FYM + 3 t/ha VC or 6 t/ha VC were found equally effective treatments with regard to available nutrients (N, P and K) status in soil after harvest.

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Research Paper

Effect of site-specific nutrient management on productivity, soil fertility and nutrient uptake in maize (*Zea mays*)

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ABSTRACT

A field experiment was conducted during the spring season of 2015 and 2016 at Crop Research Centre, Meerut, Uttar Pradesh, to study the effect of site-specific nutrient management (SSNM) on productivity, soil fertility and nutrient uptake of spring maize (*Zea mays* L.). Typic Ustochrept series soil of the experimental field was well-drained, sandy loam, slightly alkaline, low in soil organic carbon and available N, medium in available P, K and S with optimal DTPA-Zn and B content. Eleven treatments comprising 100% recommended dose of fertilizer (RDF) NP, 100% NPK (RDF), 100% NP (RDF) + 125% K, 100% NP (RDF) + 150% K, 125% NPK (RDF), 150% NPK (RDF), 100% NP (RDF) + 3 t/ha crop residue, 100% NP (RDF) + 5 t/ha FYM, 100% NP (RDF) + 3 t/ha sulphonated pressmud (SPM), site-specific nutrient management (SSNM) (+K) and SSNM (-K), were replicated thrice in randomized block design. The 2 years pooled experimental results revealed that, the maximum Kernel yield was observed with SSNM option which was significantly higher over the others. Maximum N, P, K, S, Zn and B uptake (179.10 kg/ha, 44.68 kg/ha, 171.32 kg/ha, 40.13 kg/ha, 379 g/ha and 253 g/ha), respectively, was recorded with SSNM followed by 150% NPK application. Fertilizer use as per SSNM also resulted in higher yield and uptake than 100% RDF. Improved soil-fertility parameters, viz. soil available K, S, DTPA-Zn and B, were also noticed with SSSM which remained significantly higher than the others. Improved K rates (25 and 50%) in RDF or additive use of organics (FYM/SPM/crop residue) also had positive influence on the yield, nutrient uptake and soil parameters.

Key words **:** Maize**,** Nutrient uptake, Potassium management, Soil fertility, Site-specific nutrient management

Maize is one of the most important cereal crops of Indo-Gangetic Plains (IGP). Its wider adaptability under varied agro-climatic conditions makes it unique among all other crops. Being an exhaustive crop, maize requires large amount of nutrients, particularly N and K, for giving higher yield. Imbalanced and inadequate nutrient application in maize is one of the most responsible factors for lower yield and poor quality of maize in this region. Blanket state recommendations (BSR) are also unable to suffice the nutrient needs of high-yielding cultivars of maize. Recent studies conducted in IGP by Dwivedi *et al*. (2017) reveals that farmers of this region use an excessive amount of N, optimal to sub-optimal doses of P and almost neglect K, secondary and micronutrients in their fertilization schedule for different crops including maize. Continuous omission of K from fertilization schedule has started showing K deficiency in several crops caused by K mining from soil (Singh *et al*., 2018). Under K-deficient conditions, photosynthesis in crops is depressed as a consequence of sucrose accumulation in the leaves and its negative effect on gene expression (Romheld and Kirkby, 2010). The production of less photosynthetic assimilates and reduced assimilate transport out of the leaves cause negative effect on yield production and quality of maize. Further, productivity of maize is low due to poor inherent soil fertility, imbalanced fertilizer use, non-recycling of organics and neglect of secondary and micronutrients. The supplementation of these essential nutrient can be augmented either through use of chemical fertilizer or organic recycling. Under these circumstances, an integrated use of organics and chemical fertilizer-management strategies might augment the sustainable high productivity along with improved nutrient-use efficiency in maize.

In recent years, site-specific nutrient management (SSNM) approach which is based on soil-nutrient supply and nutrient-uptake demand for targeted yield have shown

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potential to improve farm profit through optimal nutrient supply in several crops (Singh *et al*., 2015a, b). The SSNM approach not only aims to reducing fertilizer use but also an effective tool for supplying crop nutrients in achieving higher yield. In addition, it also aims at increasing nutrient-use efficiency, leading to more net returns/unit of fertilizer invested. Compared to still prevalent BSR in several developing countries, SSNM ensures improved yield and soil health on a long-term basis (Timsina *et al.,* 2013). Considering the above facts, current study was planned to see the effect of different nutrient-management options on productivity, soil fertility and nutrient uptake of spring maize in north-western IGP.

