ACCUMULATION OF MACRONUTRIENTS BY TWO SUNFLOWER (*Helianthus annuus* L.) CULTIVARS UNDER FIELD CONDITIONS.

G.J. Sfredo, J.R. Sarruge & R.J. Campo. Centro Nacional de Pesquisa de Soja/ EMBRAPA, Cx. Postal 1061, Londrina, PR, Brazil.

ABSTRACT

In order to study the accumulation of the macronutrients by sunflower plants a field experiment was carried out at the "National Center for Soybean Research", Londrina, PR, Brazil. Six fertilizers doses of NPK were used but in the present paper only the dose 0-0-0 was examined. Samples of plants were harvested from 14 days after emergence to the end of the plant cycle. The authors concluded: the maximum accumulation occurs on 73 and 82 days after emergence for leaves and stems, and 90 and 100 days for seeds and receptacle; the maximum accumulation of the macronutrients for a production of 1,000 kg of seeds was K = 131 kg; N = 81 kg; Ca = 60 kg; Mg = 19 kg; P = 13 kg and S = 4 kg; the exportation of the macronutrients correspondent to a production of 1,000 kg of seeds were N = 32 kg; K = 10 kg; P = 6 kg; Mg = 3 kg; Ca = 2kg and S = 1 kg.

INTRODUCTION

Studies on nutrient requirements by sunflower plants have received little attention in Brazil.

The establishment of the crop in this country depends upon many factors one of which is the proper application of fertilizer. In order to define the amount and the time of fertilizer aplication, it is necessary to know the age of the plant at which the nutrients are most needed.

Machado (1979) found that the maximum absorption of macronutrients to produce 1,000 kg of achenes, is as follows: N = 52 > Ca = 48 > K = 43 > Mg = 18 > P = 11 > S = 8 kg. From this, 50% of N, 58% of P, 33% of S, 26% of K, 22% of Mg, and 6% of Ca are exported at harvest. The author shows that the maximum accumulation for most of the macronutrients occurs at the end of the crop cycle. Gachon (1972) obtained similar results, with exception of potassium and magnesium which reached maximum accumulation at 87 days.

Sfredo (1983), observed that, for all the nutrient in the plant, maximum accumulation occurred at 85 days after emergence and that higher speed of accumulation happened at about 53 days.

The objective of this study was: i) to verify the accumulation of macronutrient as a function of plant age; ii) to determine the points of maximum accumulation and iii) to quantify the removal of these nutrients through harvest.

MATERIAL AND METHODS

The experiment was carried out under field conditions, at the National Soybean Research Center, EMBRAPA, at Londrina, Paraná State.

Soil was a 'Latossolo Roxo eutrófico', clay textured and had been cropped with soybean. Table 1 shows chemical analysis results from this soil.

TABLE 1. Soil chemical analysis of a 'Latossolo Roxo eutrófico' from Londrina (PR), Brazil.

Sample[1] number	pH	% C	meq/100g of soil						Base saturation (V%)
			PO_4^{-3}	K	Ca	Mg	Al	H+Al	
1	5,8	1,62	0,30	0,74	6,02	2,60	0,08	4,00	70,1
2	6,2	1,59	0,31	0,70	7,43	2,99	0,09	3,10	78,2

[1]Sample 1 corresponds to the area cropped with hybrid Contissol, and Sample 2 with cultivar Guayacan.

Chemical analysis was done at the Soil Analysis Laboratory of the E.S.A. "Luiz de Queiróz" Soil Department.

Five fertilizer rates of $N-P_2O_5-K_2O$ were used: 0-0-0; 1-1-1; 2-1-1; 1-2-1; 2-2-1; and 2-0-0, where 0 = none, 1 = 45 and 2 = 90 kg/ha. Fertilizers were applied by hand before planting and incorporated with heavy discs. Nitrogen was applied 1/3 at planting and 2/3 after 30 days, in overlay. To study nutrient absorption two sunflower genotypes were used: a short cycle (Contissol hybrid) and a medium cycle (variety Guayacan).

A Randomised Complete Block experimental design was used, with 4 reps. Plots dimensions were 13 x 30m with 16 rows 30m long, spaced 0.80m. Nutrient rates for each cultivar were the main plots.

Plant population were of 5 plants/m or 62,500 plants/ha. The samples were collected at 14 days intervals, from plant emergency to harvest. Plants from each sample were separated in leaves, stem, receptacles, and seeds, then weighed and washed following Sarruge and Haag (1974) recommendations. Plant parts were dried using forced air circulation at 70-75°C.

After dried, plant material was weighed and grounded in wiley ground with 40 mesh/inch sieve. Tissue chemical analysis for N, P, K, Ca, Mg and S were accomplished as Sarruge and Haag (1974).

