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Research Article

PRODUCTIVITY OF BED PLANTED WHEAT AS INFLUENCED BY IRRIGATION AND FERTILIZER LEVELS

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Abstract: A field experiment was conducted at Research Farm of CCS Haryana Agricultural University, Hisar to study the response of irrigation, nitrogen and phosphorus levels on economics and water productivity of timely sown bed planted wheat. The experiment consisted of sixteen treatment combinations of four levels of irrigation (Two, three, four and five irrigations in main plots) and four fertilizer levels (80, 90, 100 and 110 percent of recommended N and P *i.e.*, 150 kg N and 60 kg P_2O_5/ha) in sub-plots, laid out in split-plot design with three replications. The results showed that among the irrigation levels highest grain yield (5022 kg/ha), straw yield (8578 kg/ha), harvest index (36.9%) and B:C ratio (2.43) was recorded under five irrigated plots, whereas, among the fertilizer levels maximum grain yield (4765 kg/ha), straw yield (8134 kg/ha), harvest index (36.9%) and B:C ratio (2.40) was recorded under application of 110% N and P.

Keywords: *Wheat, Grain yield, Economics, Irrigation, Nitrogen, Phosphorus, Bed planting*

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Introduction

Wheat (*Triticum aestivum* L.) is the most important and strategic *rabi* cereal crop for food security of India. About 75 to 85% water requirement of wheat in the north-western plain zone is met through irrigation. Water productivity will be greatly enhanced with application of efficient technologies and strategies which will minimize non-beneficial ET. Improper scheduling of irrigation and poor crop establishment are the main reasons for low productivity. Ideal planting geometry is important for better and efficient utilization of plant growth resources to get the optimum productivity of wheat. It is also well-known fact that water management is one of the major factors responsible for achieving better harvest in crop production. Fertilizers also play major role in crop production, due to efficient amount of nutrients crop can grow well and utilize the nutrients with availability of sufficient amount of water. Thus, crop establishment method, irrigation schedule and fertilizer management are the major causes of yield reduction in wheat, which also affect its water and nutrient use efficiency. Crop production is influenced by its establishment and plant vigor representing the key factors towards crop development. The bed planting and furrow irrigation method is one of the most efficient surface water application methods with saving in irrigation ranging and improved fertilizer use efficiency with higher yield [1]. Since, the behaviour of nutrient distribution in the root zone soil and its use by wheat crop under bed planting may be different than that of conventional; the information on fertilizer level for better growth and yield of wheat is needed. Therefore, it becomes imperative to find out appropriate irrigation schedule and fertilizer levels, particularly, nitrogen and phosphorus, for exploiting yield potential of bed planted wheat.

Material and Methods

The field experiment was conducted during *rabi* 2018-19 at Agronomy Research Farm of CCS Haryana Agricultural University, Hisar, Haryana (India) situated at 29°10' N latitude and 75° 46' E longitude at an elevation of 215.2 m above mean sea level in a semi-arid climate with the average annual rainfall of around 450 mm, of which 70-80 percent is received during monsoon period *i.e.*, July to September and the rest is received in showers of cyclic rains during the winter and spring seasons. The soil of the field was sandy loam, having 0.36% organic carbon and pH 8.2. It was low in available N (132 kg/ha), medium in available P (11.6 kg/ha) and rich in available K (325 kg/ha). The mean weekly meteorological data during the crop seasons of 2018-19 recorded at meteorological observatory located at Research Farm of CCS Haryana Agricultural University, Hisar are given in [Fig-1]. The experimental treatments consisted of combination of four levels of irrigation (Two, three, four and five irrigations in main plots) and four fertilizer levels (80, 90, 100 and 110 percent of recommended N and P *i.e.*,150 kg N and 60 kg P_2O_5/ha) in sub-plots, laid out in split-plot design with three replications. Nitrogen doses were applied as per treatments in the form of DAP and urea, half dose as basal dose and remaining half as top dressing after first irrigation. Full dose of phosphorus as per treatments was applied in the form of DAP as basal dose. Wheat variety HD 2967 was sown on 5thNovember 2019 during *rabi* season with the help of bed planter with two rows per bed per bed (70 cm wide with 40 cm top and 30 cm furrow) maintaining 20 cm spacing between the two rows and 10 cm on both sides of the top, using recommended seed rate of 100 kg/ha. Irrigations were applied as per treatments based on critical stages approach and irrigation water was measured with the help of current meter. The biomass obtained for individual net plot after threshed, cleaned and grain obtained were converted into kg ha^{-1}. The straw yield plot wise was obtained by subtracting grain yield from biological yield and converted into kg ha^{-1}. Harvest index was calculated by dividing the grain yield (economic yield) by the total dry matter (biological yield) and multiplied by 100.

