Effect of FYM, biofertilizers and zinc on potassium uptake by maize

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Summary

A field experiment was conducted to study the effect of FYM, biofertilizers (Azotobacter and VAM) and zinc on potassium uptake by maize during two consecutive years of 2006-07 and 2007-08 at Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. Application of FYM, biofertilizers and zinc significantly increased potassium uptake by maize. Combined use of FYM and biofertilizers significantly increased potassium uptake by maize and combined use of FYM and Zn also significantly increased the potassium uptake by maize.

Key words: FYM, Biofertilizers, Zinc, Maize, Potassium, Uptake

Introduction

The use of organic materials in combination with inorganic fertilizers to optimize nutrient availability to plants is a difficult task as organic materials have variable and complex chemical nature. This requires the understanding and knowledge about the chemical composition, particularly the nutrient content and C quality of organic materials and its interaction with inorganic nutrient sources. Unfortunately, there has been little synthesis of the integrated effects of organic materials on net nutrient management. Numerous trials have compared the yields from a given amount of inorganic fertilizer (A), an organic material (B), and their combination (A+B), and in many situations (A+B) have produced higher yields than A or B alone. It should not be surprising that the combination does better because more total nutrients have been added than A or B alone (Shah and Ahmad, 2006). Biofertilizer as to replace part of the use of chemical fertilizers reduces amount and cost of chemical fertilizers and thus, prevents the environment pollution from extensive application of chemical fertilizers. With using the biological and organic fertilizers, a low input system can be carried out, and it can be helped achieving sustainability of farms (Mohammadi and Sohrabi, 2012). Thus, neither the organic manure alone nor the chemical fertilizers can achieve the yield sustainability under any cropping system where the nutrient depletion and turnover in soil plant systems is remarkable. This paper presents the results of a study on integrated use of Zn with organic and inorganic sources of N on uptake of potassium by maize crop.

Resource and Research Methods

A field study was conducted at Rajasthan College of Agriculture, Maharana Pratap University of...
Agriculture and Technology, Udaipur on typic Haplustept during 2006-07 and 2007-08. The soil of experimental field was clay loam in texture, slightly alkaline in reaction (pH 8.22 and 8.17), medium in organic carbon (0.71 and 0.73 %), available nitrogen (233 and 235 kg ha$^{-1}$), available phosphorus (13.6 and 13.9 kg ha$^{-1}$) and high in potassium (336 and 340 kg ha$^{-1}$) in 2006 and 2007, respectively. The experiment consisted of thirty two treatment combinations of two levels of organic manure (without FYM and 10 t FYM ha$^{-1}$), four levels of biofertilizers [control, Azotobacter inoculation, VAM (Glomus fasciculatum) inoculation and Azotobacter + VAM inoculation] and four levels of zinc (0, 2.5, 5 and 7.5 kg ha$^{-1}$). Azotobacter and VAM used for as a biofertilizers for fixing atmospheric and increasing phosphorus availability. The field experiment was laid out in Split Plot Design allocating organic manures and biofertilizers in main plots and zinc in subplots and replicated three times. Potassium content in maize was determined by flame photometer method given by Richard (1968). Potassium uptake (kg ha$^{-1}$) was estimated by formula nutrient content (%) X Yield (kg ha$^{-1}$)/100.

**Research Findings and Discussion**

The yield of crop is related with the amount of nutrient taken up by the crop i.e., the amount of nutrient taken up per unit amount of grain production determine the achievable yields, since the essential nutrients are involved in the metabolism of the plant. The uptake of nutrients therefore, usually follows the yield pattern (Brar and Pasricha, 1998).

**Potassium uptake :**

**Grain :**

A perusal of data presented in Table 1 show that application of FYM at 10 t ha$^{-1}$ significantly improved potassium uptakes by grain of maize over no FYM in both the years of experimentation. On pooled basis, application of 10 t FYM ha$^{-1}$ increased potassium uptake by grain of maize over no FYM by a margin of 26.77 per cent. Yazdani *et al.* (2011) also showed that application of farmyard manure increased potassium of grain of corn compared to the control.

