DRY MATTER PRODUCTION AND MACRONUTRIENTS CONCENTRATION IN TWO CULTIVARS OF SUNFLOWER (*Helianthus annuus* L.) 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 dry matter production and macronutrients concentration in different plant parts during the growth of sunflower plants, a field experiment was carried out at the Centro Nacional de Pesquisa de Soja/EMBRAPA, Londrina, PR, Brazil. The plants were grown in a Latossol Roxo eutrófico (Eutrustox). Six fertilizer levels were used: 0-0-0; 1-1-1; 2-1-1; 1-2-1; 2-0-0; (NPK), being 0 = 0; 1 = 45 kg/ha; 2 = 90 kg/ha ($N_1P_2O_5$, K_2O), with four replications. For the achenes and receptacles the maximum accumulation occurs at 90 days after emergence. The authors concluded: the highest rate of growth occurred at 56 days and the maximum dry matter production at 75 days after the emergence for leaves and stems. Among these treatments was chosen the one which gave the highest yield (level 0-0-0) for study the dry matter accumulation and the macronutrients concentration. The lowest concentration of the nutrients occurred near the period of maximum dry matter production (80 days). For foliar diagnosis the following levels may be used: N = 3.30%; P = 0.39%; K = 3.16%; Ca = 2.73%; Mg = 0.59%, and S = 0.16%.

INTRODUCTION

Research on nutrient requirement and on dry matter accumulation as a function of age in sunflower are scarce. There are some reports on sunflower nutrition and fertilization in Brazil but little is known as regard to dry matter accumulation. These information are basic to establish the period of fertilizer application in order to meet of requirement by the plants.

Gachon (1972) and Machado (1979) observed that maximum dry matter accumulation in different plant parts occurred at the end the cycle. Sfredo (1983) found maximum accumulation at 88 days and higher speed in growth at 56 days after emergence. Machado (1979) and Robinson (1973) studying the sunflower nutrient composition concluded that the nutrient absorption is fast as compared to dry matter production and so concentration is higher in younger plants, decreasing with maturity. Machado (1979) determined macronutrient concentrations in the leaves and considered good when concentration at the beginning of flowering period where: N = 3.31%; P = 0.39%; K = 2.06%; Ca = 2.95%; Mg = 0.71%, and S = 0.35%.

The objectives of this study were to: i) verify the dry matter accumulation at the different plant parts as a function of age; ii) determine macronutrient concentrations at the various stages of development; iii) determine the ideal nutrient concentration in the leaves for the plant to begin flowering.

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 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

Sample 1 corresponds to the area under the cultivar Contissol.
Sample 2 corresponds to the area under the cultivar Guayacan.

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

Five fertilizer nutrient rates combinations 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 nutrients were applied by hand before planting and incorporated with heavy discs. Nitrogen was applied 1/3 at planting and 2/3 after 30 days, 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 desing 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 colected 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. Plants 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

Fig. 1 shows that stem dry matter accumulation is higher than in other plant parts, reaching maximum at about 85 days after emergence, periods for maximum accumulation and maximum speed were close to those for stem. However, receptable and achenes reached maximum levels at about 90 days.

Gachon (1972) observed maximum dry matter accumulation in stems and leaves at full flowering. Sfredo (1983) studying the whole plant found maximum accumulation at physiologic maturity (88 days) and higher growth speed at the beginning of flowering (56 days after emergence).

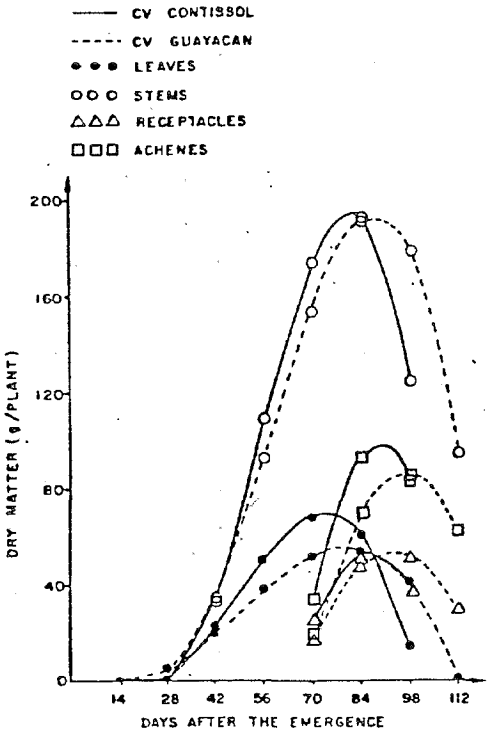

FIG. 1. Dry matter accumulation by plant parts of two sunflower cultivars as influenced by the plant age.

