Water Productivity and Water Use Pattern in Bed Planted Wheat (*Triticum aestivum* L.) under Varying Irrigation Schedules

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A B S T R A C T

Field study was conducted at Crop Research Centre of Sardar Vallabhbhai Patel University of Agri. & Tech. Meerut, Uttar Pradesh during 2014-15 and 2015-16 in a split plot design having three replications. Six land configuration systems 75 cm bed, 2 rows(B_{75-2}); 75 cm bed, 3 rows (B_{75-3}); 90 cm bed, 2 rows (B_{90-2}); 90 cm bed, 3rows (B_{90-3}), 90 cm bed, 4 rows (B_{90-4}); Flat planting , rows 22.5 cm apart were laid out in main plots whereas the subplots were three irrigation schedule practices such as 4 cm irrigation at IW/CPE 0.8; 5 cm irrigation at IW/CPE 1.0; 6 cm irrigation at IW/CPE 1.2. The objective of the study was to examine the treatment effects on water productivity, yield and profitability of wheat crop. Results showed that the grain yield (46.52; 47.63 and 44.01 and 44.88 q ha^{-1}), were significantly higher in B_{90-4} and 4cm irrigation at IW/CPE 0.8 during both the year of study. Physiological traits, yield attributes and yields were significantly influenced by land configuration and irrigation practices. In land configuration systems, B_{90-4} and 4 cm irrigation at IW/CPE 1.2 displayed significantly higher water use efficiency (2.53; 2.51 and 2.19; 2.18 kg m^{-3}) compared with other treatments. However irrigation schedules × land configuration interaction was significant for yield attributes grain, straw and biological yield. The higher net return of Rs. 57805 and Rs. 61363ha^{-1} and B: C ratio 2.08 and 2.14registered in B_{90-4} treatment. As well as irrigation schedule with IW/CPE 0.8recorded more net return Rs.53762 and Rs. 57059 ha^{-1} and B: C ratio 1.89 and 1.94than other treatments. The crop planted on 90 cm beds with 4 rows on the top of the bed and IW/CPE 0.8 is important in the *Typic Ustochrept* soil to achieve sustainable increase in wheat production to meet future demand while conserving natural resources, especially irrigation water and reducing the negative effects on the environment.

Introduction

Wheat (*Triticum aestivum* L.) is the first important and strategic *rabi* cereal crop for food security of India. The share of water to agriculture will further reduce to about 72 to 75% by 2050. About 75 to 85% water requirement of wheat in the north-western plain zone is met through irrigation. Minimizing non-beneficial ET through

efficient technologies and strategies, will greatly enhance the water productivity. The main reasons for its productivity are poor crop establishment and improper scheduling of irrigation. Amongst the other agronomic practices proper crop establishment method may considerably increase the production of wheat up to some extent. Ideal planting geometry is important for better and efficient utilization of plant growth resources get the optimum productivity of wheat. It is also well know fact that water management is one of the major factors responsible for achieving better harvest in crop production. Both crop establishment method and irrigation schedule are major causes of yield reduction in wheat, which also affect its water use efficiency. Farmers are always interested in getting higher yield which could not be possible without better crop management, good stand establishment and optimum utilization of resources. Crop production is influenced by its establishment and plant vigour representing the key factors towards crop development (Amanullah *et al.,* 2009). Planting wheat on beds (FIRBS) is a novel technique to save water and enhancing the productivity of other input applied. Typical irrigation savings under FIRBS ranged from 18 to 35% in wheat (Hobbs and Gupta, 2003) with higher yield. Other advantages of FIRBS of wheat planting are less lodging, more efficient utilization of applied nutrients, and temperature moderation (Sayre and Moreno 1997), less weed competition (Kumar *et al.,* 2014) and higher N, P and K uptake. Water table in many areas had risen to near the soil surface which contributes substantially towards crop ET and so the irrigation requirements can be considerably reduced. Wheat crop met its entire water requirement from the shallow (0.5 m) ground water table (Kahlown *et al.,* 2005). Earlier Jhorar *et al.,* (1991) observed that shallow water table (~ 1 m) can supply as much as 50 to 60 percent of water requirement of the crops. Thus, there is potential for

improvements in irrigation water use efficiency in areas where shallow water tables are a low salinity risk. Under such situations the irrigation schedule is likely to be different than the normal conditions. Proper scheduling of irrigation to crops is an important component of water saving technologies. Therefore, it becomes imperative to find out appropriate irrigation schedule for exploiting yield potential. This study was done to estimate the irrigation requirements, components of temporal water use and water productivity of bed planted wheat under shallow water table condition.

