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CROP AND WATER PRODUCTIVITY UNDER DIFFERENT SOWING METHODS AND IRRIGATION SCHEDULES OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was carried out at Amritsar during *rabi* season (winter cropping season) of 2020-21 to study the performance of wheat (*Tritivum aestivum* L.) under different sowing methods and irrigation schedules. Highest ear length (11.92 cm) and numbers of grains ear^{-1}(44.10) was recorded under conventional sowing method (straw incorporation).Test weight (1000 seeds weight) was recorded highest under happy seeder sowing (38.15 g) and similarly highest ear length (12.40 cm), number of grains ear^{-1} (44.50) and test weight (38.80 g) was recorded under irrigation scheduling at IW/CPE ratio 1.2. Highest grain yield and water productivity was recorded under conventional sowing method (straw incorporation 47.05 q ha^{-1} and 6.27 kg m^{-3} ha^{-1} respectively) and under irrigation scheduling at IW/CPE ratio1.2 (47.93 q ha^{-1} and 6.39 kg m^{-3}ha^{-1} respectively).It is inferred that sowing of wheat as conventional sowing method (straw incorporation) and scheduling irrigation at IW/CPE ratio 1.2 produced maximum yield and water productivity.

(**Key words:** Irrigation scheduling, sowing methods, water productivity, wheat)

INTRODUCTION

Wheat (*Tritivum aestivum* L.); family (Gramineae)is one of the leading cereal crops of the world. Wheat crop is most successful between the latitudes of 30^{O} and 60^{O} N and 27^{O} and 40^{O} S (Nuttenseon,1995), wheat can be grown beyond these limits, from within the Arctic Circle to higher elevations near equator. Following China, India is second largest producer of wheat. In India, production of wheat during 2019-2020 is estimated to record 106.21 million tons. In Punjab, wheat is grown on an area of 35.20 lakh hectares with the production of 182.62 lakh tons and average yield of 51.88 q ha^{-1} (Anonymous, 2020).

In India, wheat crop is mainly grown in the northern states, with Uttar Pradesh being the top most contributor of wheat. Under present circumstances demand of food grain is increasing rapidly due to explosion of human population. To sustain food grain production to the pace of demand, there is need to use existing resources efficiently. So, there is need to use existing resources efficiently to support food grain production to the level of demand. Among different resources, water and soil are important ones (Singh *et al.,* 2019). Crop residue burning in Punjab is a major problem after harvesting of paddy and wheat crops.About 85-90% of paddy straw is burnt in the field. Now-a- days burning of rice crop residue became a serious issue in Indo-Gangetic plains. Burning is a rapid and cheap option and allows quick turn around of soil for sowing wheat crop but has severe consequences like air pollution (which further results in health problems), degradation of soil and natural enemies, therefore keeps our nation on alert. To overcome these situations, it is suggested to sow wheat without burning of rice straw with happy seeder, super seeder or by conventional method (straw incorporation). Residues of crop act as a mulch and conserve water and add organic matter to the soil. Soil fertility and other agronomic practices play an indispensable role in determining the economic yield and quality of wheat (Patel *et al.*,2021). The presence of mulch on the surface and the limitation of vertical soil disturbance protects the soil from wind and water erosion (Echeherki *et al.,* 2021). Wheat production is facing so many constraints like weed competition, poor yields of rainfed crop due to uneven and erratic rainfall, poor soil organic matter etc.

All crops need adequate water supply to harvest maximum economic yield.Water availability to the crop acts as a major determinant of crop yield. Although wheat requires less water compared to rice crop but still by proper management of irrigation, water can be saved and wheat crop under Punjab conditions is grown in the period where there in determinant rainfall. Evapotranspiration losses are more as compared to precipitation. Thus, irrigation is necessary in order to grow crops during this period because of insufficient amount of rain water and high atmospheric evaporative demand of crops. Proper growth and development of wheat requires favourable amount of soil moisture in root zone. Excessive irrigation increases evapotranspiration and decreases water use efficiency and can also reduce grain yield. Irrigation scheduling based on irrigation water/cumulative pan evaporation (IW/CPE) ratio technique can be used to estimate the water needs of the

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crop. However, lack of moisture at heading, grain formation and during maturity significantly reduced the yield of wheat grain (Shirazi *et al.,* 2014).Proper timing of irrigation and application of the appropriate amount of water can maximize crop yield, while minimizing disease, fertilizer and water use.