MATERIALS AND METHODS

The field experiment was carried out during the spring of 2015 and 2016 at the crop Research Centre of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (Uttar Pradesh), India, to study the effect of potassium management on soil fertility and nutrient uptake of spring maize on light-textured soils. Eleven treatments comprising T_1,100% NP; T_2, 100% NPK; T_3, 100% NP + 125% K; T_4, 100% NP + 150% K; T_5, 125% NPK; T_6, 150% NPK; T_7, 100% NP + crop residue; T_8, 100% NP + FYM; T_9, 100% NP + SPM; T_{10}, SSNM (+K) and T_{11}, SSNM (– K), were replicated thrice in randomized block design. The recommended dose of nutrient (120, 60 and 90 kg N, P and K/ha), sulphonated pressmud (SPM), farmyard manure (FYM) and crop residue were used as per treatment. The recommendations developed by Singh *et al*. (2015a) were used to compare it with other nutrient-management options. Plot size was kept 5 m × 6 m. At maturity, net plot was harvested for 4 m × 5 m area, sundried and total biomass weight was obtained. Maize kernel was separated from cob using maize sheller and kernel yield was obtained. Kernel and stover yields are presented on hectare basis.

At the onset of experiment and at harvest time, soil samples (0–15 cm depth) were collected from 4 places of experimental plots using tube auger, mixed thoroughly and the sub-sample were pulverized using a wooden pestle and mortar, passed through a 2-mm sieve. Soils were analyzed for available N by the alkaline $KMnO_4$ method, P (0.5 M $NaHCO_3$, *p*H 8.5), exchangeable K (1 M NH_4OAc, *p*H 7.0), available S by Turbidimetric procedure (Chesnin and Yien, 1950), DTPA-Zn (Lindsay and Norvell, 1978) and hot-water soluble B (Gupta, 1967). The soil of the experimental field was sandy loam, with a bulk density of 1.43 g/cm^3 slightly alkaline in reaction (*p*H 8.06 and electrical conductivity 0.30 dS/m), low in organic carbon (4.48 g/kg) and available N (198.87 kg/ha), medium in P (13.58 kg/ha), ammonium acetate-extractable K (201.60 kg/ha), S (13.10 mg/kg), and optimal DTPA-extractable Zn (0.59 mg/kg) and hot-water soluble B (0.67 mg/kg). Representative kernel and stover sub-samples of maize were dried at 70°C, ground and then wet-digested with concentrated H_2SO_4 for determination of total N, while for total P and K samples were digested with concentrated HNO_3 and $HClO_4$ (mixed in 4:1 ratio). The N content was determined by the Kjeldahl method using N auto analyzer, total P was determined by the yellow colour method and total K content was determined by flame photometry. Total uptake of nutrients by all crops was obtained by adding the uptake of kernel and stover. The results of the present study are based on pooled statistical analysis of data over 2 years. The treatment means were compared using least significant differences at 5% level of significance.

RESULTS AND DISCUSSION

Yield attributes

The nutrient-management system directly influenced the yield attributes and these further affected the yield of crop. Data pertaining to various yield attributes, viz. cobs/plant, cob length (cm), kernels/cob, cob weight (g), kernel weight/cob (g), test weight (g) and shelling (%), as affected by various nutrient-management practices are presented in Table 1. All the yield attributes were the highest under treatment T_{10} (SSNM + K) followed by T_6 (150% NPK). Yield attributes were the lowest where only nitrogen and phosphorus were supplied. Deletion of potassium from SSNM package also caused a significant reduction in all yield attributes. Dissoky *et al*. (2013) reported significantly higher yield attributes with increasing potassium levels and thereby increased yield of maize crop. Similar findings were reported by Kumar *et al*. (2014).

