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Effect of Irrigations and Fertilizers Management on Growth and Yield of Wheat (*Triticum aestivum* L.) under Different Date of Sowing

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Abstract

A field experiment was conducted at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India during the winter season of 2015–16, to study the effect of different irrigation and fertilizer levels on wheat variety MP 3288. The experiment comprises of under three sowing dates (2nd December, 22nd December and 12th January), irrigations schedules (Three irrigations at CRI+flowering stage+milk stage and Four irrigations at CRI+late jointing stage+flowering stage+milk stage) and four fertility levels (No fertilizer, 60 N kg ha^{-1}:30 P_2O_5 kg ha^{-1}:20 k_2O kg ha^{-1}, 120 N kg ha^{-1}:60 P_2O_5 kg ha^{-1}:40 k_2O kg ha^{-1} and 180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1}). Sowing time with proper application of irrigation and fertilizer significantly influenced yield attributes and ultimately yield of the wheat. Superior grain yield (2.98, 2.49 and 3.43 t ha^{-1}) was observed under crop was sown on 2nd December with application of four irrigation and 180 N kg ha^{-1}: 90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1} over rest of the treatments. The crop sown on 2nd December produced highest yield, mainly because it had the maximum plant height (92.72 cm), number of effective tillers (297.83 m^{-2}), length of ear head (7.90 cm), no. of grains per earhead (34.46) and 1000 grain weight (41.61 g), harvest index (32.95%), net income (60234 ₹ ha^{-1}) over other sowing dates. The production efficiency was also highest with 2nd December (25.50 kg ha^{-1} day^{-1}) sowing with four irrigation (21.30 kg ha^{-1} day^{-1}) and 180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1} (29.30 kg ha^{-1} day^{-1}). The lowest production efficiency was recorded on 12th January (19.40 kg ha^{-1} day^{-1}) in the three irrigation and lower dose of fertilizer.

Keywords: Wheat, sowing, irrigations, fertilizers, yield, net income

1. Introduction

Wheat (*Triticum aestivum* L.) is considered one of the most important cereal not only in India but also in the world. Its importance comes from using its grain as a main food source for human and its straw as feed for livestock. In India it occupies an area of about 30.5 mha with a production of 98.38 mt and with national productivity of 3216 kg ha^{-1}. In state of Madhya Pradesh it occupy in total 10.8 mha area with the production of 30.7 mt and average productivity of 2478 kg ha^{-1} (Anonymous, 2018). In India, around 13.5 mha of wheat is heat stressed (Joshi et al., 2007). The productivity of wheat is reduced considerably by combined stress of temperature and moisture than by either stress alone and has considerable effect on photosynthetic processes (Shah and Paulsen, 2003). As land and water resources are limited in India, increasing the productivity of wheat from the unit area is an important part in increasing the total production and minimizes the gap between consumption and production. Such target will be achieved by increasing the cultivated area, cultivating high yield varieties, and adoption of improved cultural practices. In spite of cultivation of high-yielding varieties, improved cultural practices and plant-protection measures, favorable weather is must for good harvest (Rao et al., 1999).). Wheat yield is low in India on account of many biotic and abiotic factors. Among these, the time of sowing and planting density are of great significance which determine the proper stand establishment of the growing crop through balancing the plant to plant competition and ultimately affect the yield (Kabesh et al., 2009; Nakano and Morita, 2009). It has been observed that early sowing gives high yield than late sowing due to longer growing period (Suleiman et al., 2014) and vigorous growth associated with rapid and uniform seedling emergence and better combination of leaf size and tiller number. From an agronomic point of view, a key factor which is reflected in high wheat production is the well understanding of early crop establishment factors (Soomro et al., 2009) including time of planting, soil characteristics, seed viability and availability of plant machinery (Sulieman, 2010). It is important to define the optimal sowing date and seeding rate of winter wheat, due to the climate-change of habitats, not only from agro-technical factors (sowing date), but also from economic point of view.