To increase the water productivity of wheat, CYMMIT introduced a planting pattern termed as furrow irrigated raised bed planting system in Mexico. The adoption of the system rose from 6% of farmers in 1981 to 75% in 1994 in high-yielding irrigated wheat-growing areas of northwestern Mexico (Sayre and Hobbs 2004). In this system, the crop is planted on the top of beds and irrigation water is applied in furrows. The width of the bed and furrows commonly used are 40–45 and 25–30 cm, respectively, and the bed height is 15 cm–20 cm. Inspired by the success of irrigated maize–wheat on permanent raised beds in Mexico, furrow irrigated raised bed planting system was introduced in Indo-Gangetic Plains in the mid-1990s for wheat (Sayre and Hobbs, 2004). Even after 2 decades of its introduction and promotion, a few farmers preferred bed planting over the conventional flat planting system. This was mainly due to lack of yield advantage in furrow irrigated raised bed planting system over flat planting system. Farmers can easily respond to this technology if efforts are diverted to demonstrate yield differences between flat and bed planting systems either by modifying bed configuration or crop rows planted on the top of the bed or selection of suitable cultivars. Keeping in view the above points, a study was conducted to compare crop establishment

method especially in different bed size configurations and rows planted on the top of the bed with flat planting in wheat. Different crop establishment method were assessed for wheat productivity and water saving.

Materials and Methods

Field experiment was conducted during winter (*rabi*) seasons of 2014-15 and 2015-16 at Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U.P., India. (29º 13' 96" N, 77º 68' 43'" E a height of 237m above mean sea level) having shallow water table. The soil was sandy loam in texture and has a basic infiltration rate of 5.3 mm h^{-1}. It contained 20.9 and 6.5% moisture on weight basis at -0.03 and -1.5 MPa, respectively. Six crop establishment methods75 cm bed, 2 rows (B_{75-2}); 75 cm bed, 3 rows(B_{75-3}); 90 cm bed, 2 rows (B_{90-2}); 90 cm bed, 3rows (B_{90-3}), 90 cm bed, 4 rows (B_{90-4}); Flat planting, rows 22.5 cm apart in main plots and three irrigation schedule practices were 4 cm irrigation at IW/CPE 0.8; 5 cm irrigation at IW/CPE 1.0; 6 cm irrigation at IW/CPE 1.2 allotted to sub-plots in a split-plot design and replicated thrice were studied on the same field during both the years. After applying pre-sown irrigation, wheat cv. DBW-17 was planted on 16 and 20 November in the respective years. Under FIRBS, the dimension of the raised beds were 45 and 60 cm wide (top of the bed) x 18 cm height x 30 cm furrow width(at top) and the spacing from center of the furrow to another center of the furrow was kept at 75 and 90 cm. In furrow irrigated raised bed planting system, the crop was planted on the top of beds in bed configurations of 45 cm bed and 60 cm bed wheat sown with bed planter. The furrows were about 20 cm deep. The conventional plots were sown by drill keeping 22.5cm row spacing. All other practices were followed as per recommendations. Meteorological observatory data located at the Indian Institute

of Farming System Research, Modipuram, Meerut (Uttar Pradesh) was used to calculate the CPE. During 2014-15 crop season, 203.3 mm well distributed rainfall was received with a total pan evaporation of 77.7mm. Whereas, 2015-16 was a dry season with only 22.4 mm rainfall and 86.7 mm pan evaporation.

Irrigation through tube-well of discharge 8 litre/second was given to each plot and measured with the help of Parshall flume. For moisture depletion pattern (cm) of soil samples were taken from 0–15, 15–30, 30–60 and 60–90 cm soil depths with screw auger before and after each irrigation and also at sowing and harvesting of the crop. Fresh weight of soil was recorded and then these soil samples were dried in oven at 105°C till the constant dry weight. Moisture percentage was calculated by using the formula.

$$\text{Moisture (\%)} = \frac{\text{Fresh weight of soil–dry weight of soil}}{\text{Dry weight of soil}} \times 100$$

The moisture depletion pattern computed using the formula as suggested by Dastane (1967) and water-use efficiency by Singh *et al.,* (1960). Water productivity (WP_{I+R}) (kg m^{-3}) was computed as follows (Humphreys *et al.,* 2008).

$$\text{Water Productivity (kgm}^{-3}) = \frac{\text{Grain yield}}{\text{Total water applied to the field (I+R)}}$$

The total amount of water (input water) applied was computed as the sum of water received through irrigation (I) and rainfall (R).Rainfall data was recorded using a rain gauge installed within the meteorological station.