Harvest Index (%) = (Economic yield (kg/ha))/(Biological yield (kg/ha))

Cost of cultivation for each treatment was calculated by using the prevailing rates of different agronomic practices and the inputs used in a particular treatment. Gross returns (Rs. /ha) of various treatments were calculated on the basis of rate yield/plot fixed by the university. Returns on variable cost (Rs./ha) were worked out by subtracting the total cost of cultivation of each treatment from the gross income of respective treatment.

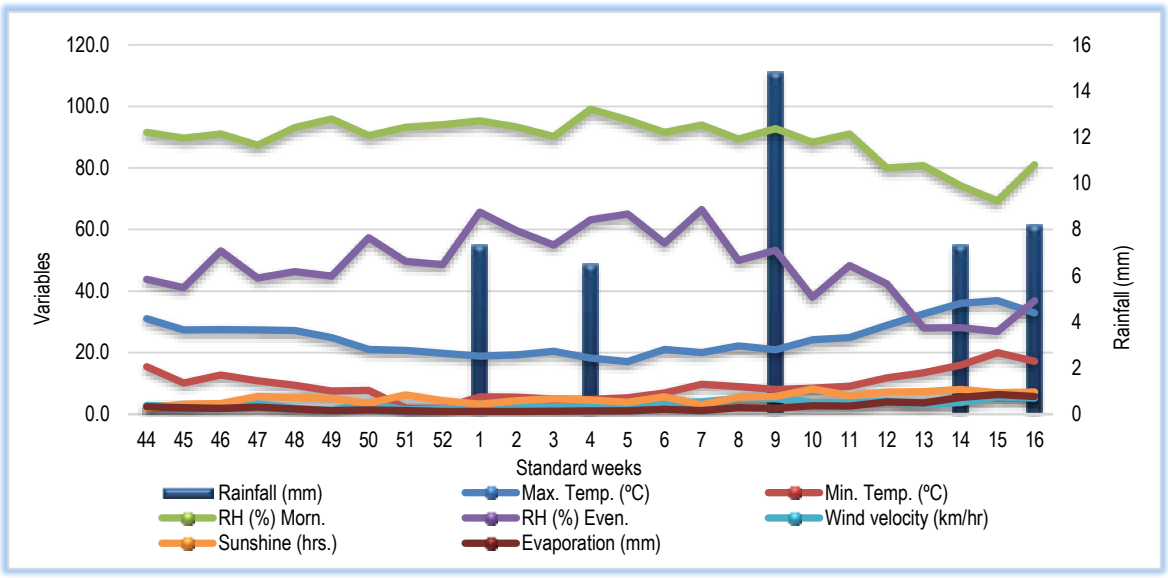

Fig-1 Mean weekly value of weather parameter during crop season of 2018-19

Table-1 *Effect of irrigation and fertilizer levels on yield attributes, yield and economics of bed planted wheat*

Treatments	Effective tillers/m²	Spike length (cm)	grains/spike	1000-grain weight(g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	B:C
Irrigation levels								
Two	483.8	9.6	58.9	41.5	3851	6924	35.73	2.11
Three	500.9	10.5	60.1	42.1	4278	7494	36.34	2.26
Four	518.5	10.9	61.3	42.2	4670	7989	36.90	2.35
Five	534.0	11.8	64.0	43.8	5022	8578	36.93	2.43
C.D.(p=0.05)	26.1	0.9	2.9	1.4	322	591	NS	-
Fertilizer levels (% Recommended NP)								
80% NP	489.9	9.8	57.3	41.0	4093	7362	35.69	2.15
90% NP	499.5	10.2	60.5	41.6	4357	7554	36.54	2.26
100% NP	520.9	11.3	62.5	43.3	4606	7934	36.73	2.35
110% NP	526.9	11.6	64.0	43.6	4765	8134	36.93	2.40
C.D.(p=0.05)	19.5	0.5	2.1	1.0	222	492	NS	-

Benefit cost ratio was also worked out by following formula:
B: C = (Gross returns (Rs/ha))/(Cost of cultivation (Rs/ha))

