EFFECT OF CALCIUM, SULPHUR AND BORON ON SUNFLOWER *(HELIANTHUS ANNUUS* L.*)* YIELD AND QUALITY

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INTRODUCTION

Sunflower *(Helianthus annuus* L.) is an important oilseed crop which provides high quality edible oil. It occupies third position in the world coming next to cotton and groundnut. Research focussing on sunflower production has been accorded lower priority than that on groundnut. Sunflower production has the advantage of being less capital and management intensive than groundnut. Thus, there is considerable scope for expanding area under sunflower. Formerly Russian varieties were widely being cultivated. Now, in many parts of the country, the traditional Russian varieties are being replaced by hybrids which are more responsive to fertilizer. With the introduction of high yielding varieties, adoption of intensive cultivation practices accompanied by the use of fertilizers, the prevalence of secondary and micronutrient deficiences has become quite evident. Sunflower has high demand for calcium, sulphur and boron for its complete growth expression. Under the circumstances, the crop is likely to respond to these nutrients. Therefore, the present investigation is aimed to assess the influence of calcium, sulphur and boron fertilization on the yield and quality attributes of sunflower.

MATERIALS AND METHODS

A field experiment was conducted on sandy clay loam soils of Gandhi Krishi Vignana Kendra Campus, University of Agricultural Sciences, Bangalore during Kharif 1980 in order to study the response of hybrid sunflower (Cv. BSH-1) to calcium, sulphur and boron fertilization. 12.5 ppm Ca, 10.0 ppm S and 0.25 ppm B were tried either individually or in combination. Both CaO and gypsum were used as sources of Ca, ammonium sulphate and gypsum were the sources of S and borax was the source of B. In addition, the crop was given the recommended dose of N, P and K (60 : 60 : 40 kg/ha) in the form of urea, diammonium phosphate and muriate of potash, respectively. The experiment consisted of nine treatments and three replications in R.B.D. layout. The biometric observations on five randomly selected plants were recorded at grand growth (40 DAS), flowering (60 DAS) and at harvesting stages. The stalk and seed yields were reported on dry weight basis. Plant samples collected at different growth stages were dried, powdered and analysed for different nutrients as per the standard procedures described by Black (1965), Jackson (1967) and Hatcher and Wilcox (1950). The oil content in sunflower seed was recorded by Nuclear Magnetic Resonance (NMR) Spectrophotometer (Brooker Minispec, P-20) against a standard reference sample.

RESULTS AND DISCUSSION

The data on the physico-chemical properties of soils of the experimental area presented in Table 1 indicate that the soil was acidic in nature (pH 5.6), low in available nitrogen and phosphorus, while high in available potassium. The soil contained 3.4 me per 100 g soil of exchangeable calcium. According to Malavolta et al. (1979), the soil may be considered as low in calcium. Similarly, the available boron content of the soil (0.46 ppm) was also low as suggested by Raychaudhari and Dutta Biswas (1974). However, the available sulphate sulphur content in the soil was adequate.

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Table 1

Some physico-chemical properties of soils of experimental site

I. **Physical**	
a) *Mechanical composition* (%)	
Coarse sand	18.89
Fine sand	34.41
Silt	9.20
Clay	35.38
Loss on solution	2.12
b) *Soil classification :*	
Vijayapura series, a member of Clayey, Oxic Paleustalfs	
c) *Texture*	
Sandy clay loam	
II. **Chemical**	
pH (1 : 2.5 soil water suspension)	5.6
Electrical conductivity (mmhos/cm at 25° C)	0.12
Organic carbon (per cent)	0.45
Available nitrogen (kg/ha)	240.0
Available P_2O_5 (kg/ha)	12.8
Available K_2O	224.0
C.E.C. (me/100 g)	11.1
Exchangeable calcium (me/100 g)	3.4
Exchangeable magnesium (me/100 g)	0.62
Base saturation (per cent)	36.8
Available sulphur (ppm)	32.0
Available boron (ppm)	0.46

