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Effect of different level of potassium and zinc on growth, yield attributes and yield of late sown wheat (*Triticum aestivum* L.) under irrigated system

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Abstract
The study pertaining to evaluation of different levels of potassium and zinc fertilizers on the growth and yield of wheat was conducted at the research farm of A. S. (P.G.) College, Lakhaoti (Bulandshahr), Uttar Pradesh during the *rabi* season of 2011-2012. Randomized complete block design with factorial arrangement used to lay out this experiment. The treatments comprised of ningth combinations of three levels each of zinc and potassium. Before sowing the seeds, the following nutrients were homogeneously incorporated into the soil; K1= 0 kg ha-1, K2= 30 kg ha-1 and K3= 60 kg ha-1 and Zn1= 0 kg ha-1, Zn2= 25 kg ha-1 and Zn3= 50 kg ha-1. Data regarding various agronomic traits (plant height, number of fertile tillers per unit area, spike length, number of spikelets per spike, number of grains per spike, 1000-grain weight, biological yield, grain yield and harvest index) of crop were recorded by using standard procedures. Application of potassium fertilizer and zinc significantly improved the growth and yield parameters of wheat. The results revealed that the application of increasing levels of potassium and Zinc upto @ 30 and 60 kg/ha and 25 and 50 kg/ha, respectively significantly increased the growth parameters viz., number of leaves plant-1, dry weight (g) at different growth stages and yield attributing characters like length of ear head, number of grains ear-1, test weight (g), grain and straw yields but harvest index non-significan with as compared to control. Thus, the present studies indicated that the application of 25 kg Zn ha-1 with 30 kg K2O in enhanced the productivity late sown wheat crop.

Keywords: Effect of different, potassium and zinc, growth, sown wheat

1. Introduction

Wheat (*Triticum aestivum L.*) is the staple food and second most important food crop after rice in the country, which contributes nearly one-third of the total food grains production. India is the second largest producer of wheat in the world and produce nearly 96 mt of wheat in an area of about 30 m ha with a productivity of almost 31q/ha. (Annual progress report 2013-14 of directorate of wheat research, karnal) [4].Wheat is the staple food of the world population which ranks first in total area in the world. Potassium is a "work horse" plant nutrient. Perhaps this is why it is not bound into any specific plant compound. Therefore, potassium is free to travel and to wheel and deal with in the plant almost at well. It should not be surprising that a shortage of potassium can result in loss of crop yield, quality and profitability. Application of potassium in combination with micronutrients like zinc had significant effect on grain yield of wheat (Emen and Moqied, 1998) [5]. Zinc is essential for the synthesis of plant growth regulator also called auxin (IAA); such compound regulates the growth and development of plants. Zinc uptake is promoted by liberal use of potassium. That is the reason due to which fertilizer, enriched with zinc is preferable for intensive farming system. The present experiment was designed to determine the yield and yield components of wheat under the effect of potassium and zinc. However, farmers in this region generally used only nitrogen or nitrogen and phosphorus fertilizers. Intensification of cropping system with greater use of potassium free chemical fertilizers and adoption of high yielding varieties have resulted in the mining of soils leading to K and Zn deficiency. To grow the crop successfully it is necessary that the nutrient requirement of the crop is met. Therefore, for sustaining soil fertility and optimum crop productivity on long term basis, K removal through the crops should be replenished with balanced and adequate K fertilization.

In this context it became almost essential to apply potassium and zinc from external source on soil test basis. Delay in sowing due to harvesting of sugercan, drastically reduces the grain yield of wheat. Each fortnight delay in sowing time from mid November, reduced the wheat grain yield by 5.0 q ha^{-1} in eastern part of the country (Khan and Chatterjee, 1981) [7]. It is largely assumed that the rise in temperature during terminal growth stage of wheat is the major cause of reduction in grain yield under late sown conditions. Keeping this in view, present study was, therefore, carried out to find out the optimize levels of potassium and on of late sown wheat under western Uttar Pradesh.

