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Effect of different levels of N application and foliar spray of zinc on nutrient uptake by crop and available nutrient in soil of hybrid maize

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Abstract
A field experiment was conducted during *kharif* seasons of 2020-21and 2021-22 on clayey soil at Mansarover Global University, Sehore (Madhya Pradesh) to study the effect of different levels of N and foliar spray of zinc on nutrient uptake by crop and available nutrient in soil. Results revealed that significantly highest nutrient uptake by crop and available nutrient status of nitrogen, phosphorus, Potash and zinc in soil after harvest of crop was recorded with the application of Nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$ followed by application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$, nitrogen-120 kg/ha + 1.5% foliar spray of $ZnSO_4$, nitrogen-120 kg/ha + 1.0% foliar spray of $ZnSO_4$. The lower nutrient uptake by crop and available status of nitrogen, phosphorus, potash and zinc in soil after harvest of crop was recorded with the application of nitrogen-00 kg/ha + 0.0% foliar spray of $ZnSO_4$ (control) under Sehore region.

Keywords: Maize, nutrient uptake, nitrogen, zinc, phosphorus and potash

Introduction
India is the 7th largest producer of maize and ranked 4th position in area in the world. It is referred to as the cereal of the future for its valuable nutritional values in human diet. It is mainly used as feed for animals followed by food for human and industrial use as raw material in food processing, poultry, dairy and ethanol industry. In India, maize is grown in both *Kharif* and *Rabi* Season, But productivity of maize in *Kharif* is less than *Rabi* season, this is due the controlled ecosystems prevailed during the *Rabi* season, Kharif maize represents around 83% of maize area in India, while rabi maize correspond to 17% maize area. It covers total area of 19.65 million hectares with production of 18.9 million tonnes in the world. The area under maize cultivation in India during 2021-22 was 12.56 lakh hectares with production of 31 million metric tonnes and productivity of 1970 kg ha^{-1}. Maize is the major crop of the Chhindwara district of Madhya Pradesh. Chhindwara is known as Corn City. Corn is grown in entire district due to presence of suitable soil and climate needed for corn to grow. The area under maize cultivation in Chhindwara during 2021-22 was 2.95 lakh hectares with production of 12 lakh metric tonnes and productivity of 4126 kg ha^{-1}.

Maize is not only used for consumption of human but it is also used for the feed and fodder of cattle and raw material for industries. The products prepared from maize are corn cooking oil, corn starch, corn syrup, products needed for distilleries and fermentation. Now days, biofuel can also be made from maize. The hybrid maize crop is highly nutrient responsive crop requires about 120 kg N, 60 kg P_2O_5, 40 kg K_20 and 5.25 kg Zinc to produce 5-6 t of grain yield. It has high nutritional value as it contains about 62.3% starch, 11.1% protein, 4.6% oil, 1.8% fibre, 4.3% sugar and 1.3% ash. Maize is a high nutrient demanding crop, which also requires micronutrients along with major elements. Nitrogen is a vital plant nutrient and a major yield determining factor in maize production. Nitrogen is a component of protein and nucleic acids and also mediates the utilization of phosphorus, potassium, and other elements in plants. Recently developed high yielding cultivars of hybrid maize require considerable high amount of nutrient specially nitrogen and zinc. The foliar application of zinc enhances the uptake and accumulation of nitrogen and finally increased grain yield.

Nitrogen is one of the important primaries non-metals nutrients which require large quantity for the plant growth and nutrition. Plant normally contains 1-5% weight of this nutrient. Furrow slice soil layer 0-15 cm depth of most soil contains nitrogen in the range of 0.02 to 0.4% by weight.

Nitrogen as the most frequently used macro element has the key role in increasing yield and utilization of potassium, phosphorus and other micro and macro elements in plants (Kisetu *et al.*, 2014) [114]. Zinc application as a positive factor for the maximum utilization of nitrogen fertilizer. The optimal rate of zinc foliar spray for achieving significant grain yield response was in the range from 1.0 to 1.5 kg Zn/ha. Grain yield increase was 18% as compared to the treatment fertilized only with NPK. Plants fertilized with 1.0 kg Zn/ha significantly increased both total N uptake and grain yield (Potarzycki *et al*., 2009) [11]. Zinc exerts a great influence on the fundamental processes of plants, such as nitrogen metabolism, the absorption of nitrogen and the quality of the protein, chlorophyll synthesis and photosynthesis, carbonic anhydrase activity, resistance to biotic and abiotic stresses and protection against oxidative damage (Mousavi, 2011) [13].

