Int.J.Curr.Microbiol.App.Sci (2018) *7*(9): 3778-3787

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 09 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.709.467

Impact of Integrated Nutrient Management on Nutrient Uptake by Maize Crop from Soil under Rainfed Condition in Eastern Part of Uttar Pradesh, India

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A B S T R A C T

Keywords

Maize (*Zea mays*), Integrated nutrient management

Article Info

Accepted:
04 August 2018
Available Online:
10 September 2018

The present investigation entitled on "Integrated nutrient management in maize under rainfed condition in Eastern part of U.P." was conducted during *kharif* season of 2014-15 and 2015-16 Agronomy Research Farm Narendra Deva University of Agriculture & Technology (Narendra Nagar), Kumarganj Faizabad (U.P.) Higher uptake of major nutrients *viz.*, nitrogen, phosphorus, potassium, iron and zinc was significantly higher with the application of T_{12}- 75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application + $FeSO_4$ @ 10 kg ha^{-1} as soil application in maize.

Introduction

Maize (*Zea mays*, referred to as corn in North America) originated in central Mexico in around 5,000 BC. The crop was introduced to Europe in the sixteenth century, from where it spread to Africa and Asia. It is now one of the most widely-grown crops around the world in both temperate and tropical regions.

It is among the 10 most important world crops by value. According to the FAO, world production in 2012 was over 870 million tons, grown on 158 million hectares of land. Sources such as the FAO's Agricultural Market Information System (AIMS) and The International Grains Council have forecasted production increasing to as high as 990 million tons in 2014-2015 grown on almost 200 million hectares. Over 80% of maize production is located in the Americas (53%) and Asia (28%), followed by Europe (15%). Key areas of cultivation include the US maize belt, north eastern China and Eastern Europe.

Major producers in 2012 included the United States (over 270 million tons), China (over 200 million tons) and Brazil (71 million tons), followed by India, Mexico, Argentina, Ukraine, Indonesia, France and Canada. 70% of the total acreage for maize cultivation is in the developing world. Maize is grown both (as sweet corn) for human consumption and (as field corn) for other uses such as animal feed and biofuels. Worldwide, only around 15% of maize production is used for food consumption with most production going to animal feed. However, the proportion of maize production for food production in developing countries is higher at 25% and even higher in regions such as South East Asia where it is an estimated 30-40%, whilst in parts of Sub-Saharan Africa it can be as high as 70-80%. The crop is a staple food for an estimated 1 billion people across sub-Saharan Africa, South Asia and Latin America. In Africa maize forms part of the diet for 50% of the population, and consumption can be as high as 328 grams per person per day.

Phosphorus is an essential nutrient both as a part of several key plant structure components and act as catalysis in the conversion of numerous key biochemical reactions in plants. Phosphorus is needed in capturing and converting the sun's energy into useful plant compounds. Thus the phosphorus is essential for the general health and vigor of all plants. Some specific growth factors that have associated with phosphorus are stimulated root development, increased stalk and stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, improved in crop quality, and increased resistance to plant diseases. Phosphorus deficiency is more difficult to diagnose than a deficiency of nitrogen or potassium. The maize plants, tend to show an abnormal discoloration when phosphorus is deficient. The plants are usually dark bluish-green in color with leaves and stem becoming purplish. The degree of purple is influenced by the genetic makeup of the plant, some hybrids showing much greater discoloration than others. The purplish colour is due to accumulation of sugar which favours the synthesis of anthrocynin. Phosphorus is highly mobile in plants and when deficient it may be translocated from old plant tissue to young growing areas.

Potassium is essential for vigorous growth of the plant and for many other metabolic activities. The young seedling does not need much potassium, but the rate of uptake jumps up to a peak level to tasseling. Zinc influence the formation of some enzymes and promotes the growth hormones in the plant. It is also associated with uptake of nutrients and water in relation to plant. High uptake of other nutrients increases the demands of zinc. Zinc deficiency symptoms are described as "white bud" in maize.