Concentrations of N and P (Fig. 2) are reduced as plant grows, except for the achenes, and are lowest for both nutrients in the stem. Highest concentrations of P and N were found in the achenes and in the leaves, respectivelly, showing high degree of translocation of these two nutrients from leaves and stems to achenes after flowering stage (20 days). Similar results for N and P were found by nutrients (Machado 1979 and Robinson 1973).

Fig. 3 shows that potassium (K) concentration in the leaves remains stable until full flowering, decreasing afterwards probably due to higher dry matter accumulation at this time, showing a dilution effect.

Potassium concentration in the stem decreases continuosly, from the beginning to the end of the cycle. The receptacle presents certain stability along the cycle, although a little increase in concentration has been observed on cultivar Contissol. Achenes present decreasing concentration, showing dilution effect, probably due to reduction in absorption of K by these organs. These results agree with those obtained by Machado (1979), for K in the leaves wich decreased after 30 days.

Calcium (Ca) concentrations increased in leaves and receptacle from the beginning to the end of the cycle for cultivar Guayacan, decreasing in the achenes and staying unchanged in the stems (Fig. 3). Cultivar Contissol, showed no change in concentrations of Ca in leaves, stem, and receptacles, but decreasing in the achenes. As a consequence, cultivar Guayacan showed higher Ca absorption capacity.

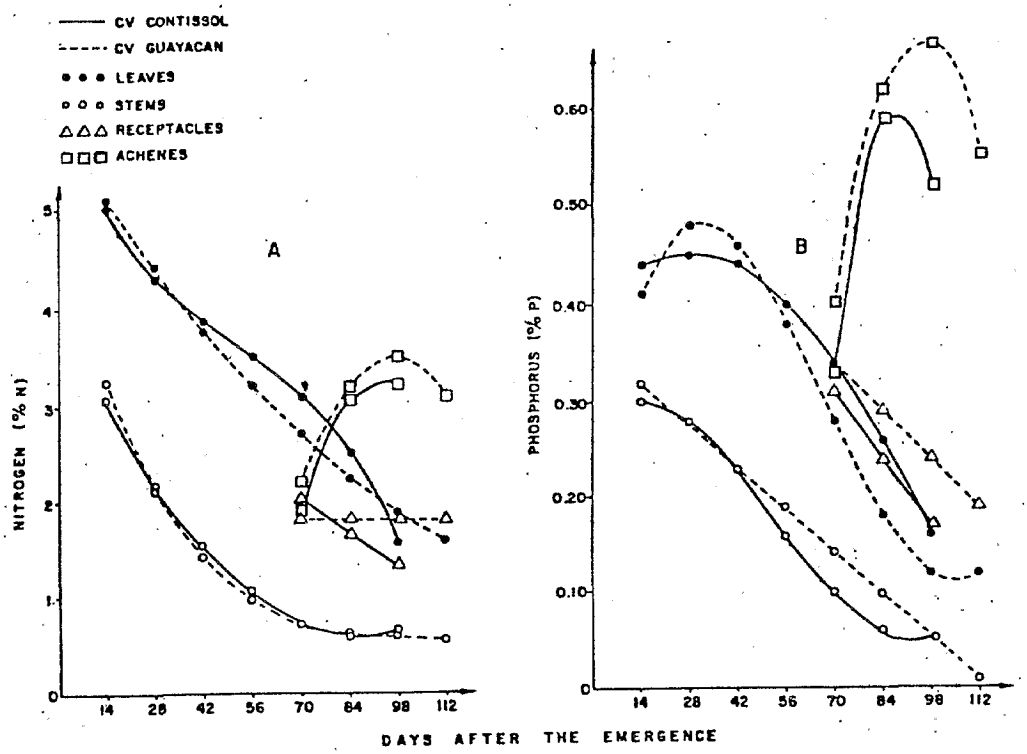

FIG. 2. Nitrogen (A) and phosphorus (B) concentration in plant of two sunflower cultivars as influenced by the plant age.

