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EFFECT OF PHOSPHORUS AND COPPER LEVELS ON YIELD AND NUTRIENTS UPTAKE BY WHEAT

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ABSTRACT

A field experiment was conducted during rabi season of 2008-09 and 2009-2010 to study the effect of phosphorus and copper levels on yield and nutrients uptake by wheat at Lakhaoti, (Bulandshahr). Results indicated that the maximum average grain and straw yield of 47.49 and 56.50 q ha^{-1} were recorded with 90 kg P_2O_5 ha^{-1} which was accounted for 23.8 and 20.4 % increase, respectively over control. Application of copper improved the grain and straw yield of wheat up to 5.0 kg ha^{-1} thereafter grain and straw yield was reduced with 10 kg Cu ha^{-1} application. Significantly higher amount (13.5 %) of grain protein was observed with 90 kg P_2O_5 ha^{-1} application while it was lowest (13.28 %) in control. Protein content in grain tended to decrease with Cu levels. The nutrients uptake by grain and straw of wheat increased significantly with increasing levels of P over control except copper uptake by wheat crop. Copper application increased the uptake of N and Cu up to 5 and 10 kg ha^{-1}, respectively. There was a reduction in sulphur uptake with copper application over control.
Keywords: Phosphorus, copper, yield, nutrient uptake, wheat

INTRODUCTION

Phosphorus is an important nutrient need for normal growth and development of the plants. Phosphorus plays an important role in energy transformation and metabolic process in plants. It is known to be associated with nucleus formation, cell division and nitrogen fixation, fat and albumen formation and transfer of the heredity. In some soils, wheat, gram, oat, soybean are highly responsive to phosphorus fertilization. The continuous use of phosphatic fertilizers may disturb the nutritional balance, particularly of micronutrients, which may become a limiting factor in crop production. Among various micronutrients copper is important owing to its vital and indispensable role in plant growth. It is a constituent of cytochrome oxidase besides being a component of many enzymes such as ascorbic acid oxidase, phenolase lactase etc. It also promotes the formation of vitamin A in plants. Information regarding systermatic studies on levels P and Cu and their interaction for wheat crop in alluvial soil of Bulandshahr, is lacking. Keeping in view the above facts a study was undertaken to find out the effect of P and Cu on wheat grown on alluvial soil.

MATERIALS AND METHODS

A field experiment was conducted at research farm of Amar Singh College Lakhaoti, Bulandshahar (UP) during *rabi* season of 2008-09 and 2009-2010. The soil was sandy loam in texture and slightly alkaline in reaction with pH 7.9 It had 3.5 g kg^{-1} organic carbon, 162 kg ha^{-1} available nitrogen, 9.5 kg ha^{-1} available phosphorus, 160 kg ha^{-1} available potassium, 16 kg ha^{-1} available S and 0.15 mg kg^{-1} available Cu. Sixteen treatment combinations comprising four levels of P (0, 30, 60 and 90 kg P_2O_5 ha^{-1}) and four levels of Cu (0, 2.5, 5 and 10 kg Cu ha^{-1}) were evaluated in randomized block design with three replications. The calculated amount of phosphorus as diammonium phosphate and copper as copper sulphate was applied as per treatments at the time of sowing. All the treatments received nitrogen and potassium @ 150 and 40 kg ha^{-1} through urea and muriate of potash, respectively at the time of sowing. Wheat cultivar UP-2425 was taken as test crop and sown in lines at 20cm apart using a uniform seed rate of 125 kg ha^{-1} on 6 Nov. 2008 and 5 Nov. 2009. The grain and straw yields of net plot were recorded after threshing. The grain and straw yield of crop was converted in q ha^{-1} from net plot. The grain and straw samples of wheat collected at harvesting were analyzed for their N, P, K, S and Cu contents. Phosphorous content in grain and straw was estimated in di-acid (HNO_3: $HClO_4$, 3:1) by Vanadomolybdate yellow colour method and potassium by flame photometer. Sulphur content was estimated by turbidimetric method (Chesnin and Yien, 1951) in the extract. Copper in the extract was determined on an atomic absorption spectrophotometer. Nitrogen content in grain and straw samples was estimated by modified Kjeldahl method (Jackson 1973). Protein content in grain was computed by multiplying nitrogen percentage with 6.25.