Fertilizer plays an important role to increase the productivity of rainfed maize. It is reported by scientist that 50% increase in yield of rainfed crops attributed to fertilizer application. Response to application of fertilizer nutrient in dryland was reported across the location in the country Katyal *et al.,* (1999). Continuous use of only chemical fertilizers in intensive cropping system is leading to imbalance of nutrients in soil, which has an adverse effect on soil health and also on crop yields. On the other hand, continuous use of organics helped to build up soil humus and beneficial microbes besides, improving the physio-chemical properties of soil. But, use of organics alone does not result in spectacular increase in crop yields, due to their low nutrient content and limited availability. Therefore, in the present context, a judicious combination of organics and chemical fertilizers helps to maintain soil and crop productivity. The lack of information on these aspects under rainfed condition made an impetus to undertake the present study. Organic manures not only supply the plant nutrients but also improve soil health. Moreover, the amount of micronutrients present in organic manures may be sufficient to meet the requirement of crop production (Duhan and Singh 2002). To sustain the soil fertility and crop productivity the role of organic manures and organic nutrients are very important. In view the above facts the present investigation entitled "Integrated nutrient management in maize under rainfed condition in eastern part of U.P." was conducted during *kharif* seasons of 2014 and 2015 at Agronomy Research Farm of N.D. University of Agriculture &Technology, Kumarganj Faizabad (U.P) with following objectives: the effect of Integrated Nutrient Management on quality of maize as well as nutrient uptake of maize.

Materials and Methods

Experiment was conducted during the *kharif* season of 2014 and 2015 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.), which is located 42 km away from Faizabad on Faizabad- Raibarelly Road. Geographically, the experimental site falls under sub-tropical climate and is located at 26.47º N latitude and 82.12º E longitudes with an elevation of about 113 meter above mean sea level in the Indo-Gangetic alluvial soil belt of eastern Uttar Pradesh.

Plant analysis for nutrient uptake

Plant sample (grain/ and stalk/straw/strover) were collected randomly from each experimental unit at the time of harvest for evaluation of nutrient content and uptake. The samples were dried in oven to 60^0 for eight hours. Oven dried samples (grain/ and stalk/ straw/ strover) were grinded in stainless steel grinder for analysis of nitrogen, phosphorous, potassium zinc and iron.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient contentin grain \% x Grain yield (kg/ha)}}{100}$$

Nitrogen uptake (kg ha^{-1})

The processed straw and grain samples were digested with concentrated H_2SO_4 in presence of catalyst mixture modified Kheldahl method was adopted for determination of nitrogen content in straw yield obtain nitrogen uptake in seed and content in plant respectively. For the estimation of nitrogen uptake in seed and con tent in plant. Instruments: Kjelplus (microkjeldhal apparatus), Bunsen burner, glassware etc.

Procedure

0.5 gram of powdered sample was digested with concentrated H_2SO_4 in presence of digestion mixture ($CuSO_4$ + K_2SO_4 + Selenium powder in (200:10:1) till the digest gave clear bluish green colour. The digested sample was further diluted carefully with distilled water to known volume. Then a known amount of aliquot was transferred to distillation unit (Micro kjeldahl – apparatus) and liberated ammonia was trapped in boric acid containing mixed indicator. Later, it was titrated against standard H_2SO_4 solution and the amount of ammonia liberated was estimated in the form of nitrogen as per procedure given by Black (1965).