Materials and Methods

An experimental was conducted at Institute Farm, Department of Soil Science & Agril. Chemistry, Faculty of Agriculture Science and Technology, Mansarover Global University, Sehore in Madhya Pradesh during *kharif* seasons of 2020-21 and 2021-22. The climate of Sehore is warm and temperate where maximum temperature exceeds 42 ˚C in May and June. The winters are cool and minimum temperature reaches as low as 10 ˚C in December and January. Occurrence of frost is expected from the last week of December to the first week of February. The soil was sandy clay in texture and slightly alkaline in reaction (*p*H 7.8) with electric conductivity 0.30 dS/m, low in available N, and medium to low in available P, high in available K and sufficient to low in available zinc. A combination of 16 treatments, viz., Sixteen treatments comprising of nutrient management practices viz., Nitrogen-00 kg/ha + 0.0% foliar spray of $ZnSO_4$ (Control) (T_1), Nitrogen-00 kg/ha + 0.5% foliar spray of $ZnSO_4$ (T_2), Nitrogen-00 kg/ha + 0.1% foliar spray of $ZnSO_4$ (T_3), Nitrogen-00 kg/ha + 0.1.5% foliar spray of $ZnSO_4$ (T_4), Nitrogen-60 kg/ha + 0.0% foliar spray of $ZnSO_4$ (T_5), Nitrogen-60 kg/ha + 0.5% foliar spray of $ZnSO_4$ (T_6), Nitrogen-60 kg/ha + 1.0% foliar spray of $ZnSO_4$ (T_7), Nitrogen-60 kg/ha + 1.5% foliar spray of $ZnSO_4$ (T_8), Nitrogen-120 kg/ha + 0.0% foliar spray of $ZnSO_4$ (T_9), Nitrogen-120 kg/ha + 0.5% foliar spray of $ZnSO_4$ (T_{10}), Nitrogen-120 kg/ha + 1.0% foliar spray of $ZnSO_4$ (T_{11}), Nitrogen-120 kg/ha + 1.5% foliar spray of ZnSO4 (T_{12}), Nitrogen-150 kg/ha + 0.0% foliar spray of $ZnSO_4$ (T_{13}), Nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$ (T_{14}), Nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$ (T_{15}) and Nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$ (T_{16}) were evaluated in Factorial CRD design with three replications with gross and net sizes of 5.0 m × 6.00 m and 4.0 m × 5.0 m, respectively. Maize 'Hybrid Maize PAC-759' was sown at 60 cm × 30 cm spacing on July 2020 and June 2021. The recommended dose of fertilizers is as per treatments.

Results and Discussion

Effect of nitrogen levels and foliar spray of zinc on nitrogen uptake by crop: Significantly higher nitrogen uptake by crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. The lower nitrogen uptake by crop was recorded with the application of control plot (Table 1).

Effect of nitrogen levels and foliar spray of zinc on phosphorus uptake by crop

Significantly higher phosphorus uptake by crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$ (Table 2). The lower phosphorus uptake by crop was recorded with the application of control.

Effect of nitrogen levels and foliar spray of zinc on potash uptake by crop

Significantly higher potash uptake by crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. Potash uptake by crop was lower recorded of control (Table 3).

Effect of nitrogen levels and foliar spray of zinc on zinc uptake by crop

Significantly higher zinc uptake by crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. The lower zinc uptake by crop was recorded with the application of control (Table 4).

Effect of nitrogen levels and foliar spray of zinc on available nitrogen of soil

Significantly higher available nitrogen of soil after harvesting of crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. The lower available nitrogen of soil after harvesting of crop was recorded with the application of control plot (Table 5).

Effect of nitrogen levels and foliar spray of zinc on available phosphorus of soil

Significantly higher available phosphorus of soil after harvesting of crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$ (Table 6). The lower available phosphorus of soil after harvesting of crop was recorded with the application of control.

