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SHORT COMMUNICATION

EFFECT OF SULPHUR FERTILIZATION ON GROWTH OF OPIUM POPPY IN CALCAREOUS SOILS OF SOUTH RAJASTHAN

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A field study was conducted to investigate the effect of sulphur fertilization on growth of opium poppy in alkaline calcareous soils of south Rajasthan. Sulphur application significantly increased dry matter accumulation/plant, leaf area index, crop growth rate and leaf area duration. Chlorophyll content of leaves of opium poppy increased while leaf sap pH reduced by S application. Increasing levels of S up to 150 kg/ha enhanced growth of crop, whereas, chlorophyll content of leaves increased up to 200 kg/ha sulphur application. Among three sources of S, elemental S proved to be a better source than gypsum and gypsum + elemental S (1:1) in respect of growth in alkaline calcareous soils. Gypsum + elemental S (1:1) also resulted in highest chlorophyll content in leaves at 110-115 DAS. This study conclude that application of S @ 150 kg/ha through elemental sulphur can improve opium poppy plant growth and leaf chlorophyll content and can reduce leaf sap pH significantly.

***Key words*: Growth, gypsum, opium poppy, sulphur**

Opium poppy (*Papaver somniferum* L.) occupies a prominent place among medicinal plants since time immemorial. It provides raw opium (latex) which contains more than 40 alkaloids (Hussain and Sharma 1993), out of which only six, namely morphine, codeine, thebaine, papaverine, narcotine and narceine occurs in measurable quantity, all others occur only in traces (Thakur 1983). In Rajasthan, opium poppy is mainly cultivated in Kota, Jhalawar, Chittorgarh, Bhilwara and Udaipur districts. In India, opium poppy, has not yet received adequate scientific attention in respect of its secondary and micronutrient requirements. Tomar *et al.* (1993) reported that application of sulphur significantly improves the growth as well as latex, seed and husk yields of opium poppy. A large number of crops grown in alkaline calcareous soils of south Rajasthan have shown spectacular yield responses following sulphur application (Singh 1988). Since information on sulphur fertilization in opium poppy is meagre, an investigation was undertaken to study the effect of sulphur fertilization on growth of opium poppy in south Rajasthan.

A field experiment was conducted during winter seasons of *1989-90* and *1990-91* at Rajasthan College of Agriculture, Udaipur. The soil (Vertisol) of the experimental field was clay-loam in texture, calcareous and alkaline in reaction, medium in available N (282-275 kg/ha), high in available P_2O_5 (66-66 kg/ha) and high in available K_2O (405-406 kg/ha) with pH 8.40-8.45 and 20-22 ppm available sulphur. The treatment combinations consisted of 5 levels of sulphur (50,100, 150 and 200 kg S/ha) and no sulphur as control and three sources of sulphur [gypsum, elemental sulphur and elemental sulphur + gypsum (1:1)] were used. All thirteen treatment combinations were replicated in randomised block design. Sulphur treatments were applied at the time of sowing at

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10 cm depth. Opium poppy (variety- JA-16) was sown on 23rd November in 1989 and on 2nd November in 1990. Ninety kg nitrogen in three splits and 40 kg P_2O_5/ ha were given through urea and DAP, respectively. The experimental fields were quite homogeneous in fertility status.

During crop growth plant samples were collected at 60,75,90,105 and 120 days after sowing (DAS) from each treatment plot for estimation of dry matter accumulation (DMA) and leaf area index (LAI). Crop growth rate (CGR) was calculated at 75 and 90 DAS and leaf area duration (LAD) was worked out at 120 DAS. Total chlorophyll content (Arnon, 1949) in fresh leaves was estimated at flowering (90-95 DAS) and 110-115 DAS. Leaf sap pH of homogenized mass of fresh leaves and distilled water (1:10) was estimated at 110-115 DAS.

Data on dry matter accumulation (DMA) per plant and leaf area index (Table 1) indicate significant improvement by application of sulphur. When compared with control the increases in DMA per plant ranged from 25 to 40 per cent in 1989-90 and 25 – 50 per cent in 1990-91. Further, sulphur application also brought about significant improvement in CGR at 75 and 90 DAS and LAD at 120 DAS. Total chlorophyll content of leaves at flowering (90-95 DAS) and 110-115 DAS increased significantly due to sulphur application, while it reduced the leaf sap pH at 110-115 DAS.

Sulphur is a constituent of succinyl Co – A, taking part in chlorophyll synthensis (Mapson and Goddard, 1951). Sahu and Singh (1987) also reported that sulphur application increased the chlorophyll content and reduced leaf sap pH of groundnut in alkaline calcareous soils.

Table 1. Effect of sulphur fertilization on leaf area index , crop growth rate and leaf area duration in opium poppy.