The treatment 0-0-0 yielded highest dry matter and seeds for both cultivars. Plant from this treatment were used to study the nutrient absorption (Sfredo 1983).

For the regression analysis were chosen the equation best adjusted statistically up to the 3rd degree.

RESULTS AND DISCUSSION

Nitrogen and Phosphorus

Figure 1 shows that the highest nitrogen (N) as well as phosphorus (P) accumulation occur in the achenes. This shows that the exported nutrients are proporcionally greater than the total absorbed. Maximum accumulation of both nutrients occurs between 70 and 90 days after emergence for the different plant parts.

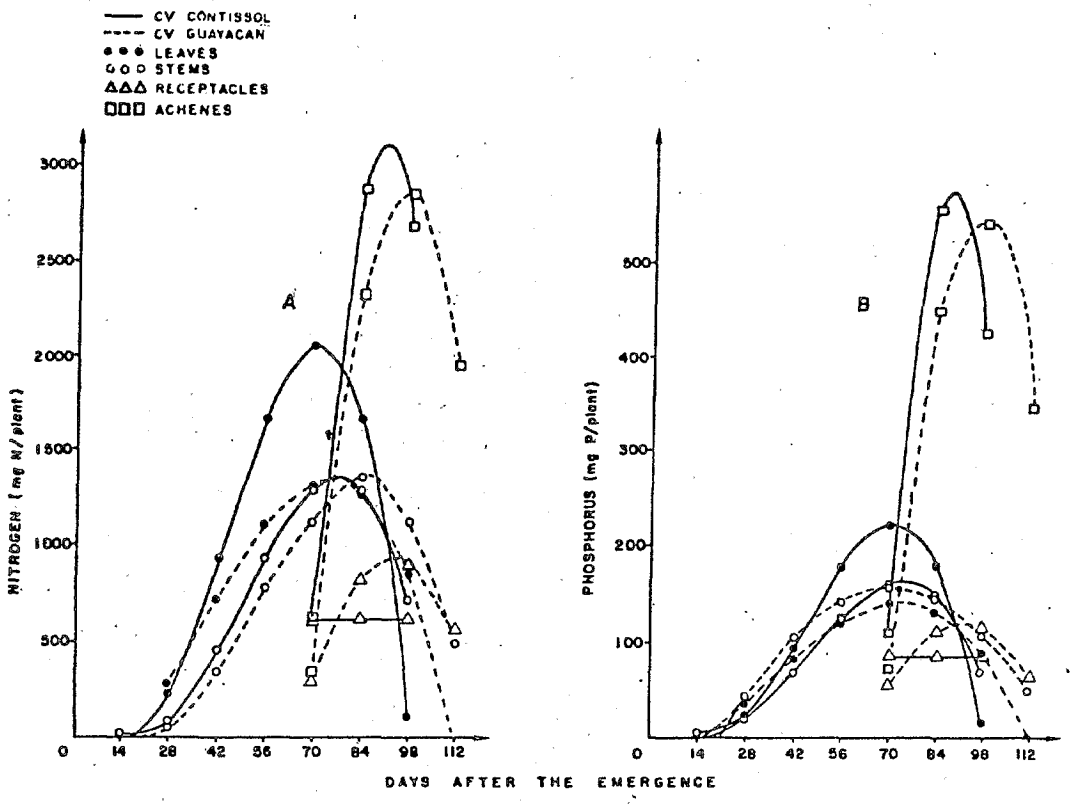

FIG. 1. Nitrogen (A) and phosphorus (B) accumulation in plant parts of two sunflower cultivars as influenced by the plant age.

Gachon (1972) and Machado (1979) found maximum accumulation points at the end of the sunflower cycle for the achenes, indicating that absorption of these nutrients occurs up to this period, but this is not indicated by the data in Fig. 1. The highest speed of absorption happens between 30 and 50 days after emergence for leaves and stems. According to Sfredo (1983), the highest speed of absorption for the whole plant was observed at 56 days after emergence.

Potassium and Calcium

Highest accumulation of these nutrients were observed in the stems (Fig. 2). There is little accumulation of potassium in the leaves, while calcium accumulates in similar amounts both in the leaf and the stem.

Maximum accumulation of both nutrients in different plant parts is observed between 73 and 90 days after emergence (Fig. 2). Gachon (1972) showed similar results for potassium, but observed greater accumulation of calcium in the leaves as compared to the stems. The higher speed for absorption for both nutrients occurs between 43 and 57 days after emergence for leaves and stems (Fig. 2). Sfredo (1983) observed that higher speed of absorption of K and Ca for the whole plant happened at 52 days after emergence with maximum accumulation at 85 days.