The data presented in Table 1 show that potassium uptake by grain of maize increased significantly with the inoculation of Azotobacter, VAM and dual inoculation of Azotobacter and VAM over uninoculated control during both the years. On pooled basis, inoculation of Azotobacter, VAM and Azotobacter + VAM increased 13.94, 19.37 and 27.80 per cent total potassium uptake over control, respectively. Inoculation with AMF seemed to be effective treatment to improve corn nutrient uptake.

<table>
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<tr>
<th>Table 1 : Effect of FYM, biofertilizers and zinc on potassium uptake (kg ha$^{-1}$) by maize</th>
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<tr>
<td><strong>Treatments</strong></td>
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<td><strong>FYM (t ha$^{-1}$)</strong></td>
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<td>C.D. (P=0.05)</td>
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<td><strong>Zinc levels (kg ha$^{-1}$)</strong></td>
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also reported by Abasi et al. (2011).

A perusal of data presented in Table 1 further show that application of zinc at increasing levels significantly influenced the potassium uptake by grain of maize up to 5.0 kg Zn ha\(^{-1}\) during both the years and on pooled basis. Further increase in level up to 7.5 kg Zn ha\(^{-1}\) though had positive influence but failed to bring about significant enhancement during both the years as well as on pooled basis. On pooled basis, application of 2.5, 5.0 and 7.5 kg Zn ha\(^{-1}\) resulted in 10.61, 17.41 and 19.27 per cent increased potassium uptake, respectively over control. This could possibly be ascribed to higher availability of these nutrients and resultant higher biomass yield (Murugappan et al., 1998).

Data presented in Table 2 show significant interactive effects of FYM and biofertilizers on potassium uptake by grain of maize during both the years of experimentation. Data revealed that dual inoculation of Azotobacter + VAM along with 10 t FYM ha\(^{-1}\) recorded the highest potassium uptake by grain of maize and recorded 60.25 per cent higher over control, on pooled basis.

Combined effect of FYM and zinc levels on potassium uptake (Table 3) by grain of maize revealed that application of zinc significantly increased potassium uptake by grain of maize from 11.09 to 12.37, 11.78 to 12.93 and 11.44 to 12.65 kg ha\(^{-1}\) (no zinc to 7.5 kg Zn ha\(^{-1}\) at no FYM, respectively during 2006, 2007 and on pooled basis). Application of FYM at 10 t ha\(^{-1}\) significantly increased uptake of potassium by grain to 13.27 kg ha\(^{-1}\) giving an increase of 25.33 per cent over 2.5 kg Zn ha\(^{-1}\), 15.19 kg ha\(^{-1}\) giving an increase of 31.44 per cent over 5.0 kg Zn ha\(^{-1}\) and 16.47 kg ha\(^{-1}\) giving an increase of 32.96 per cent over 7.5 kg Zn ha\(^{-1}\), respectively on pooled basis. The highest potassium uptake by grain of maize of 16.82 kg ha\(^{-1}\) was obtained at 7.5 kg Zn ha\(^{-1}\) along with 10 t FYM ha\(^{-1}\) which was found significantly higher over control by a margin of 47.03 per cent. However, application of zinc significantly increased the potassium uptake by grain of maize up to 5.0 kg ha\(^{-1}\) with or without FYM during each year and on pooled basis.
Stover:

A critical examination on data presented in Table 1 reveals that application of FYM at 10 t ha\(^{-1}\) significantly enhanced potassium uptake over no FYM application by stover of maize during both the years. On pooled basis, application of 10 t FYM ha\(^{-1}\) increased potassium uptake by stover over no FYM by a margin of 26.01 per cent. Significant improvement in content and uptake of potassium as a consequence of organic manuring have also been reported by Negm \textit{et al.} (2002).

Data presented in Table 1 show that potassium uptake by stover of maize increased significantly with inoculation of \textit{Azotobacter}, VAM and dual inoculation of \textit{Azotobacter} + VAM over uninoculated during both the years. On pooled basis, inoculation of \textit{Azotobacter}, VAM and dual inoculation of \textit{Azotobacter} + VAM increased the potassium uptake by 12.15, 17.69 and 26.31 per cent, respectively over no inoculation. Different species of AM significantly increased K uptake in leafs (Miransari \textit{et al.}, 2009).

