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Effect of Zinc With and Without FYM on Forage Production, Quality and Zinc Nutrition of Forage Sorghum Genotypes

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ABSTRACT

A field trial was conducted in an alluvial soil (Orchrept) using six important genotypes of forage sorghum and five Zn levels with and without FYM at Forage Research Farm, Anand (Gujarat). Among six genotypes, promising hybrids AS-15 and AS-22 produced significantly higher green forage (GF) and dry matter (DM) yields as compared to the existing varieties in total of two cuts in the pooled analysis. Hybrid AS-11 was at par with the M.P.Chari and S.S.G.59-3 for DMY. These hybrids were found to be relatively more responsive, S-1049 was least responsive and AS-11, M. P .Chari and S.S.G. 59-3 were medium responsive to Zn application. Application of $ZnSO_4$ produced significantly higher DM and CP yields as compared to no Zn (control). Application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha showed significantly higher DM accumulation as compared to Zn alone during 1988, 1989 and in pooled analysis indicating the addition effect of FYM. Zinc content of forage sorghum was higher in Zn levels having FYM as compared to those without FYM. Application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha significantly enhanced the Zn uptake by the crop as compared to Zn alone which ultimately increased DM and CP yields of sorghum. Among existing varieties, application of 25 kg $ZnSO_4$/ha alone and alongwith 10 T FYM/ha to the variety S.S.G. 59-3 gave 10 and 20 per cent higher CPY, respectively over control. Application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha to S.S.G. 59-3 showed the maximum total return *in vitro* dry matter digestibility and digestible dry matter whereas higher incremental cost benifit ratio of 1:4.47 was obtained when 25 kg $ZnSO_4$/ha was applied.

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INTRODUCTION

Dry matter production of forage sorghum varieties was increased due to application of zinc sulphate in the soil (Nair, 1980). Dangarwala *et al.* (1983) reported Zn status of soils of Kheda district, Gujarat State as deficient in 14 % , medium in 43 % and sufficient in 43 % of soils. zinc deficiency is not only adversely affects plant growth but also impairs health of milch animals. The use of organic manures may play a significant role in increasing the availability of Zn in deficient soil by formation of complexes with polyvalent cations. Relatively little work has been reported in Gujarat regarding the efficiency of zinc alone or in combination with FYM to forage sorghum. Thus, the experiment was conducted on multicut types of forage sorghum to find out the effect of zinc, with and without FYM on growth and forage production of sorghum during *summer* season.

TABLE 1

Green forage, dry matter and crude protein yields of forage sorghum genotypes as influenced by zinc levels with and without FYM (total of two cuts).

Treatments	Green forage yield (q/ha)				Dry matter yield (q/ha)				Crude protein yield (q/ha)			
	1987	1988	1989	Pooled	1987	1988	1989	Pooled	1987	1988	1989	pooled
Genotypes (G)												
AS-11 (G_1)	593	483	521	532	137.9	109.6	125.9	124.5	9.07	8.22	7.77	8.35
AS-15 (G_2)	615	714	535	621	149.6	172.4	132.4	151.5	8.15	11.33	8.62	9.37
AS-22 (G_3)	630	561	544	578	152.4	133.7	145.7	143.9	9.09	9.30	8.88	9.09
S-1049 (G_4)	329	304	385	339	82.5	86.6	121.4	96.8	7.46	7.82	9.23	8.17
M. P. Chari (G_5)	355	353	379	362	100.8	99.1	95.4	98.4	7.00	8.14	8.99	8.04
S.S.G. 59-3 (G_6)	399	400	386	395	99.2	101.2	103.2	101.2	7.43	9.12	9.68	8.74
S. Em. ±	30	108	77	45	7.6	3.9	7.9	8.7	0.70	0.45	0.53	0.58
C. D. at 5%	96	NS	NS	130	23.8	12.3	25.0	27.5	NS	1.43	NS	NS
Zinc levels (Zn_1)												
Control (Zn_0)	470	428	427	441	113.8	100.1	111.4	108.4	7.51	7.87	8.13	7.84
25 kg $ZnSO_4$/ha (Zn_1)	487	472	451	470	118.9	118.7	118.7	118.7	7.64	9.31	8.97	8.64
25 kg $ZnSO_4$ + 10 T FYM/ha (Zn_1 F)	537	515	514	522	128.8	133.8	138.8	133.8	8.58	9.96	9.32	9.29
50 kg $ZnSO_4$/ha (Zn_2)	467	454	462	461	114.7	117.1	122.9	118.2	7.85	8.72	9.32	8.63
50 kg $ZnSO_4$ + 10 T FYM/ha (Zn_2F)	507	477	437	473	125.8	115.8	111.3	117.7	8.58	9.07	8.57	8.74
S. Em. ±	21	90	70	39	5.2	3.8	4.8	2.7	0.37	0.37	0.48	0.24
C. D. at 5%	NS	NS	NS	NS	NS	10.8	13.7	7.4	NS	1.07	NS	0.66
Int. G x Zn	Sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	Sig.

