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To determine the effect of foliar spray of Zinc and Iron on quality of wheat grain under normal and late sown conditions

Madhukar Singh, OP Singh, Amit Kumar, Subhash Kumar and Sanjay Kumar Tripathi

Abstract
The field experiments were conducted at Student's Instructional Farm, of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.) India, during Rabi seasons *i.e.* 2017-18 and 2018-19. The objectives of investigation were to "Studies of foliar application with zinc and iron on growth, yield and quality of Wheat (*Triticum aestivum* L.) Under normal and late sown conditions". It was designed in split plot design with three replications. The two date of sowing *i.e.* timely (D_1) and late sown (D_2) conditions were allocated in the main plots and in sub plot that significantly higher yield (kg/ha), (4951 and 5110) significant higher with normal sown condition with both years, Foliar spray application of zinc 200 ppm showed significantly better response both years *i.e.* (4852 and 5008) and iron level 200 ppm given statistically best response *i.e.* (4823 and 4978) compare to control.
Traits like grain growth rate, number of grain per spike, test weight, harvest index, zinc content in grain, iron content in grain and protein content exhibit same results enhancing to get higher grain yield of wheat with both concerning experimental years.

Keywords: Condition, growth, experiment, protein content, seasons

Introduction
Wheat (*Triticum aestivum* L.) is one of the most important cereal crops of the word. The importance of Wheat at global level can be realized from the fact that the FAO symbol is a breaded wheat spike with the Latin motto 'Flat pains' meaning 'let there be bread' bread made from wheat has been the stuff of life for millions of millions human being, right from the dawn of civilization when man first turned from arboreal or nomadic life to settled agriculture based on cultivation. Wheat is the most widely cultivated crop, which provides food and nutrition to two-third population of the world. India ranks second in wheat production in the world next to China.
Zinc (Zn) is one of the important elements for plant growth and plays an important role as a metal component or as a functional, structural, or regulatory cofactor of many enzymes and also required for various metabolic functions. It is obvious for both animals and plants. Zinc is responsible for protein synthesis, gene expression, proper growth and immune system. Physically Zn deficiency is manifested as stunting, common health problem in children like diarrhea, low birth weight, high rate of infection, skin lesions and impaired wound healing. Similarly, Fe is important for the production of Red blood corpuscles (RBC) in blood and carries oxygen to every tissue where O_2 is used for combustion of food to produce energy.
Zn and Fe nutrition can affect the susceptibility of plants to drought stress. Foliar application of zinc greatly affects plant growth and crop production. It is, therefore, important to study the efficiency of foliar application of zinc on yield of wheat under water stressed condition at different growth stages of the crop.

Location and Climatic Conditions
All facilities related to study were available at the Experimental Research Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Geographically Kanpur is located at 26.30° North Longitude and 80.16° East Longitude and is above 127 meters at above sea level. It lies in the sub-tropical regions where Wheat is grown in Rabi seasons. During experimentations, temperature was cool during vegetative growth while it was cool during grain filling stages in both years of experimentations.

Weather conditions prevailing during study are presented in Table No. 1. Which was noted from Department of Meteorology, C.S. Azad University of Agriculture and Technology Kanpur.

Material and Experimental technique: Treatments and design

Table 1: The following treatments are to be applied in Rabi sown variety of wheat (*Triticum aestivum* L.) K-307

Location	:	Student Instructional Farm Kanpur
Statistical Design	:	Split Plot Design Main plot: Date of sowing (D) Sub plot: Treatment (T)
Replication	:	Three (3)
Area	:	42×25 =1050 m^2
Single Plot Size	:	4×3 m^2
Total No. of Plots	:	54
Date of Sowing	:	2
Variety	:	(K-307) Shatabdi
Plant to Plant Distance	:	20
Row to Row Distance	:	15

Main plot treatment (02)
D_1: Normal sown condition: Last week of November
D_2: Late sown condition: First week of December

Sub plot (Zn) 03 Sub plot (Fe) 03 Date of sowing (02)

0 ppm Zn_0		0 ppm Fe_0	D_1
200 ppm Zn_1	×	200 ppm Fe_1	×
400 ppm Zn_2		400 ppm Fe_2	D_2

Table 2: Treatment Combinations: Total combination of treatment will be 18 these are below following-

S. No.	Treatment combinations	S. No.	Treatment combinations
1.	T_1 D_1 Zn_0 Fe_0	10.	T_{10} D_2 Zn_0 Fe_0
2.	T_2 D_1 Zn_0 Fe_1	11.	T_{11} D_2 Zn_0 Fe_1
3.	T_3 D_1 Zn_0 Fe_2	12.	T_{12} D_2 Zn_0 Fe_2
4.	T_4 D_1 Zn_1 Fe_0	13.	T_{13} D_2 Zn_1 Fe_0
5.	T_5 D_1 Zn_1 Fe_1	14.	T_{14} D_1Zn_1 Fe_1
6.	T_6 D_1 Zn_1 Fe_2	15.	T_{15} D_2 Zn_1 Fe_2
7.	T_7 D_1 Zn_2 Fe_0	16.	T_{16} D_2 Zn_2 Fe_0
8.	T_8 D_1 Zn_2 Fe_1	17.	T_{17} D_2 Zn_2 Fe_1
9.	T_9 D_1 Zn_2Fe_2	18.	T_{18} D_2 Zn_2 Fe_2

Stages of foliar application of zinc and iron
1. Tillering stages
2. Booting stages

Source of seed material
The seeds of Wheat variety K-307 were obtained from department of seed science of the CSA University of agriculture & technology Kanpur during each year of experimentation.