Kernel and stover yield

Kernel and stover yields of maize ranged from 3.62 to 7.21 and 5.09 to 7.92 t/ha, respectively under different treatments (Table 1). The maximum kernel and stover yields were 7.21 and 7.92 t/ha, respectively, with T_{10} (SSNM + K) which remained statistically at par with treatment T_6 (150% NPK) and significantly higher than rest of the treatments. Application of SSNM also out yielded the recommended dose of fertilizer (RDF, T_2) which indicates that current fertilizer recommendations in maize under IGP are not sufficient to meet the crop requirement or sustainable high yield. Deletion of potassium or addition of super-optimal level of potassium over 100% NPK also resulted a significant variation in the kernel yield. The kernel yield in treatment T_{10} increased by 20.90% over T_{11} indicating the significance of optimum nutrient supply for the entire deficient nutrient which might have resulted in improved sink capacity (Singh *et al*., 2014). Yield gain in maize was of

12.1 and 30.0% owing to additional application of 25 and 50% K over 100% NPK (T_2). Tabatabaii *et al*. (2009) reported that, kernel yield of maize increases with application of higher potassium doses mainly because of more K availability for photosynthetic activities, higher dry-matter accumulation and ultimately sink-capacity improvement. Application of organic sources (FYM/ crop residue/ SPM) improved the kernel yield significantly over that of T_2 treatment. Among different organic sources, treatment T_8 (100% NP + FYM) showed the maximum yield gain as compared to the others. The stover yield increased by 17.85% under T_{10} (SSNM + K) over T_{11} (SSNM – K) and this showed the importance of potassium in maize cultivation. Our results cinform the findings of Singh *et al.*(2019). Hargilas *et al*. (2017) also concluded that SSNM enhances yield and profitability of maize under sub-humid conditions.

Nutrient content

Kernel nutrients, viz. N, P, K, S, Zn and B, ranged between 1.48 and 1.88%, 0.29 to 0.40%, 0.26 to 0.41%, 0.20 to 0.36%, 20.3 to 31.3 mg/kg and 13.3 to 20.0mg/kg, respectively (Table 2). Similarly, the nutrient content in stover ranged from 0.41 to 0.65%, 0.14 to 0.20%, 1.31 to 1.79%, 0.26 to 0.34%, 14.3 to 20.3 mg/kg and 7.50 to 12.65 mg/kg, respectively, for N, P, K, S, Zn and B. The

Table 1. Effect of nutrient-management options on yield attributes and yield of maize (data pooled over 02 years)

Treatment	Cobs/ plant	Cob length (cm)	Kernel/ cob	Cob weight (g)	Kernel weight/cob (g)	Test weight (g)	Shelling (%)	Kernel yield (t/ha)	Stover yield (t/ha)
T_1	1.00	16.4	324.7	205.0	115.0	220.0	56.0	3.62	5.09
T_2	1.20	17.4	338.3	210.0	128.0	231.0	61.9	4.53	5.62
T_3	1.26	18.3	357.0	217.0	153.0	234.0	69.1	5.08	6.06
T_4	1.44	18.5	378.9	220.0	161.0	236.0	70.7	5.89	6.85
T_5	1.62	19.2	395.2	235.0	170.0	241.0	71.4	6.58	7.34
T_6	1.78	17.8	371.4	230.0	165.0	236.0	71.7	6.78	7.54
T_7	1.26	17.2	362.9	218.0	150.0	225.0	69.8	5.62	6.66
T_8	1.62	17.5	365.5	220.0	154.0	227.6	70.0	6.32	7.02
T_9	1.44	17.1	361.2	215.0	148.0	222.0	69.5	4.88	5.88
T_{10}	1.84	20.6	430.3	237.0	177.0	254.3	73.8	7.21	7.92
T_{11}	1.60	17.0	374.2	225.0	156.0	232.0	69.6	5.74	6.72
SEm±	0.05	0.6	13.2	5.9	5.7	6.5	2.5	0.21	0.24
CD (P=0.05)	0.16	1.6	37.9	18.5	16.0	19.9	7.2	0.61	0.70

T_1, 100% NP; T_2, 100% NPK; T_3, 100% NP + 125% K; T_4, 100% NP + 150% K; T_5, 125% NPK; T_6, 150% NPK; T_7, 100% NP + crop residue; T_8, 100% NP + FYM; T_9, 100% NP + SPM; T_{10}, SSNM (+K) and T_{11}, SSNM (– K)

Table 2. Nutrient content in kernel and stover of maize as influenced by nutrient-management options (data pooled over 2 years)