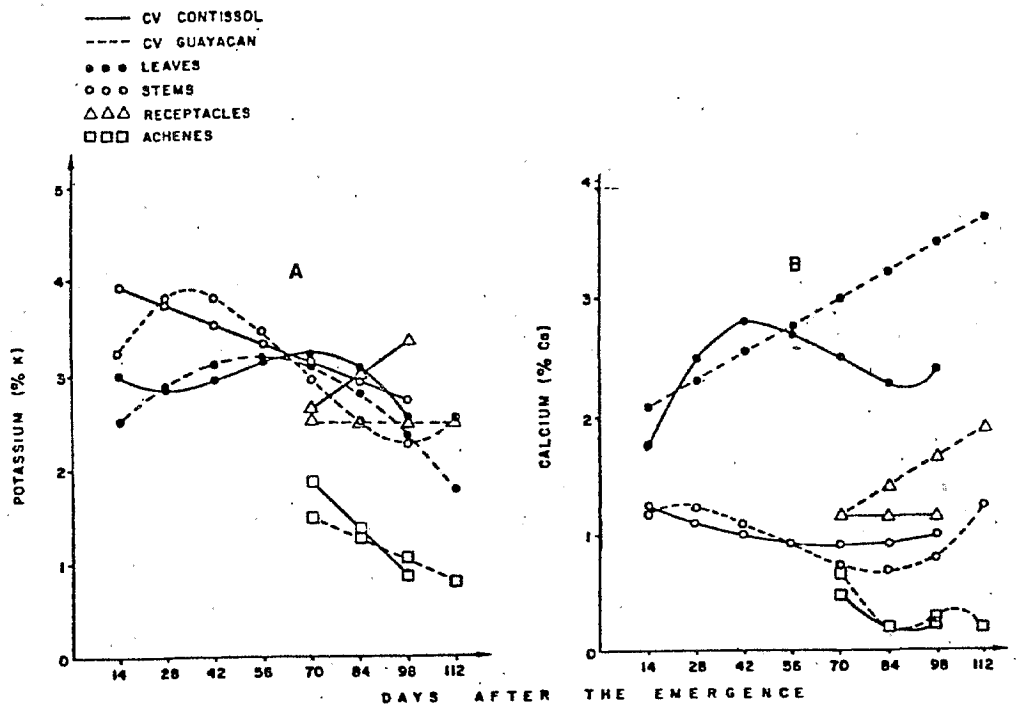

FIG. 3. Potassium (A) and calcium (B) concentration in plant of two sunflower cultivars as influenced by the plant age.

Machado (1979) found that Ca concentration increased in the leaves as the plant grew, a little decrease in the stem and in achenes, and a stabilization in the receptacle. Fig. 3 shows little translocation of K and Ca nutrients from the vegetative to reproductive plant parts.

Fig. 4 shows both cultivars having identical behavior for magnesium (Mg) absorption by leaves and stems until flowering, differing afterwards.

