Influence of Integrated Nutrients on Growth and Yield Attributes of Maize (*Zea mays* L.)

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SYNOPSIS

Influence of Integrated Nutrients on Growth and Yield Attributes of Maize (Zea mays L.)

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INTRODUCTION

Maize popularly 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 crops after wheat and rice. The maize is grown throughout the year in all states of the country for various purposes including fodder for animals, food grain, sweet corn, baby corn, green cobs and pop corn. Corn flour is consumed widely in Indian cooking. The states Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat account for 85 per cent of India's maize production and 80 per cent of area under cultivation.

Maize or corn can be cultivated successfully in variety of soils ranging from clay loam to sandy loamy to black cotton soil. For better yield of maize, one should consider soils with good organic matter content having good water holding capacity. The well drained soils with pH 5.5 to 7.0 are preferred for maize farming. Any soil deficiency can be overcome by adding FYM, compost, other organic matter and also by using fertilizers.

Organic corn production can be done but it has some challenges: maintaining a diverse crop rotation, developing a balanced, sustainable, low cost fertility plan and mastering the art of mechanical weed control, but based on some of the farmers we should be able to produce corn that yields from 80 to 100 percent of conventional production. Organic corn gets a bit hard to produce as we move to larger acreages, since this makes it more difficult to deal with the rotation, fertility and mechanical weed control issues.

There has been an increase of use of inorganic fertilizer use for increasing yield in India. It increases the yield to some extent but excessive use of inorganic fertilizers degrades soil and has bad effects in the long run. Growing of maize using only chemicals is bad for soil as chemical fertilizers contain acids, including sulfuric and hydrochloric acids. These acids dissolve soil crumbs which is the material that holds rock particles together. While the fertilizers help plants to grow, they do not do much for the soil. They do not help to improve the health or the structure of the soil. Hence, when the chemical fertilizers are used for prolonged duration, the soil gets damaged as the trace nutrients are not replenished in the soil. When these cementing materials are destroyed, the result is a compacted surface that decreases infiltration. Using only chemicals deteriorate the soil. The production also starts to decrease year after year. The acidity of chemical fertilizers also negatively affects the soil pH, thereby changing the kinds of microorganisms that can live in the soil.

Therefore balanced use of chemical fertilizers and organic manures will lead to good production of soil and keeps the soil in good health. The yield is a lot better in the combined use of organic and inorganic fertilizers.

OBJECTIVE:

1. To study the effect of Integrated Nutrients on Growth and Yield Attributes of Maize.
2. To determine nutrient content and uptake of major nutrients under different treatments.
3. Workout the economics of different treatments

REVIEW OF LITERATURE

An experiment was conducted at college of Agriculture, Mandya, Karnataka in the *rabi* season of 2007-08 on sandy loam soil to study the effect of INM on yield, nutrient uptake and economics of maize (*Zea mays* L.). The results revealed that combined application of 150:75:40 kg NPK ha^{-1} + 10 t FYM ha^{-1} recorded higher grain yield (65.9 q ha^{-1}), gross returns (Rs.44,375 ha^{-1}), B:C ratio(2.62), NPK uptake (160.8,41.9 and 77.8 kg ha^{-1}) followed by 75% recommended through N fertilizers and 25% N through poultry manure which were at par with each other.

Jimjala *et al.* (2016) conducted a field experiment at NAU in Gujarat to study the effects of INM on baby corn. They applied different combinations of nitrogen with chemical and vermicompost with and without bio-fertilizers. The treatment with 100% RDF from chemical fertilizer with biofertilizer was recorded higher yield and net returns over all other combinations.

Thavaprakaash *et al.* (2005) conducted field experiments at TNAU, Coimbatore during late *rabi* 2002 (January to March) and 2002-03(December to March) seasons to study the impact of varied crop geometry, short duration intercrops and INM practices on production of baby corn based intercropping systems. Yield levels of intercrops were higher under closer row geometry(45 cm) than 60 cm spacing, INM practices had less influence on intercrops yield whereas baby corn equivalent yields were higher at 60 cm row spacing, intercropped baby corn with 50%NPK+Poultry manure+azospirillium+phosphobacteria than other combinations.

