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Effect of Sowing Time, Nitrogen, and Zinc Scheduling on Chlorophyll content and Number of Spikelets per Spike in Wheat (*Triticum aestivum* L.)

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ABSTRACT: An experiment was conducted in factorial split design in the Agricultural Research farm of BHU, Varanasi for two years 2018-19 and 2019-20 in the *rabi* seasons to study the effect of sowing time, nitrogen, and zinc management. To study the effect of sowing time crop was sown in the second fortnight of November and the first fortnight of December and a similar dose of 150 kg of nitrogen was applied to the crop at various growth stages like basal, CRI stage, and flag leaf visible stage in both treatments but one of the nitrogen treatments included the application of urea 2% at anthesis stage where 9.2 kg urea was saved from 150 kg nitrogen for spraying. Zinc management included four levels of treatments: Z_1: 0 kg ha^{-1} Zn, Z_2: 5.0 kg ha^{-1} Zn as basal, Z_3:1.7 kg ha^{-1} Zinc as basal + 0.50% $ZnSO_4$ spray at Z31 (stem elongation) + 0.50% at Z75 (milking), Z_4: 1.7 kg ha^{-1} Zinc as basal + 0.50% $ZnSO_4$ spray at Z60 (Anthesis) + 0.50% $ZnSO_4$ spray at Z85 (Dough stage). Chlorophyll content was found to be maximum in Z_2 up to 60 days after sowing and after foliar application with 0.5% zinc sulfate, chlorophyll content was found to increase in Z_3 as compared to Z_4. The number of spikelet formations was also affected by Z_3. Two of the parameters showed a significant result in the second fortnight of November and the effect of nitrogen was found to be non-significant.

Keywords: Chlorophyll content, number of spikelet, sowing time, foliar application, zinc.

INTRODUCTION

Wheat being the most important cereal crop, it grown in vast areas of Indian geography and various cropping systems. The time left after harvesting of *kharif* crop and changing climatic scenario has been a matter of concern in order to maintain yield. It has been proved that delayed sowing decreases the yield up to a significant level due to less period for optimum vegetative growth and high temperature during anthesis and grain filling leading to poor grain quality and less yield.

Since nitrogen is a component of protoplasm, protein, chlorophyll, alkaloids, hormones, and vitamins, a sufficient level of nitrogen is required for efficient crop production. It is well-known fact that nitrogen is highly essential for the Crown root initiation stage and flag leaf stage to nourish crop vegetative as well as reproductive growth. Increased dry matter synthesis from nitrogen ultimately leads to higher yields (Reena *et al.*, 2017). A common micronutrient shortage in humans is dietary zinc (Zn) insufficiency. Zinc fertilization has been shown to be a successful strategy for increasing wheat's grain Zn concentration and reducing human Zn insufficiency. It is vital to use the right Zn fertilizer forms and application techniques in order to optimize the benefits of Zn fertilization. Though soil application is highly essential for crop establishment and proper growth, for quality concerns as well as yield attributing characters, zinc foliar application is a suitable option (Zhao *et al.,* 2020).

