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Effect of Crop Establishment Methods, Irrigation Scheduling and Agrochemicals on Growth and Yields Parameters of Wheat

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ABSTRACT

A field experiment was conducted during the *Rabi* seasons of 2023-24 and 2024-25 at the Agronomy Research Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya. To study the effect of sowing methods, irrigation scheduling, and agrochemicals application on growth and yield parameters of wheat. The experiment consist of three crop establishment methods i.e Line sowing, Furrow Irrigated Raised Bed (FIRB), and System of Wheat Intensification (SWI), three irrigation levels i.e 1.0 IW/CPE ratio, 0.75 IW/CPE ratio and 5 Irrigation each at (CRI, Tillering, late jointing, flowering and milking) in main plot and three agrochemical treatments i.e Hydrogel @ 10 kg ha^{-1}, Salicylic acid @ 200 ppm and Hydrogel 10 kg ha^{-1} + Salicylic acid @ 200 ppm. Results reveals that higher plant height was recorded with line sowing with 1.0 IW/CPE ratio 1.0 and hydrogel 10 kg ha^{-1} + salicylic acid 200 ppm. Higher flag leaf area was recorded under SWI sowing whereas, maximum total tillers was recorded under line sowing with higher level of irrigation and agrochemical application. Furrow Irrigated Raised Bed sowing method produced the highest grain yield (48.29 and 50.34 q ha^{-1}) followed by Line sowing method whereas Line sowing method recorded highest Straw yield and System of wheat Intensification recorded the highest harvest index (40.61 and 42.00%). Irrigation at IW/CPE ratio 1.0 recorded significantly higher enhanced growth and yield parameters compared to 0.75 IW/CPE ratio. The combined application of hydrogel (10 kg ha^{-1}) and salicylic acid (200 ppm) resulted in superior crop performance. The findings suggest that FIRB sowing combined with optimal irrigation and agrochemical application is most effective under late-sown conditions.

Keywords FIRB, Irrigation scheduling, Hydrogel, Salicylic acid, Late sowing.

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important crop of the globe that play an important role in food security. In 2023-24, wheat cultivated in about 220 million hectares worldwide, with total production of about 799 MMT with an average productivity of about 3.63 tonnes ha^{-1}. (FAO 2025).

Surface irrigation methods used in *rabi* crops with low water use efficiency of 30-40 % due to higher non-beneficial ET losses (Rajanna *et al.* 2019). Therefore it is important to improve irrigation efficiency for sustainable crop production.

Wheat yield and water use efficiency are significantly influenced by the deficit irrigation (Galavi and Moghaddam 2012). Irrigation scheduling is important to protect crop from water stress during the critical growth stages. Water stress can markedly reduce grain yield, mainly through its negative impact on test weight. Irrigation scheduling is an essential agronomic practice to improve crop productivity and also reduce the risk of pest and disease incidence.

Resource conservation technologies i.e Furrow Irrigated Raised bed System (FIRBS) become important. Under this system crop sown on raised bed, with better water distribution system in furrows, which reduces lodging and improve cultural practices (Monsefi *et al.* 2016). Studies shows that FIRB can save about 18-36% of irrigation water in wheat cultivation (Hobbs and Gupta 2003), with positive correlation with crop yield. Moreover, this system offers several agronomic benefits, including improved crop establishment, enhanced weed control, reduced soil compaction (Karunakaran and Behera 2013), and increased uptake of essential nutrients such as nitrogen, phosphorus, and potassium (Idnani and Kumar 2012).

Soomro *et al.* (2017) revealed that FIRB method recorded the water saving of 50.73%, with 54.37% increase in water productivity and 25% higher yield compared to conventional sowing method. Similarly, Bakhsh *et al.* (2016) observed improved crop performance and water-use efficiency in major crops grown under bed planting systems.

