RESPONSE OF WHEAT (*TRITICUM AESTIVUM*) CULTIVARS TO IRRIGATION SCHEDULING AND DATES OF SOWING ON YIELD AND ECONOMICS

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1. Abstract

A field experiment was conducted under loamy sand soil during *Rabi* seasons of 2023-24 at Research Farm, Vivekananda Global University, Jagatpura, Jaipur. The experiment comprises four irrigation scheduling treatments (Irrigation at 0.6 ETc, 0.8 ETc, 1.0 ETc and 1.2 ETc), three cultivars (Raj 4120, Raj 4079 and Raj 4238) and three dates of sowing (15^{th} November, 30^{th} November and 15^{th} December) assigned, respectively to main plot, sub plot and sub-sub plots were replicated three times in split plot design. Results revealed that highest grain yield, net return and B:C ratio of wheat recorded by treatment I_4 (Irrigation at 1.2 ETc) with cultivar Raj 4079 under crop sown on 15^{th} November in study year. Harvest index of wheat cultivars were not significantly influenced due to different irrigation scheduling and sowing dates.

2. Introduction

Wheat [*Triticum aestivum* (L.) emend.Fiori & Paol)] is grown all over the world for its wider adaptability and high nutritive value than any other food crop. Currently it is grown on an area of about 224.82 million hectares and production of about 784.91 million tonnes with productivity of 3.26 tonnes per hectare (Anonymous, 2023). Since 1960, world production of wheat and other grain crops has tripled and is expected to grow further through the middle of the 21^{st} century. It is occupying 17 per cent of crop acreage worldwide, feeding about 40 per cent of the world population and good supplement for nutritional requirement of human body as it contains 12.60 per cent protein and 78.10 per cent carbohydrate (Kumar *et. al*., 2011). Global demand of wheat is increasing due to the unique viscoelastic and adhesive properties of gluten proteins, which facilitate the production of processed foods, whose consumption is increasing as a result of the worldwide industrialization process and the westernization of the diet. India has the largest area under wheat cultivation (30.4 million hectares), but ranks second in production (99.70 million tonnes) after China with the average productivity of 3279 kg ha^{-1} (ICAR-IIWBR, 2018). It is cultivated mainly in the states of Uttar Pradesh, Madhya Pradesh, Punjab, Rajasthan, Haryana, Bihar, Gujarat and Maharashtra. Among the different states of India, Uttar Pradesh rank first in both area and production, while Punjab ranks first in productivity. In Rajasthan, the crop occupies an area of 2.96 million hectares and production of 11.35 million tonnes with an average productivity of 3831 kg ha^{-1} (Anonymous, 2023).

3. Material and Methods

The field experiment was conducted during *Rabi* season 2023 at Research farm, Vivekananda Global University, Jagatpura, Jaipur, Rajasthan (75° 47' East longitudes, 26° 51' North latitude and at altitude of 390 m above mean sea level). The soil of experimental field was loamy sand in texture, slightly alkaline in reaction containing 0.25% organic C, with *p*H 8.2, EC 0.15ds m^{-1}, available nitrogen 136.5 kg ha^{-1}, phosphorous 33.30 kg ha^{-1} and potassium 195.45 kg ha^{-1}. The meteorological data was recorded daily from sowing to harvest from meteorological observatory situated near the experimental farm. The experimental site characterized by aridity of the atmosphere and extremity of temperature both in summer (45.5°C) and winter (4°C). Under semi-arid climatic conditions, the area receives 500-700 mm per annum rainfall which is mostly occurring during July to September. Rainfall received during the wheat growing season (Nov. to April) was 22.9 mm. The mean monthly maximum and minimum temperatures during the wheat growing season (Nov. to April) varied from 21.55 to 38.32 and 6.05 to 23.25°C, respectively. The cumulative bright sunshine hours during the growing season varied between 6.70 to 10.05 hrs. The experiment was laid out in Split plot design with three replications. Thirty six treatment combinations were investigated. Treatments comprises four irrigation levels: I_1 (0.6 ETc), I_2 (0.8 ETc), I_3 (1.0 ETc) and I_4 (1.2 ETc), three cultivars: C_1 (Raj-

