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Efficient Nutrient Management for High Crop Yield and Quality in Maize Crop

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ABSTRACT

The field experiment on maize crop was conducted at research farm of C.S.A. University of Agriculture & Technology Kanpur, during Kharif season 2015-16 and 2016-17. The doses of experiment were Control, 100% NPK , 100% NPK+ S40, 100% NPK + Zn5, 100% NPK+S40 +Zn5, 125% NPK, 125% NPK + S40, 125% NPK + Zn5, 125% NPK + S40 + Zn5 and 150% NPK. The results showed that the grain yield of maize first year (2015) varied from 14.33 to 30.78 q ha^{-1} and in second year (2016) varied from 14.85 to 32.80 q ha^{-1} and the straw yield of maize first year (2015) varied from 38.91 to 81.10 q ha^{-1} and in second year (2016) varied from 39.48 to 82.13 q ha^{-1} . It was noted the N uptake in maize grain varied from 18.62 to 50.09 kg ha^{-1} and 19.45 to 57.07 kg ha^{-1}, P from 3.86 to 10.46 kg ha^{-1} and 4.15 to 11.45 kg ha^{-1}, K from 39.55 to 116.34 kg ha^{-1} and 41.13 to 124.64 kg ha^{-1}, S from 4.72 to 14.15 and 5.04 to 15.74 kg ha^{-1}, Zn from 343.92 g to 923.40 g100kg^{-1} and 360.11 g to 1000.40 g100kg^{-1} in first and second years, respectively. It was noted the N uptake in maize straw varied from 13.68 to 46.22 kg ha^{-1} and 14.60 to 47.63 kg ha^{-1}, P from 4.30 to 10.54 kg ha^{-1} and 4.34 to 11.49 kg ha^{-1}, K from 68.81 to 208.42 kg ha^{-1} and 69.87 to 211.89 kg ha^{-1}, S from 8.21 to 18.65 and 8.29 to 21.35 kg ha^{-1}, Zn from 1231.65 g to 3649.50 g100kg^{-1} and 1273.23 g to 3757.44 g100kg^{-1} in first and second years, respectively. The protein content varied from 6.73 to 7.94% and 6.66 to 8.01%, oil from 6.53 to 7.59% and 6.61 to 7.80%, lysine from 21.2 to 33.20 mg/100g and 21.4 to 34.53 mg/100g in first and second years, respectively. The dose of 125% NPK+S40+Zn5 were found most suitable in respect of crop yield, nutrient content, uptake of nutrient and quality of maize except lysine content in maize.

Key words: *Maize, Nutrient, Grain, Crop, NPK*

INTRODUCTION

Maize (*Zea mays* L.) is the most important grain crop in South Africa and is produced throughout the country under diverse environments. Successful maize production depends on the correct application of production inputs that will sustain the environment as well as agricultural production. These inputs are, inter alia, adapted cultivars, plant population, soil tillage, fertilisation, weed, insect and disease control, harvesting, marketing and financial resources.

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In developed countries, maize is consumed mainly as second-cycle produce, in the form of meat, eggs and dairy products. In developing countries, maize is consumed directly and serves as staple diet for some 200 million people. Most people regard maize as a breakfast cereal. However, in a processed form it is also found as fuel (ethanol) and starch. Starch in turn involves enzymatic conversion into products such as sorbitol, dextrine, sorbic and lactic acid, and appears in household items such as beer, ice cream, syrup, shoe polish, glue, fireworks, ink, batteries, mustard, cosmetics, aspirin and paint. Approximately 8,0 million tons of maize grain are produced in South Africa annually on approximately 3,1 million ha of land. Half of the production consists of white maize, for human food consumption.

The cereals occupy about 54% of total cropped area in India. The *India* produces *Maize occupies* about 3.6% of the total cropped *area* of *India.* Maize is the third most important cereal crop in India after rice and wheat. It accounts for 9 per cent of total food grain production in the country. Karnataka, Rajasthan, Andhra Pradesh, Maharashtra, and Uttar Pradesh are the major maize producing states together contribute 60 per cent of area and 70 per cent of maize production in India. Last year in India in 2015-16, maize occupied 86.27 lakh ha area and production was estimated 13 per cent low about 210.2 lakh tonnes (Third Advance Estimates dt. 9-5-2016) as against 92.71 lakh ha and 241.7 lakh tonnes in previous year respectively. In Gujarat, the maize occupies more area in 2015-16 about 4 lakh ha as against 3.82 lakh ha in 2014-15 but production remains slight low about 5.96 lakh tonnes as against 6.31 lakh tonnes in previous year. Hence, maize price remain stable around Rs. 300 per 20 kg throughout the year with slight ups and downs. This is mainly due to reduction of export from 28.26 lakh tonnes in 2014-15 to about 6.5 lakh tonnes in 2015-16 as maize price remained slight higher than the world level.

