Impact of irrigation scheduling, moisture conservation practices and nutrient management on performance of wheat (*Triticum aestivum* L.)

Abstract

A field experiment was conducted during two consecutive *Rabi* seasons 2020-21 and 2021-22 at Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India, situated at 125.9 meter altitude, 26.49122^0 North latitude, 80.307012^0 East longitude, to study **"Impact of irrigation scheduling, moisture conservation practices and nutrient management on performance of wheat (*Triticum aestivum* L.)".** The experiment consisted three irrigation scheduling *viz:* I_1: two irrigations at CRI and Jointing stage, I_2: three irrigations at CRI, Jointing and Booting stage and I_3: Four irrigations at CRI, Tillering, Booting and Milking stage, two moisture conservation practices *viz:* M_0: without mulching and M_1: Organic mulch @ 10 t ha^{-1} + Kaolin 6% spray and three nutrient management practices *viz:* N_1: 100% RDF (150:60:40 kg ha^{-1} NPK), N_2: 85% RDF + FYM @ 5.0 t ha^{-1} and N_3: 75% RDF + FYM @ 10.0 t ha^{-1}. The experiment was laid out in double split plot design with three replications. On pooled basis of two years experimentation the results indicated that, four irrigations at CRI, Tillering, Booting and Milking stage (I_3) recorded highest value of grain yield (4381.60 kg ha^{-1}), straw yield (6651.15 kg ha^{-1}) and harvest index (39.70 %) with profitability in terms of net return (Rs. 83908.79 ha^{-1}), under moisture conservation practices, organic mulch @ 10 t ha^{-1} + Kaolin 6% spray (M_1) recorded significantly highest grain yield (4230.40 kg ha^{-1}) and straw yield (6578.57 kg ha^{-1}). Among the nutrient management treatments, 85% RDF + FYM @ 5.0 t ha^{-1} (N_2) also recorded maximum grain yield (4117.60 kg ha^{-1}) and straw yield (6338.71 kg ha^{-1}) and net return (Rs. 77770.83 ha^{-1}) compared to other treatments.

Key words: FYM, Irrigation scheduling, Kaolin, Moisture conservation practices, Nutrient management, Organic mulch, Wheat.

Introduction:

Wheat (*Triticum aestivum* L.) is the first important and strategic cereal crop for the majority of world's population. Globally, wheat cultivated in 222.21 million hectares area with the production of 779.03 million metric tonnes and productivity of 3.51 metric tonnes per hectare during the year of 2021-22 **(Anonymous, 2022, b).** In India total area under wheat is 316.15 lakh hectare (31.61 million hectares), with the production of 109.52 million tonnes and productivity of 3464.0 kg ha^{-1} during the year of 2020-21 **(Anonymous, 2021-22, a)**. India has 18% of world population, having 4% of world's fresh water, out of which 80% is used in agriculture. The judicial application of water calls for immediate attention and this is possible only by following some

UNDER PEER REVIEW

scientific basis for water application to the crop. One such scientific approach particularly in water scarcity area is critical crop growth stage approach for scheduling of irrigation. To increase the duration of moisture availability with the existing available moisture, the losses of it from plants (transpiration) and soil (evaporation) have to be reduced. For this antitranspirants and mulches, respectively are being tried under many occasions. Irrigation scheduling is important to maximize crop yields and ensure sustainable water use.

Moisture conservation with organic mulch helps to mitigate the drought stress, increase water productivity and reduce the soil degradation, resulting in enhancing the productivity of crops. The spray of kaolin on wheat crop resulted in better growth parameters. They attributed the favourable effect of kaolin spray on plant growth which might be due to reduction in transpirational losses of water due to reflection of part of solar radiation incident on leaf surface, thus making the soil moisture available for better growth over longer period **Thakuria *et al.*, (2004).** Wheat is generally grown in intensive cropping system with higher use of inorganic NPK fertilizers. Optimal fertilizer management is necessary to maintain sustainable yields, improve nutrient use efficiency of fertilizers and save fertilizer resources. The inclusion of organic manure with inorganic fertilizers may serve as a chelating and complexing agent which prevents the nutrients from precipitation, fixation, oxidation and leaching. Application of organic manures may also improve availability of native nutrients in soil as well as the efficiency of applied fertilizers. FYM is a good source of nutrients and contributed towards build-up of organic matter in soil.

