The Pharma Innovation Journal 2021; 10(5): 399-402

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10 (5): 399-402

www.thepharmajournal.com
Received: 05-02-2021
Accepted: 18-03-2021

R Raghunath
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

P Saravana Pandian
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

PP Mahendran
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Kudumiyanmalai, Tamil Nadu, India

T Ragavan
Coastal Saline Research Centre, Tamil Nadu Agricultural University, Ramanathapuram, Tamil Nadu, India

R Geetha
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

Corresponding Author:
R Raghunath
Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India

Effect of sulphur on growth and yield attributes of sugarcane in sulphur deficient soils of Kaalaiyarkovil block of Sivagangai district

R Raghunath, P Saravana Pandian, PP Mahendran, T Ragavan and R Geetha

Abstract
A field experiment was conducted with twelve treatments to evaluate the effect of sulphur on growth, yield attributes and yield of sugarcane in a sulphur-deficient soil series of Kaalaiyarkovil block in Sivagangai district, during the year 2018. The results revealed that the application of sulphur @ 100 kg ha^{-1} as soil application in the form of $FeSO_4$ along with STCR based NPK recommendation registered the maximum growth and yield attributes and cane yield (155.00 tonnes ha^{-1}), followed by T_{12} (150.00 tonnes ha^{-1}). However, they were statistically on par with each other.

Keywords: Sulphur, sugarcane, Kaalaiyarkovil, FeSO4

Introduction
Sugarcane, otherwise called as *Saccharum officinarum* is a vital multi-purpose crop grown by many farmers in India. Sugarcane is also an economically important crop among the farmers. Normally it grows well in tropic and sub-tropic regions. Among the other Carbon fixation C_4 crops like maize, wheat, rice and sorghum, sugarcane is the one of the major crops not only in India but all over the world. Sugarcane is an industrial crop which helps in the production of sugar and bioenergy. Sugarcane industries contributes more to the growth and development of India's agricultural economy. Among the agro based industries, sugarcane industries are in the second place next to cotton industry. It creates greater impact in the lives of more than 5 crores of farmers. Not only the farmers, but also the other people and fields who depend on the sugarcane industries get benefited directly or indirectly. Approximately, every year in India 35.5 crore tonnes and 3 crore tonnes of sugarcane and sugar is produced respectively. Not only in production but also in consumption of sugar, India is in the second place next to Brazil and Cuba. According to the estimation of current financial year, around 2.6 crore tons of sugar is used for domestic purpose. In India, around 35% of sugar is used in house and consumed as food. In the manufacture of beverages and food products, more than 65% of sugar is used as industrial raw material and main ingredient [7]. In 2019-2020, the total area under sugarcane cultivation in India was 4867 (000' ha), with production of 376.905 million tonnes and productivity of 77.6 t ha^{-1}. In Tamil Nadu the total cultivated area was 206 (000' ha) with production of 20600 ('000 tonnes) and productivity of 100 tonnes ha^{-1} [6].

Sulphur is one of the essential elements in crop production, and it is essential for improving the yield and quality of crops often ranked behind nitrogen, phosphorus and potassium in importance [8]. Sulphur is placed in the 4th position next to N, P, K [15]. Sulphur plays an important role in the plants metabolism and required for photosynthesis and protein metabolism. Sulphur requirement is higher for the sugarcane and it was reported that the application of sulphur increases the yield and quality of sugarcane [2]. Sulphur is the constituent of protein of protoplasm and essential amino acids like cysteine, cysteine and methionine. The amino acid cysteine which forms protein thiamine, biotine and hormones need sulphur nutrition [10]. Sugarcane exhibits luxury consumption and removes a considerable quantity of S from the soil. Among the various diffidence of sugarcane production the sulphur deficiency plays an important role [14]. This may be due to the lack of awareness among the farmers about the sulphur containing fertilizer. So the application of sulphur is not being practiced till now among the farmers. Therefore in order to optimize the sulphur application and to evaluate the best sulphur source for sugarcane crop, the experiment was conducted.

Materials and Methods

A field experiment was carried out to study the response of sulphur on growth and yield of sugarcane in a farmer's field located at Pallithambam village Kaalaiyarkovil block in Sivagangai district, Tamil Nadu during the year 2018. The experimental soil was classified under the *Typic Haplustalf*. The experimental soil was neutral in soil reaction (pH 6.9), low in available N (191 kg ha^{-1}), medium in available P and K (19, 179 kg ha^{-1}). The soil was deficient in available sulphur.

