Original Research Article

Influence of thermal regimes and irrigation schedules on growth, yield attributes and yield of wheat (*Triticum aestivum* L.) varieties

Abstract

A field experiment was conducted at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India during the *rabi* season of 2020-2021 and 2021-2022, to study the Influence of thermal regimes and irrigation schedules on growth, yield attributes and yield of wheat (*Triticum aestivum* L.) varieties. The experiment was conducted in split plot design with three thermal regimes (3rd December, 18th December and 2nd January), four irrigation schedules (IW: CPE=1.0, IW: CPE= 0.9, IW: CPE= 0.8 and IW: CPE=0.7) and two varieties (Lok 1 and MP 3336) with three replications. Sowing time with proper application of irrigation and varieties significantly influenced yield attributes and ultimately yield of the wheat. Higher grain yield (4,735 kg ha^{-1}) was observed under crop was sown on 3rd December thermal regimes with IW: CPE=1.0, irrigation schedule and variety MP 3336 over rest of the treatments. It may be due to the maximum number of effective tillers (484.2 m^{-2}), length of earhead (8.70 cm), no. of grains earhead^{-1} (45.5) and harvest index (41.91%) as compare to other treatment combinations. Significant lowest grain yield was noted under 2nd January thermal regimes with IW: CPE= 0.7, irrigation schedule and variety Lok 1.

Keywords: Grain yield, straw yield, wheat, thermal regimes, irrigations schedule

Introduction

Wheat (*Triticum aestivum* L.) is an essential cereal grain and staple food for millions of people worldwide, as well as an important crop for India during the green revolution and post green revolution era. It is India's second most important crop after rice, occupying approximately 29 mha and producing 109.1 mt (USDA.2021). In Madhya Pradesh, this crop is presently being cultivated on 5.52 mha with a production of 15.47 mt and productivity of 3198 kg ha^{-1} (Department of Agriculture, M.P., 2020).

Wheat demand in the developing world is expected to increase by 60% by 2050. (CIMMYT, 2013).

The thermal environment is one of the most important factors governing crop phenology and the efficient conversion of biomass into economic yield. Wheat yield is highly affected by late sown environment. Wheat is sown at different times of the year for a variety of reasons, including the presence of previous crops and diversity in cropping systems. Wheat planted late usually experiences high temperatures during the grain filling period, results in a lower crop yield. Because of the longer growing period, early sowing produces a higher yield than late sowing (Munir *et al*., 2002; Tanveer *et al*., 2003). It has been realized that the average yield of wheat of this region, sown during November sown environment, is well comparable to the state average, but the declining trend in wheat yield has been noticed with delayed sowing i.e., in the month of December and January. A sudden increase in temperature for 4-5 days at any stage of the wheat crop can reduce crop yield (Spiertz *et al*., 2006), and even a one-day abnormal increase in temperature at the grain formation and filling stages can result in significant grain losses (Alexander *et al*. 2010). It is primarily due to the shorter growth period available to late-sown wheat, combined with high temperatures and hot winds during the reproductive growth period, tends to result in forced maturity and, ultimately, poor grain yield.

Water is necessary at every stage of plant development, from seed germination to plant maturation, in order to harvest wheat with the highest potential yield. The optimum use of irrigation water enables the effective utilization of all other production elements and increases yield per unit of area and time. There is a positive correlation between grain yield and irrigation frequencies (Kumar *et al*., 2012). Irrigation had a significant impact 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 yield, straw yield and harvest index. (Malik *et al*. 2012).

Varieties play an important role in obtaining higher yield of wheat crop. The varieties are losing their yield potential due to changes in various edaphic and environmental conditions. Therefore, the selection of suitable variety for the particular location is a paramount importance. Keeping these facts in mind, the current study was designed to determine the Influence of thermal regimes and irrigation schedules on growth, yield attributes and yield of wheat (*Triticum aestivum* L.) varieties.

