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IMPACT OF LAND CONFIGURATIONS AND SOIL APPLIED ZINC ON GROWTH AND YIELD OF WHEAT (*Triticum aestivum* L.)

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ABSTRACT

An experiment was conducted at Students' Research Farm, Department of Agriculture, Amritsar during the *rabi* season of 2021-2022. The experiment was laid out in split plot design with two land configurations as main plot treatments *viz.,* Bed planting method, flat planting method and four zinc levels as subplot treatments *viz.,* Absolute control, RDF+0 kg Zn ha^{-1}, RDF+ 10 kg Zn ha^{-1} and RDF+ 20 kg Zn ha^{-1}. There were eight treatment combinations replicated three times. The soil was sandy loam in texture with pH 8.16 indicating alkaline in reaction. The bed plating method recorded a maximum and significantly higher number of tillers meter^{-1} row length, dry matter accumulation, straw yield, grain yield and available nutrient (N, P, K and Zn). Plant height, test weight, pH and EC were not influenced significantly.

The plant height, number of tillers meter^{-1} row length, dry matter accumulation, straw yield, grain yield and available nutrients (N, P, K and Zn) were influenced significantly by zinc application. Application of RDF+ 20 kg Zn ha^{-1} recorded significantly higher plant height, number of tillers meter^{-1} row length, dry matter accumulation, straw yield, grain yield and available nutrients and was at par with RDF+ 10 kg Zn ha^{-1}. Test weight was not influenced significantly.

Interaction effects of land configurations with zinc application were found to be not significant in respect of all growth characters, yield attributes, available nutrients and grain and straw yield.

(Keywords: Land configurations, growth attributes, yield, zinc and available nutrients)

INTRODUCTION

In terms of area and production, wheat is India's second most vital food crop after rice. Wheat (*Triticum aestivum* L.) is an essential staple food crop for billions of people worldwide and the most important cereal crop. Following China, India is the world's second-largest producer of wheat. Wheat is mostly cultivated in northern India, with Uttar Pradesh being the main producer (Singh and Kumar, 2022). Land configuration aids in increasing rainfall infiltration, reducing erosion and total runoff, facilitating drainage, and, ultimately, improving water use efficiency. The broad bed and furrow system's raised bed zone has been better oxygenated, has lower permeability, and is feasible to profound seed placement and improved crop growth, all of which affect yield. (Khade *et al.,*2017). Zinc (Zn) is among the most critical and essential micronutrients for plant growth, and it is absorbed by plant roots as Zn^{2+}. It is involved in plant metabolic activities, and its absence affects plant growth.

Zinc is considered necessary for the stimulation of plant enzyme systems, protein synthesis, photosynthetic activity, the replication of genetic material (DNA) during cellular division, and the synthesis of chlorophyll and carbohydrates (Karad *et al.,* 2021).With this view in mind, a study was undertaken to ascertain the effect of land configurations and zinc on growth and yield under wheat cultivation.

MATERIALS AND METHODS

A field experiment was conducted at Students' Research Farm, Khalsa College, Amritsar, Punjab, India during the *rabi* season of 2021-2022. The experiment was laid out in split plot design with two land configurations *viz.,* Bed and Flat planting method as main plot treatments and four zinc levels *viz.,* Absolute control, RDF+0, RDF+ 10, RDF+ 20 kg Zn ha^{-1} as subplot treatments with eight treatment combinations replicated three times. The soil of the experimental plot was low in available nitrogen (186.60 kg ha^{-1}) and organic carbon (0.40 %), medium in available phosphorus (19.32 kg ha^{-1}) and available potassium (249.82 kg ha^{-1}) as regards to fertility status and alkaline in reaction

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(pH 8.16). The soil contained diethylene triamine Penta Acetate (DTPA)- extractable Zn was 0.89 mg kg^{-1}. The soil of the experimental field was sandy loam in texture. During the growing season of the crop, the maximum temperature varied from 16.84°C to 45.27°C and the minimum temperature ranged from 5.26°C to 28.39°C. The relative humidity varied from 16.52 to 79.03% during the period of the crop season. Unnat PBW 550 was used in this study. The observations were taken at harvest with respect to plant height, number of tillers $meter^{-1}$ row length, dry matter accumulation, test weight (g), straw yield (q ha^{-1}), grain yield (q ha^{-1}), pH, EC and available nutrients (N,P,K and Zn) . In order to represent the plot, five plants of wheat from each net plot were selected randomly for various biometric observations on growth and post-harvest studies. The selected five plants were labelled and all biometric observations were recorded properly on them. Grain and Straw yields were recorded on plot basis. pH was recorded by pH meter (Jackson, 1967), EC was estimated by electrical conductivity meter (Jackson, 1967), available N (Subbiah and Asija, 1965), available P (Olsen *et al.,* 1954), available K (Merwin and Peech, 1951) and available Zn (Lindsay and Norvell, 1978) were estimated and uptake was calculated by formula given

$$\text{Macronutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Macronutrient content (\%) grain/ straw yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Micronutrient uptake (g ha}^{-1}\text{)} = \frac{\text{Micronutrient content (mg kg}^{-1}\text{) grain/ straw yield (kg ha}^{-1}\text{)}}{1000}$$

RESULTS AND DISCUSSION

Effect on growth attributes:

The data pertaining to various growth attributes studied viz., plant height, number of tillers $meter^{-1}$ row length and dry matter accumulation at harvest as influenced by various treatments are presented in Table 1.