The experiment was conducted with 12 treatments and replicated thrice with the test crop of Sugarcane (var. CO 86032). The treatment details are follows T_1 – Control, T_2 - Recommended dose of fertilizer (275:62.5:112.5 kg N, P_2O_5 and K_2O ha^{-1}), T_3 - N, P_2O_5, K_2O on STCR basis, T_4 - T_3 + Sulphur @ 50 kg ha^{-1} as Gypsum, T_5 - T_3 + Sulphur @ 100 kg ha^{-1} as Gypsum, T_6 - T_3 + Sulphur @ 150 kg ha^{-1} as Gypsum, T_7 – T_3 + Sulphur @ 50 kg ha^{-1} as Elemental S, T_8 - T_3 + Sulphur @ 100 kg ha^{-1} as Elemental S, T_9 – T_3 + Sulphur @ 150 kg ha^{-1} as Elemental S, T_{10} - T_3 + Sulphur @ 50 kg ha^{-1} as $FeSO_4$, T_{11} – T_3 + Sulphur @ 100 kg ha^{-1} as $FeSO_4$, T_{12} - T_3 + Sulphur @ 150 kg ha^{-1} as $FeSO_4$.

From each treatment five plants were randomly selected and tagged for observing the growth and yield parameters on the 90, 150, 210 DAT and at harvest stage. Plant height was measured from the ground level to tip of the boot leaf and expressed in the centimeter (cm), Number of tillers, Leaf area index were observed at vegetative stage and Number of millable canes, Cane length, Cane girth, Cane yield were recorded.

Results and Discussion

Influence of sulphur application on growth attributes

The significant growth attributes such as plant height, number of tillers, leaf area of index were significantly higher in the treatment receiving NPK on STCR basis along with application of Sulphur @ 100 kg ha^{-1} as $FeSO_4$. The increased growth and yield attributes might be due to the optimum supply of S for sugarcane during the critical stages.

Plant height

The results showed that application of sulphur significantly influenced the plant height (Table 1). Among the various treatments the maximum plant height of 140.5, 239.5, 284.2 and 330.8 cm at 90, 150, 210 DAP and harvest stage separately was recorded with the treatment receiving STCR based N, P_2O_5 and K_2O along with application of sulphur @ 100 kg ha^{-1} as $FeSO_4$ (T_{11}) followed by the application of STCR based N, P_2O_5 and K_2O with 150 kg S ha^{-1} as $FeSO_4$. However they were statistically on par with each other. Sulphur has a number of oxidising functions in plant nutrition and it is a constituent of Fe-S protein called ferridoxin, which is responsible for transfer of electrons during the first phase of photosynthesis that is light dependent reactions [11]. Increase in plant height increases might be due to the increased uptake of nutrients and also carbohydrates synthesis, which in term would have favourably influenced the N-metabolism and consequently on the vegetative growth of sugarcane. Similar findings were reported in groundnut [5].

Leaf area index

The leaf area index was significantly influenced by the application of sulphur. The mean value of leaf area index was increased from 90th, 150th, and 210th day and declined at the harvest stage (Table 2). The treatment combination of STCR based N, P_2O_5 and K_2O and sulphur @ 100 kg ha^{-1} as $FeSO_4$ registered the highest leaf area index of 4.76, 5.57, 5.87 and 5.50 at 90, 150, 210 DAT and at harvest stage respectively. Application of sulphur increased the LAI of Sugarcane irrespective of levels and sources of sulphur as compared to the treatment receiving NPK alone. Crops. The N and S have the synergistic relationship which could have favourably influenced the uptake of nitrogen [16].

Number of tillers

The effect of sulphur on number of tillers of sugarcane at 150th day after planting (DAP) is depicted in Table 3. The number of tillers ranged between 60.2 to 123.3 (000' ha^{-1}). The highest number of tillers were observed (123.3 (000' ha^{-1})) in the T_{11} treatment. Similar results were reported by Baluram *et al.* [3] in rice crop by applying sulphur @ 40 kg ha^{-1} in combination with recommended NPK. Tillering is an important physiological activity in sugarcane crop. The tiller production reflect on the total number of millable canes at harvest which ultimately reflects on cane yield. Incorporation of STCR based NPK inconjoint with sulphur @ 100 kg ha^{-1} as $FeSO_4$ registered the maximum of tillers. Application of sulphur might have induced the shoot growth which inturn could have increased the number of tillers. This results are in corroboration with the earlier reports of Aneg Singh *et al.* [1].

