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Response of irrigation schedule and nitrogen on growth and yield of wheat (*Triticum aestivum* L.) under irrigated conditions of Punjab

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Abstract
The experiment was laid out at Campus for research and advance studies, Dhablan of G. S. S. D. G. S. Khalsa College, Patiala during *rabi* season 2017-18. A set of 12 treatment combinations including three irrigation schedule I_1 (at CRI stage), I_2 (at CRI & Flowering stage), I_3 (CRI, Late jointing and Milking stage) in main plot and Four nitrogen levels N_0 (0 kg ha^{-1}), N_1 (75 kg ha^{-1}), N_2 (125 kg ha^{-1}) and N_3 (175 kg ha^{-1}) in sub plot. Growth parameter at 30, 60, 90, 120 DAS and at harvest like plant height, dry weight kg ha^{-1} and number of tillers per meter square was significantly maximum with the application of I_3 (CRI, Late jointing and Milking stage) with N_3 (175 kg ha^{-1}). Similarly significantly higher yield and yield attributes (length of spike, grain per spike, test weight, harvest index, grain, straw and biological yield) was found with application of I_3 (CRI, Late jointing and Milking stage) and N_2 (125 kg ha^{-1}).

Keywords: Irrigation, nitrogen, wheat, growth, yield

Introduction
Wheat (*Triticum aestivum* L.) is crucial cereal crop which is the staple food is major part of country due to rich fibers and instant carbohydrates. Approximately 93.50 million tonnes of wheat is produce in India per year. India ranks 7th in exporting agriculture produce (Anonymous, 2018a). About 29.8 million-hectare land in India is under the cultivation of wheat. Therefore, India stands at 2nd position in wheat production in world. Due to the increase in population the country has to enhance the production of wheat to 105 million tons per annum (Anonymous 2017) [3]. Uttar Pradesh is the largest producer of wheat. The state produces up to 300.01 lakh net tons of wheat and area is 96 lakh ha of land in the state. In Punjab state stands at 3rd position in wheat producer and it produces upto 16.08 million-tonnes. In early stage of its growth wheat leads cool climate and more temperature during this stage is detrimental for tillering and also leads to several disease. Optimum temperature being from 12 to 25 ^{o}C seed size does not alter germination but affects growth, development and yield. Wheat is grown all type of soil and water log soil with alkaline nature can decorticate the crop. Growth and development of plants is the result of many physiological processes which are affected by soil moisture (Begum and Paul 1993) [5]. Yield of wheat is largely affected by irrigation and better result both in terms of biotic components, straw yield and seed yield can be attained by the application of optimum irrigation. Wheat crop cause moisture stress at critical stages of growth and development emanate in decrease in yield and protein content. Under such situations to find out some appropriate solution for to increase water use efficiency of crop without renounce yield should receive top most priority. After irrigation, nitrogen fertilizer is the second very important input for growth and development (Lenka *et al* 2009) [12]. Wheat is used as food and straw is fodder of livestock as it contains nutrients. The most important role of nitrogen in the plant is its presences in structure of protein, the most important building substance for which the living material or protoplasm of every cell is mad in addition nitrogen is also found in chlorophyll the green colouring matter of leaves. They are many experiment reports that nitrogenous fertilizer enhances water productivity (Oweis *et al* 2000 and Pandey *et al* 2001) [17, 19]. The deficiency of nitrogen affects the plant growth, quality, grain size and yield of crop.

Material and Methods
The experiment was conducted at Campus for Research and Advance Studies Dhablan, PG Department of Agriculture G. S. S. D. G. S. Khalsa College Patiala, during *Rabi* season 2017-18. Soil of the experimental field was clay loam in texture, soil pH 7.3 free from salts,