Materials & Methods:

A field experiment was conducted during two consecutive *Rabi* seasons 2020-21 and 2021-22 at Students' Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India, situated at 125.9 meter altitude, 26.49122^0 North latitude, 80.307012^0 East longitude, to study **"Impact of irrigation scheduling, moisture conservation practices and nutrient management on performance of wheat (*Triticum aestivum* L.)".** The experiment consisted three irrigation scheduling *viz:* I_1: two irrigations at CRI and Jointing stage, I_2: three irrigations at CRI, Jointing and Booting stage and I_3: Four irrigations at CRI, Tillering, Booting and Milking stage, two moisture conservation practices *viz:* M_0: without mulching and M_1: Organic mulch @ 10 t ha^{-1} + Kaolin 6% spray and three nutrient management practices *viz:* N_1: 100% RDF (150:60:40 kg ha^{-1} NPK), N_2: 85% RDF + FYM @ 5.0 t ha^{-1} and N_3: 75% RDF + FYM @ 10.0 t ha^{-1}. The experiment was laid out in double split plot design with three replications. The variety, HD-2967 was used for sowing in experiment. The soil was moist, well drained with uniform plane topography. The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 7.69 and 7.67 (1:2.5 soil: water suspension method given by **Jackson, 1973**), Organic carbon percentage in soil is 0.30 and 0.29 per

UNDER PEER REVIEW

cent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 181.40 and 179.25 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P was 12.50 and 11.28 kg ha^{-1} (Olsen's calorimetrically method**, Olsen *et al.*, 1954**) available potassium was 170.0 and 168.25 kg ha^{-1} (Flame photometer method given by **Hanwey and Heidel, 1952**) respectively in 2020-21 and 2021-22. Mulching was done in respective treatment with paddy straw @ 10 t ha^{-1}. Respective treatments were treated with two spray of kaolin @ 6% solution on 49 DAS (at maximum Tillering stage) and 69 DAS (20 days, after first spray). FYM @ 5 t ha^{-1} in N_2 and 10 t ha^{-1} in N_3 treatments were applied before sowing at the time of field preparation. The crop availed sun radiation in terms of daily minimum temperature and maximum temperature during the study period varied between 6.0^0C to 21.3^0C and 4.9^0C to 21.1^0C and 17.0^0C to 39.6^0C and 15.7^0C to 40.9^0C during 2020-21 and 2021-22, respectively. During the crop period, a total rainfall of 16.5 mm and 63.9 mm was received during the year of 2020-21 and 2021-22, respectively. Over all the climatic condition during both year found congenial for crop growth and development except higher temperature at dough stage during 2021-22 creates hot climatic condition which causes slight shrinkage of grain ultimately reduce yield upto 8.6% compared to 2020-21.

Results and Discussion:

Growth parameters:

Four irrigations at CRI, Tillering, Booting and Milking stage reported maximum plant height, more number of tillers and number of effective tillers at harvest than that rest of irrigation schedules (Table 1). The better growth under organic mulch @ 10 t ha^{-1} + Kaolin 6% spray was might be due to properly distribution of adequate available soil moisture and also conserve the soil moisture in the root zone of crop results in increase the nutritional supply throughout the crop duration. Similar findings of present investigation were also reported by **Mishra (1996), Jana *et al.* (2001)** and **Saren *et al.* (2004).** Integration of 85% RDF + FYM @ 5.0 t ha^{-1} being statistically superior compared to other treatments and recorded significantly maximum growth parameters (Table 1). The increment in growth with increase in fertility was due to rapidly transformation of synthesized photosynthates into protein to form more protoplasm, thus increasing the number as well as size of cell which might have increased the plant height. The beneficial effect of FYM might be attributed to increased activities of heterotrophic bacteria and fungi in soil, which in turn increased the activity of soil enzymes responsible for the conversion of unavailable form of nutrients to available form. The similar beneficial effect of nutrient management in wheat are also reported by several scientist **Menka *et al.*, (2007), Sheoran *et al.*, (2017) and Choudhary *et al.* (2022).**

UNDER PEER REVIEW

Yield attributes and Yield:

The increases in number of irrigations, provided adequate supply of moisture in soil profile, which play an important role in nutrient uptake resulting in improving yield attributes and ultimately yield of crop. Application of four irrigations at CRI, Tillering, Booting and Milking stage reported an increment of 21.42% in length of ear, 8.66% in weight of ear, 3.45% in test weight and similarly, 22.30% in grain yield, 14.74% in straw yield and 3.98% in harvest index over two irrigations at CRI and Jointing stage (Table 2 & 3**) (Jana *et al.* (2001) and Meena *et al.*, (2015**). Application of organic mulch @ 10 t ha^{-1} + Kaolin 6% spray resulted in 12.76% and 11.60% higher grain and straw yield, respectively over without mulching. It may be due to mulching increases moisture retention in soil **(Sarwar *et al.*, 2013)** and kaolin spray reduce evaporation losses of water from plant by reflecting solar radiation from plant leaf surface (**Mishra (1996).** Integration of inorganic source of nutrients with organic manure (FYM) significantly improved yield attributes and yield of wheat and under 85% RDF + FYM @ 5.0 t ha^{-1} increased length of spike, weight of ear and test weight by 5.30%, 55.57% and 1.26%, respectively, over 75% RDF + FYM @ 10.0 t ha^{-1} (Table 2 & 3**)**. The respective treatment also increases to the tune of 7.16% in grain yield and 4.37% in straw yield. It might be due to integration of FYM with fertilizer doses improve nutrient use efficiency in soil which ultimately improve plant growth and development in terms of better yield attributing characters and improvement in yield. **Singh *et al.* (2021)** and **Thakur *et al.* (2021).**

Economics:

The benefit: cost ratio are realised from four irrigations i.e. 24.46% higher than that two irrigations treatment (Table 4). The profitability was minimum under two irrigations, due to lower yield on account of extremely moisture stress in root zone. Similar findings were also reported by **Thakur *et al.* (2000)**, **Gora *et al.*, (2017) and Niwas *et al.* (2019).** Organic mulch @ 10 t ha^{-1} + Kaolin 6% spray significantly increment evaluated 12.36% in gross return, 20.35 % in net return and fetched about 1.59 times benefit over investment of rupee 1.0 compare to without mulching treatment (Table 4). Similarly, integration of 85% RDF + FYM @ 5.0 t ha^{-1} also evaluated significantly increment upto 6.19% in gross return, 9.27% in net return and 7.84% in B:C ratio compared to 75% RDF + FYM @ 10.0 t ha^{-1} which exhibited lowest B:C ratio (1.53). The above finding are in similar trend with the finding of **Narolia *et al.*, (2016) and Kumar *et al.*, (2017).**

Conclusion:

On the basis of above findings of result, it is concluded that, four irrigations at CRI, Tillering, Booting and Milking stage, organic mulch @ 10 t ha^{-1} + Kaolin 6% spray and integration of 85% RDF + FYM @ 5.0 t ha^{-1} were found significantly superior for increasing growth, yield and also B:C ratio of wheat.

UNDER PEER REVIEW

UNDER PEER REVIEW

Table: 1 Effect of treatments on growth parameters of wheat

Treatments	Plant height (cm) at harvest			No. of tillers (m^{-2}) at 90 DAS			No. of effective tillers (m^{-2}) at harvest		
	2020-21	2021-22	Pooled	2020-21	2020-21	Pooled	2020-21	2020-21	Pooled
A. Irrigation scheduling									
Two irrigations at CRI and Jointing stage	78.65	80.16	79.40	358.43	360.45	359.44	344.63	347.03	345.83
Three irrigations at CRI, Jointing and Booting stage	82.46	84.00	83.23	376.63	378.75	377.69	362.33	364.65	363.49
Four irrigations at CRI, Tillering, Booting and Milking stage	89.26	90.61	89.94	389.21	391.36	390.29	377.08	379.28	378.18
SEd±	**1.23**	**1.39**	**0.93**	**3.88**	**3.37**	**2.57**	**2.61**	**2.86**	**1.95**
CD at 5%	**3.43**	**3.86**	**2.14**	**10.77**	**9.37**	**5.93**	**7.25**	**7.95**	**4.51**
B. Moisture conservation practices									
Without mulching	82.14	83.60	82.87	372.30	374.38	373.34	358.14	360.46	359.30
Organic mulch @ 10 t ha-1 + Kaolin 6% spray	84.77	86.25	85.51	377.22	379.32	378.27	364.55	366.84	365.70
SEd±	**1.02**	**1.05**	**0.73**	**1.87**	**1.89**	**1.33**	**2.23**	**2.45**	**1.66**
CD at 5%	**2.50**	**2.58**	**1.60**	**4.58**	**4.64**	**2.90**	**5.46**	**6.01**	**3.61**
C. Nutrient management									
100% RDF (150:60:40 kg ha^{-1} NPK)	83.20	84.33	83.76	373.51	375.60	374.55	360.78	362.68	361.73
85% RDF + FYM @ 5 t ha^{-1}	85.86	88.00	86.93	380.53	382.66	381.60	367.33	370.40	368.86
75% RDF + FYM @ 10 t ha^{-1}	81.31	82.45	81.88	370.23	372.30	371.26	355.93	357.88	356.90
SEd±	**1.30**	**1.33**	**0.93**	**3.56**	**3.56**	**2.51**	**2.73**	**3.00**	**2.03**
CD at 5%	**2.69**	**2.75**	**1.87**	**7.35**	**7.34**	**5.06**	**5.65**	**6.21**	**4.09**
D. Interactions (A×B×C)									
SEd±	**3.20**	**3.26**	**2.28**	**9.81**	**8.72**	**6.17**	**6.71**	**7.37**	**4.98**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