Yield parameters

Number of millable canes

The effect of sulphur fertilization on number of millable cane (NMC) was found to be significant. It ranged from 50.5 ('000 ha^{-1}) to 102.6 ('000 ha^{-1}). Among the treatments combinations, highest number of number millable canes were observed while applying 100 kg sulphur as $FeSO_4$ in combination with STCR based N, P_2O_5 and K_2O (T_{11}) 102.6 (000 ha^{-1}). The T_1 treatment showed the lowest value 50.5 (000 ha^{-1}) (Table 4). NMC is an important yield attribute that decides the cane yield. Application of sulphur increases the nitrate reductase activity, which would have increased the vegetative growth of the plants and increasing the number of millable canes. Aneg singh *et al.* [1] reported that application of sulphur @ 80 kg ha^{-1} increased the number of millable cane.

Single cane weight

As observed in other parameters the single cane weight was also higher (1.51 kg $cane^{-1}$) in the treatment which has received STCR based N, P_2O_5 and K_2O with sulphur @ 100 kg ha^{-1} as $FeSO_4$ (T_{11}) and it is onpar with T_{12} (1.49 kg $cane^{-1}$). The treatment which received the elemental sulphur showed the lowest impact on the cane yield attributes because of its slow oxidation rate [4]. The lowest cane weight (0.91 kg $cane^{-1}$) was observed in T_1. The treatments T_5 and T_9 were onpar with each other (1.39) and (1.31) kg $cane^{-1}$ respectively (Table 4). Similar result was also reported by Vijay kumar *et al.* [17]. Baluram *et al.* [3] reported that application of sulphur increased the test weight of rice crop because the sulphur application increases the energy transformation and translocation from source to sink.

Length and girth of millable cane

The effect of sulphur fertilization on the length of millable cane clearly indicated that a positive response was observed irrespective of source and levels of sulphur. It ranged from 179.80 to 243.60 cm. The highest cane length was observed in the T_{11} treatment (243.60 cm) (Table 4). The effect of sulphur fertilization on girth of millable cane was found to be significant. The mean value of girth of millable cane varied between 10.70 and 6.00 cm (Table 5). The treatments T_5 (8.70 cm) and T_9 (8.50 cm) were on par with each other and recorded lower girth as compared to the T_{11} (10.70 cm). The solubility of gypsum was reported to be lowest (Ksp = 2.4 x 10^{-5}). Similarly, due to poor oxidation of elemental sulphur, the sulphate availability in the labile pool could have been by reduced. Similar findings were already reported by Shukla and Menhilal [13].

Number and length of internode in millable cane (Table 5)

The effect of sulphur fertilization on mean number of internodes were found to be statistically significant. The values ranged from 27.70 to 12.10. Application of STCR based N, P_2O_5 and K_2O with sulphur @ 100 kg ha^{-1} as $FeSO_4$ recorded the maximum number of internodes (27.70) which was on par with T_{12} (25.60). Similarly the treatment T_5 and T_9 were onpar with each other (20.10) and (19.70), The lowest number of internodes 12.10 was observed in T_1 (absolute control). Similar to the girth, length of internodes in millable cane was found to be significant and varied between 12.50 and 6.30 cm, respectively. Conjoint incorporation of STCR based N, P_2O_5 and K_2O with sulphur @ 100 kg ha^{-1} as $FeSO_4$ (T_{11}) recorded the maximum length of internode per millable cane (12.50 cm) which was on par with T_{12} (12.30 cm) and the shorter length of internode (6.30 cm) per millable cane was observed in T_1 (absolute control). Shinde [12] registered high intermodal length while applying 80 kg S ha^{-1}. Vijay kumar *et al.* [17] reported that application of sulphur increases the number of internodes and length of internode in sugarcane crop.

