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Performance of Wheat (*Triticum aestivum* L.) under different Irrigation Scheduling and Sowing Dates

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ABSTRACT: Wheat is a temperature sensitive crop, its delayed sowing exposes the crop to temperatures stress. Irrigation at critical stages is important for proper crop growth and development. Irrigation scheduling can reduce the adverse effect of high temperature to some extent thereby in achieving optimum yield. A field experiment was carried out at agricultural engineering farm, College of Agriculture Engineering, JNKVV, Jabalpur (M.P.). Twelve treatment combinations comprised of three sowing dates, *viz*., 03 December, 18 December and 02 January were assigned to the main-plots and four Irrigation water/Cumulative Pan Evaporation (IW/CPE) ratio based irrigation scheduling in sub-plot treatments *viz*., 1.0, 0.9, 0.8 and 0.7 was laid out in split- plot design with three replications. All the crop growth characters *viz*., plant height (91.60 cm) and number of tillers m^{-2} (415.25), yield attributes *viz*., number of effective tillers m^{-2} (402.6) and number of grains $earhead^{-1}$ (45.21), and grain yield (4.64 t ha^{-1}) and straw yield (6.79 t ha^{-1}) were significantly superior in first sowing (03 December) over the others. Among the irrigation scheduling, 1.0 IW/CPE level recorded significantly superior crop growth characters *viz*., plant height (89.25 cm) and number of tillers m^{-2} (370.44), and yield attributes *viz*., number of effective tillers m^{-2} (358.2) and number of grains $earhead^{-1}$ (44.77) which ultimately increased the grain (4.51 t ha^{-1}) and straw yield (6.68 t ha^{-1}). A strong linear positive relationship was observed between the grain yield with plant growth characters and yield attributes. A linear increase in grain yield was observed with the increase in growth characters and yield attributes. This suggests that 03 December sowing dates and 1.0 IW/CPE level of irrigation could be the best treatment to achieve optimum yield.

Keywords: Date of sowing, IW/CPE, growth & yield characters, grain yield, straw yield.

INTRODUCTION

Wheat is the most important source of carbohydrates, grown all over the world on 215 Mha area with the production of 765 Mt (FAOSTAT, 2021). In India, it has second rank after the rice, covers a total area and production of 29 Mha and 103 Mt, respectively with the yield of 3420 kg ha^{-1} during the year 2019 (World Agriculture production, USDA, 2020). In Madhya Pradesh, wheat is grown in an area of 5.52 Mha with the production of 15.47 Mt during the year of 2018-19 (Agriculture statistics at a glance, 2019). Water is an important input required to achieve higher wheat yield. Wheat is sensitive crop for water stress especially during its critical period of crop growth. Water stress at crown root initiation (CRI) and flowering stage may lead to decrease the yield (Niwas *et al.*, 2020). Irrigation water plays an important role to maintain the turgidity of cell and hence, plays a crucial role in the photosynthesis. It is important for the absorption of nutrients and to maintain metabolic activities of the crop plants. Also, water stress at early stage of crop results in the reduced plant population and hence, the grain yield. Water is one of the important resources among the various resources therefore, efficient utilization of irrigation water is essential. Thus, irrigation at right time and in sufficient amount might bring about the reduction in irrigation number with economic crop yield. Therefore, there is a need for use of scientific method to schedule irrigation. Irrigation scheduling based on climatological approach is a scientific method that allows to apply a known amount of water. Furthermore, sowing of wheat gets delayed in the rice-wheat cropping system due to late harvesting of transplanted rice. Sowing time is a crucial factor for achieving higher yield. Delayed sowing exposes the crop to low temperature during the early stages and high temperature to the later part of life cycle of the crop, high temperature at reproductive stage leads to reduce yield. Higher temperature hastens the growth stages of wheat while reducing the growth rate with reduced leaf size, tillering capacity and spike length that results in lower yield (Mullakery & Jones 2000; Sial *et al.*, 2001). Late sowing results in reduction of crop growth duration (Agrawal *et al.*, 1999) that results

in reduced wheat yield (Khande *et al*., 2021) Moreover, the impact of high temperature on the crop yield can be lowered by the adoption of agronomic management strategies like adjusting date of sowing (Jeet *et al*., 2010). Irrigation scheduling can counteract the adverse effect of high temperature up to a certain level. The choice of sowing date with irrigation scheduling could be an option to obtain optimum yield with the more water use efficiency. In view of above facts, present study was undertaken in order to evaluate water use efficiency of wheat under different levels of irrigation schedules among different dates of sowing.