MATERIALS AND METHODS

A field experiment was carried out at Student's Research Farm of the P.G. Department of Agriculture, Khalsa College Amritsar, during *rabi* season (winter cropping season) of 2020-2021. The soil of experimental field was sandy loam with pH 8.4, 0.21 dSm^{-1}, low in organic carbon (0.39 per cent), available N (179 kg ha^{-1}), available P (22 kg ha^{-1}) and available K (296 kg ha^{-1}).Three methods of sowing *viz.,*M_1 (conventional sowing straw removal), M_2 (conventional sowing straw incorporation) and M_3 (happy seeder sowing method) and four irrigation schedules *viz.,*[irrigation at IW/CPE (Irrigation Water/Cumulative Pan Evaporation) = 1.2 (I_1), irrigation at IW/CPE = 1.0 (I_2), irrigation at IW/CPE = 0.8 (I_3) irrigation at IW/CPE = 0.6 (I_4)] were evaluated in split plot design with three replications. Seed of Unnat PBW 343, a genotype of wheat was sown on 30 October, 2020 with 125 kg N ha^{-1} applied in two equal splits (at first and second irrigation), a basal dose of 62.5 kg P_2O_5 ha^{-1} was applied at the time of sowing.The post-sowing irrigations were applied as per schedules. The depth of each irrigation was 7.5 cm. All other agronomic practices were kept normal and uniform for all treatments. The crop was harvested on 24^{th}April 2021.

Data on various growth parameters such as ear length (cm), number of grains ear^{-1}, test weight (1000 seeds weight in g),and yield parameters such as grain yield (q ha^{-1}), straw yield (q ha^{-1}), biological yield (q ha^{-1}), harvest index (%) and water productivity (kg m^{-3}) were generated by using five plants selected at random, for each treatment. The water productivity was calculated by the formula

$$\text{Water productivity (kg m}^{-3}\text{)} = \frac{\text{Grain yield kg ha}^{-1}}{\text{Irrigation water applied m}^{3}\text{ ha}^{-1}}$$

Statistical analysis of the data recorded was done as per split plot design (Gomez and Gomez,1984) using CPCS-1 software developed by the Department of Mathematics and Statistics, PAU, Ludhiana.

RESULTS AND DISCUSSION

Effect of sowing methods

Scrutiny of data presented in Table 1indicated that different sowing methods showed significant effect on ear length, number of grains ear^{-1}, test weight and grain yield.Treatment conventional sowing (straw incorporation) produced highest ear length which was statistically at par with treatment conventional sowing (straw removal) and was significantly higher than the treatment happy seeder sown wheat. The highest ear length (11.92 cm) was recorded in treatment conventional sowing (straw incorporation) and the lowest ear length (9.90 cm) was recorded in treatment happy seeder sown wheat. The results were found in conformity with Gautam *et al.* (2020), the utmost grain yield was found in incorporation (MB plough + disc harrow + rotavator (53.20 q ha^{-1}), conventional method (52.47 q ha^{-1}) and happy seeder (52.60 q ha^{-1}) as compared to zero-till drill (51.10 q ha^{-1}).Same value of numbers of grains ear^{-1}under treatment conventional sowing (straw incorporation) (44.10)given in the Table 1 which was statistically at par with treatment conventional sowing (straw removal) (42.95) and significantly higher than the treatment happy seeder (40.70). Test weight (g) of treatment happy seeder (38.15) was at par with conventional sowing (straw incorporation) method (37.10) and which was significantly higher than the conventional sowing (straw removal) method (35.15).