Digestion of plant sample

Half gram powdered sample was pre-digested with concentrated nitric acid overnight. Further, predigested sample was treated with diacid (nitric acid+ perchloric acid in the ratio 10: 4) mixture and kept on sand bath for digestion till snow white solid residue was obtained. After complete digestion precipitate was dissolved in 6 N HCl and transferred to the hundred ml volumetric flask through Whatman No. 42 filter paper and finally the volume of extract was made to 100 ml with double distilled water and preserved for further analysis. The percentage of nitrogen was multiplied with grain and straw yield obtain nitrogen uptake in seed and straw content in plant respectively.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient contentin grain \% x Grain yield (kg/ha)}}{100}$$

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in straw \% x straw yield (kg/ha)}}{100}$$

Phosphorus (kg ha^{-1})

Phosphorus in plant digested sample were digested with di acid mixture having nitric and pre chloric acid and determined by vanadomolybdo phosphoric yellow colour method (Jackson, 1973) by using spectrophotometer at 470 nm. The percentage of phosphorous was multiplied with grain and content in plant to obtain phosphorous uptake in grain and content in plant.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in grain \% x Grain yield (kg/ha)}}{100}$$

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in Straw \% x straw yield (kg/ha)}}{100}$$

Instruments:- Spectrophotometer. Determination of posphorous content: Digestion

50 mg dried and well ground plant material was taken in a 50 ml conical flask and 3 ml of 9:1 H_2SO_4 and $HClO_4$ mixture was added. The flasks were heated gently over a hot plate for 5-10 minutes and there after the heating temperature was raised when the frothing in the mixture ceased.

Digestion was continued until the solution become colorless. The digest was cooled and diluted to 100ml, distilled water.

Reagents

Vanadate-molybdate reagent

Prepare solution A by dissolving 25g of ammonium molybdate in about 400ml of warm water. Prepare solution 'b' separately by dissolving 1.25g of ammonium metavanadate in about 300 ml of boiling water, cool it and add 250ml of concentrated HNO_3. Cool again at room temperature. Now add solution 'A' to solution 'B' and dilute to 1 liter.

Standard 'P' solution

Prepare solution containing 100 mg P L^{-1} by dissolving 0.439g of dried KH_2PO_4 in water, acidifying with 25 ml of 7N H_2SO_4 and making the volume to 1 L.

Estimation

Transfer a suitable volume, not more than 30 ml to 50 ml volumetric flask so that it contains 0.05 to 1.0 mg of P and the acid equivalent is between 0.6 and 1.6 N in the final volume of 50 ml. Add 10 ml of the vanadate-molybdate solution and dilute to 50 ml with water. Mix well and read the colour intensity after 10 minutes using blue filter (420 nm). Run a blank without P solution simultaneously. Take 0.50, 1.00, 1.50, 2.00 and 2.50 ml of the 100 mg P L^{-1} solution in 50 ml volumetric flasks and develop colour in identical manner. Prepare standard curve by plotting P concentrations on X-axis and percent transmission / colorimeter readings on Y-axis. Calculate P content of sample using the standard curve.

Potassium (kg ha^{-1})

The samples are digested with di-acid mixture and determined separately by using flame photometer (Jackson, 1973). The percentage of potassium content was multiplied with grain and straw to obtain uptake of potassium in grain and straw respectively was determined by flame photometer after making appropriate dilution (Jackson, 1973).

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in grain \% x Grain yield (kg/ha)}}{100}$$

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in straw \% x straw yield (kg/ha)}}{100}$$

Instruments

Flame photometer, Volumetric flask (25ml), pipette. Determination of potassium content

50 mg dried and well crushed plant material was taken in a 50 ml conical flask and 10 ml HNO_3 and $HClO_4$ (9:1) ratio was added to it. The flasks were heated gently over a hot plate for 10 minutes and thereafter, the heating temperature was raised up to 120^0 C when the frothing in the mixture was seized. Digestion was continued until the solution became colorless. The digest was cooled and diluted upto 100 ml with distilled water. The K content was measured with the help of a flame photometer and values were expressed as mg g^{-1} dry weight of plant. Standard curves for sodium, potassium and calcium were prepared using the graded concentrations of KCl and $CaCl_2$ respectively.

Zinc and Iron content and uptake in grain and stalk

A known weight of plant material was digested with di-acid mixture having nitric acid and per-chloric in 2:1 ratio. The intensity of colour was recorded on atomic absorption spectrophotometer by using zinc and iron hallows cathode lamp (Lindsey and Narvell, 1978).