1. **Field Preparation:** To obtain better and uniform germination, pre-sowing irrigation was given and field was prepared to five tilth by one deep ploughing and four cultivator followed by planking the field.
2. **Application of Fertilizers:** A total dose of 150 kg/ha Nitrogen, 80 kg/ha phosphorus and 60 kg/ha potash, through urea, single super phosphate (SSP) and murate of potash (MOP) were used in the experiment. Half dose of nitrogen, total phosphorus and potash were given as basal dose before sowing of seed; remaining half dose of nitrogen was given in two equal split doses, one at tillering and other at the time of spike initiation.
3. **Seed Material and Seed Rate:** The seeds of Wheat variety K-307 were obtained from department of seed science of Csa University of agriculture & technology Kanpur during each year of experimentation. Seed require for timely 100-110 kg ha^{-1} and late sown condition 120-125 kg ha^{-1}.
4. **Method of sowing and weeding:** Sowing was done at 15 cm row spacing by drill method behind the deshi plough in furrows at 3-4 cm depth. Plant to plant distance was maintained 20 cm.
5. **Inter culture:** For better growth and utilization of different fertilizers and nutrients by the plant, field was kept free from all kinds of weed during experimentation. Two weeding were done one at 30 days after sowing and second at 60 days after sowing.
6. **Irrigation:** First irrigation at crown root initiation (CRI), second irrigation at tillering, third irrigation at booting stage and fourth irrigation at milking stage, so total number of four irrigation were done in field during crop season.

Observations recorded

1. **Chlorophyll Intensity (%):** Chlorophyll intensity was measured by SPAD- 502 (Minolta Japan) meter. This instrument gives the SPAD value, which is directly proportional to the greenness or chlorophyll intensity of leaves. The chlorophyll intensity in leaves was measured in between 9:30 to 10:30 a.m. hour on clear sky day. The SPAD values were recorded from the top most fully development four (4) randomly leaf from net area of the plot.
2. **Protein content of (%):** The total soluble protein content was estimated by using method of Lowery *et al.,* (1951) Procedure: 0.5 ml aliquot was mixed with 5 ml of reagent c and allowed to stand for 10 minutes. Thereafter 0.5 ml of folin reagent (reagent D) was added with instant mixing. After 30 minutes, change in absorbance was recorded at 750 nm in spectronic – 20 against reagent blank. A standard curve was prepared with graded concentration of bovine serum albumin (BSA).
3. **Grain weight $plant^{-1}$:** Firstly collect three plant of tagged main shoot. After threshing these and weighing and total value is divided by three for calculation of one plant grain weight.
4. **Test weight (g):** Random samples were collected from threshed plants of each plot and 1,000-seeds were counted separately from these samples and weighed in gram.

Result and Discussion
Chlorophyll intensity (%) at pre-anthesis
The data presented in table 3 revealed that chlorophyll intensity (%) at pre-anthesis influenced by foliar application of Zinc and iron at normal and late sown condition-

1. **Effect of sowing date:** The mean value of chlorophyll intensity at pre-anthesis was significantly influenced by sowing during in both years timely sowing date D_1 *i.e.* 34.37 and 35.82 recorded significantly maximum chlorophyll intensity during 2017-18 and 2018-19 respectively.
2. **Effect of zinc level:** The effect of zinc level was to chlorophyll intensity (%) and late sowing date

chlorophyll intensity at pre-anthesis found to be maximum Zn_2 *i.e.* 34.72 and 36.89 over control during both years showing statistically significant and given good response while minimum in Zn_0 with both year of experimentation respectively.