Cane yield

A profound influence on the application of sulphur on cane yield was recorded irrespective of its levels of sources. The cane yield varied from 46.0 to 155.0 t ha^{-1} (Table 6). Among the treatmental combination application of sulphur @ 100 kg ha^{-1} as $FeSO_4$ incombination with STCR based N, P_2O_5 and K_2O (T_{11}) recorded the maximum cane yield of 155 t ha^{-1} followed by T_{12} (150.0 t ha^{-1}) However, they were statistically onpar with each other. As the experimental field was deficient in sulphur (7.9 mg kg^{-1}), external sources of sulphur made a higher impact on cane yield. Johnson and Richard [9] reported a strong relationship between sulphur application and sugarcane yield and quality. Aneg singh *et al.* [1] reported that application of sulphur @80 kg ha^{-1} increased the sugarcane yield significantly. Application of sulphur increases the uptake of N, P and K because of its synergistic relationship as evidenced from the study. Application of sulphur increase the photosynthesis rate and carbohydrate assimilation which would have helped in improving the yield attributes and ultimately cane yield [2].

Conclusion

From the above results, it can be concluded that the STCR based application of NPK along with sulphur fertilization is extremely important for sustaining the production and productivity of sugarcane crop and also for improving the soil fertility. Hence application of 100 kg sulphur as $FeSO_4$ incombination with STCR based N, P_2O_5 and K_2O can be recommended in the sulphur deficient area of Sivagangai district to harvest the maximum yield in sugarcane.

Table 1: Effect of sulphur on plant height at various growth stages of sugarcane in *Typic haplustalf*

Treatment No.	90th DAP	150th DAP	210th DAP	At harvest
T_1	116.9	189.3	210.2	242.9
T_2	122.6	196.2	218.9	252.7
T_3	126.9	204.4	227.9	264.2
T_4	131.6	214.9	243.1	279.3
T_5	136.5	229.2	268.4	312.4
T_6	138.5	234.2	275.8	321.0
T_7	128.7	208.6	234.6	271.7
T_8	132.5	218.7	250.4	291.0
T_9	138.7	230.3	265.7	308.2
T_{10}	135.0	222.9	255.4	296.6
T_{11}	140.5	239.5	284.4	330.8
T_{12}	139.7	238.9	283.0	328.5
Mean	132.36	218.91	251.5	291.61
SEd	2.98	3.99	4.98	3.44
CD (P = 0.05)	6.22	8.3237	10.39	7.18

Table 2: Effect of sulphur on LAI at various growth stages of sugarcane in *Typic haplustalf*

Treatment No.	90th DAP	150th DAP	210th DAP	At harvest
T_1	2.25	3.40	3.57	3.30
T_2	2.39	3.67	3.84	3.56
T_3	2.59	3.92	4.24	3.82
T_4	3.13	4.43	4.76	4.36
T_5	4.19	5.06	5.34	4.98
T_6	4.41	5.30	5.59	5.22
T_7	2.82	4.18	4.49	4.07
T_8	3.35	4.69	5.01	4.67
T_9	4.08	5.05	5.33	4.95
T_{10}	3.70	4.90	5.10	4.75
T_{11}	4.76	5.57	5.87	5.50
T_{12}	4.68	5.53	5.83	5.49
Mean	3.53	4.64	4.91	4.56
SEd	0.07	0.11	0.12	0.11
CD (P = 0.05)	0.16	0.24	0.24	0.24

Table 3: Effect of sulphur on number of tillers (150th DAP) of sugarcane in *Typic haplustalf*

Treatment No.	No. of tillers (000' ha^{-1})
T_1	60.2
T_2	92.2
T_3	94.1
T_4	92.5
T_5	106.6
T_6	117.4
T_7	82.1
T_8	99.5
T_9	110.1
T_{10}	104.2
T_{11}	123.3
T_{12}	122.8
Mean	100.42
SEd	2.40
CD (P = 0.05)	5.02

Table 4: Effect of sulphur on yield attributes of sugarcane in *Typic haplustalf*

Treatment no.	Number of millable cane ('000 ha^{-1})	Cane weight (kg cane^{-1})	Length of millable cane (cm)
T_1	50.5	0.91	179.8
T_2	76.9	1.04	187.4
T_3	79.3	1.11	195.1
T_4	77.2	1.23	207.6
T_5	88.5	1.39	228.3
T_6	98.6	1.44	235.2
T_7	68.4	1.17	201.5
T_8	82.0	1.29	213.7
T_9	92.7	1.37	224.8
T_{10}	84.7	1.31	217.2
T_{11}	102.6	1.51	243.6
T_{12}	100.7	1.49	241.4
Mean	83.52	1.27	214.63
SEd	1.76	0.02	2.63
CD (P = 0.05)	3.69	0.04	5.49