MATERIALS AND METHODS

A field experiment was conducted during the *summer* seasons of 1987 to 1989 on an alluvial soil (Orchrept) having pH 8.3, low in N (163.3 kg/ha), medium in available phosphorus (38.1 kg P_2O_5/ha) and potassium (238 kg K_2O/ha), EC 0.22 mmhos/cm and low DTPA extractable Zn (0.54 ppm). A basal dose of 40 kg N/ha each of N and P_2O_5 was given as urea and superphosphate, respectively. Another 40 kg N/ha was given in two splits at thirty days and at first cut. The first and second cuts were taken at 50% flowering stage. There were six forage sorghum genotypes (AS-11, AS-15, AS-22, S-1049, M. P. Chari and S.S.G. 59-3) and five combinations of Zn, i.e. 0 kg $ZnSO_4$/ha, 25 kg $ZnSO_4$/ha, 25 kg $ZnSO_4$ + 10 T FYM/ha, 50 kg $ZnSO_4$/ha and 50 kg $ZnSO_4$ + 10 T FYM/ha (Zn_0, Zn_1, Zn_1F, Zn_2 and Zn_2F, respectively) in split plot design having three replications. After recording dry matter yield, the plant samples were digested in di-acid mixture as described by Jackson and Ulirich (1969). The acid extract was used for analysis of different nutrients viz. P and Zn. Phosphorus in the acid extract was determined by Vanadomolybdo phoshoric yellow colour method and Zn by acomic-absorption spectrophotometer. The total N was estimated from dry matter by conventional Kjeldhal's method. Subsequently the protein content of dry matter was computed for each treatment by multiplying its nitrogen percentage with conversion factor 6.25.

Recommended cultivation practices were followed for raising the crop.

RESULTS AND DISCUSSION

Green forage and dry matter yield

The results (Table 1) indicated that green forage yields of promising hybrids AS-11, AS-15 and AS-22 were found significantly superior than the existing varieties S-1049, M. P. Chari and S.S.G. 59-3 during the year 1987 and in the pooled in total yields of two cuts, however, all of them were at par. Promising hybrids AS-15 and AS-22 produced significantly higher dry matter yield as compared to the existing varieties, however, these were at par during all the individual years and in the pooled analysis. The higher

TABLE 2

Ineraction effect of G X Zn for crude protein yield (q/ha) on pooled basis (total of two cuts).

G/Zn	Zn_0	Zn_1	Zn_1F	Zn_2	Zn_2F
G_1	8.75	8.29	7.92	8.00	8.81
G_2	8.58	10.64	7.84	7.92	9.88
G_3	7.53	9.28	10.45	9.67	8.50
G_4	7.08	8.05	9.34	8.60	7.78
G_5	7.63	7.41	9.24	7.78	8.15
G_6	7.45	8.19	8.93	9.82	9.34
S. Em. ±		0.58			
C.D. at 5%		1.61			

TABLE 3

Zn content (first cut and second cut) in forage sorghum.

Treatment	Content in ppm							
	First cut				Second cut			
	1987	1988	1989	Pooled	1987	1988	1989	Pooled
Getotype								
G_1	24.95	24.61	22.02	23.86	17.82	18.78	17.78	18.13
G_2	22.68	20.99	18.50	20.72	9.40	13.35	12.36	11.70
G_3	26.43	26.71	23.11	25.42	14.42	14.28	13.47	14.05
G_4	22.84	25.99	22.74	23.86	6.97	12.86	12.09	10.64
G_5	25.76	25.86	23.04	24.89	5.67	12.52	14.14	10.78
G_6	22.36	24.33	22.10	22.93	12.31	13.77	14.39	13.49
S. Em. ±	0.82	0.70	0.67	0.42	0.90	0.32	0.70	1.09
C. D. at 5%	NS	2.54	2.45	1.28	3.28	1.16	2.55	3.43
Zinc level								
Zn_o	25.11	24.12	21.10	23.44	9.86	12.73	12.34	11.64
Zn_1	22.01	24.06	21.09	22.38	11.88	14.55	14.25	13.56
Zn_1F	23.63	25.40	22.59	23.87	9.45	15.32	14.68	13.15
Zn_2	23.90	23.70	21.14	22.91	11.34	14.14	14.10	13.19
Zn_2F	26.21	26.48	23.66	25.45	12.96	14.56	14.82	14.11
S. Em. ±	0.95	0.75	0.75	0.48	0.66	0.65	0.57	0.36
C. D. at 5%	NS	NS	NS	1.34	1.93	NS	NS	1.03