2. Methodology

The field experiment was conducted in factorial randomized block design with three replications. The treatments comprised of ningth combinations of three levels each of zinc and potassium. The field experiment was conducted during the *Rabi* season of 2011-2012 at the research farm of A. S. (P.G.) College, Lakhaoti (Bulandshahr), Uttar Pradesh. The farm is situated on the Bulandshahr-Garhmukteshwar road at a distance of 18 km from Bulandshahr towards Syana town.WR 544 (PUSA GOLD) is a wheat variety suitable for l ate sown and irrigated conditions. The latitude and longitude of the experimental site are 28.4° N and 77.1°E respectively with an elevation of about 245.83 m above mean sea level. The soil of the experimental site was low in organic carbon with available nitrogen of 221.3 kg/ha. The status of available phosphorus and potassium was medium.The texture of the soil was sandy loam and the pH value was 7.4. In regards to application of nitrogen and phosphorus @ 120 and 60 kg/ha were applied to the crop (PUSA GOLD), respectively. Full dose of phosphorus and half dose of nitrogen were applied as basal. Remaining half of the nitrogen was applied in two equal split doses at tillering and stems elongation stage. Zinc and potassium doses as per treatments were applied through Zinc sulphate (21 % Zn) and Murate of potash (60 % K_2O) at the time of sowing. All other agronomic practices were kept same for all the treatments. Observations were recorded at the time of harvesting and grain yield was recorded after threshing. Five ear head were sampled from the tagged plants in each plot and then length was measured in centimeter. The average length of ear head was calculated. The total number of grains of ten selected spikes were counted and averaged to get the number of grains spike-1. A random sample of grains was drawn from grain yield of each plot. From this sample, 1000-grain were counted at random and their weight (g) was recorded. Harvesting was done when the maturity symptoms were observed. The border rows were harvested first as bulk and kept separately. The remaining plants from net plot area were then harvested. Threshing of the plants from net plot area and border rows crop was done separately. Threshed grains were separated out manually and grains were sun dried to moisture of 12 % before recording their weight. Straw yield was recorded by subtracting the weight of grains from the weight of each net plot. Harvest index of each plot was calculated with the help of following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (q/ha)}}{\text{Biological yield (q/ha)}} \times 100$$

Soil pH was determined with the help of glass electrode pH meter in 1:2.5 soil water suspensions. Electrical conductivity was determined with the help of EC meter in 1:2.5 soil water suspensions as described by Jackson (1973) [6]. Organic carbon was determined with the help Walkley and Black's rapid titration method as advocated by Walkley and Black's (1934) [14]. The available nitrogen content in soil samples was determined by alkaline permanganate method as described by Subbiah and Asija (1956) [13]. The available phosphorus in soil determined by Olsen's method as per procedure described by Olsen's *et al.* (1954) [10]. The Available K in the soil was extracted by 1N neutral ammonium acetate as an extractant (Jackson, M. L. 1967) [6] and K in the extract was determined by Flame photometer. Available Zn in the soil was extracted by DTPA and Zn in the extract was determined by Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978) [8].

3. Results and Discussion

3.1 Growth studies

The effect of zinc levels on the main shoot height was not significant at all the growth stages. Increasing levels of zinc induced only numerical increases in the main shoot height. Varying levels of potassium had no significant effect on the main shoot height (Table 1). The effect of zinc levels on the number of tillers per main shoot was not significant at all the growth stages. Potassium levels influenced the number of tillers per plant significantly at all the growth stages of crop (Table 2). Crop responded to potassium significantly up to 30 kg/ha with respect to number of tillers per main shoot at all the three stages. Beyond 30kg/ha, there were numerical increases only in the number of tillers per plant at all the three stages (50 and 75 days after sowing and harvest). At harvest, crop with 30 kg K_2O/ha (7.24) produced 16.16% higher number of tillers (7.24 per plant) than control (6.07 per plant) and 1.38% lesser than 60 kg K_2O/ha (7.34 per plant). The effect of increasing levels of potassium was significant on the dry matter accumulation per plant at different stages (50 and 75 days after sowing and harvest) except first stage i.e. 25 days after sowing., increasing levels of potassium increased the dry matter accumulation per plant only up to 30 kg K_2O/ha though the numerical increases beyond this level were observed at these stages. At the time of harvest, the dry matter accumulation produced with 30 kg K_2O/ha was 5.22 % higher (40.49 g/plant) than control (38.38 g/plant) and 0.84 % lower than 60 kg K_2O/ha (40.78 g/plant). The variations caused in the dry matter accumulation per plant by zinc levels were not significant at any one of the crop stages. Only numerical increases were observed up to 25 kg Zn/ha at all the stages of crop. At the stages (50 and 75 days after sowing and harvest), increasing levels of potassium increased the dry matter accumulation per plant only up to 30 kg K_2O / ha though the numerical increases beyond this level were observed at these stages. These findings are in partial confirmity of the results reported by Sakal *et al.* (1979) [11], Dasalkar *et al.* (1992) [3] and Shahabifar and Mostashri, (2002) [12].