The highest grain yield was obtained by sowing with conventional sowing (straw incorporation) (47.05 q ha^{-1}) which was at par with conventional sowing (straw removal) (45.45 q ha^{-1}) and was significantly higher than happy seeder (42.90 q ha^{-1}) treatment.Among the different sowing methods, conventional sowing (straw incorporation) treatment (69.50) had the highest straw yield and it was significantly at par with conventional sowing (straw removal) (68.40) which were significantly higher than happy seeder (62.95) treatment. Highest biological yield was observed in conventional sowing (straw incorporation) (120.40) method and found at par with conventional sowing (straw removal) (114.70) method, which was significantly highest than happy seeder (104.30) method. Water productivity of wheat was also significantly influenced by sowing methods. Sowing method conventional sowing (straw incorporation) (6.27) showed maximum water productivity which was statistically at par with conventional sowing (straw removal) (6.06) and significantly higher than happy seeder (5.72) treatment. Long-term straw incorporation lowered soil bulk density but improved the soil organic matter, total N, available N, available P, and available K more strongly than straw removal (Zhang *et al*., 2021). Jin *et al*.(2020) concluded that: in the rice–wheat rotation system, returning 1,500–4,500 kg ha^{-1} of rice straw and of wheat straw from the field which helps to increase the organic carbon content and quality of the soil and promotes high annual yields.

Effect of irrigation scheduling

As evident from data (Table 1), irrigation significantly affected the ear length, number of grains ear^{-1}, test weight, grain yield, straw yield and water productivity of crop**.** Maximum grain yield was obtained in treatment where was irrigation applied at irrigation schedule of IW/CPE ratio 1.2(47.93 q ha^{-1}) which was statistically at par with IW/CPE ratio of 1.0 (46.48 q ha^{-1}) and significantly higher than IW/CPE ratio 0.8(44.80 qha^{-1}) and IW/CPE ratio 0.8 (42.26 qha^{-1}) treatments. The results were also in conformity with Aryan *et al.,*2018. They observed that moisture regimes of 1.0 IW/CPE ratio were found suitable for higher growth of wheat crop.

Table 1. Effect of sowing methods and irrigation scheduling on yield and yield attributes of wheat

Treatments	Ear length (cm)	Number of grains ear^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)	Water productivity (kg m^{-3})
Main Plot -Sowing methods								
M_1 (Conventional Sowing -Straw removal)	10.96	42.95	35.15	45.45	68.40	114.70	39.90	6.06
M_2 (Conventional Sowing -Straw incorporation)	11.92	44.10	37.10	47.05	69.50	120.40	40.30	6.27
M_3 (Happy Seeder Sowing)	9.90	40.70	38.15	42.90	62.95	104.30	39.10	5.72
SEm (±)	0.42	0.63	0.56	1.20	1.65	2.69	0.14	0.16
CD (p=0.05)	1.22	1.80	1.62	3.53	4.68	7.66	0.33	0.40
Sub Plot -Irrigation scheduling								
I_1 (IW/CPE=1.2)	12.40	44.50	38.80	47.93	70.50	122.40	40.10	6.39
I_2 (IW/CPE=1.0)	11.90	43.80	37.60	46.78	68.20	117.80	40	6.23
I_3 (IW/CPE= 0.8)	10.10	41.90	35.80	44.80	65.60	110.30	39.70	5.97
I_4 (IW/CPE=0.6)	9.28	39.80	35.10	42.26	63.50	102.10	39.37	5.63
SEm (±)	0.22	0.38	0.46	1.3	1.56	2.34	-	0.8
CD (p=0.05)	0.60	1.05	1.34	2.94	4.47	6.90	-	0.21

