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Gyanendra Kumar
Department of Agronomy, SVBPUA&T, Modipuram, Meerut, Uttar Pradesh, India

Himanshu
Department of Agronomy, Bundelkhand University, Jhansi, Uttar Pradesh, India

Pankaj Kumar
Department of Agronomy, CSAUA&T, Kanpur, Uttar Pradesh, India

Anil Kumar Nishad
Department of Agricultural Meteorology, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

Vishuddha Nand
Department of Agricultural Meteorology, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

NS Rana
Department of Agronomy, SVBPUA&T, Modipuram, Meerut, Uttar Pradesh, India

Sanjay
Department of Agricultural Meteorology, ANDUA&T, Kumarganj, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Gyanendra Kumar
Department of Agronomy, SVBPUA&T, Modipuram, Meerut, Uttar Pradesh, India

To assess the nutrient uptake by maize crop and residual soil fertility

Gyanendra Kumar, Himanshu, Pankaj Kumar, Anil Kumar Nishad, Vishuddha Nand, NS Rana and Sanjay

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Abstract
Application of Zn, B, S, Zn + B + S along with 100% NPK led to an increase in nutrient content in plant tissues and therefore higher uptake of N, P, K, S, Zn and B. Contents of N, P, K, Zn and B in grains ranged from 1.23 to 1.74, 0.19 to 0.37, 0.25 to 0.44, 0.18 to 0.36 %, 0.31 to 0.62 and 0.34 to 0.65 ppm, respectively, lowest being with no fertilizer and highest with 75% NPK + FYM @ 7.5 t + Zn + B + S. Respective ranges of uptake were 41.0-128.6 kg ha^{-1} (N), 8.5-32.0 kg ha^{-1} (P), 53.1-133.4 kg ha^{-1} (K), 12.2-45.1 kg ha^{-1} (S), 19.2-90.4 g ha^{-1} (Zn) and 22.3-90.4 g ha^{-1} (B). In general, grains accumulated more N and P than stover. A reverse pattern was observed in respect of K, S, Zn and B having been higher in stover. Wu *et al.* (2005) [5] were also of the similar opinion. Crop cultivation without fertilizer application resulted in negative nutrient balance in soil whereas application of nutrients had a favorable effect on nutrient replenishment. Crop grown with 75% NPK + FYM @ 7.5 t + Zn + B + S fetched highest gross (₹85225 ha^{-1}) and net returns (₹55730 ha^{-1}) with highest B:C ratio (2.89) followed by 100% NPK + Zn, 100% NPK + *Azotobacter* + PSB, 100% NPK + *Azotobacter* and 75% NPK + FYM @ 7.5 t. Jeet *et al.* (2012) [6] also obtained higher returns from maize with integrated and balanced nutrient management.

Keywords: *Azotobacter*, NPK led and fertilizer

Introduction
Maize (*Zea mays* L.) is one of the most important cereal crops next to rice and wheat in world agricultural economy both as food for men and feed for animals. It is the most versatile crop having wider adaptability and known as queen of cereals for its highest genetic yield potential. Maize grains contain approximately 72% starch, 10% protein, and 4% fat and a calorific value 365 Kcal/100 g. Low production costs and high consumption of maize flour and cornmeal, especially where micronutrient deficiencies are common, public health problems, make this food staple and ideal food vehicle for fortification (Ranum *et al.*, 2014) [4]. Sulphur, as constituent of amino acid like methionine, cysteine, cysteine and vitamin, help in chlorophyll formation, involved in forming and stabilizing the tertiary structure of enzyme and other proteins. Zinc has important functions in plants as component of RNA polymerase enzymes, imparts synthesis IAA, photosynthesis and auxin activity (Mullar *et al.*, 2000) [2]. Boron plays an important role in cell-wall synthesis, sugar transport, cell division, differentiation, membrane functioning, root elongation, regulation of plant hormone level, and generative growth of plants (Martens, 1995) [1].
Stagnation in yields decline in using level of inputs has become a claim since mid 1980's (Duxbury *et al.*, 2000) [3]. Response of maize to applied organic manures is notable and hence integrated nutrient management (INM) is very important nutrient management strategy in maize based production systems. (Farmer Portal, 2011-12) [7].

Material and Methods
The present study was conducted at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (Uttar Pradesh), India during *kharif* season of 2015 on the topic of "To assess the nutrient uptake by maize crop and residual soil fertility." The experiment was conducted in Randomized Dlock Design (RBD) and replicated the three times.The different growth parameters studies were maize as effect of nutrient management practices, nutrient management practices on cobs per plant, nutrient management

Practices on various rows, nutrient management practices on yield attributes and nutrient management practices on N, P content.

