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# Effect of scheduling irrigation based on IW/CPE ratio on dry matter accumulation, yield attributes, yield and Economics of Wheat crop (*Treiticum aestivum* L.)

**Sudhir Pal, Suresh Kumar, Hemant Kumar Gangwar, Anshul Singh and Parvesh Kumar**

## Abstract
The field experiment was conducted at student᾽s Instructional form of Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Rabi*, 2016-17. The treatments comprised of five levels of irrigation schedule *viz*. CRI stage ($I_1$), 0.6 IW/CPE ratio ($I_2$), 0.8 IW/CPE ratio ($I_3$), 1.0 IW/CPE ratio ($I_4$), and 1.2 IW/CPE ratio ($I_5$) were comprised in Randomize Block Design with four replications. The experimental results indicated the growth attributes *viz*., number of shoots, plant height, dry matter accumulation and yield attributing characters *viz*., number of grains spike$^{-1}$, number of spike m$^{-2}$, length of spike, test weight, grain and straw yield by crop was significantly was 1.0 IW/CPE ratio ($I_4$) moisture regime which was at par with 1.2 IW/CPE ratio ($I_5$) moisture regime and significantly higher over at the CRI stage ($I_1$), 0.6 IW/CPE ratio ($I_2$), 0.8 IW/CPE ratio ($I_3$). The moisture regime significantly economics of the treatment were recorded of ($I_4$) 1.0 IW/CPE ratio (6 irrigation). On the basis of result obtained application of ($I_4$)1.0 IW/CPE ratio moisture regime found to be more suitable higher yield of wheat variety PBW -154. On pooled basis Wheat cultivar PBW-154 accrued the maximum net return (Rs. 55821 ha$^{-1}$) with B:C ratio of 1.82 of under 1.0 IW/CPE moisture regime $I_4$.

**Keywords:** Wheat, moisture regime, growth, dry matter accumulation, yield attributes, yield and economics

## Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the world. Among the world's most important food grains, it ranks next to rice. It is eaten in various forms by more than one billion in the world. India is the second largest producer of wheat in the world. It is a pre-dominant winter season crop of north western plain zones and during 2016-17, production in India was 97.44 million tons from an area of 30.73 million hectares with productivity of 3172 tones ha$^{-1}$ (Anonymous, 2016-17) [1]. UP ranks first in respect of crop coverage area (9.13 million hectares) and production (24.57 million tons) but average productivity is low (2690 t ha$^{-1}$) (Anonymous, 2016-17) [1]. Water is a precious and scare input plays a vital role in assured crop production since it is essential for the maintenance to turgidity, absorption of nutrients and the metabolic process of the plants. Therefore, it becomes imperative to develop an optimum irrigation schedule to maintain the sufficient available soil moisture throughout the crop period for best exploitation of crop yield potential. Among the several recognized criteria of irrigation scheduling, climatologically approach is very scientific and widely accepted among the scientists and research workers throughout the world. It is well known that evapo-transpiration by a full crop cover is closely associated with the evaporation from an open pan (Dastane, 1972) [5]. Parihar *et al.* (1976) [14] suggested a relatively more practical meteorological approach of IW/CPE which is a ratio between fixed amount of irrigation water (IW) and cumulative pan evaporation minus rains. This IW/CPE approach merits on account of its simplicity of operation and high-water use efficiency. Therefore, the climatologically approach of scheduling irrigation by evaluating different IW/CPE ratios in wheat crop has been proposed in this study. It is an established fact that in future, less and less of water will be available for agriculture on account of increasing water demand for domestic, industrial and other purposes. It is estimated that even after achieving the full irrigation potential, nearly 50% of the total cultivated area will remain rain fed (Vision, 2020) [22].
Irrigation water is a major constraint for assumed crop production. Evapo-transpiration by a full crop cover is closely associated with the evaporation from an open pan. At present irrigation is very costly input so will be used very judiciously.

Parihar *et al.* (2003) [15] suggested a relatively more practical meteorological approach of IW/CPE, the ratio between a fixed amount of irrigation water (IW) and Cumulative Pan Evaporation, as a basis for irrigation scheduling to crops. The IW/CPE approach merits special consideration on account of its simplicity of operation. IW/CPE is taken for applying water to wheat and for comparative study treatments at critical growth stages, Patel and Upadhayay, (1993) [16] reported that the higher grain yield with IW/ CPE ratio 1.0 of 6 cm irrigation, resulted in improved yield attributes, *viz*. effective tiller meter$^{-2}$, number of grains spike$^{-1}$, grain weight per spike$^{-1}$ and 1000-grain weight. Keeping all this in view, an attempt has been made to study the effect of irrigation scheduling based on IW/CPE ratio on yield and economics of wheat crop.

