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Growth and yield performance of maize under varying level of integrated nutrient management: A review

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Abstract

This review article focuses on the previous works & studies on impact of INM in maize production. Long-time research which was lead in different areas has shown that in addition to natural resources deterioration, abiotic-biotic stress, deficiency of several plant nutrients (macro & micro) nutrients is also an essential factor which influences yield reduction, productivity declination, and shrinkage in net profit. Therefore, Integrated use of chemical and organic fertilizer on yield and yield attributes component of maize is very crucial for assurance of food security & food self-sufficiency. Integrated Nutrient Management (INM) aims at adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefit from all possible sources of plant nutrients. The integrated use of major plant nutrients (nitrogen, phosphorus, and potash) along with different organic carbon sources (animal manures and plant residues) together with liquid bio-fertilizers (beneficial microbes) significantly improves maize growth, yield and yield components together with grower's income.

Keywords: Growth, yield performance, maize under, integrated nutrient management

Introduction

Maize, a staple crop with significant global importance, serves as a primary source of food, feed, and industrial raw material across diverse regions of the world. Its productivity is essential to the economic stability and food security of many developing countries. However, the growth and yield of maize are heavily influenced by the adequacy and management of soil nutrients, which pose a substantial challenge in varying agro-ecological zones. Integrated Nutrient Management (INM) emerges as a promising approach that combines the use of chemical fertilizers, organic amendments, and biofertilizers to optimize the health and fertility of soil, thereby enhancing crop performance.

Materials and Methods

This review paper uses secondary data of different literature reviews about Integrated Nutrient Management in Maize production. Our purpose of this review was to study about the different practices for betterment in yield, nutrient content, uptake & status, quality, physiochemical properties of soil and economics of maize. The relevant and important published work of different plant scientists under Integrated Nutrient Management in maize production system had been reviewed in this paper.

Results and Discussion

We made to present a brief summary of work carried out in different countries related to our topic Integrated Nutrient Management with different headings are as follows

Impacts of Integrated Nutrient Management in Maize

Impact of INM on yield and yield attributes

Application of FYM @ 10 t ha⁻¹ on 1000 grain weight of maize crop increase the production which is found in kharif season maize in different states of India (Tetarwal *et al.*, 2011)^[17].

Thousand grain weight will be significantly higher with 100% (210 g) than 75% (201 g) N of recommended dose duriarif season in India (Singh *et al.*, 2009)^[16].

Higher number of grains per row was obtained with azotobacter inoculation than no inoculation which assisted to give significantly higher number of grains per cob owing to

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insignificantly higher number of grains rows per cob. These together with higher thousand grain weight was able to give significantly higher grain yield in the treatment with azotobacter seed inoculation (4.55 t ha⁻¹) in comparison to inoculation (3.95 t ha⁻¹). This all might be due to an improvement in nutrition status of the soil and creation of suitable environment for better root growth through secretion of growth promoting substances (gibberellins, cytokinin and auxin) and availability of nitrogen fixed by microorganisms. Jayaprakash *et al.* (2004)^[3] studied the growth parameters of maize with application of organic manures. The application of vermicompost @ 2 t ha⁻¹ recorded significantly higher LAI compared to no organics and was on par with that of application of FYM @ 10 t ha⁻¹.

Ravi *et al.* (2012)^[13] in their research trial conducted at agricultural research station Arabhavi of Karnataka and they also confirmed that, the use of 75 per cent RDF with other organic and bio-fertilizer significantly increases the grain yield of quality protein maize.

Kannan *et al.* (2013)^[5] the results revealed that leaf area, plant height and yield parameters like number of grains per cob, 100 seed weight and yield (4112 kg ha⁻¹), weight of the cob in maize was recorded maximum in INM practice including FYM and recommended dose of NPK as compared to other treatments.

Higher plant height, cobs/plant, grains/cob, grain and biological yield were recorded with 150% RDF which was at par with RDF + 10 t/ha FYM, further significantly higher dry matter at the time of harvest was recorded with RDF + 10t/ha FYM which was at par with 150% RDF.

A field study in Tamil Nadu during rabi found that application of vermicompost@ t/ha along with 100% RDF (120-60-00 kg N-P-K/ha) showed its superiority with respect to yield parameters like number of grains per cob, 100 seed weight and yield (Kannan *et al.*, 2013)^[5].

Significantly higher grain yield was recorded with application of 100% RDF + BF + GM (one row of Sunhemp between two rows of maize) over rest of all treatments. When 25% RDF + biofertilizers (Azotobacter + PSB) + green manuring with sunhemp + compost was applied, significantly taller plants and highest total plant dry matter content were recorded (Kalhapure *et al.*, 2013)^[4].

Highest number of cobs per plant, number of grains per cob and weight of 100 grains were produced with the treatment of 25% RDF + biofertilizers (Azotobacter + PSB) + green manuring with sunhemp +compost whereas number of cobs per plant were in usual or expected amount with the application of biofertilizers (Azotobacter + PSB) + green manuring with sunhemp + compost (Kalhapure *et al.*, 2013)^[4].

Impact of INM on nutrient content, uptake & soil status

The average use of fertilizer in the eastern midhills is 90 kg/ha comprised of 57 kg urea, 30 kg DAP and 3 kg Potash, whereas only 36 kg/ha fertilizer is used in the mid-western and far-western midhills. In the Terai, where adoption of Improved technology is higher than the hills, 84 kg/ha urea, 62 kg/ha DAP and 32 kg/ha potash is used. Despite poor access, farmers in the high-hill reported using 37 kg fertilizer per ha in maize fields on average (Paudyal *et al.*, 2001)^[11].

