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Effects of Gypsum as a Sulphur Fertilizer in Cotton (*Gossypium hirsutum* L.) Production

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ABSTRACT

Experiments were conducted on cotton variety CIM-109 to study its responses to gypsum as sulphur source at various locations in the Punjab. Preliminary results showed positive increase in seed cotton yield due to the application of 50 kg gypsum per hectare. These responses were obtained in soils having plough pan and sulphate - sulphur (SO_4-S) availability in the range of 8-10 mg kg^{-1} of soil.

Key Words: Gypsum; Sulphur fertilizer; Cotton

INTRODUCTION

Soil tests carried out in the Punjab indicated a general sufficiency level of sulphur to cater for plant needs but 25% of cultivated area has SO_4-S < 10 mg kg^{-1} of soil, which is critical threshold for most crops (Ahmad *et al.,* 1992). High soil pH, light textured soils, low level of organic matter besides development of plough pan further aggravates the availability of sulphur to growing crops (Hue *et al.*, 1984). Sulphur shortage often impedes protein synthesis leading to accumulation of soluble nitrogen compounds. These compounds cause leaf crinkling and other morphological abnormalities (Tiwari *et al*., 1997). Total sulphur requirement of cotton may approach the level of phosphorus. Cotton absorbed 12-15 kg ha^{-1} of sulphur and for adequate nutrition 0.2% SO_4-S was desired in cotton petioles and leaves during mid-season (Jordan & Ensminger, 1958). Proteolysis hardly occurs during sulphur starvation of cotton plant (Ergle & Eaton, 1951; Ergle, 1954). Cotton yield was significantly increased due to added sulphur @ 22 kg ha^{-1} (Matthews, 1972) or 11 kg ha^{-1} (Messick, 1992). Fertilizers, which have hitherto contained sulphur as a combining ingredient, are being replaced with high analysis fertilizer that are low in sulphur. Crop intensity has increased and determinate cotton varieties which develop nutrients demand more rapidly are common in culture. This necessitated to conduct preliminary trials on sulphur nutrition of cotton crop in the cotton growing areas of the Punjab to improve the efficacy of fertilizer recommendations to farmers.

MATERIALS AND METHODS

Field studies were conducted for two seasons in 1992-94, at three locations in the cotton growing areas of the Punjab. The soil samples were collected before planting crop from the plough layer of the experimental sites and analysis carried out as per methods described by Jackson (1958). The range of values for physical and chemical characteristics of experimental sites has been presented in Table I. Cotton cutlivar CIM-109 was planted during 28th May to 6th June at a spacing of 75 cm between rows and 30 cm between plants in the rows. The layout of the experiment was randomized complete block and had four replications. The area of each plot was 105 m^2. Gypsum as source of sulphur at the rate of 0, 50, 100 and 200 kg ha^{-1} was broadcast and incorporated in the soil at the time of seedbed preparation. All experimental units also received 50 kg P_2O_5 ha^{-1} as diammonium phosphate at planting and 150 kg N ha^{-1} as urea in three splits i.e. planting, flowering and peak flowering stages. Crop received normal irrigation and standard production practices of the area were followed during the season. The crop was kept free of pests through scheduled spray during the season. The seed cotton was harvested from a net plot size of 4 x 20 m^2 area and yield corrected on hectare basis. Seed cotton yield and its components i.e. number of bolls per plant and boll weight were recorded from 10 consecutive plants in each treatment. The lint samples for fibre quality were collected by harvesting five random plants from one square metre area in each plot at maturity stage. Fibre characteristics were determined in the laboratory by employing methods given

Table I. Soil Characteristics of experimental sites (0-30 cm depth)

Locations	pHs	Organic matter (%)	$NaHCO_3$ "P" (mg kg^{-1})	NH_4OAc "K" (mg kg^{-1})	$CaCl_2$ "SO_4-S" (mg kg^{-1})	Texture
Sahiwal	8.1-8.3	0.48-0.56	9-13	190-220	7-9	Sandy silt loam
Bahwalpur	8.2-8.4	0.53-0.67	12-14	222-248	9-10	Sandy silt loam
Multan	8.0-8.2	0.61-0.75	8-10	197-241	8-10	Silty loam

by Morton and Hearle (1975). Data obtained were subjected to statistical analysis (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Seed cotton yield, number of bolls per plant and boll weight showed significant response to sulphur fertilization (Table II). The addition of 50 to 100 kg ha^{-1} of gypsum improved seed cotton yield at all locations during both crop seasons. The response at three locations could be ascribed to deep sandy profile and low organic matter of the soil. Results obtained in this experiment fully demonstrate sulphur need for cotton crop in soil having about 10 mg kg^{-1} of SO_4-S. The increase in yield due to application of gypsum as source of sulphur has been obtained in several cotton growing areas of the world (Mathews, 1972; Mascagni *et al*., 1991; Tandon, 1995).

