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A review on integrated nutrient management (INM) approach for maize

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Abstract

Soil fertility maintenance requires a balanced application of inorganic and organic nutrient sources. Maize popularly as known as “Corn” is one of the most versatile emerging cash crops having wider adaptability under varied climatic conditions. It is called queen of cereals globally. In India, maize or corn is the third most important food cash crop after wheat and rice. The maize is grown throughout the year in all the states of country for various purposes. Sustainable agricultural productivity might be achieved through a wise use of integrated nutrient management. Integrated use of chemical and organic fertilizer on yield and yield components of maize is very crucial for assurance of food security. Integrated nutrient supply/management (INS) aims at maintenance or 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 in an integrated manner which includes; Maintain or enhance soil productivity through a balanced use of fertilizers combined with organic and biological sources of plant nutrients. Different kinds of organic materials such as FYM, bio compost, vermicompost, animal manures, green manures, crop residues, composts, and industrial wastes have been used in maize systems. This paper has reviewed the research work carried out by various scientists in India and abroad.

Keywords: integrated nutrient management, organic fertilizer, chemical fertilizer bio-fertilizer

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crop in the world agriculture as food, feed and industrial raw material which ranked third largest cereals following rice and wheat respectively. It is grown across a wide range of agro ecological zones, due to its wider adaptability. In India, Andhra Pradesh was reported to be the largest producer of maize among the producing state contributing 21 per cent (%) of total production, followed by Karnataka 16%, Rajasthan 10%, Bihar and Maharashtra 9% each as well as Uttar Pradesh and Madhya Pradesh each contribute 6% (P Chennankrishnan, and K Raja, 2012) [12]. Majorly poor management of fertilizer has key role to play in obtaining low yield productivity, so in order to achieve optimum crop productivity management of nutrients through judicious application of organic sources, bio-fertilizers and micro-nutrients are required. Furthermore, the fertilizer management is one of the most important factors that influence the growth and yield of maize crop. (Ghaffari, *et al.*, 2011) [1].

Maize is considered as most exhaustive crop after sugar cane and requires both micro and macro nutrients to obtain high growth and yield potentials. In fact, organic nutrients not only provide plant with nutrients but also improve and or sustain the soil health. Integrated nutrient management (INM) is a judicious use of organic and inorganic sources of nutrient to crop fields for sustaining and maintaining soil productivity. However, the use of appropriate and conjunctive use of application of suitable nutrients through organic and inorganic solely or in combination can provide the solutions to the problems such as increase in the price of inorganic fertilizers and deterioration effect of soil fertility and productivity. Hence, judicious application of these combinations can sustain the soil fertility and productivity.

Materials and Methods

In September 2017 literature reviews were collected on the different aspect about integrated nutrient management in maize, the purpose of this review study was to know the different nutrient management practices on maize growth, yield quality produce and nutrient uptake The relevant and important published work available on maize has been reviewed.

Results and Discussion

Attempts are, therefore made to present a brief summary of work carried out in India and abroad relating to the INM under reviewed under given headings.

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Effect of integrated nutrient management on maize Growth

Louraduraj (2006)^[8] taken a field trial during the *rabi* season of 2002- 2003 on clay loam soil at Coimbatore (Tamil Nadu) and reported that combined application of 100% RDF (135-62.5-50 kg N-P-K/ha) with 5.0 t/ha vermicompost significantly increased plant height, dry matter accumulation and leaf area index in maize as compared to other treatment combinations.

Khadtare *et al.* (2006)^[7] carried out the research work at college farm of Anand Agricultural University, Anand (Gujarat) during *rabi* season of 2005-06 and reported that significantly higher values were recorded in respect of cob girth, cob length and green cob weight in treatment RDF (150-50-00 kg N-P-K /ha) followed by 75 % RDN+ 25 % N through vermicompost (VC) prepared from *Parthenium hysterophorus* L.) and 75 % RDN + 25 %N through VC prepared from *Amaranthus spinosus* L.).