Effect of land configurations

The results revealed that with two land configurations, the maximum plant height of wheat was recorded under the bed planting method as compared to the flat planting method but they significantly did not differ from one another.

Throughout the investigation, the bed planting method had a statistically higher number of tillers and dry matter accumulation than the flat planting method. This could be due to good air and moisture movement in the bed system, as well as increased net solar radiation, which could have resulted in better nutrient uptake and utilization, resulting in an increase in the number of tillers and dry matter accumulation. Kaur and Dhaliwal (2015) reported highest number of tillers under bed planting method than flat planting method. Tomar *et al.* (2015) supported our result by concluding that raised bed planting had higher dry matter accumulation which might be due to better availability of nutrients and moisture to the crop than the flat planting method.

Effect of zinc levels

The tallest plants were recorded under $ZnSO_4$ @ 20 kg ha^{-1} at harvest. However, it was found to be at par with $ZnSO_4$ @10 kg ha^{-1}. The shortest plants of wheat were recorded in control where no nutrient was provided at all during the investigation. The rise in plant height might be attributed to Zn increasing the availability of important nutrients, leading to higher metabolic and enzymatic activity, which in turn promoted the division of cells and cell extension, resulting in an increase in plant height. Yadav and Dutta (2022) investigated the effect of zinc application on yield and quality of summer maize in light textured soil and found that the application 5.0 kg Zn ha^{-1} resulted in significantly higher plant height. The similar kind of increment in plant height of pigeonpea was also reported by Shah *et al.* (2016) and Thamke (2017) with the soil application of $ZnSO_4$ applied at the magnitude of 20 kg ha^{-1} and 15 kg ha^{-1}, respectively.

Application of $ZnSO_4$ @ 20 kg ha^{-1} produced a greater number of tillers than all other treatments including the lowest count with control. It might be because of the better-balanced availability of Zn in conjunction with the suggested fertilizer. These results are in accordance with Naik and Das (2007), who reported adequate supply of zinc produced more number of tillers. Jondhale also reported maximum number of tillers in rice crop due to soil application of $ZnSO_4$ @ 30 kg ha^{-1}.

In the plots treated with zinc, maximum dry matter accumulation was observed in $ZnSO_4$ @ 20 kg ha^{-1} than control. This might be owing to the inclusion of zinc, which has a significant function in a wide range of physiological and molecular actions as well as producing more dry matter in cereals. Kumar *et al.* (2016) reported that an increase in levels (40 kg ha^{-1}) of $ZnSO_4$ increased the dry matter yield significantly up to 20 kg ha^{-1}.

Interaction effect

The interaction effect due to land configuration and zinc levels on growth attributes *viz.,* plant height, number of tillers $meter^{-1}$ row length and dry matter accumulation at harvest was found to be non-significant.

Yield and Yield attribute

The data related to yield and yield attributes *viz.,* test weight, straw, and grain yield at harvest as influenced by various treatments are presented in Table 1.

Effect of land configurations

The test weight of wheat was found to be non-significantly higher in raised beds (36.88) than in flat planting (36.66) methods.

Data pertaining to the grain and straw yield of wheat as affected by land configurations showed that the grain and straw yield of wheat was found significantly higher in a raised bed over a flatbed. It might be due to improved crop growth and development in raised beds owing to the existence of an extensive root system, which increased nutrient absorption from the soil in the bed system, resulting in increased photosynthesis and transfer of assimilate from source to sink. Tomar *et al.* (2015) reported highest grain and straw yield in urdbean under bed planting method. Khade *et al.* (2017) also noticed maximum yield on raised beds.

Effect of zinc levels

The test weight of wheat was found to be non-significant due to zinc application.

The data with respect to grain and straw yield highlighted that $ZnSO_4$ @ 20 kg ha^{-1} produced a significantly higher yield as compared to other treatments. This could be owing to the use of zinc, which plays an important part in crop growth activities such as photosynthetic processes, respiration, and nitrogen metabolism-protein synthesis. It is also involved in the production of IAA, the regulation of auxin concentration in plants, and other biochemical and physiological processes such as the initiation of development for reproductive organs. Jondhale *et al.* (2021) also noted a significant increase in grain and straw yield of rice with the application of 15 kg $ZnSO_4$ ha^{-1}. Singh *et al.* (2012) conducted an experiment to study the effect of zinc on yield of chickpea. The results showed that grain and straw yield increased significantly by 9.8 and 11.4 % respectively with the application of 5 kg Zn ha^{-1}.