MATERIAL AND METHODS

Field experiment was conducted during the *rabi* season of 2020-21 at Agricultural Engineering farm, College of Agriculture Engineering, JNKVV, Jabalpur (M.P.). Twelve treatment combinations comprised of three sowing dates *viz*., 03 December, 18 December and 02 January were assigned to main-plots and four IW/CPE based irrigation scheduling *viz*., 1.0, 0.9, 0.8 and 0.7 in sub-plot under split- plot design. The soil of the experiment was clay-loam in texture, neutral soil pH (7.1), medium in soil organic carbon (0.55 %) with low in N (257.18 kg ha^{-1}), medium P (15.83 kg ha^{-1}) and high in (301.25 kg ha^{-1}). Fertilizers were applied uniformly through urea, di-ammonium phosphate (DAP) and Muriate of potash (MOP) @ 120:60:40, $N:P_2O_5:K_2O$. Half dose of nitrogen and full dose of DAP and MOP were applied as basal. Rest half of nitrogen was applied after the first irrigation. The wheat variety "MP 3336" was selected for the experiment and sown as per the treatment assigned using 120 kg ha^{-1} seed rate. All the package of practices were done as per the recommendation of this area.

Total rainfall received during the season was 22 mm in 2 rainy days. The crop was exposed to the 132.2 sunshine hours. The experiment field was prepared by ploughing followed with disc harrowing. After levelling, field layout was done as per the treatment applied. A comeup Irrigation was given for uniform germination. After that, irrigation was done as per the scheduling. The depth of irrigation was fixed 50 mm for four IW/CPE levels of irrigation as per the formula suggested by Parihar *et al*. (1974).

$$\text{IW/CPE} = \frac{\text{Irrigation water depth(IW)}}{\text{Cumulative pan evaporation(CPE)}}$$

There was a difference in number of irrigations. The crop growth character *viz*., plant height and number of tillers m^{-2} were observed at 90 DAS and yield attributes *viz*., number of effective tillers m^{-2} and number of grains $earhead^{-1}$ were recorded. Grain and straw yield were recorded and expressed in t ha^{-1}.

Statistical analysis

The data obtained was statistically analyzed using OPSTAT software available online at CCS Haryana Agriculture University (www.hau.ernet.in). The Data were tabulated and analyzed by using ANOVA (Gomez and Gomez 1984). The significant difference between treatment means were compared using critical differences at 5 % levels of probability.

RESULTS AND DISCUSSION

A. Crop growth characters

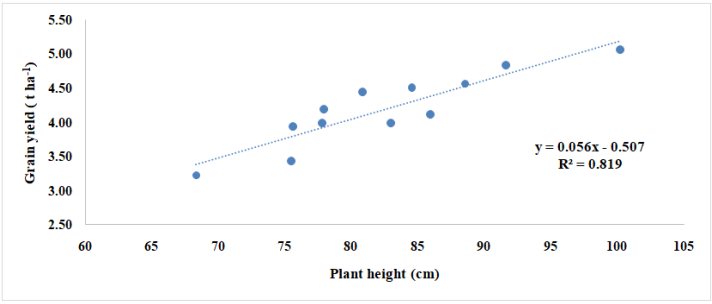
Date of sowing significantly influenced the growth character *viz*., plant height and no. of tillers (m^{-2}) at 90 DAS (Table 1). Plant height (91.61cm) was significantly more in 03 December sowing date than 18th December and 2nd January. This might be because of better favourable conditions available at 3rd December that favoured growth and development of wheat crop. Alam *et al.* (2022) also observed significantly more plant height in timely sowing of wheat. The results are in close line with Prasad (2016); Pathania *et al*. (2018). Singh and Vimal (2022) also noted highest plant height and no. of tillers in timely sowing over the other delayed sowing. Among the irrigation scheduling, 1.0 IW/CPE recorded more plant height (89.25 cm) and no. of tillers m^{-2} (378.22) over the others. This might be because of sufficient moisture availability at root zone that made soluble nutrients available to the crop plant that resulted in increased plant height. The results are corroborated with the findings of Deo *et al.* (2017) that the plant height was significantly different due to moisture regimes. Lanjhewar *et al.* (2022) also observed more plant height and no. of tillers m^{-2} with the more number of irrigations.