It is clear from data (Table 1) that application of zinc at increasing levels significantly influenced the potassium uptake by stover of maize upto 5.0 kg Zn ha\(^{-1}\) during both the years and on pooled basis. Further increase in level to 7.5 kg Zn ha\(^{-1}\) though had positive influence but failed to bring about significant enhancement during both the years as well as on pooled basis. On pooled basis, application of 2.5, 5.0 and 7.5 kg Zn ha\(^{-1}\) resulted in 9.04, 15.36 and 17.62 per cent increased potassium uptake by stover over control, respectively.

Data presented in Table 4 show that the significant interactive effect of FYM and biofertilizers on potassium uptake by stover of maize during both the years of experimentation. On pooled basis, data revealed that dual inoculation of \textit{Azotobacter} + VAM along with 10 t FYM ha\(^{-1}\) recorded the highest potassium uptake by stover of maize which was 59.05 per cent higher over no inoculation no FYM.

Combined effect of FYM and zinc levels (Table 5) showed that application of zinc at increasing levels along with FYM increased significantly the potassium uptake by stover of maize during both the years of

| Table 5: Combined effect of FYM and zinc on potassium uptake (kg ha\(^{-1}\)) by stover of maize |
|---------------------------------|-------------|-------------|-------------|-------------|-------------|
|                                 | 0 2.5 5 7.5 | 0 2.5 5 7.5 | 0 2.5 5 7.5 |
| FYM (t ha\(^{-1}\))           |            |            |            |
| 0                              | 44.14 46.79 48.38 49.15 | 44.99 47.54 49.93 50.52 | 44.57 47.17 49.16 49.83 |
| 10                             | 52.09 58.26 62.63 63.96 | 53.82 60.09 64.05 65.77 | 52.95 59.18 63.34 64.87 |
| S.E. ±                         | 1.34 1.35 | 0.96 0.96 | 0.96 0.96 |
| C.D. (P=0.05)                  | 3.81 3.88 | 2.68 2.68 | 2.68 2.68 |

| Table 6: Combined effect of FYM and biofertilizers on total potassium uptake (kg ha\(^{-1}\)) by maize crop |
|---------------------------------|-------------|-------------|-------------|-------------|-------------|
|                                 | B0 B1 B2 B3 | B0 B1 B2 B3 | B0 B1 B2 B3 |
| FYM (t ha\(^{-1}\))           |            |            |            |
| 0                              | 53.55 58.72 61.43 62.36 | 55.43 60.69 62.72 64.02 | 54.49 59.70 62.07 63.19 |
| 10                             | 62.91 72.50 76.68 84.83 | 65.05 74.63 78.79 88.78 | 63.98 73.56 77.74 86.81 |
| S.E. ±                         | 1.80 1.96 | 1.33 1.33 | 1.33 1.33 |
| C.D. (P=0.05)                  | 5.45 5.94 | 3.85 3.85 | 3.85 3.85 |

| Table 7: Combined effect of FYM and zinc on total potassium uptake (kg ha\(^{-1}\)) by maize crop |
|---------------------------------|-------------|-------------|-------------|-------------|-------------|
|                                 | 0 2.5 5 7.5 | 0 2.5 5 7.5 | 0 2.5 5 7.5 |
| FYM (t ha\(^{-1}\))           |            |            |            |
| 0                              | 55.23 58.07 60.62 61.52 | 56.77 59.90 62.74 63.44 | 56.00 59.29 61.68 62.48 |
| 10                             | 65.02 73.19 78.58 80.13 | 67.43 75.55 81.04 83.24 | 66.22 74.37 79.81 81.68 |
| S.E. ±                         | 1.59 1.57 | 1.12 1.12 | 1.12 1.12 |
| C.D. (P=0.05)                  | 4.53 4.47 | 3.14 3.14 | 3.14 3.14 |
experimentation. On pooled basis, application of 7.5 kg Zn ha$^{-1}$ along with 10 t FYM ha$^{-1}$ recorded significantly highest potassium uptake by stover over control (No FYM and no zinc) by a margin of 45.55 per cent. However, application of zinc significantly increased the potassium uptake by stover of maize upto 5.0 kg ha$^{-1}$ with or without FYM during each year and on pooled basis. 