Grain yield was determined at maturity and the cost of cultivation of wheat was worked out. Cost of labour, tractor for tillage and

sowing, weeding, fertilizer application, harvesting and threshing were calculated as per prevailing market rates during the period of experimentation. Gross return was worked out at the prevailing market prices. Benefit: cost ratio was calculated dividing net returns by the cost of cultivation of individual treatment.

Results and Discussion

Moisture depletion pattern

The data on soil profile moisture extraction pattern of wheat crop under different irrigation levels and tillage practices treatments is shown in (Table 1). The soil profile was divided in four layers (0-15, 15-30, 30-60 and 60-90 cm) and the maximum amount of water was extracted (absorbed) from 0-15 cm layer followed by 15-30 cm and 30-60 cm. However, minimum water was extracted from 60-90 cm during both the year of study. The moisture extraction from the surface layer (0-15 cm) was increased slightly with increase in irrigation frequency during both the year of study (Kingra and Mahey, 2013 and Singh *et al.,* 2015).

The land configuration furrow irrigated raised beds plots stored more moisture from the deeper profile layer than flat planting practice and vice-versa during both the year of study. The highest total moisture depletion (15.0 and 15.4 cm)from each layer was observed under flat method of sowing as compare to other land configuration methods, B_{75-2}, B_{75-3}, B_{90-2}, B_{90-3}, and B_{90-4} due to more availability of moisture in rhizospher. The amount of moisture depleted decreased with the soil depth due to lower density of roots in deeper layer compared with the upper layer. Due to increased surface evaporation the percentage contribution of upper 30 cm layer was more. The highest moisture depletion under the flat method might be due to less availability of moisture at upper layer and more evaporation from upper surface. These results confirmed the findings of Maurya and Singh (2008).

Maximum total depletion (15.2 and 15.6 cm) occurred with the application of IW: CPE 0.8 during each year of experiment. Upper soil layer (0– 15 and 15–30 cm) contributed about 62 % while the deeper layer (30–60 and 60–90 cm) accounted 38 % of the total moisture depletion. The per cent contribution from the deeper layer was comparatively more under IW: CPE 0.8 than the IW: CPE 1.0 and IW: CPE 1.2 because under moisture stress condition roots penetrate to deeper layer of the soil to meet to their water requirement.

Yield attributes and yield

Data on yields attributing characters viz. number spike, number of grains spike[-1], test weight and yield as influenced by land configuration and different irrigation schedules are presented in (Table 2). The number of spike, number of grains spike[-1], and test weight higher with B_{90-2} as compare to remaining treatments during the year of study. The number of grains pike[-1] was higher in 90 cm than 75 cm beds and flat planting. The irrigation scheduling 4 cm irrigation at IW/CPE 0.8 recorded significantly values for all the above yield attributes as compare to other irrigation schedules. Stimulated vegetative growth of wheat on account of adequate and prolonged supply of water in treatment manifested itself in increased number of spike, number of grains spike[-1], and test weight (Jat and Singh, 2003; Maurya and Singh, 2008). The magnitude of increase in spike length due to improvement in moisture supply by irrigation with furrow irrigated raised beds was observed under IW/CPE 0.8 irrigation schedules with B_{90-2} land configuration as compared to other treatments combination during 2014-15 and 2015-16, respectively. The present result corroborated

the earlier findings of Jat and singh (2003), Maurya and singh (2008). The grain (46.52, 47.63 q ha^{-1}), significantly higher (Table 2) were recorded with B_{90-4} land configuration the as compared to all other treatments during experimentation. The grain yield increased 11.00 and 12.02 %, with B_{90-4} land configuration over flat planting during first and second year, respectively. Treatments B_{75-4} and flat planting were at par with each other during both the year of study. However, B_{90-2} was recorded the lowest grain yield during both the year of study.

