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Effect of irrigation schedules on productivity of late sown varieties of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted at Kumarganj, Ayodhya during *Rabi* season of 2017-18 to evaluate the effect of irrigation schedules on productivity of late sown varieties of wheat (*Triticum aestivum* L.). Result revealed that the irrigation schedules significantly affected grain and straw yields as well as most of the growth and their attributes of wheat. 1.0 IW/CPE ratio recorded highest plant height (92.94 cm), number of tillers (389.24 m^{-2}), dry matter accumulation (882.50 g m^{-2}) at harvest stage and LAI (4.98) at 90 DAS as well as higher grain (37.40 q ha^{-1}), straw yield (50.86 q ha^{-1}) and biological yield (88.25 q ha^{-1}) over rest of the irrigation schedules. Among the varieties number of tillers (386.74 m^{-2}), dry matter accumulation (989.93 g m^{-2}), grain yield (42.00 q ha^{-1}), straw yield (56.99 q ha^{-1}) and biological yield (98.99 q ha^{-1}) were significantly recorded maximum with PBW- 373 while plant height (91.20 cm), and LAI (4.88) were recorded maximum with HUW- 234 at harvest stage.

Keywords: CRI, growth, irrigation schedules, IW/CPE ratio, wheat and yield

Introduction
Wheat (*Triticum aestivum* L.) is the most important crop among all cereals used as a food grain in the world. It provides nearly 55% of the carbohydrate and 20% of food calories which is consumed by two billion people (36% of the world population) as staple food. Globally, wheat covers an area of about 219.51 million ha with a production of 758.02 million metric tonnes and productivity of 3450 kg ha^{-1}. India has the largest area under wheat (30.70 million hectares), but ranks second in production (98.51mt) after China with the average productivity of 3200 kg ha^{-1} (USDA, 2017-18). Among wheat cultivated states, Uttar Pradesh rank first with respect to area (9.65 m ha) and production (26.87 mt) but the productivity is much lower (2786 kg ha^{-1}) than Punjab (4491 kg ha^{-1}) and Haryana (4574 kg ha^{-1}) (DACFW, 2016) [7]. There are many factors responsible for low yield of wheat but insufficient irrigation and varieties are the most important. Water is essential at every developmental phase starting from seed germination to plant maturation for harvesting the maximum potential yield of wheat. There is a positive correlation between grain yield and irrigation frequencies (Kumar *et al.*, 2012) [14]. Irrigation had significant influence on dry matter accumulation, leaf area index, no of spike m^{-2}, number of grains per spike and test weight that ultimately led to high grain and straw yield and harvest index. (Malik *et al.* 2012) [15]. Scheduling irrigation showed significant effect on growth character *viz*., plant height, number of shoots m^{-1}, leaf area index as well as dry matter accumulation m^{-2} at 60, 90 DAS and at harvest stage reported by (Yadav and Verma 1991) [25]. Irrigation missing at some critical growth stage sometime drastically reduces grain yield due to lower test weight. Efficient water management, being one of the good agronomic management practices, it not only leads to improve crop productivity but also minimize susceptibility from disease and insect pest under favourable environment for flourishing these biotic stress (Singh *et al.*, 2011) [22]. Delay in sowing normally reduces individual plant growth and no. of tillers (Shivani *et al.*, 2003) [24].
Varieties play an important role in obtaining higher yield of wheat crop. Variety UP 262 showed higher LAI at heading and greater number of grains per ear head and finally produced higher grain yield and harvest index over sonalika. (Malik *et al* 2012) [15]. The results revealed that the significant differences were observed among different late sown varieties in relation to yield and yield contributing parameters like effective tillers (m^{-2}), number of grains per spike

and 1000 grain weight (g). (Kaur 2017) [12]. The present studies were executed to determine astute irrigation schedules and varieties for wheat grown under agro ecological condition of Ayodhya.

