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Review

Organic and inorganic fertilizer use for increased maize yield

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Maize is an important crop across the globe. In sub-Saharan Africa, maize is a staple food for an estimated 50 % of the population and provides 50 % of the basic calories. It is also an important feed source for livestock. By far, poor soil fertility of tropical soils remains the most important constraint to the profitable cultivation of the crop in this region due to its high demand for nutrients. Improvement and sustainability in the yield of maize can be attained through adequate and balance supply of nutrients by applying both organic and inorganic soil amendments. This review is therefore aimed at discussing the role of organic and inorganic soil amendments in enhancing the yield of maize.

Keywords: Plant nutrition, maize, soil fertility, yield, poor soil

INTRODUCTION

Maize (*Zea mays*) together with rice (*Oryza sativa*) and wheat (*Triticum aestivum*) are the most popular cereals in the world, but the popularity of maize remains outstanding due to characteristics such as high yielding potential, ease of processing, relatively high digestibility and less costly than other cereals (Jaliya et al., 2008). It is grown extensively with equal success in temperate, sub-tropical and tropical regions of the world. It is a good source of food and feed for humans and livestock. It is also a source of raw materials for industries that produce products such as corn flakes, corn oil and corn syrups (Agbato 2003).

.To fully exploit the genetic potential of maize, it is empirical to provide it the suitable condition of growth. Adediran and Banjoko (2003) recorded poor yield in maize when nutrients were not adequately supplied. Plant growth and establishment, development and yield are attribute highly influenced by inorganic fertilizers (Stefano et al., 2004).The availability of sufficient growth nutrients from inorganic fertilizers promote cellular activities, cell multiplication and enlargement and luxuriant growth (Fashina et al., 2002).

Maize is a heavy feeder and poses a strong exhaustive effect on soils in the tropics which are already low in nutrients. Maize requires adequate and balance supply of nutrient for proper growth and yield and thus the role of fertilizer is inevitable in its production (FAO, 2007). The low nutritional status of tropical soils thus poses a greater constraint to the profitable cultivation of maize.

According to FAO (2007), maize has the potential of yielding up to 7.5 t / ha given the requirement management. Nevertheless, yields in the tropics still remain below 5 t / ha and this attributed to low nutrient status of tropical soils especially nitrogen, phosphorus and potassium. It is therefore empirical to supply adequate and balance nutrient through organic and inorganic source for a sustainable and profitable production of maize.

Role of organic fertilizers in plant nutrition and nutrient maintenance

One of the benefits of organic fertilizer is that the nutrients are released more slowly than in chemical fertilizers. This slower process allows the plants to process the fertilizer in a more natural way and will not result in over fertilizing which could damage the plants. Another benefit of organic fertilizer is its role in soil improvement. It will help the soil to retain moisture. The organic substances can break up clay in the soil. The soil drainage and air circulation of the soil can also be improved.

Among the organic sources, farmyard manure (FYM) is most important as it contains all the nutrients needed for crop growth including trace elements, albeit in small quantities. The efficiency of manure utilization by a crop is determined by the method of application, time to incorporation and the rate of decomposition in the soil. Characteristically, not all of the nutrients in manure are directly available after its incorporation in the soil. Organic forms of nutrients must first be mineralized into plant-available forms such as nitrate. The rate of mineralization is variable and depends on soil type, moisture, temperature, and manure composition. When cow dung and urine are mixed, a balanced nutrition is made available to the plants. Swift et al., (1994) observed that in households where crop and livestock production are integrated, FYM can become a major nutrient source for food crops and reduce the need for fertilizers.

Importance of mineral fertilizers use in maize production

Maize has a strong exhausting effect on the soil and it is generally observed that maize fails to produce good grain yield in plots without fertilizer application (Kumar, 1993). Maize responds to nitrogen and phosphorus which reduce the number days to tasseling and silking. Sharar *et al*, (2003) reported that NPK fertilizers help to increase grain yield when applied at the right time and with the right rate but excessive or inadequate levels will lower the yield under prevailing conditions. The use of chemical fertilizers brings about increase in yield of crops because the elements in those fertilizers are readily available to be used by crops as compared to organic fertilizers. According to Ashgar *et al,* (2010) mineral fertilizers play an important role in increasing the maize yield and their contribution is 40-45 percent. NPK fertilizers exert strong influence on plant growth, development and yield and the availability of sufficient growth nutrients in NPK fertilizers lead to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth (Fashina et al., 2002).