The results have clearly shown that the grain yield in land configurations B_{75-2}, B_{75-3}, B_{90-2} and B_{90-3} was lower than that in flat planting due to low plant density, but the yield was higher in B_{90-4} than flat planting. The irrigation schedules having good tillering and higher rates of photosynthesis, had high biomass production and therefore was more suited for furrow irrigated raised bed planting system than flat planting.

Among the irrigation schedules IW/CPE 0.8 and IW/CPE 1.0 produced higher number of spikes than IW/CPE 1.2. The significantly higher grain yield was obtained in IW/CPE 0.8 irrigation schedules and increased the grain yield 17.27 and 17.02 % over IW/CPE1.2.

Interaction effects between irrigation schedules and land configuration in relation to number of spikes, number of grains spike^{-1}, and grain yield were significant (Table 2). The magnitude of increase in spike length due to improvement in moisture supply by irrigation with furrow irrigated raised beds was observed under IW/CPE 0.8 irrigation schedules with B_{90-2} land configuration as compared to other treatments combination during 2014-15 and 2015-16, respectively. Higher grain yield with bed planting of wheat has been also reported by Bhahma *et al.,* (2007), Kumar (2010), Thind *et al.,* (2010), Singh and Katiyar (2014).

Consumptive use

The consumptive use of water (23.0 and 23.8 cm) was more under flat method (Table 3) followed by the B_{75-2}, B_{75-3}, B_{90-2}, B_{90-3} and lowest value of consumptive use was recorded under B_{90-4} land configuration. The consumptive use of water directly related with moisture depletion and it was higher under flat method and lowest under bed B_{90-4} land configuration. During 2015-16 total consumptive use of water was more than 2014-15. The consumptive use of water directly related with moisture depletion and it was higher under flat method and lowest under B_{90-4} land configuration. So, consumptive use of water was also in the order of moisture depletion. During first year total consumptive use of water was more than the second year mainly due to the differences in weather conditions, such as hot and dry wind and lesser number of rainy day use of water (17.2 and 17.6 cm) was under the irrigation schedule of IW: CPE1.2 due to combination of higher surface evaporation and more transpiration so that moisture stresses condition occurs. Similar results reported by Ahamad (2002), Maurya and singh (2008).

The consumptive use of water showed an increasing trend with increase in irrigation water during both the years. The highest consumptive use was recorded with irrigation schedule of IW: CPE 0.8. This was mainly due to fact that the greater loss of applied water through evapotranspiration because of more availability of water resulted into better foliage and ultimately better plant growth. As a result of this was greater absorption of moisture by crop favored by highest water use at wettest regime. In contrast, the lowest consumptive use of water (17.6 and 17.2 cm) was under the irrigation schedule of IW: CPE 1.2 due to combination of lower surface evaporation and reduced transpiration under less moisture availability.

Table.1 Effect of land configuration and irrigation schedules on moisture depletion pattern

Treatment	Depth of soil (cm)								Total Moisture Depletion (cm)	
	0-15		15-30		30-60		60-90			
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Land conturation										
75 cm bed, 2 rows	4.2	4.4	4.0	4.1	3.4	3.5	2.6	2.6	14.2	14.5
75 cm bed, 3 rows	3.9	4.1	4.0	3.9	3.2	3.3	2.6	2.6	13.6	13.9
90 cm bed, 2 rows	3.8	3.9	3.7	3.8	1.9	2.0	2.0	2.0	11.3	11.7
90 cm bed, 3 rows	3.8	3.8	3.4	3.5	2.0	2.1	2.0	2.0	11.2	11.5
90 cm bed, 4 rows	3.6	3.7	3.3	3.4	1.9	1.9	1.7	1.7	10.4	10.7
Flat planting	4.1	4.2	4.2	4.2	3.4	3.5	3.4	3.5	15.0	15.4
Irrigation schedules										
4 cm irrigation at IW/CPE 0.8	4.4	4.6	4.2	4.3	3.4	3.4	3.2	3.3	15.2	15.6
5cm irrigation at IW/CPE 1.0	4.1	4.2	3.9	4.0	3.0	3.0	2.6	2.7	13.5	13.9
6 cm irrigation at IW/CPE 1.2	3.2	3.3	3.1	3.1	1.6	1.7	1.2	1.3	9.1	9.4

Table.2 Effect of land configuration and irrigation schedules on yield attributes and yield