Materials and Methods

The experiment was conducted on wheat crop during *Rabi* season 2020-2021 and 2021-2022 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh. The soil of experimental land was sandy clay loam with pH 7.1, EC 0.25 ds/m and 0.54 % organic carbon, medium in available N (257.18 kg/ha), P (15.83 kg/ha) and K (301.25 kg/ha). The site of experiment is located at 23º09’ N latitude and 79º58’ E longitude and an altitude of 411 above mean sea level. Twenty-four treatment combinations, consisting of three thermal environments (3rd December, 18th December and 2nd January) in main plots, four IW: CPE ratio-based irrigation schedules (I_1= 1.0, I_2= 0.9, I_3= 0.8 and I_4= 0.7) in sub-plots and two wheat varieties (V_1= Lok 1 and V_2= MP 3336) in sub-sub plots were laid out in split plot design with three replications. The field was prepared properly to carry out wheat sowing. The graded and healthy seed of wheat crop was sown in line 20 cm apart with seed rate of 125 kg/ha. Fertilizers were applied uniformly to all the plots through urea, di ammonium phosphate and muriate of potash @120-60-40 kg $N\text{-}P_2O_5\text{-}K_2O$ per ha. Half of the nitrogen and full dose of phosphorus and potash were given basal and remaining nitrogen was given in two splits. Irrigations as per treatments were applied in individual plots. Depth of irrigation was 5 cm for each irrigation schedule. However, a shallow come-up Irrigation was given immediately after sowing of the wheat crop to all the treatments. Total rainfall received was 22.0 mm and 51.5 mm distributed in 2 and 7 rainy days during first and second year respectively. The IW: CPE ratios were calculated based on depth of irrigation water and the cumulative pan evaporation during the period. After crop establishment, five plants were randomly selected from each plot for recording periodical observations on growth and yield attributing parameter like plant height, number of tillers, number of effective tillers, earhead length, number of grains per earhead, 1000-grain weight, grain yield and straw yield. The data collected were statistically analyzed by using OP state software.

3. Results and Discussion

3.1. Effect of thermal regime

Sowing environment plays important role in the growth, development and yield of wheat. Different growth, yield attributes and yield of wheat varieties vary significantly under different thermal regimes. The crop sown on 3rd December thermal regime recorded the highest plant height (94.0 cm), number of effective tillers m^{-2} (484.2), earhead length (8.70 cm), number of grains per earhead (45.5), 1000 grain weight (45.5 g). Grain yield (4,735 kg ha^{-1}), straw yield (6,580 kg ha^{-1}) and harvest index (41.91%) were also maximum over rest of the thermal regimes (Table 1). It is might be due to the congenial environment condition enhances growth and nutrient uptake, resulting in delay maturity and ultimately increases the grain yield, whereas delay in crop sowing cause reduction in yield (Choudhary *et al*. (2010). The reduction in yield and lower magnitude of yield attributes in late sown crop might be due to the exposure to higher temperature during the reproductive phase of the crop. An increase in temperature tends to promote growth, which in turn dilutes the amount of carbohydrates and chlorophyll in late-sown crops. Thus, these findings confirm those of Agrawal *et al*. (2001), Throat *et al*. (2015), Prasad *et al*. (2017), Bobade *et al*. (2017) and Khande *et al*. (2021).

3.2. Effect of irrigation schedules

Water is essential at every developmental phase starting from seed germination to plant maturation for harvesting the maximum potential yield of wheat. Treatment I_1 (Irrigation at 1.0, IW/CPE ratio) significantly increased the plant height (96.4 cm), number of effective tillers m^{-2} (489.9), earhead length (8.50 cm), number of grains per earhead (47.2) and 1000 grain weight (45.8 g) over I_2, I_3 and I_4 (Table 1). Grain yield (4,496 kg ha^{-1}), straw yield (6,335 kg ha^{-1}) and harvest index (41.52%) were also maximum as compare to rest of the irrigation schedules (Table 1). The lowest growth, yield and yield attributes were found under I_4 (IW: CPE= 0.7) irrigation schedule. This was due to fewer number of irrigations I_4 (IW: CPE= 0.7) than I_1 (IW: CPE= 1.0) ratio which received more irrigations during its whole growth period. All the growth, yield attributes and yield are significantly superior under irrigation schedule I_1 (IW: CPE= 1.0) probably because of the increased water availability in the root zone resulted in absorption of nutrients from the soil which ultimately gives vigorous growth and reproductive capacity of the wheat. This finding is in conformity with Salunkhe *et al.* (2012), Verma *et al*. (2017), Deo *et al.* (2017), Pal *et al*. (2020) and Gajbhiye (2021) also reported similar results.