YIELD AND QUALITY OF SUNFLOWER

CALCIUM

The data presented in Table 2 reveal that application of calcium increased the seed yield of sunflower significantly over control. The increase in seed yield due to the addition of 12.5 ppm calcium as calcium oxide and gypsum was 13.78 and 19.50 per cent over control. Similar effects of calcium application on yield attributing characteristics like diametre of capitulum and 1 000 seed weight were also noticed. The above results are in agreement with those obtained by Venkata Rao and Govindarajan (1960) and Satyanarayana et al. (1977). They opined that the response of crops particularly oilseed crops to liming was primarily due to increased supply of calcium and not due to increase in soil pH associated with the liming of acid soils. According to Malavolta et al. (1979) 4.0 me of calcium per 100 g soil was considered as a critical level of calcium. Since the soils of the present investigation contained only 3.4 me of calcium per 100 g soil, the sunflower crop might have responded significantly to the addition of 12.5 ppm calcium. Further, it is evident from the data presented in Table 2 that gypsum as a source of calcium was more effective in increasing the seed yield of sunflower than calcium oxide. It is quite obvious that calcium in gypsum is relatively more soluble than calcium oxide which might have helped in better utilization of added calcium right from the early stages of growth of the plant. Another important aspect of gypsum is

Table 2

Yield and quality of sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Diametre of capitulum (cm)	1000 seed weight (g)	Seed yield (q/ha)	Stalk yield (q/ha)	Oil content (%)	Oil yield (kg/ha)
Control	12.18	30.23	9.70	16.90	38.77	375.39
Ca (CaO)	13.73	34.31	11.25	18.25	38.85	437.06
S (Ammonium sulphate)	14.54	33.84	12.35	20.55	41.00	506.35
B (Borax)	14.13	33.72	12.55	18.55	40.05	502.63
Ca + S (Gypsum)	14.39	32.46	12.05	19.00	39.90	480.80
Ca + S (Ammonium Sulphate)	13.95	31.84	12.25	17.65	40.05	490.61
Ca + B	14.50	33.66	12.60	19.25	41.65	524.79
S + B	14.16	33.04	12.95	17.60	42.40	549.08
Ca + S + B	14.88	34.56	14.50	22.30	41.50	601.75
S.Em. ±	0.43	N.S.	0.57	1.004		
C.D. at 5%	1.06	—	1.41	2.48		

its sulphur content in available form. With the addition of gypsum as a source of calcium there is a concomitant supply of sulphur to the plants. The beneficial effect of sulphur to an oilseed crop like sunflower has been ample demonstrated by several workers (Chopra and Kanwar, 1966; Virmani and Gulati, 1971; Satyanarayana et al., 1977).

Addition of calcium in the form of CaO did not improve the oil content favourably but it had considerable effect on oil yield per hectare and the increase in oil yield was 14.1 per cent over control. Gypsum applied as a source of calcium also increased the oil content by 1.27 units and the oil yield by about 22 per cent over control. The beneficial effect of calcium on oil yield is possibly due to its favourable effect on seed yield. The superiority of gypsum over CaO arises due to its soluble sulphate sulphur content.

SULPHUR

Application of 10 ppm sulphur either as ammonium sulphate or as gypsum increased the seed yield of sunflower significantly over control. The corresponding increase in seed yield over control was 24.46 and 19.5 per cent. Significant increase in sunflower stalk yield was also noticed due to addition of sulphur. Likewise, the diametre of the capitulum and 1 000 seed weight increased considerable under these treatments. Several workers have demonstrated the beneficial effect of sulphur application on the yield of oilseed crops such as cotton, groundnut, mustard and sunflower.

Ammonium sulphate as a source of sulphur was more effective than gypsum in increasing the seed yield of sunflower (Table 2), possibly due to the fact that sulphur in ammonium sulphate is in highly water soluble form, while in gypsum it is sparingly soluble. Since the total precipitation received during the crop growth period was sub-normal (377.7 mm), lack of moisture in the soil might have decreased the solubility of sulphur in gypsum.

Addition of sulphur had significant effect on both the oil content and oil yield per hectare. The seed oil content due to addition of ammonium sulphate and gypsum was 41.0 and 39.9 per cent respectively. Similarly, the improvement in oil yield was 25.87 and 21.9 per cent over control. Since oilseed crops like sunflower, mustard, soybean and groundnut have high sulphur requirement as their oil storage organs are mostly proteins rich in sulphur (Subbiah and Singh, 1970), the supply of adequate quantity of sulphur to these crops is of paramount importance. Marquard et al. (1968) observed considerable increase in oil content of mustard with the supply of adequate quantity of sulphur.