As per the USDA report of May, 2016, the world maize production has been estimated about 96.88 crore tonnes in 2015-16 which is 4.6 per cent lower than last year (101.35 crore tonnes). Whereas, total coarse grains production was also slightly decreased from 130.42 crore tonnes in 2014-15 to 125.82 crore tonnes in 2015-16 and year ending stock would be about 24.45 crore tonnes same as previous year. Hence, in ensuing season too, the maize price will remain stable at world level and in India also became of good monsoon possibility. This reveals the limited chance for maize export in current year. The Government has fixed MSP Rs. 273 per 20 kg (Rs. 1365 per quintal) for the current year. With this background, the research team of Department of Agricultural Economics, Junagadh Agricultural University has analysed the historical monthly price data of maize from last twelve years collected from Dahod Regulated Market. The econometric analysis revealed that the prices of maize may remain in the range of Rs. 280 to 300 per 20 kg (1400 – 1500 Rs/qtl) during October to December, 2016 (i.e. at harvest). Hence, farmers are suggested to take their own decision for the inclusion of maize crop in their cropping plan accordingly.

MATERIALS AND METHOD

The experiment was conducted at research farm Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the Kharif season 2015 and 2016. The maize verity Azad Uttam were taken for study with 10 treatment and 4 replication the initial characterstics of soil (initial stage) were also analyse to know the nutrient status of soil. The soil of experimental field is low in organic carbon, available N_2 and available Zn but medium in case of available P, K and available S. The pH and EC was soil in normal range. The pH EC and organic carbon are analyse by the method described by Jackson[3]. Available N_2 was determine by Alkaline permanganate method as described by Subbiah and Asija[9]. Available phosphorus was extracted with 0.5

M $NaHCO_3$ Olsen *et al*[5]. The P was determine in extract by vandomolybdate yellow colour method Jackson[3]. The available K was determined by flame photometer. Available sulphur was determined by Chesnin and Yien[2]. Available zinc was estimated by atomic absorption spectrophotometer. The plant samples were also analysed for N P K, S and Zn. Nitrogen was determined by Kjeldal's method[3]. Phosphoras was determined calorimetrically[1]. Potassium was determined by flame photometric method. Sulphar was determined by Chesnin and Yien[2]. Zinc was determined by atomic absorption spectrophotometer.

Table-1 Effect of different fertilizer treatments on grain and Straw yield of maize in both years

Treatments combination	Grain yield in q ha^{-1}		Straw yield in q ha^{-1}	
	2015-16	2015-16	2016-17	2016-17
Control	14.33	38.91	39.48	14.85
100 % NPK	21.16	56.52	57.39	22.30
100% NPK+S_{40}	25.15	66.40	67.11	26.60
100%NPK+Zn5	24.40	66.29	67.76	25.60
100%NPK+S_{40}+Zn5	27.60	72.52	73.50	28.90
125%NPK	24.92	67.97	68.43	26.96
125%NPK+S_{40}	27.80	69.46	70.01	29.50
125%NPK+Zn5	27.15	68.64	69.66	28.40
125%NPK+S_{40}+Zn5	30.78	81.10	82.13	32.80
150%NPK	26.16	69.63	68.87	29.40
Mean	24.94	65.74	66.43	26.53
S.E. (d)	**0.468**	**0.184**	**0.174**	**0.544**
C.D. (P=0.05)	**0.960**	**0.378**	**0.358**	**1.116**