Result

The highest soil organic carbon (0.49 %) was recorded in plot having application of 75% NPK along with FYM 7.5 t + Zn + B + S (Table 4.19). Though it was statistically at par with those receiving 75% NPK + FYM @ 7.5 t, 100% NPK + Zn + B + S, 100% NPK + *Azotobacter* + PSB and 75% NPK + FYM @ 7.5 t + *Azotobacter* + PSB and significantly higher than over rest of the plots. Application of Zn, B, S and FYM alone or together increased the organic carbon content over 100% NPK. The plots receiving no nutrients exhibited lowest organic carbon content as analysed after the crop harvest.

Table 1: Effect of nutrient management practices on days taken 50% tasseling and silking stages of crop growth

Treatments	Days taken to 50% tasseling	Days taken to 50% silking
Control	45.5	47.1
100% NPK	52.3	54.4
75% NPK + FYM @ 7.5 t	56.1	57.4
100% NPK + Zn	59.0	64.3
100% NPK + B	57.9	62.4
100% NPK + S	58.2	62.5
100% NPK + Zn + B + S	59.1	64.5
75% NPK + FYM @ 7.5 t + Zn + B + S	60.2	64.8
100% NPK + *Azotobacter*	56.9	62.3
100% NPK + PSB	56.9	62.3
100% NPK + *Azotobacter* + PSB	58.2	63.2
75% NPK + FYM @ 7.5 t + *Azotobacter* + PSB	58.7	63.5
SEm±	1.8	2.1
CD (P= 0.05)	5.5	6.2

Table 2: Effect of nutrient management practices on cobs plant^{-1}, cob length, grain rows cob^{-1}, grains cob^{-1}

Treatments	Cobs plant^{-1}	Cob length (cm)	No. of grain rows cob^{-1}	No. of grains cob^{-1}
Control	1.0	16.2	12.7	363.3
100% NPK	1.3	16.8	13.7	429.0
75% NPK + FYM @ 7.5 t	1.3	17.2	13.7	476.0
100% NPK + Zn	1.7	17.9	15.0	497.4
100% NPK + B	1.7	17.4	14.0	488.7
100% NPK + S	1.7	17.5	14.3	488.5
100% NPK + Zn + B + S	1.7	18.1	15.0	498.4
75% NPK + FYM @ 7.5 t + Zn + B + S	2.0	19.0	16.0	503.3
100% NPK + *Azotobacter*	1.3	17.3	14.0	481.5
100% NPK + PSB	1.7	17.3	13.7	481.3
100% NPK + *Azotobacter* + PSB	1.7	17.6	14.3	490.3
75% NPK + FYM @ 7.5 t + *Azotobacter* + PSB	1.7	17.7	14.3	490.7
SEm±	0.31	0.7	0.5	16.5
CD (P= 0.05)	NS	1.1	1.3	48.6

Table 3: Effect of nutrient management practices on grains row^{-1}, cob weight, grain weight cob^{-1}, test weight and shelling percentage

Treatments	No. of grains row^{-1}	Cob weight (g)	Grain weight cob^{-1} (g)	Test weight (g)	Shelling (%)
Control	32.7	200.0	110.0	217.3	55.0
100% NPK	34.0	205.0	125.0	228.7	60.9
75% NPK + FYM @ 7.5 t	34.7	212.0	145.0	228.9	68.3
100% NPK + Zn	40.3	232.0	155.0	235.6	66.8
100% NPK + B	38.3	215.0	150.0	230.0	69.7
100% NPK + S	39.0	216.0	150.0	230.0	69.4
100% NPK + Zn + B + S	41.0	234.0	158.0	236.5	67.5
75% NPK + FYM @ 7.5 t + Zn + B + S	42.2	236.0	160.0	238.0	70.0
100% NPK + *Azotobacter*	38.7	214.0	149.0	229.6	69.6
100% NPK + PSB	36.5	212.0	148.0	229.4	69.8
100% NPK + *Azotobacter* + PSB	40.0	217.0	152.0	231.1	67.7
75% NPK + FYM @ 7.5 t + *Azotobacter* +PSB	40.0	228.0	154.0	233.2	67.5
SEm±	1.0	2.9	2.3	2.9	2.7
CD (P= 0.05)	2.8	8.8	6.9	8.6	7.9

Table 4: Effect of nutrient management practices on grain, stover and biological yield (q ha^{-1}) and harvest index (%)