Wakene *et. al.* (2007) carried out the field experiment on study of INM techniques to increase maize production and soil fertility for three consecutive years(2001 to 2003) on acidic alfisols of Bako Agricultural Research Centre, western Ethopia. It was found out that the use of Mucuna (*Mucuna pruriens* L.) as improved fallowing with FYM or low dose of NP fertilizers could improve both maize yield and soil fertility in western Ethopia.

Neeraj Kumar Verma (2011) conducted a field experiment during *rabi* season of 2006 to 2007 and 2007 to 2008 to study the effect of sowing dates and integrated nutrient management on growth, yield and quality of winter maize. Different combinations of treatments were given but application of N_2O (100 kg ha^{-1}) with FYM (7.50 t ha^{-1}) at the

sowing date of 25th October significantly influenced the growth, yield and quality of maize and was recorded 9.35 and 23.07 % more grain yield over the other treatment combinations.

Syed Ansar-ul Haq conducted a field experiment at Shalimar Campus during 2004 and 2005 on a silty clay loam soil to study the effect of INM in maize under irrigated Agro-ecosystem of Kashmir Valley. The eighteen different combinations was tried but the highest benefit:cost ratio of Rs.2.83 and net profit of Rs.46194.47 was recorded with treatment combination of 10 t FYM and 150:100:50 kg N:P2O5:K2O/ha along with Azospirillum+PSB inoculation.

Ghaffari et al. (2009) conducted a field experiment to evaluate the integrated nutrients effect on growth, yield and quality of maize (*Zea mays* L) during spring,2009, University of Agriculture, Faisalabad. The experiment was laid out in randomised complete block design(RCBD) having three treatments and it was found out that the recommended dose of NPK in addition with single nutrient use efficiency up to 11.5% which induced significant increase in grain yield as compared to control and also in the treatment where recommended dose of NPK was applied alone and the quality parameter of maize(oil contents) significantly improved by foliar application of multi nutrient solutions but recommended dose of fertilizer in addition to single spray of multi-nutrients was economical.

Fanuel Laekemariam and Gifole Gidago conducted a field experiment during rainy season of 2009 and 2010 with an aim to evaluate growth and yield response of maize to variable rates of compost and inorganic fertilizer integration. It was found out that application of compost 5t/ha by fortifying with urea was better than large quantities of compost plus urea. Raising the quantities of compost 10t/ha and supplementing with urea did not result in corresponding increase in maize grain yield. Moreover, access to large quantities of compost preparation material by small holder farmers in the study site could be disincentive to integrated 10t/ha compost.

Kumar *et al.* (2013) conducted a field experiment at Research farm of ICAR RC for NEH region, Jharnapani, Nagaland during the two consecutive seasons of 2013 and 2014 in *kharif* for evaluating fodder yield of baby corn(*Zea mays* L.) as influenced by mulching, liming and integrated nutrition management under foot hill condition of Nagaland. After using different treatments it was found out that straw mulching with application of lime in furrow @ 1.0 t/ha and 125% RDF(IN)+24%(ON) proved the best for getting higher baby corn and fodder productivity under foot hill condition of Eastern Himalaya, India.

Shilpashree *et al.* (2012) carried out a field study at College of Agriculture, Navile, Shimoga to study the effect of INM practices on distribution of nitrogen fractions in soil. Except inorganic nitrogen fractions, organic nitrogen fractions were recorded high in integrated treatments compared to the treatment which received nitrogen only in the form of fertilizers.

Gupta *et al.* (2014) carried out a field experiment in sub-tropical region under foothills of north-west Himalays for the effects of INM on growth and yield of maize (*Zea mays* L.) and the pronounced residual effect of organic and inorganic fertilizers, applied in maize crop was observed on yields of maize-gobhi sarson cropping system in the kharif seasons of 2006, 2007 and 2008. The experiment was conducted with 10 treatments of N, P, K, FYM, crop residue and zinc sulphate nutrients. The highest growth, yield and yield components of maize crop were recorded with 100% recommended fertilizer dose-RFD + ZnSO4 20 kg/ha and the grain yield (2409 kg/ha) was about 101% higher over the control. In case of gobhi sarson, the highest seed yield (1081 kg/ha) was observed as a pronounced residual effect of 10 t/ha FYM in preceding maize crop; which was about 81% higher over the control. The treatments where 50% N was substituted by FYM and crop residue in maize crop had the best reflection in enhancing the seed yield of gobhi sarson to the tune of 74 and 70% over the control and 16 and 13% over farmer's practice. The highest rain water use efficiency (RWUE) and heatuse efficiency (HUE) was recorded in treatment 100% RFD + ZnSO4 20 kg/ha in maize crop and 10 t/ha FYM in gobhi sarson.