3. **Effect of Iron level:** Among iron level to chlorophyll intensity (%) at post-anthesis were found to be significant Fe_2 *i.e.* 33.92 followed by Fe_1 33.81 in 2017-18 and Fe_2 35.81 followed by Fe_1 35.58 over control in year 2018-19 but Fe_2 and Fe_1 were showed same significant response.
4. **Interaction effect of sowing date and zinc level:** It is proved that interaction effect between sowing date and zinc level to chlorophyll intensity (%) evolved was non-significant both years however in higher value combination recorded D_1Zn_2 *i.e.* 36.07 following by D_1Zn_1 35.26 in 2017-18 and D_1Zn_2 *i.e.* 338.01 and D_1Zn_1 36.32 in year 2018-19 while lowest combination D_2Zn_0 was found to be during both years.
5. **Interaction effect of sowing date and Iron level:** Interaction effect combination was *i.e.* D_1Fe_2 34.99 and 36.77 highest during both years and lowest combination found to be D_2Fe_0 *i.e.*31.68 and 32.45 in both years respectively to chlorophyll intensity at pre-anthesis.
6. **Interaction effect between zinc level and iron level:** It is observed that the value of both experimental years chlorophyll intensity (%) noted non significant but numerically maximum value of chlorophyll intensity (%) measured in combination Zn_2Fe_2 *i.e.* 34.89 and 38.46 during both years as compared to other combination as minimum in combination Zn_0Fe_0 both concerning years respectively.
7. **Interaction effect among of sowing date, Zinc level and Iron level:** The value of interaction effect among sowing date, zinc level and iron level to chlorophyll intensity (%) was obtained maximum from combination $D_1Zn_2Fe_2$ *i.e.* 36.78 and 39.98 while minimum in combination $D_2Zn_0Fe_0$ *i.e.* 29.85 and 29.25 with both years of experimentation 2017-18 and 2018-19 respectively.

Table 3: Chlorophyll intensity (%) at pre-anthesis as influenced by foliar application of Zinc and Iron at normal and late sown condition

Treatments	Chlorophyll intensity (%) at pre-anthesis							
	2017-18				2018-19			
	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0 Fe_0	30.75	29.85		30.30	31.95	29.25		30.60
Zn_0 Fe_1	32.07	31.09		31.58	33.50	31.85		32.67
Zn_0 Fe_2	32.57	31.68		32.12	33.98	32.66		33.32
Zn_1 Fe_0	33.65	32.47		33.06	34.85	33.64		34.24
Zn_1 Fe_1	36.53	33.40		34.96	37.75	35.80		36.77
Zn_1 Fe_2	35.62	33.07		34.34	36.37	34.94		35.65
Zn_2 Fe_0	35.21	32.74		33.97	35.42	34.46		34.94
Zn_2 Fe_1	36.22	33.57		34.89	38.65	35.95		37.30
Zn_2 Fe_2	36.78	33.81		35.29	39.98	36.95		38.46
Mean	34.37	32.40		33.39	35.82	33.94		34.88
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0	31.79	30.87		31.33	33.14	31.25		32.19
Zn_1	35.26	32.98		34.12	36.32	34.79		35.55
Zn_2	36.07	33.37		34.72	38.01	35.78		36.89
Mean	34.37	32.40		33.39	35.82	33.94		34.88
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Fe_0	33.20	31.68		32.44	34.07	32.45		33.26
Fe_1	34.94	32.68		33.81	36.63	34.53		35.58
Fe_2	34.99	32.85		33.92	36.77	34.85		35.81
Mean	34.37	32.40		33.39	35.82	33.94		34.88
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	30.30	31.58	32.12	31.33	30.60	32.67	33.32	32.19
Zn_1	33.06	34.96	34.34	34.12	34.24	36.77	35.65	35.55
Zn_2	33.97	34.89	34.89	34.71	34.94	37.30	38.46	36.90
Mean	32.44	33.81	33.81	33.39	33.26	35.58	36.90	34.88
Factors	SE (diff.)		CD at 5%		SE (diff.)		CD at 5%	
D	0.32		1.40		0.38		1.67	
Zn	0.34		0.79		0.47		1.10	
Fe	0.37		0.76		0.44		0.92	
D x Zn	0.48		N.S.		0.67		N.S.	
D x Fe	0.52		N.S.		0.63		N.S.	
Zn x Fe	0.64		N.S.		0.77		N.S.	
D x Zn x Fe	0.90		N.S.		1.09		N.S.	

Chlorophyll Intensity (%) at post-anthesis

The data presented in Table 4 revealed that chlorophyll intensity (%) at post-anthesis influenced by foliar application of Zinc and iron at normal and late sown condition-

1. **Effect of sowing date:** The mean value of chlorophyll intensity at post-antheis was significantly influenced by sowing date in both years timely sowing date D_1 *i.e.* 36.60 and 37.82 recorded significantly maximum chlorophyll intensity during 2017-18 and 2018-19 respectively
2. **Effect of zinc level:** The zinc level to chlorophyll intensity (%) was found to be maximum Zn_2 *i.e.* 36.90 and 38.92 over control in both years showing statistically significant response with Zn_1 *i.e.* 35.89 and 37.97 during

2017-18 and 2018-19.

