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Multinutrient Supersulphate - SG100 as a Sulphur Fertilizer for Sustainable Cotton Production

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ABSTRACT

Studies were carried out to evaluate the response of cotton to Multinutrient Supersulphate-SG100 as a sulphur fertilizer under field conditions. The treatments consisted of 0, 125, 250, 375 and 500 kg Multinutrient Supersulphate-SG100 per hectare. Cotton cultivar CIM-446 was planted in the last week of May in a randomized complete block design and had four replications. All experimental units also received 50 kg P_2O_5 ha^{-1} at planting and 150 kg N ha^{-1} in three split doses i.e. planting, flowering and peak flowering stages. The crop was kept free of pests with scheduled sprays and standard crop husbandry practices of the area were followed during the season. Experimental results showed significant increase in seed cotton yield due to application of multinutrient supersulphate. The addition of 125 kg supersulphate per hectare seemed sufficient to overcome sulphur deficiency in silt loam soils for optimum cotton production. The petiole sulphate-sulphur concentration increased with increasing doses of supersulphate fertilizer. These responses were obtained in soils having sulphate-sulphur (SO_4-S) availability of 8-10 mg kg^{-1} of soil.

Key Words: Multinutrient; Sulfur fertilizer; Cotton

INTRODUCTION

Nitrogen and phosphorus are most commonly used fertilizers in cotton crop. The fertilizer use of other nutrients is almost minimal. The secondary element sulphur is important for maximum cotton yield. However, cotton crop in general shows a sporadic response to added sulphur. Total sulphur taken up by cotton crop in different areas of the world ranges from 7 to 33 kg ha^{-1}. Deficiency symptoms occur when soils have available SO_4-S less than 10-15 mg kg^{-1} of soil (Hearn, 1981). Sulphur deficiencies are most likely to occur on light textured soils or in areas where root system is confined largely to upper surface soil because of compaction or perched water table (Hue *et al.,* 1984). Sulphur in soils is mostly associated with organic matter. Once mineralized from soil, it becomes readily available to plants. Rain, irrigation water and atmospheric sulphur also contribute to sulphur resources (Nabi *et al.,* 1990; Ahmad *et al.,* 1992).

Apprehension exists that sulphur content of the Punjab soils are depleting due to use of high analysis sulphur-free fertilizer and intensive agriculture. High soil pH, low level of organic matter, besides development of plough pan, further aggravates the availability of sulphur to growing crops. Studies conducted on cotton revealed that it required continuous supply of sulphur for normal growth and development. Proteolysis hardly occurs during sulphur starvation of cotton plant (Ergle & Eatin, 1951; Ergle, 1954). Experiments conducted on cotton in Malawi showed significant increase in yield due to added sulphur at the rate of 22 kg ha^{-1} (Mathews, 1972). Cotton growers in South Carolina invariably add 11 kg ha^{-1} of sulphur to obtain maximum cotton yield (Messick, 1992). Analysis of fine, mixed, hypothermic Typic Camborthid soils "Pucca soil series" from Multan region have indicated 10-22 mg kg^{-1} of available sulphur (Ahmad, 1994). This necessitated conducting trials on sulphur nutrition of cotton crop to improve the accuracy of fertilizer recommendations at farmers' fields.

MATERIALS AND METHODS

Experiment was conducted at Central Cotton Research Institute, Multan during crop season 2000-2001. Soil samples were collected before planting crop from the plough layer of the experimental site and analysis carried out as per methods described by Jackson (1962). The range of values for physical and chemical characteristics of the site are presented in Table I.

Table I. Physical and chemical characteristics of the experimental site at planting stage (at 0-30 cm soil depth)

Parameters	Values
pHs	8.30
ECe (d Sm^{-1})	2.12
Organic Matter (%)	0.46
Total Nitrogen (%)	0.03
NO_3-N (mg kg^{-1})	8.20
$NaHCO_3$-"P" (mg kg^{-1})	7.90
NH_4OAc-"K" (mg kg^{-1})	121.70
AB-DTPA-"Zn" (mg kg^{-1})	0.47
Hot Water-"B" (mg kg^{-1})	0.38
$CaCl_2$-"SO_4-S" (mg kg^{-1})	8.10
Textural Class	Silt loam

Fertility rating indicate low level of organic matter, poor supply of nitrogen, low to marginally adequate supply of phosphorus and sulphur and sufficient level of potassium for cotton production. Chemical composition of Multinutrient Supersulphate - SG100 is: Zinc sulphate 2%, Ferrous sulphate 2%, Magnesium sulphate 0.5%, Calcium (from $CaSO_4$) 16%, Sulphur (from $CaSO_4$) 14%, Organic Matter 22%.

Cotton cultivar CIM-446 was planted in the last week of May 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. Multinutrient Supersulphate -SG100 as a source of sulphur was applied and its doses consisted of 0, 125, 250, 375, 500 kg ha^{-1}, all broadcasted 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. at planting, flowering and peak flowering stages. The crop was kept free of pests through scheduled spray during the season. Crop received normal irrigation and standard production practices of the area were followed during the season.

