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# RESPONSE OF WHEAT CULTIVARS TO COPPER APPLICATION IN RELATION TO YIELD AND NUTRIENTS UPTAKE

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## ABSTRACT

*A field experiment was conducted at Research Farm of Amar Singh College Lakhaoti, Bulandshahr (UP) during rabi season of 2008-09 and 2009-2010 to study the response of wheat cultivars to copper in relation to yield and nutrient uptake. Results indicated that wheat cultivar PBW-343 recorded average higher grain (48.65 q ha$^{-1}$) and straw yield (57.75 q ha$^{-1}$) and lowest in Raj. 3765 (45.70 and 55.62 q ha$^{-1}$). The grain and straw yield of the wheat cultivars increased with copper application up to 5 kg ha$^{-1}$ beyond which the declining trend was observed at 10 kg Cu ha$^{-1}$ application. Significantly higher protein content (13.66 %) was recorded in wheat cultivar UP-2425. Declining trend in protein content (from 13.72% at control to 13.40 % at 10 kg Cu ha$^{-1}$) was noticed with addition of copper. In general, higher amounts of nutrients were utilized by PBW-343 cultivar. The uptake of N and P was improved up to 5 and 2.5 kg Cu ha-1 respectively. Potassium and S uptake decreased with increasing levels of Cu. The uptake of Cu by the crop improved significantly with its addition.*

**Keywords:** Wheat cultivars, copper, yield, nutrient uptake

## INTRODUCTION

Wheat (*Triticum aestivum (L.*) is an important cereal crop of India after rice (*Oryza sativa L*). It is one of the most important food crops for half of the world population and usually accorded a prime place among cereals because of the vast acreages devoted to its cultivation on account of high nutritive value (13-15% protein, 65-70% carbohydrates and vitamin). Role of micronutrients in balanced plant nutrition is well established. 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 laccase etc. It also promotes the formation of vitamin A in plants. Copper requirement of the crop plants differed among crop cultivars because of wide variation in sensitivity to copper stress and soil types (Singh and Prakesh, 2009). High yielding varieties of crop required more plant nutrients including copper as compared to low yielding/traditional crop varieties. No systematic information is available on the response of different wheat cultivars to copper in alluvial soils. Therefore, a need was felt to evaluate different wheat cultivars with various copper doses for their best performance in terms of grain and straw yield and nutrient uptake by the wheat cultivars in alluvial soil.

## MATERIALS AND METHODS

A field experiment was conducted at research farm of Amar Singh College Lakhaoti, Bulandshahr (UP) during *rabi* season of 2008-09 and 2009-2010. The soil was sandy loam in texture and slightly alkaline in reaction (pH 7.9) low in organic carbon (3.5 g kg$^{-1}$), available nitrogen (171kg ha$^{-1}$), available phosphorus (9.5 kg ha$^{-1}$), available potassium (112 kg ha$^{-1}$), available S (15 kg ha$^{-1}$) and available Cu (0.15 mg kg$^{-1}$). Four cultivars of wheat namely Raj-3765, PBW-343, UP-2425, PBW-502 and four levels of Cu (0, 2.5, 5 and 10 kg Cu ha$^{-1}$) were evaluated in randomized block design with three replications. Wheat cultivars were sown in lines at 20 cm apart using a uniform seed rate of 125 kg ha$^{-1}$ in the first week of November during both the years, respectively. Recommended doses of N, $P_2O_5$ and $K_2O$ @ 150, 60, and 40 kg ha$^{-1}$ were applied through urea, single superphosphate and muriate of potash, respectively at the time of sowing. The calculated amount of copper sulphate as per treatments was applied at the time of sowing. Irrigation was applied on the basis of critical physiological stages of the crop. The grain and straw yields were recorded at harvest. The grain and straw samples of wheat cultivars were collected at the time of harvesting and analyzed for their N, P, K, S and Cu contents. Phosphorous content in grain and straw samples was estimated by Vanadomolybdate yellow colour method and potassium by flame photometer. Sulphur content was estimated by turbidimetric method (Chesnin and Yien, 1951) in the extract obtained after digestion with $HNO_3$ and perchloric acid. Copper in the di acid digested extract of the plant material was determined on an atomic absorption spectrophotometer. Nitrogen content in wheat grain and straw was estimated by modified Kjeldahl method. Protein percentage was computed by multiplying N content with 6.25.