3. **Effect of Iron level:** Among iron level to chlorophyll intensity (%) at post-anthesis were found to be significant Fe_2 36.17 followed by Fe_1 35.95 in 2017-18 and Fe_2 38.05 followed by Fe_1 37.46 over control in year 2018-19 but in both years Fe_2 and Fe_1 showed significant same response.
4. **Interaction effect of sowing date and zinc level:** It is proved that interaction effect between sowing date and zinc level to chlorophyll intensity (%) evolved was non-significant both years however maximum value in combination D_1Zn_2 *i.e.* 38.22 followed by D_1Zn_1 37.14 in 2017-18 followed by D_1Zn_2 *i.e.* 39.78 and D_1Zn_1 38.69 in year 2018-19 while lowest combination D_2Zn_0 was found to be during in both years.
5. **Interaction effect of sowing date and Iron level:** Interaction effect combination was D_1Fe_2 *i.e.* 37.35 and 38.74 highest in both years and lowest combination found to be D_2Fe_0 *i.e.* 33.82 and 35.40 in both years respectively to chlorophyll intensity at post-anthesis.
6. **Interaction effect between zinc level and iron level:** It is visualized that the value of both experimental chlorophyll intensity (%) noted non significant but numerically maximum value of chlorophyll intensity (%) measured in combination Zn_2Fe_2 *i.e.* 37.64 and 39.65 both years as compared to other combination as minimum in combination Zn_0Fe_0 both concerning years respectively.
7. **Interaction effect among of sowing date, Zinc level and Iron level:** The mean value of interaction effect among sowing date, zinc level and iron level to chlorophyll intensity (%) was obtained maximum from combination $D_1Zn_2Fe_2$ *i.e.* 39.22 and 40.56 while minimum in combination $D_2Zn_0Fe_0$ *i.e.* 31.83 and 32.65 during both years of experimentation 2017-18 and2018-19 respectively.

Table 4: Chlorophyll intensity (%) at post-anthesis as influenced by foliar application of Zinc and Iron at normal and late sown condition

Treatments	Chlorophyll intensity (%) at post-anthesis							
	2017-18				2018-19			
	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0 Fe_0	33.86	31.83		32.84	33.85	32.65		33.25
Zn_0 Fe_1	34.20	33.16		33.68	34.25	34.56		34.40
Zn_0 Fe_2	35.28	33.68		34.48	36.89	35.90		36.39
Zn_1 Fe_0	35.89	34.73		35.31	37.75	36.76		37.25
Zn_1 Fe_1	37.99	35.62		36.80	39.55	37.55		38.55
Zn_1 Fe_2	37.55	35.27		36.41	38.77	37.45		38.11
Zn_2 Fe_0	36.49	34.92		35.70	38.53	36.80		37.66
Zn_2 Fe_1	38.96	35.80		37.38	40.25	38.66		39.45
Zn_2 Fe_2	39.22	36.06		37.64	40.56	38.75		39.65
Mean	36.60	34.56		35.58	37.82	36.56		37.19
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0	34.44	32.89		33.95	34.99	34.37		34.68
Zn_1	37.14	35.20		35.89	38.69	37.25		37.97
Zn_2	38.22	35.59		36.90	39.78	38.07		38.92
Mean	36.60	34.56		35.58	37.82	36.56		37.19
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Fe_0	35.41	33.82		34.61	36.71	35.40		36.05
Fe_1	37.05	34.86		35.95	38.01	36.92		37.46
Fe_2	37.35	35.00		36.17	38.74	37.36		38.05
Mean	36.60	34.56		35.58	37.82	36.56		37.19
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	32.84	33.68	34.48	33.66	33.25	34.40	36.39	34.68
Zn_1	35.31	36.80	36.41	36.17	37.25	38.55	38.11	37.97
Zn_2	35.70	37.38	37.64	36.90	37.66	39.45	39.65	38.92
Mean	34.61	35.95	36.17	35.58	36.05	37.46	38.05	37.19
Factors	SE (diff.)		CD at 5%		SE (diff.)		CD at 5%	
D	0.45		1.96		0.25		1.10	
Zn	0.45		1.96		0.44		1.02	
Fe	0.51		1.06		0.42		0.87	
D x Zn	0.65		N.S.		0.63		N.S.	
D x Fe	0.72		N.S.		0.59		N.S.	
Zn x Fe	0.89		N.S.		0.73		N.S.	
D x Zn x Fe	1.26		N.S.		1.03		N.S.	

Protein content (%)

The data presented in table no. 5. Revealed that protein content (%) as influenced by foliar application of zinc and iron at normal and late sown condition.

1. **Effect of sowing date:** The mean value of protein content to sowing date evolved that late sowing date D_2 statistically decreased protein content (%) of wheat *i.e.* 11.78 and 11.84 over normal and late sowing date D_1 10.85 and 11.02 during the year 2017-18 and 2018-19 respectively hence normal sowing date showing statistically good response over late sown condition.
2. **Effect of zinc level:** The mean value of protein content (%) was statistically influenced by zinc 400ppm showed maximum *i.e.* 11.62 and 11.79 during both experimental year followed by zinc level 200ppm over control 2017-18 and 2018-19.

