Annals of Plant and Soil Research 15(2): 156-159 (2013)

INTEGRATED EFFECT OF COPPER AND FARMYARD MANURE ON YIELD, QUALITY AND UPTAKE OF NUTRIENTS IN WHEAT

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Received: September, 2012, Reviced accepted: July, 2013

ABSTRACT

A field experiment was conducted at Bichpuri, Agra (U.P.) during rabi season of 2005-06 and 2006-07 to study, the effect of copper and farmyard manure on yield and uptake of nutrients by wheat. The four levels each of copper (0, 1.25, 2.50 and 3.75 kg ha^{-1}) and FYM (0, 5, 10 and 15 t ha^{-1}) were examined in randomized block design with three replications. The results revealed that increasing levels of FYM significantly augmented the grain and straw yield over control. Wheat crop also responded significantly to the application of copper. The magnitude of response was more marked with combined use of FYM and copper than their alone application. The uptake of nutrients by wheat grain and straw increased significantly with increasing levels of FYM. Copper application increased the uptake of N and copper up to 2.5 and 3.75 kg ha^{-1}, respectively. The uptake of potassium and sulphur was not affected significantly with copper levels. Phosphorus uptake decreased significantly with higher level of copper over control. The content of protein increased significantly with FYM but decreased with copper application. Protein yield improved with copper and FYM addition.

Keywords: Copper, FYM, yield, quality, nutrient uptake, wheat

INTRODUCTION

The advent of high yielding wheat varieties, frequent use of high levels of fertilizers and irrigation has resulted in to increased cropping intensity and crop productivity in India. In the areas of intensive cropping, application of micronutrients is almost ignored that leads to imbalance in the nutrient management. Inspite of heavy inputs the crop yields are declining because of limitation of one or more micronutrients. Among the micronutrients, copper has been noted to be a limiting element (Singh and Swarup 1982). Copper 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. Farmyard manure is a complete food for crops including Cu with wide ranging benefits. Thus the integrated use of copper and farmyard manure improved the availability of copper in soils and play a significant role in improving quality and grain development (Poongathai and Mathan, 2002). Yet, integrated effect of copper and farmyard manure on performance of quality and crop productively in Agra region of Uttar Pradesh has not been investigated in detail. The present investigation involved a study on integrated use of copper and FYM on yield, quality and uptake of nutrients in wheat.

MATERIALS AND METHODS

Field experiments were conducted during 2005-07 on sandy loam soil with wheat at RBS College farm, Bichpuri, Agra. The soil had pH 7.9, 3.4 g organic carbon kg^{-1}, 155 kg available N ha^{-1}, 7.5 kg available P ha^{-1}, 110 kg available K ha^{-1} 15 kg available S ha^{-1} and 0.17 mg kg^{-1} available copper. The experiment was laid out in a randomized block design with three replications. The treatments consisted of four levels each of copper (0, 1.25, 2.50 and 3.75 kg ha^{-1}) and FYM (0, 5, 10 and 15 t ha^{-1}). A basal dose of 150 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} were applied through urea, diammonium phosphate and muriate of potash, respectively. Half dose of nitrogen and entire dose of phosphorus and potassium were applied at the time of sowing and remaining N fertilizer was applied in the equal splits at tillering and flowering stage. The copper was applied at the time of sowing through copper sulphate. The N, P and K contents of FYM were 0.51, 0.25 and 0.58%, respectively and incorporated in to soil 15 days prior to sowing of wheat. Wheat (PBW 343) was sown in first week of November in both the years. Grain and straw yield was recorded at harvest. The grain and straw amples collected at harvest were analysed for N content by modified Kjeldahl method. The phosphorus, K and S in binary acid digest were determined using vanadomolybdate yellow colour method (Jackson 1973), flame photometer and turbid metric method (Chesnin and Yien, 1951), respectively. The copper content in digest was determined on atomic absorption spectrophotometer. Protein content was computed by multiplying protein content with 6.25.