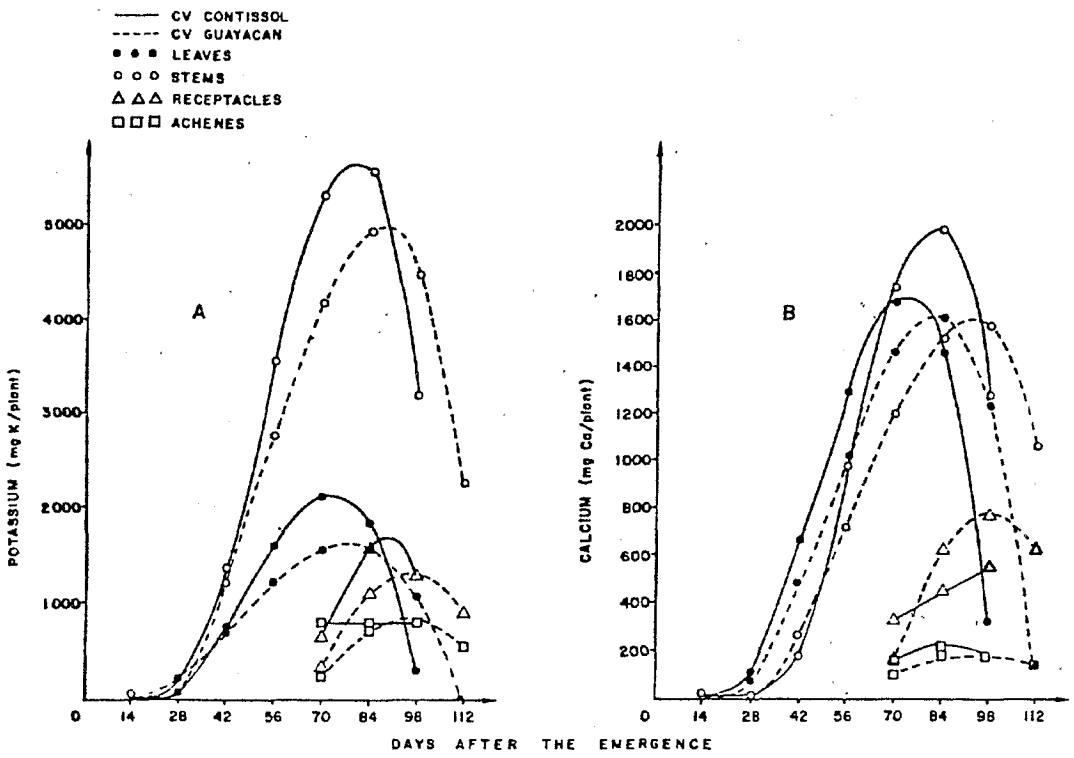

FIG. 2. Potassium (A) and calcium (B) accumulation in plant parts of two sunflower cultivars as influenced by the plant age.

Sulfur and Magnesium

Similarly to K and Ca, the highest accumulation of S and Mg occured in the stems. The accumulations in the leaves are identical for both. Maximum accumulation for both nutrients in different plant parts were observed between 73 and 100 days after emergence. Gachon (1972) observed that leaves and stems accumulate equal quantities of Mg and reach maximum levels at about 80 days. The highest speed of Sand Mg absorption by leaves and stems occur between 45 and 55 days after emergence.

Sfredo (1983) observed higher speed of absortpion for S and Mg for the whole plant at 53 days and maximum accumulation at 85 days after emergence.

Nutrient Export

As shown in table 2, the order of plant nutrient extraction was as follows: K > N > Ca > Mg > P > S, and the nutrient export was: N > K > P > Mg > Ca > S.

The third place for P in the order of exported nutrients is due to its higher percentage as compared to the total absorbed (37.9%), since it ranks fifth in the total quantity absorbed.

As shown in Table 2, K was absorbed in greater quantities (131 kg of K/ha), representing four times than that found by Robinson (1973) (29 kg of N/ha) and Machado (1979) (43kg of K/ha). Probably, the greater accumulation of K found