RESULTS AND DISCUSSION

Grain and straw yield

The graded enhancement of P application rate from 0 to 90 kg P_2O_5 ha^{-1} recorded significant

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increase in grain and straw yield of wheat over control in both the years. The highest average grain and straw yield of 47.49 and 56.50 q ha^{-1} were recorded with 90 kg P_2O_5 ha^{-1} which was accounted for 23.8 and 20.4 % increase, respectively over control. Lowest average grain and straw yield 38.36 and 46.92 q ha^{-1} was obtained with control. The favourable effect of phosphorus application on yield might be owing to better nutritional environment in plant and positive effect on root formation, proliferation and their activities. Kumar et al. (2006) reported that the phosphorus dose for WH-547 needs to be raised to 120 kg P_2O_5 ha^{-1} to harvest its potential. Application of copper improved the grain and straw yield of wheat up to 5.0 kg ha^{-1} thereafter grain and straw yield was reduced with 10 kg Cu ha^{-1} application. A reduction in yield with 10 kg Cu ha^{-1} might be due to excess of Cu and its interaction with other micronutrients like Zn (Dangarwala 2001). Application of 5 kg Cu ha^{-1} recorded significantly higher average grain yield (44.24 q ha^{-1}) which was found to 6.7, 3.0 and 2.5 % higher than those obtained with 0, 2.5 and 10 kg Cu ha^{-1}, respectively. Singh (1994) reported that the addition of Cu increased the grain and straw yield of wheat up to 5 kg Cu ha^{-1} level. Singh and Prakash (2009) and Kumar et al. (2010) also confirmed our findings.

Table 1: Effect of phosphorus and copper levels on grain and straw yield and protein content of wheat.

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Protein content (%) Grain		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
Phosphorus (kg ha^{-1})									
0	37.90	38.82	38.36	46.32	47.53	46.92	13.25	13.31	13.28
30	40.41	42.78	41.59	49.11	50.41	49.76	13.31	13.37	13.34
60	43.46	45.26	44.41	53.04	54.06	53.55	13.43	13.43	13.43
90	46.89	48.09	47.49	55.68	57.33	56.50	13.50	13.50	13.50
CD (P=0.05)	1.28	1.52	1.61	1.64	1.84	1.78	0.148	0.137	
Copper (kg ha^{-1})									
0	40.61	42.32	41.46	44.39	50.71	47.55	13.50	13.56	13.53
2.5	42.22	43.71	42.96	50.99	52.23	51.61	13.43	13.43	13.43
5.0	43.44	45.05	44.24	52.20	53.77	52.98	13.31	13.37	13.34
10.0	42.39	43.88	43.13	51.56	52.62	52.09	13.25	13.25	13.25
CD (P=0.05)	1.28	1.52	1.61	1.64	1.84	1.78	0.148	0.137	

Increasing levels of phosphorus increased the protein content of wheat grain. Significant highest amount (13.5 %) of grain protein was observed with 90 kg P_2O_5 ha^{-1} application, while it was lowest (13.28 %) in control. The increase in protein content with P application was reported by Chaudhary et al. (2003). Application of graded doses of copper noticed decreasing trend in protein content in grain and minimum amount of protein was observed with 10 kg Cu ha^{-1} application. The data (Table 2) indicate a consistent increase in nitrogen uptake with an increase in the amount of P from 0 to 90 kg P_2O_5 ha^{-1} indicating a beneficial effect on N absorption by wheat crop. This increase in N uptake may be attributed to increased crop yield and N content in wheat grain and straw with P levels. Singh *et al*.