yield might be due to higher plant height. Hybrid AS-11 was at par with the existing varieties M. P. Chari and S.S.G. 59-3 for dry matter yield when results were pooled. Patel (1985) found that hybrid AS-15 yielded higher green forage (528 q/ha), dry matter (153 q/ha) and crude protein (6.61 q/ha) yields than M. P. Chari (402, 128.6 and 5.32 q/ha GF, DM & CP yields) and pioneer hybrid X-988 (437, 79.6 and 5.20 q/ha GF, DM and CP yields) during the *kharif* season of 1983 under Anand condition. Raj and Patel (1989) also reported that promising hybrid AS-15 produced significantly higher dry matter yield than M. P. Chari during the *summer* season of 1983 at the Forage Research Farm, GAU, Anand. Similar type of results were also observed by Patel and Patel (1988).

Effect of Zn

The green forage yield of forage sorghum increased markedly due to application of 25 kg and 50 kg $ZnSO_4$/ha over control during all the individual years and in the pooled but the differences were non-significant. Application of 25 kg and 50 kg $ZnSO_4$/ha produced significantly higher dry matter yield as compared to no application of Zn during 1989, and in pooled analysis but both these levels were at par. The reason for significant increase in the yield of dry matter due to application of zinc over no zinc as the soil contained deficient available zinc. Application of Zn significantly increased the Zn uptake by the crop, which in dry matter rose from 108.4 q/ha under no-zinc to 118.7 q/ha and 118.2 q/ha under 25 kg and 50 kg $ZnSO_4$/ha treatments, respectively. The crude protein yield also increased from 7.84 to 8.64 and 8.63 q/ha due to zinc application. The results are in accordance with the results reported by Hegde and Relwani (1974), Patel and Patel (1988), Tikande (1985) and Raj *et al.* (1989).

Promising hybrids AS-15 and AS-22 were found to be relatively more Zn responsive, S-1049 was least responsive and AS-11, M.P. Chari and S.S.G. 59-3 were medium in zinc response.

Application of FYM

In the presence of Zn at the rate of 25 kg $ZnSO_4$/ha, application of 10 T FYM/ha gave higher green forage yield as compared to Zn alone in two cut of three years but these differences were non-significant. The higher yield might be due to higher plant height. Application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha produced significantly higher dry matter yield as compared to Zn alone during 1988, 1989 and in pooled analysis indicating the addition effect of FYM. However, further increase in the rate of Zn application (50 kg $ZnSO_4$/ha) with 10 T FYM/ha reduced yield significantly during 1988, 1989 as well as on pooled basis, which might be due to nutrient imbalance in soil plant systems. The concentration of Zn in forage sorghum of first cut and second cut (Table 3) was higher in Zn levels having FYM as compared to those without FYM. The increase in Zn content by the application of FYM was due to production of complexing agents which form stable organometallic complexes with Zn that facilitates its efficient utilization by plants resulting in increased yield and concentration (Stevenson & Ardakani, 1972 and Patel and Patel, 1988).

The significantly higher phosphorus was removed by the genotype AS-15 than other genotypes except AS-11 and AS-22 in total of two cuts in pooled analysis (Table 4). Highest uptake of phosphorus was recorded for the treatment recording higher dry matter and crude protein yields of sorghum. Application of

TABLE 4

Phosphorus and Zn uptake of forage sorghum genotypes as influenced by zinc levels with and without FYM (total of two cuts).