In hour of rising water scarcity and sustainable agriculture practices, integration of improved sowing methods and optimized irrigation scheduling and use of agrochemicals i.e. hydrogel and salicylic acid provide an effective technique to improve water productivity under water limited water condition. Hydrogel improve water holding capacity, while salicylic acid improves plant tolerance to abiotic stress through physiological regulation. Based on this, it is hypothesized that the interaction among sowing methods, irrigation scheduling, and the application of hydrogel and salicylic acid can significantly influence wheat growth and yield, particularly under water stress conditions. Therefore, the present study was conducted to evaluate the individual and combined effects of different crop establishment methods, irrigation regimes, and agrochemical applications on growth and yield.

MATERIALS AND METHODS

The present experiment was conducted during *Rabi* season of 2023-24 and 2024-25 at the Agronomy experimental farm of Acharya Narendra Deva University of Agricultural and Technology, Ayodhya to estimate the outcome of various sowing methods, irrigation scheduling and agrochemical application on growth and yield parameters of wheat. The experimental site was situated about 42 kms away from Ayodhya city on Ayodhya-Raibareilly road at 26.47 0 N latitude, 82.12 0 E longitude and an altitude of 113 meters above mean sea level. The investigation was carried out in Split Plot Design (SPD) with three replications, using plot size of 5.0 × 3.6 m. The experiment included three sowing methods i.e. Line sowing, Furrow Irrigated Raised Bed (FIRB), and System of Wheat Intensification (SWI), Three irrigation levels i.e. 1.0 IW/CPE ratio, 0.75 IW/CPE ratio and 5 Irrigation each at (CRI, Tillering, late jointing, flowering and milking) in main plot and Three agrochemical treatments i.e. Hydrogel @ 10 kg ha^{-1}, Salicylic acid @ 200 ppm and Hydrogel 10 kg ha^{-1} + Salicylic acid @ 200 ppm in sub-plot. All approved agronomic operation was equivalently put in to all of the experimental units. Fertilizer amount of N: P: K at the rate of 120-60-40 Kg ha^{-1} was put in to all the experiment plots. Wheat variety HD-2967 was tested, at the rate of 100 Kg ha^{-1} seed rate for line

sowing, 80 Kg ha^{-1} for FIRB and 20 Kg ha^{-1} for SWI.

RESULTS AND DISCUSSION

Effect of crop establishment method

The data pertaining to Table 1. Revealed that different crop establishment methods significantly influenced growth parameters wheat. Among the different sowing methods, FIRB (Furrow Irrigated Raised Bed) recorded the highest plant height at 90 DAS (92.3 and 97.8 cm during 2023–24 and 2024–25, respectively), which was at par with line sowing but significantly superior over SWI (System of Wheat Intensification). However, at harvest, line sowing recorded the highest plant height (153.4 and 160.9 cm), followed by FIRB, while SWI recorded the lowest plant height. SWI recorded the significantly higher number of tillers at both 90 DAS (32.4 and 33.3) and 120 DAS (39.4 and 40.8), indicating its superiority in promoting vegetative proliferation. SWI recorded the highest flag leaf area at both growth stages, followed by FIRB and line sowing. Higher flag leaf area under SWI may enhance assimilate production, though it did not translate proportionally into plant height. This result is supported by the study. Dhaliwal *et al.* 2020a and Dhaliwal *et. al* 2020b.

Data pertaining to Grain yield (Table 2) was also significantly affected by the Furrow Irrigated Raised Bed (FIRB) method produced the highest grain yield of 48.29 and 50.34 q ha^{-1} during 2023–24 and 2024–25, respectively. while SWI recorded the lowest grain yield. A similar trend was observed in straw yield and biological yield, which was also significantly influenced by all treatments. FIRB recorded the highest straw yield, followed by line sowing, while SWI recorded the lowest values. Hossain *et al.* (2006) reported that superior grain yield of wheat crop with FIRB sowing was due to improvement in yield components. They further described that increase in these yield components were due to greater and efficient utilization of, moisture, solar radiation and nutrients available into soil solution. These results are

Table 1. Effect of Crop establishment method, Irrigation scheduling and Agrochemical sprays on growth of wheat.