BORON

Application of 0.25 ppm boron alone increased the seed yield of sunflower significantly over control. The increase in yield was 22.71 per cent over control. Similar increase in the yield attributing characteristics like diametre of capitulum and 1 000 seed weight were also noticed. The high response of sunflower to boron application might be attributed to low level of available boron (0.46 ppm) in the soils of the present study. Satyanarayana et al. (1977) reported that sunflower responded to the application of boron up to 4 kg per hectare due to the low level of available boron in the laterite soils of Bangalore. According to Berger (1949) sunflower is a high boron requiring crop. Since boron plays a major role in the reproductive phase rather than vegetative phase (Blamey, 1976), application of boron might help in proper seed setting, development of capitulum, seed filling and ultimately increasing the seed yield of sunflower. Further increase in seed yield of sunflower was noticed when boron was supplemented with either calcium or sulphur. The highest seed yield (14.5 q/ha) was recorded when 0.25 ppm boron was applied along with 10 ppm sulphur in the form of gypsum. It is interesting to note that the response of sunflower to either calcium or sulphur was more pronounced when boron was supplemented. Several workers reported that boron solubility in soil decreases moderately with the addition of lime. At the same time, boron requirement of plants is known to increase under conditions of sufficient calcium supply (Midgley and Dunklee, 1939; Katalymov, 1960). Because of this relationship, the sunflower crop with high boron requirement responded considerably due to the combined addition of calcium, sulphur and boron to an acid soil.

The oil content of sunflower seeds and the oil yield per hectare were increased considerably due to the addition of boron. The increase in oil content was 1.3 units and that of oil yield was 25.27 per cent over control. Further improvement in oil content and oil yield was noticed when boron was added in combination with calcium and sulphur. The maximum oil content (42.40%) was recorded when boron was added along with sulphur. The increase in oil yield was proportionate to the increase in seed yield due to various treatment combinations. Dangale and Zende (1976) and Holmes (1980) observed that application of boron along with sulphur increased the oil content of seed significantly.

CONCENTRATION AND UPTAKE OF NUTRIENTS BY SUNFLOWER

CALCIUM

The data on the concentration of nutrients in sunflower plant tissue at various growth stages (table 3) indicated that application of

Table 3

Concentration and uptake of nitrogen by sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Concentration (%)				Uptake (kg/ha)		
	40 th day	60 th day	at harvest	seed	stalk	seed	total
Control	2.85	3.36	1.31	2.38	22.14	23.09	45.23
Ca (CaO)	3.13	3.31	1.49	2.72	26.38	30.59	56.97
S (Ammonium sulphate)	3.54	3.59	1.59	2.73	32.57	33.79	66.36
B (Borax)	3.31	3.50	1.49	2.45	27.70	30.66	58.36
Ca + S (Gypsum)	3.31	3.41	1.54	2.78	29.32	33.42	62.74
Ca + S (Ammonium sulphate)	3.36	3.45	1.77	2.99	31.30	36.70	68.00
Ca + B	3.03	3.59	1.63	2.89	31.37	36.41	67.78
S + B	3.41	3.59	1.54	2.94	27.15	37.93	65.08
Ca + S + B	3.41	3.92	1.54	3.03	34.25	43.59	77.84
S. Em. ±	0.06	0.057	0.069	0.088	2.06	2.16	3.11
C.D. at 5%	0.15	0.14	0.17	0.22	5.09	5.32	7.68

calcium significantly increased the nitrogen content in sunflower plant tissue on 40th day after sowing. The content of nitrogen was further increased on 60th day after sowing. This increase in nitrogen content is expected because of the fact that the crop was top dressed with the second dose of nitrogen on 40th day after sowing, which might have resulted in greater absorption and accumulation of nitrogen in plant tissue on 60th day. However, the nitrogen content appreciably decreased at harvest. Dilution effect due to increased dry matter production and possible translocation of nitrogen from the vegetative parts to reproductive organs at the later stages of growth might explain the above phenomenon. The sunflower seeds receiving calcium in the form of gypsum contained higher nitrogen content (2.78%) as compared to CaO (2.72%) but the difference was not significant.

Similarly, the uptake of nitrogen by sunflower plants, seeds and the total uptake increased significantly with the addition of calcium. The uptake of nitrogen followed a pattern similar to dry matter production and nitrogen concentration in sunflower plants. According to Mate and Verga (1963) availability of soil nitrogen increased by liming of acid soils. They attributed this phenomenon to the increased microbial activity which has resulted in the greater uptake of nitrogen by plants.