Wheat grows mainly during dry seasons, where irrigation

is necessary because precipitation in the growing season is far less than the crop water requirement. However, water resources are usually limited. Hence, irrigation scheduling is used to allocate irrigation water rationally in crop growing stages in order to maximize crop yield, water productivity and profit under the limited conditions (Thorat et al., 2015). Wheat is sensitive to moisture stress, it needs frequent irrigation for good growth and yield (Mishra et al., 1995; Alderfasi and Nielsen., 2001). But yield increase and water use efficiency decrease above 4 irrigations (Chen et al., 2014). The crop parameters and yield of wheat were significantly higher under high frequency irrigation and grain yield reduced drastically with increase in maximum allowable depletion (MAD) of available soil water from 40–75% (Mugabe and Nyakatawa, 2000; Panda et al., 2003; Gontia and Tiwari, 2008). Fertilizers constitute an integral part of improved crop-production technology. Proper amount of fertilizer application is considered a key to the bumper crop production (Prasad et al., 2016). In addition, there is a synergy between fertilizer and water for their effects on wheat productivity more so in arid and semi-arid regions that generally experience nitrogen deficiency. However, both water and nitrogen are subjected to losses by many pathways if not managed properly. Consequently, there is a considerable interest in technologies that enhance nitrogen use efficiency and productive use of applied irrigation water leading to increased productivity. Keeping view in mind, the experiment had been conducted to find out optimum dose of fertilizer and irrigation level under different environment for yield maximization.

2. Materials and Methods

The experiment was carried out at Research Farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India located at latitude 23.20722° and longitude 79.9539° during winter season 2015–16. The soil of the experimental site was sandy clay loam with pH 7.5, EC 0.48 dS m^{-1} and 0.68% OC. The total rainfall was 135 mm received during crop season. The total 24 treatments combinations were evaluated in a split-split plot design with three replications, three sowing dates (D_1-2nd December, D_2-22th December and D_3-12th January) as main-plot treatment, two Irrigation schedules-(I_1-Three irrigations at CRI+flowering stage+milk stage and I_2-Four irrigations at CRI+late jointing stage+flowering stage) were as sub-plot treatment and four Fertilizer levels (F_1-No Fertilizer, F_2-60 N kg ha^{-1} :30 P_2O_5 kg ha^{-1}:20 k_2O kg ha^{-1}, F_3-120 N kg ha^{-1}:60 P_2O_5 kg ha^{-1}:40 k_2O kg ha^{-1} and F_4-180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1}) were as sub-sub plot treatment. Fertilizers were applied in the plots in the form of urea (source of nitrogen), DAP (source of phosphorus) and MOP (source of potassium) respectively. Half of the recommended dose of nitrogen and all of the phosphorus and potash were applied at the time of sowing, while the remaining nitrogen was applied as top dressing through broadcasting. Immediately after crop establishment, five plants were randomly selected from each plot for recording periodical observations on yield attributing parameter like 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 analysis as per method of "Analysis of variance Technique" appropriate for split-split plot design for interpretation of results given by Steel and Torrie, 1960.

3. Results and Discussion

3.1. Effect of date of sowing

In this present investigation yield, yield attributes and economics of wheat differ significantly under crop down at different dates. The plant height (92.72 cm), number of effective tillers m^{-2} (297.83), earhead length (7.90 cm), number of grains per earhead (34.46) and 1000 grain weight (41.61 g) were recorded higher when crop sown on 2nd December over rest of the dates. Grain yield (2.98 t ha^{-1}), straw yield (6.55 tha^{-1}), harvest index (32.95 %), production efficiency (25.50 $kgha^{-1}$ day^{-1}) and net income (₹ 60234 ha^{-1}) were also maximum than other sowing dates (Table 1). Agrawal et al. (2001), Throat et al. (2015), Jat et al. (2013), Tomar et al. (2014); Tahir et al. (2009) also found similar results.

3.2. Effect of irrigation schedules

Irrigation at every critical and sensitive stages are directly affect the crop yield and productivity. Four irrigations at crown root initiation, late tillering, flowering and milk stages are produced maximum yield, attributes and income. The plant height (86.67 cm), number of effective tillers m^{-2} (277.19), earhead length (7.78 cm), number of grains per earhead (33.61) and 1000 grain weight (41.39 g) were recorded higher when four irrigation were given to crop over there irrigations. Grain yield (2.49 tha^{-1}), straw yield (5.44 t ha^{-1}), harvest index (33.13 %), production efficiency (23.32 kg ha^{-1} day^{-1}) and net income (₹ 73642 ha^{-1}) were also maximum than three irrigations (Table 1) (Mukherjee, 2012; Thorat et al., 2015). The yield increases for both grain and straw 3.3 and 1.1% respectively however, profit increase was in the tune of Rs. 16871 due to the different in difference in costs involved.