Effect of nitrogen levels and foliar spray of zinc on available potash of soil

Significantly higher available potash of soil after harvesting of crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. The lower available potash of soil after harvesting of crop was recorded of control treatment (Table 7).

Effect of nitrogen levels and foliar spray of zinc on available zinc of soil

Significantly higher available zinc of soil after harvesting of crop was recorded with the application of nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$, which was statistically at par with the application of nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$, nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$. The lower available zinc of soil after harvesting of crop was recorded with the application of control (Table 8).

Table 1: Effect of different levels of N and foliar spray of Z on uptake of N by maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Uptake of N by maize at 2020-21					
N 00	53.23	61.61	64.92	70.36	62.53
N 60	82.64	97.85	105.26	113.14	99.72
N 120	125.67	133.27	140.49	144.12	135.88
N 150	149.61	153.71	160.18	165.49	157.28
Mean	102.79	111.61	117.71	123.28	
	N		**Z**		**N × Z**
SEm±	1.96		1.96		3.93
CD at 5%	5.66		5.66		11.31
Uptake of N by maize at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	38.28	42.01	44.86	51.19	44.08
N 60	67.00	77.17	84.06	92.65	80.22
N 120	99.59	106.21	111.82	118.96	109.15
N 150	123.85	129.82	133.30	136.87	130.96
Mean	82.18	88.80	93.51	99.92	
	N		**Z**		**N × Z**
SEm±	1.96		1.96		3.92
CD at 5%	5.65		5.65		11.30
Uptake of N by maize at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	45.76	51.81	54.89	60.77	92.48
N 60	74.82	87.51	94.66	102.90	100.20
N 120	112.63	119.74	126.15	131.54	105.61
N 150	136.73	141.76	146.74	151.18	11.60
Mean	53.31	89.97	122.52	144.10	
	N		**Z**		**N × Z**
SEm±	1.38		1.38		2.77
CD at 5%	3.89		3.89		7.79

Table 2: Effect of different levels of N and foliar spray of Z on uptake of P by maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Uptake of P by maize at 2020-21					
N 00	31.66	35.21	36.77	38.22	35.47
N 60	44.59	49.64	51.92	53.23	49.90
N 120	56.92	59.33	61.27	62.32	59.96
N 150	63.43	64.83	66.75	68.44	65.86
Mean	49.20	52.26	54.18	55.55	
	N		**Z**		**N × Z**
SEm±	0.80		0.80		1.59
CD at 5%	2.30		2.30		4.59
Uptake of P by maize at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	31.82	35.04	36.97	37.92	35.44
N 60	46.36	49.37	52.27	54.58	50.64
N 120	57.26	59.20	60.50	62.41	59.84
N 150	63.94	65.44	67.27	68.68	66.33
Mean	49.85	52.26	54.25	55.90	
	N		**Z**		**N × Z**
SEm±	0.62		0.62		1.25
CD at 5%	1.81		1.81		3.62
Uptake of P by maize at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	31.74	35.13	36.87	38.07	35.45
N 60	45.57	49.51	52.09	53.91	50.27
N 120	57.09	59.26	60.88	62.36	59.90
N 150	63.68	65.14	67.01	68.56	66.10
Mean	49.52	52.26	54.22	55.73	
	N		**Z**		**N × Z**
SEm±	0.50		0.50		1.01
CD at 5%	1.42		1.42		2.84

Table 3: Effect of different levels of N and foliar spray of Z on uptake of K by maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Uptake of K by maize at 2020-21					
N 00	99.12	106.97	112.36	115.47	108.48
N 60	138.22	147.98	154.38	157.38	149.48
N 120	165.58	171.61	175.40	178.27	172.71
N 150	182.91	185.46	188.15	192.39	187.23
Mean	146.46	153.01	157.57	160.87	
	N		**Z**		**N × Z**
SEm±	2.67		2.67		5.34
CD at 5%	7.70		7.70		15.39
Uptake of K by maize at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	98.81	105.80	111.84	113.12	107.39
N 60	140.72	150.03	155.51	160.83	151.77
N 120	166.65	172.22	175.57	179.40	173.46
N 150	183.11	187.35	189.88	193.95	188.57
Mean	147.32	153.85	158.20	161.82	
	N		**Z**		**N × Z**
SEm±	2.41		2.41		4.83
CD at 5%	6.96		6.96		13.93
Uptake of K by maize at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	98.97	106.39	112.10	114.29	107.94
N 60	139.47	149.01	154.95	159.09	150.63
N 120	166.12	171.92	175.49	178.84	173.09
N 150	183.01	186.40	189.02	193.17	187.90
Mean	146.89	153.43	157.89	161.35	
	N		**Z**		**N × Z**
SEm±	1.80		1.80		3.60
CD at 5%	3.57		5.05		10.11