3. **Effect of iron level:** The mean value of protein content (%) statistically influenced by iron level in both years among the iron level 400 ppm and 200 ppm statistically showed same response *i.e.* 11.43 and 11.42 in 2017-18 and during 2018-19 *i.e.* 11.60 and 11.53 respectively.
4. **Interaction effect of date of sowing and zinc level-** It is visualized that D_1Zn_2 combination showing highest protein content (%) *i.e.* 11.15 and minimum D_2Zn_0 *i.e.* 11.33 in 2017-18 and 2018-19 *i.e.* 11.42 and 11.38 respectively.
5. **Interaction effect of date of sowing and iron level:** During first year and second year interaction effect showed non-significant effect but maximum combination of protein content (%) was found to be D_1Fe_2 *i.e.* 10.96 and 11.24 during both years and minimum value D_2Fe_0 *i.e.* 11.54 and 11.60 both experimental years.
6. **Interaction effect of zinc level and iron level:** The interaction effect of zinc level and iron level on protein content (%) more value of the combination Zn_2Fe_2 *i.e.* 11.85 and 12.16 during both years and minimum value was recorded in control Zn_0F_{e0} *i.e.* 10.69 and 10.72 respectively.
7. **Interaction effect of sowing date, zinc level and iron level:** The interaction effect of sowing date, zinc level and iron level was found to be non significant but numerically more value of the combination $D_1Zn_2Fe_2$ *i.e.* 11.35 and 11.91 followed by $D_1Zn_2Fe_1$ *i.e.* 11.25 and 11.41 and least in combination $D_2Zn_0Fe_0$ *i.e.* 11.12 and 11.16 for both corresponding years of experimentation.

Table 5: Protein content (%) in grain after harvesting of wheat grain as influenced by foliar application of zinc and iron at normal and late sown condition

Treatments	Protein content (%)							
	2017-18				2018-19			
	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0 Fe_0	10.26	11.12		10.69	10.28	11.16		10.72
Zn_0 Fe_1	10.48	11.39		10.93	10.62	11.45		11.03
Zn_0 Fe_2	10.62	11.48		11.05	10.66	11.53		11.09
Zn_1 Fe_0	10.85	11.75		11.30	10.89	11.81		11.35
Zn_1 Fe_1	11.12	12.12		11.62	11.30	12.16		11.74
Zn_1 Fe_2	10.89	11.89		11.39	11.16	11.97		11.56
Zn_2 Fe_0	10.85	11.76		11.30	10.95	11.82		11.38
Zn_2 Fe_1	11.25	12.21		11.73	11.41	12.26		11.83
Zn_2 Fe_2	11.35	12.35		11.85	11.91	12.42		12.16
Mean	10.85	11.78		11.31	11.02	11.84		11.43
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0	10.45	11.33		10.89	10.52	11.38		10.95
Zn_1	10.95	11.92		11.43	11.11	11.98		11.54
Zn_2	11.15	12.10		11.62	11.42	12.16		11.79
Mean	10.85	11.78		11.31	11.02	11.84		11.43
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Fe_0	10.65	11.54		11.09	10.70	11.60		11.15
Fe_1	10.95	11.90		11.42	11.11	11.95		11.53
Fe_2	10.96	11.90		11.43	11.24	11.97		11.60
Mean	10.85	11.78		11.31	11.02	11.84		11.43
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	10.69	10.93	11.05	10.89	10.72	11.03	11.09	10.94
Zn_1	11.30	11.62	11.39	11.43	11.35	11.74	11.56	11.55
Zn_2	11.31	11.73	11.85	11.62	11.38	11.83	12.16	11.79
Mean	11.10	11.42	11.43	11.31	11.15	11.53	11.60	11.43
Factors	SE (diff.)		CD at 5%		SE (diff.)		CD at 5%	
D	0.08		0.34		0.11		0.47	
Zn	0.09		0.22		0.13		0.31	
Fe	0.06		0.13		0.10		0.22	
D x Zn	0.14		N.S.		0.19		N.S.	
D x Fe	0.09		N.S.		0.15		N.S.	
Zn x Fe	0.14		N.S.		0.18		N.S.	
D x Zn x Fe	0.16		N.S.		0.26		N.S.	

Grain weight per plant (g)

The data presented in table no. 6 revealed that grain weight per plant (g) as influenced by foliar application of zinc and iron at normal and late sown condition.

1. **Effect of sowing date:** The mean value of sowing date observed that normal sowing date D_1 statistically significant increased grain weight per plant (g) of wheat *i.e.* 8.30 and 8.59 over late sowing date D_2 7.69 and 7.88 during the year 2017-18 and 2018-19 respectively hence normal sowing date showing statistically better response over late sown condition of grain weight/plant.
2. **Effect of zinc level:** The mean value of grain weight per plant (g) was statistically influenced by zinc 400 ppm showed maximum *i.e.* 8.25 and 8.63 during both experimental year followed by zinc level 200ppm over control 2017-18 and 2018-19.
3. **Effect of iron level:** The mean value of grain weight per plant (g) statistically significant influenced by iron level during both years among the iron level 400 ppm and 200 ppm statistically showed same response under lined by

same bar *i.e.* 8.11 and 8.12 in 2017-18 and during 2018-19 *i.e.* 8.43 and 8.32 respectively.