Treatment	N content (%)		P content (%)		K content (%)		S content (%)		Zn content (mg/kg)		B content (mg/kg)	
	Kernel	Stover	Kernel	Stover	Kernel	Stover	Kernel	Stover	Kernel	Stover	Kernel	Stover
T_1	1.48	0.41	0.29	0.14	0.26	1.31	0.20	0.26	20.3	14.3	13.3	7.50
T_2	1.56	0.43	0.30	0.16	0.31	1.40	0.24	0.26	21.2	15.2	14.2	8.40
T_3	1.60	0.44	0.32	0.17	0.34	1.49	0.25	0.27	23.3	16.3	14.5	8.90
T_4	1.65	0.49	0.33	0.18	0.35	1.53	0.26	0.27	24.7	15.6	15.4	9.80
T_5	1.70	0.60	0.34	0.19	0.37	1.60	0.27	0.24	25.5	16.5	15.6	10.50
T_6	1.68	0.56	0.35	0.16	0.33	1.69	0.27	0.25	25.2	16.8	16.9	11.80
T_7	1.49	0.42	0.31	0.16	0.30	1.52	0.26	0.24	23.5	16.6	13.8	8.20
T_8	1.50	0.44	0.32	0.17	0.29	1.43	0.26	0.23	23.4	15.6	14.4	9.35
T_9	1.52	0.52	0.33	0.18	0.32	1.45	0.35	0.31	27.9	16.6	14.9	9.58
T_{10}	1.88	0.65	0.40	0.20	0.41	1.79	0.36	0.33	31.3	20.3	20.0	12.65
T_{11}	1.62	0.46	0.34	0.15	0.31	1.54	0.33	0.34	30.5	20.1	15.6	12.20
SEm±	0.12	0.04	0.03	_	0.03	0.06	_	_	1.31	0.62	0.84	0.55
CD (P=0.05)	0.35	0.11	0.07	N S	0.07	0.18	N S	N S	2.66	1.79	1.70	1.11

T_1, 100% NP; T_2, 100% NPK; T_3, 100% NP + 125% K; T_4, 100% NP + 150% K; T_5, 125% NPK; T_6, 150% NPK; T_7, 100% NP + crop residue; T_8, 100% NP + FYM; T_9, 100% NP + SPM; T_{10}, SSNM (+K) and T_{11}, SSNM (– K)

NPK content of kernel and stover were significantly higher under treatment T_{10} as compared to the other treatments with exception of treatments T_5 and T_6. Kernel and stover S content remain unaffected due to application of different treatments. The maximum kernel and stover Zn and B content recorded in treatment T_{10} was significantly higher than the other treatments. Neither the deletion of potassium nor the addition of super-optimal level of potassium over recommended NPK resulted any significant effect on kernel and stover nitrogen content. Application of organic sources or nutrient recommendation as per SSNM approach could not bring any significant effect on kernel and stover N, P and S content. The K content in stover differed significantly due to the additional application of 25 and 50% NPK over 100% NPK as well as application of nutrient as per recommendation of SSNM compared with treatment T_2. Among different organic sources, except SPM other 2 sources (FYM and crop residue) did not show any significant effect in kernel zinc content in comparison to treatment T_2 (100% NPK). On the other hand, nutrient application based on SSNM (+K) improved the zinc content in both kernel and stover as compared to the other treatments. Kernel and stover zinc and boron content did not differ significantly due to deletion of K from RDF or 25% additional application. Similarly, kernel and stover B content did not differ due to integrated organic use (FYM/residue) over treatment T_2. These results are in close conformity with the finding of Kumar *et al*. (2017).

Nutrient uptake

The uptake of nitrogen, phosphorus, potassium, sulphur, zinc and boron in maize kernel ranged from 54.3 to 135.5 kg/ha, 10.9 to 28.8 kg/ha, 9.41 to 28.1 kg/ha, 7.24 to 24.3 kg/ha, 73.3 to 221.0 g/ha, 47.9 to 145.6 g/ha, respectively, in different treatments (Table 3). Similarly, nutrient uptake in maize stover ranged between 20.8 and 51.5 kg/ha, 7.13 and 15.8 kg/ha, 66.7 and 141.7 kg/ha, 13.7 and 26.8 kg/ha, 70.2 and 157.9 g/ha, 38.2 and 106.9 g/ha, respectively, under various nutrient-management options. The highest nutrient uptake by kernel and stover was recorded under treatment T_{10} which was significantly higher than all the other treatments. Deletion of K from RDF resulted a significant decrease in N and P uptake of maize kernel, while additional application of 25% K over 100% NPK could not bring any significant change. Application of FYM along with 100% NP resulted in significant increase in kernel and stover N content as compared to treatment T_2. These findings are in agreement with the findings of Sindhi *et al.* (2016).