Interaction effect

The interaction effect due to land configuration and zinc levels on yield and yield attribute *viz.,* test weight, straw and grain yield at harvest was found to be non-significant.

Soil parameters

The data related to soil parameters viz., pH, EC and available nutrients after harvest as influenced by various treatments are presented in Table 2.

Effect of land configurations

The data pertaining to soil pH and EC as influenced by land configuration at harvest of the wheat crop had shown non significant results on soil parameters.

The perusal of data showed that there was a significant difference in available N, P, K, and zinc in soil due to land configurations. The value of available nutrients was higher in raised beds than in flat planting methods because of an increase in mineralization and transformation of nutrients due to less structural disruption of aggregates and settlement in raised beds than in flat planting methods, which leads to a better soil environment and thus increases zinc soil availability. Fahong *et al.* (2004) supported our findings by concluding that bed planting reduced soil surface exposure to flooding by 40%, eliminating top soil crusting on the top of the bed where the crop was planted and preventing nutrient losses through runoff, which are more common in flat planting methods.

Effect of zinc levels

The data pertaining to soil pH and EC as influenced by different levels of zinc through soil application had no significance on soil parameters.

The soil application of $ZnSO_4$@ 20 kg ha^{-1} significantly reduced available P content in the soil which might be due to the antagonistic effect between Zn and P. In contrast, the highest DTPA- Zn and available N were found with the application of $ZnSO_4$@ 20 kg ha^{-1}. The synergistic effect of N and Zn may have resulted in increased accessible N and zinc application enhanced DTPA-Zn content in the soil, potentially due to improved solubility, diffusion, and mobility of the applied inorganic Zn fertilizer, resulting in elevated soil Zn status. Soil-applied zinc had a non-significant effect on available K content in the soil. Similar kind of increase in available nutrients was reported by Kumar *et al.* (2018) through soil application of $ZnSO_4$ at the magnitude of 25 kg ha^{-1} in rice cultivation.

Interaction effect

The interaction effect due to land configuration and zinc levels on soil parameters *viz.,* pH, EC, and available nutrients after harvest was found to be non-significant.

Table 1. Impact of land configuration and soil applied zinc on growth attributes, yield and yield attributes of wheat crop

Treatments	Plant height (cm) at harvest	Number of tillers $meter^{-1}$ row length at harvest	Dry matter accumulation (q ha^{-1}) at harvest	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Land configurations						
Bed planting method	83.18	59.42	97.25	36.92	49.45	72.95
Flat planting method	82.29	55.40	92.50	36.65	44.97	66.19
SE(m)±	0.39	0.46	1.25	0.16	0.97	1.50
CD (p=0.05)	—	1.37	3.73	—	2.90	4.48
Zinc levels						
Control	78.23	53.40	88.20	36.40	40.70	64.90
RDF+ Zn @ 0 kg ha-1	82.31	56.70	94.70	36.90	47.65	69.90
RDF+ Zn @ 10 kg ha-1	84.62	58.41	96.20	36.91	49.40	71.60
RDF+ Zn @ 20 kg ha-1	85.79	61.14	100.40	36.97	51.10	71.90
SE(m)±	0.63	0.43	1.28	0.26	0.80	1.15
CD (p=0.05)	1.88	1.28	3.82	—	2.39	3.43
Interaction						
SE(m)±	0.79	0.58	1.20	0.32	0.95	1.59
CD (p=0.05)	—	—	—	—	—	—

Table 2. Effect of land configuration and soil applied zinc on soil parameters of wheat

Treatments	pH	EC(dSm^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Zn(g ha^{-1})
Land configurations						
Bed planting method	8.17	0.31	192.82	18.69	251.54	0.97
Flat planting method	8.14	0.29	189.06	16.67	245.13	0.91
SE(m)±	0.15	0.004	0.77	0.27	1.06	0.01
CD (p=0.05)	—	—	2.30	0.80	3.16	0.03
Zinc levels						
Control	8.16	0.28	164.47	15.39	242.54	0.77
RDF+ Zn @ 0 kg ha-1	8.17	0.30	197.06	20.59	248.90	0.86
RDF+ Zn @ 10 kg ha-1	8.15	0.31	200.13	17.42	250.69	1.04
RDF+ Zn @ 20 kg ha-1	8.15	0.31	202.11	17.34	251.23	1.09
SE(m)±	0.18	0.01	0.95	0.23	1.99	0.01
CD (p=0.05)	—	—	2.84	0.68	—	0.03
Interaction						
SE(m)±	0.27	0.01	1.22	0.32	2.92	0.02
CD (p=0.05)	—	—	—	—	—	—

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