3.3. Effect of fertilizer dose

This experiment was consisted of four fertilizer levels (no fertilizer, 60 N kg ha^{-1}:30 P_2O_5 kg ha^{-1}: 20 k_2O kg ha^{-1}, 120 N kg ha^{-1}:60 P_2O_5 kg ha^{-1}:40 k_2O kg ha^{-1} and 180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1}). Superior plant height (94.61 cm), no. of effective tillers m^{-2} (328.94), earhead length (8.48 cm), number of grains per earhead (39.17) and 1000 grain weight (42.16 g) were recorded when 180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1} given to crop over rest of the treatments. Grain yield (3.38 tha^{-1}), straw yield (7.79 tha^{-1}), harvest index (30.07 %), production efficiency (31.96 kg ha^{-1} day^{-1}) and net income (₹ 56728 ha^{-1}) were also higher over rest of the treatments. Ram et al., 2012, Prasad et al., 2016 also found related findings.

Table 1: Effect of sowing dates, irrigation schedules and fertility levels on growth, yield and economics of treatments

Treatments	Plant height (cm)	No. of effective tillers m^{-2}	Length of earhead (cm)	No. of grains ear-head^{-1}	1000 grain weight (g)	Grain Yield (t ha^{-1})	Straw Yield (t ha^{-1})	Harvest index (%)	Production efficiency (kg ha^{-1} day^{-1})	Net income (₹ ha^{-1})
Date of sowing										
D_1-2nd Dec.	92.72	297.83	7.90	34.46	41.61	3.22	6.55	32.95	25.50	60234
D_2-22nd Dec.	86.21	292.25	7.85	32.83	39.33	2.56	5.61	31.33	23.93	51352
D_3-12th Jan.	78.40	284.13	7.72	32.00	39.81	1.84	4.07	31.13	19.40	37855
SEm±	2.14	2.43	0.08	0.72	0.26	0.20	0.23	0.22	1.56	
CD (*p*=0.05)	6.26	6.6202	0.2431	2.2571	0.7737	0.599	0.680	0.67	4.679	
Irrigation schedules										
I_1-CRI+FL+ML	80.7	277.19	7.78	32.58	39.11	2.40	5.38	30.85	22.56	56771
I_2-CRI+LJ+FL+ML	86.67	305.61	7.87	33.61	41.39	2.48	5.44	31.31	23.32	73642
SEm±	0.8	2.49	0.041	0.32	0.21	0.117	0.137	0.127	1.11	
CD (*p*=0.05)	2.41	7.4862	0.1233	0.9588	0.6211	0.351	0.413	0.382	3.318	
Fertility levels										
F_1: Nodose (Control)	69.55	262.11	7.45	28.44	38.47	1.29	1.87	40.82	12.60	30034
F_2:60 N kg ha^{-1}:30 P_2O_5 kg ha^{-1}:20 k_2O kg ha^{-1}	79.64	279.28	7.55	30.17	39.99	2.36	5.25	31.01	21.89	41113
F_3:120 N kg ha^{-1}:60 P_2O_5 kg ha^{-1}:40 k_2O kg $^{-1}$	87.43	295.28	7.86	35.22	40.56	2.76	6.64	29.36	25.74	49346
F_4:180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1}	94.61	328.94	8.48	39.17	42.16	3.35	7.79	30.07	31.96	56728
SEm±	3.03	3.51	0.047	0.383	0.204	0.093	0.151	0.12	0.758	
CD (*p*=0.05)	9.09	10.5202	0.1397	1.1490	0.6114	0.278	0.454	0.37	2.273	

CRI: Crown root initiation; LJ: Late jointing stage; FL: Flowering stage; ML: Milk stage

4. Conclusion

Higher plant height, number of effective tillers/m^2, length of earhead, number of grains per earhead, 1000 grain weight, harvest index, production efficiency, net income, grain and straw yield was recorded in wheat sown on 2nd December with four irrigations and 180 N kg ha^{-1}:90 P_2O_5 kg ha^{-1}:60 k_2O kg ha^{-1}.

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