4. Yield attributes and yield

Varying levels of zinc did not influence the ear length significantly though numerical increases were observed up to 25 kg Zn/ha. Increasing levels of potassium increased the ear length linearly up to 50 kg/ha but significant increase was observed only up to 30 kg K_2O/ha. The ear length recorded with 30 kg. K_2O/ha (12.06 cm) was 14.34 % greater than control (10.33 cm) and 3.23 % shorter than 60 Kg. K_2O/ha (12.45 cm). Increasing levels of zinc had no significant effect on the number of grains per ear but numerical increases were observed effectively up to 25 kg./ha and moderately up to 50 kg./ha. The effect of potassium application was recorded significant on the number of grains per ear. Increase in the level of potassium increased the number of grains per ear significantly only up to 30 kg K_2O/ha. The grains per ear counted with 30 kg K_2O/ha were 5.06 % higher (62.27 per ear) than control (59.12 per ear) and 0.55 % lesser than 60 kg K_2O/ha (62.61 per ear). The different levels of zinc showed non-significant differences on test weight, However, numerical increases were observed with increase in the levels of zinc up to 50 kg/ha The effect of different levels of potassium was significant on the test weight. Increasing levels of potassium increased the test weight significantly up to 30 kg K_2O/ha. The test weight recorded with 30 kg K_2O/ha was 4.53 % higher (36.89 g) than control (35.22 g) and equal to 60 kg K_2O/ha. Different levels of zinc had no significant effect on the above ground biomass. The numerical increase in the above ground biomass was seen only up to 25 kg Zn/ha. Increasing levels of potassium caused significant differences in the above ground biomass but such increases were observed significant up to 30 kg K_2O/ha. The above ground biomass recorded with 30 kg K_2O/ha was 10.33 % higher (76.10 q/ha) than control (68.24 q/ha) and 1.89 % lower than 60 kg K_2O/ha (77.54 q/ha). Increasing levels of zinc had no significant effect on the straw yield. Every increase in the level of zinc rather made numerical decrease in the straw yield. The effect of increasing levels of potassium was not significant on the straw yield but numerical increases were noticed effectively up to 30 kg K_2O/ha and moderately up to 60 kg K_2O/ha. Varying levels of zinc had significant effect on the grain yield. Increasing levels increased the grain yield significantly up to 25 kg Zn/ha. The grain yield recorded with 25 kg Zn/ha (30.27 q/ha) was 6.1 per cent higher than control (28.40 q/ha) and 0.85 per cent lower than 50 kg Zn/ha (30.53 q/ha). The effect of potassium levels on the grain yield was significant. Significant increase in the grain yield was noticed up to 30 kg K_2O/ha. The grain yield recorded with 30 kg K_2O/ha (30.84 q/ha) was higher and lower by 11.12 and 0.32 per cent over control (27.41 q/ha) and 60 kg K_2O/ha (30.94 q/ha), respectively. Increasing levels of potassium and zinc had no significant effect on the harvest index. Every increase in the level of zinc rather made numerical decrease in the straw yield. Varying levels of zinc had significant effect on the grain yield. Increasing levels increased the grain yield significantly up to 25 kg Zn/ha. The effect of varying levels of zinc on harvest index was not significant. Increasing levels of potassium caused significant differences in the above ground biomass but such increases were observed significant up to 30 kg K_2O/ha. The effect of increasing levels of potassium was not significant on the straw yield but numerical increases were noticed effectively up to 30 kg K_2O/ha and moderately up to 60 kg K_2O/ha. The effect of potassium levels on the grain yield was significant. Significant increase in the grain yield was noticed up to 30 kg K_2O/ha. Increasing levels of potassium had no significant effect on the harvest index. These findings are in full confirmity of the results reported by Alam (1995) [1], Zhao *et al.* (1998) [15], Amanullah (2006) and Mathur (2011) [2].

Conclusion

It can be concluded that late wheat responded significantly to added potassium and zinc. The highest yield advantage was attained when 30 and 25 kg/ha potassium and zinc was applied, respectively. Therefore, the application of 30 and 25 kg/ha potassium and zinc respectively can be the optimum doses to obtain the maximum yield of late sown wheat under irrigated condition. WR 544 (Pusa Gold) is a wheat variety suitable for late sown and irrigated conditions.