4120), C_2 (Raj-4079) and C_3 (Raj-4238) and three dates of sowing: D_1 (15^{th} Nov.), D_2 (30^{th} Nov.) and D_3 (15^{th} Dec.). In the recommended irrigation treatments applied at different irrigation intervals according to ET_C level with the help of water meter. Standard crop production practice and methods were followed for weeding, fertilizer application and crop protection management to grow the crop. Crop was harvested manually in the end week of March and First week of April when 80% of the grains turned to golden colour. Grain and biological yield were recorded at the harvest. Least significant difference at 0.05% level of probability was used to test the significance of differences among treatment means. In the recommended irrigation treatments applied at different irrigation intervals according to ET_C level with the help of water meter. Standard crop production practice and methods were followed for weeding, fertilizer application and crop protection management to grow the crop. Five plants were selected randomly from each plot and tagged permanently.

3.1 Grain yield (kg/ha)

The dried plant from each plot was threshed manually and winnowed. The clean seed obtained from individual plot were weighed and the weight recorded as grain yield in kg/ha.

3.2 Straw yield (kg/ha)

Straw yield was obtained by subtracting the grain yield from biological yield. The grain and straw yield recorded under each plot were converted into kg/ha.

3.3 Biological yield (kg/ha)

After complete sun drying, harvested bundles of each net plot were weighed for biological yield and converted in kg/ha.

3.4 Harvest index

The ratio of economic yield (grain yield) to the biological yield was worked out and expressed in percentage (Donald and Hamblin, 1976).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \text{ X } 100$$

3.5 Net returns

In order to evaluate the effectiveness of different treatments and ascertain the most remunerative treatment, total expenses incurred on cultural operations from preparatory tillage to harvesting including additional treatment cost for each treatment were computed and subtracted from the respective gross income to workout net monetary returns ha^{-1}. Gross income was computed taking prevailing market prices of the commodities. Thus, net returns were computed as.

Net returns = Gross returns – Total cost of cultivation

3.6 Benefit: Cost ratio

This was calculated for each treatment by dividing net return with cost of cultivation. The computation details of economics for each treatment are given in appendices at the end. B: C ratio is computed using formula

$$\text{B:C ratio} = \frac{\text{Gross returns (₹ ha}^{-1})}{\text{Cost of cultivation (₹ ha}^{-1})}$$

4. Results and Discussion

4.1 Effect on yield

Results depicted in table 4.1 showed that the irrigation scheduling, cultivars and date of sowing had a significant impact on yield of wheat. Results revealed that the highest yield of wheat in term of grain, straw and biological yield recorded under irrigation treatment I_4 (Etc 1.2) with the respective values (5178, 6139 and 11317 kg ha^{-1}), respectively. The above treatment found similar to irrigation treatment I_3 (Etc 1.0). Increment in yield due to availability of sufficient moisture in the soil profile under I_4 irrigation schedule, plant nutrients particularly nitrogen, phosphorus and potassium were more available and might have translocated to produce more dry matter. Secondly, higher yield with higher levels of irrigation might be due to its key role in root development by reducing mechanical resistance of soil, higher transpiration, greater nutrient uptake and more photosynthesis due to metabolic activities in plant (Bhunia *et al*., 2006). The other reason of yield increase might be that