Treatments	Plant height (cm) 90 DAS		Total No. of Tillers At harvest		Flag Leaf Area 90 DAS		120 DAS	
	2023-24	2024-25	2023-24	2024-25	2023-24	2024-25	2023-24	2024-25
Sowing method								
Line Sowing	90.7	96.0	153.4	160.9	28.8	29.8	36.0	37.4
FIRB	92.3	97.8	146.8	154.9	31.1	32.0	38.0	39.9
SWI	86.3	91.7	120.8	123.2	32.4	33.3	39.4	40.8
SE(m)±	**0.66**	**0.65**	**1.40**	**1.71**	**0.38**	**0.48**	**0.41**	**0.53**
CD (p=0.05)	**2.08**	**2.06**	**4.41**	**5.40**	**1.20**	**1.52**	**1.28**	**1.65**
Irrigation Scheduling								
1.0 IW/CPE	83.5	88.6	146.0	150.9	31.6	32.8	39.2	40.7
0.75 IW/CPE	81.1	84.1	134.6	141.8	29.9	30.7	36.4	38.0
Farmer practice	80.5	81.5	137.0	142.9	28.0	28.6	35.9	36.7
SE(m)±	**0.60**	**0.54**	**1.14**	**1.40**	**0.31**	**0.39**	**0.33**	**0.43**
CD (p=0.05)	**1.90**	**1.69**	**3.60**	**4.41**	**0.98**	**1.24**	**1.04**	**1.35**
Agrochemicals								
Hydrogel 10 kg ha^{-1}	81.9	79.1	139.3	145.1	29.5	30.7	37.3	38.5
Salicylic Acid 200 ppm	82.7	80.7	141.3	146.9	32.1	32.9	38.5	40.3
Hydrogel 10 kg ha^{-1} + Salicylic Acid 200 ppm	84.1	82.1	143.8	150.5	33.5	34.8	.39.5	41.9
SE(m)±	**1.18**	**0.96**	**1.58**	**1.96**	**0.42**	**0.53**	**0.46**	**0.60**
CD (p=0.05)	**3.41**	**2.78**	**4.56**	**5.66**	**1.20**	**1.53**	**1.34**	**1.73**

Table 2. Effect of Crop establishment method, Irrigation scheduling and Agrochemical sprays on yield of wheat.

Treatments	Yield (q ha^{-1})							
	Grain yield		Straw yield		Biological yield		Harvest Index	
	2023-24	2024-25	2023-24	2024-25	2023-24	2024-25	2023-24	2024-25
Sowing method								
Line Sowing	44.190.	48.23	67.68	73.53	108.86	120.76	38.13	39.43
FIRB	48.29	50.34	68.19	72.14	112.48	121.48	39.71	40.93
SWI	38.51	42.08	55.80	57.67	93.31	98.74	40.61	42.00
SE(m)±	**0.72**	**0.80**	**1.08**	**1.09**	**1.72**	**1.92**	**0.18**	**0.14**
CD (p=0.05)	**2.28**	**2.52**	**3.40**	**3.44**	**5.43**	**6.05**	**0.57**	**0.45**
Irrigation Scheduling								
1.0 IW/CPE	44.75	48.81	66.07	69.79	109.82	117.60	40.26	41.09
0.75 IW/CPE	39.24	44.96	61.70	65.77	99.95	109.72	38.70	40.49
Farmer practice	40.01	44.89	61.69	65.70	99.70	109..57	39.13	40.48
SE(m)±	**0.59**	**0.66**	**0.88**	**0.89**	**1.40**	**1.57**	**0.15**	**0.12**
CD (p=0.05)	**1.86**	**2..05**	**2.77**	**2.81**	**4.44**	**4.94**	**0.46**	**0.37**
Agrochemicals								
Hydrogel 10 kg ha^{-1}	41.63	46.49	63.36	65.41	103.99	112.90	39.48	40.74
Salicylic Acid 200 ppm	42.51	47.39	64.25	68.29	105.76	114.68	39.64	40.88
Hydrogel 10 kg ha^{-1} + Salicylic Acid 200 ppm	43.84	48.76	66.25	69.72	109.09	117.48	39.67	41.06
SE(m)±	**0.55**	**0.76**	**1.07**	**0.10**	**1.62**	**1.53**	**0.20**	**0.16**
CD (p=0.05)	**1.59**	**2.20**	**3.11**	**2.97**	**4.69**	**4.41**	**0.57**	**0.46**

in agreement with Özberk *et al.* (2009) ,Dhaliwal *et al.* 2020a and Dhaliwal *et.al* 2020b.