A field study was conducted in the winter season 2013 for knowing the effect of Integrated Nutrient Management on Growth and Yield Parameters of Maize (*Zea mays* l.) as well as Soil Physico chemical Properties in Lovely Professional University, Phagwara, Punjab (India). The growth parameters (plant height and leaf area) were found to be highest under INM (Integrated Nutrient Management) of poultry manure (PM) or farm yard manure (FYM)and recommended dose of fertilizers (RDF) which are statistically on par but comparatively higher than T_1 (100% RDF). The yield parameters (number of grains per cob, cobs weight per plant, Test weight and stover yield) were significantly higher under INM compared to T_1 (100% RDF). Furthermore, post harvest soil physico-chemical properties (organic carbon and available nitrogen) were significantly improved under T_3 (5t PM + 50% RDF), whereas soil available phosphorus was recorded maximum under T_5 (5t PM + 100% RDF) compared to control and rest of the treatments combination. Therefore, the integration

of 50% RDF along with either 5t/ha FYM or PM or both resulted in maximum maize productivity on par compared with sole use of 100% RDF.

A field study was carried out by for two consecutive years (*Kharif* 2011 and 2012) in Experimental Farm of Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, J&K, India during kharif 2011 and 2012 to study the influence of integrated nutrient management on yield and yield attributes of sweet corn var. Super-75. The results revealed that yield contributing characters *viz.*, cob length and diameter with and without husk, number of cobs per plant, rows per cob, grains per row and weight of cob with and without husk were significantly higher with application of 75% (NPK) + Farmyard manure (FYM) (4.5 t ha-1) + biofertilizer (Azotobacter + Phosphate solubilizing bacteria (PSB) over unfertilized control and other treatments. This treatment also proved to be significantly superior to rest of the treatments including unfertilized control in increasing cob yield with and without husk, fodder yield and green biomass yield during both years of experimentation. The ratio of cob to fodder yield during 2011 was recorded highest in treatment FYM (18 t ha-1), while during 2012, NPK (90:60:40 kg ha-1) recorded the highest ratio of cob to fodder yield.(Shahid *et al.* 2011)

A field experiment to determine the effect of plant population densities on maize was conducted by at the Agricultural Research Institute, Dera Ismail Khan, in mid July 2009. The effect of six plant population densities *i.e.* T1(40000 plants ha–1), T2 (60000 plant ha–1), T3 (80000 plants ha–1), T4 (100000 plants ha–1), T5 (120,000 plants ha–1) and T6 (140,000 plants ha–1) was investigated using maize variety Azam. Results showed that plant population of 40000 ha–1 produced maximum number of grains per row (32.33) and grains per ear (447.3). However, 60000 plants ha–1 produced the maximum number of ears per plant (1.33), number of grain rows per ear (15.44), biomass yield (16890 kg ha–1) and grain yield (2604 kg ha–1). Therefore, planting density of 60000 plants ha–1 (keeping plant to plant distance of 22.70cm) is recommended for obtaining higher yield of maize. (Abuzar *et al.* 2009).

Kalhapure *et al.* (2011) the field experiment was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri for two consecutive *kharif* seasons of years 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.) without deteriorating the soil qualities. Application of 25% recommended dose of fertilizers (RDF) in

combination with biofertilizers (Azotobacter chroococcum+ phosphate solubilizing bacteria), green manuring with sunhemp and incorporation of compost @10 t/ha improves soil physico-chemical properties (*viz.* decrease in alkaline pH by 0.4, bulk density by 0.04 g/cm3 and increase in infiltration rate by 0.65 cm/hr). This was also responsible for improving the nutrient status of soil in respect of organic carbon, available N and available P2O5 which were increased by 0.14%, 4.4 kg/ha and 11.7 kg/ha, respectively over the initial nutrient status of soil. Maize grain yield was increased by 252.38% over control and 147.62% over application of 100% RDF with combined use of organic and inorganic fertilizers which was 7.4 t/ha with highest gross return (`95.9x103/ha) and net return (`54.2x103/ha). Maximum B:C ratio (1.30) was also observed in jointly use of 25% RDF, compost, biofertilizers and green manuring and it was followed by application of 100% RDF (1.26) which was responsible for deterioration of nutrient status of soil.