Treatment	Phosphorus uptake (kg/ha)				Zn uptake (g/ha)			
	1987	1988	1989	Pooled	1987	1988	1989	Pooled
Genotypes								
G_1	50.93	40.00	36.30	42.41	298.3	260.2	253.1	270.6
G_2	50.37	59.83	46.85	52.28	220.2	283.9	227.0	243.7
G_3	49.44	45.66	50.00	48.33	302.0	260.9	301.3	288.1
G_4	31.11	35.93	43.89	36.98	119.8	170.9	200.4	163.7
G_5	40.74	39.44	34.63	38.27	160.9	184.6	180.2	175.2
G_6	34.63	38.00	31.30	34.82	172.8	199.4	184.8	185.7
S. Em. ±	1.35	2.97	3.69	3.26	8.3	8.1	20.1	16.3
C. D. at 5%	4.91	10.79	NS	10.27	30.1	29.5	73.0	51.5
Zn levels								
Zn_0	46.14	41.05	41.51	42.90	189.8	188.1	200.5	192.8
Zn_1	41.20	43.06	40.74	41.67	209.1	218.8	220.8	216.3
Zn_1F	45.83	48.30	44.44	46.19	223.0	270.5	264.0	252.5
Zn_2	41.51	42.75	39.51	41.26	190.9	226.9	220.8	212.9
Zn_2F	39.66	40.74	36.27	38.89	248.9	229.0	216.2	231.4
S. Em. ±	1.96	1.52	2.91	1.28	15.1	11.4	13.8	7.8
C. D. at 5 %	NS	4.43	NS	3.57	NS	33.3	NS	22.0

farmyard manure alongwith 25 kg $ZnSO_4$/ha caused a considerable and significant increase in uptake of P_2O_5 from the soil (46.19 kg/ha). In addition to being a source of P, farmyard manure is known to build up available P in the soil and improvement of certain physical characteristics of soil. Higher yield and uptake of phosphorus due to application of farmyard manure may be attributed to increasing availability of phosphorus from soils to plants (Sharma, 1987). Application of farmyard manure alongwith higher dose of Zn (50 kg $ZnSO_4$/ha) failed to increase in uptake of P_2O_5 from the soil might be due to nutrient imbalance in soil-plant systems. The significantly higher Zn uptake recorded by the genotype AS-22 than other genotypes except AS-11 and AS-22 in total of two cuts in pooled analysis. Among the existing varieties, S.S.G. 59-3 showed the higher Zn uptake than S-1049 and M. P. Chari in pooled analysis. Application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha significantly increased the Zn uptake by the crop, which in dry matter rose from 108.4 q/ha (no-zinc) to 133.8 q/ha. The crude protein yield was also increase from 7.84 to 9.29 q/ha due to 25 kg $ZnSO_4$ + 10 T FYM/ha.

Crude protein yield

Hybrid AS-15 showed higher crode protein than other genotypes, however, these differences were non-significant (Table 1) in total yield of two cuts in the pooled analysis. Application of 25 kg or 50 kg $ZnSO_4$/ha alone produced significantly higher crude protein yield than control (Tikande, 1985). In the presence of Zn 25 kg $ZnSO_4$/ha, application of 10 T FYM/ha gave 10.2 per cent higher yield as compared to Zn alone in pooled analysis indicating the addition effect of FYM. Higher

TABLE 5

Pooled green forage yield of S.S.G. 59-3 at 25 kg $ZnSO_4$/ha level alone and alongwith FYM and their economics.

Treatment	*Pooled GFY (q/ha)*	*Total return Rs/ha*	*Additional return over control Rs/ha*	*Additional Cost Rs/ha (Zn & FYM level)*	*Gross ICBR*	*Net ICBR*
S.S.G. 59-3 X No Zinc	341	10,230	—	—	—	—
S.S.G .59-3 X 25 kg $ZnSO_4$/ha	382	11,460	1,230	225	1:5.47	1:4.47
S.S.G. 59-3 X 25 kg $ZnSO_4$ + 10 T FYM/ha	428	12,840	2,610	725	1:3.66	1:2.66

Selling price of green forage yield of sorghum = Rs.30/0
Cost of zinc sulphate @ Rs.9/-kg
Cost of FYM @ Rs.50/- per Metric Tonnes.

TABLE 6

Chemical composition of S.S.G. 59-3 at 25 kg $ZnSO_4$/ha level alone and with FYM during *Summer*, 1989 season (calculated production of DDM on the basis of av. yield of DM of three years).