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The response of Maize to K application was noticed more in upland soil in comparison to low land. This may be due to low availability of K in upland soil. (Kumar *et al.*, 2004)^[3].

Impact of INM on physio-chemical properties of soil

Significantly lowest pH was observed in application of 25% RDF+ biofertilizers (Azotobacter+ PSB) + green manuring with sunhemp + compost. Also, the decrease in pH over initial value is more in treatments which included either sole application of biofertilizers, green manuring and compost or their combination with inorganic nutrient sources. When manures and chemical fertilizers are applied to soil, nitrification and decomposition processes produce various acids. Nitrification process releases hydrogen ion into soil solution. The organic matter added with 198 A.H. Kalhapure *et al.*, 2013^[4] green manuring and compost application acts as a pH buffer, releasing H⁺ which are responsible for reducing alkalinity of the soil (Antil and Singh, 2007)^[11].

Application of Azotobacter with phosphate solubilizing bacteria as biofertilizers are also responsible for decreasing soil pH by producing organic acids which has been already reported (Mohammadi and Sohrabi, 2012)^[9].

The infiltration rate of soil is depending upon the arrangement of soil particles, porosity and stability of soil aggregates. But there is inverse relation between bulk density and infiltration rate of soil. The soils of the treatments in which biofertilizer, green manuring with sunhemp and compost were applied in combination recorded higher infiltration rate which might be due to the better soil particle aggregation & microbial respiration. Decrease of bulk density and increase in infiltration rate as the effect of addition of organic and inorganic fertilizers in soil were reported in no cropped field (Martens and Frankenberger, 1992)^[8].

Impact of INM on quality

Significantly higher grain yield, crude protein, crude protein yield, lysine, methionine and tryptophan were recorded with application of P50-PEC + P50 one foliar spray at silking stage (Paramesh *et al.*, 2014)^[10].

Significantly higher biological yield, grain yield, harvest index and protein (%) were obtained under 5.0 ton of vermicompost + 75% recommended dose of NPK (Yadav *et al.*, 2016)^[20].

An experiment on sandy clay loam soil to evaluate the effect of integrated nitrogen management in maize during rabi season. Maximum crude protein (%) of maize (8.63%) was attained in 100 RDN from urea which was remained at par with application of 75% N from urea + 25% N from poultry manure with crude protein of 8.46% (Iqbal *et al.*, 2014)^[2].

Higher grain and protein yield was recorded with 100% RDF + FYM @ 10 t/ha over rest of treatments (Makwana, 2014).

Uptake of nutrients

Yadav *et al.* (2006)^[21] also observed that use of FYM proved the best in term of maize nutrient uptake.

Kumar *et al.* (2007)^[6] results indicated that among inorganics, application of 100 per cent RDF with vermicompost @ 2.5 t ha⁻¹ recorded significantly higher dry matter production in leaf, stem, cob, yield and yield attributes and uptake of nitrogen, phosphorus and potassium which consequently resulted in higher yields and returns in sweet corn.

Thavaprakash and Velayudham (2007) ^[18] reported that the highest uptake of N (192.7 kg ha⁻¹), P (25.0 kg ha⁻¹) and K (379.5 kg ha⁻¹) was noted due to combined application of inorganic, biofertilizers and poultry manure in sweet corn. Rao *et al.* (2010) ^[12] also suggested that, the integrated application of nutrients in maize grown under rain fed maintain and sustain soil resources. The nutrients (NPK) uptake was found to be significantly higher due to integration of 50% RDF along with either poultry manure or FYM than sole application of 100% RDF.

Waghmode *et al.* (2010) ^[19] results indicated that the maximum uptake of N, P₂O₅ and K₂O in sweet corn was observed due to combined application of FYM (7.5 t ha⁻¹) with RDF and zinc sulphate @ 10 kg ha⁻¹ (253.1, 24.42 and 177.1 kg ha⁻¹, respectively).

Sannathimappa *et al.* (2011) ^[14] reported that higher nitrogen uptake (139 kg ha⁻¹), phosphorus uptake (58 kg ha⁻¹) and potassium uptake (131 kg ha⁻¹) and highest grain and stover yield of maize (4,689 kg ha⁻¹ and 6.68 t ha⁻¹ respectively) was observed in treatment 8 *i.e.* 75 kg N through inorganic fertilizer, 25 kg N through compost, *Azospirillum*, recommended P and K with french bean intercrop.

Sarwar *et al.* (2012) ^[15] the study revealed that highest N uptake in maize 98.7 kg ha⁻¹ was observed with 50% + 50% (CF + FYM) and 8 kg Zn ha⁻¹ application. The study revealed that substitution of 25 or 50% N with FYM + 4 kg Zn ha⁻¹ performed better than 100% N fertilizer alone, with respect to leaf area index, grain and straw yield, soil organic matter content and nutrient uptake.

Conclusion

In conclusion, this review paper emphasizes the management strategies of organic and inorganic nutrients, sources role, and the significances of Integrated Nutrient Management in maize. With the increasing global food insecurity, the haphazard use of chemical fertilizer is leading to soil deterioration, soil acidification, and environmental pollution. The INM is the alternative approach for sustainable, eco-friendly, and cost-effective management for improving soil fertility, soil productivity, quality, nutrient uptake, status and reducing the impact of inorganic fertilizers on the environment. The Integrated Nutrient Management system also significantly increases the availability of nutrient status in the soil as well as microbial activity in the soil. INM enhances the physiochemical status of soil by maintaining pH & increase gross return. Hence, Integrated Nutrient management (INM) can be an option which is a flexible approach to minimize the use of chemical sources of nutrients along with maximization of their efficiency and farmer's economic profit.

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