A thrice replicated 2 year field trial was conducted during 2010 and 2011 for knowing the effect of integrated nutrient management for sustainable production system of maize (Zea mays L.) in indo-gangetic plain zone of India. The results revealed that combination of 100% NPK + 5 t FYM+ Azotobactor + PSB recoded higher mean growth attributes viz.,plant height (201.25 cm), dry weight/plant (267.25 g), LAI at 60 DAS (4.2), yield attributing component and yield viz., cob/plants (1.1), number of grain/cob (541.2) and test weight (245.05 g), grain yield (53.15 q/ha), quality parameters viz., protein content (8.38%) and protein yield (445.4kg/ha), total nutrients uptake and economics viz.,net return/ha (Rs 36073.5), B:C ratio (2.86), production efficiency (59.1 kg/day/ha) and economic efficiency (400.8 Rs/day/ha), besides achieved maximum nitrogen used efficiency as compared to rest of its counterparts Thus, study suggests that maize can be successfully grown under Indo-Gangetic plain zone on 100% NPK + 5 t FYM+ Azotobactor + PSB and harvest maximum productivity and profitability besides, improving used efficiency of nitrogen. (Tomar *et al.* 2017).

Field experiments were conducted by Shah et al. at Langate cluster of National Agriculture Innovation Project (SRLS-3) Kupwara during two *kharif* seasons of 2008 and 2009 to work out the influence of varying nutrient management practices on maize crop. The experiment comprised of seven integrated nutrient management practices laid in a randomised block experimental design. Application of 100% RDF(NPK)+vermicompost @ 3 tonnes per hectare recorded maximum kernels per cob, number of cobs per meter square, thousand grain weight, cob length and grain yield per hectare (3.26 quintals). The highest nutrient uptake 95.1, 20.8 and 84.1 kgs of NPK respectively was observed with the

application of 100% NPK+ 3 tonnes of vermicompost per hectare. The findings also revealed that vermicompost application @ 5.5 tonnes per hectare+farm yard Manure(FYM)@5.5 tonnes per hectare to maize crop recorded the high soil availability of N, P and K status of 394.8, 21.37 and 169.8 kgs per hectare respectively.

Babita Bharti and Raj Paul Sharma (1972-2017) carried on a project to study the long term effect of integrated nutrient management on soil properties and available nutrients, surface and subsurface soil samples were drawn from the long-term field experiment (LTFE) which is in progress on a Typic Hapludalfs at Research Farm of College of Agriculture, CSK HPKV, Palampur, Himachal Pradesh, India since Rabi, 1972. The rotation followed was maize-wheat and the treatments included various combinations of N, P, K, Zn, lime, hand weeding and farm yard manure. Results from the study showed that integrated nutrient management over the years resulted in improvement in the soil properties as well as status of available nutrients in the soil at both the depths. Continuous application of urea as a source of N has resulted in acidification of soils (pH 4.3) while lime application increased the pH to 6.2 in the surface soil and 6.0 in subsurface soil. The treatment 100 % NPK + FYM resulted in 66 per cent increase in soil organic carbon content over initial value. Similar effects were recorded on cation exchange capacity and available nutrients.

Keerthi *et. al.* (2013) the field experiment was conducted on sandy loam soil of Agriculture College Farm, Naira during rabi, 2012-13. The experiment was laid out in randomized block design with the seven treatments, each replicated four times. Among the fertility levels tried, application of 180-75-60 kg N P K ha-1 + vermiwashat 20, 35 and 50 DAS recorded the highest growth parameters, yield attributes and cob yield which was however, found parity with 180-75-60 kg N P K ha-1 + vermicompost. Integrated nutrient management treatments exhibited their superiority at the highest levels of fertilization over the same levels under chemical sources in enhancing green cob yield.