RESULTS AND DISCUSSION

A linear increase in grain yield was observed up to 2.5 kg Cu ha^{-1} accounting 0.31 and 0.57 t ha^{-1} increase over control with the application of 1.25 and 2.50 kg Cu ha^{-1}, respectively and thereafter the yield increase with further increase in level of copper was not significant. Poongothai and Mathan (2002) observed that the lower rate of Cu increased the yield of maize when compared to higher rates. Application of FYM improved the grain yield significantly over control. Among the different levels of FYM, significantly highest yield was recorded with 10 FYM ha^{-1} and resulted in 22.8% increase in grain yield over control. Grain yield under 10 t FYM ha^{-1} dose was not significantly different from 15 t FYM ha^{-1} dose. The beneficial effect of FYM on yield was also reported by Dahiya *et al.* (1987) and Chandael *et al.*. This increase might be due to steady decomposition of FYM and release of nutrients throughout the crop growth period coupled with better assimilation of nutrients (Kumar *et al.* 2008). The interaction effect (Table 2) revealed that application of 2.50 kg Cu ha^{-1} was superior to the other levels when it was applied along with FYM. These findings indicate that the combined application of copper and FYM is superior to sole application of either Cu or FYM. A similar trend was observed in the case of straw yield. Application of Cu increased the straw yield over control. The interaction effect was also significant. Among the integrated treatments the highest value of straw yield (7.00 t ha^{-1}) was recorded in treatment having integration of 3.75 kg Cu with 15 t FYM ha^{-1} and resulted an increase of 52.8% over control.

Table 1: Effect of copper and FYM levels on grain and straw yield and protein content and yield in grain

Treatments	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		Protein (%) Grain	Protein yield (kg ha^{-1})
	2007-08	2008-09	2007-08	2008-09		
Copper (kg ha^{-1})						
0	4.10	4.18	5.70	5.84	14.0	574.0
1.25	4.41	4.50	5.99	6.15	13.9	613.0
2.50	4.67	4.79	6.45	6.58	13.7	639.8
3.75	4.70	4.82	6.46	6.62	13.6	639.2
CD (P=0.05)	0.33	0.28	0.41	0.46	0.25	47.5
FYM (t ha^{-1})						
0	3.86	3.96	5.34	5.51	12.9	497.9
5	4.41	4.52	6.10	6.30	13.3	586.5
10	4.74	4.84	6.53	6.66	14.1	668.3
15	4.87	4.96	6.63	6.72	14.8	720.7
CD (P=0.05)	0.33	0.28	0.41	0.46	0.25	47.5

Increasing levels of FYM increased the protein content of wheat grain. Significantly highest amount (14.8%) of grain protein was recorded under 15 t FYM ha^{-1}, while it was lowest (12.9%) in control. Application of graded levels of copper noticed a decreasing trend in protein content in grain and minimum amount of protein (13.6%) was noted with 3.75 kg ha^{-1} copper application. The yield of protein in wheat grain increased with copper application up to 2.5 kg Cu ha^{-1} significantly over control. This increase may be attributed to increased grain yield with copper application. Application of FYM up to 15 t ha^{-1} increased the protein yield from 497.9 to 720.7 kg ha^{-1}, which may be due to greater grain production.

Table 2: Interactive effect of copper and FYM levels on grain and straw yield

FYM (t ha^{-1})	Copper levels (kg ha^{-1})				Copper levels (kg ha^{-1})			
	0	1.25	2.50	3.75	0	1.25	2.50	3.75
	Grain yield (t ha^{-1})				Straw yield (t ha^{-1})			
0	3.65	3.85	4.05	4.11	4.58	5.31	5.64	5.67
5	4.06	4.40	4.68	4.72	5.67	6.03	6.53	6.57
10	4.35	4.73	5.04	5.05	6.12	6.44	6.91	6.92
15	4.50	4.86	5.16	5.15	6.22	6.52	6.97	7.00
CD (P=0.05)	0.66				0.56			

Nitrogen uptake by wheat crop was influenced significantly by levels of Cu and FYM (Table 3). Application of lower levels of copper caused an increase in N uptake by wheat grain and straw. This improvement in N uptake was mainly due to higher production of grain and straw. Singh (1994) and Singh and Prakash (2009) reported similar results. Data showed that uptake of nitrogen was maximum (116.4 and 47.1 kg ha^{-1}) under 15 t FYM ha^{-1} followed by 10, 5 and control and each level differed significantly among themselves. Increased uptake of N with FYM could be assigned to supplementation of soil reservoir on mineralization of organic nitrogen of FYM as well as enhanced microbial activity of ammonifiers and nitrifiers in particular due to available organic carbon. Dahiya *et al.* (1987) and Singh *et al.* (1994) reported similar results. Uptake of P by grain and straw tended to decrease with Cu levels and minimum values were recorded with 3.75 kg Cu ha^{-1}. Thus, copper had an antagonistic effect on P nutrition of the crop. These results are in agreement with the findings of Singh and Prakash (2009).