The petiole samples for sulphate-sulphur assay were collected at flowering stage consisting of fully expanded young leaves, usually 4th or 5th from the terminal. The samples were analyzed for SO_4-S according to methods of (Yoshida *et al.,* 1976). The seed cotton was harvested from a net plot size of 4 x 20 m area and yields corrected on hectare basis. Seed cotton yield components, i.e. number of bolls per plant and boll weight were recorded on 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 by (Morton & Hearle, 1975). Data obtained were subjected to statistical tests as per methods described by (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Data presented in Table II indicate significant increase in seed cotton yield, number of bolls and boll weight due to different doses of Supersulphate as a source of sulphur. The increase in seed cotton yield resulted due to increase in number of bolls per plant and boll weight. The addition of gypsum resulted in about 7% increase in seed cotton yield. The seed cotton yield ranged from 1865 to 2000 kg ha^{-1}. It seems that addition of 125 kg gypsum ha^{-1} could cater the need and to overcome hidden hunger of sulphur for sustainable cotton production. The significant increase in yield due to application of sulphur has been obtained in several cotton growing areas of the world (Mathews, 1972; Mascagni *et al*., 1991; Tandon, 1995; Malik *et al*., 2000).

Total dry matter production and plant structure are among some of the parameters often used to evaluate usefulness of fertilizer dose. Data presented in Table III indicate that dry matter yield and plant height increased with addition of Supersulphate. The higher number of nodes on main stem is concomitant to greater number of sympodium, higher foliage and large plant structure. These canopy characteristics often result in higher dry matter yield per unit land area. Hearn (1981) has reported similar response to sulphur fertilizer in cotton plant.

Table II. Effect of supersulphate on seed cotton yield and its components

Supersulphate Doses (kg ha^{-1})	Seed cotton yield (kg ha^{-1})	Number of bolls plant^{-1}	Boll weight (g)
0	1865	19	3.12
125	1955	21	3.33
250	1990	22	3.36
375	1995	22	3.40
500	2000	22	3.40
LSD (P < 0.05)	40.7	0.91	0.12

Table III. Effect of supersulphate on dry matter yield and plant structure at maturity stage

Supersulphate Doses (kg ha^{-1})	Dry matter yield (g m^{-2})	Main stem height (cm)	Number of nodes on main Stem	Internodal length (cm)
0	789	103	29	3.52
125	853	119	31	3.82
250	888	129	32	4.04
375	891	134	32	4.17
500	899	136	32	4.21
LSD (P < 0.05)	41.05	10.28	2.15	0.42

The production of fruiting positions is dependent on vertical and horizontal growth of cotton plant. Data presented in Table IV indicate significant increase in fruiting positions and intact fruit brought about by application of sulphur fertilizer. These results agree with those of (Hearn, 1981; Guinn, 1998).

Sulphur concentration in leaf tissues at flowering stage increased due to application of supersulphate at planting time (Table V). The highest concentration of sulphur was observed in treatment receiving 500 kg supersulphate ha^{-1}. The increase in concentration of sulphur resulted in increase in yield. Similar results have been reported by (Zehler *et al*., 1981; Hodges, 1991).

Table IV. Effect of supersulphate on fruit production at maturity stage

Supersulphate Doses (kg ha^{-1})	Total number of fruiting positions m^{-2}	Total number of intact fruit m^{-2}	Fruit shedding (%)
0	375	93	75
125	405	111	74
250	437	121	72
375	457	129	72
500	468	133	72
LSD (P < 0.05)	38.05	13.60	0.96

Table V. Effect of supersulphate on SO_4-S in leaf petioles at peak flowering stage

Supersulphate Doses (kg ha^{-1})	SO_4-S (µg g^{-1} d.w.)
0	2137
125	2225
250	2258
375	2289
500	2313

Lint samples analyzed for quality showed a little variation due to supersulphate application (Table VI). The reason being that fibre characteristics are determined primarily by the genetic make-up of variety (Malik & Baluch, 1978; Mullins, 1996). Moreover, environmental factors apparently exert so much influence on fibre quality that little effect from sulphur can be elucidated, unless availability of nutrients in soil is extremely low.

Table VI. Effect of supersulphate on fibre characteristics

Supersulphate Doses (kg ha^{-1})	Fibre length (mm)	Uniformity ratio (%)	Fineness (ug $inch^{-1}$)	Fibre strength (000 lbs $inch^{-1}$)
0	26.6	46.2	4.6	92.5
125	26.1	46.4	4.6	93.6
250	26.5	46.4	4.6	93.6
375	26.7	46.5	4.6	93.1
500	26.7	46.4	4.5	93.4
LSD ($P < 0.05$)	N.Sig.	N.Sig.	N.Sig.	N.Sig.