irrigation scheduling at 1.2 ETc and 1.0 ETc throughout growth and reproductive phase created longer reproductive period with larger photosynthetic surface and reproductive storage capacity to attain higher allocation of net photosynthates to grain yield. The results obtained by (Sharma and Pannu, 2008; Sarwar *et al*., 2010; Kumar *et al*., 2015; and Mishra and Kushwaha, 2016) also confirm the findings of present investigation.
Further data analyzed on the cultivars of wheat and found that the cultivar Raj 4079 attain the maximum yield (5012, 6123 and 11135 kg ha^{-1}) for grain, straw and biological yield, respectively. This recorded at par with Raj 4238. Wheat yield is a complex process and governed by interaction between source (photosynthesis and availability of assimilates) and sink component (storage organs). Thus, as a consequence of marked improvement in both these regulative process as evidenced from higher accumulation of biomass and nutrients as well as yield components under variety Raj 4079 led to significant increase in grain yield. Further, the grain yield of wheat is dependent on two most important components namely spikes per unit area and weight of grains (test weight). Thus, due to more number of grains by virtue of increased number of spikes and more test weight under Raj 4079, increased the grain yield over Raj 4238 and Raj 4120, and remained at par with variety Raj 4238. Since, biological yield is a sum of grain and straw yield produced by the crop, the increased grain yield under Raj 4079 might have resulted in higher biological yield in this variety. The marked variation in various yield components and yield between varieties was observed by (Sardana, 2001 and Singh *et al*., 2007).
Data presented on date of sowing in table 4.1 showed that the crop sown on 15th November obtained maximum yield grain, straw and biological yield with due respective values 5232, 6220 and 11452 kg ha^{-1}, respectively. This was statistically at par with sowing on 30th November sown crop. This might be due to cumulative effect of poor expression of vegetative growth and yield contributing characters i.e. number of spikes, ear length, grains $spike^{-1}$ and test weight under late sown conditions accompanied with high temperature and hot winds which leads toward forced maturity of the crop and ultimately resulted in lower grain , straw and biological yield. The early sown crop, on the other hand, having favorable cool weather conditions for longer duration recorded better growth and yield attributes resulted in greater productivity Kulhari *et al.*, (2003). Similar results have also been reported by (Jat *et al*., 2013; Tomar *et al*., 2014; Mumtaz *et al*., 2015 and Marasini *et al*., 2016).

4.2 Effect on economics

Results revealed that the net return and benefit: cost ratio was influenced by irrigation management practices during study year (Table 4.1). The maximum net return (77782 $Rs.ha^{-1}$) recorded with irrigation treatment I_4 (Irrigation at 1.2 ETc) which found at par with the treatment I_3 (Irrigation at 1.0 ETc).. Further data revealed that benefit: cost ratio (2.74) was recorded with irrigation treatment I_3 (Irrigation at 1.0 ETc) followed by treatment I_4 (irrigation at 1.2 ETc) and I_2 (irrigation at 0.8 ETc). These results are in closed conformity with the findings of (Kumar *et al.*, 2013).
Varieties exhibited differences in their economics and the highest net return and benefit cost ratio was obtained in Raj 4079 followed by Raj 4238 and Raj 4120, respectively (Table 4.1). These findings are similar to that of (Shirpurkar *et al.*, 2008; Mumtaz *et al.*, 2015). Further, results found that the highest net return and benefit cost ratio obtained in the crop sown on 15th November followed by the crop sown on 30th November and 15th December, respectively. It was due to significantly higher grain and straw yield on 15th November sown crop than the crop sown on 15th December, which resulted in higher net return and benefit cost: ratio. Similar results have been reported earlier by (Singh *et al.*, 2010; Hussain *et al.*, 2015).

Conclusion

Based on the finding of the present investigation concluded recommended that wheat varieties Raj 4079 should be sown on 15th November with irrigation scheduling at 1.0 ETc and under late sown conditions the variety Raj 4238 performed better under the semi-arid agro-climatic conditions of Jaipur.

Table: 1. Effect of irrigation scheduling, cultivars and varying sowing dates on yield and economics of wheat

Treatment	Grain yield	Straw yield	Biological yield	Harvest index	Net returns	B:C ratio
Irrigation scheduling						
I_1 (Etc 0.6)	3466	4020	7486	46.49	43176	2.10
I_2 (Etc 0.8)	4630	5588	10217	45.43	69696	2.67
I_3 (Etc 1.0)	5024	6016	11040	45.7	76667	2.74
I_4 (Etc 1.2)	5178	6139	11317	45.97	77782	2.68
SEm±	74	87	138	0.77	2236	
CD(P= 0.05)	255	300	478	NS	7737	
Cultivars						
V_1 (Raj 4120)	3817	4178	7995	47.71	46877	2.08
V_2 (Raj 4079)	5012	6123	11135	44.95	78122	2.81
V_3 (Raj 4238)	4894	6022	10916	45.03	75491	2.75
SEm±	60	58	104	0.66	1656	
CD(P= 0.05)	180	173	311	NS	4966	
Date of sowing						
D_1 (15^{th} NOV.)	5232	6220	11452	45.91	82106	2.89
D_2 (30^{th} NOV.)	4813	5784	10597	45.72	72713	2.69
D_3 (15^{th} DEC.)	3678	4318	7996	46.07	45671	2.07
SEm±	41	37	80	0.61	1359	
CD(P= 0.05)	117	105	228	NS	3864	

NS: Non Significant

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