4. **Interaction effect of date of sowing and zinc level:** It is visualized that interaction effect of sowing date and zinc level showed non-significant effect but D_1Zn_2 combination showing highest grain weight per plant (g) *i.e.* 8.54 and minimum D_2Zn_0 7.29 in 2017-18 and in 2018-19 *i.e.* 8.97 and 7.36 respectively.
5. **Interaction effect of date of sowing and iron level:** During first year and second year interaction effect showed non-significant effect but maximum combination of grain weight per plant (g) was found to be D_1Fe_2 *i.e.* 8.42 and 8.80 during both years and minimum value D_2Fe_0 *i.e.* 7.49 and 7.60 both experimental years.
6. **Interaction effect of zinc level and iron level:** The interaction effect of zinc level and iron level on grain weight per plant (g) more value of the combination Zn_2Fe_2 *i.e.* 8.40 and 8.94 during both years and minimum value was recorded in control Zn_0F_{e0} *i.e.* 7.24 and 7.45 respectively during 2017-18 and 2018-19.
7. **Interaction effect of sowing date, zinc level and iron level:** The interaction effect of higher order was found to be non-significant but numerically more value of the combination $D_1Zn_2Fe_2$ *i.e.* 8.70 and 9.31 followed by $D_1Zn_2Fe_1$ *i.e.* 8.63 and 8.95 and least in combination $D_2Zn_0Fe_0$ *i.e.* 7.02 and 7.04 for both corresponding years of experimentation.

Table 6: Grain weight per plant ear as influenced by foliar application of zinc and iron at normal and late sown condition

Treatments	Grain weight per plant							
	2017-18				2018-19			
	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0 Fe_0	7.46	7.02		7.24	7.86	7.04		7.45
Zn_0 Fe_1	7.88	7.37		7.62	8.06	7.50		7.78
Zn_0 Fe_2	8.08	7.48		7.78	8.24	7.56		7.90
Zn_1 Fe_0	8.27	7.72		7.99	8.47	7.80		8.13
Zn_1 Fe_1	8.92	7.91		8.41	8.97	8.17		8.57
Zn_1 Fe_2	8.49	7.84		8.16	8.85	8.06		8.45
Zn_2 Fe_0	8.30	7.75		8.02	8.65	7.98		8.31
Zn_2 Fe_1	8.63	8.04		8.33	8.95	8.31		8.63
Zn_2 Fe_2	8.70	8.11		8.40	9.31	8.58		8.94
Mean	8.30	7.69		7.99	8.59	7.88		8.23
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0	7.80	7.29		7.54	8.05	7.36		7.70
Zn_1	8.56	7.82		8.19	8.76	8.01		8.38
Zn_2	8.54	7.96		8.25	8.97	8.29		8.63
Mean	8.30	7.69		7.99	8.59	7.88		8.23
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Fe_0	8.01	7.49		7.75	8.32	7.60		7.96
Fe_1	8.47	7.77		8.12	8.66	7.99		8.32
Fe_2	8.42	7.81		8.11	8.80	8.06		8.43
Mean	8.30	7.69		7.99	8.59	7.88		8.23
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	7.24	7.62	7.78	7.54	7.45	7.78	7.90	7.71
Zn_1	7.99	8.41	8.16	8.18	8.13	8.57	8.45	8.38
Zn_2	8.02	8.33	8.40	8.25	8.31	8.63	8.94	8.62
Mean	7.75	8.12	8.11	7.99	7.96	8.32	8.43	8.23
Factors	SE (diff.)		CD at 5%		SE (diff.)		CD at 5%	
D	0.15		0.66		0.13		0.57	
Zn	0.14		0.33		0.13		0.31	
Fe	0.16		0.34		0.14		0.30	
D x Zn	0.20		N.S.		0.19		N.S.	
D x Fe	0.16		N.S.		0.21		N.S.	
Zn x Fe	0.28		N.S.		0.25		N.S.	
D x Zn x Fe	0.40		N.S.		0.36		N.S.	

Test weight (g)

The data presented in table no. 7. Revealed that test weight (g) as influenced by foliar application of zinc and iron at normal and late sown condition.