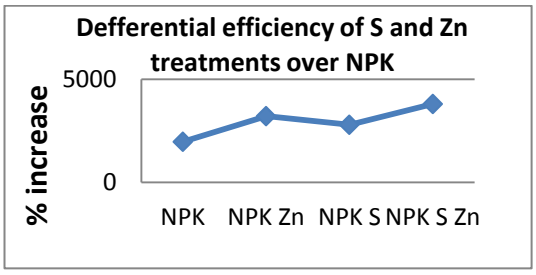

Fig. 1: Maize Grain yield 1st year

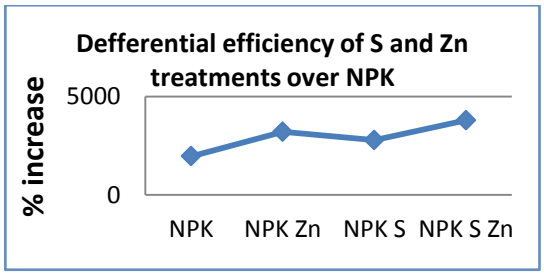

Fig. 2: Maize Grain yield 2nd year

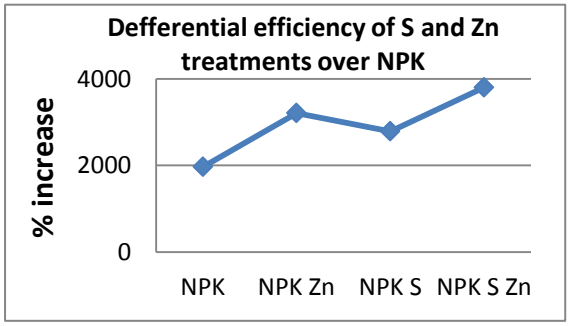

Fig. 3: Maize Straw Yield 1st year

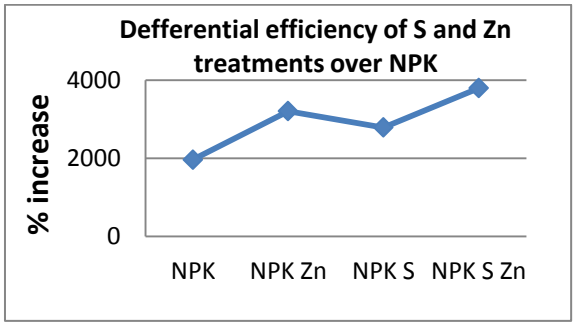

Fig. 4: Maize Straw yield 2nd year

Table-2 Effect of different treatments on uptake of N P K S and Zn of maize grain in both year

Treatment	Uptake values 2015-16					Uptake values 2016-17				
	N(kgha^{-1})	P(kgha^{-1})	K(kgha^{-1})	S(kgha^{-1})	Zn(gha^{-1})	N(kgha^{-1})	P(kgha^{-1})	K(kgha^{-1})	S(kgha^{-1})	Zn(gha^{-1})
T_1	18.62	3.86	39.55	4.72	343.92	19.45	4.15	41.13	5.04	360.11
T_2	31.74	6.13	63.05	7.82	529.00	34.11	6.69	66.67	8.02	568.65
T_3	37.01	7.29	8349	10.56	679.05	42.56	8.24	88.57	11.70	731.50
T_4	38.06	7.07	78.56	9.51	707.60	40.19	7.42	83.71	10.75	755.20
T_5	42.50	8.55	94.66	12.42	828.00	46.52	8.95	99.41	12.29	881.45
T_6	36.38	7.72	82.23	9.96	623.00	42.86	8.08	88.96	10.78	660.52
T_7	44.75	8.61	101.19	12.78	695.00	47.49	9.14	105.31	13.57	722.75
T_8	41.81	8.41	95.56	11.67	787.35	46.00	9.08	100.25	12.21	837.80
T_9	50.09	10.46	116.34	14.15	923.40	57.07	11.15	124.64	15.74	1000.4
T_{10}	39.50	8.10	91.56	11.51	627.84	47.04	9.11	102.90	13.23	727.65
S.E. (d)	**0.212**	**0.162**	**0.468**	**0.196**	**0.789**	**0.328**	**0.118**	**0.511**	**0.148**	**0.633**
C.D. (P=0.05)	**0.435**	**0.332**	**0.961**	**0.402**	**1.619**	**0.673**	**0.243**	**1.048**	**0.304**	**1.299**

Table-3 Effect of different treatments on Protein, Oil and Lysine content (%) of maize grain in both year