Materials and methods

The field experiment was conducted at Agronomy Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.), during the *rabi* season from December 15, 2017 to April 27, 2018. The experimental site falls under sub-tropical zone in Indo-gangatic plains and lies between 260.47 North latitude, 820.12 East longitudes, at an altitude of about 113.0 meter from mean sea level. The soil of experimental field was low in available nitrogen (156.10 kg ha^{-1}) and organic carbon (0.42%), medium in available phosphorus (15.13 kg ha^{-1}) and potassium (280.42 kg ha^{-1}). The reaction of the soil was slightly alkaline. The total rainfall during course of experimentation was 1.0 mm. During the crop season, the lowest temperature (4.7℃) was recorded in the month of January and the maximum (39.2℃) in the month of April. The experiment was laid out in a split plot design replicated three times with main plot treatments four irrigation schedules *viz.* I_1 at CRI, late jointing and milking stage, I_2 at CRI, late jointing flowering and milking stage I_3 0.8 IW/CPE ratio, I_4 at 1.0 IW/CPE ratio were randomized in the main plots while varieties *viz.* V_1 (PBW 373), V_2 (HUW 234), V_3 (Halna K 7903) and V_4 (lok 1) were allocated to subplots. Wheat varieties was sown on 15th December 2017 and harvested at 27rd April 2018. Seed rate 120 kg ha^{-1} was taken with 20 cm row spacing. The field plots were separated with plot border of 0.5m size. Irrigations applied as per treatment on the basis of critical levels and IW/CPE ratio as per schedule approach using 6 cm depth of irrigation water. A recommended dose of NPK fertilizer was 120:60:40 kg ha^{-1} were applied in the form of urea, Diammonium phosphate (DAP) and muriate of potash (MOP), respectively. Whole of P and K and half of N was applied as basal dose and remaining nitrogen was top-dressed after first irrigation. All other agronomic practices were kept normal for all the treatments. Observations regarding growth like plant height (cm), number of tillers (m^{-2}), dry matter accumulation (gm^{-2}) were recorded at 30, 60, 90 DAS and at harvest stage. While observations regarding leaf area index (LAI) were taken at 30, 60 and 90 DAS. Plant height was recorded by selecting 5 random plants from each net plot and tagged and height of plant was measured with the help of meter scale from soil surface to apex of the plant at 30, 60, 90 DAS and at harvest of the crop and mean value from all the recorded data was worked out. Similarly the leaf area of five plants was measured by automatic leaf area meter at 30, 60 and 90 DAS of the crop and Leaf area index was calculated by dividing the leaf area per unit land area. For dry matter accumulation, plants falling within 50 cm row length from second row marked were cut close to the ground surface and dried in a hot air oven maintained at 65±2 °C till constant dry weight. Dry matter of plants was recorded and expressed in gram per meter square. Harvesting of individual plot was done at physiological maturity when crop turned yellowish as like straw colour. Harvested plants were sun dried for few days in same plots followed by carefully bundled, tagged and finally brought to threshing floor. The bundle weight of net plot was recorded individually. Whole biomass was weighted just before the threshing. Threshing was done by power thresher plot wise and cleaned separately for taking the grain weight from the net plots. Straw yield was recorded by subtracting grain weight from total biomass yield. All the data were recorded in kg $plot^{-1}$ which were finally converted into q ha^{-1}. Data collected on different growth, yield and quality parameters were analyzed statistically by Fisher's analysis of variance technique and the least significant difference (LSD) test at 5% probability level was employed to test the significance of treatment means (Gomez & Gomez, 1984) [9].

Results and Discussion

Data regarding dynamic growth and their attributes and yield of wheat as influenced by different irrigation schedules and varieties are presented in Tables and discussed in different sections.