B. Yield attributing characters

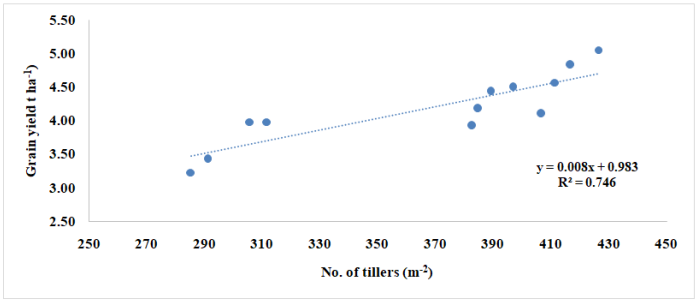
The observation on various yield attributes of wheat were recorded and summarized in the table1. A cursory glance on the data represented revealed that the number of effective tillers per m^{-2}, no. of grains $earhead^{-1}$ were significantly more in 03 December sown date than 18 December and 02 January. This might be because of favourable weather conditions of low temperature coupled with less sunshine hours and high relative humidity favoured its vegetative growth establishment in the field thereby a greater number yield attributes of wheat. Prasad (2016) also observed yield attributing characters *viz*., no. of effective tillers and no. of grains $earhead^{-1}$ were reduced with the delay in sowing. Throat (2015); Jain (2019) were also observed more yield attributes in timely sowing over the delayed sowing. Among the irrigation scheduling, 1.0 IW/CPE level registered significantly more number of effective tillers and number of grains $earhead^{-1}$. This might be because of more moisture availability that favoured more yield attributing characters of the wheat. Pal *et al*., 2020 also observed more yield attributes *viz*., number of spikes, no. grains $earhead^{-1}$. Lanjhewar *et al.* (2022) also observed more yield attributes under the irrigation scheduling at IW:CPE = 1.0.

Table 1: Performance of growth characters at 90 DAS and yield attributes of wheat under different irrigation scheduling and sowing dates.

Treatments	Plant height (cm)	No. of tillers (m^{-2})	No. of effective tillers (m^{-2})	No. of grains earhead^{-1}
Sowing dates				
03 December	91.61	415.25	402.6	45.21
18 December	79.77	388.25	366.8	40.17
02 January	76.18	298.42	282.9	38.62
SEm ±	**1.15**	**9.02**	**5.4**	**2.84**
CD (5%)	**4.64**	**36.35**	**21.6**	**1.4**
Irrigation scheduling (IW/CPE)				
1.0	89.25	378.22	358.2	44.77
0.9	83.46	370.44	356.7	42.37
0.8	80.68	362.33	344.4	40.61
0.7	76.67	358.22	343.8	37.58
SEm ±	**0.72**	**1.6**	**8.5**	**0.32**
CD (5%)	**2.17**	**5.0**	**2.8**	**0.95**



(a)



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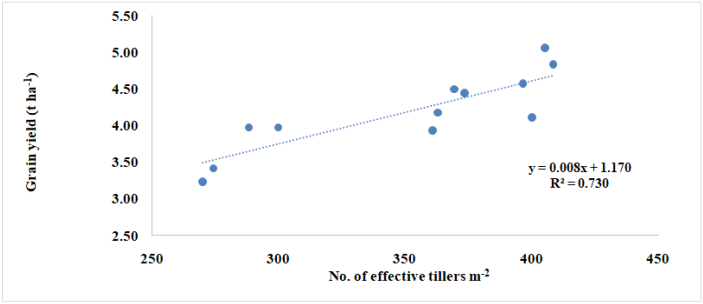

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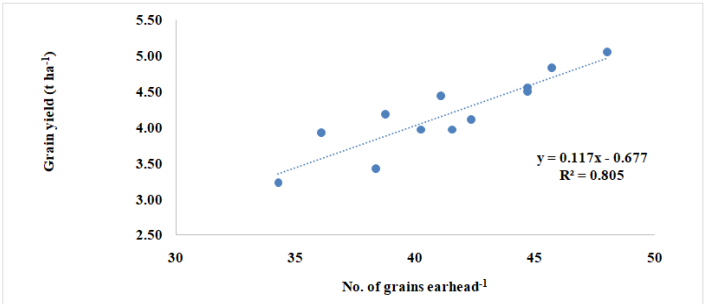

(d)

Fig 1. Relationship between grain yield (t ha^{-1}) with (a) Plant height (cm), (b) No. of tillers m^{-2}, (c) No. of effective tillers m^{-2} and (d) No. of grains earhead^{-1}.

