

Response of Dryland Sorghum to Sulphur Application

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Abstract : A field experiment was conducted during *kharif* seasons from 1989 to 1992 to study the effect of sulphur on dryland sorghum grown on a Typic Ustipsamments deficient in available S. Three sources of S, viz., ammonium sulphate (AS), gypsum (GS) and elemental sulphur (ES) were tested at 20, 40, 60 and 80 kg S ha⁻¹ levels along with two controls. A significant fodder yield response to S was obtained only when the rainfall distribution was favourable (895 mm, 41 rainy days) and yield levels were high. Application of 20 kg S ha⁻¹ through gypsum or elemental sulphur, or use of ammonium sulphate to supply 80 kg N ha⁻¹, was found advantageous, both from yield and economic points of view.

Key words : Sorghum, sulphur source, sulphur uptake, dryland.

Sulphur is emerging as an important major nutrient on account of its widespread deficiency, particularly in light textured soils. Large S deficient area, even in dryland has been reported in sandy soils of North Gujarat (Patel and Kalyanasundaram, 1988). In the present experiment, response of dryland sorghum to S application was studied.

Materials and Methods

A field experiment was conducted for four consecutive years from 1989, at different sites during *kharif* seasons, using sorghum (Cv. Malvan) as a test crop at AICRP for Dryland Agriculture centre, Sardar Krushinagar, in RBD with four replications. There were 16 treatments of which, 12 treatments consisted of three sources of S, viz., ammonium sulphate (AS), elemental sulphur (ES) and gypsum (GS), each at four levels, i.e., 20, 40, 60 and 80 kg ha⁻¹. The AS was applied in two equal splits, half as basal and half as top dress, at 30 days after sowing (DAS). In addition, there were two S levels, viz., 20 and 40 kg S ha⁻¹ through ammonium sulphate applied entirely as basal. The remaining two treatments were controls, one receiving N only in the form of urea and another receiving Ca equivalent to 40 kg S ha⁻¹, supplied through GS. The soils of experimental plots were alkaline in reaction, non-saline, low in organic carbon as well as available S content and well supplied with available

P (14 to 51 kg P ha⁻¹) and K (164 to 285 kg K ha⁻¹).

The N was applied at the recommended level of 80 kg ha⁻¹, in two equal splits, i.e., half as basal and half as top dress, at 30 DAS. The amount of N added through ammonium sulphate was taken into account and the deficit was added through urea. Application of P and K was not done as experimental plots were well supplied with available P and K. The dry matter yield of fodder was recorded at harvesting. The soil and plant samples were collected at the time of harvesting. Heat soluble S content in soil (William and Steinbergs, 1959) and S concentration in sorghum plant (Chaudhary and Cornfield, 1966) were determined using turbidimetric method.

Results and Discussion

The yield differences were significant for the year 1990, when the rainfall distribution was favourable and the yield levels were high (Table 1). Since the soil was deficient in available S (5.5 ppm), this was expected. In other three years also, the soil was deficient in available S (5 to 6.8 ppm), but rainfall distribution was not good during the years 1989 and 1992, and the rainfall was very low during 1991 resulting in low fodder yield. During these three years, the coefficient of variability (C.V.) was high and a significant response to S could not be obtained. The pooled

Table 1. Dry fodder yield ($t\ ha^{-1}$) of sorghum as influenced by the sources and rates of S application

Treatment	Year				Pooled	Cost - Benefit ratio
	1989	1990	1991	1992		
*AS ₂₀	6.19	13.81	2.86	3.82	6.67	1:12
*AS ₄₀	5.12	13.81	2.14	3.93	6.25	1:13
*AS ₆₀	6.35	13.97	3.87	4.32	7.12	1:6
*AS ₈₀	6.49	16.51	3.77	5.19	7.99	1:8
AS ₂₀	5.71	14.60	2.56	3.59	6.62	1:11
AS ₄₀	5.75	13.65	3.87	3.95	6.81	1:7
ES ₂₀	5.02	16.19	2.78	3.48	6.87	1:7
ES ₄₀	4.64	18.41	2.02	3.71	7.20	1:3
ES ₆₀	4.58	16.35	4.36	4.75	7.51	1:2
ES ₈₀	6.23	17.62	2.48	3.70	7.51	1:2
GS ₂₀	5.24	16.03	3.57	3.56	7.10	1:54
GS ₄₀	5.38	17.14	2.09	4.00	7.15	1:28
GS ₆₀	5.44	16.19	4.56	4.15	7.59	1:25
GS ₈₀	6.19	17.46	1.56	2.64	6.97	1:12
Ab - control	5.32	12.06	2.98	2.97	5.83	-
Ca - control	4.70	12.70	4.17	3.33	6.22	-
CD (5%) T	NS	2.24	NS	NS	NS	-
YxT	-	-	-	-	1.89	-
CV(%)	19.80	10.20	54.00	24.20	19.40	-
Rainfall (mm)	778.0	895.4	288.4	1518.2	-	-
Rainy days	26	41	20	34	-	-
Heat soluble S (ppm)	5.00	5.50	6.00	6.85	-	-