1. **Effect of sowing date:** The mean value of test weight to sowing date was recorded that normal sowing date D_1 statistically increased test weight (g) of wheat *i.e.* 38.94 and 38.97 over late sowing date D_2 36.78 and 36.98 during the year 2017-18 and 2018-19 respectively hence normal sowing date showing statistically significant good response over late sown condition.
2. **Effect of zinc level:** The mean value of test weight (g) was statistically influenced by zinc 400ppm showed significant maximum Zn_2 *i.e.* 38.51 and 38.62 during both experimental year followed by zinc level 200 ppm *i.e.* 37.91 and 38.01.
3. **Effect of iron level:** The mean value of test weight (g) statistically influenced by iron level in both years among the iron level 400 ppm and 200 ppm showed statistically same response *i.e.* 38.09 and 37.98 in 2017-18 and during 2018-19 *i.e.* 38.29 and 37.96 respectively.
4. **Interaction effect of date of sowing and zinc level:** It is observed that D_1Zn_2 combination showed highest test weight (g) *i.e.* 39.78 and minimum D_2Zn_0 36.22 in 2017-

18 and 2018-19 *i.e.* 39.71 and 36.37 respectively.

5. **Interaction effect of date of sowing and iron level:** During first year and second year interaction effect showed non-significant effect but maximum combination of test weight (g) was found to be D_1Fe_2 *i.e.* 39.23 and 39.38 during both years and minimum value D_2Fe_0 *i.e.* 36.55 and 36.71 both experimental years.
6. **Interaction effect of zinc level and iron level:** The interaction effect of zinc level and iron level on test weight (g) more value of the combination Zn_2Fe_2 39.15 and 39.48 during both years and minimum value was recorded in control Zn_0Fe_0 *i.e.* 37.00 and 37.12 respectively.
7. **Interaction effect of sowing date, zinc level and iron level:** The interaction effect of higher order was found to be non-significant but numerically more value of the combination $D_1Zn_2Fe_2$ *i.e.* 40.65 and 40.82 followed by $D_1Zn_2Fe_1$ *i.e.* 39.95 and 39.41 and least in combination $D_2Zn_0Fe_0$ *i.e.* 36.05 and 36.20 for both corresponding years of experimentation 2017-18 and 2018-19.

Table 7: Test weight as influenced by foliar application of zinc and iron at normal and late sown condition

Treatments	Test weight							
	2017-18				2018-19			
	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0 Fe_0	37.95	36.05		37.00	38.05	36.20		37.12
Zn_0 Fe_1	38.15	36.27		37.21	38.25	36.41		37.33
Zn_0 Fe_2	38.25	36.35		37.30	38.40	36.50		37.45
Zn_1 Fe_0	38.74	36.81		37.77	38.87	36.97		37.92
Zn_1 Fe_1	39.25	37.01		38.13	39.11	37.15		38.13
Zn_1 Fe_2	38.80	36.86		37.83	38.92	36.99		37.95
Zn_2 Fe_0	38.76	36.82		37.79	38.91	36.97		37.94
Zn_2 Fe_1	39.95	37.30		38.62	39.41	37.49		38.45
Zn_2 Fe_2	40.65	37.65		39.15	40.82	38.14		39.48
Mean	38.94	36.78		37.86	38.97	36.98		37.97
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Zn_0	38.11	36.22		37.16	38.23	36.37		37.30
Zn_1	38.93	36.89		37.91	38.96	37.07		38.01
Zn_2	39.78	37.25		38.51	39.71	37.53		38.62
Mean	38.94	36.78		37.86	38.97	36.98		37.97
Treat.	D_1	D_2		Mean	D_1	D_2		Mean
Fe_0	38.48	36.55		37.51	38.61	36.71		37.66
Fe_1	39.11	36.86		37.98	38.92	37.01		37.96
Fe_2	39.23	36.95		38.09	39.38	37.21		38.29
Mean	38.94	36.78		37.86	38.97	36.98		37.97
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	37.00	37.21	37.30	37.17	37.12	37.33	37.45	37.30
Zn_1	37.77	38.13	37.83	37.91	37.92	38.13	37.95	38.00
Zn_2	37.79	38.62	39.15	38.52	37.94	38.45	39.48	38.62
Mean	37.52	37.98	38.09	37.86	37.66	37.97	38.29	37.97
Factors	SE (diff.)		CD at 5%		SE (diff.)		CD at 5%	
D	0.24		1.03		0.27		1.18	
Zn	0.26		0.60		0.30		0.70	
Fe	0.27		0.56		0.30		0.63	
D x Zn	0.37		N.S.		0.43		N.S.	
D x Fe	0.38		N.S.		0.43		N.S.	
Zn x Fe	0.47		N.S.		0.53		N.S.	
D x Zn x Fe	0.66		N.S.		0.75		N.S.	

Harvest index (%): The data presented in Table no. 8 revealed that harvest index (%) as influenced by foliar application of zinc and iron at normal and late sown condition.