Effect of irrigation scheduling

Irrigation scheduling significantly influenced all growth parameters. The irrigation at 1.0 IW/CPE ratio recorded the highest plant height at 90 DAS (83.5 and 88.6 cm) and at harvest (146.0 and 150.9 cm) during both the years, which was significantly higher than 0.75 IW/CPE and farmer's practice. Similarly, the number of tillers was recorded highest under 1.0 IW/CPE (31.6 and 32.8 at 90 DAS; 39.2 and 40.7 at 120 DAS) during both the years. Flag leaf area followed a similar trend, with the highest values recorded under 1.0 IW/CPE. These results are in great concurrence with Si *et.al* 2023. It is well established that any condition of water stress to plants is normally linked with lower growth and yield performance (Choudhary *et al.* 2021)

Irrigation scheduling also recorded a significant effect on grain yield. The irrigation at 1.0 IW/CPE ratio recorded the highest grain yield (44.75 and 48.81 q ha^{-1}), which was significantly superior to both 0.75 IW/CPE and farmer's practice during both the years. 1.0 IW/CPE resulted in maximum straw yield; biological yield and harvest index whereas farmer's practice recorded the lowest. These results are in great concurrence with Rajanna and Dhindwal (2019). It is well established that any condition of water stress to plants is normally linked with lower growth and yield performance (Patel and Rank 2022).

Effect of agrochemicals

Agrochemical applications significantly influenced growth attributes. The application of hydrogel (10 kg ha^{-1}) and salicylic acid (200 ppm) recorded the highest plant height (84.1 and 82.1 cm at 90 DAS; 143.8 and 150.5 cm at harvest) during both the years. The same treatment also resulted in the highest number of tillers (33.5 and 34.8 at 90 DAS; 39.5 and 41.9 at 120 DAS), indicating a synergistic effect. Flag leaf

area was also recorded highest under the application of hydrogel (10 kg ha^{-1}) and salicylic acid (200 ppm). These results are in accordance of Karim *et al.* 2011 and Shweta *et. al.* 2022.

The application of hydrogel (10 kg ha^{-1}) and salicylic acid (200 ppm) recorded the highest grain yield (43.84 and 48.76 q ha^{-1}) during both the year, followed by salicylic acid (200 ppm) and hydrogel (10 kg ha^{-1}). This could be due to providing sufficient moisture to plants for photosynthesis and respiration activities and might be due to due to higher moisture availability with hydrogel supplication. These results are in harmony of Chouhan *et al.* (2017) and Bana *et. al.* 2018.

CONCLUSION

It can be concluded that crop establishment methods, irrigation scheduling, and agrochemical application significantly influenced the growth and yield of wheat under late-sown conditions. Among the different methods, the furrow irrigated raised bed (FIRB) system superior in terms of grain yield, while line sowing resulted in higher straw yield and SWI recorded a higher harvest index. Irrigation scheduled at an IW/CPE ratio of 1.0 significantly enhanced growth and yield parameters compared to 0.75 IW/CPE, highlighting the importance of adequate moisture availability during critical stages. Moreover, the combined application of hydrogel (10 kg ha^{-1}) and salicylic acid (200 ppm) showed a synergistic effect in improving crop performance over individual applications. Therefore, it can be concluded that the integration of FIRB sowing method with irrigation at IW/CPE ratio 1.0 and combined use of hydrogel and salicylic acid is an effective and sustainable approach for maximizing wheat productivity under late-sown conditions.

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