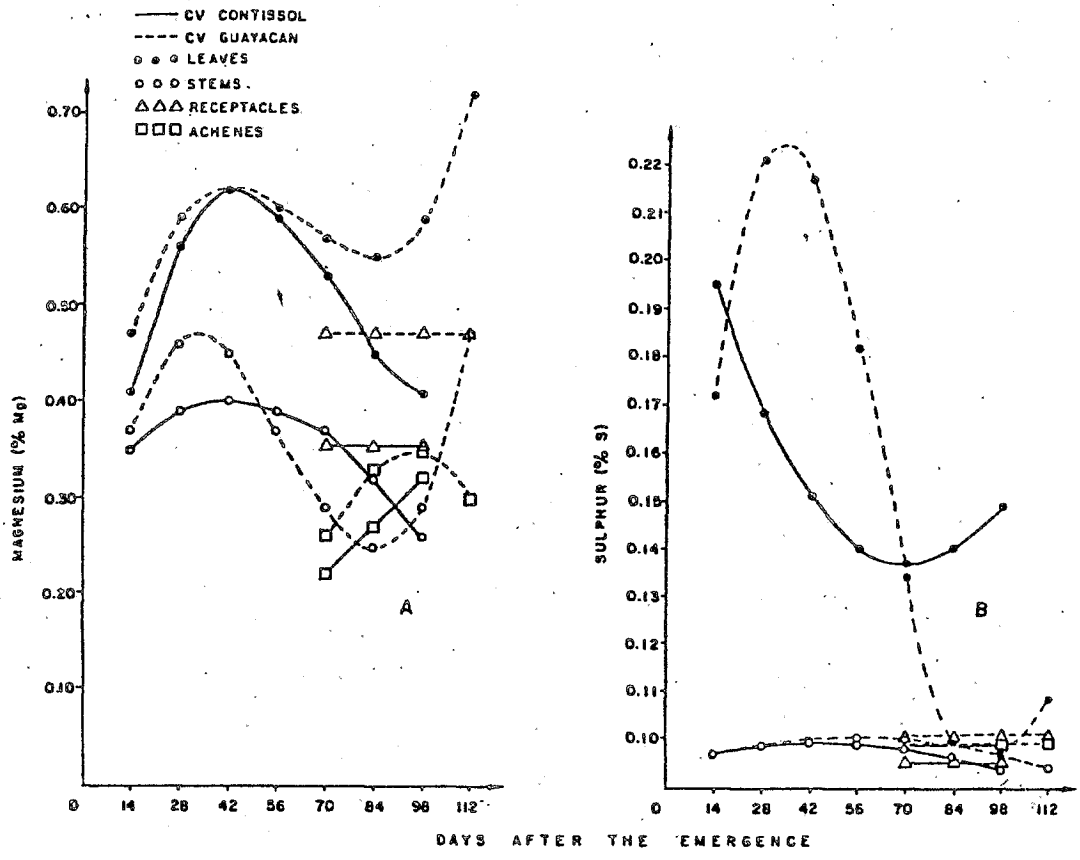

FIG. 4. Magnesium (A) and sulphur (B) concentration in plant parts of two sunflower cultivars as influenced by the plant age.

Cultivar Guayacan begins to reabsorb Mg at physiological maturity (84 days), with concentrations increasing until the end at the cycle. However, Mg concentration in cultivar Contissol decreases until the end of the cycle after reaching maximum concentration at 42 days. Other differences between these two cultivars is related to the Mg translocation to achenes. It is high as Contissol and low in 'Guayacan'.

Absorption of sulfur (S) (Fig. 4) was found to show little difference only in the leaf. In cultivar Guayacan concentration increased up to 30 days, and decreased afterwards, while in 'Contissol' the concentration decreases reaching a minimum at full flowering.

The range of concentration in the leaves optimum for each macronutrient in both cultivars at the beginning of flowering (56 days) is: N = 3.18-3.51%; P = 0.38-0.40%; K 3.13-3.18; Ca = 2.71-2.76; Mg = 0.59-0.60% e S = 0.14-0.18%. These values can be used for foliar diagnosis of the nutrient levels of

sunflower and are considered adequate for a good development of sunflower plants. The observed values are close to those estimated by Machado (1979), except for K and S which were found to be 2.06-2.91% and 0.35-0.41%, respectivelly.

CONCLUSIONS

Based on data from this work the following conclusion are drawn:

1. in general, growth speed is greatest at beginning of the flowering period, whereas, maximum dry matter accumulation occurs after physiologic maturit;

2. in general, maximum nutrient concentrations occurred, close to or short after maximum dry matter accumulation period (88 days), clearly showing the effect of nutrient dilution in the plant;

3. the range of nutrient concentrations in the leaves, obtained at the beginning of flowering, which can be considered as indicative of the nutritional state of sunflower were: N = 3.18-3.51%; P = 0.38-0.40%; K = 3.13-3.18%; Ca = 2.71-2.76%; Mg = 0.59-0.60% and S = 0.14-0.18%.

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).