The concentration of phosphorus in sunflower plant tissue was lowest in control and increased significantly due to the addition of calcium (Table 4). Higher phosphorus content was noticed when gypsum was added as a source of calcium. Phosphorus content in general decreased with the advancement in the age of the crop. It is interesting to note that

Table 4

Concentration and uptake of phosphorus by sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Concentration (%)				Uptake (kg/ha)		
	40 th day	60 th day	at harvest	seed	stalk	seed	total
Control	0.15	0.12	0.09	0.46	1.50	4.43	5.93
Ca (CaO)	0.19	0.16	0.12	0.48	2.23	5.43	7.66
S (Ammonium sulphate)	0.21	0.15	0.17	0.50	3.42	6.22	9.64
B (Borax)	0.18	0.15	0.12	0.49	2.02	6.14	8.16
Ca + S (Gypsum)	0.20	0.16	0.14	0.51	2.59	6.14	8.73
Ca + S (Ammonium sulphate)	0.20	0.15	0.10	0.51	1.68	6.26	7.94
Ca + B	0.18	0.16	0.10	0.50	1.90	6.35	8.25
S + B	0.19	0.14	0.10	0.49	1.80	6.35	8.15
Ca + S + B	0.19	0.16	0.10	0.52	2.13	7.42	9.55
S. Em. ±	0.006	N.S.	0.008	0.008	0.195	0.32	0.48
C.D. at 5%	0.014	—	0.02	0.02	0.48	0.79	1.06

the sunflower seeds contained higher phosphorus content than the sunflower plants.

The uptake of phosphorus by sunflower stalks, seeds and total uptake by sunflower plants increased significantly due to the addition of calcium. The total uptake of phosphorus increased from 5.93 kg per hectare in control to 7.67 and 8.73 kg per hectare with 12.5 ppm Ca added as CaO and gypsum respectively. Of the total phosphorus removed by the sunflower plants the seeds contained about 58 per cent and the remaining 42 per cent was present in stalk. According to Robson (1970) calcium encouraged phosphorus absorption through increased root density, thus increasing the accessibility of absorption sites of phosphorus.

The data on calcium concentration in sunflower plant tissue on 40th day, 60th day and at harvest presented in Table 5 indicated that the tissue calcium concentration increased appreciably with the addition of calcium. The accumulation of calcium in plant tissue increased progressively with the age of the crop and maximum accumulation of calcium was noticed at the time of harvest. Calcium which is relatively immobile in plant system obviously gets accumulated in plant tissue due to poor translocation and distribution of calcium to various plant parts. Further, it is evident from the data on the concentration of calcium in sunflower seeds that the level of calcium in sunflower seeds was more or less constant in all the treatments and the difference was not significant. These results are in agreement with those obtained by Loganathan and Krishnamoorthy (1977). They pointed out that 90 per cent of the calcium absorbed by the whole plant was retained in the vegetative parts. The uptake of calcium by sunflower plant exhibited the same trend as that of calcium concentration in plant tissue.

The concentration of sulphur in plant tissue on 40th day after sowing was lowest (0.44%) in control which was significantly increased to 0.54 and 0.62 per cent in plants receiving calcium in the form of CaO and gypsum (Table 6). The higher content of sulphur in gypsum treated plants is possibly due to its sulphur content in soluble form. The concentration of sulphur in plant tissue decreased progressively with the age of the crop and it was minimum at harvest. According to Bromfield (1973) the rate of uptake of sulphur was maximum (0.22 kg/ha/day) during the eighth week after emergence. However, the percentage of sulphur decreased with advancement of age of the crop possibly due to the dilution effect as a result of increased dry matter production. Similar results were also reported by Pathak and Pathak (1972).

The uptake of sulphur by sunflower plants was slightly increased with the addition of CaO as a source of calcium, but the increase in uptake was not significant over control. On the other hand, gypsum when added as a source of calcium, the sulphur uptake by sunflower plants significantly increased. It is mostly due to its sulphur content in soluble form. According to Rao (1978), calcium and sulphur were synergistic and consistant in their effect when applied as gypsum.

The plant tissue concentration of boron fluctuated during the growth period (Table 7). Boron content in plant tissue on 60th day was lower than those recorded on 40th day and at harwest. Addition of calcium increased the content of boron both in the sunflower plants and seeds, but the increase was not significant.