* Applied in two equal splits.
 ES Elemental sulphur (85% S), Rs. 9.40 kg^{-1} .
 Urea Rs. 3.00 kg^{-1} .

AS Ammonium sulphate (24% S), Rs. 2.12 kg^{-1} .
 GS Gypsum (16% S), Rs. 0.15 kg^{-1} .
 Dry fodder Rs. 0.80 kg^{-1} .

analysis also showed a high C.V. and a non-significant response to S application. The interaction Y x T was significant but did not indicate a significant variation in fodder yield during the years 1989, 1991 and 1992.

During 1990, among AS treatments, AS₈₀ gave the maximum yield; among ES levels, ES₄₀ gave significantly higher yield over ES₂₀ and among GS levels, increase above GS₂₀ was not significant. The need for higher amount of AS (AS₈₀) to get the same yield due to GS₂₀ and ES₂₀ may be due to higher solubility of AS and consequent leaching loss in sandy soils.

A significant yield response to AS₈₀, ES₂₀ and GS₂₀ was evident and the yield increase was 36.9, 40.1 and 32.9%, respectively, over the

absolute control. The per cent yield increase over the control, due to AS₈₀ in other three years was, 22.0, 26.5 and 74.7; that due to GS₂₀ was 19.8 and 19.9 during 1991 and 1992, and that due to ES₂₀ was, 17.2 during 1992. Their failure to reach statistical level of significance may be attributed to high C.V. The cost-benefit ratios, averaged over the four years for AS₈₀, GS₂₀ and ES₂₀ were 1:8, 1:54 and 1:7 (Table 1) indicating an overall economic benefit.

The results suggest that to harvest maximum yields during good rainfall years, application of S is needed. Since S application is known to leave a considerable residual S in soil (Tandon, 1991) and more so in the case of drought years, practice of fertilizing S deficient dryland soils,

Table 2. Sulphur content (pooled over 4 years) in plant and soil under different treatments

Treatment	S Content in fodder (%)	S uptake (kg ha ⁻¹)	Heat soluble S content in soil after crop harvest (ppm)
*AS ₂₀	0.077	4.09	12.1
*AS ₄₀	0.086	4.08	13.0
*AS ₆₀	0.082	4.72	13.6
*AS ₈₀	0.083	5.40	17.5
AS ₂₀	0.088	4.43	15.5
AS ₄₀	0.091	5.24	17.6
ES ₂₀	0.095	5.15	16.8
ES ₄₀	0.095	5.17	18.2
ES ₆₀	0.113	5.38	19.1
ES ₈₀	0.099	6.09	17.9
GS ₂₀	0.102	5.61	16.3
GS ₄₀	0.101	5.47	17.1
GS ₆₀	0.096	5.76	18.6
GS ₈₀	0.103	5.54	18.4
Ab—control	0.062	2.89	10.2
Ca—control	0.067	3.58	10.0
CD(5%)T	0.0108	1.09	2.3
YxT	0.0217	2.19	4.7
CV(%)	17.33	31.40	21.1

* Applied in two equal splits.

once in 3 to 5 years, can be advantageous. Such an approach is practicable, because rainfall status during a year can not be predicted accurately in advance to decide application, but a favourable rainfall once in a few years is common.

The data on increase in available S content (Table 2) due to AS₈₀, ES₂₀ and GS₂₀ indicate a substantial increase after one crop, and this increase can be expected to maintain S fertility for the next few years (Patel *et al.*, 1993). Increase in S content in fodder and S uptake (Table 2) by the crop, due to these treatments, was also significant.

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