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Table 1: Main shoot height (cm) as influenced by zinc and potassium levels at different stages of crop growth

Zinc and K levels	Growth stages			
	25 DAS	50 DAS	75 DAS	Harvest
(A) Zinc Sulphate Levels				
(i) Control	11.84	25.20	62.76	76.38
(ii) 25 kg/ha	12.04	26.02	63.63	77.16
(iii) 50 kg/ha	12.13	26.94	63.80	77.80
SE±	0.13	0.46	0.52	0.52
CD 5%	NS	NS	NS	NS
(B) K- levels				
(i) Control	11.82	25.41	62.22	76.64
(ii) 30 kg/ha	12.02	26.21	63.84	77.11
(iii) 60 kg/ha	12.18	26.54	64.12	77.58
SE±	0.13	0.46	0.52	0.52
CD 5%	NS	NS	NS	NS

DAS= days after sowing

Table 2: Tillers per plant as influenced by zinc and potassium levels at different growth stages of wheat

Zinc and K levels	Growth stages		
	50 DAS	75 DAS	Harvest
(A) Zinc Sulphate Levels			
(i) Control	5.22	6.71	6.51
(ii) 25 kg/ha	5.29	7.31	7.03
(iii) 50 kg/ha	5.89	7.12	7.11
SE±	0.13	0.12	0.14
CD 5%	NS	NS	NS
(B) K- levels			
(i) Control	4.87	6.39	6.07
(ii) 30 kg/ha	5.67	7.27	7.24
(iii) 60 kg/ha	5.87	7.49	7.34
SE±	0.13	7.49	0.14
CD 5%	0.27	7.49	0.30

Table 3: Dry matter accumulation per plant as influenced by zinc and potassium levels at different growth stages of wheat

Zinc and K levels	Growth stages			
	25 DAS	50 DAS	75 DAS	Harvest
(A) Zinc Sulphate Levels				
(i) Control	9.33	12.89	26.33	39.67
(ii) 25 kg/ha	9.44	12.89	26.67	39.56
(iii) 50 kg/ha	9.39	12.78	25.56	40.33
SE±	0.15	0.27	0.34	0.33
CD 5%	NS	NS	NS	NS
(B) K- levels				
(i) Control	8.67	11.56	24.33	38.33
(ii) 30 kg/ha	9.61	13.22	26.78	40.44
(iii) 60 kg/ha	9.89	13.78	27.44	40.78
SE±	0.15	0.27	0.34	0.33
CD 5%	NS	0.58	0.72	0.69

Table 4: Ear length, grains per ear and thousand grain weight as influenced by zinc and potassium levels at different stages of crop growth

Zinc and K levels	Ear length (cm)	Grains/ear	Thousand grain weight (g)
(A) Zinc Sulphate Levels			
(i) Control	11.09	60.19	36.00
(ii) 25 kg/ha	11.91	61.31	36.56
(iii) 50 kg/ha	11.84	62.50	37.00
SE±	0.24	0.45	0.27
CD 5%	NS	NS	NS
(B) K- levels			
(i) Control	10.33	59.12	35.22
(ii) 30 kg/ha	12.06	62.27	36.89
(iii) 60 kg/ha	12.45	62.61	36.89
SE±	0.24	0.45	0.22
CD 5%	0.50	0.95	0.47

Table 5: Above ground biomass, straw yield, grain yield and harvest index as influenced by zinc and potassium levels at different stages of crop growth

Zinc and K levels	Above ground biomass (q/ha)	Straw yield (q/ha)	Grain yield (q/ha)	Harvest index
(A) Zinc Sulphate Levels				
(i) Control	74.31	45.92	28.40	38.31
(ii) 25 kg/ha	75.45	45.18	30.27	40.45
(iii) 50 kg/ha	72.12	41.59	30.53	42.47
SE±	1.01	0.96	0.26	0.53
CD 5%	NS	NS	0.55	NS
(B) K- levels				
(i) Control	68.24	40.83	27.41	40.28
(ii) 30 kg/ha	76.10	45.27	30.84	40.79
(iii) 60 kg/ha	77.54	46.60	30.94	40.17
SE±	1.01	0.96	0.26	0.53
CD 5%	2.13	NS	0.55	NS