Treatments	Leaf area index (LAI)				Crop growth rate ($g\ m^{-2}\ day^{-1}$)				Leaf area duration	
	75 DAS		90 DAS		75 DAS		90 DAS			
	1989-90	1990-91	1989-90	1990-91	1989-90	1990-91	1989-90	1990-91	1989-90	1990-91
Control	1.32	1.55	1.56	1.57	2.7	2.2	10.7	13.2	29.6	33.2
Sulphur	1.89*	2.09*	2.13*	2.27*	3.3*	3.4*	13.3*	15.8*	44.4*	50.7*
Levels of sulphur (kg/ha)										
50	1.57	1.80	1.73	2.08	3.1	3.1	11.0	14.3	32.7	43.5
100	1.93	2.09	2.03	2.15	3.3	3.4	12.2	13.7	46.2	50.5
150	2.00	2.26	2.32	2.31	3.5	3.5	13.0	17.3	49.0	54.0
200	2.07	2.22	2.46	2.54	3.5	3.6	17.0	17.9	49.6	54.7
CD (P = 0.05)	0.09	0.11	0.12	0.16	0.2	0.3	0.6	1.1	1.6	3.3
Sources of sulphur										
Gypsum (Gy.)	1.88	2.06	2.03	2.11	3.3	.32	12.8	15.3	43.4	48.2
Elemental sulphur (Es.)	1.95	2.13	2.26	2.45	3.4	3.5	13.8	16.3	46.0	55.1
Gy. + Es. (1:1)	1.86	2.09	2.11	2.25	3.3	3.4	13.3	15.8	43.8	48.7
CD (P = 0.05)	NS	NS	0.11	0.14	NS	NS	0.6	NS	1.4	2.8

* Significant at 5 per cent P
NS: Non-significant

Improvement in DMA per plant, LAI, CGR and LAD seems to have resulted on account of improved sulphur nutrition of crop plants. Several workers (Mathur *et al*. 1973, Singh and Singh 1984, Sahu and Singh 1987) have reported restoration of balanced nutritional level of crop plants following sulphur application in alkaline calcareous soils. Thus the sulphur treatment resulted the crop plants to carry out productive photosynthesis for longer period, through increased LAD and dry matter accumulation.

The DMA per plant and LAI significantly increased with increasing levels of sulphur up to 150 kg/ha at all the growth stages. At 75 and 90 DAS, CGR increased up to 150 kg S/ha in 1989-90 and up to 100 kg S/ha in 1990-91. At 90 DAS, 100 and 150 kg S/ha increased CGR over 50 kg S/ha, and 200 kg S/ha proved superior over 50, 100 and 150 kg S/ha. In 1990-91, 150 and 200 kg S/ha increased CGR over 50 and 100 kg S/ha. The LAD increased significantly with increasing levels of sulphur up to 150 kg/ha. At flowering, application of 100,150 and 200 kg/ha increased total chlorophyll content of leaves over 50 kg S/ha. While 100 and 150 kg S/ha were at par with each other. 200 kg S/ha treatment was found to be superior to 100 and 150 kg S/ha in 1989-90. At 110-115 DAS total chlorophyll content of leaves increased up to 200 kg S/ha. The leaf sap pH of the leaves reduced significantly up to 150 kg S/ha in 1989-90, while during 1990-91, it reduced up to 100 kg S/ha. Significant effects of higher levels of sulphur application as compared with lower levels in increasing growth characters seem to be on account of increased availability of sulphur and reduced precipitation or otherwise in semi-arid tropics as a low contact with low soil mass (Saroha and Singh 1979).

With respect to sources of sulphur, elemental S proved to be a better source in comparison to gypsum and gypsum + elemental sulphur (1:1) in increasing dry matter accumulation per plant and LAI at various growth stages of crop, except LAI at 75 DAS. Elemental sulphur improved the CGR only in 1989-90 at 90 DAS in comparison to gypsum and gypsum + elemental sulphur (1:1). Further, elemental sulphur recorded maximum LAD than gypsum and gypsum + elemental sulphur (1:1). At flowering, elemental sulphur proved superior to gypsum and gypsum + elemental sulphur (1:1) in respect of total chlorophyll content of leaves (Table 2). Whereas, at 110-115 DAS elemental sulphur and gypsum + elemental sulphur (1:1) were equally effective in increasing

Table 2. Effect of sulphur fertilization on leaf chlorophyll content and leaf sap pH in opium poppy.

Treatment	Total chlorophyll content (mg/g fw)				Leaf sap pH	
	Flowering		110-115 DAS			
	1989-90	1990-91	1989-90	1990-91	1989-90	1990-91
Control	1.16	1.40	1.39	1.47	6.79	6.63
Sulphur	1.57*	1.63*	1.67*	1.68*	6.52*	6.36*
Levels of sulphur (kg/ha)						
50	1.33	1.51	1.48	1.60	6.61	6.45
100	1.59	1.62	1.61	1.56	6.54	6.33
150	1.64	1.68	1.74	1.71	6.49	6.38
200	1.73	1.73	1.85	1.84	6.44	6.27
CD (P = 0.05)	0.08	0.08	0.06	0.07	0.07	0.06
Sources of sulphur						
Gypsum (Gy.)	1.44	1.59	1.55	1.63	6.57	6.43
Elemental Sulphur (Es.)	1.73	1.74	1.72	1.69	6.49	6.36
Gy. + Es.(1:1)	1.55	1.58	1.74	1.72	6.50	6.28
CD (P = 0.05)	0.06	0.06	0.06	0.06	0.06	0.06

* Significant at 5 per cent P

chlorophyll content of leaves and reducing leaf sap pH. The superiority of elemental sulphur over gypsum and gypsum + elemental sulphur (1:1) might be due to sustained release of sulphate sulphur from elemental sulphur in alkaline calcareous soils (Singh 1988. Intodia and Sahu 1999).

At 150 and 200 kg S/ha, elemental sulphur and gypsum + elemental sulphur (1:1) recorded more chlorophyll content in leaves than gypsum. The maximum chlorophyll content was recoded with gypsum + elemental sulphur (1:1) at 200 kg S/ha. This effect might be due to sustained supply of sulphate sulphur from 50 per cent gypsum and 50 per cent elemental sulphur in gypsum + elemental sulphur (1:1) treatment.

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