MATERIALS AND METHODS

To study the effect of sowing time, nitrogen, and zinc management on rabi wheat, field experimentation was conducted for two years 2018-19 and 2019-20 on the agricultural farm of the Institute of Agricultural Sciences, Banaras Hindu University. Experimentation was conducted in factorial split design where the main plot carried two factors *i.e.,* sowing time and nitrogen management while the subplot carried one factor *i.e.,* zinc management. Sowing time had two levels *i.e.,* Sowing in the second fortnight of November (D_1) and Sowing in the first fortnight of December (D_2). Nitrogen management also had two levels *i.e.,* a) N_1:150 kg ha^{-1} Nitrogen [75 kg basal + 37.5 kg at Z20 (main shoot only) + 37.5 kg at Z37 (flag leaf visible)] and b) N_2: 150 kg ha^{-1} Nitrogen [70 kg basal + 35.5 kg at Z20 (main shoot only) + 35.4 kg at Z37 (flag leaf visible) + 9.2 kg as 2% urea application at Z60 (beginning of anthesis stage)]. In subplot zinc management consisted of (Z_1) Control *i.e.,* 0 kg Zn ha^{-1}, (Z_2) 5 kg ha^{-1} Zinc as basal, (Z_3) 1.7 kg ha^{-1} Zinc as basal + 0.50% $ZnSO_4$ spray at Z31 (stem elongation) + 0.50% at Z75 (milking), (Z_4) 1.7 kg ha^{-1} Zinc as basal + 0.50% $ZnSO_4$ spray at Z60 (Anthesis) + 0.50% $ZnSO_4$ spray at Z85 (Dough stage) as subplot treatment. The experiment was repeated in three replications and each replication had sixteen treatments. The sowing date remained the same for both years. 30th November and 14th December were assigned to D_1 and D_2, respectively. 100 kg ha^{-1} seed rate was applied keeping the line-to-line spacing 20.0cm. Phosphorus and potassium were applied at the rate of 60 kg ha^{-1}. Standard cultural practices like irrigation and weed management were followed as per requirement.

The weekly mean maximum temperature ranged from 19.8 to 39.5^{o}C with an average in the year 2018-19, and 13.6 to 38.1^{o}C in the year 2019-20. The weekly mean minimum temperature varied from 3.9 to 20.5^{o}C during the year 2018-19, and 7.0 to 21.3^{o}C in the year 2019-20. The mean fluctuation in the maximum and minimum temperatures was very close during both years.

For determination of chlorophyll content, wheat leaves were analyzed by using a SPAD meter on the field in standing crop (ten tagged plants) at 30, 60, and 90 days after sowing. The number of spikelets per ear/spike was counted after harvesting. Reading was taken from ten tagged spikes and the total number of spikelets was averaged by ten to calculate the number of spikelets per spike. Statistical analysis was done following methods given by Gomez and Gomez (1984). To determine the growth stages for application of nitrogen and zinc application, the Zadoks scale (Zadoks *et al.,* 1974) was followed.

RESULT AND DISCUSSION

Table 1 shows the data regarding the effect of time of sowing, nitrogen, and zinc management on the chlorophyll content of wheat. Table 3 indicates the interaction among different treatments for chlorophyll content and the number of spikelets per spike. Chlorophyll content attained maximum value when wheat was sown in the second fortnight of November (D_1). Observations, taken in 30 days intervals up to 90 days after sowing, showed that chlorophyll content was lower in crops sown in the first fortnight of December as compared to the second fortnight of November (D_2). In the early growth stages, D_2 noticed lower temperatures than D_1during the early growth phases. Lower temperature inhibits the transport, uptake, and availability of plant nutrients, especially nitrogen and zinc (Boczulak *et al.,* 2014; Brennan *et al.,* 1993; Kumar and Meena 2023).

It is well established that nitrogen is a major component of chlorophyll molecules surrounding magnesium in the center. The disruption of chlorophyll production by zinc shortage was studied by Hisamitsu *et al.* (2001). Zinc, which serves as a structural and catalytic component of proteins and enzymes as well as a co-factor for the normal development of pigment biosynthesis, is responsible for increased chlorophyll quantities (Balashouri, 1995).

Table 1: The table shows the effect of time of sowing, nitrogen, and zinc management on Chlorophyll content (SPAD value) at 30, 60, and 90 DAS in wheat.