Relationship between growth characters and yield (t ha^{-1}). The regression analysis was carried out by fitting linear response function between grain yield and growth characters. The analysis between grain yield with plant height (cm) and number of tillers m^{-2} showed a linear increase in yield with the increase in plant height and number of tillers as depicted in fig. 1(a) and (b).

There was a positive significant relationship between plant height (cm) and no. of tillers (m^{-2}) and grain yield (t ha^{-1}) under different sowing dates and irrigation schedules, Fig. 1 (a-b). It is evident from the graph that with the increase in growth characters *viz*., plant height (R^2 = 81%) and no. of tillers (R^2 = 74 %), the grain yield increases. This might be because of favourable environment provided by the 1st sowing date and 1.0 IW/CPE for the growth of crop plant. Buttar *et al.* (2018); Pathania *et al.* (2018) also observed linear increase in grain yield with the increase in growth characters.

Relationship between yield attributing characters and Grain yield (t ha^{-1}). The regression analysis (Fig. 1 c-d) shows a positive significant relationship between number of effective tillers (m^{-2}) and no. of grains per earhead^{-1} and grain yield (t ha^{-1}) under different sowing dates and irrigation schedules. It is evident from the graph that with the increase in yield attributing characters, the grain yield increases. The coefficient of determination shows 73 percent and 80 percent variation in grain yield. This might be because of favourable environment provided by the 3rd December sowing date and 1.0 IW/CPE levels that might have resulted in better crop yield attributes. Buttar *et al.* (2018) also observed significance of sowing dates and irrigation on yield attributes and yield of wheat. Pal *et al*. (2020) also observed more yield attributes with the more moisture availability. Lanjhewar *et al*. (2022) also observed reduced yield and yield attributes with delayed sowing and less irrigations.

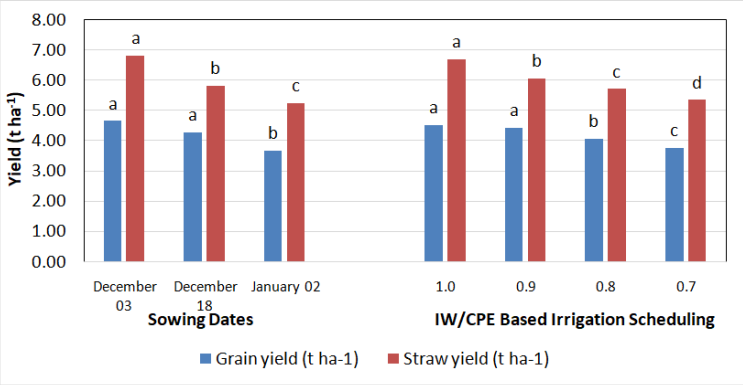

Fig. 2. Performance of grain and straw yield of wheat under different sowing dates and irrigation scheduling**.**

Grain and straw yield (t ha^{-1}). Date of sowing and IW/CPE based irrigation scheduling showed a significant influence on grain and straw yield (Fig. 2). It is clear from the graph that the grain yield and straw yield were significantly more under 03 December sowing date than other sowing dates. Prasad (2016); Pathania *et al*. (2018) also observed significant influence on yield. Lanjhwar *et al*. (2022) also observed reduced yield with the delay in sowing. Among the irrigation scheduling, 1.0 IW/CPE level recorded significantly more grain and straw yield over the other IW/CPE levels. As also observed by Thorat (2015); Jain (2019). Lanhjewar *et al*. (2022) also observed significantly more yield under more number of irrigations. Alam *et al.* (2022) also observed more yield at 1.0 IW/CPE ratio.

CONCLUSIONS

The study concludes that 03 December sowing produces higher growth and yield attributes thus resulting significantly higher yield of wheat. Among the irrigation schedules, 1.0 IW/CPE level produced higher growth and yield attributes. However, decrease in level of irrigation level has negative effect on growth and yield attributing characters. A strong positive relationship was observed between growth and yield attributes with grain yield. Hence, to achieve the optimum yield 03 December sowing date and 1.0 IW/CPE ratio proved to be the best treatment in wheat.

FUTURE SCOPE

The 03 December sowing date and 1.0 IW/CPE level could be taken to achieve optimum yield of wheat.