Plant height

The irrigation schedules significantly affected the plant height at all the stages of crop growth except at 30 DAS. At advance stages (60, 90 DAS and harvest stage) plant height increased with increasing the levels of irrigation from three to six irrigation. The highest plant height was (66.34cm), (92.02) and (92.94 cm) recorded under 1.0 IW/CPE ratio (I_4) which was at par with 0.8 IW/CPE ratio (I_3) and showed significant superiority over CRI, late jointing and milking stage (I_1) and CRI, late jointing, flowering and milking stage (I_2). At harvest stage maximum plant height (92.94 cm) was recorded with 1.0 IW/CPE ratio (I_4) and minimum (79.04 cm) with CRI, late jointing and milking stage (I_1).With applied irrigation at 1.0 IW/CPE ratio in crops were provided with adequate moisture to meet their various requirements, which resulted into higher plant height. This might be due to increasing the irrigation levels, which maintained various metabolic processes. Significant reduction in plant height due to decrease in irrigation levels was also reported by Brahma *et al.* (2007) [6] and Kumar *et al.* (2016) [13]. Varieties significantly influenced the plant height at various growth stages. At 30 DAS, there was no significant difference in plant height due to varieties. However, plant height at 60, 90 DAS and at harvest was found to be significant. The maximum plant height (65.10 cm), (90.30 cm) and (91.20 cm) were recorded under V_2 (HUW 234) and it was at par with V_1 (PBW 373) and V_4 (Lok 1) and these showed significant superiority over V_3 (Halna K 7903) at 60, 90 DAS and at harvest stage. Variation in plant height among cultivars might also be probably due to their genetic characters reported by Jat and Singh (2004) [10].

Number of tillers

Number of tillers (m^{-2}) were not influenced significantly due to different irrigation schedules at 30 DAS. However, the effect of irrigation schedules on number of tillers (m^{-2}) at 60, 90 DAS and at harvest were found to be significant. At 60 and 90 DAS the 1.0 IW/CPE ratio (I_4) treatment being at par with 0.8 IW/CPE ratio (I_3), recorded maximum number of tillers m^{-2} (388.93 and 401.27) which was significantly superior over I_1 and I_2 irrigation schedule, respectively. The maximum number of tillers (389.24 m^{-2}) was recorded with 1.0 IW/CPE ratio and minimum (340.04 m^{-2}) with irrigation at CRI, late jointing and milking stage at harvest stage. The higher number of tillers were associated with 1.0 IW/CPE ratio (I_4) at all the stages of crop growth. It might be due to increase the number of irrigation to the crop. Constant moisture level in field maintained the various metabolic processes which led to profuse tillering, the findings are in support to those of Aslam *et al.* (2015) [3], Yousaf *et al.* (2014) [26] and Kumar *et al.* (2016) [13]. In case of varieties, Significant differences was found on number of tillers m^{-2} at 60, 90 DAS and at harvest stage except 30 DAS. At later stages, maximum number of tillers m^{-2} (386.74) were noticed under V_1 (PBW 373) treatment which was statistically at par with V_2 (HUW 234) and V_4 (LOK 1) treatment but significantly higher over V_3 (Halna K 7903) treatment. While minimum no. of tillers (333.49 m^{-2}) was noticed under V_3 (Halna K 7903) treatment. Variation in number of tillers among cultivars might also be probably due to their genetic characters as well as climatic requirement of the different cultivars. The findings are in support to those of Mishra *et al.* (2003) [17].

Leaf area index

In general, leaf area index was increased at higher rate up to 60 DAS and then increased at slowest rate up to 90 DAS during the course of investigation. A cursory glance over the data indicate that leaf area index was not significantly affected due to irrigation schedule at 30 DAS. Maximum leaf area index (4.87) and (4.98) was recorded at 60 and 90 DAS under irrigation schedule of I_4 (1.0 IW/CPE ratio) which was at par with I_3 (0.8 IW/CPE ratio) while significantly higher over I_1 (CRI, late jointing and milking stage) and I_2 (CRI, late jointing, flowering and milking stage) treatments, respectively. Significantly higher leaf area index was observed with increasing the irrigation levels. However, there was no significant difference between 0.8 and 1.0 IW/CPE irrigation levels. Increase in LAI under increased moisture availability. This might be due to fact that moisture and nutrient supply contributed to more number of green leaves, size of leaves etc., led to higher leaf area and leaf area index. The lowest LAI was recorded under CRI, late jointing and milking stage. It is quite evident that leaf expansion is normal, if relative water content is about 90 to 100 per cent. If it falls below 70-75 per cent, leaf expansion stops, cell expansion is more affected by moisture stress than cell division. The results were in close proximity to those of Pal *et al.* (1996) [18], Rahman *et al.* (2006) [19] and Saren *et al.* (2004) [21].