Seed cotton yield was significantly higher at different doses of gypsum compared to control (Table III). On the percentage basis, there was 5, 9 and 12% increase in seed cotton yield, respectively over control. This indicated that the gypsum application promoted plant growth through an adequate supply of sulphur nutrient and also the other nutrients imperative for cotton growth. Seed cotton yield increased with increasing level of gypsum. Throughout the experimental period, top yield was obtained where gypsum

Table II. Effects of gypsum doses on seed cotton yield and its components at different locations during 1992-1994

	1992-93			1993-94		
Gypsum doses (kg ha^{-1})	**Seed cotton Yield (kg ha^{-1})**	**Number of bolls Plant^{-1}**	**Boll weight (g)**	**Seed cotton Yield (kg ha^{-1})**	**Number of bolls Plant^{-1}**	**Boll weight (g)**
(A) Sahiwal						
0	1537	15	2.46	1951	18	2.30
50	1588	16	2.51	2023	21	2.67
100	1645	17	2.57	2141	21	2.82
200	1780	18	2.62	2176	22	2.91
LSD ($p<0.05$)	73.8	0.67	0.06	122.9	2.7	0.34
(B) Bahawalpur						
0	2617	24	2.72	1591	21	2.48
50	2741	28	2.90	1688	22	2.57
100	2905	28	3.00	1720	23	2.63
200	2925	29	3.00	1777	24	2.67
LSD ($p<0.05$)	110.6	3.0	0.17	29.1	1.8	0.12
(C) Multan						
0	2105	21	2.47	2085	22	2.46
50	2254	23	2.66	2230	25	2.57
100	2314	24	2.70	2239	26	2.63
200	2370	24	2.77	2260	26	2.70
LSD ($p<0.05$)	65.9	1.6	0.17	100.5	2.4	0.08

Table III. Effect of gypsum doses on seed cotton yield and its components (mean of three locations)

Gypsum Doses (kg $ha^{-1)}$	**Season**		**Mean**	**Per cent Increase Over Control**	**Increase per kg Gypsum**
	1992	**1993**			
(a) Seed Cotton Yield (kg ha^{-1})					
0	2086	1876	1981	-	-
50	2194	1980	2087	5	2.1
100	2288	2033	2161	9	1.8
200	2358	2071	2215	12	1.2
LSD (Years) $p<0.05$ = 25.97					
LSD (Locations) $p<0.05$ = 31.81					
LSD (Treatments) $p<0.05$ = 32.38					
(b) Number of Bolls Plant^{-1}					
0	20	20	20	-	-
50	22	23	23	15	-
100	23	23	23	15	-
200	24	24	24	20	-
LSD (Years) $p<0.05$ = 0.60					
LSD (Locations) $p<0.05$ = 0.73					
LSD (Treatments) $p<0.05$ = 0.79					
(c) Boll Weight(g)					
0	2.55	2.41	2.48	-	-
50	2.69	2.60	2.65	6.9	-

was applied @ 200 kg ha^{-1}. There was 2.1, 1.8 and 1.2 kg increase in seed cotton yield per kg of applied gypsum at the levels of 50, 100 and 200, respectively.

Lint samples analyzed for quality showed a little variation due to gypsum application (Table IV). The reason being that genetic and climatic factors exert so much influence on fibre quality that a little direct effect from sulphur can be elucidated (Malik & Baluch, 1978; Mullins, 1996).

Table IV. Effects of different doses of gypsum on fibre quality (mean of two seasons) Location : Multan

Gypsum Doses (kg ha^{-1})	Fibre length (mm)	Uniformity ratio (%)	Fineness (µg inch^{-1})	Fibre strength (000 lbs/ inch^2)
0	25.6	46.2	4.6	92.5
50	25.8	46.4	4.6	93.6
100	25.5	46.4	4.6	93.6
200	25.7	46.2	4.5	93.1
Stat. Sig.	N.Sig.	N.Sig.	N.Sig.	N.Sig.

Keeping in view these trials, it is recommended to apply 100 to 200 kg ha^{-1} of gypsum in soils having alkaline pH, low organic matter and deep sandy profile for sustainable cotton production.

Table V. Economic analysis

Gypsum Doses (kg ha^{-1})	Seed cotton yield (kg ha^{-1})	Increase in yield over control (kg ha^{-1})	Cost of fertilizer (Rs. ha^{-1})	Value of increased yield (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Value cost ratio
0	1981	-	-	-	-	-
50	2087	106	50	1272	1222	25.0
100	2161	180	100	2160	2060	22.0
200	2215	234	200	2400	2200	12.0

Cost of gypsum @ Rs.1.00 kg^{-1}, value of seed cotton @ Rs.12.00 kg^{-1}

Economic analysis (Table V) shows that highest net return of Rs. 2128 ha^{-1} with value cost ratio of 11.6 was achieved through the addition of gypsum @ 200 kg ha^{-1}, followed by gypsum @ 100 ha^{-1} having net return of Rs. 1976 ha^{-1} and a value cost ratio of 20.8. Hence, it is recommended that gypsum @ 100 to 200 kg ha^{-1} should be applied to get the best economic yield of cotton.

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