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Entire proceedings

Paper in proceedings
Impact of Phosphorus Placement Methods after Three Years of Different Tillage Practices on Maize Productivity and Soil Properties

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Introduction

Minimal soil disturbance under conservation agriculture may limit the supply of immobile nutrients (such as phosphorus) to plant roots due to stratification of these nutrients close to the soil surface. Maize (Zea mays L.) roots usually do not proliferate into the middle of the rows until the plant has six to seven fully emerged leaves but a high P concentration in maize prior to the 6-leaf stage will significantly increase final grain yield (Aldrich et al. 1986). Phosphorus availability is critical during the early stages of plant growth when the movement of P to plant roots (P absorption by the plant) is reduced with cold soil temperatures (Alley et al. 2009). This can occur during winter (rabi season) when most maize is grown in Bangladesh (Ali et al. 2009). Also P moves very little in soils, and thus, available soil P levels can be built with P fertilizer application appropriate for the tillage practice. The aim of present study was to determine the effects of tillage practices and P placement methods on soil physical, chemical and yield of maize crops on a Grey Terrace Soil in Bangladesh.

Materials and methods

The experiment was situated at BARI, Gazipur in agro-ecological zone 28 (Modhupur Tract). The soil belongs to the Chhiata series of the Grey Terrace Soils (Aeric Albaquept). Phosphorus was placed by a) broadcast according to farmers’ practice during final land preparation, b) surface banding (application on the soil surfaces 3-5 cm apart and on both sides of the row), and c) deep band (application at 6-8 cm below the surface 4-6 cm apart on both sides of the row. Both the band placements were done at five leaf stage, i.e. at 30 DAS) along with three tillage practices: a) zero tillage (ZT)- a single slit is opened by furrow opener and seeds were sown, b) conventional tillage (CT)- ploughed by rotary tiller up to 10-12cm depth (2 passes), and c) deep tillage (DT)- tillage by chiseling up to 25 cm depth followed by rotavator (3 passes). Treatments were arranged with tillage assigned to main plots and P placement methods in sub-plots. The maize residue was retained by weight over the three years of experimentation (2009-10, 2010-11 and 2011-12).

Results and Discussion

The surface band P placement method gave higher yield (P <0.05) than other placement methods (Fig. 1). In 2011-12 (P <0.05), the highest grain yield (9.4 t ha⁻¹) was obtained by surface band P placement with ZT followed by CT and DT under surface band P placement. The minimum tillage practices under broadcast and deep band placement methods showed the highest available and total P content in soil after harvesting of maize in 2012. The highest available P (24 mg kg⁻¹) and total P (288 mg kg⁻¹) was in 0-6 cm soil treated by ZT along with surface band applications, followed by broadcast applications under ZT. The deep band placement under CT and DT showed the highest values of P for total and available P at 7-12 and 13-18 cm soil depth. These were followed by surface band under CT in the same depth increments (Fig. 2).
Figure 1. Effect of tillage practices and P placement methods on maize yield per hectare over three years of experimentation. The standard error values (±) are 0.25, 0.26 and 0.29 for the years 2009-10, 2010-11 and 2011-12, respectively. (Legend: T₁=Zero Tillage, T₂=Conventional Tillage, and T₃=Deep Tillage, whereas P₁=Broadcast, P₂=Surface band and P₃=Deep band).

Figure 2. Effects of tillage and P placement methods on available and total P in soil after three years of maize cultivation. See Fig. 1 for abbreviations. (Standard errors (±) are 1.27, 0.66, 0.65 and 0.35 for Available P and 8.8, 6.8, 4.7 and 4.7 for total P at 0-6, 7-12, 12-18 and 19-24 cm soil depth respectively).

The effects of ZT with 30 % straw retention after three years of maize cultivation on soil organic matter (OM) status, total N and moisture content at field capacity as well as permanent wilting point and available water content were also significantly higher than CT and DT. Tillage practices did not influence other physical and chemical properties. Neither did P placement methods influence soil physical properties and OM status of soil.

Conclusions

The surface band P placement method with ZT, CT and DT gave significantly higher yield than broadcast and deep band placements. The minimum tillage practices under broadcast and deep band placement methods showed the highest available and total P content in soil after harvesting of maize. Phosphorus was stratified in the topsoil with zero tillage along with broadcasting and surface band applications but the CT and DT practices under broadcast and deep band placements resulted in the almost similar distribution of P with soil depth up to 24 cm.

References