3.3. Effect of varieties

Selection of suitable crop varieties according to the agroclimatic conditions may play crucial role in realizing the optimum production of any crop commodity (Singh *et al*., 2008). Result of present study indicated that variety MP 3336 attained significantly higher grain yield (4,341 kg ha^{-1}) and straw yield (5,836 kg ha^{-1}) as compared to Lok 1. This might be due to higher yield attributes viz., number of effective tillers m^{-2} (445.9), earhead length (8.24 cm) and number of grains per earhead (44.6) and harvest index (42.69%). This could be because of genetic makeup of that particular variety as well as climatic requirement of the different varieties. These results are similar to those of Tripathi *et al*. (2013), Alam *et al*. (2013), Satyendra Kumar *et al*. (2013) and Prasad *et al*. (2017).

4. Conclusion

On the basis of present investigation, it may be concluded that the 3rd December thermal regime with irrigation schedule (IW: CPE= 1.0) and MP 3336 produced higher yield attributes viz., number of effective tillers m^{-2}, length of earhead, number of grains per earhead and harvest index resulting in a higher grain yield than Lok 1.

Table 1: Effect of thermal regimes and irrigation schedules on growth, yield attributes and yield of wheat varieties (mean of two years)

Treatments	Plant height (cm)	No. of effective tillers (m^{-2})	Length of earhead (cm)	Number of grains $earhead^{-1}$	1000 grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index
Thermal regimes								
E_1- 03 December	94.0	484.2	8.70	45.5	45.5	4,735	6,580	41.91
E_2- 18 December	91.6	432.0	8.08	42.9	43.6	4,244	5,594	43.21
E_3- 02 January	86.8	374.2	7.41	40.4	40.6	3,660	5,031	42.00
SEm±	0.89	6.83	0.05	0.49	0.49	59.35	73.82	0.09
CD (5%)	3.46	26.66	0.21	1.92	1.90	231.71	288.21	0.34
Irrigation schedules (IW: CPE Ratio)								
I_1- 1.0	96.4	489.9	8.50	47.2	45.8	4,496	6,335	41.52
I_2- 0.9	93.1	452.9	8.25	44.5	44.2	4,342	5,969	42.11
I_3- 0.8	89.2	411.7	7.94	41.8	42.6	4,146	5,570	42.63
I_4- 0.7	84.6	366.2	7.58	38.2	40.4	3,868	5,067	43.24
SEm±	0.84	5.48	0.06	0.56	0.52	47.69	46.21	0.18
CD (5%)	2.49	16.29	0.18	1.66	1.53	141.72	137.31	0.55
Varieties								
V_1- Lok1	93.6	414.4	7.89	41.2	45.1	4,085	5,634	42.06
V_2- MP 3336	88.1	445.9	8.24	44.6	43.4	4,341	5,836	42.69
SEm±	0.56	3.82	0.04	0.39	0.36	21.59	27.99	0.10
CD (5%)	1.63	11.15	0.11	1.13	1.04	63.02	81.72	0.30