UNDER PEER REVIEW

Table: 2 Effect of treatments on yield attributes of wheat

Treatments	Length of ear (cm)			Weight of ear (g m^{-2})			Test weight (g)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
A. Irrigation scheduling									
Two irrigations at CRI and Jointing stage	9.41	9.44	9.43	799.44	808.00	803.72	38.56	38.41	38.48
Three irrigations at CRI, Jointing and Booting stage	10.35	10.55	10.45	836.66	850.33	843.50	38.88	38.66	38.77
Four irrigations at CRI, Tillering, Booting and Milking stage	11.44	11.47	11.45	870.00	876.72	873.36	39.88	39.73	39.81
SEd±	**0.13**	**0.13**	**0.08**	**3.85**	**5.08**	**3.19**	**0.26**	**0.29**	**0.19**
CD at 5%	**0.38**	**0.38**	**0.19**	**10.71**	**14.12**	**7.36**	**0.72**	**0.83**	**0.45**
B. Moisture conservation practices									
Without mulching	10.28	10.32	10.30	828.51	835.33	831.92	38.89	38.73	38.81
Organic mulch @ 10 t ha-1 + Kaolin 6% spray	10.51	10.66	10.58	842.22	854.70	848.46	39.32	39.14	39.23
SEd±	**0.09**	**0.12**	**0.07**	**4.38**	**5.07**	**3.35**	**0.29**	**0.34**	**0.22**
CD at 5%	**0.22**	**0.29**	**0.16**	**10.72**	**12.42**	**7.30**	**NS**	**NS**	**NS**
C. Nutrient management									
100% RDF (150:60:40 kg ha^{-1} NPK)	10.42	10.45	10.43	714.44	732.33	723.38	39.02	38.88	38.95
85% RDF + FYM @ 5 t ha^{-1}	10.61	10.82	10.72	1086.66	1094.38	1099.38	39.40	39.20	39.30
75% RDF + FYM @ 10 t ha^{-1}	10.16	10.19	10.18	705.00	708.33	706.66	38.90	38.73	38.81
SEd±	**0.10**	**0.14**	**0.09**	**4.49**	**6.26**	**3.85**	**0.32**	**0.42**	**0.26**
CD at 5%	**0.22**	**0.30**	**0.18**	**9.28**	**12.94**	**7.75**	**NS**	**NS**	**NS**
D. Interactions (A×B×C)									
SEd±	**0.26**	**0.36**	**0.22**	**11.01**	**15.35**	**9.45**	**0.78**	**1.02**	**0.64**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