Treatment	Number of spike (m^{-1}) row length		No. of grains spike^{-1}		Test weight (g)		Grain yield (q ha^{-1})	
	2014-15	2014-15	2014-15	2014-15	2015-16	2015-16	2014-15	2015-16
Land configuration								
75 cm bed, 2 rows	115	118	54.7	56.8	43.46	43.80	39.33	40.18
75 cm bed, 3 rows	97	100	51.0	53.0	41.40	41.67	40.28	41.39
90 cm bed, 2 rows	134	140	55.9	58.6	44.15	44.67	37.80	38.57
90 cm bed, 3 rows	128	133	55.4	57.8	44.01	44.41	43.06	44.12
90 cm bed, 4 rows	110	115	52.8	54.4	43.51	43.87	46.52	47.63
Flat planting	81	84	50.0	52.3	42.74	42.95	41.92	42.52
SEm(±)	*2.03*	*1.96*	*0.35*	*0.45*	*0.14*	*0.15*	*0.57*	*0.54*
C.D. (P=0.05)	*6.40*	*6.16*	*1.11*	*1.41*	*0.45*	*0.46*	*1.79*	*1.70*
Irrigation schedules								
4 cm irrigation at IW/CPE 0.8	119	123	55.0	57.7	44.17	44.58	44.01	44.88
5 cm irrigation at IW/CPE 1.0	112	117	53.0	55.4	43.72	43.23	42.92	43.97
6 cm irrigation at IW/CPE 1.2	101	105	46.8	47.9	40.75	40.87	37.53	38.35
SEm(±)	*0.73*	*0.76*	*0.20*	*0.20*	*0.10*	*0.12*	*0.18*	*0.18*
C.D. (P=0.05)	*2.14*	*2.22*	*0.57*	*0.58*	*0.29*	*0.34*	*0.51*	*0.53*
Interaction I × B	Sig	Sig	Sig	Sig	NS	NS	44.01	44.88

Table.3 Effect of land configuration and irrigation schedules on consumptive use and water-use efficiency

Treatment	Consumptive Use (cm)		Water use efficiency (kg m^{-3})	
	2014-15	2015-16	2014-15	2015-16
Land configuration				
75 cm bed, 2 rows	22.2	22.8	1.77	1.76
75 cm bed, 3 rows	21.6	22.1	1.86	1.87
90 cm bed, 2 rows	19.3	20.0	1.96	1.93
90 cm bed, 3 rows	19.2	19.7	2.24	2.24
90 cm bed, 4 rows	18.4	19.0	2.53	2.51
Flat planting	23.0	23.6	1.82	1.80
Irrigation schedules				
4 cm irrigation at IW/CPE 0.8	23.2	23.8	1.90	1.88
5 cm irrigation at IW/CPE 1.0	21.5	22.1	1.99	1.99
6 cm irrigation at IW/CPE 1.2	17.2	17.6	2.19	2.18

Consumptive use by the crop includes total soil moisture depletion (cm) and soil moisture contributes

Table.4 Effect of land configuration and irrigation schedules on water productivity

Treatment	Total water applied (cm)		Water Productivity (kg m^{-3})	
	2014-15	2015-16	2014-15	2015-16
Land configuration				
75 cm bed, 2 rows	19	16	2.07	2.51
75 cm bed, 3 rows	19	16	2.12	2.59
90 cm bed, 2 rows	19	16	1.99	2.41
90 cm bed, 3 rows	19	16	2.27	2.76
90 cm bed, 4 rows	19	16	2.45	2.98
Flat planting	19	16	2.21	2.66
Irrigation scheduling				
4 cm irrigation at IW/CPE 0.8	21	16	2.10	2.81
5 cm irrigation at IW/CPE 1.0	20	15	2.15	2.93
6 cm irrigation at IW/CPE 1.2	17	18	2.21	2.13

Total water used by the crop includes applied irrigation and effective rainfall

Table.5 Economics of the treatments

Treatment	Cost of cultivation (Rs. ha^{-1})		Gross income (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Land configuration								
75 cm bed, 2 rows	28520	29343	73628	78008	45108	48065	1.58	1.64
75 cm bed, 3 rows	28520	29343	75347	80036	46827	50093	1.64	1.71
90 cm bed, 2 rows	27820	28643	71199	75303	43379	46060	1.56	1.61
90 cm bed, 3 rows	27820	28643	79774	84390	51954	55147	1.87	1.93
90 cm bed, 4 rows	27820	28643	85625	90606	57805	61363	2.08	2.14
Flat planting	28740	29630	77590	81727	49950	52764	1.74	1.78
Irrigation schedules								
4 cm irrigation at IW/CPE 0.8	28490	29380	81485	86055	53762	57059	1.89	1.94
5 cm irrigation at IW/CPE 1.0	28206	28930	79775	84571	51752	55075	1.83	1.90
6 cm irrigation at IW/CPE 1.2	27923	28813	70331	74445	42008	44649	1.50	1.55

Irrigation schedule of 4 cm irrigation IW: CPE 0.8 in contrast, the lowest consumptive.