However, the leaf area index of different varieties did not significantly affected at 30 DAS. The maximum leaf area index at 60 DAS (4.78) and 90 DAS (4.88) were recorded with varieties of V_2 (HUW 234) which was at par with V_1 (PBW 373) and V_4 (LOK 1) while significantly superior over V_3 (Halna K 7903) treatment. The maximum (4.98) and minimum (4.23) leaf area index at 90 DAS was credited to cultivar PBW 373 and Halna K 7903 respectively. It might be probably due to their genetic characters of varieties. Leaf area index was little increased at 90 days after sowing due to decreasing growth rate and senescence stage which showed drying and shattering of the leaves reported by Bachhao *et al.* (2018) [4].

Dry matter accumulation

Analogous to growth characters, the dry matter production increased at successive growth stages of the crop. Among the various growth stages the highest value of dry matter was recorded at harvest stage. Dry matter accumulation on different growth stages were significantly affected by irrigation schedules except at 30 DAS. The maximum dry matter accumulation was recorded under 1.0 IW/CPE ratio (I_4) which was at par with 0.8 IW/CPE ratio (I_3) and significantly superior over CRI, late jointing and milking stage (I_1) and CRI, late jointing, flowering and milking stage (I_2) at 60, 90 DAS and at harvest stage. The maximum dry matter accumulation (882.50 gm^{-2}) was obtained with 1.0 IW/CPE ratio (I_4) and minimum (759.83 gm^{-2}) under CRI, late jointing and milking stage (I_1) at harvest stage.

Dry matter accumulation (gm^{-2}) at 30 DAS was not influenced significantly. Because there were enough and uniform moisture at the time of sowing which led to proper growth and development. Highest dry matter accumulation was recorded under 1.0 IW/CPE ratio which was at par with 0.8 IW/CPE ratio. This might be due to increase in plant height, number of tillers and LAI with adequate moisture supply. All these factors contributed for full turgidity and opened leaves, which increased the photosynthetic activity of crops, resulting in higher dry matter accumulation. The lowest dry matter accumulation was obtained under CRI, late jointing and milking stage. This might be due to lack of optimum moisture, which resulted in reduced plant height, number of tillers and leaf area and led to reduced photosynthetic activity which ultimately reflected in lowest dry matter accumulation. The increase in dry matter accumulation due to increase in irrigation levels was reported by Saren *et al.* (2004) [21] and Kumar *et al.* (2012) [14].

Dry matter accumulation was not significantly influenced due to varieties at 30 DAS. At later stages 60, 90DAS and at harvest stage higher dry matter accumulation (589.01, 841.44 and 989.93 gm^{-2}) recorded with V_1 (PBW 373) which was significantly superior over V_2 (HUW 234), V_3 (Halna K7903) and V_4 (LOK 1), respectively. Maximum dry matter accumulation (989.93 gm^{-2}) was recorded with PBW 373 and minimum (588.68 gm^{-2}) with Halna (K 7903). This might be due to healthy tillers lead to higher nutrients absorption capacity, more number of spike bearing tillers due to less mortality resulted higher dry matter production at harvest stage. Minimum dry matter accumulation was recorded with Halna K 7903 at harvest stage, which reflected due to less number of spikes bearing tillers m^{-2} resulted less dry matter production. Similar findings were reported by Sardana *et al.* (1999) [20]. Dry matter accumulation increased with the advancement in age of the wheat crop reported by Bachhao *et al.* (2018) [4].