## Materials and methods

Field experiments were conducted during the *Rabi* season 2016-17 at student's instructional farm, Narendra Deva university of Agriculture & Technology, Kumarganj Ayodhya. The farm is located 42 km away from Ayodhya city on Ayodhya-Raibareily road at 26.47˚ N latitude and 82.12˚ E longitude and about 113 meter above the mean sea level. The experimental soil was silty loam having with pH 8.20, EC 0.30 dSm$^{-1}$, organic carbon 4.0 g kg$^{-1}$ available N 187, P 17.25 and K 269 kg ha$^{-1}$. To assess the properties of soil sample experiment, soil pH and EC determined by following Chopra and Kanwar (1991) [3]. Soil organic carbon was determined by Walkley and Black (1934) [23] rapid titration procedure as outline by Jackson (1973) [7]. Soil available nitrogen was determined following Subbiah and Asija (1956) [20]. Available phosphorus was determined by Olsen *et al.* (1956) [13] method. Available potassium was determined by following Jackson (1973) [7]. The experiment was laid out in randomized block design with four replications. Five treatments comprised of four levels of moisture regime (a) $I_2$; 0.6 IW/CPE ratio (b) $I_3$; 0.8 IW/CPE ratio (c) $I_4$; 1.0 IW/CPE ratio and $I_5$; 1.2 IW/CPE ratio and (e) CRI stage ($I_1$). The wheat variety PBW-154 was sown in 20 cm row to row distance on 2th Dec. in 2016 and harvested on 14$^{th}$ April 2017. Fertilization was done by using inorganic fertilizers and half of nitrogen and full dose of phosphorus and potash were applied at the time of sowing as per treatments. The remaining nitrogen as per treatment was top dressed after first irrigation. N, P, and K were applied through urea, DAP and muriate of potash, respectively. The cultural practices were followed as per recommendations. Irrigations as per treatments were applied in individual plots by flooding. The IW/CPE ratios were calculated based on depth of irrigation water and the cumulative pan evaporation during the period. Plants from 25 cm row length from second rows were selected randomly at 60, 90 after sowing and at harvest stage and they were cut close to the ground surface. Then they were sum dried and collected individually in paper bags after cutting in small pieces. After sun drying, these samples were put in an electric oven at 65 $^{o}$C till the constant dry weight. The dry weight of the plants obtained was finally expressed in gm$^{-2}$.

The weight was recorded and expressed an average dry matter in gram plant$^{-1}$. From the individual plot the crop of net plot area was harvested for taking observation. The final seed weight was recorded in kg plot$^{-1}$ and converted into quintal hectare$^{-1}$. The gross returns were calculated by multiplying the price of grain and straw with their respective yields, net returns were calculated by subtracting total variable cost from gross returns and benefit cost ratio was calculated by dividing the net return with total variable cost under respective treatment. The treatment comparisons were made using t-test at 5% level of significance.

## Results and discussion

### Effect on crop growth

Data on progressive plant height at the successive stages of crop growth as influenced by various moisture regimes have been summarized in Table-1. In general, plant height increased up to 90 DAS stage, there after the rate of increased in plant height was nominal at harvest stage of the crop. In all the stages of growth, the tallest plants were recorded with an irrigation practice of $I_4$ (IW/CPE of 1.0) which was statically at par with $I_5$ (IW/CPE of 1.2) and the shortest plants with $I_1$ (at CRI stage) and $I_2$ (0.6 IW/CPE ratio). The highest plant growth (89.50 cm) was received with $I_4$ at harvest which was 34.59% increased over $I_1$ (at CRI stage). The highest plant height could be attributed to the fact that due to proper supply of moisture which affects the solubility of nutrients resulted in increment of plant height. The finding were in close conformity with Deo *et al*. (2017) [6], Jat *et al*. (2015) [8], Dangar *et al*. (2017) [4], Nayak *et al.* (2015) [12], Kaur and Mahal (2016) [6].

### Dry matter accumulation

The data regarding dry matter accumulation depicted in table-1 revealed that the dry matter accumulation increased with successive increment of days after sowing 60, 90 and at harvest stage of the crop. The higher dry matter accumulation (285.68 at 60, 743.50 at 90 DAS and 944.25 at harvest) were recorded with the moisture regime $I_4$ (1.0 IW/CPE ratio) which was significantly superior over $I_3$ (0.8 IW/CPE) and $I_2$ (0.6 IW/CPE) and $I_1$ (CRI stage), however, it was statically at par with $I_5$ (1.2 IW/CPE ratio) and minimum was recorded with $I_1$ (CRI stage). This might be due to increase in plant height and uptake of nutrients through maintaining adequate moisture supply. All these contributed for full turgidity and opened leaves, which increased the photosynthetic activity of crops, resulting higher dry matter accumulation. The lowest dry matter accumulation might be due to lack of desired moisture, which resulted in reduced plant height and led to reduced photosynthetic activity which ultimately reflected in lowest dry matter accumulation. These results with response of moisture regimes was also reported by Deo *et al*. (2017) [6], Jat *et al*. (2015) [8], Dangar *et al.* (2017) [4], Chouhan *et al*. (2017) [2] and Kumar *et al*. (2018) [11].