## RESULTS AND DISCUSSION

Wheat cultivar PBW-343 recorded average higher grain (48.65 qha$^{-1}$) and straw yield (57.75 qha$^{-1)}$ as compared to other wheat varieties which was 6.5 and 3.8 % higher over cultivar Raj -3765 (Table 1). Among four wheat cultivars, two cultivars namely UP-2425 (47.65 q ha$^{-1}$) and PBW-502 (47.12 q ha$^{-1}$) were found statistically at par in term of grain yield. The wheat cultivar Raj-3765 recorded minimum grain yield (45.70q ha$^{-1}$) as compared to other cultivars. On the basis of grain yield response, the wheat cultivars may be arranged as PBW-343 > UP-2425 >PBW-502 >Raj-3765. Raj 3765 produced the lowest grain and straw yield of wheat. Mukherjee (2012) reported similar results in wheat. The grain and straw yield of the wheat cultivars increased with copper application upto 5 kg ha$^{-1}$ in both the crop season, beyond which the declining trend was observed at 10 kg Cu ha$^{-1}$ application (Table 2). Poongothai and Mathan (2002) and Kumar et al. (2010) reported similar results in maize. Highest average grain yield (48.46 qha$^{-1}$) was recorded with 5 kg Cu ha$^{-1}$, while lowest grain yield (45.49 q ha$^{-1}$) in control treatment. The increase in average grain yield of wheat cultivars due to 2.5, 5.0 and 10.0 kg Cu ha$^{-1}$ application was 4.3, 6.5 and 4.9 % over control treatment, respectively. Significant average higher grain and straw yield of wheat cultivar (PBW-343) at 5 kg Cu ha$^{-1}$ application indicated that coppers fertilizers in balanced manner should be applied to get economic yield of wheat crop in those areas/ fields where soils are deficient in available copper.

**Table 1:** Effect of copper application and wheat cultivars on grain and straw yield and protein content in grain

| Treatments | Grain yield (q ha$^{-1}$) | | | Straw yield (q ha$^{-1}$) | | | Protein content (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2008 -09 | 2009-10 | Mean | 2008-09 | 2009-10 | Mean | 2008-09 | 2009-10 | Mean |
| Cultivar | | | | | | | | | |
| Raj-3765 | 45.18 | 46.23 | 45.70 | 54.86 | 56.39 | 55.62 | 13.62 | 13.50 | 13.56 |
| PBW-343 | 48.14 | 49.16 | 48.65 | 56.95 | 58.65 | 57.75 | 13.62 | 13.56 | 13.59 |
| UP-2425 | 47.13 | 48.17 | 47.65 | 55.86 | 56.75 | 56.30 | 13.68 | 13.63 | 13.66 |
| PBW-502 | 46.70 | 47.55 | 47.12 | 55.41 | 56.45 | 55.93 | 13.43 | 13.43 | 13.43 |
| CD(P=0.05) | 1.60 | 1.95 | 2.01 | 2.07 | 1.98 | 2.16 | 0.148 | 0.120 | |
| Copper ( kg ha$^{-1}$) | | | | | | | | | |
| 0 | 44.95 | 46.04 | 45.49 | 53.41 | 54.82 | 54.11 | 13.75 | 13.68 | 13.72 |
| 2.5 | 46.88 | 47.99 | 47.43 | 55.61 | 57.15 | 56.38 | 13.62 | 13.62 | 13.62 |
| 5.0 | 48.05 | 48.88 | 48.46 | 55.99 | 58.25 | 57.12 | 13.43 | 13.50 | 13.47 |
| 10.0 | 47.27 | 48.20 | 47.73 | 57.06 | 57.94 | 57.50 | 13.43 | 13.37 | 13.40 |
| CD (P=0.05) | 1.60 | 1.95 | 2.01 | 2.07 | 1.98 | 2.16 | 0.148 | 0.120 | |