low in organic carbon (0.52), medium in available nitrogen (262 kg ha^{-1}), high in available phosphorus (22.6 kg ha^{-1}) and medium in available potassium (129 kg ha^{-1}). A set of 12 treatment combinations including three irrigation schedule I_1 (at CRI stage), I_2 (at CRI & Flowering stage), I_3 (CRI, Late jointing and Milking stage) in main plot and Four nitrogen levels N_0 (0 kg ha^{-1}), N_1 (75 kg ha^{-1}), N_2 (125 kg ha^{-1}) and N_3 (175 kg ha^{-1}) in sub plot. Treatments were replicated three times as per split- plot design. Nitrogen was applied as per treatments in the form of urea (46% N). A uniform seed rate of 100 kg ha^{-1} used. Sowing were done in the furrows spaced 22.5 cm with help of 'Kera' method by placing seed at a depth of 5 cm and then covered with soil. Weeds were controlled manually twice by hoeing the crop at 30 and 60 days after sowing. Irrigation was done as per treatment. Plant height, dry matter and growth parameters in each plot were recorded at 30 days interval after sowing. In order to study the dry matter production, plant samples were taken from one-meter row length in each plot after removing the root, the remaining plant samples were first sun-dried and then dried in an electric oven at 70°C for 72 hrs till constant weight and the weight (g) was recorded. The crop was harvested from net plot and threshed with the help of thresher. After threshing and winnowing, the weight of grain obtained from each net plot area was recorded in kg/ plot and then converted in q ha^{-1}. Data were analyzed in SAS 9.4 using the GLM procedure to evaluate differences between the treatments and means were compared LSD test at $p < 0.05$.

Result and Discussion

Effect of Irrigation schedule & Nitrogen on growth parameters

The data regarding the effect of irrigation scheduling and nitrogen on plant height (cm), dry weight (kg ha^{-1}) and tiller density (m^{-2}) at 30, 60, 90, 120 DAS and at harvest are given in Table 1 shows that Irrigation treatments had significant effect on all growth parameters. Significantly higher value of plant height, dry weight and tiller density was found with application of I_3 (CRI, Late jointing and Milking stage) followed by I_2 (CRI and flowering stage) (94.81 cm) and I_1 (CRI stage) (87.63cm), but however plant height, dry matter was statistically non significant with I_3 (CRI, Late jointing and Milking stage), I_2 (CRI and flowering stage) and I_1 (CRI stage) at early stages of crop (30 & 60 DAS). Significant higher growth parameters may be due to the optimum moisture supplies under more regular irrigation treatments promoted the division and expansion of cell components and thereby stem elongation, which effectively increased the plant growth in terms of plant height. These results are in understanding with those reported by Malik *et al.* (2012) [13], Pal *et al.* (2001) [18], Verma *et al.* (2017) [26], Maliwal *et al* (2000) [14].

All growth parameters (Plant height, dry weight, tiller density) increase significantly with the application of N_4 (175 kg N ha^{-1}) over N_0 (0 kg N ha^{-1}), N_1 (75 kg N ha^{-1}), N_2 (125 kg N ha^{-1}) at 30, 60, 90, 120 DAS and at harvest. The increase in plant height at level of nitrogen could be attributed to the fact that nitrogen being an essential constituent of plant tissue induced rapid cell division and cell elongation. Favorable effect of N applied up to 120 kg N ha^{-1} has been also been reported by Patel *et al* (1995) [20] and Sharma *et al* (2005) and Ali *et al*. (2011) [1].

The increase in dry weight in response to application of N fertilizes is probably due to enhanced available of nitrogen which enhanced more leaf area resulting in higher photo assimilates and thereby resulted in more dry accumulation. The results confirm the findings of Patel *et al* (1995) [20] and Chaturvedi (2006) [6].

Successive increase in N levels from 0 to 175 kg ha^{-1} did significant influence the number of effective tiller due to nitrogen increase vegetative growth of plant, which further increases the effective tillers. These results are in line with the work of Ali *et al.* (2011) [1].

Table 1: Response of irrigation schedule and nitrogen on growth of wheat (*Triticum aestivum* L.)

Treatment	Plant height (cm)					Dry Weight (g)		
	30 DAS	60 DAS	90 DAS	120 ADAS	At Harvest	30 DAS	60 DAS	90 DAS
I_1	13.28	25.17	59.83	85.86	87.63	59.12	2960.42	5470.58
I_2	13.27	25.15	60.43	93.73	94.81	59.27	2888.5	5976.25
I_3	14.16	26.98	66.61	103.76	106.62	60.4	3167.67	8673.08
CD	NS	NS	4.43	5.17	6.17	NS	NS	322.9
N_0	12.7	17.21	747.31	76.17	76.77	54.67	2615.56	5405.56
N_1	13.2	25	61.68	89.8	90.41	56.11	2832.78	6440.56
N_2	13.64	28.84	67.83	103.04	105.04	62.49	3059.89	6947.11
N_3	14.72	32	72.33	108.78	113.19	65.11	3313.89	7366.67
CD	0.73	1.8	4.09	5.67	2.52	5.31	210.89	266.63

