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Impact of phosphorus and zinc application on growth and yield of wheat (*Triticum aestivum* L.) under late sown condition

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Abstract
The present experiment entitled "Impact of phosphorus and zinc application on growth and yield of wheat (*Triticum aestivum* L.) Under middle zone of U.P." was carried out at Shradheya Bhagwati Singh Agriculture Research Farm, Hajipur, Chandra Bhanu Gupta Krishi Snatkottar Mahavidyalaya, BKT, Lucknow (UP). The experiment was comprising with four levels of phosphorous i.e., (0, 60, 80 and 100 Kg/ha) and three levels of zinc (0,5 and 10 kg ha^{-1}) thus, all possible 12 treatment combinations were tested in randomized block design (Factorial experiment). Examination of data clearly indicated that increasing levels of phosphorus and zinc were responsible for increased growth and yield attributes. Application of 100 kg P_2O_5 ha^{-1} being at par with 80 kg P_2O_5 ha^{-1} P_2O_5 ha^{-1} produced more taller plants and number of tillers $plant^{-1}$as well as maximum LAI at 90DAS. Maximum dry matter accumulation was also noted under 100 kg P_2O_5 ha^{-1}. Higher values of test weight, grain yield, straw yield and biological yield was associated with application of 100 kg P_2O_5 ha^{-1}. Like phosphorus the highest level of zinc attained maximum values of above growth and yield parameters.

Keywords: Associated, attributes, factorial and examination

Introduction
Wheat (*Triticum aestivum* L) 2n=42 gives almost 55% of carbohydrates and 20% of the food calories. It contains 78.10%, 14.70%, 2. 10%, and 2.10% of carbohydrates, protein, fat, minerals and some proportions of minerals (zinc, iron) and vitamins (thiamine and vitamin-B) Additionally, wheat is a wonderful source of trace minerals like selenium and magnesium, which are essential for overall health. Wheat grains are also rich in pantothenic acid, riboflavin and a few minerals, sugars and so forth. Furthermore, bran is a dietary source of fibre, potassium, phosphorus, magnesium, calcium, and niacin in small amounts, as well as a niacin source. (Alemu 2017) [1].

Phosphorus is the backbone of any fertilizer management program and plays a significant part in energy-related activities and the growth of the root systems. Its absorption takes place at a rapid rate throughout the crop development period and its accumulation in plant reaches the maximum about two weeks before the maturity in the case of many crops including wheat. Phosphorus concentration below 0.1% in dry leaf tissue is considered deficient. Phosphorus deficiency also reduces the size and yield of grains. The phosphorus-deficient wheat plants bear less as well as smaller ears (Sawyer 2004) [17].

Zinc is important for plant nutrition and is regarded to be a crucial component of several enzyme complexes. This micronutrient is necessary for all six enzyme classes in addition to regulating growth, protein synthesis, energy production, enzyme activation, gene expression, phytohormone action, carbohydrate metabolism, fertility, seed production, and disease resistance (Hafeez *et al.* (2013) [6], Sandeep *et al.* (2019) [16] Protein, carbohydrate, and auxin metabolism are all impacted by a deficiency of Zn, and reproductive health is also negatively impacted (Sadeghzadeh 2013) [15].

Information regarding to effect of phosphorus and zinc on production of wheat crop is lacking in this region. Thus, an attempt has been made to evaluate the alone and combined effect of these nutrients.

Materials and Methods
A field experiment entitled "Impact of phosphorus and zinc application on growth and yield of

wheat (*Triticum aestivum* L.) under late shown condition." was undertaken at the Shradheya Bhagwati Singh Agriculture Research Farm, Hajipur, Chandra Bhanu Gupta Krishi Snatkottar Mahavidyalaya, B.K.T, Lucknow (U.P.) situated at Latitude: of 26°59′ North, and Longitude: 80'54' East at an altitude of 116 meters above mean sea level. The experimental location comes under the Agro-Climatic Zones of Central Plains of Uttar Pradesh comprising Allahabad, Fatehpur, Pratapgarh, Sultanpur, Raebareli, Unnao, Lucknow, Barabanki, Sitapur, Hardoi, Kheri and Pilibhit districts which fall under this sub-zone. This area receives on an average 979 mm of rainfall; the climate ranges from dry sub-humid to semi-arid and the soil is alluvium calcareous sandy loam type. The climate of Bakshi Ka Talab is warm and temperate. In winter, there is less rainfall than in summer. The average annual temperature in Bakshi Ka Talab is 24.9°C. The precipitation is about 1045 mm per year. The experiment consisted with four levels of phosphorous i.e., (0, 60, 80 and 100 Kg/ha) and three levels of zinc (0,5 and 10 kg/ha). Thus, all possible 12(P_0Z_0, P_0Z_1, P_0Z_2, P_1Z_0, P_1Z_1, P_1Z_2, P_2Z_0, P_2Z_1, P_2Z_2, P_3Z_0, P_3Z_1 and P_0Z_2) treatments combinations were tested in randomized block design (Factorial experiment) with three replications. Observations on growth and yield parameters were taken and their results are discussed as under:

Results and Discussion

The impact of phosphorus application on plant height was significant at all growth stages (Table 1). In general plant growth increase with the advancement of crop growth stages and reached a maximum at 90 DAS. The tallest plant (104.14 cm) was recorded at 90 DAS with Phosphorus @ 100 kg ha¹. Similar results are found by Rahim, (2010) [14]. That phosphorus application had significantly increased the plant height of wheat. Similarly, Faraz (2020) [5] and Ali (2020) [20] both observed that increasing the P dose resulted in an increase in plant height. Hussain *et al.* (2008) [7] reported that a wheat crop with 120 kg P2O5 ha¹ gives the plant maximum height.