Water-use efficiency

It is evident from the data (Table 3) that highest water use efficiency was recorded (2.53 and 2.51kg m^{-3}) under B$_{90-4}$ land configuration over flat planting method (B$_6$) during both the year of study. Treatment B$_{90-4}$ increased 39.01and 39.44%over flat method during 2014-15 and 2015-16, respectively. This might be due to higher grain yield obtained under B$_{90-4}$ land configuration with lesser amount of water used. Declined water-use efficiency (WUE) under flat method with IW: CPE 0.8 might be due to fact that grain yield did not increase proportionately to that of consumptive use under this treatment.

An examination of data (Table 3) clearly indicates that water-use efficiency decreased with increase in levels of irrigation during both the years. Maximum value of WUE, 2.19 and 2.18kgm^{-3}, were noted in IW: CPE 1.2 during first and second years respectively. It increased 15.2 and 16.0% over IW: CPE 0.8 during first and second year, respectively. However minimum water-use efficiency was under IW: CPE 0.8 during both the years. Decrease in WUE with IW: CPE 0.8 based on the fact that the proportionate increase in grain yield was less than increase in the consumptive use of water (Singh and katiyar 2014; and Singh *et al.,* 2015).

Water productivity

Maximum water productivity was registered (2.45 and 2.98 kg m^{-3}) under B$_{90-4}$ land configuration, followed by B$_{90-3}$> flat, B$_{75-3}$>B$_{75-2}$>B$_{90-2}$, treatments during both the years. Higher water productivity (2.21kg m^{-3}) was affected by irrigation schedule of IW: CPE 1.2 during 2014-15, but during 2015-16

higher water productivity (2.93 kg m^{-3}) was observed under IW/CPE 1.0. Increase in water productivity (Table 4) with IW: CPE 1.2 based on the fact that the proportionate increase in grain yield with lesser number of irrigations during experimentation (Kumar 2010; Singh *et al.,* 2015).

In general, water productivity affected by irrigation schedules the higher water productivity observed with IW: CPE 0.8 during both the year of study. However minimum water productivity was observed in IW: CPE 1.2. Decrease in water productivity with IW: CPE 1.2.

Economics

Grain and straw yield were major outputs, which cause differences in net return (Table 5). The crop gave highest gross return of (85625 and 90606 Rs.ha^{-1}), net income (57805 and 61363Rs.ha^{-1}) and benefit cost ratio (2.08 and 2.14) were recorded with 90 cm bed, 4 rows (B$_{90-4}$) land configuration (Table 5). In case irrigation schedules, the maximum gross income (Rs. 81485 and 86055 ha-1), and net income (53762 and 57059 Rs. ha^{-1}) and benefit: cost ratio (1.89 and 1.94) was recorded with IW/CPE 0.8 treatment followed by IW/CPE 1.0 in both the years. This might be due to higher productivity of the wheat crop. These results are in conformity with the findings of Kumar *et al.,* (2013) Naresh *et al.,* (2013). This was due to the proportionately higher in output in comparison to almost similar input. Thus economically the 90 cm bed, 4 rows (B$_{90-4}$) land configuration and 4 cm irrigation at 0.8 IW/CPE proved superior over all the treatments combination under present investigation

From the present investigation, it could be concluded that water productivity, water use

efficiency and yield of wheat affects significantly with the land configuration and irrigation schedule. The land configuration and irrigation schedule performed consistently better results in B_{90-4} and IW/CPE 0.8 obtained higher water productivity, water use efficiency and grain yield, gross return and net return with B: C ratio during experimentation. However, yield advantage in furrow irrigated raised bed planting system over flat planting system. Farmers can easily respond to this technology if efforts are diverted to demonstrate yield differences between flat and bed planting systems either by modifying land configuration or crop rows planted on the top of the beds or selection of suitable irrigation schedule.

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