Treatments	*Per cent* IVDMD		*Production(q/ha)* DDM		
	1st cut	*2nd cut av.*	*1st cut*	*2nd cut*	*Total of two cuts*
S.S.G. 59-3 x No Znic	34.98	37.25 36.12	17.14	13.30	30.44
S.S.G. 59-3 X 25 kg $ZnSO_4$/ha	36.00	43.74 39.87	18.76	21.65	40.41
S.S.G. 59-3 X 25 kg $ZnSO_4$ + 10 T FYM/ha	49.60	39.96 44.78	26.69	22.50	49.19

IVDMD = *In Vitro* Dry Matter Digestibility.
DDM = Digestible Dry Matter.

dose of Zn alone (50 kg $ZnSO_4$/ha) and alongwith FYM did not show any effect over low dose of Zn alone or alongwith FYM but it was significantly superior than control.

Genotype X Zn interaction

Application of 25 kg $ZnSO_4$/ha synthesized higher crude protein by AS-15 and AS-22 as compared tp control indicating the effect of Zn (Table 2). Likewise, the application of 10 T FYM/ha alongwith 25 kg $ZnSO_4$/ha gave higher yield as compared to Zn alone indicating additional effect of FYM for hybrid AS-22 only.

Thus, from the present experiment, it was observed that promising hybrids were better as compared to the existing varieties, including local one. Application of 25 kg $ZnSO_4$ + 10 T FYM/ha can gave significantly higher dry matter and crude protein yields as compared to control.

Among existing varieties, application of 25 kg $ZnSO_4$/ha alone and 25 kg $ZnSO_4$ + 10 T FYM/ha to the sorghum variety S.S.G. 59-3 gave 10 and 20 per cent higher crude protein yield over no application of Zn on pooled basis (Table 2).

Data on economics presented in table 5 revealed that application of 25 kg $ZnSO_4$ alongwith 10 T FYM/ha to forage sorghum variety S.S.G. 59-3 produced the maximum total return Rs.12,840/- as compared to no application of Zn (Rs.10,230/-) and application of 25 kg $ZnSO_4$/ha alone (Rs.11,460/-).

Application of 25 kg $ZnSO_4$ alongwith 10T FYM/ha to forage sorghum variety S.S.G. 59-3 also showed the maximum IVDMD content (44.78 %) and DDM production (49.19 q/ha) as shown in Table 6.

These results suggest that *summer* forage sorghum grown on zinc deficient soils of middle Gujarat zone needs application of 25 kg ZnSO4 alone once in 3 years or 25 kg $ZnSO_4$ once in 3 years plus 10 T FYM/ha every year for quality forage production.

REFERENCES

Dangarwala, R. T., B. S. Trivedi, M. S. Patel and P. M. Mehta (1983). Micronutrient Research in Gujarat, Gujarat Agric. Univ., Anand, Gujarat.

Hegde, B. P. and L. L. Relwani (1974). Effect of different levels of nitrogen and zinc on yield and quality of *Jowar* (*sorghum bicolor*) fodder. *Indian J. agric. Res.* **8** : 17-24.

Jackson, M. L. and A. Ulrich (1969). Analytical methods for use in plant analysis, California Agric. Exp. Stn, Bull. 766.

Nair, K. B. (1980). *Jowar*, ICAR, New Delhi, Low Priced Book Series No.6 p. 85.

Patel, P.C. (1985). Effect of nitrogen and zinc on forage yield, content and uptake of nutrients by hybrid forage sorghum (*Sorghum bicolor* (L.) Moench). M. Sc.(Agri.) thesis submitted to G.A.U., Anand (Unpublished).

Patel, P. C. and J. R. Patel (1988). Effect of zinc with and without organic manures on growth and zinc nutrition of different genotypes of forage sorghum. *J. Indian Soc. Soil Sci.* **36** : 820-822.

Raj, M. F. and B. K. Patel (1989). Influence of nitrogen on the content of different nutrients and their uptake by forage sorghum. *GAU Res. J.* **14** (2) : 82-95.

Raj, M. F., B. K. Patel and P. C. Patel (1989). Effect of zinc on yield and nutrient content of sumner forage sorghum. *G.A.U. Res. J.* **14** (2) : 79-81.

Sharma, R. A. (1987). Effect of phosphorus application on rainfed sorghum in vertisol of Indore. *J. Indian Soc. Soil Sci.* **35** : 158-60.

Stevenson, F. J. and M. S. Ardakani (1972). Micronutrients in Agriculture, Am. Soc. Agron., Madison, Wisconsin, USA.

Tikande, B. B. (1985). Effect of soil and foliar application of zinc on the yield and uptake of nutrients by sorghum CSH-9. *Thesis abst.* **11** (3) : 234.