Table 5: Effect of sulphur on girth, number and length of internode of sugarcane in in *Typic haplustalf*

Treatment no.	Girth of millable cane (cm)	Number of internodes per millable cane	Length of internode per millable cane (cm)
T_1	6.00	12.1	6.3
T_2	6.50	12.8	7.0
T_3	7.10	13.3	7.4
T_4	7.20	14.5	8.9
T_5	8.70	20.1	10.0
T_6	9.70	23.4	11.0
T_7	6.80	13.9	8.0
T_8	7.40	15.8	9.7
T_9	8.50	19.7	10.7
T_{10}	8.30	17.2	10.0
T_{11}	10.70	27.7	12.5
T_{12}	10.60	25.6	12.3
Mean	8.13	18.01	9.63
SEd	0.68	1.08	0.29
CD (P = 0.05)	1.42	2.25	0.59

Table 6: Effect of sulphur on sugarcane on cane yield (t ha^{-1}) in in *Typic haplustalf*

Treatment no.	Cane yield (t ha^{-1})
T_1	46.00
T_2	80.00
T_3	88.00
T_4	95.00
T_5	123.00
T_6	142.00
T_7	80.00
T_8	105.00
T_9	127.00
T_{10}	111.00
T_{11}	155.00
T_{12}	150.00
Mean	108.50
SEd	2.72
CD (P = 0.05)	5.67

References

1. Aneg Singh, Srivastava RN, Singh SB. Effect of sources of sulphur on yield and quality of sugarcane. Sugar tech 2007;9(1):98-100.
2. Aneg Singh, Srivastava RN, Singh SB. Effect of nutrient combinations on sugarcane productivity. Sugar Tech 2003;5(4):311-313.
3. Baluram Singh SK, Latare AM, Omkar Kumar. Effect of Sulphur, Zinc and Boron Application on Growth and Yield of Hybrid Rice (*Oryza sativa* L.) Journal of Ind. Soc. Soil Sci 2014;62(2):184-186.
4. Bob Weidenfeld. Sulphur application effects on soil properties in a calcareous soil and on sugarcane growth and yield. Journal of plant nutrition 2011;34(7):1003-1013.
5. Chaubey. Response of groundnut (*Arachis hypogaea*) to source and level of sulphur fertilization in mid-western plains of Uttar Pradesh. Ind. journal of Agronmy 2000;45(1):166-169.
6. Co-operative sugar report. Indian Sugarmill Association 2020.
7. Final report on sugarcane and sugar industry. NITIAYOG 2020.
8. Jeschke M, Diedrick K. Sulfur fertility for crop production. CROP INSIGHTS, Pioneer Dupont 2010;20:1-12.
9. Johnson RM, Richard Jr. EP. Sugarcane Yield, Sugarcane quality and soil variability in Louisiana. Agronomy Journal 2005;97:760-771.
10. Monohar Rao PJ. Soil and Foliar diagnosis in sugar factory lab for determining on macro and micro nutrients required for sugarcane growth. Ind. Sug 1977;27:671-685.
11. Randall PJ. Evaluation of the sulphur status of soils and plants. Techniques and interpretation. Proc. of TSI-FAI symp. Sulphur in Indian agriculture. New Delhi 1988;Sl/3:1-15.
12. Shinde CP. Yield, quality and economics of sugarcane as influenced by sulphur application. Cooperative sugar 2005;37(2):29-32.
13. Shukla, Menhilal. Competition functions and productivity in sugarcane based associative and successive cropping systems in relation to nitrogen and sulphur nutrition, Indian J Agric. Sci 2002;72(6):315-318.
14. Singh A, Rao SP, Gupta AK, Kushwaha HP. Effect of P and S application on yield, quality of nutrient content in sugarcane. Indian Sugar 1997;47(2):33-37.
15. Tandon HLS. Sulphur Research and Agricultural Production in India. Third ED. The sulphur Institute, Washington, D.C. USA 1991, 140.
16. Tiwari KM. Sulphur in balanced fertilisation in Northern India. Proc. TSI/PM/IFA symposium on sulphur in balanced fertilisation. New Delhi 1997, PSII /I-SI-1/15.
17. Vijay Kumar, Goyal NK, Kambooj BR. Effect of different levels and sources of sulphur application on sugarcane production. Sugar tech 2011;13(2):103-107.