Treatments	Protein content (%)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)
Control	7.04	22.3	34.2	56.5	39.4
100% NPK	7.62	42.1	65.5	107.6	39.1
75% NPK + FYM @ 7.5 t	8.02	42.3	66.7	109.0	38.8
100% NPK + Zn	9.85	47.4	69.3	116.7	40.2
100% NPK + B	9.56	45.2	67.2	112.4	40.2
100% NPK + S	9.62	45.2	66.5	111.7	40.4
100% NPK + Zn + B + S	9.91	47.8	70.5	118.3	40.4
75% NPK + FYM @ 7.5 t + Zn + B + S	9.97	48.8	72.5	121.3	40.6
100% NPK + *Azotobacter*	9.51	45.1	67.7	112.8	39.9
100% NPK + PSB	9.45	44.7	67.3	112.0	38.7
100% NPK + *Azotobacter* + PSB	9.68	45.6	68.1	113.7	40.1
75% NPK + FYM @ 7.5 t + *Azotobacter* + PSB	9.79	45.7	68.3	113.9	40.0
SEm±	0.20	1.45	1.48	4.0	0.56
CD (P= 0.05)	0.60	4.27	4.36	12.0	NS
Treatments	Protein content (%)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)

Table 5: Effect of nutrient management practices on N, P content (%) in grain and stover at harvest stage

Treatments	N content (%)		P content (%)	
	Grain	Stover	Grain	Stover
Control	1.23	0.39	0.19	0.12
100% NPK	1.33	0.47	0.31	0.14
75% NPK + FYM @ 7.5 t	1.40	0.51	0.32	0.15
100% NPK + Zn	1.72	0.55	0.34	0.16
100% NPK + B	1.67	0.52	0.33	0.17
100% NPK + S	1.68	0.47	0.33	0.17
100% NPK + Zn + B + S	1.73	0.49	0.33	0.18
75% NPK + FYM @ 7.5 t + Zn + B + S	1.74	0.60	0.37	0.19
100% NPK + *Azotobacter*	1.66	0.51	0.31	0.13
100% NPK + PSB	1.65	0.47	0.30	0.13
100% NPK + *Azotobacter* + PSB	1.69	0.49	0.31	0.14
75% NPK + FYM @ 7.5 t + *Azotobacter* + PSB	1.71	0.53	0.30	0.16
SEm±	0.06	0.01	0.01	0.01
CD (P= 0.05)	0.16	0.03	0.03	0.03

Conclusion

In general, nutrient application prolonged vegetative phase and crop took more time to attain 50% and 50% silking. Crop fertilized with 75% NPK + FYM @ 7.5 t + Zn + B + S took 60.2 days for 50% tasseling and 64.8days for 50% silking as against 45.5and 47.5 days respectively without nutrient application. Application of Zn, B, S, Zn + B + S, *Azotobacter*, PSB and *Azotobacter* + PSB delayed 50% tasseling by 6.7, 5.6, 5.9, 6.8, 4.6, 4.6 and 5.9 days respectively and 50% silking by 9.9, 8.0, 8.1, 10.1, 7.9, 7.9 and 8.8 days respectively in comparison to the crop given 100% NPK. Yield attributes i.e cob length, number of grain rows per cob, number of grains per row, number of grains per cob, grain yield per plant and test weight recorded at harvest exhibited significant variation under different of treatments. Crop raised with 75% NPK + FYM @ 7.5 t + Zn + B + S had highest number of cobs per plant (2.0), cob length (19.0), number of grain rows per cob (16.0), number of grains per cob (503.3), number of grains per row (42.2) and test weight (238.0). The respective lowest of 1.0, 16.2, 12.7, 363.3, 32.7 and 217.3 was recorded in crop receiving no fertilizer. Application of Zn, B, S, Zn + B + S, *Azotobacter*, PSB and *Azotobacter* + PSB increased grain weight per cob by 24, 20, 20, 26.4, 19.2, 18.4 and 21.6 % over 100% NPK respectively. Accordingly shelling percentage was also highest with 75% NPK + FYM @ 7.5 t + Zn + B + S (70.0) and lowest (55.0) in crop receiving no fertilizer/manure. Nutrient content in grain and stover of maize differed significantly under different treatments. The content of N, P, K, S, Zn and B varied from 1.23 to 1.74%, 0.19 to 0.37%, 0.25 to 0.44%, 0.18 to 0.36 %, 0.31 to 0.62 ppm and 0.34 to 0.65 ppm in grain respectively. The highest being in crop receiving 75% NPK + FYM @ 7.5 t + Zn + B + S and lowest with no nutrient application. Respective content in stover ranged from 0.39 to 0.60%, 0.12 to 0.19%, 1.39 to 61%, 0.24 to 0.38 %, 0.36 to 0.83 ppm and 0.43 to 0.81 ppm being the highest same treatments.

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