Highest straw yield was observed in IW/CPE ratio 1.2 (70.50 q ha^{-1}) which was at par with IW/CPE ratio1.0 (68.20 q ha^{-1}) and significantly higher than IW/CPE ratio 0.8 (65.60 q ha^{-1}) and IW/CPE ratio0.6 (63.50 q ha^{-1}) treatments. Similar results were observed by Alam *et al.* (2010).They reported that among the treatments, irrigation at IW: CPE of 1.2 gave the maximum yield (51.47 t ha^{-1}). Highest water productivity was recorded in IW/CPE ratio1.2, which was statistically at par with IW/CPE ratio1.0 and significantly higher than in IW/CPE ratio 0.8 and IW/CPE ratio 0.6. The results were in close agreement with the findings of Deshmukh and Wadatkar (2015). They reported that irrigation scheduling at IW/CPE ratio 1.2 recorded significantly highest grain yield of 39.37 q ha^{-1} and 39.44 q ha^{-1} in 2011-12 and 2012-13 respectively as compared to rest of treatments.Therefore, proper timing of irrigation and application of appropriate amount of water can maximize crop yield with minimal disease, fertilizer and water use.

It is inferred from the data sowing methods and irrigation scheduling has a crucial role in enhancing plant growth and yield of the crop. It is also referred that conventional sowing (straw incorporation) method of wheat and scheduling irrigation at IW/CPE ratio 1.2 produced maximum yield and water productivity, could be recommended for cultivation of wheat in sandy loam soils of Punjab.

REFERENCES

Alam, M.S., S.A. Mallik, D.J. Costa, M.S. Alam and A. Alam, 2010. Effect of irrigation on the growth and yield of carrot (*Daucus carota* spp. *sativus*) in hill valley. Bangladesh J. agric. Res.**35**(2):323-329.

Anonymous, 2020. Package of Practices for *Rabi* Crops. Punjab Agricultural University, Ludhiana. pp. 1- 8.

Aryan, R.K., A.K. Singh, S.R., Misra, R. Chaudhary, P. Katiyar, N. Kumar and J. Pandey, 2018. Performance of growth and yield on under variable moisture regimes at wheat (*Triticum aestivum* L.) cultivars. Int. J. Chem. Stu. **6**:3021-3023.

Deshmukh, M.M. and S.B. Wadatkar, 2015. Optimization of irrigation scheduling on the basis of IW/CPE ratio for wheat. Int.Q. J. Life Sci.**10**:1543-1547.

Echcherki, S., M. A. Feddal, R. Labad and Y. Bendid, 2021. Comparison of the effect of three tillage techniques on soil structure and consequences on the root development of durum wheat. J. Soils and Crops,**31**(2):170-179.

Gautam, A., V. Singh,and G.S. Aulakh, 2020. Effect of various sowing technologies of wheat cultivation under rice-wheat cropping system in the western plain zone of Punjab. Int. Refereed, Peer Reviewed & Indexed Q. J. Sci. Agric. Eng.**9:**460-461.

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for agricultural research, pp. 97-107. John Willey and Sons, New York.

Jin, Z., T. Shah, L Zhang, H. Liu and S. Peng, 2020. Effect of straw returning on soil organic carbon in rice–wheat rotation system: A review. Food Energy Secur.2020;9: e200.https://doi.org/10.1002/fes3.200

Nuttenseon, M.Y. 1995.Wheat-cliamatic relationships and the use of phenology in ascertaining the thermal and photothermal requirements of wheat. Washington, DC, American Institute of crop ecology, pp. 388. https://www.cabdirect.org/cabdirect/abstract/19571700406.

Patel, B. R., P. P. Chaudhari, Veeresh Hatti and N. H. Desai, 2021. Performance of wheat (*Triticum aestivum* L.) under soil and foliar nutrition. J. Soils and Crops,**31**(2): 225-230.

Shirazi, S. M., H. Zardari, Z. Yusop, Z. Ismail, and F. Othman, 2014. Performance of wheat crop under different irrigation regimes and nitrogen levels. A field experiments. J. Environ. Prot.and Ecol.**15**(3):973-982.

Singh, R., A. Singh, S. Kumar and A. Singh, 2019. Effect of different methods of sowing and mulching levels on growth and yield of wheat. J.Pharmacogn.Phytochem.**8**(3): 3253-3256.

Zhang, J., W. Li, Y. Zhou, Y. Ding, L. Xu, Y. Jiang, and G. Li, 2021.Long-term straw incorporation increases rice yield stability under high fertilization level conditions in the rice–wheat system. The Crop J.**9**(5):1191-1197.

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