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in grain \% x straw yield (kg/ha)}}{1000}$$

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content in straw \% x straw yield (kg/ha)}}{1000}$$

Experimental finding

Nutrients uptake by crop

Nitrogen uptake (kg ha^{-1})

The data of nitrogen uptake by maize (kg ha^{-1}) as influenced by integrated nutrient management practices have been presented in Table- 1 and graphically depicted in Fig.1. Perusal of the data pertaining to effect of integrated nutrient management on nitrogen uptake by maize indicated significant difference. The maximum nitrogen uptake by maize (160.71 and 120.58 kg ha^{-1}) was recorded with T_{12} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) which was significantly superior over all the treatments except T_{10} and T_{11} having values 154.41kg/h, 116.30kg/h and 153.31kg/h, 113.40kg/h, respectively during both the years (2014, 2015). Application of $ZnSO_4$ @ 25 kg ha^{-1}or $FeSO_4$ @ 10 kg ha^{-1}or both with 100 % RDF, the nitrogen uptake of maize was increased by 10.20%, 9.7%, 17.26% and 55.30%, 53.93%, 71.56% respectively over 100 % RDF alone and 64.0%, 64.14%, 75.41% and 8.02%, 7.02%, 19.30% respectively over control during both the years(2014,2015). Similarly, application of FYM @ 6 t ha^{-1}or $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or all three jointly applied with 75 % RDF, the nitrogen uptake of maize was increased 11.62%, 21.81%, 2094%, 26.78% and 11.35%, 22.49%, 19.94%, 23.00 % respectively over 100% RDF alone and 67.06%, 82.2%, 80.98%, 89.68% and 60.13%, 76.15%, 71.76%, 82.61% respectively over control during both the years (2014 and 2015). Also application of phosphorus solubilizing bacteria and Azotobactor with 75% RDF increased the Nitrogen uptake during both the years (2014, 2015) increased by 48.38%, 2.31% and 10.67% and 6.96% over 75% RDF alone.

Phosphorus uptake (kg ha^{-1})

The data on phosphorus uptake by maize (kg ha^{-1}) as influenced by integrated nutrient management practices have been presented in Table 1 and graphically depicted in Fig.-1. Persual of the mean data pertaining to effect of integrated nutrient management on phosphorus uptake by maize indicated significant difference. The maximum phosphorus uptake by maize (20.98 and 21.82 kg ha^{-1}) was recorded with T_{12-} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) which was significantly superior over all the treatments except T_{11} and T_{10} having values (27.74, 20.52 kg ha^{-1}) and (27.94, 21.04 kg ha^{-1}) respectively during both the year 2014 and 2015. Application of $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or both with 100 % RDF, the phosphorus uptake of maize was increased by 10.20%, 9.72%, 17.26% and 7.79%, 7.04%, 19.32%, respectively over 100% RDF alone during both the years (2014 and 2015) and 64.90%, 64.18%, 70.71% and 55.23%, 53.89%, 71.54% respectively over control. Similarly, application of FYM @ 6 t ha^{-1}or $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or all three jointly applied with 75 % RDF, the phosphorus uptake of maize was increased by 11.35%, 21.79%, 20.92%, 26.32% and 12.45%, 22.46%, 19.44%, 27.08% respectively over 100% RDF alone and 66.99%, 82.25%, 80.95% and 61.67%, 76.06%, 71.71%, 27.00 respectively over control during both the years (2014 and 2015). Also the application of Phosphorous Solubilizing Bacteria and Azotobacter with 75% RDF the phosphorus uptake was increased by 4.95%, 0.44% and 10.62%, 6.94% over 75% RDF alone during both the years (2014, 2015).