The experiment was conducted at the Brahmanand Mahavidyalaya Agricultural Research Farm, Hamirpur (Uttar Pradesh) during *rabi* seasons of 2006-07 and 2007-08 on maize and revealed that application of 100 kg N/ha along with 7.5 t FYM/ha significantly influenced the plant height, leaf area index and number of days to maturity and silking. (Verma *et al.* 2012)^[21].

A field study was carried out during *kharif* 2009 at College of Agriculture, UAS, Dharwad (Karnataka) by Shilpashree *et al.* (2012)^[15] and reported that higher dry matter accumulation, plant height, number of leaves per plant, leaf area and leaf area index of maize were observed by applying 100% RDF (100-50-25 kg N-P-K/ha) + 7.5 t/ha FYM.

A field study was carried out at Manakkadavu, Pollachi, (Tamil Nadu) during *rabi* seasons of 2012 and 2013 on maize by Kannan *et al.* (2013)^[6] and found that application of vermicompost @ 5 t/ha + RDF (120-60-00 kg N-P-K/ha) significantly increased plant height and leaf area index as compared to control.

An experiment was conducted during *kharif*, 2010 at Instructional Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) to study the effect of integrated nutrient management on growth, productivity and economics on maize by Joshi *et al.* (2013)^[3]. They suggested RDF (120-60-30 kg N-P-K/ha) + FYM @ 10 t/ha resulted in maximum plant height, dry matter production and leaf area index, which was 96.5% higher over control.

Field experiment was conducted at Breeder Seed Production farm of Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) for two consecutive *kharif* seasons of 2010 and 2011 to find out most efficient and economic combination of different organic and inorganic sources of nutrients to increase the productivity of hybrid maize (*Zea mays* L.) by Kalhapure *et al.* (2013)^[4] and found that application of 25% RDF (30-15-15 kg N-P-K/ha) + biofertilizers (*Azotobacter*+ PSB)+ green manuring with sunnhemp + compost resulted in significantly taller plants and maximum total plant dry matter accumulation.

Iqbal *et al.* (2014)^[2] conducted an experiment at Department of Agronomy, University of Agriculture, Faisalabad (Pakistan), on sandy clay loam soil to evaluate the effect of integrated nitrogen management in maize during *rabi* season of 2012. They reported that significantly highest plant height and number of leaves per plant observed under application of 75 % N from urea + 25 % N from poultry manure which was at par with 100 % N from urea.

An experiment was conducted during *rabi* seasons of 2004-2005 and 2005-2006 at Parbhani (Maharashtra) and reported that application of 100 % RDF (120-60-40 kg N-P-K/ha) + 10 t FYM/ha recorded highest growth attributes *viz.* plant height, total dry matter production at harvest of maize. (Shinde *et al.* 2014)^[16].

Nagavani and Subbian (2014)^[11] conducted a field experiment on hybrid maize during *kharif* and *rabi* seasons of 2008 and 2009 at the irrigated upland farm of Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu). The results revealed that significant increase in growth parameters *viz.*, plant height, LAI of hybrid maize were recorded with the application of 50 % RDF through poultry manure + 50 % RDF through inorganic fertilizers followed by 50 % RDF through vermicompost + 50 % RDF through inorganic fertilizers.

An experiment was conducted during *rabi* season of 2005-2006 at Parbhani (Maharashtra) by Maske *et al.* (2015)^[9] and revealed that application of 100 % RDF (120-60-40 kg N-P-K/ha) + 10 t FYM/ha recorded highest growth parameters like, Plant height, dry matter accumulation per plant of maize.

Yield attributes and yield

Louraduraj (2006)^[8] conducted an experiment during 2002-03 in *rabi* maize at Coimbatore (Tamil Nadu). He noted that application of 100% RDF (135-62.5-50 kg N-P-K/ha) alongwith vermicompost @ 5 t/ha recorded significantly higher grain yield over other treatment combinations.