Effect of NPK fertilizers on growth and yield of maize

NPK fertilizers which in other words called chemical fertilizers are used in modern agriculture to correct known plant-nutrient deficiencies; to provide high levels of nutrition, which aid plants in withstanding stress conditions; to maintain optimum soil fertility conditions; and to improve crop quality. Adequate fertilization programmes supply the amounts of plant nutrients needed to sustain maximum net returns (Leonard, 1986). NPK fertilizers play very vital role in the growth and development of most cereal crops, especially maize. During the growth period of maize, growth parameters like plant height, seedling weight, stem diameter etc are highly influence by the presence of NPK fertilizer. The vegetative growth of maize is significantly affected by increasing level of NPK fertilizer application. Ashgar *et al,* (2010) reported in their work that plant height was observed to increased lineally with increase in NPK application, plants that were treated with fertilizer recorded the maximum height (198.55 cm) and that were not treated had the minimum height (143.60 cm). Nitrogen plays a very vital role in promoting vegetative growth components of most crops at the expense of yield or reproductive factors; high doses of Nitrogen have been implicated in the delayed maturity of maize (Ekwere et al., 2013). NPK fertilizers equally have some effects on the yield of maize in relation to the rate, time of application and other prevailing conditions that might affects nutrients uptake by the maize plants. Kolawole and Joyce (2009) reported in their work that, maize plants that were treated with NPK fertilizer at 400 kg ha^{-1} produced significantly higher relative grains and 100-seeds weight than the plants that were not fertilized. Ashgar *et al,* (2010) have indicated that the application of NPK (15:15:15) fertilizer gave 425 grains per cob and also bigger size of grains under suitable conditions. Jaliya *et al*. (2008) conducted a research and reported that increase in fertilizer rate resulted in increased number of grains/cob, cob weight/plant, cob yield/ha, grain weight/plant, grain yield/ha and 100-grain weight. Another study carried out in Nigeria showed that the application of NPK led to a prolonged residual effect in the soil. Grain yield of maize positively correlated with soil organic carbon, CEC; aggregate stability and bulk density (Mbah and Onweremadu, 2009). Law-Ogbomo and Law-Ogbomo (2009) investigated the effect of NPK fertilizer on maize and found that the optimum level of NPK (60 kg N plus 27.6 kg plus 49.8 kg) for increased dry cob yield and grain yield was 400 kg/ha. The impact

of N application on growth and yield of maize grown alone and in combination with cowpea was studied. The application of N fertilizer at 225 kg/ha to maize intercropped with cowpea resulted in higher grain of maize (Haseeb-ur-Rehman et al., 2010). Obdiebube *et al*. (2012) studied the effect of different levels of NPK (15:15:15) on maize and found that the 0.15 kg level improved maize growth and yield better than the lower levels applied. The application of biofertilizers and half doses of NPK and sulphur improved the yield and yield components of maize (El-koly et al., 2005). The complementary application of organic and inorganic fertilizers gave yield that was comparable to the inorganic fertilizer and also improved the nutrients composition of maize grains better than either organic or inorganic fertilizers applied alone (Makinde and Ayoola, 2010). The application of fertilizer N positively affected soil organic carbon and improved soil physico-chemical properties (Sarma et al., 2013). Babajide *et al*. (2008) applied composted Thitonia biomass and N mineral fertilizer and found that these amendments enhanced soil physical and chemical properties and the rates of application correlated positively with most of the measured parameters. The sole use of inorganic fertilizers increased maize grain yield by 75, 56 and 244 % in different cropping seasons. The integrated use of inorganic fertilizers with farmyard manure or low rate of NPK fertilizer improved both soil fertility and maize yield (Negssa et al., 2007). Ahmed *et al*. (2013) combined organic fertilizer source with 50 % of recommended NPK fertilizers and found that these fertilizers produced the highest grain and biological yields of maize over the 50 % NPK treatment and were statistically similar to the 100 % NPK fertilizer. From the study, the effect of farmyard manure was more pronounced among the organic sources. Soil organic matter, total N, extractable P and K, EC and total soluble salts were all greatest in treatments receiving organic sources with 50 % recommended NPK fertilizers. The application of poultry manure plus inorganic fertilizers resulted in highest grain yield whiles the least yield was obtained when only inorganic fertilizer was applied (Adamu and Leye, 2012). Agyenim-Boateng *et al*. (2006) also studied the effect of poultry manure on growth and yield of maize. They reported that poultry manure application gave 53 % increase in soil N and also increased exchangeable cations. The application of 4 t/ha poultry manure gave higher grain and biomass yields which were similar to the NPK fertilizer applied in the Feeric Acrisol in the semi-deciduous rainfed forest zone of Ghana.

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