Table 4: Effect of different levels of N and foliar spray of Z on uptake of Zn by maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Uptake of Zn by maize at 2020-21					
N 00	148.47	176.45	192.14	208.51	181.39
N 60	253.15	298.93	327.03	352.31	307.85
N 120	391.87	428.24	455.31	486.82	440.56
N 150	509.41	535.98	567.23	592.10	551.18
Mean	325.72	359.90	385.43	409.94	
	N		**Z**		**N × Z**
SEm±	9.75		9.75		19.50
CD at 5%	28.09		28.09		56.18
Uptake of Zn by maize at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	144.64	169.93	186.10	198.05	174.67
N 60	254.48	292.72	320.58	352.99	305.20
N 120	393.40	422.10	455.77	481.34	438.15
N 150	504.41	530.18	558.39	587.50	545.11
Mean	324.23	353.73	380.21	404.97	
	N		**Z**		**N × Z**
SEm±	8.51		8.51		17.02
CD at 5%	24.51		24.51		49.03
Uptake of Zn by maize at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	146.55	173.19	189.12	203.28	178.03
N 60	253.82	295.83	323.80	352.65	306.52
N 120	392.63	425.17	455.54	484.08	439.36
N 150	506.91	533.08	562.81	589.80	548.15
Mean	324.98	356.81	382.82	407.45	
	N		**Z**		**N × Z**
SEm±	6.47		6.47		12.94
CD at 5%	12.84		18.16		36.33

Table 5: Effect of different levels of N and foliar spray of Z on available nitrogen in soil after harvest of crop

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Available N at 2020-21					
N 00	221.33	221.87	222.29	222.45	221.99
N 60	223.38	223.41	223.63	224.03	223.61
N 120	224.52	225.08	226.13	226.32	225.51
N 150	227.18	227.22	227.38	228.08	227.46
Mean	224.10	224.40	224.86	225.22	
	N		**Z**		**N × Z**
SEm±	0.42		0.42		0.83
CD at 5%	1.20		1.20		2.40
Available N at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	221.51	221.90	222.32	222.58	222.08
N 60	223.48	223.70	224.06	224.55	224.44
N 120	225.14	226.16	226.16	226.38	224.90
N 150	227.21	227.25	227.41	228.13	225.29
Mean	224.18	224.44	224.90	225.29	
	N		**Z**		**N × Z**
SEm±	0.41		0.41		0.82
CD at 5%	1.19		1.19		2.38
Available N at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	221.42	221.89	222.31	222.52	222.03
N 60	223.41	223.45	223.67	224.05	223.64
N 120	224.53	225.11	226.14	226.35	225.53
N 150	227.19	227.23	227.40	228.11	227.48
Mean	224.14	224.42	224.88	225.26	
	N		**Z**		**N × Z**
SEm±	0.29		0.29		0.58
CD at 5%	0.82		0.82		1.64

Table 6: Effect of different levels of N and foliar spray of Z on available P in soil after harvest of maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Available P at 2020-21					
N 00	12.11	12.18	12.19	12.21	12.18
N 60	12..24	12.27	12.29	12.31	12.28
N 120	12.33	12.37	12.41	12.45	12.39
N 150	12.50	12.51	12.59	12.62	12.56
Mean	12.30	12.33	12.37	12.40	
	N		**Z**		**N × Z**
SEm±	0.02		0.02		0.04
CD at 5%	0.06		0.06		0.11
Available P at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	12.14	12.19	12.22	12.23	12.19
N 60	12.26	12.28	12.30	12.32	12.29
N 120	12.35	12.39	12.44	12.47	12.41
N 150	12.53	12.55	12.62	12.67	12.59
Mean	12.32	12.35	12.39	12.42	
	N		**Z**		**N × Z**
SEm±	0.02		0.02		0.04
CD at 5%	0.06		0.06		0.12
Available Pat Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	12.13	12.19	12.21	12.22	12.18
N 60	12.28	12.30	12.32	12.34	12.28
N 120	12.34	12.38	12.43	12.46	12.40
N 150	12.51	12.53	12.61	12.65	12.57
Mean	12.31	12.34	12.38	12.41	
	N		**Z**		**N × Z**
SEm±	0.014		0.014		0.028
CD at 5%	0.040		0.040		0.080