Treatment	2015-16			2016-17		
	Protein (%)	Oil (%)	Lysine (mg/100g)	Protein (%)	Oil (%)	Lysine (mg/100g)
T_1	6.73	6.53	33.2	6.66	6.61	34.53
T_2	7.31	6.55	24.4	7.19	7.05	23.7
T_3	7.83	7.05	23.2	7.83	7.56	24.5
T_4	7.37	6.60	25.3	7.36	7.45	24.8
T_5	7.88	7.85	26.2	8.00	7.78	22.5
T_6	6.90	6.61	24.2	6.91	6.98	22.7
T_7	7.28	7.47	23.2	7.34	7.37	25.7
T_8	7.25	6.70	22.4	7.32	7.59	22.7
T_9	7.94	7.59	22.4	8.01	7.80	23.5
T_{10}	7.78	6.45	21.2	7.33	6.91	21.4
S.E. (d)	**0.101**	**0.058**		**0.107**	**0.056**	
C.D. (P=0.05)	**0.208**	**0.120**		**0.221**	**0.115**	

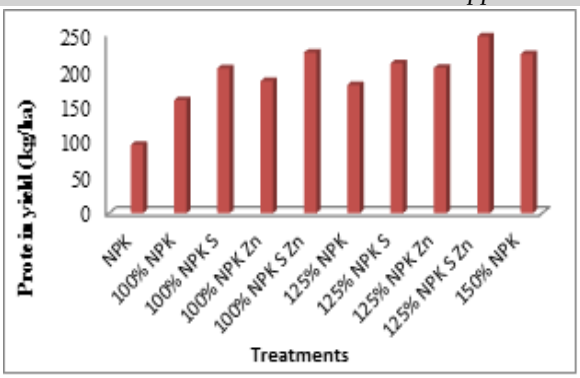

Fig. 5:.Mean harvest of protein under different treatments from maize grain

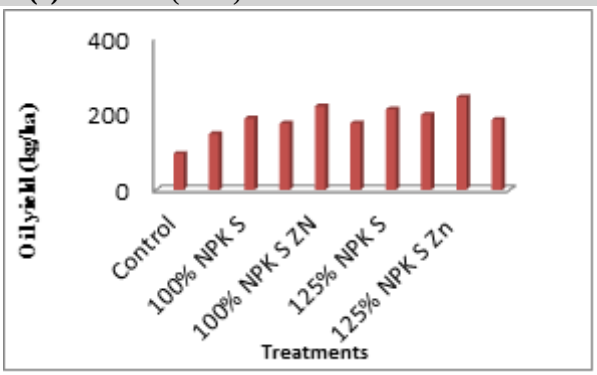

Fig. 6: Mean harvest of oil under different treatments from maize kernel was observed in treatment 125% NPK+S+Zn followed by 100% NPK+S+Zn (about 240 kg ha^{-1}).

RESULT AND DISCUSSION

Fertilizers are play very important role in the yield of economy of the crop. Fertilizer alone contributed 55 to 60% to achieve the biological yield of a crop. In inceptisols five most limiting nutrients have been identified i.e. N,P,K,S and Zn. The element S and Zn are the recent additions in this list. The several side nutrient specific trails conducted at different locations both on farm and off farm established the need of sulphur and zinc along with NPK for yield maximization. The results of present study are discussed as under:-

Grain yield:- There were significant variations in the data under different treatments. During first year it varied from 14.33 to 30.78 q ha^{-1} with a mean value of 24.94 q ha^{-1}. Among NPK levels 125% NPK gave significantly higher yield over to 100% NPK to the tune of about 18% in grain yield. Further increase in NPK doses upto 150% the increase in yield was not significant. Addition of sulphur to 100% NPK also caused significant increase of about 18%. At 125% NPK addition of S resulted significant increase of about 11%. Addition of zinc to 100% NPK also caused significant increase of about 15%. At 125% NPK addition of Zn resulted significant increase of about 9%. Addition of S+Zn to 100% NPK also caused significant increase of about 30%. At 125% NPK addition of S+Zn resulted significant increase of about 23%.

Similarly during second year the data varied from 14.85 to 32.80 q ha^{-1} with a general mean value of 26.53 q ha^{-1}. Among NPK levels 125% NPK gave significantly higher yield to 100% NPK to the tune of about 20% in grain yield. Further increase in NPK doses upto 150% the increase in yield was not significant. Addition of sulphur to 100% NPK also caused significant increase of about 19%. At 125% NPK addition of S resulted significant increase of about 9%. Addition of zinc to 100% NPK also caused significant increase of about 14%. At 125% NPK addition of Zn resulted significant increase of about 5%. Addition of S+Zn to 100% NPK also caused significant increase of about 29%. At 125% NPK addition of S+Zn resulted significant increase of about 21%. The trend of variation in grain yield due to differential levels of nutrients is defected. The grain yield of maize as affected by nutrient treatments is given in Table 1. The data of current study are in agreement with several workers[7].