Potassium uptake (kg ha^{-1})

The data on potassium uptake by maize (kg ha^{-1}) as influenced by integrated nutrient management practices have been presented in Table- 1 and graphically depicted in Fig.-1. Perusal of the data pertaining to effect of integrated nutrient management on potassium uptake by maize indicated significant difference. The maximum potassium uptake by of maize (130.61 and 98.00 kg ha^{-1}) was recorded with T_{12-} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) which was significantly superior over all the treatments except T_{11} and T_{12} having values (125.49, 94.52 kg ha^{-1}) and (124.60, 92.16 kg ha^{-1}) respectively during both the years (2014 and 2015). Application of $ZnSO_4$ @ 25 kg ha^{-1}or $FeSO_4$ @ 10 kg ha^{-1}or both with 100 % RDF, the potassium uptake of maize was increased by 10.22%, 9.74%, 17.27%, and 7.99%, 7.03%, 19.31% respectively over 100 % RDF alone and 69.81%, 6908%, 80.69% and 55.29%, 53.91%, 71.56% respectively over control during both the years (2014, 2015). Similarly, application of FYM @ 6 t ha^{-1}or $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or all three jointly applied with 75 % RDF, the potassium uptake of maize was increased by 11.63%, 21.82%, 20.95%, 26.79% and 11.35%, 22.43%, 19.44%, 27.00%, respectively over 100 % RDF alone and 72.00%, 87.69%, 83.32%, 95.34% and 60.11%, 76.14%, 71.74%, 29.60% respectively over control during both the years (2014 and 2015). Also the application of Phosphorous Solubilizing Bacteria and Azotobacter with 75% RDF alone increases the potassium uptake by (4.97%, 2.31% and 10.67%, 6.95%) respectively over 75% RDF alone during both the years (2014 and 2015).

Zinc uptake (g ha^{-1})

The data on Zinc uptake by maize as influenced by integrated nutrient management practices have been presented in Table- 1 and graphically depicted in Fig.-1 Perusal of the data pertaining to effect of integrated nutrient management on zinc uptake by maize indicated significant difference. The maximum Zinc uptake by maize (233.91, 176.09 g ha^{1}) was recorded with T_{12-} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) during both the year (2014 and 2015) which was significantly superior over all the treatments except T_{10} and T_{11} having values 225.49, 169.83 kg ha^{-1} and 223.88, 165.60 kg ha^{-1} respectively during both the year.

Table.1 Effect of INM on nutrient uptake by maize

Treatments	N(kg/h)		P(kg/h)		K(kg/h)		Zn(ppm)		Fe(kg/h)	
	2014	**2015**	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	2015
T_1 Control	84.74	66.02	15.33	11.95	68.86	53.66	123.74	96.42	8.47	6.60
T_2 100% NPK alone	126.76	94.94	22.94	17.18	103.01	77.16	185.10	138.64	12.68	9.49
T_3 75 % NPK alone	111.45	76.42	20.17	13.83	90.57	62.11	162.75	111.60	11.14	7.64
T_4 75 % NPK +Azotobactor	116.99	84.58	21.17	15.30	95.08	68.74	170.84	123.51	11.70	8.46
T_5 75 % NPK +PSB	114.03	81.74	20.63	14.79	92.67	66.43	164.85	119.37	11.40	8.17
T_6 100 % NPK +$ZnSO_4$ @ 25 Kgha^{-1} as soil application	139.70	102.53	25.28	18.55	113.54	83.33	204.01	149.73	13.97	10.25
T_7 100 % NPK +$FeSO_4$ @ 10 Kgha^{-1} as soil application	139.10	101.62	25.17	18.39	113.05	82.59	203.14	148.40	13.91	10.16
T_8 100 % NPK +$ZnSO_4$ @ 25 Kgha^{-1} as soil application+ $FeSO_4$ @ 10 Kgha^{-1} as soil application	148.65	113.27	26.90	20.50	120.81	92.06	217.07	165.42	14.86	11.37
T_9 75 % NPK +FYM @ 6 t ha^{-1}	141.50	105.72	25.60	19.32	115.00	85.92	206.63	155.94	14.15	10.68
T_{10} 75 % NPK +FYM @ 6 t ha^{-1}+$ZnSO_4$ @ 25 Kgha^{-1} as soil application	154.41	116.30	27.94	21.04	125.49	94.52	225.49	169.83	15.44	11.63
T_{11} 75 % NPK +FYM @ 6 t ha^{-1} +$FeSO_4$ @ 10 Kgha^{-1} as soil application	153.31	113.40	27.74	20.52	124.60	92.16	223.88	165.60	15.33	11.34
T_{12}75 % NPK+ FYM @ 6 t ha^{-1} +$ZnSO_4$ @ 25 Kgha^{-1} as soil application+$FeSO_4$ @ 10 Kgha^{-1} as soil application	160.71	120.58	28.98	21.82	130.61	98.00	233.91	176.09	16.02	12.06
SEm±	5.73	4.46	1.09	0.80	4.93	3.78	9.17	6.80	0.62	0.46
CD (P= 0.05)	16.81	13.69	3.21	2.37	14.48	11.08	26.89	19.94	1.84	1.37