Treatments	**Chlorophyll content 30 DAS**		**Chlorophyll content 60 DAS**		**Chlorophyll content 90 DAS**	
	2018-19	2019-20	2018-19	2019-20	2018-20	2019-20
Time of sowing						
D_1	39.590	39.519	40.467	40.844	40.078	40.458
D_2	38.239	38.319	37.148	37.664	38.478	37.715
SEm±	0.274	0.166	0.457	0.426	0.344	0.575
LSD (P=0.05)	0.947	0.575	1.583	1.475	1.192	1.989
Nitrogen management						
N_1	39.382	39.202	39.587	39.860	39.576	40.030
N_2	38.447	38.636	38.028	38.648	38.981	38.143
SEm±	0.274	0.166	0.457	0.426	0.344	0.575
LSD (P=0.05)	NS	NS	NS	NS	NS	NS
Zinc management						
Z_1	37.222	37.234	36.859	37.145	37.173	36.754
Z_2	40.637	40.491	40.938	41.831	39.279	39.698
Z_3	38.997	38.976	39.129	40.200	41.813	41.928
Z_4	38.803	38.975	38.304	37.841	38.848	37.965
SEm±	0.239	0.259	0.499	0.362	0.354	0.338
LSD (P= 0.05)	0.699	0.757	1.458	1.056	1.033	0.985

Number of spikelets per ear (Table 2) was found to be significantly higher (23.54 mean) in plots sown in the second fortnight of November (D_1) as compared to D_2 (16.928 mean). The result shows a similarity with the review given by Wiersma (2021).

The effect of nitrogen on the number of spikelets per ear was found to be non-significant. The reason could be the difference in the amount of nitrogen applied did not affect the number of spikelets significantly and the nitrogen was applied at similar growth stages in both treatments up to Z37 (flag leaf visible stage). Terminal spikelet formation completes by the Z30 stage but continues up to anthesis in other effective tillers. In N_2, the application of urea was carried out after anthesis which has no role in spikelet formation. This can be compared with the review of Acevedo *et al*. (2002).

In the case of zinc management, the effects of all the treatments were significantly different from each other. Z_3 recorded the maximum number of spikelets per ear followed by Z_2 treatment. Z_1 where no zinc was applied gave the lowest number of spikelets. Z_2 also observed fewer spikelets as the zinc foliar application was given in the later stages like the anthesis and dough stage, unlike Z_3 where zinc was applied at the stem elongation and milking stage. Continuous application of zinc throughout the life cycle improves plant growth and yield-attributing characteristics (Zoz *et al.,* 2012). This statement can be used to justify the result of the current study.

Table 2: Showing effect of time of sowing, nitrogen, and zinc management on the number of spikelets per spike.

No. of spikelet per spike	2018-19	2019-20		2018-19	2019-20
D_1	22.453	24.631	**Z_1**	16.815	18.999
D_2	15.836	18.020	**Z_2**	20.365	22.546
N_1	19.794	21.980	**Z_3**	21.297	23.474
N_2	18.495	20.671	**Z_4**	18.101	20.284
SEm ±	0.522	0.478	**SEm±**	0.201	0.202
CD	1.807 NS (For N)	1.653 NS (For N)	**CD**	0.587	0.591

Table 3: Showing interaction among different factors at different growth stages in both experimental years.

Types of interaction	Chlorophyll content (SPAD value)		Number of spikelets per spike	
	2018-19	2019-20	2018-19	2019-20
A × B	NS	NS	NS	NS
A × C	S (except at 30 DAS)	S (except at 30 DAS)	S	S
B × C	S (except at 30 DAS)	S (except at 30 DAS)	S	S
A × B × C	NS	NS	NS	NS

CONCLUSIONS

From the above study, it was found that chlorophyll content and the number of spikelets per spike were highly influenced by the time of sowing (second fortnight of November). The effect of nitrogen was found to be non-significant for both parameters. Zinc application at the rate of 1.7 kg ha^{-1} Zinc as basal + 0.50% $ZnSO_4$ spray at Z31(stem elongation) + 0.50% at Z75 (milking) gave maximum chlorophyll at 90 days after sowing and the maximum number of spikelets per spike but Z_2 (5.0 kg ha^{-1}) observed maximum chlorophyll content up to 60 days after sowing.

FUTURE SCOPE

By a judicious application of nitrogen and zinc in the proper amount and growth stages in the optimum time of sowing, characters enhancing yields like chlorophyll content and spikelet numbers can be enhanced to get maximum return. Further studies can be done to find out the proper growth stages to increase the uptake and assimilation of nutrients and we will be capable enough to beat the adverse effect of climate change on grain yield.

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Conflict of Interest. None.

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