Khadtare *et al.* (2006)^[7] carried out the research work at college farm of Anand Agricultural University, Anand (Gujarat) during *rabi* season of 2005-06 and reported that significantly higher values were recorded in respect of green cob yield and green fodder yield in treatment RDF (150-50-0 NPK/ha) followed by 75 % RDN + 25 % N through VC prepared from *Parthenium hysterophorus* L.) and 75 % RDN + 25 %N through VC prepared from *Amaranthus spinosus* L. Pawar and Patil (2007)^[14] observed from University of Agricultural Science, Dharwad (Karnataka) in sandy loam soil during *rabi* season of 2004 and revealed that application of vermicompost @ 5 t/ha along with 100% RDF (120-60-40 kg N-P-K/ha) recorded significantly higher grain and straw yields over other treatments in maize.

Tetarwal *et al.* (2011)^[20] laid out a field experiment at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) during 2008-09 in rainfed maize and concluded that application of 100% RDF (40-15 kg N-P/ha) + 10 t/ha FYM resulted in higher cobs per plant, grains per cob, grain yield and biological yield over other treatments.

Verma *et al.* (2012)^[21] laid out an experiment at the Brahmanand Mahavidyalaya, Agricultural Research Farm, Hamirpur (Uttar Pradesh) during *rabi* seasons of 2006-07 and 2007-08. They studied that yield attributes such as diameter of cob, weight of cobs per plant, grain and straw yields were found significantly higher with application of inorganic fertilizer of 100 kg nitrogen/ha along with 7.5 t FYM/ha.

Joshi *et al.* (2013)^[3] laid out an experiment on maize during *kharif* 2010 at Udaipur (Rajasthan). They suggested that maximum values for almost all yield parameters *viz.*, number of cobs per plant, test weight, cob weight and grain weight per cob were obtained with 100% RDF (120-60-30 kg N-P-K/ha) + FYM @ 10 t/ha.

A field study was carried out at Manakkadavu, Pollachi, (Tamil Nadu) during *rabi* 2012 and 2013 on maize by Kannan *et al.* (2013)^[6]. They found that application of vermicompost@ 5 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.

Shinde *et al.* (2014)^[16] conducted a field experiment during *rabi* seasons of 2004-2005 and 2005-2006 at Parbhani (Maharashtra) and found that application of 100 % RDF (120-60-40 kg N-P-K/ha) + 10 t FYM/ha recorded highest cobs/plant, 1000- grain weight, grain yield and straw yields of maize.

Pandey and Avasthi (2014)^[13] evaluated a field experiment on *rabi* maize during the year 2010-11 at experimental field of Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh) and found that grain yield and straw yield were higher in RDF (120-60-40 kg N-P-K/ha) + FYM 10 t/ha.

A field experiment was conducted to evaluate the integrated use of organic and inorganic source of nutrients on growth, yield and economics of hybrid maize during *kharif* and *rabi* seasons of 2008 and 2009 at the irrigated upland farm of Tamil Nadu Agricultural University, Coimbatore (Tamil Nadu) by Nagavani and Subbian (2014)^[11] and they revealed that significant increase in yield components, grain and straw yields of hybrid maize were recorded with the application of 50 % RDF through poultry manure + 50 % RDF through inorganic fertilizers followed by 50 % RDF through vermicompost + 50 % RDF through inorganic fertilizers.

The experiment was conducted during *rabi* season of 2005-2006 at Parbhani (Maharashtra) by Maske *et al.* (2015)^[9] and revealed that application of 100 % RDF (120-60-40 kg NPK/ha) + 10 t FYM/ha recorded highest yield attributes *viz.*, cobs per plant, 1000- grain weight, grain yield and straw yield of maize.

Nutrient content, uptake and soil status

A field experiment was conducted on medium calcareous soil of Instructional Farm, Junagadh Agricultural University, Junagadh (Gujarat) during the season of 2005-06 to study the response of *rabi* maize (*Zea mays* L.) to vermicompost and nitrogen levels. An application of 120 kg N/ha + 1.5 t vermicompost/ha resulted in significantly higher nutrient content and uptake compared with 80 kg N/ha + 1.5 t vermicompost/ha and control. (Meena *et al.* 2007)^[10].