Results and Discussion

Effect on yield attributing parameters and yield

The perusal of data related to yield attributes and yield of wheat presented in [Table-1] revealed that they were significantly influenced by different irrigation and fertilizer levels. Among the irrigation levels, maximum number of effective tillers (534.0 m^{-2}), spike length (11.8 cm), grains per spike (64.0) and 1000-grain weight (43.8 g) were recorded with application of five irrigations, which was statistically at par with four irrigations effective tillers (518.5 m^{-2}) and number of grains per spike (61.3) significantly superior than all other lower levels of irrigation. Application of two irrigations recorded minimum number of effective tillers were produced with (483.8 m^{-2}), spike length (9.6 cm), grains per spike (58.9) and 1000-gran weight (41.5 g) followed by three irrigations. Among the irrigation levels, application of five irrigations produced maximum grain (5022 kg/ha) and straw yield (8578 kg/ha) of bed panted wheat, significantly higher than other levels of irrigation and it was followed by four irrigations (4670 and 7989 kg/ha) and three irrigations (4278 and 7494 kg/ha), whereas, the lowest grain (3851 kg/ha) and straw yield (6924 kg/ha) was produced with application of two irrigations. Among the irrigation levels the range of harvest index was 35.73 to 36.93 %. Maximum harvest index (36.93 %) was recorded with five irrigations followed by four irrigations (36.90 %), whereas lowest harvest index (35.73 %) was recorded in two irrigations [Table-1]. This may be due to fact that availability of sufficient moisture for proper vegetative growth and development of the crop increased the plant height, dry matter accumulation, no. of tillers and leaf area index of crop, which contributed in increased photosynthesis activity, and in turn higher yield attributes were produced. The results have been confirmed with the finding of Kumar *et al.* (2016) [2].

Among the fertilizer levels, application of 110 % recommended NP produced maximum number of effective tillers (526.9/m^2), spike length (11.6 cm), grains per spike (64.0) and1000-grain weight (43.6 g), which was statistically similar to application of 100 % recommended NP and significantly higher than the other lower levels of fertilizers, whereas, the lowest yield attributes were produced under application of 80% NP. Among fertilizer levels, application of 110 % recommended NP recorded the highest grain yield (4765 kg/ha) and straw yield (8134 kg/ha), which was statistically at par with 100 % recommended NP (4606 and 7934 kg/ha) and significantly higher than lower levels of fertilizers, the minimum grain (4093 kg/ha) and straw yield (7362 kg/ha) being produced by application of 80 % recommended NP. Thus, there was significant increase in grain yield with each successive increase in fertilizer level up to 100% recommended NP, and thereafter, there was numerical increase in grain yield at 110 % recommended NP, but the difference was non-significant. The maximum harvest index 36.93 % was observed in 110% recommended NP, while minimum was produced by 80% recommended NP (35.69 %). Yield attributes were higher under higher dose of fertilizers because due to sufficient amount of available nutrients, the crop plants had good growth and as a result produced higher yield attributes, which directly contributed in the increase of grain and straw yield of wheat. Kumar and Dhillon (2014) [3] and Wang *et al.* (2018) [4] also reported increase in yield parameters and grain yield with increase in nitrogen levels.

Effect on the economics of bed planted wheat

The economics was calculated for the wheat cultivation and the data related to Benefit cost ratio (B:C) for different irrigation and fertilizer levels are presented in [Table-1]. Maximum B:C (2.43) was recorded under the application of five irrigation, followed by four irrigations (2.35), whereas, lowest B:C (2.11) was recorded under two irrigation. Similar result was found by Kumar *et al.* (2014) [5] and Kumar *et al.* (2019) [6]. Among the fertilizer levels highest B:C (2.40) was recorded under the application of 110% NP, where lowest B:C ratio (2.15) was recorded under application of 80% NP. The increase in B:C was due to increase in grain yield. The results have conformity with the result of Kumar *et al.* (2018) [7].

Conclusion

The grain and straw yield of bed planted wheat as well as its B:C increased with increase in irrigation and fertilizer levels. Maximum grain and, straw yield was recorded with five irrigations, whereas, in case of fertilizer levels there was significant increase in grain and straw yield upto 100% NP, beyond which the increase was not significant, but the B:C increased upto application of 110% NP:

Application of research: Raised bed planting of wheat is resource conservation technology, which saves irrigated water and improves the nutrient use efficiency. This research indicates the levels of irrigation and fertilizers to be adopted in the bed planted wheat in semi-arid conditions.

Research Category: Agronomy

Abbreviations: NP: Nitrogen & Phosphorus; ET: Evapotranspiration; DAP: Diammonium Phosphate

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Study area / Sample Collection: Research Farm, Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125004, India

Cultivar / Variety / Breed name: Wheat (*Triticum aestivum* L.) variety HD 2967

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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