### Yield attributes and yield

The yield attributes and yield significantly influenced by moisture regime presented Table-l. The data on yield attributes character like number of spike m$^{-2}$, number of grain spike$^{-1}$, grain and straw yield were recorded highest with the level of irrigation $I_4$ (1.0 IW/CPE ratio) which was statistically at par with $I_5$ (1.2 IW/CPE ratio) however, it was significantly superior over with $I_2$ (0.6 IW/CPE ratio), $I_3$ (0.8 IW/CPE ratio) and $I_1$ (at CRI stage). Considering the progress of yield in percentage, it was 90.75% higher over the application of irrigation at CRI stage. It was due to timely and adequate supply of water at the crop growth and development stage and this did interfere with crop growth and profuse tillering continued with increasing rate at harvest. Similar result has also been reported by Rehman *et al.* (2000) [17], Dangar *et al*. (2017) [4], Kumar *et al*. (2018) [11]. The highest thousand grain weight was recorded with $I_4$ (1.0 IW/CPE ratio) which was statistically at par with $I_5$ (1.2 IW/CPE ratio) while significantly higher than CRI stage. The highest value of test weight might be due to favorable vegetative growth and development obtained under adequate water supply during entire period of wheat crop. This result is in close conformity to those obtained by Deo *et al.* (2017) [6].

## Economics

The data presenting to economics depicted in Table-2 revealed that the maximum cost of cultivation of Rs. 31698 $ha^{-1}$ was recorded with moisture regime of irrigation $I_5$ (1.2 IW/CPE ratio) followed by moisture regime $I_4$ (1.0 IW/CPE ratio). The cost of cultivation was increased in the greater number of irrigations, while minimum cost of cultivation Rs. 24768 $ha^{-1}$ was computed under less moisture regime at CRI stage. The gross return was increased with increased in grain and straw yield of wheat crop. The maximum gross return Rs. 86364 was received with $I_4$ (1.0 IW/CPE ratio) followed by $I_5$ (1.2 IW/CPE ratio) where minimum net return Rs. 47076 was received with $I_1$ (at CRI stage). Increased in net return were recorded with increase in level of moisture regimes. The highest benefit cost ratio (1.82) was also received with $I_4$ (1.0 IW/CPE ratio) followed by $I_5$ (1.2 IW/CPE ratio) and minimum cost benefit ratio (0.90) was recorded with $I_1$ (at CRI stage). This was higher due to the magnitude of increase in grain and straw yield of the wheat crop. These finding are well supported by Jat *et al*. (2015) [8], Singh *et al*. (2012) [19], Tripathi and Bastia (2012) [21] and Yadav and Singh (2014) [24].

## Conclusion

On the basis of present investigation, it may be concluded that the moisture regime 1.0 IW/CPE ratio (5-6 irrigation) was found suitable for achieving higher, yield attributes, yield, net return and benefit cost ratio of wheat crop.

**Table 1:** Growth parameter, dry matter accumulation, yield attributes and yield as influence by moisture regimes on wheat crop.

| Treatments | Plant height (cm) | | | Dry matter accumulation ($gm^{-2}$) | | | Number of spike $m^{-2}$ | Number of grains $spike^{-1}$ | Yield ($q\ ha^{-1}$) | | Test weight (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60DAS | 90DAS | At harvest | 60DAS | 90DAS | At harvest | | | Grain | Straw | |
| $I_1$ | 35.77 | 64.12 | 66.50 | 173.13 | 409.00 | 581.25 | 292.75 | 35.00 | 22.37 | 35.75 | 36.00 |
| $I_2$ | 39.30 | 78.99 | 80.70 | 227.17 | 632.07 | 870.40 | 351.75 | 41.25 | 34.37 | 47.37 | 42.00 |
| $I_3$ | 41.40 | 82.60 | 83.75 | 240.91 | 704.74 | 915.00 | 374.25 | 45.00 | 38.50 | 53.00 | 42.50 |
| $I_4$ | 46.00 | 87.95 | 89.50 | 285.68 | 743.50 | 944.25 | 398.00 | 52.00 | 42.67 | 56.75 | 43.22 |
| $I_5$ | 43.70 | 85.07 | 86.90 | 268.30 | 722.69 | 959.25 | 385.00 | 48.00 | 40.87 | 55.06 | 42.75 |
| SEm± | 1.02 | 1.48 | 1.96 | 12.58 | 11.29 | 24.64 | 5.79 | 1.36 | 0.92 | 0.99 | 0.35 |
| CD (P=0.05) | 3.15 | 4.57 | 5.19 | 38.77 | 34.78 | 75.92 | 17.85 | 4.19 | 2.84 | 3.06 | 1.40 |

**Table 2:** Economics as influenced by moisture regime on wheat crop.

| Treatment | Total cost (Rs.) | Gross return (Rs. $ha^{-1}$) | Net return (Rs. $ha^{-1}$) | (B: C ratio) |
|---|---|---|---|---|
| $I_1$ | 24768 | 47076 | 22308 | 0.90 |
| $I_2$ | 28233 | 70062 | 41829 | 1.48 |
| $I_3$ | 29388 | 78462 | 49074 | 1.66 |
| $I_4$ | 30543 | 86364 | 55821 | 1.82 |
| $I_5$ | 31698 | 82932 | 51234 | 1.61 |

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