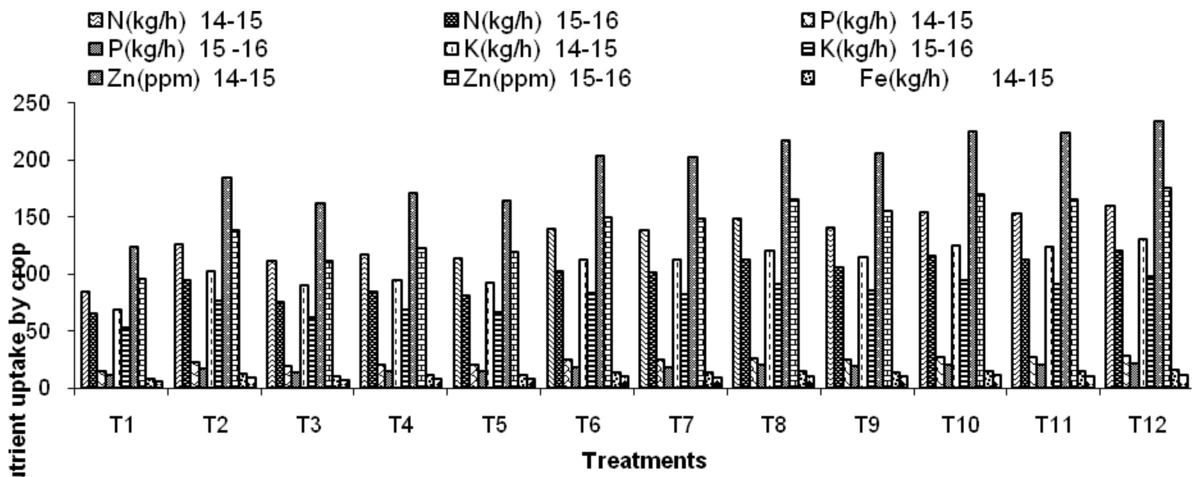

Fig. 1: Effect of INM on nutrient uptake by maize

Application of $ZnSO_4$ @ 25 kg ha^{-1}or $FeSO_4$ @ 10 kg ha^{-1}or both with 100 % RDF, the Zinc uptake of maize was increased by 10.21%, 9.74%, 17.27% and 7.99%, 7.03%, 19.31% respectively over 100 % RDF alone and 64.86%, 64.16%, 75.42% and 55.28%, 53.90%, 71.56%, respectively over control during both the years (2014 and 2015). Similarly, application of FYM @ 6 t ha^{-1} or $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or all three jointly applied with 75 % RDF, the Zinc uptake of maize was increased by 11.63%, 21.82%, 20.95%, 26.36% and 12.47%, 22.49%, 19.44%, 27.01% respectively over 100 % RDF alone and 60.98%, 82.22%, 80.92%, 89.03%,as well as 61.72%, 76.13%, 71.74%, 92.62% respectively over control during both the years (2014 and 2015).