1. **Effect of sowing date:** The mean value of sowing date evolved that normal sowing date D_1 statistically increased harvest index (%) of wheat *i.e.* 38.32 and 39.01 over late sowing date D_2 36.81 and 37.97 during the year 2017-18 and 2018-19 respectively hence normal sowing date showing statistically good response over late sown condition during both year.
2. **Effect of zinc level:** The mean value of zinc level to harvest index (%) was statistically influenced by zinc 400 ppm showed significant maximum *i.e.* 38.38 and 39.33 during both experimental year followed by zinc level 200 ppm *i.e.* 37.89 and 38.90.
3. **Effect of iron level-** The mean value of harvest index (%) statistically influenced by iron level in both years among the iron level 400 ppm and 200 ppm statistically showed same response *i.e.* 37.89 and 37.75 in 2017-18 and during 2018-19 *i.e.* 38.79 and 38.68 respectively.
4. **Interaction effect of date of sowing and zinc level:** It is visualized that D_1Zn_2 combination showing highest harvest index (%) *i.e.* 39.15 and minimum D_2Zn_0 35.80 in year 2017-18 and in 2018-19 *i.e.* 39.80 and 36.69 respectively.
5. **Interaction effect of date of sowing and iron level:** During first year and second year interaction effect showed non-significant effect but maximum combination of harvest index (%) was found to be D_1Fe_2 *i.e.* 38.61 and 39.27 during both years and minimum value D_2Fe_0 *i.e.* 36.28 and 37.39 both experimental years.

6. **Interaction effect of zinc level and iron level:** The interaction effect of zinc level and iron level on harvest index (%) higher value of the combination was found to be Zn_2Fe_2 *i.e.* 38.77 and 39.72 during both years and minimum value was recorded in control Zn_0Fe_0 *i.e.* 35.82 and 36.54 respectively.
7. **Interaction effect of sowing date, zinc level and iron level:** The interaction effect of higher order was found to be non-significant but numerically maximum value of the combination $D_1Zn_2Fe_2$ *i.e.* 39.48 and 40.14 followed by $D_1Zn_2Fe_1$ *i.e.* 39.43 and 39.93 and least in combination $D_2Zn_0Fe_0$ *i.e.* 35.12 and 35.83 for both corresponding years of experimentation.

Table 8: Harvest index (%) as influenced by foliar application of zinc and iron at normal and late sown condition

Treatments	Harvest Index (%)					
	2017-18			2018-19		
	D_1	D_2	Mean	D_1	D_2	Mean
Zn_0 Fe_0	36.53	35.12	35.82	37.25	35.83	36.54
Zn_0 Fe_1	37.10	35.95	36.52	37.89	36.97	37.43
Zn_0 Fe_2	37.60	36.34	36.97	38.24	37.27	37.75
Zn_1 Fe_0	38.44	36.83	37.63	39.26	38.11	38.68
Zn_1 Fe_1	39.03	37.15	38.09	39.68	38.62	39.15
Zn_1 Fe_2	38.76	37.14	37.95	39.43	38.34	38.88
Zn_2 Fe_0	38.54	36.90	37.72	39.33	38.22	38.77
Zn_2 Fe_1	39.43	37.86	38.64	39.93	39.06	39.49
Zn_2 Fe_2	39.48	38.07	38.77	40.14	39.31	39.72
Mean	38.32	36.81	37.56	39.01	37.97	38.49
Treat.	D_1	D_2	Mean	D_1	D_2	Mean
Zn_0	37.07	35.80	36.43	37.79	36.69	37.24
Zn_1	38.74	37.04	37.89	39.45	38.36	38.90
Zn_2	39.15	37.61	38.38	39.80	38.86	39.33
Mean	38.32	36.81	37.56	39.01	37.97	38.49
Treat.	D_1	D_2	Mean	D_1	D_2	Mean
Fe_0	37.83	36.28	37.05	38.61	37.39	38.00
Fe_1	38.52	36.98	37.75	39.16	38.21	38.68
Fe_2	38.61	37.18	37.89	39.27	38.31	38.79
Mean	38.32	36.81	37.56	39.01	37.97	38.49
Treat.	Fe_0	Fe_1	Fe_2	Mean	Fe_0	Fe_1	Fe_2	Mean
Zn_0	35.82	36.52	36.97	36.43	36.54	37.43	37.75	37.24
Zn_1	37.63	38.09	37.95	37.89	38.68	39.15	38.88	38.90
Zn_2	37.72	38.64	38.77	38.37	38.77	39.49	39.72	39.32
Mean	37.05	37.75	37.89	37.56	37.99	38.69	38.78	38.49
Factors	SE (diff.)		CD at 5%	SE (diff.)		CD at 5%		
D	0.10		0.46	0.12		0.58		
Zn	0.10		0.26	0.11		0.26		
Fe	0.11		0.24	0.13		0.27		
D x Zn	0.16		N.S.	0.16		N.S.		
D x Fe	0.16		N.S.	0.18		N.S.		
Zn x Fe	0.16		N.S.	0.18		N.S.		
D x Zn x Fe	0.29		N.S.	0.32		N.S.		

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