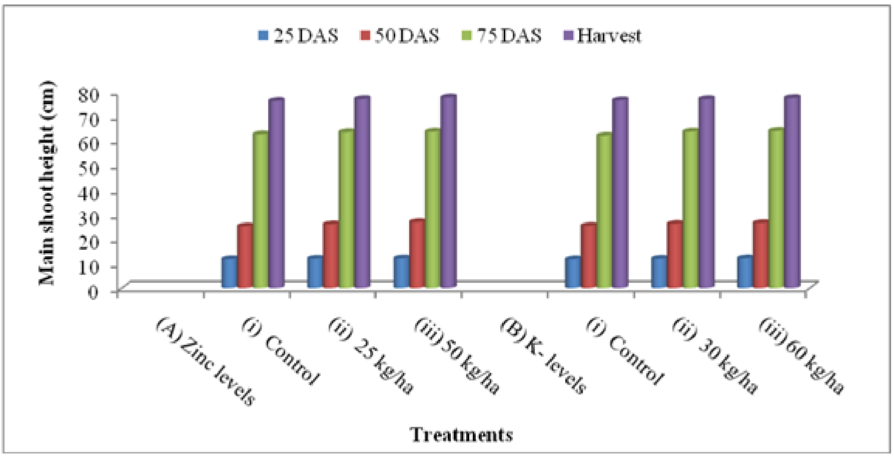

Fig 1: Main shoot height (cm) as influenced by zinc and potassium levels at different stages of crop growth

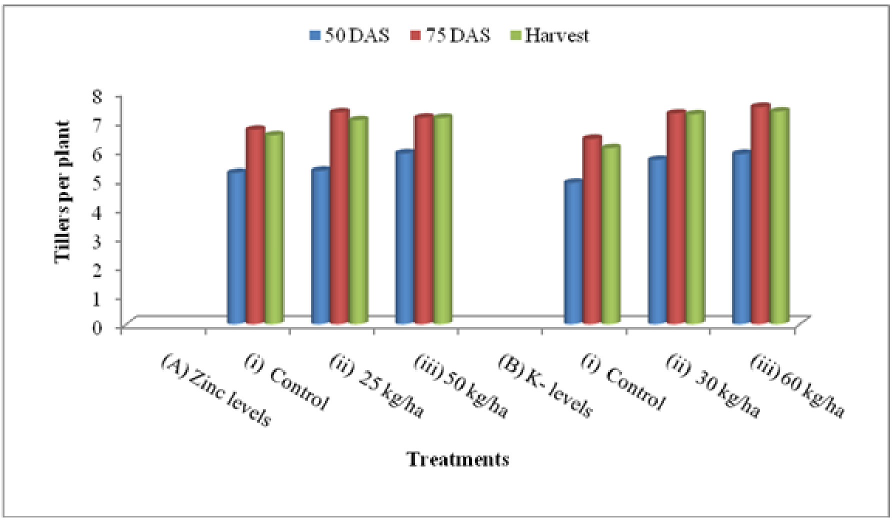

Fig 2: Tillers per plant as influenced by zinc and potassium levels at different stages of crop growth

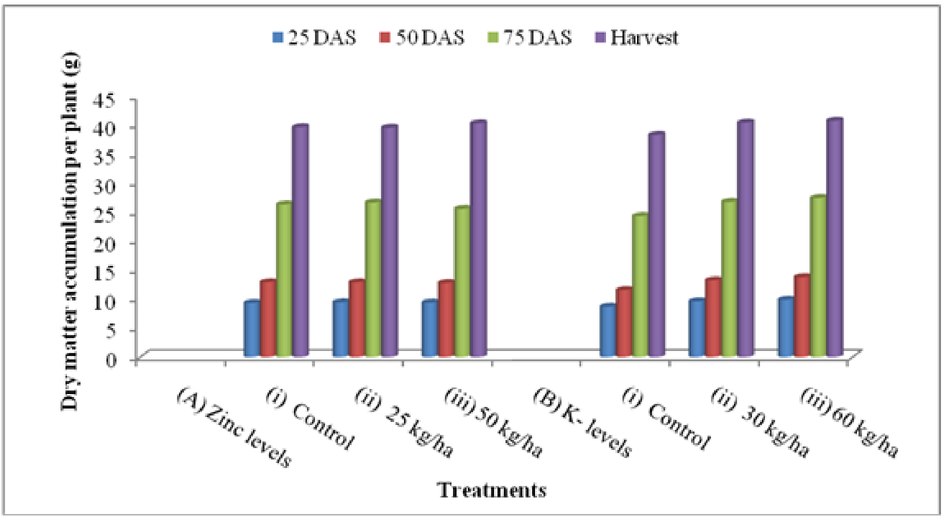

Fig 3: Dry matter accumulation per plant (g) as influenced by zinc and potassium levels at different stages of crop growth

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