Straw yield:- The straw yield of maize as affected by nutrient treatments is given in Table 1. There were significant variations in the data under different treatments. During first year it varied from 38.91 to 81.10 q ha^{-1} with a mean value of 65.74 q ha^{-1}. Among NPK levels 125% NPK gave significantly higher yield over 100% NPK to the tune of about 20% in straw yield. Further increase in NPK doses upto 150%, the increase in yield

was also significant. Addition of sulphur to 100% NPK also caused significant increase in yield of about 17% over 100% NPK alone. At 125% NPK addition of S resulted in on significant increase in yield over 125% NPK. Addition of zinc to 100% NPK also caused significant increase in yield of about 17%. The yield differences in 125% NPK+Zn and 125% NPK were also small but significance. Addition of S+Zn sequentially to 100% and 125% NPK resulted in significant increases in straw yield to the tune of 28% and 19% respectively.

Similarly during second year the data varied from 39.48 to 82.13 q ha^{-1} with a mean value of 66.43 q ha^{-1}. Among NPK levels 125% NPK gave significantly higher yield uptake to 100% NPK to the tune of about 19% in straw yield. Further increase in NPK doses upto 150% the increase in yield was significant. Addition of sulphur to 100% NPK also caused significant increase of about 17%. However, there was small but significant increases in straw yield due to addition of S to 125% NPK alone. Addition of zinc to 100% NPK also caused significant increase of about 18%. At 125% NPK addition of Zn also caused significant increase in straw yield. Addition of S+Zn to 100% NPK also caused significant increase of about 28%. At 125% NPK addition of S+Zn resulted significant increase of about 20%. The data of current study are in agreement with several workers[6].

Uptake- The uptake values indicate the appropriate quantity of nutrients required for optimum yield in present investigation. It was noted the N uptake in maize grain varied from 18.62 to 50.09 kg ha^{-1} and 19.45 to 57.07 kg ha^{-1}, P from 3.86 to 10.46 kg ha^{-1} and 4.15 to 11.45 kg ha^{-1}, K from 39.55 to 116.34 kg ha^{-1} and 41.13 to 124.64 kg ha^{-1}, S from 4.72 to 14.15 and 5.04 to 15.74 kg ha^{-1}, Zn from 343.92 g to 923.40 g$100kg^{-1}$ and 360.11 g to 1000.40 g$100kg^{-1}$ in first and second years, respectively. It was noted the N uptake in maize straw varied from 13.68 to 46.22 kg ha^{-1} and 14.60 to 47.63 kg ha^{-1}, P from 4.30 to 10.54 kg ha^{-1} and 4.34 to 11.49 kg ha^{-1}, K from 68.81 to 208.42 kg ha^{-1} and 69.87 to 211.89 kg ha^{-1}, S from 8.21 to 18.65 and 8.29 to 21.35 kg ha^{-1}, Zn from 1231.65 g to 3649.50 g$100kg^{-1}$ and 1273.23 g to 3757.44 g$100kg^{-1}$ in first and second years, respectively. The uptake values of nutrients in grain and straw increased due to concentration of these nutrients and biological yield of grain and straw. The uptake values indicate the appropriate quantity of nutrients required for optimum yield in present investigation. Any reduction in above dose level cause declying in yield of maize crop. Similar kind of results has been reported by Singh and pathak[7].

Crop quality- The crop quality of maize as affected by nutrient treatments is given in Table 3. The maximum protein and oil content in maize grain was observed in T_9 (125% NPK + S40 +Zn5) treatment and lowest in control. In case of lysine content the highest value was recorded in control and lowest in T_9 treatment combination. Thus there is a negative relationship appeared in between protein and oil content. The data of current study are in agreement with several workers[4,8].

CONCLUSION

The dose of 125% NPK+S40+Zn5 was the best dose amongs all in terms of grain yield, straw yield, uptake values and crop quality. So it is concluded that application of Sulphur and Zinc along with the combination of 125NPK gave best results to the farmers.

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