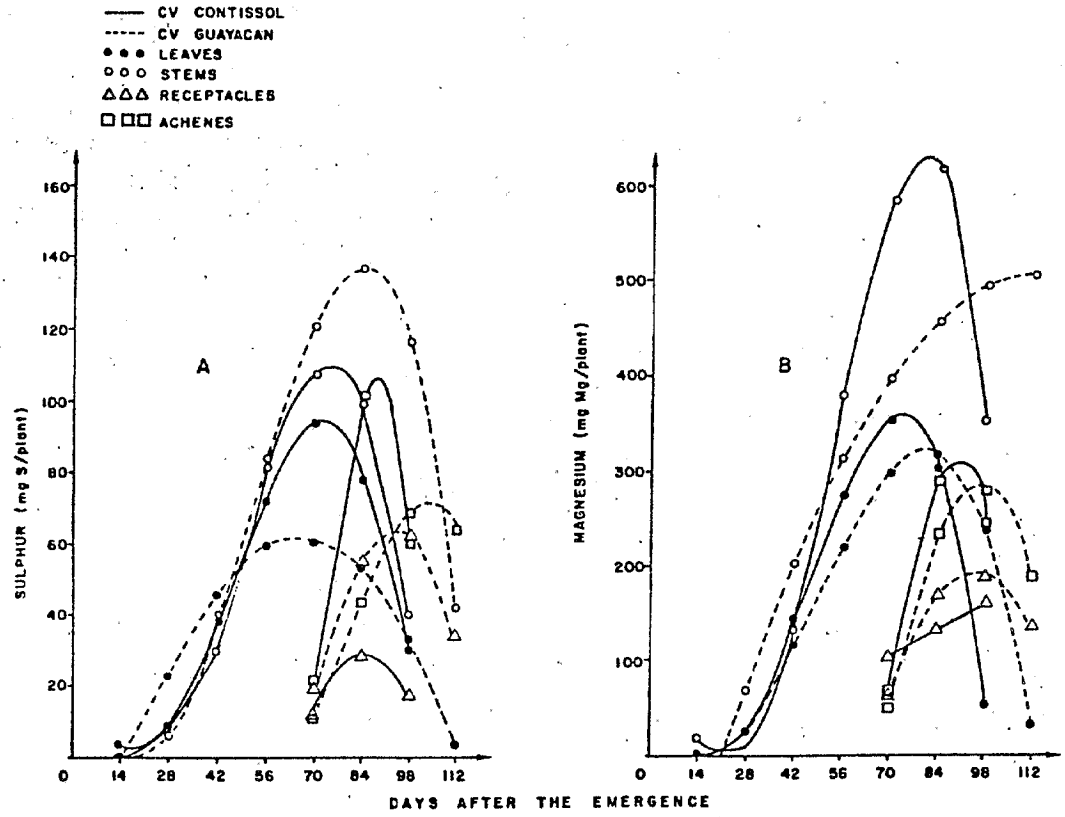

FIG. 3. Sulphur (A) and magnesium (B) accumulation in plant of two sunflower cultivar as influenced by the plant age.

in this study was due to the higher yields obtained as compared to the other authors.

The order of nutrient extraction found in this study was similar to that found by Semihnenko et al. (1960) and Rollier (1972) (mentioned by Vrânceanu, 1977), Robison (1973), Machado (1979), and Gachon (1972) found a nutrient export order similar to that shown in Table 2.

CONCLUSIONS

1. Maximum nutrient accumulation occured between 73 and 100 days and the point inflection between 45 and 57 days after emergence;

2. Maximum accumulation of macronutrients (kg) for a production of 1,000 kg of grain in decreasing order was: K = 131 > N = 81 > Ca = 60 > Mg = 19 > P = 13 > S = 4;

3. Exportation of macronutrients (kg) for a production of 1,000 kg of grain in decreasing order was: N = 32; K = 10; P = 6; Mg = 3; Ca = 2, and S = 1.

TABLE 2. **Maximum whole plant nutrient accumulation and exportation at harvest (kg/ha), by two sunflower cultivars for a grain yield of 1,000 kg/ha.**

Nutrients	Maximum accumulation			Nutrient exportation		
	Contissol	Guayacan	Average	Contissol	Guayacan	Average
N	79	82	81	33	31	32
P	12	13	13	5	6	6
K	134	127	131	10	9	10
Ca	59	61	60	2	2	2
Mg	18	19	19	3	3	3
S	3	4	4	1	1	1

REFERENCES

GACHON, L. 1972. La cinétique de l'absorption des eléments nutritifs majeurs chez de Tournesol. **Annales Agronomiques** 23, 547-566.

MACHADO, P.R. 1979. Absorção de nutrientes por duas cultivares de girassol (*Helianthus annuus* L.) em função da idade e adubação, em condições de campo. ESALQ. Piracicaba (SP), 83p. (MsC Thesis).

ROBINSON, R.G. 1973. Elemental composition and response to nitrogen of sunflower and corn. **Agronomy Journal** 65, 318-320.

SARRUGE, J.R. & HAAG, H.P. 1974. Análise química em plantas. Piracicaba (SP). ESALQ/USP, 52p.

SFREDO, G.J. 1983. Absorção de nutrientes por duas cultivares de girassol (*Helianthus annuus* L.), em condições de campo. ESALQ. Piracicaba (SP). 99p. (PhD Teses).

VRÂNCEANU, A.V. 1977. El girasol. Madrid, Mundi Prensa, 397p.