**Total uptake**: 

A perusal of data presented in Table 1 shows that application of FYM at 10 t ha$^{-1}$ significantly improved total potassium uptake over no FYM in both the years of experimentation. On pooled basis, application of 10 t FYM ha$^{-1}$ increased total potassium uptake over no FYM by a margin of 26.16 per cent. Minhas and Sood (1994) also reported that the organic matter after decomposition release macro- and micronutrients to the soil solution, which becomes available to the plants, resulting in higher uptake.

Data presented in Table 1 show that total potassium uptake by maize increased significantly with the inoculation of Azotobacter, VAM and dual inoculation of Azotobacter and VAM over uninoculated control during both the years. On pooled basis, inoculation of Azotobacter, VAM and Azotobacter + VAM increased 12.49, 18.03 and 26.63 per cent total potassium uptake over control, respectively. VA-mycorrhizas increased nutrients uptake through a reduction of the distance that nutrients must diffuse to plant roots by accelerating the rate of nutrient absorption and nutrient concentration at the absorbing surface and finally by chemically modifying the availability of nutrients for uptake by plants through mycorrhizal hyphae (Somani, 2004).

A critical examination on data presented in Table 1 further shows that application of zinc at increasing levels significantly influenced the total potassium uptake by maize upto 5.0 kg Zn ha$^{-1}$ during both the years and on pooled basis. Further increase in level to 7.5 kg Zn ha$^{-1}$ though had positive influence but failed to bring about significant enhancement during both the years as well as on pooled basis. On pooled basis, application of 2.5, 5.0 and 7.5 kg Zn ha$^{-1}$ resulted in 9.36, 15.77 and 17.95 per cent increased total potassium uptake by maize, respectively over control. This could possibly be ascribed to higher availability of these nutrients and resultant higher biomass yield (Khattak et al., 2006).

Data presented in Table 6 revealed the significant combined effect of FYM and biofertilizers on total potassium uptake by maize during both of the years and on pooled data basis. Data revealed that dual inoculation of Azotobacter + VAM along with 10 t ha$^{-1}$ recorded highest total potassium uptake by maize that was 59.31 per cent higher over control on pooled basis. The improved physico-chemical properties with the FYM incorporation and the nutrients supplied or its transformation would also have positive effect directly on organism as well as indirectly through plant growth as observed in the present study. Similar findings have also been reported by Dwivedi et al. (2003).

Combined effect of FYM and zinc levels on total potassium uptake by maize (Table 7) revealed that application of zinc significantly increased total potassium uptake from 55.23 to 61.52, 56.77 to 63.44 and 56.00 to 62.48 kg ha$^{-1}$ (no zinc to 7.5 kg Zn ha$^{-1}$ at no FYM, respectively during 2006, 2007 and on pooled basis). Application of FYM at 10 t ha$^{-1}$ significantly increased uptake of potassium to 66.22 kg ha$^{-1}$ giving an increase of 18.25 per cent over no zinc no FYM, 74.37 kg ha$^{-1}$ giving an increase of 25.43 per cent over 2.5 kg Zn ha$^{-1}$, 79.81 kg ha$^{-1}$ giving an increase of 29.39 per cent over 5.0 kg Zn ha$^{-1}$ and 81.68 kg ha$^{-1}$ giving an increase of 30.73 per cent over 7.5 kg Zn ha$^{-1}$, respectively on pooled basis. However, the highest total potassium uptake by maize of 81.68 kg ha$^{-1}$ was obtained at 7.5 kg Zn ha$^{-1}$ along with 10 t FYM ha$^{-1}$ which was found significantly higher over control by a margin of 45.86 per cent. However, application of zinc significantly increased the total potassium uptake by maize upto 5.0 kg ha$^{-1}$ with or without FYM during each year and on pooled basis. Karki et al. (2005) have also reported significant improvement in the uptake of nutrients due to Zn applied in conjunction with FYM under different soil crop climatic conditions Kaushik et al. (2013), Ravi et al. (2013) and Raskar et al. (2013).

**Literature Cited**