Yield parameters

Grain and straw yield was influenced significantly by different irrigation schedules. Highest grain yield (37.40 q ha^{-1}) and straw yield (50.86 q ha^{-1}) was recorded under 1.0 IW/CPE ratio which was at par with 0.8 IW/CPE ratio (I_3) and was significantly superior over rest of the treatments. The minimum grain yield (31.81 q ha^{-1}) and straw yield (44.18 q ha^{-1}) was recorded under (I_3) treatments. Highest grain yield and straw yield was recorded under 1.0 IW/CPE ratio this might be due to adequate moisture availability, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes. Better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yield. Irrigation at CRI, late jointing and milking stage recorded lowest grain yield due to poor moisture supply during growth period. Poor moisture supply during critical stages reduced the yield attributes and resulted in poor grain and straw yield. Similar finding were reported by Bahera *et al.* (2002) [5] and Ahmad and Kumar (2015) [1].

Grain and straw yield was significantly influenced by different varieties. The highest grain yield (42.0 q ha^{-1}) and straw yield (56.99 q ha^{-1}) was credited to cultivar PBW 373 followed by Lok 1. The reason behind this might be due to good plant stand, more number of spike bearing tillers, length of spike and more number of grains $spike^{-1}$ with more test weight. Minimum grain (24.60 q ha^{-1}) and straw yield (34.27 q ha^{-1}) were recorded with cultivar Halna (K 7903) this might be due to less number of spike bearing tillers, small shoots head and less number of grains spike^{-1} and poor grain development. Similar findings were obtained by Dhaka *et al.* (2006) [8] and Maurya *et al.* (2014) [16] and Joshi *et al.* (2016) [11]. Biological yield was influenced significantly by irrigation schedules and varieties of wheat crop. The maximum biological yield (88.25 q ha^{-1}) was obtained under treatment I_1 (1.0 IW/CPE ratio). This might be due to adequate supply of water which contributed to increasing in dry matter accumulation. Productivity of biological yield of a crop collectively determined by vigour of the vegetative growth, development as well as yield attribute. Better vegetative growth coupled with high yield attribute resulted into higher biological yield. The minimum biological yield (75.98 q ha^{-1}) recorded under treatment I_1 (CRI, late jointing and milking stage), this might be due to both poor growth and yield attributes. Similar finding were reported by Sharma *et al.* (2000) [23]. The maximum biological yield (98.99 q ha^{-1}) was recorded with the variety V_1 (PBW 373). The increase in biological yield under this treatment was mainly due to improvement in yield attributing character and growth of crop. The minimum biological yield (58.87 q ha^{-1}) recorded under the variety V_3 (Halna K 7903) because of less yield attributing character and growth of crop at harvest in comparison to other varieties treatments. Similar finding were reported by Bachhao *et al.* (2018) [4].

Table 1: Plant height and number of tillers as influenced by different irrigation schedules and varieties of wheat

Treatment	Plant height (cm)				Number of tillers (m^{-2})			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
(A) Irrigation schedules (main plot factor)								
I_1	23.96	56.33	78.26	79.04	201.83	339.77	350.56	340.04
I_2	24.84	61.38	85.14	85.99	211.89	352.53	363.72	352.81
I_3	25.04	63.86	88.58	89.47	221.66	381.04	393.14	381.34
I_4	25.86	66.34	92.02	92.94	219.08	388.93	401.27	389.24
SEm +_	0.47	0.92	1.82	2.47	5.77	6.84	8.21	8.35
CD(P=0.05)	NS	3.18	6.32	8.55	NS	23.69	28.40	28.91
(B) Different varieties (sub plot factor)								
V_1	24.31	63.77	88.58	89.47	206.43	386.43	398.70	386.74
V_2	25.39	65.10	90.30	91.20	215.34	371.45	383.24	371.74
V_3	24.39	55.80	77.40	78.18	211.64	333.22	343.80	333.49
V_4	25.61	63.24	87.72	88.60	221.09	371.45	382.95	371.46
SEm +_	0.48	1.19	1.79	1.61	3.74	7.40	7.01	6.66
CD(P=0.05)	NS	3.48	5.22	4.70	NS	21.60	20.46	19.44

Table 2: LAI and Dry matter accumulation as influenced by different irrigation schedules and varieties of wheat