Effect of Irrigation schedule & Nitrogen on yield and yield parameters

Irrigation scheduling had significant effect on effective tillers (m^{-2}), spike length (cm), no. of grain per spike, test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%). Significant higher value of effective tillers (230.08 m^{-2}), spike length (10.73 cm), no. of grain per spike (49.77) test weight (45.17), grain yield (43.28 q ha^{-1}), straw yield (64.18 q ha^{-1}) and harvest index (39.96%) was found with application of I_3 (CRI, Late jointing & Milking stage) over I_1 (CRI stage) and I_2 (CRI & Flowering stage). However lowest value of effective tillers (120 m^{-2}), spike length (9.98 cm), no. of grain per spike (37.46), test weight (39.98) grain yield (26.87 q ha^{-1}) straw yield (43.75 q ha^{-1}) and harvest index (36.73%) was found with application of I_1 (CRI stage).

This may be due to cause that sufficient moisture in the soil profile under three scheduling of irrigation levels, plant nutrients particularly nitrogen, phosphorus and potassium were more available and might have translocated to produce more dry matter. Secondly, higher levels of irrigation might be due to its key role in root development by dropping mechanical resistance of soil, higher transpiration, greater nutrient uptake and more photosynthesis due to metabolic activities in plant. Similar results was found by Ghosh & Pusta (1997) [7], Meena *et al*. (1998) [15], Ram *et al.* (2013) [23], Sharma *et al*. (1990) [24] Kumar *et al.* (2015) [11], Hati *et al.* (2001) [8], Pardhan *et al*. (2013)

Nitrogen application had also significantly effect on effective tillers (m^{-2}), spike length (cm), no. of grain per spike, test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%). Significant higher value of effective tillers (232.94 m^{-2}), spike length (12.01 cm), no. of grain per spike (49.20) test weight (44.81 g), grain yield (46.12 q ha^{-1}) and harvest index (42.01%) was found with application of N_2 (125 Kg ha^{-1}) but it was statistically at par application of N_3 (175 Kg ha^{-1}). Straw yield was significant higher with application of N_3 (175 Kg ha^{-1}). The least value of effective tillers (107.89 m^{-2}), spike length (8.60 cm), no. of grain per spike (36.28), test weight (39.76 g), grain yield (20.43 q ha^{-1}), straw yield (37.78 q ha^{-1}) and harvest index (34.66%) was found with application of N_0.

This might be due to nitrogen enhanced the plant to synthesize more photosynthesis which help in growth of plant. Ultimately yield and yield parameters are improved with application of nitrogen. Similar results was found by Naresh *et al.* (2014) [16], Ali *et al.* (2011) [1], Iqbal *et al.* (2012) [9], Singh *et al.* (2006) [25], Jan & Noor (2007) [10], Bahrani *et al.* (2013) [4].

Table 2: Response of irrigation schedule and nitrogen on yield of wheat (*Triticum aestivum* L.)

Treatment	Effective Tillers	Spike Length (cm)	No. of grains per spike	Test Weight (gm)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index
I_1	120	9.98	37.46	39.98	26.87	43.75	36.73
I_2	196.13	10.49	45.39	42.18	37.28	57.71	38.71
I_3	230.08	10.73	49.77	45.17	43.28	64.18	39.96
CD	12.59	0.29	3.06	2.16	2.57	3.19	1.14
N_0	107.89	8.6	36.28	39.76	20.43	37.78	34.66
N_1	156.78	10.02	42.67	41.7	32.18	50.22	38.09
N_2	230.67	12.01	49.2	44.81	46.12	63.65	42.01
N_3	232.94	10.96	48.68	43.5	44.49	69.2	39.1
CD	8.55	1.39	5.59	2.07	3.28	5.08	2.41

Conclusion

On the basis of above study it is concluded that growth parameters, yield and yield attributes were significantly higher with I_3 (CRI, Late jointing and Milking stage) & with the application of N_3 (175 kg ha^{-1}), on the other hand, with the application of N_2 (125 kg ha^{-1}) the yield and yield attributes were at par with N_3 (175 kg ha^{-1}).

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