Economic analysis (Table VII) shows that highest net return of Rs.1819 ha^{-1} with value cost ratio of 3.6 was achieved through the addition of 250 kg Supersulphate, followed by 125 kg ha^{-1} having a net return of Rs. 1603 ha^{-1} and a value cost ratio of 3.8. Hence, it is recommended that supersulphate at the rate of 125 to 250 kg ha^{-1} should be applied to get the best economic yield of cotton.

Table VII. Economic analysis

Supersulphate 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	1865	-	-	-	-	-
125	1955	90	575	2178	1603	3.8
250	1990	125	1150	2969	1819	3.6
375	1995	130	1725	3088	1363	1.8
500	2000	135	2300	3206	906	1.4

Cost of Supersulphate - SG100 @ 4.60 kg^{-1}; value of seed cotton @ Rs.23.75 kg^{-1}.

CONCLUSIONS

The optimum Multinutrient Supersulphate - SG100 dose was 125 kg ha^{-1} to obtain maximum yield. Plant analysis indicated that SO_4-S concentration of 2225 ug g^{-1} d.wt. at flowering stage was appropriate enough for harvesting good yield.

REFERENCES

Ahamad, N., M.T. Saleem, M. Rashid and J. Jalil, 1992. Sulphur status of Pakistan Soils. *NFDC Publication No. 7/92,* Islamabad.

Ahmad, N., 1994. Sulphur status and crop response in Pakistan soils. *NFDC Publication No.2/94.* Islamabad.

Ergle, D.R., 1954. Utilization of storage sulphur by cotton and the effect on growth and chlorophast pigments. *Bot. Gaz.,* 115: 225–34.

Ergle, D.R. and F.M. Eaton, 1951. Sulphur nutrition of cotton. *Plant Physiol.,* 26: 639–54.

Gomez, A.A. and K.A. Gomez, 1984. *Statistical Procedures for Agricultural Research.* 2nd ed. John Wiley & Sons, Inc. New York, USA.

Guinn, G., 1998. Causes of square and boll shedding. *Proc. Beltwide Cotton Conferences,* National Cotton Council, Memphis, TN, USA pp. 1355-1364.

Hearn, A.B., 1981. Cotton Nutrition. *Field Crop Abstr.,* 34: 11–34.

Hodges, S.C., 1991. Nutrient uptake by cotton. *Proc. Beltwide Cotton Conf.* National Cotton Council, Memphis, TN, USA. pp. 938–40.

Hue, N.V., F. Adams and C.E. Evans, 1984. Plant available sulphur as measured by soil solution sulphate and phosphate extractable sulphate in a Ultisol. *Agron. J.,* 76: 726–30.

Jackson, M.L., 1962. *Soil Chemical Analysis.* Constable & Co., London.

Malik, M.N. and Z.A.M. Baluch, 1978. Effect of environment and cultural practices on cotton yield. *The Pakistan Cottons,* 22: 161–91.

Malik, M.N.A., M.I. Makhdum and F.I. Chaudhry, 2000. Sulphur fertilization of field grown cotton (*Gossypium hirsutum* L.). *The Pakistan Cottons* (in press).

Mathews, G.A., 1972. Effects of nitrogen, sulphur, phosphorus and boron on cotton in Malawi. *Exptl. Agric.,* 8: 219–24.

Mascagni, H.J., W.E. Sabbe, R.L. Maples, M.E. Terhune and W.N. Miley, 1991. Influence of sulphur on cotton yield on a sandy soil. *Proc. Beltwide Cotton Conf.* National Cotton Council, Memphis, T.N. USA pp. 928–30.

Messick, D.L., 1992. Soil test interpretation for sulphur in the United States - an overview. *Sulphur in Agriculture,* 16: 24–5.

Morton, W.E. and J.W.S. Hearle, 1975. *Physical Properties of Textile Fibres.* The Textile Institute, London.

Mullins, G.L., 1996. Cotton response to rate and source of sulphur on a coastal plain soil. *Proc. Beltwide Cotton Conferences,* National Cotton Council, Memphis, T.N. USA pp. 1432–4.

Nabi, G., Rahmat Ullah and M. Saleem, 1990. Sulphur fractions and their extractability in some arid and semi-arid soils of Pakistan. *Tropical Agriculturist,* 146: 45–55.

Tandon, H.L.S., 1995. Sulphur in Indian Agriculture: Update 1995. *Sulphur in Agriculture,* 19: 3–8.

Yoshida, S; D.A. Forno, J.H. Cock and K.A. Gomez, 1976. *Laboratory Manual for Physiological Studies in Rice.* 2nd ed. International Rice Research Institute, Philippines.pp.70.

Zehler, E., H. Kreepe and P.A. Getting, 1981. Potassium sulphate and potassium chloride. Their influence on the yield of cultivated plants. International Potash Institute, Switzerland. *IPI Research Topic* # 9, 1–108 pp.

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