Table 3: Effect of Cu and FYM on uptake of N, P, K and S (kg ha^{-1}) and Cu (g ha^{-1}) in wheat grain and straw (mean of 2 years)

Treatments	Nitrogen		Phosphorus		Potassium		Sulphur		Copper	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Copper (kg ha^{-1})										
0	93.1	38.2	9.6	6.8	21.6	129.4	8.7	7.2	32.4	26.0
1.25	99.0	40.2	9.5	6.7	23.3	135.6	9.1	7.1	44.5	38.1
2.50	104.1	41.0	9.1	6.6	24.2	145.8	9.2	7.1	53.1	46.0
3.75	104.0	40.0	9.0	6.0	23.8	144.2	8.6	6.5	65.3	51.8
CD (P=0.05)	7.88	2.17	0.45	0.46	NS	NS	NS	NS	8.69	7.31
FYM (t ha^{-1})										
0	81.2	30.8	7.2	4.7	18.6	118.4	6.4	4.9	42.3	33.9
5	94.8	37.7	8.8	5.8	22.3	136.7	8.0	6.3	48.2	39.9
10	108.2	42.8	10.1	7.2	25.2	147.8	9.7	7.7	52.4	44.3
15	116.4	47.1	10.9	8.4	26.7	151.0	11.4	8.9	52.4	43.7
CD (P=0.05)	7.88	2.17	0.45	0.46	4.65	16.50	1.76	0.93	8.69	7.31

The results (Table 3) indicate a significant increase in phosphorus uptake with FYM levels over control. The P uptake in grain increased from 7.2 to 10.9 kg ha^{-1} and in straw from 4.7 to 8.4 kg ha^{-1} with 15 t FYM ha^{-1}. The higher uptake of P could be due to solubilization effect of organic acids produced during decomposition of FYM, improved aeration and better root proliferation. These results are agreement with those reported by Dahiya *et al.* (1987). The K uptake by wheat grain and straw was not affected significantly with copper levels over control. However, a slight increase was noted with lower level of copper. FYM application (15 t ha^{-1}) resulted in a significant increase in the K uptake in grain and straw from 18.6 to 26.7 and 118.4 to 151.0 kg ha^{-1}, respectively (Table 3). Higher uptake of K was observed due to its application through FYM. The sulphur uptake with levels of copper was not affected significantly over control (Table 3). The higher level of copper had an adverse effect on S uptake by the wheat crop. This may be due to the fact that the relative decrease in S content due to Cu application was more compared with the increase in grain and straw yields and therefore uptake decreased. Sulphur uptake in grain and straw under various levels of FYM ranged from 6.4 to 11.4 and 4.9 to 8.9 kg ha^{-1}, respectively with each level being significant. The use of FYM helped in making up the deficiency of S either through the readily available S content of salt especially at early stage or on oxidation of elemental S to sulphate especially at later stages. Singh *et al.* (1994) reported similar results. Copper addition under different levels helped in balancing the copper content in soil solution and thus enhanced the activity and uptake of Cu by the crop. The uptake of Cu increased from 32.4 to 65.3 g ha^{-1} in grain and from 26.0 to 51.8 g ha^{-1} in straw with 3.75 kg Cu ha^{-1}. Similar results were reported by Singh and Swarup (1982), Barik and Chandel (2001), Singh and Prakash (2009) and Sharma *et al.* (2012). The highest Cu uptake by wheat grain and straw was recorded with the application of 10 t FYM ha^{-1} followed by 15, 5 and control. Copper uptake by wheat grain and straw increased from 42.3 to 52.4 and 33.9 to 44.3 g ha^{-1} with 10 t FYM ha^{-1}. This might be due to increased availability of Cu as noted in the study which was also reflected in higher and Cu content of the produce.

From the study, it could be inferred that integrated use of 2.5 kg Cu alongwith FYM either @ 10 to 15 t ha^{-1} is beneficial in terms of obtaining high crop productivity and uptake of nutrients by wheat. Protein content of wheat grain was also influenced significantly and favourably by FYM.

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