Materials and Methods

Technical Program of Work:

A field experiment will be conducted in randomized block design consists of ten treatments with three replications at the Agricultural Research Farm of Lovely Professional University, Jalandhar, Punjab during *kharif* seasons of year 2018. The experimental site will be located at 31°14'43.8"N &75°41'44.1"E.

Soil Analysis:

Soil Parameters

1. Soil pH
2. Soil EC
3. Organic carbon (%)
4. Available nitrogen
5. Available phosphorus
6. Available potassium
7. Available sulphur

Plant Analysis

1. Available nitrogen
2. Available phosphorus
3. Available potassium

Quality parameters:

1. Protein content

Analytical methods will be following during investigation are as under

Sr.No.	**Test parameter**	**Method**	**References**
Soil parameters			
1	pH (1:2.5)	Glass electrode	Sparks (1996)

2	EC (1:2.5)	Conductivity meter	Sparks (1996)
3	Organic C	Wet digestion	Walkley and Black (1934)
4	Available N	Alkaline potassium permagnate method	Subbiah & Asija (1956)
5	Available P	Olsen's Method	Olsen *et al*. (1954)
6	Available K	Flame photometer	Jackson (1973)
Plant parameters			
8	N(%)	Kjeldahl method	Jackson (1973)
9	P(%)	Vanadomolybdate yellow colour method	Jackson (1971)
10	K(%)	Flamephotometer method	Dhyan Singh (2003)

Collection of samples

I. Initial soil sample

Initial soil sample will be collected before experimentation for the study of physico-chemical properties.

II. Post–harvest soil samples :

Post harvest soil sample will be collected from each plot at a depth of 0-15cm.

III. Straw and grain samples:

Straw and grain sample will be collected after the harvest of crop.

Brief Introduction about the work

- Crop : Maize
- Variety : PMH2
- Total no. of treatments : 10
- Replications : 3
- Total no. of plots : 30
- Net Plot Area : 3 X 4 = 12 m^2
- Total Net Area : 30 X 12= 360 m^2
- Design of Experiment : Randomized Complete Block Design(RCBD)
- Period of Work : 2018-19
- Seed Rate : 8 kg/ acre
- Topic Under discussion : Influence of Integrated Nutrients on Growth and Yield Attributes of Maize (*Zea mays* L.)

Treatments details:

T1	Control
T2	100% RDF(90:60:40)
T3	100% FYM(15 tonnes/ha)
T4	100% vermicompost(5 tonnes/ha)
T5	Biofertilizer(Azatobacter + phosphate solubilizing bacteria)
T6	75% NPK + 50% FYM
T7	75% NPK + 50% vermicompost
T8	75% NPK + 50% biofertilizer
T9	75% NPK + 25% FYM + 25% vermicompost
T10	75% NPK + 50% FYM + 50% biofertilizer

Layout:

R1	**R2**	**R3**
T1	T7	T10
T5	T2	T3
T7	T3	T6
T10	T1	T7
T2	T9	T2
T8	T4	T8
T3	T10	T9
T4	T5	T1
T6	T8	T4
T9	T6	T5

Observations:

A. Different Growth Parameters (30, 60 and 90 DAS)

1. Plant height (cm)
2. No. of green leaves per plant (Number/plant)
3. Stem girth per plant (cm)
4. Leaf area per plant (cm)
5. Dry matter production (g)

B. Different Yield Parameters:-

1. Number of grains per cob (g)
2. Number of Cobs (Number/plant)
3. 1000 grain weight (gm)
4. Grain Yield (Kg/ha)
5. Straw Yield (Kg/ha)
6. Cob length (cm)
7. Harvest Index (%)

Proposed Work Timeline:

The experiment will be conducted on short duration hybrid variety PMH2

1. Time of sowing : First week of July 2018
2. Spacing : 60 X 20 cm
3. Weed Management : Pre- emergence – Atrazine 50 WP @ 800g/acre

   in 200 litre of water within 2 days of sowing

4. Irrigation: 4-6 depending on rainfall.

5. Harvesting: Harvesting is done when outer cover of turns white from green.

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