Treatment	Leaf area index			Dry matter accumulation (gm^{-2})			
	30DAS	60DAS	90DAS	30DAS	60DAS	90DAS	At harvest
(A) Irrigation schedules (main plot factor)							
I_1	1.32	4.14	4.23	69.97	452.10	645.85	759.83
I_2	1.38	4.50	4.60	72.53	488.21	697.45	820.53
I_3	1.44	4.69	4.79	73.11	498.65	712.36	838.08
I_4	1.43	4.87	4.98	75.52	525.09	750.13	882.50
SEm +_	0.03	0.09	0.11	1.32	7.68	12.60	13.81
CD(P=0.05)	NS	0.33	0.39	NS	26.60	43.60	47.79
(B) Different varieties (sub plot factor)							
V_1	1.35	4.68	4.79	70.99	589.01	841.44	989.93
V_2	1.40	4.78	4.88	74.13	492.53	703.61	827.78
V_3	1.38	4.10	4.19	71.21	350.26	500.37	588.68
V_4	1.44	4.64	4.75	74.79	532.26	760.37	894.55
SEm +_	0.02	0.08	0.09	1.40	9.49	13.59	15.70
CD(P=0.05)	NS	0.25	0.27	NS	27.71	39.68	45.84

Table 3: Grain yield, straw yield and biological yield as influenced by different irrigation schedules and varieties of wheat

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
I_1	31.81	44.18	75.98
I_2	34.60	47.45	82.05
I_3	36.00	47.81	83.81
I_4	37.40	50.86	88.25
SEm +_	0.59	0.92	1.46
CD (P=0.05)	2.041	3.21	5.08
V_1	42.00	56.99	98.99
V_2	35.20	47.58	82.78
V_3	24.60	34.27	58.87
V_4	38.00	51.46	89.46
SEm +_	0.62	0.89	1.64
CD (P=0.05)	1.92	2.61	4.81

Conclusion

Based on the results discussed above of investigation, it can be concluded that the growth parameter like plant height, number of tillers, dry matter accumulation and leaf area index were recorded maximum with irrigation at 1.0 IW/CPE ratio than other irrigation schedules. In case of varieties all the growth parameter except plant height and LAI were recorded higher with variety PBW 373. Whereas plant height and LAI were recorded higher with variety HUW 234. The yield parameter like grain yield, straw yield and biological yield were maximum with irrigation at 1.0 IW/CPE ratio with PBW 373.

References

1. Ahmad A, Kumar R. Effect of irrigation scheduling on the growth and yield of wheat genotypes. Agric. Sci. Digest 2015;35(3):199-202.
2. Anonymous. Foreign Agricultural Service, United State Department of Agriculture. Wheat outlook 2015, 1-21.
3. Aslam M, Ali MA, Waqar MQ, Sangi AH, Khalid L. Demonstration and evaluation of the effect of different irrigation frequencies on the growth and yield of wheat in standing cotton. Int. J Adv. Res. in Biol. Sci 2015;2(2):96-101.
4. Bachhao KS, Kolekar PT, Nawale SS, Kadlag AD. Response of different wheat varieties to different sowing dates. Journal of Pharmacognosy and Phytochemistry 2018;7(1):2178-2180.
5. Behera UK, Ruwali PK, Verma PK, Pandey HN. Productivity and water use efficiency of macaroni (*Triticum durum*) and bread wheats (*T. aestivum*) under varying irrigation levels and schedules in the Vertisols of central India. Indian. J of Agron 2002;47(4):518-25.
6. Brahma R, Janawade AD, Palled YB. Effect of irrigation schedules, mulch and antitranspirant on growth, yield and economics of wheat. Karnataka Journal of Agricultural Sciences 2007;20(1):6-9.
7. DACFW. Directorate of Economics & Statistics. Department of Agriculture, cooperation & Farmer Welfare 2016-17.
8. Dhaka AK, Bangarwa AS, Pannu RK, Malik RK, Garg R. Phenological development, yield and yield attributes of different wheat genotypes as influenced by sowing time and irrigation. Agricultural Science Digest 2006;26(3):174-177.
9. Gomez KA, Gomez AA. Statistical Procedure for Agricultural Research. 2nd 680p. Wiley, N. York, USA 1984.