The numbers of tillers plant were significantly maximum with Phosphorus @ 100 kg ha¹. The maximum number of tillers plant¹ was found up to 90 DAS and thereafter, decreased. This might be because of mutual competition among the plants for light, nutrients and other growth input resulting in mortality of tillers after 90 DAS. The crop dry matter accumulation (g m³) significantly increased continuously with the advancement of the crop growth stages. The effect of Phosphorus application on crop dry matter accumulation was influenced at all growth stages. The highest value was recorded with Phosphorus @ 100 kg ha¹. Dry matter accumulation of plants is the outcome of photosynthetic activities. Phosphorus fertilization thus promoted rapid and increased plant growth in terms of the number of tillers plant and dry matter accumulation. The findings of the present investigation are in close conformity with those of Jain and Dahama (2006) [8], Sharma (2011) [19], Yadav *et al.* (2015) [21] and Arshad *et al.* (2016) [3] who reported that the number of tillers m² and dry matter production increased significantly due to phosphorus fertilization.

The leaf area index significantly increased continuously with the advancement of the crop growth stages. It could be due to adequate supply of Phosphorus up to the reproductive stage and favourable conditions which leads to the increased no. of leaves and leaf area, finally maximum leaf area index (6.86) was observed with Phosphorus at 90 DAS.

Yield is the outcome of crop efficiency as influenced by various management practices. Grain and straw yield were significantly affected by different Phosphorus applications over control. Significantly maximum yield was obtained with Phosphorus @ 100 kg ha. Kumar *et al.* (2001) [11], Jain and Dahama (2006) [8] and Jat *et al.* (2007) [9] also recorded significant improvement in wheat grain yield with an increase in phosphorus levels.

The beneficial effect of phosphorus application on growth and yield attributes contributed to higher grain and straw yield in the present experiment. The application of phosphorus increased vegetative growth as evident from dry matter production (Table 1) possibly under phosphorus fertilization, its extensive roots absorb and utilize nutrients effectively (Panda and Rai (2008) [13], and Arshad *et al.* (2016) [3] have also reported similar findings.

A faster rate of grain yield improvement when phosphorus fertilization was applied as opposed to straw fertilization led to a significant improvement in biological yields, indicating a better source-sink relationship. These results conform with those of Sepat and Rai (2013) [18].

The grain yield, straw yield and total biological yield (Table 2) were also significantly affected by the application of Zinc @ 10 kg ha over the rest of the zine treatments. This might be because zine application plays an important role in the biosynthesis of IAA and initiation of primordial for the reproductive part which has favoured the metabolic reaction within the plant. Similar results showing the increase in wheat yield with the application of zinc were reported by Khan et al. (2008) [10], Singh et al. (2015) [20] and Arshad et al. (2016) [3] The greater photosynthesis efficiency or more nutrient availability due to increased decomposition rate of organic matter or improved individual plant performance might be the possible reasons for higher grain and straw yield in zinc applied plots compared to other plots.

In the present study, the interaction effect of Phosphorus and zinc were observed on grain yield and straw yield was found significant results. The maximum values of grain yield (41.33 q ha¹) and straw yield (43.85 q ha) were observed with Phosphorus @ 100 kg ha Zinc @ 10 kg ha¹ however, the lowest grain (29.21 q ha¹) and straw (36.63 q ha¹) yield were recorded with a combination of no Phosphorus no Zine. The addition of zine with P may maintain a favourable balance between the applied nutrients in the plant for its optimum growth and Zn enhanced the utilization of P by its effect on metabolism. Similar results were also reported by Dewal (2002) [4] and Mafi et al. (2013) [12].

Table 1: Effect of various levels of phosphorus and zinc on growth attributes of wheat

Treatments	Growth attributes			
Phosphorus (kg ha^{-1})	**Plant height**	**N of tiller m^{-2}**	**DMA**	**LAI 90 DAS**
0	85.73	326.30	857.56	6.03
60	88.91	344.00	955.14	6.25
80	92.96	361.55	1081.98	6.48
100	96.64	380.77	1209.42	6.86
S.Em +	0.21	0.63	2.68	0.05
CD at 5%	0.64	1.88	7.92	0.16
Zinc (kg ha^{-1})				
0	89.70	347.75	994.02	6.35
5	91.12	363.16	1029.48	6.34
10	92.35	358.58	1054.57	6.52

S.Em +	0.18	0.55	2.32	0.04
CD at 5%	0.55	1.63	6.86	0.14

Table 2: Effect of various levels of phosphorus and zinc on yield attributes and yield attributes of wheat

Treatments	Yield attributes and yield			
Phosphorus (kg ha^{-1})	**Test weight**	**Grain yield (q ha^{-1})**	**Straw yield q ha^{-1})**	**Biological yield (q ha^{-1})**
0	38.96	32.52	39.00	71.50
60	40.80	35.72	40.40	76.19
80	41.50	37.83	41.90	79.73
100	41.76	38.55	43.50	82.05
S.Em +	0.11	0.22	0.232	0.66
CD at 5%	0.33	0.65	0.68	1.94
Zinc (kg ha^{-1})				
0	38.88	32.77	40.07	72.84
5	40.90	36.34	41.47	77.81
10	41.15	37.77	42.97	81.74
S.Em +	0.09	0.189	0.201	0.57
CD at 5%	0.29	0.554	0.59	1.67

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