The interaction effect of copper and wheat cultivars was significant with respect to grain and straw yield (Table 2). Wheat cultivar PBW-343 gave higher grain yield of 49.10 and 50.21 q ha$^{-1}$ with 5 kg Cu ha$^{-1}$ application during 2008-09 and 2009-10 respectively, while wheat cultivar Raj-3765 recorded lowest grain yield (46.55 and 47.56 q ha$^{-1}$) at 5 kg Cu ha$^{-1}$. Similar trend was observed in straw yield of wheat cultivars. Singh and Prakash (2009) reported that application of copper up to 2.50 kg ha$^{-1}$ significantly increased the grain and straw yield of wheat cultivars. The highest protein content (13.66 %) was recorded in wheat cultivar UP-2425 than PBW-343 (13.59%), Raj-3765 (13.56%) and PBW-502 (13.43%). Wheat cultivars PBW -502, on the other hand, contained lowest amount of protein in its grain. Application of copper had an adverse effect on protein content in wheat grain and minimum values were recorded at 10 kg Cu ha$^{-1}$ level. Similar results were reported by Singh (1994). PBW-343 cultivar removed higher amount of N from the soil over other cultivar and minimum by PBW-502.

**Table 2:** Interactive effect of copper levels and wheat cultivars on grain and straw yield

| Cultivars | 2008-09 | | | | 2009-10 | | | |
|---|---|---|---|---|---|---|---|---|
| | Copper ( kg ha$^{-1}$) | | | | Copper ( kg ha$^{-1}$) | | | |
| | 0 | 2.5 | 5 | 10 | 0 | 2.5 | 5 | 10 |
| Grain yield (q ha$^{-1}$) | | | | | | | | |
| Raj-3765 | 43.06 | 45.10 | 46.55 | 46.00 | 44.12 | 46.14 | 47.56 | 47.11 |
| PBW-343 | 46.50 | 48.30 | 49.10 | 48.65 | 47.54 | 49.72 | 50.21 | 49.17 |
| UP-2425 | 45.04 | 47.22 | 48.70 | 47.55 | 46.22 | 48.31 | 49.51 | 48.62 |
| PBW-502 | 45.20 | 46.90 | 47.85 | 46.88 | 46.27 | 47.81 | 48.22 | 47.91 |
| CD (P=0.05) | 3.21 | | | | 3.91 | | | |
| Straw yield (q ha$^{-1}$) | | | | | | | | |
| Raj-3765 | 53.70 | 54.57 | 55.49 | 55.68 | 54.84 | 56.40 | 57.07 | 57.28 |
| PBW-343 | 54.79 | 56.77 | 57.70 | 58.53 | 56.41 | 59.00 | 59.91 | 58.93 |
| UP-2425 | 53.15 | 55.97 | 57.70 | 56.60 | 54.14 | 57.19 | 58.13 | 57.52 |
| PBW-502 | 52.00 | 55.12 | 57.10 | 57.40 | 53.90 | 55.99 | 57.87 | 58.02 |
| CD (P=0.05) | 4.14 | | | | 3.97 | | | |