In case of P uptake in kernel, application of organic sources (FYM/ SPM/ crop residue) along with 100% NP had significant effect for accumulating more P as compared

Table 3. Effect of nutrient-management options on major and micro-nutrient uptake in maize(data pooled over 2 years)

Treatment	N uptake (kg/ha)			P uptake(kg/ha)			K uptake(kg/ha)			S uptake (kg/ha)			Zn uptake (g/ha)			B uptake (g/ha)		
	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total
T_1	54.3	20.8	75.2	10.9	7.1	17.9	9.4	66.7	76.1	7.2	13.7	20.9	73.3	70.2	143.6	47.9	38.2	86.1
T_2	70.7	24.1	94.8	14.0	8.9	23.0	14.5	78.7	92.7	10.4	15.2	25.6	96.3	85.5	181.8	64.3	47.2	111.5
T_3	81.3	26.7	107.9	16.3	10.3	26.6	18.3	90.3	108.6	12.2	16.9	29.2	118.4	98.8	217.5	73.9	53.9	127.6
T_4	97.2	33.6	130.8	19.4	12.3	31.8	20.0	104.8	125.4	14.7	19.2	33.9	145.7	106.8	252.5	90.4	67.1	157.5
T_5	111.9	44.0	155.9	22.4	14.2	36.3	23.7	117.4	141.8	17.1	19.8	36.2	167.9	120.7	288.6	102.6	77.5	180.1
T_6	119.3	44.1	163.4	26.7	14.3	40.6	26.8	124.2	150.9	18.8	21.4	40.1	181.3	132.7	313.9	121.5	93.5	214.9
T_7	83.7	27.9	108.4	17.4	10.7	28.1	15.6	99.9	116.8	14.7	15.9	30.7	132.0	110.7	242.7	67.3	48.2	115.6
T_8	94.8	30.8	124.1	20.2	11.9	32.2	17.3	100.1	117.3	16.4	16.1	32.5	147.0	109.9	256.4	84.0	62.3	146.3
T_9	74.2	30.6	110.7	16.1	10.6	26.7	16.6	85.4	100.9	17.1	18.2	35.5	135.9	97.3	233.2	90.7	67.3	157.9
T_{10}	135.5	51.5	179.1	28.8	15.8	44.7	28.1	141.7	171.3	24.3	26.8	52.1	221.0	157.9	378.9	145.6	106.9	252.5
T_{11}	92.9	30.9	123.9	19.5	10.1	29.6	18.9	103.5	121.3	19.5	24.5	43.7	175.0	135.2	310.3	89.5	81.9	171.5
SEm±	5.51	1.27	-	0.70	0.58	-	0.97	3.85	-	0.66	0.79	-	5.96	4.39	-	3.71	3.55	-
CD (P=0.05)	15.52	3.66	-	2.02	1.74	-	2.90	11.06	-	1.88	2.37	-	17.11	12.59	-	10.66	9.90	-

T_1, 100% NP; T_2, 100% NPK; T_3, 100% NP + 125% K; T_4, 100% NP + 150% K; T_5, 125% NPK; T_6, 150% NPK; T_7, 100% NP + crop residue; T_8, 100% NP + FYM; T_9, 100% NP + SPM; T_{10}, SSNM (+K) and T_{11}, SSNM (− K) to treatment T_2. Application of nutrient as per SSNM resulted significantly higher NPK uptake by maize kernel and stover than T_2. This enhancement in the P level could have been due to additional P supply through organic source of N associated with release of fixed P owing to production of organic acid during mineralization of organic manure (Pathania *et al.*, 2015). The optimum K supply in different treatments had significantly higher K uptake. Ijaz *et al.* (2014) reported that K uptake in kernel increased with the increased K use. The sulphur uptake in kernel and stover was significantly higher in the treatment consisting application of SPM along with 100% NP over treatment T_2, while other 2 organic sources were unable to show such effect. It was also noticed that the additional application of 50% K as well as 25 and 50% NPK over RDF exhibited a significant effect on kernel and stover S uptake. The uptake of sulphur by maize kernel and stover increased by increasing the yield of crop and efficient nutrients supply owing to balanced nutrient-management practices (Sarwar *et al.*, 2012). The uptake of Zn and B by maize kernel and stover was significantly higher in T_{10} than the most of the treatments. Additional application of K or NPK over recommended RDF also brought a significant effect in the uptake of Zn and B by Kernel. Among the organics, the effect of FYM application was found significant by accumulating more Zn and B in comparison to treatment T_2. Our results confirm the findings of Ayeni *et al.* (2012). Nutrient application on SSNM basis (T_{10}) resulted in higher zinc uptake than RDF (T_2).