Table 7: Effect of different levels of N and foliar spray of Z on available K in soil after harvest of maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Available K at 2020-21					
N 00	431.49	433.07	434.40	435.98	433.74
N 60	436.50	437.76	438.01	440.53	438.20
N 120	441.90	443.25	444.74	445.38	443.82
N 150	446.03	447.78	448.20	449.82	447.96
Mean	438.98	440.96	441.34	442.93	
	N		**Z**		**N × Z**
SEm±	1.29		1.29		2.58
CD at 5%	3.72		3.72		7.44
Available K at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	430.56	432.40	433.33	436.98	433.32
N 60	437.98	439.33	440.04	442.87	440.05
N 120	443.66	444.92	446.74	447.72	445.75
N 150	448.70	450.78	451.87	453.15	451.12
Mean	440.22	441.86	443.99	445.18	
	N		**Z**		**N × Z**
SEm±	1.15		1.15		2.30
CD at 5%	3.32		3.32		6.64
Available K at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	431.03	432.74	433.87	436.48	433.53
N 60	437.24	438.54	439.03	441.70	439.13
N 120	442.78	444.08	445.74	446.55	444.79
N 150	447.37	449.28	450.03	451.49	449.54
Mean	440.23	441.86	443.00	445.18	
	N		**Z**		**N × Z**
SEm±	0.86		0.86		1.73
CD at 5%	2.42		2.42		4.85

Table 8: Effect of different levels of N and foliar spray of Z on available Zn in soil after harvest of maize

Levels of N (kg ha^{-1})	Foliar spray of Z (%)				
	Z 0	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
Available Zn at 2020-21					
N 00	0.843	0.921	0.924	0.927	0.904
N 60	0.931	0.933	0.936	0.938	0.935
N 120	0.941	0.944	0.949	0.955	0.947
N 150	0.964	0.968	0.974	0.987	0.973
Mean	0.920	0.942	0.946	0.952	
	N		**Z**		**N × Z**
SEm±	0.003		0.003		0.006
CD at 5%	0.009		0.009		0.018
Available Zn at 2020-21					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	0.873	0.924	0.928	0.931	0.914
N 60	0.935	0.938	0.940	0.943	0.939
N 120	0.946	0.948	0.951	0.954	0.950
N 150	0.962	0.969	0.970	0.984	0.971
Mean	0.929	0.945	0.947	0.953	
	N		**Z**		**N × Z**
SEm±	0.002		0.002		0.004
CD at 5%	0.006		0.006		0.013
Available Zn at Pooled data					
(kg ha^{-1})	**Z 0**	**Z 0.5**	**Z 1.0**	**Z 1.5**	**Mean**
N 00	0.858	0.922	0.926	0.929	0.909
N 60	0.933	0.936	0.938	0.941	0.937
N 120	0.943	0.946	0.950	0.954	0.948
N 150	0.963	0.969	0.972	0.986	0.972
Mean	0.924	0.943	0.946	0.952	
	N		**Z**		**N × Z**
SEm±	0.001		0.001		0.003
CD at 5%	0.005		0.005		0.010

Conclusion

Based on the pooled results of two-year experimentation, it is concluded that higher nutrient uptake by crop and maintained nutrient status of nitrogen, phosphorus, potash and zinc along with efficient nutrient management in *kharif* maize can be achieved by either nitrogen-150 kg/ha + 1.5% foliar spray of $ZnSO_4$ or nitrogen-150 kg/ha + 1.0% foliar spray of $ZnSO_4$ or nitrogen-150 kg/ha + 0.5% foliar spray of $ZnSO_4$ according to availability of labourers under bhopal region.

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