Table 5

Concentration and uptake of calcium by sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Concentration (%)				Uptake (kg/ha)		
	40 th day	60 th day	at harvest	seed	stalk	seed	total
Control	2.03	2.57	3.73	0.32	63.40	3.08	66.48
Ca (CaO)	2.17	2.50	3.67	0.35	66.88	3.92	70.80
S (Ammonium sulphate)	2.13	2.33	3.37	0.35	69.15	4.32	73.47
B (Borax)	2.10	2.70	3.53	0.33	65.77	4.18	69.95
Ca + S (Gypsum)	2.23	2.53	4.03	0.37	77.28	4.40	81.70
Ca + S (Ammonium sulphate)	2.20	2.40	4.10	0.35	72.23	4.29	76.52
Ca + B	2.30	2.63	3.97	0.35	76.51	4.41	80.92
S + B	2.07	2.40	3.87	0.33	68.55	4.11	72.66
Ca + S + B	2.20	2.47	3.73	0.37	83.59	5.24	88.83
S. Em. ±	N.S.	N.S.	N.S.	N.S.	N.S.	0.35	N.S.
C.D. at 5%	—	—	—	—	—	0.61	—

Table 6

Concentration and uptake of sulphur by sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Concentration (%)				Uptake (kg/ha)		
	40 th day	60 th day	at harvest	seed	stalk	seed	total
Control	0.44	0.35	0.29	0.15	4.81	1.41	6.22
Ca (CaO)	0.54	0.30	0.25	0.22	4.47	2.46	6.93
S (Ammonium sulphate)	0.62	0.37	0.29	0.25	5.99	3.04	9.03
B (Borax)	0.56	0.38	0.23	0.19	4.17	2.42	6.59
Ca + S (Gypsum)	0.62	0.37	0.28	0.22	5.25	2.66	7.91
Ca + S (Ammonium sulphate)	0.58	0.36	0.28	0.23	4.96	2.87	7.83
Ca + B	0.55	0.33	0.27	0.23	5.14	2.95	8.09
S + B	0.60	0.36	0.34	0.25	6.06	3.21	9.27
Ca + S + B	0.62	0.35	0.31	0.26	6.92	3.69	10.61
S. Em. ±	0.022	N.S.	0.014	0.012	0.36	0.19	0.395
C.D. at 5%	0.054	—	0.035	0.03	0.89	0.47	0.97

Table 7

Concentration and uptake of boron by sunflower as influenced by calcium, sulphur and boron fertilization

Treatment	Concentration (%)				Uptake (kg/ha)		
	40 th day	60 th day	at harvest	seed	stalk	seed	total
Control	38.91	13.55	25.49	6.79	43.25	6.59	49.84
Ca (CaO)	46.54	26.45	28.23	7.23	51.19	8.11	59.30
S (Ammonium sulphate)	40.83	22.81	26.45	8.15	54.36	10.00	64.36
B (Borax)	49.64	32.20	36.03	14.14	67.01	17.72	84.73
Ca + S (Gypsum)	40.83	17.95	24.53	10.93	47.02	13.27	60.29
Ca + S (Ammonium sulphate)	42.68	18.15	26.17	10.93	45.97	13.59	59.56
Ca + B	47.73	26.03	36.03	11.88	69.65	14.96	84.61
S + B	52.71	31.24	38.91	13.68	68.33	17.72	85.05
Ca + S + B	49.83	27.60	33.16	14.14	74.00	20.26	94.26
S. Em. ±	3.12	3.10	1.999	1.183	4.77	1.74	4.69
C.D. at 5%	7.70	7.66	4.94	2.92	11.77	4.30	11.59

The study of Oertli (1961) with sunflower indicated that boron uptake was not significantly affected by the concentration of calcium in the nutrient solution. According to Blamey (1976) soil amelioration with lime or gypsum had no effect on boron concentration in the leaf, but it resulted in a slight increase in boron concentration in sunflower seeds.

SULPHUR

The data on nitrogen content in sunflower plant indicated that addition of 10 ppm sulphur significantly increased the plant tissue nitrogen content on 40th day after sowing. Maximum nitrogen content (3.54%) was recorded when sulphur was added in the form of ammonium sulphate. In general, the nitrogen content in sunflower plant tissue was slightly higher on 60th day, but at harvest it was appreciably lower than that recorded both on 40th and 60th day after sowing. Addition of sulphur also increased the nitrogen content in sunflower seeds significantly. Similar increase in the uptake of nitrogen by sunflower stalk and seeds was noticed. Gypsum as a source of sulphur was as efficient as ammonium sulphate in increasing the nitrogen content and nitrogen uptake by plants. The efficiency of sulphur as a source of sulphur to oilseed crops was evaluated by Subbiah and Singh (1970). They found that gypsum was as efficient as other standard sulphur sources like ammonium sulphate and sodium sulphate. There are evidences to suggest that sulphur application influences the uptake of other nutrients and it was attributed mainly to the stimulative action of sulphur on nitrogen bacteria. According to Chopra and

Kanwar (1966), Dube and Mishra (1969), Pathak and Pathak (1972) and Aulakh et al. (1977), the uptake of nitrogen increased significantly by sulphur fertilization.