UNDER PEER REVIEW

Table: 3 Effect of treatments on yield of wheat

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index (%)		
	2020-21	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**	**2020-21**	**2021-22**	**Pooled**
A. Irrigation scheduling									
Two irrigations at CRI and Jointing stage	3731.66	3433.13	3582.40	6021.50	5571.90	5796.70	38.25	38.11	38.18
Three irrigations at CRI, Jointing and Booting stage	4175.83	3841.76	4008.80	6503.66	6019.54	6261.60	39.08	38.94	39.01
Four irrigations at CRI, Tillering, Booting and Milking stage	4564.16	4199.03	4381.60	6907.50	6394.81	6651.15	39.77	39.62	39.70
SEd±	**57.46**	**45.15**	**36.54**	**74.37**	**68.16**	**50.44**	**0.11**	**0.39**	**0.20**
CD at 5%	**159.52**	**125.34**	**84.26**	**206.45**	**189.21**	**116.31**	**0.31**	**1.08**	**0.46**
B. Moisture conservation practices									
Without mulching	3907.77	3595.15	3751.46	6122.00	5666.79	5894.39	38.91	38.76	38.84
Organic mulch @ 10 t ha-1 + Kaolin 6% spray	4406.66	4054.13	4230.40	6833.11	6324.04	6578.57	39.16	39.02	39.09
SEd±	**43.49**	**34.52**	**27.76**	**59.46**	**55.15**	**40.55**	**0.32**	**0.19**	**0.18**
CD at 5%	**106.41**	**84.48**	**60.49**	**145.50**	**134.95**	**88.35**	**NS**	**NS**	**NS**
C. Nutrient management									
100% RDF (150:60:40 kg ha^{-1} NPK)	4180.00	3845.60	4012.80	6541.33	6054.60	6297.97	38.94	38.79	38.86
85% RDF + FYM @ 5 t ha^{-1}	4289.16	3946.03	4117.60	6583.83	6093.58	6338.71	39.39	39.25	39.32
75% RDF + FYM @ 10 t ha^{-1}	4002.50	3682.30	3842.40	6307.50	5838.06	6072.78	38.77	38.63	38.70
SEd±	**57.47**	**46.47**	**36.94**	**85.16**	**79.80**	**58.35**	**0.28**	**0.32**	**0.21**
CD at 5%	**118.61**	**95.92**	**74.32**	**124.31**	**164.70**	**117.41**	**NS**	**NS**	**NS**
D. Interactions (A×B×C)									
SEd±	**140.76**	**113.83**	**90.48**	**208.60**	**195.47**	**142.93**	**0.70**	**0.78**	**0.52**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

UNDER PEER REVIEW

Table: 4 Effect of treatments on economics of wheat

Treatments	Gross return (Rs. ha^{-1})			Net return (Rs. ha^{-1})			B:C Ratio		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
A. Irrigation scheduling									
Two irrigations at CRI and Jointing stage	112840.20	108181.00	110510.60	66819.50	62083.95	64451.72	1.45	1.34	1.39
Three irrigations at CRI, Jointing and Booting stage	124746.60	119548.40	122147.50	77605.88	72331.38	74968.63	1.64	1.53	1.58
Four irrigations at CRI, Tillering, Booting and Milking	135041.10	129374.20	132207.60	86780.38	81037.22	83908.79	1.79	1.67	1.73
SEd±	**1454.28**	**690.39**	**671.89**	**795.16**	**630.95**	**640.45**	**0.01**	**0.009**	**0.008**
CD at 5%	**4014.98**	**1906.03**	**1854.97**	**2195.28**	**1741.94**	**1768.17**	**0.04**	**0.02**	**0.01**
B. Moisture conservation practices									
Without mulching	116971.60	112109.90	114540.80	72220.95	67282.91	65751.93	1.61	1.49	1.55
Organic mulch @ 10 t ha^{-1} + Kaolin 6% spray	131446.90	125959.10	128703.00	81916.22	76352.12	79134.16	1.65	1.53	1.59
SEd±	**689.25**	**747.62**	**871.29**	**371.09**	**296.09**	**328.77**	**0.009**	**0.01**	**0007**
CD at 5%	**1682.10**	**1824.56**	**2126.37**	**905.65**	**722.62**	**802.36**	**0.02**	**0.02**	**0.01**
C. Nutrient management									
100% RDF (150:60:40 kg ha^{-1} NPK)	125073.70	119871.10	122472.40	77029.66	71747.09	74388.38	1.60	1.48	1.54
85% RDF + FYM @ 5 t ha^{-1}	127506.00	122167.70	124836.80	80477.96	75063.70	77770.83	1.70	1.59	1.65
75% RDF + FYM @ 10 t ha^{-1}	120048.10	115064.80	117556.40	73698.13	68641.77	71169.95	1.58	1.47	1.53
SEd±	**1199.04**	**986.53**	**1012.40**	**715.16**	**750.03**	**819.08**	**0.01**	**0.01**	**0.009**
CD at 5%	**2475.36**	**2036.64**	**2090.06**	**1476.42**	**1548.41**	**1690.96**	**0.03**	**0.02**	**0.01**
D. Interactions									
A×B×C									
SEd±	**2937.03**	**2416.50**	**2479.88**	**1751.79**	**1837.21**	**2006.33**	**0.03**	**0.02**	**0.02**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

UNDER PEER REVIEW

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UNDER PEER REVIEW

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