seasonal income (Rs. ha^{-1})	Total net income (Rs. ha^{-1})	Net extra income over control (Rs.ha^{-1})
T_1	100% fertigation	45920	61733	111305	54200
T_2	100% fertigation with foliar sprays	47140	66022	119038	61933
T_3	80% fertigation	43934	60792	109608	52503
T_4	60% fertigation	41948	52277	94255	37149
T_5	100% N and K fertigation	41340	59505	107287	50182
T_6	100% CF under DI	41340	58048	104661	47556
T_7	No fertilizer under DI	35991	11681	21061	-36044
T_8	100% CF under SI	33000	57105	57105	0
T_9	100% CF with foliar sprays under SI	34220	62135	62135	5029

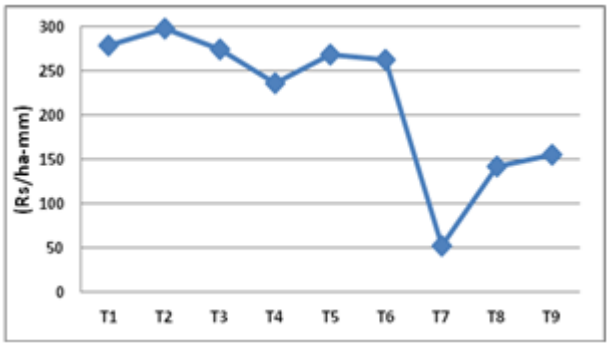

Figure 1: Water productivity

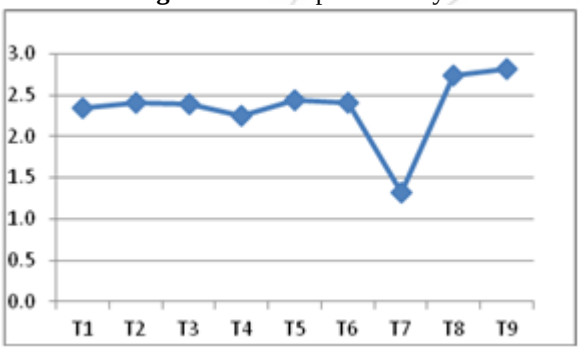

Figure 2: B: C ratio

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