While working at Gajraula (Uttar Pradesh) by Tripathi *et al.* (2007) on maize in *kharif* seasons of 2002-03 and 2003-04. They concluded that application of bio compost @ 5 t/ha with 75% N and P through fertilizer (100% RDF 120-60-60 kg N-P-K/ha) recorded higher available organic carbon and N in soil after crop harvest.

Singh and Nepalia (2009) conducted an experiment at Rajasthan College of Agriculture, Udaipur (Rajasthan) during *kharif* season of 2004-05. They reported that application of vermicompost @ 5 t/ha with 100% RDF (90-40 kg N-P/ha) on maize improved organic carbon content, N and P status of soil than control.

A field experiment was started by Tetarwal *et al.* (2011)^[20] during 2008-09 at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) and concluded that application of 100% RDF (40-15-00 kg N-P-K/ha) + 10 t/ha FYM registered maximum NPK uptake by maize and available N and P status to the tune of 1.28 and 14.89 % respectively over initial status of soil fertility.

Singh *et al.* (2012)^[19] laid out a field experiment during 2007-08 in *kharif* maize at Instructional Farm of Agronomy, Rajasthan College of Agriculture, Udaipur (Rajasthan). They found that application of FYM @ 10 t/ha along with 100%

RDF (120-26.21-33.2 kg N-P-K/ha) recorded significantly higher uptake of nitrogen and phosphorus by grain, straw and total uptake by crop over control.

A field experiment was carried out at Breeder Seed Production farm of Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) for two consecutive *kharif* seasons of 2010 and 2011 on hybrid maize. They revealed that significantly higher values of organic carbon, available N, P₂O₅ and K₂O content in soil were recorded with application of 25% RDF (30-15-15 kg N-P-K/ha) + biofertilizers (*Azotobacter* + PSB) + green manuring with sunnhemp + compost. (Kalhapure *et al.* 2013)^[4].

Pandey and Avasthi (2014)^[13] evaluated a field experiment on *rabi* maize during the year 2010-11 at experimental field of Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh) and found that total porosity, CEC, organic carbon, available N, P₂O₅ and Zn in soil recorded highest with the application of RDF (120-60-40 kg N-P-K/ha) + FYM 10 t/ha.

Quality

A field experiment was started by Singh *et al.* (2011) on sandy loam soil at Varanasi (Uttar Pradesh) during pre-*kharif* season of 2004-05 and reported that application of 75% RDF (100% RDF 180-38.7-74.7 kg N-P-K/ha) + 25% FYM failed to express any significant result for protein content in maize grain.

Verma *et al.* (2012)^[21] laid out an experiment at the Brahmaand Mahavidyalaya Agricultural Research Farm, Hamirpur (Uttar Pradesh) during *rabi* seasons of 2006-07 and 2007-08. They studied that protein content (8.20%) in maize grain found significantly higher with application of inorganic fertilizer of 100 N kg/ha with 7.5 t FYM/ha.

Shinde *et al.* (2014)^[16] carried out a field experiment during *rabi* seasons of 2004-2005 and 2005-2006 at Parbhani (Maharashtra) and revealed that highest values of protein per cent and protein yield of maize were recorded with application of 100 % RDF (120-60-40 kg N-P-K/ha) + 10 t FYM/ha.

Iqbal *et al.* (2014)^[2] conducted an experiment at Department of Agronomy, University of Agriculture, Faisalabad (Pakistan) on sandy clay loam soil to evaluate the effect of integrated nitrogen management in maize during *rabi* season of 2012. 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%.

Conclusion

From the discussion, it can be concluded that higher growth, yield, quality, nutrient uptake can be achieved by appropriate combine application of organic and inorganic fertilizers in maize. Results proved that integrated ways of nutrient management on maize crop have multipurpose on the improvement of soil fertility and crop productivity in the sustainable manners. It is commonly believed that the combination of organic and inorganic fertilizer will increase synchrony, enhancing the efficiency of the fertilizers, and also reducing environmental problems that may arise from their use.

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