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REFERENCES

Agriculture statistics at a glance (2019), http://eands.dacnet.nic.in

Anonymous. World Agriculture Production by USDA. 2020. http://ipad.fas.usda.gov/search.aspx+

Agrawal, K. K., Shankar, U., Upadhyay, A. P. and Gupta V. K (1999). Accumulated heat unit requirements for different Phenophases of wheat cultivars as influenced by sowing dates and sowing dates at Jabalpur. *Journal of Agrometeorology*, *1* (2), 173-176.

Alam, M. A., Naresh R. K., Vivek, Kumar, S. and Singh, H. L. (2022). Effect of sowing methods and Irrigation Scheduling on Production and Productivity of Wheat Crop. *Biological Forum- An International Journal*, *14*(2a), 445-452.

Buttar, B.S., Kingra, P. K. and Singh, S. P. (2018). Effect of Sowing dates, Irrigation and Mulching on growth and Yield of Wheat. *Agric Res J.*, *55*(2), 243-250.

Deo, K., Mishra S. R., Singh A. K., Mishra A. N. and Singh, A. (1984). Water requirement of wheat crop for optimum production using CROPWAT model. *Journal of Medicinal Plants Studies*, *5*(3), 338-342.

Fao. 2021, fao.org/faostat/en/#data

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedure for Agriculture Research. John Wiley & sons, New York, *2*, 241-71.

Jeet, S., Saini, K. S., Kumar, R. and Kumari, A. (2010). Effect of seed rates and nitrogen levels in relation to crop residue management on microenvironment of bed planted soybean (*Glycine* max)- wheat (*Triticum aestivum*) system. *Environment & Ecology*, *28*(3), 1571-1577.

Jain, P. (2019). Fertilizer and water interaction for prediction wheat yield under varying thermal regimes in vertisol using CERES wheat model. Ph.D. Thesis. Department of Agronomy. Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur.

Khande, D., Agrawal, K. K. and Bhan, M. (2021). Phenology and heat unit requirement of wheat under various thermal environments and different methods of sowing in Tawa Command area of Madhya Pradesh. *Anveshak, 51*(2).

Lanjhewar, A., Agrawal, K. K., Bhan, M. and Patel, K. (2022). Influence of Thermal Regimes and irrigation schedules on Growth, Yield attributes and Yield of Wheat (*Triticum aestivum* L.) Varieties. *International Journal of Environment and climate change, 12*(12), 484-490.

Mullarkey, M. and Jones, P. (2000). Isolation and analysis of thermotolerant mutants of wheat. *Journal of Experimental Botany*, *51*(342), 139-146.

Niwas, R., Singh, B. N., Verma, V. K., Kumar, V., Kumar, K., Singh, D. P. and Singh, D. (2020). Effect of Irrigation Management (IW/CPE Ratio & Critical Growth stages) on yield and quality of Wheat (*Triticum aestivum* L.). *International Journal of current microbiological applied Sciences*, *11*, 1349-1354.

Pal, S., Kumar S., Gangwar, H. K., Singh, A. and Kumar, P. (2020). Effect of scheduling irrigation based on IW/CPE ratio on dry matter accumulation, yield attributes, yield and Economics of Wheat crop (*Trieticum aestivum* L.). *Journal of Pharmacognosy and Phytochemistry*, *9*(4), 1946-1949.

Parihar, S. S., Khera, K. L., Sandhu, K. S. and Sandhu, B. S. (1976). Comparison of irrigation scheduling based on pan evaporation and growth stages in winter wheat. *Indian Journal of Agronomy*, *68*, 650-653.

Pathania, R., Prasad, R., Rana, R. S., Mishra, S. and Sharma, S. (2018). Growth and yield of wheat as influence by dates of sowing and varieties in north western Himalayas. *Journal of Pharmacognosy and Phytochemistry*, *7*(6), 517-520.

Prasad, S. (2016). Effect of sowing time and nutrient management on growth and yield of heat tolerant varieties of wheat. Ph.D. Thesis. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (2016).

Sial, M. A., Arain, M. A., Javed, M. A. and Nizamani, N. A. (2001). Response of wheat genotypes on yield and yield components with changing plant population densities. *Pak. J. Bot.*, *33*, 797-800.

Singh, H. and Vimal, S. C. (2022). Optimum Date of sowing for Maximization of Seed Yield and its Quality Parameters in Wheat (*Triticum aestivum* L.). *Biological Forum – An International Journal, 14*(2a), 63-70.

Throat, N. (2015). Assessment of wheat productivity using CERES-wheat model as influenced by varieties, planting dates and irrigation in vertisol. Ph.D. Thesis. Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur.

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