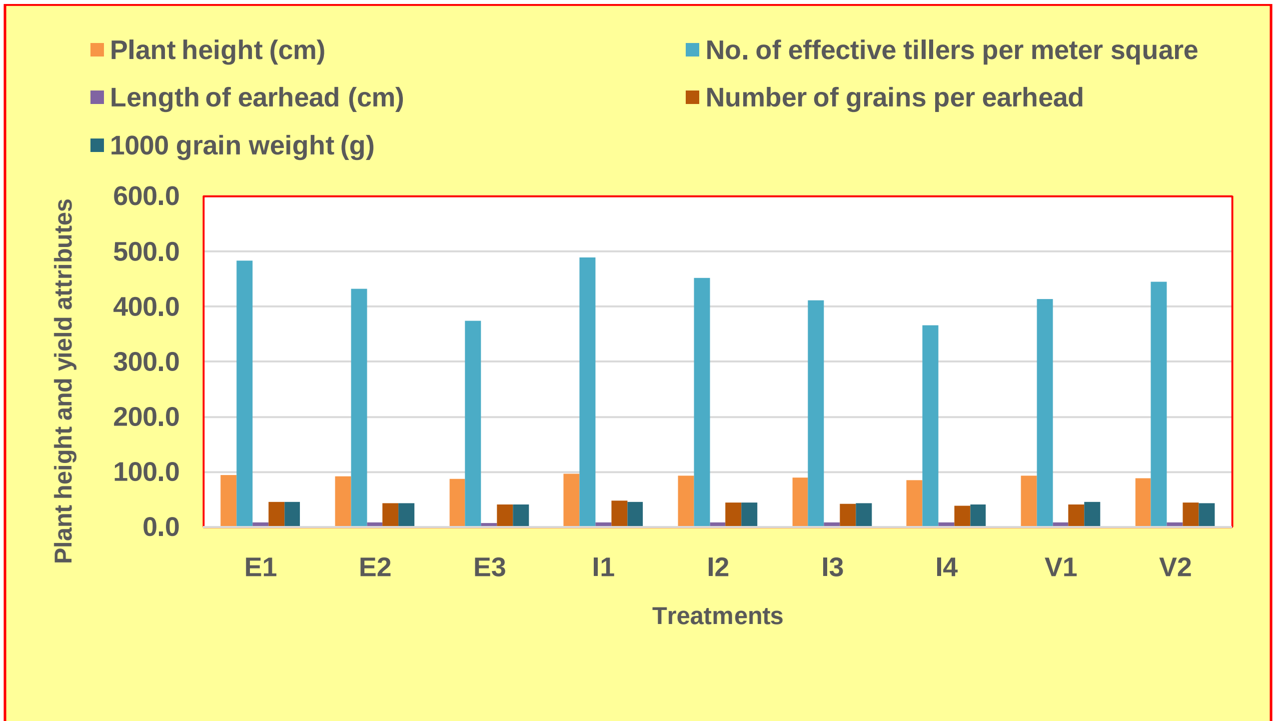

Fig. 1 Yield attributes of wheat as influenced under various treatments

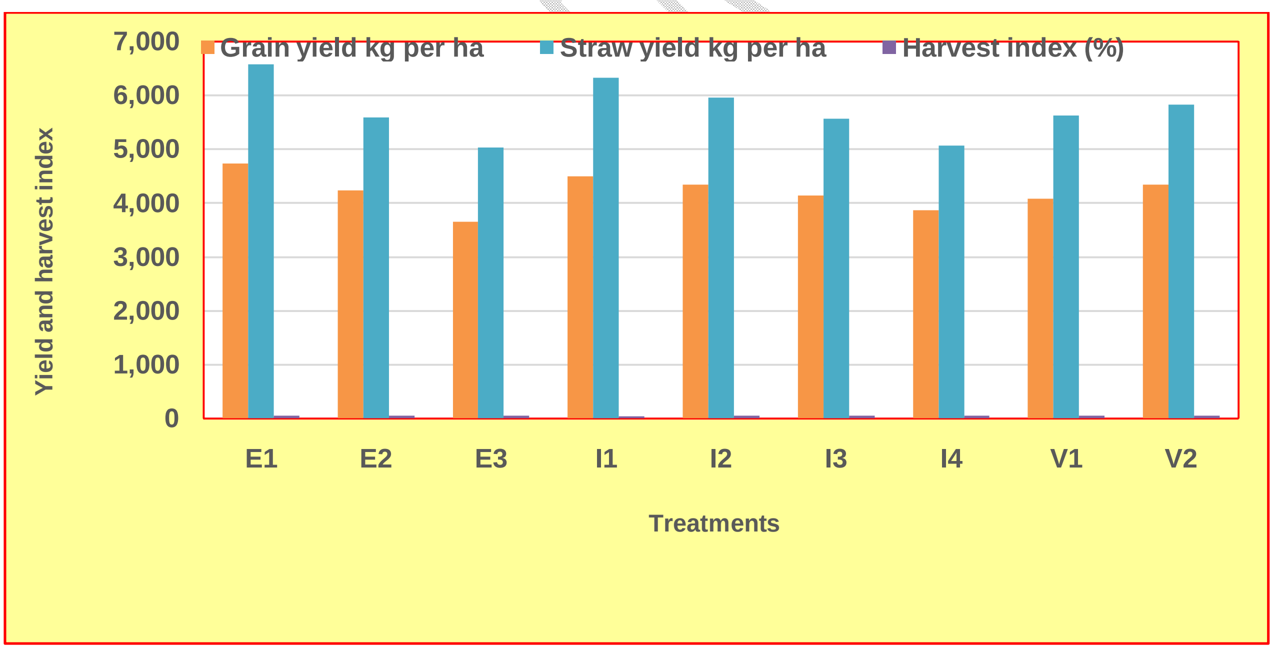

Fig. 2 Grain yield, straw yield and harvest index under various treatments

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