Table 2: Effect of phosphorus and copper levels on uptake of N, P, K, S (kg ha^{-1}) and Cu (g ha^{-1}) by wheat (average of two years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur		Copper	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Phosphorus (kg ha^{-1})										
0	81.6	27.4	7.8	4.7	18.9	103.6	7.6	4.5	39.3	31.1
30	90.8	29.8	9.5	6.0	21.4	110.1	8.8	5.3	42.5	30.7
60	96.5	32.6	11.3	7.0	23.1	119.9	9.8	6.2	45.8	30.4
90	103.1	35.1	13.3	8.3	25.1	127.6	10.2	6.6	44.0	30.1
CD (P=0.05)	3.73	2.54	1.94	1.65	0.88	8.51	0.31	0.31	NS	NS
Copper (kg ha^{-1})										
0	90.7	30.3	10.7	6.7	22.1	112.4	9.2	5.9	33.6	21.4
2.5	93.2	31.5	10.6	6.6	22.4	115.5	9.5	5.9	39.2	28.9
5.0	95.6	33.0	10.7	6.6	22.0	118.4	9.3	5.7	45.1	32.1
10.0	92.5	30.0	9.9	6.2	21.5	115.0	8.3	5.1	53.7	39.9
CD (P=0.05)	3.73	2.54	NS	NS	NS	NS	0.31	0.31	6.36	1.74

(1998) reported similar results. Application of copper increased the uptake of N by wheat grain and straw significantly up to 5 kg ha^{-1} level. Thereafter, a reduction was noted at 10 kg Cu ha^{-1}. Data present in Table 2 indicate that P uptake by wheat grain and straw increased significantly with increasing level of P and highest P uptake was observed with application of 90 kg P_2O_5 ha^{-1} i.e. 13.3 and 8.3 kg ha^{-1} and lowest in control i.e. 7.8 to 4.7 kg ha^{-1} in grain and straw, respectively. The increase in P uptake by grain and straw with 90 kg P_2O_5 ha^{-1} were 70.5 and 76.6% over no phosphorus. The increase in P uptake with higher application of P resulted from enhanced supply of P to the plant during early growth stage at which it was utilized in larger quantities. Similar findings were reported by Kumar *et al.* (2006). Phosphorus uptake by wheat grain and straw decreased with the application of 10 kg Cu ha^{-1} over its lower doses. The decrease in P uptake with higher dose of Cu might be due to antagonistic effect between P and Cu. The potassium uptake by wheat grain and straw increased significantly at all the levels of P fertilization as compared to control. It increased from 18.9 to 25.1 kg ha^{-1} in grain and from 103.6 to 127.6 kg ha^{-1} in straw with 90 kg P_2O_5 ha^{-1}. Singh (1994) also reported similar results. Copper application did not affect the utilization of K by grain and straw significantly over control.

The uptake of S increased significantly with P application from 7.6 to 10.2 kg ha^{-1} in grain and from 4.5 to 66.0 kg ha^{-1} in straw with 90 kg P_2O_5 ha^{-1}. Copper application decreased the sulphur uptake by wheat grain and straw significantly over control. The lower values of S uptake by the crop were recorded at 10 kg Cu ha^{-1}. An increasing trend of Cu uptake was observed with P application and maximum Cu uptake was found with 60 kg P_2O_5 ha^{-1} (45.8 and 30.4 g ha^{-1}) and lowest in control (39.3 and 31.1 g ha^{-1}). The increase in Cu uptake with P application may be due to increase in grain and straw yield of wheat. The higher level (90 kg P_2O_5 ha^{-1}) of P, had an adverse effect on the utilization of Cu by the crop. Copper uptake by the crop increased significantly with increasing levels of copper application (Table 2). Highest Cu uptake was found with 10 kg Cu ha^{-1} (53.7 and 39.9 g ha^{-1} by grain and straw, respectively) and lowest in control (33.6 and 21.4 g ha^{-1}). The increase in Cu uptake with 10 kg Cu ha^{-1} was 60.0 and 86.4% over control in grain and straw, respectively. Kumar et al. (2010) reported similar results in barley.

From the study, it can be concluded that the 90 kg P_2O_5 ha^{-1} and 5.0 kg Cu ha^{-1} application seems to be optimum dose for wheat cultivation in these alluvial soil.

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