10. Jat LN, Singh SM. Growth, yield attribute and yield of wheat (*Triticum aestivum* L.) under different planting pattern of cropping system and varities. Indian Journal of Agronomy 2004;49(2):111-113.
11. Joshi MA, Faridullah S, Kumar A. Effect of heat stress on crop phenology, yield& seed quality attributes of wheat. J of Agro-meteorology 2016;18(2):206-215.
12. Kaur C. Performance of Wheat Varieties under Late and Very Late Sowing Conditions. Int. J Curr. Microbial App. Sci 2017;6(9):3488-3492.
13. Kumar A, Nand V, Kumar R. Effect of different levels of irrigation under integrated nutrient management (INM) on wheat (*Triticum aestivum* L.) for central plain agro climatic zone of Utter Pradesh, India. Plant Archives 2016;16(1):395-398.
14. Kumar P, Pannu RK, Khokhar SK. Effect of organic sources of nutrition and irrigation levels on growth and yield of wheat (*Triticum aestivum* L.). Int. J Life Sci. Bt. & Pharm. Res 2012;1(4):178-186.
15. Malik GC, Wasim Iftikar, Banerjee M, Ghosh DC. Effect of Irrigation, Variety and Nitrogen on Growth and Productivity of Wheat (*Triticum aestivum* L.) International Journal of Bio-resource and Stress Management 2012;3(2):158-164.
16. Maurya P, Kumar V, Maurya KK, Kumawat N, Rakesh Kumar R, Yadav MP. Effect of potassium application on growth and yield of wheat varieties, Department of Agronomy, CSAU & T, Kanpur, India 2014;9(4):1371-1373.
17. Mishra V, Mishra RD, Singh M, Verma RS. Dry matter accumulation at pre and post- anthesis and yield of wheat (*Triticum aestivum* L.) as affected by tempreture stress and genotype. Indian Journal of Agronomy 2003;48(4):277-281.
18. Pal SK, Kaur J, Thakur R, Verma UN, Singh MK. Effect of irrigation, seeding date and fertilizer on growth and yield of wheat (*Triticum aestivum* L.). Indian Journal of Agronomy 1996;41(3):386-389.
19. Rehman S, Khalil S, Muhammad F, Rehman A, Khan A, Rehman A *et al*. Phenology, leaf area index and grain yield of rainfed wheat influenced by organic and inorganic fertilizers. Pakistan Journal of Botany 2006;42(5):3671-3685.
20. Sardana V, Sharma SK, Randhawa AS. Performance of wheat cultivars under different sowing dates and level of nitrogen under rainfed condition. Ann. Agri. Res 1999;20(1):60-63.
21. Saren BK, Dey S, Mandal D. Effect of irrigation and sulphur on yield attributes, productivity, consumptive use, and consumptive use efficiency of wheat (*T. aestivum*). Indian J Agri. Sci 2004;74(5):257-261.
22. Singh A, Singh D, Kang JS, Agrawal N. Management practices to mitigate the impact of high temperature on wheat: A review. IIOABJ 2011;2(7):11-22.
23. Sharma, Karambir, Ram Niwas, Singh M. Effect of sowing time on radiation use efficancy of wheat cultivars. Journal of Agro meteorology 2000;2(2):166-169.
24. Shivani, Verma VN, Kumar S, Pal SK, Thakur R. Growth analysis of wheat (*Triticum aestivum*) cultivars under different seeding dates and irrigation levels in Jharkhand. Indian Journal of Agronomy 2003;48(4):282-286.
25. Yadav GL, Verma JK. Effect of irrigation regime, nitrogen and zinc fertilization on growth and yield of late sown wheat (*T. aestivum* L.). Indian J Agron 1991;36:50-56.
26. Yousaf M, Shaaban M, Ali S, Ibrahim A, Shah F. Effect of nitrogen application rates and timings of first irrigation on Wheat growth and yield. International Journal of Agriculture Innovations and Research 2014;2(4):2319-1473.