Iron uptake (kg ha^{-1})

The data on iron uptake by maize as influenced by integrated nutrient management practices have been presented in Table-1 and graphically depicted in Fig.-1. Perusal of the data pertaining to effect of integrated nutrient management on iron uptake by maize indicated significant difference. The maximum iron uptake by maize (16.02 and 12.06 kg ha^{-1}) was recorded with T_{12} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) which was significantly superior over all the treatments except T_{10} and T_{11} having values (15.44, 11.63 ppm) and (15.33, 11.34 ppm) respectively during both the years (2014, 2015) in the research work of maize. Application of $ZnSO_4$ @ 25 kg ha^{-1}or $FeSO_4$ @ 10 kg ha^{-1}or both with 100 % RDF, the Iron uptake of maize was increased by 10.17%, 9.70%, 17.19%, and 8.00%, 17.06%, 50.06% respectively over 100 % RDF alone and 64.93%, 64.27%, 75.44% and 55.30%, 53.93%, 77.27% respectively over control during both the years (2014, 2015).

Similarly, application of FYM @ 6 t ha^{-1}or $ZnSO_4$ @ 25 kg ha^{-1} or $FeSO_4$ @ 10 kg ha^{-1} or all three jointly applied with 75 % RDF, the Iron uptake of maize was increased by 11.59%, 21.76%, 20.89%, 26.34% and 12.53%, 22.55%, 19.49%, 27.08% respectively over 100 % RDF alone and 67.06%, 82.29%, 80.99%, 89.13%, and 61.81%, 76.96%, 71.81%, 82.72% respectively over control during both the years 2014 and 2015.

Also application of PSB and Azotobactor with 75%% RDF alone increase the Iron uptake by (5.02%, 2.33%), (10.76%, 6.93%) respectively over 75% RDF alone during both the year (2014 and 2015).

Nutrient uptake by maize

The statistical data in Table-1 reveals that there significant variation found in different treatments due to effect of various sources of nutrients over control. Highest uptake of N, P, K, Zn and Fe was observed with the application of T_{12} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application + $FeSO_4$ @ 10 kg ha^{-1} as soil application) could be due incorporation of FYM along with macro and micro inorganic nutrients and hence increased availability of N and P which added in the soil through organic and inorganic resources by *Azotobacter* and phosphate solubilizing bacteria. Satish *et al.*, (2011) has also been reported that the combination of organic and inorganic fertilizer showed higher uptake values of all the three nutrients, which is in close conformity with the results obtained in present investigation. Apart from the improvement in uptake of nutrients the manures applied in these treatments have also a positive effect with respect to soil physical properties viz., water holding capacity and structural stability of a soil and improve the soil microbial population which are responsible for N- fixation and phosphorus solubilization. Similar results were also reported by Ranganathan and Selvaseelan (1997), Muzira *et al.*, (2005) and Mohapatra *et al.*, (2008) in maize crop.

Addition of organic sources like FYM, increases the NPK uptake by maize crop.There was immense effect of integrated nutrient management practices on maize crop productivity and quality. These farm practices are proved to be economical in long term use. Similarly maximum net return of maize production (Rs. 36050, 33573) and maximum B: C (1.19,1.22) ratio were also found with T_{12} (75% NPK+FYM @ 6t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} as soil application $FeSO_4$ @ 10 kg ha^{-1} as soil application) during both the years (2014 and2015).

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How to cite this article:

Rajesh Ranjan Kumar, Neeraj Kumar, Jang Bahadur Rana, Chandra Pal and Navaneet Kumar. 2018. Impact of Integrated Nutrient Management on Nutrient Uptake by Maize Crop from Soil under Rainfed Condition in Eastern Part of Uttar Pradesh, India. *Int.J.Curr.Microbiol.App.Sci.* 7(9): 3778-3787. doi: https://doi.org/10.20546/ijcmas.2018.709.467