Effect on soil fertility

Maximum soil available nitrogen and phosphorus were noticed with the application of 150% RDF (T_6) at the harvest time but available nitrogen and phosphorus in 0–15 cm soil depth did not differ significantly. Such results may be ascribed to the application of N and P which were almost similar to all the treatments. These results corroborated the findings of Panneerselvam and Palaniyandi (2014). Availability of potassium differs significantly in 0–15 cm layer and the maximum available K (216.5 kg/ha) was noticed with the application of 150% NPK (T_6) which was significantly higher than the other treatments except T_3, T_4, T_5, T_{10} and T_{11}. Additional application of 50% K as well as 50% NPK over RDF also had significant positive effect on soil available K. Soil K did not differ significantly due to adoption of SSNM or organic use in maize over RDF (Tiwari *et al.*, 2006). Increasing levels of K (125% and 150%) along with other nutrients increased the potassium status in soil. Sharma and Banik (2012) also reported that, soil-available K increased with the balanced use of NPK.

Maximum available sulphur (21.2 kg/ha) was recorded with the application of SSNM + K (T_{10}), being significantly higher than the other treatments except T_{11}. Additional application of potassium and organic sources (FYM/SPM/crop residue) over RDF did not result in any significant effect on soil S; however, availability of S increased significantly owing to adoption of SSNM for maize or with increased application of NPK as compared to RDF practice. These results are in close conformity with those of Karimizarchi *et al*. (2012).

At the time of harvesting, availability of zinc and boron in soil sample varied significantly from 0.68 to 1.61 mg/kg and 0.70 to 0.1.06 mg/kg, respectively. Further, the maximum available zinc and boron 1.61 and 1.06 mg/kg, respectively, were noticed with application of SSNM + K (T_{10}) which was significantly higher than most of the treat-

Table 4. Effect of nutrient-management options on soil fertility parameters at maize at harvesting during 2016

Treatment	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)	Available S (kg/ha)	Available Zn (mg/kg)	Available B (mg/kg)
T_1	201.6	15.3	196.1	13.3	0.68	0.70
T_2	203.8	15.6	205.4	13.8	0.69	0.77
T_3	205.4	15.6	213.6	14.6	0.75	0.60
T_4	203.8	15.9	216.5	15.4	0.79	0.83
T_5	208.8	16.3	213.8	16.4	0.82	0.79
T_6	211.5	18.7	216.5	17.5	0.91	0.81
T_7	206.4	16.5	204.8	13.9	0.78	0.79
T_8	206.8	16.7	203.9	14.7	0.79	0.80
T_9	203.3	16.9	204.2	15.4	0.81	0.52
T_{10}	207.5	15.5	221.2	21.2	1.31	1.06
T_{11}	204.4	15.6	210.3	18.9	1.56	0.91
SEm±	7.29	0.93	2.96	0.77	0.05	0.05
CD (P=0.05)	NS	NS	8.76	2.31	0.15	0.16

T_1, 100% NP; T_2, 100% NPK; T_3, 100% NP + 125% K; T_4, 100% NP + 150% K; T_5, 125% NPK; T_6, 150% NPK; T_7, 100% NP + crop residue; T_8, 100% NP + FYM; T_9, 100% NP + SPM; T_{10}, SSNM (+K) and T_{11}, SSNM (– K) ments except SSNM–K (T_{11}). Availability of zinc and boron in the soil remained unchanged with additional application of potassium or skipping of potassium over RDF. Additional application of 25 or 50% NPK could not exhibit any significant effect. Availability of Zn and B increased significantly because of to adoption of SSNM for maize as compared to RDF. Moreover, organic sources did not exhert any significant effect on the availability of zinc over RDF. Kannan *et al*. (2013) also reported that an integration of essential nutrients in maize cultivation improves the soil-fertility by improving soil-available nutrients status.

In the view of the above, it may be concluded that inadequate use of nutrients in maize under extensively cultivated soils of IGP causing production fatigue and soil health depletion. Site specific nutrient management in spring maize may be a viable option in terms of improved crop productivity, nutritional quality and sustainable soil fertility view point. Future research needs to build upon optimized nutrient supply in maize using organic and inorganic sources.

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