The difference in N uptake by various wheat cultivars may be due to variation in their production capacity of grain and straw. Similar results were reported by Mukherjee (2012). The nitrogen uptake by grain and straw increased from 99.9 to 104.7 kg ha$^{-1}$ and 34.4 to 35.0 kg ha$^{-1}$ with 5 kg Cu ha$^{-1}$, respectively. This increase may be attributed mainly to increased grain and straw yield of wheat. Similar results were reported by Singh (1994) and Kumar et al. (2010). The data (Table 2) revealed that PBW-343 cultivar utilized the higher amounts of P than those of other cultivars. The lower value of P uptake by PBW-502 may be attributed to lower grain and straw production. These results are similar to those of Singh and Prakesh (2009) and Mukherjee (2012). The levels of Cu addition resulted in decreased P removal by the cultivars; it decreased from 9.5 to 8.7 kg ha$^{-1}$ in grain and from 6.2 to 5.3 kg ha$^{-1}$ in straw as the dose of Cu was increased from 0 to 10 kg Cu ha$^{-1}$. The results indicate an adverse effect of Cu on P utilization by wheat crop. Singh and Prakesh (2009) observed reduction in available P with copper application. Amongst cultivars, maximum uptake of potassium was recorded with PBW-343. However, the differences in K uptake of cultivars were not statistically significant. A progressive increase in copper levels up to 5 kg ha$^{-1}$ slightly increased the uptake of K by the crop over control.

**Table 3:** Effect of copper on uptake of N, P, K, S (kg ha$^{-1}$) and Cu (g ha$^{-1}$) by wheat cultivars (mean of two years)

| Treatments | Nitrogen | | Phosphorus | | Potassium | | Sulphur | | Copper | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cultivar | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| Raj-3765 | 99.2 | 33.7 | 9.3 | 5.9 | 23.2 | 123.1 | 8.8 | 5.3 | 53.0 | 40.8 |
| PBW-343 | 105.9 | 36.2 | 9.6 | 6.2 | 24.9 | 127.0 | 8.8 | 5.4 | 52.7 | 40.2 |
| UP-2425 | 104.2 | 34.4 | 9.4 | 5.8 | 23.7 | 124.7 | 9.2 | 5.3 | 54.0 | 40.5 |
| PBW-502 | 101.3 | 34.1 | 8.9 | 5.6 | 23.2 | 123.9 | 8.4 | 5.4 | 53.0 | 39.1 |
| CD (P=0.05) | 2.12 | 0.46 | 0.49 | 0.22 | NS | NS | NS | NS | NS | NS |
| Copper ( kg ha$^{-1}$) | | | | | | | | | | |
| 0 | 99.9 | 34.4 | 9.5 | 6.2 | 22.9 | 120.0 | 9.2 | 5.8 | 38.6 | 28.4 |
| 2.5 | 103.4 | 35.0 | 9.6 | 6.1 | 23.9 | 119.5 | 9.1 | 5.7 | 50.0 | 35.0 |
| 5.0 | 104.7 | 35.0 | 9.5 | 5.9 | 23.9 | 126.9 | 8.8 | 5.2 | 59.1 | 45.5 |
| 10.0 | 102.5 | 34.0 | 8.7 | 5.3 | 23.2 | 126.2 | 8.1 | 4.7 | 68.2 | 51.4 |
| CD (P=0.05) | 2.12 | 0.46 | 0.49 | 0.22 | NS | NS | 0.8. | 0.40 | 5.1 | 4.2 |

Wheat cultivars did not affect the S uptake significantly, however, maximum uptake was noted in UP 2425. The S uptake by the cultivars decreased with increasing levels of copper and such decrease was significant with 10 kg Cu ha$^{-1}$. The magnitude of decrease in S uptake was higher at higher levels of Cu as compared to its lower levels. Among the cultivars, UP 2425 removed relatively more amounts of copper in its grain and straw over other cultivars. The uptake of copper increased from 38.6 to 68.2 g ha$^{-1}$ in grain and from 28.4 to 51.4 g ha$^{-1}$ in straw with increasing levels of Cu from 0 to 10 kg ha$^{-1}$. The higher uptake of copper of higher levels of Cu application was a consequence of more competition resulting in more exploitation of fertilizer copper for absorption. Similar results were reported by Barik and Chandel (2001). From the results, it may be concluded that PBW-343 showed the best results in respect of yield and uptake of nutrients. Application of 5 kg Cu ha$^{-1}$ produced higher yields of wheat cultivars.

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