The above authors also emphasized the beneficial effect of sulphur fertilization on the uptake of soil phosphorus by plants. It is evident from the data that sulphur fertilization resulted in higher concentration and uptake of phosphorus by sunflower plants. In general, the trend of the effect of sulphur treatment on phosphorus concentration and uptake by sunflower plants was similar to that of nitrogen except that accumulation of phosphorus in sunflower seeds was more than that in the stalk.

The effect of sulphur application on the concentration of calcium in sunflower plants was not significant. However, it had favourable effect on the uptake and utilization of calcium by sunflower seeds. It is clear from the data that addition of calcium as CaO increased the concentration and uptake of calcium by the plant which was further enhanced when CaO was supplemented with sulphur. The effect of gypsum was comparable with the above treatment combination. These results suggested that calcium and sulphur are synergistic in their effect.

The beneficial effect of sulphur application on the sulphur content and sulphur uptake is quite obvious and needs no elucidation. The results of the present study indicate that the addition of 10 ppm sulphur either as ammonium sulphate or gypsum significantly increased the concentration of sulphur in plant tissue over control. However, the concentration of sulphur decreased continuously with the age of the crop. The sulphur content in seeds also increased significantly, but its content in seeds was lower than that in stalks. The uptake of sulphur by stalk and seed followed a similar pattern to sulphur concentration and dry matter production. The total uptake of sulphur by sunflower plants was 9.13 kg per hectare of which 4.84 and 4.29 kg were in stalk and seeds respectively.

The concentration and uptake of boron by sunflower plants and seeds increased due to the addition of sulphur, but the increase was not significant. Tanaka (1967) speculated that there might be a slight effect of sulphate ion on the accumulation of boron in plants. However, Gupta (1979) suggested that sulphur application had no effect on the boron concentration of peas, cauliflower, red clover and wheat.

BORON

Application of 0.25 ppm boron significantly increased the plant tissue concentration of nitrogen, phosphorus and boron over control, but the increase in the concentration of calcium and sulphur was only marginal. It is interesting to note that when boron was added in combination with either calcium or sulphur resulted in greater accumulation of calcium and boron in the plant tissue, while the sulphur content did not improve and those of nitrogen and phosphorus decreased. It is mostly due to the increased response of sunflower to added calcium and sulphur when supplemented with boron, which has resulted in higher dry matter production and consequent dilution of nutrient concentration in plant tissue under these treatment combinations.

Application of 0.25 ppm boron alone did not improve the concentration of N, P, Ca and S in sunflower seeds significantly over control, but when it was supplemented with either calcium, or sulphur the nutrient in seeds appreciably increased. In general, the uptake of all the nutrients was highest when boron was added along with gypsum. It might be attributed to the fact that the soils of the present investigation contained low amount of available boron (0.46 ppm).

From the above discussion of the results, it may be suggested that application of 0.25 ppm boron along with gypsum supplying 12.5 ppm Ca and 10 ppm S would benefit the sunflower production to the maximum particularly in acid soils.

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L'EFFET DU CALCIUM, DU SOUFRE ET DU BORE SUR LE RENDEMENT ET LA QUALITÉ DU TOURNESOL

Résumé

L'hybride de tournesol BSH-1 a réagi par une réponse significative à l'application du calcium, du soufre et du bore sur les sols latérites. Pour l'amélioration significative du rendement et de la qualité du tournesol on recommande l'application de 10 ppm de soufre sous forme de gypse et 0,25 ppm de bore sous forme de borax en association avec les doses recommandées de N, P et K, surtout sur les sols acides.

LOS EFECTOS DEL CALCIO, DEL AZUFRE Y DEL BORO SOBRE LA PRODUCCIÓN Y LA CALIDAD DEL GIRASOL

Resúmen

El híbrido de girasol BSH-1 respondió de manera significativa a la aplicación del calcio, del azufre y del boro en los suelos con laterita. Para mejorar sensiblemente la producción y la calidad del girasol, se recomienda a aplicar 10 ppm azufre bajo forma de bórax, junto con las dosis de N, P y K recomendados, especialmente en los suelos ácidos.