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EFFECTS OF DIFFERENT SOWING DATES ON THE GROWTH AND DEVELOPMENT OF YAM BEAN (Pachyrhizus erosus URBAN)

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ABSTRACT

The effects of different sowing dates on the growth and development in Yam bean (Pachyrhizus erosus Urban) were investigated with reference to the photoperiodic changes during the plant cycle. Whatever the sowing dates, tuberization was initiated between 4 and 6 weeks after sowing. Floral induction occurred under short days. When the whole cycle of the plant took place under short days, tuberization and flowering processes started at the same time. Plants under those conditions (October and December sowings) presented a reduced shoot due to the fact that tuber bulking competed with the development of the aerial parts. The cycle duration did not exceed 5 months. Plants which ran their vegetative phase under long days (May plants) delayed the tuber growth which occurred only after the development of a large and vigorous foliage resulting from vine production. The cycle duration could reach 8 to 9 months. February plants which began their cycle under short days but did not achieve it before going through the long day influence, presented successively short and long day pattern of development.

Additional key words: Growth patterns, tuberization, yield, tropical legume.

INTRODUCTION

Yam bean (Pachyrhizus erosus, Leguminosae: Faboideae) is a tropical tuberous legume considered as one of the promising alternative crop which deserves to be spread in the tropical crop producing regions. First of all, as many other legumes, it evolves a relationship with the rhizobium and can cover all its nitrogenous needs by dinitrogen fixation. It produces fleshy tubers, with a well-balanced amino-acid composition, which can be eaten raw or cooked (Marta-Evans et al. 1977). Immature pods cannot be eaten without appropriate cooking precautions (Schroeder, 1967) because of the presence of rotenone, a respiratory inhibitor (Hansberry et al. 1941), present in the whole green parts of the plant, which is an efficient protection against insect attacke. Yam bean can also develop an important aerial part, rich in protein that might be used as forage or as green manure to improve the physico-chemical properties of the soil (Cortes 1970).

Many authors had described the cultural practices necessary to improve tuber yield or to safeguard tuber and grain production, sowing being the best and the easiest way of propagating the crop. Zepeda (1971) recommended an early cutting of the spikes to increase twofold the yield. Zinsou et al. (1987) showed that GA3 and CCC spraying favored tuber and grain yields respectively. The seasons of sowing are given but need to be adapted in

function of the photoperiodic conditions encountered in the different intertropical regions. Our report gives some indications about the behavior of the crop when four sowing dates are used.

MATERIALS AND METHODS

Yam bean Pachyrhizus erosus Urban, cv TPE 1) seeds were kindly supplied by Dr. Steele of I.I.T.A., Ibadan, Nigeria and multiplied locally. The experiment was laid down to see whether there was any effect on the yam bean cycle and growth when the sowings were carried out under field conditions in February, May, October and December. Plots were ridged at 80 cm. 3 seeds per hole were sown 60 cm apart on the ridges. The holes were thinned at 1 plant after one month. Plants from February and May were staked because of the important development of the vines and in order to facilitate the sampling. Plants received a chemical fertilization brought as basic slag containing 70 kg of P205 per hectare and as potassium sulphate representing 120 kg of K20 per hectare. The nodulating rhizobium was present and efficient in the soil. Each plot contained 240 plants and 10 whole plants were randomly and periodically harvested to follow the growth characteristics. Sampling became impossible after 22 weeks so the results reported here concerned the first periods of growth for February and May sowings. However plants from October and December sowings had already completed their cycles.

RESULTS

Effects of sowing dates on the growth pattern of yam bean

The effect of the sowing dates on the growth patterns would be better understood if the sequence of the photoperiodic changes during the year were given. In Guadeloupe the length of the shortest day is 11 h and that of the longest one is 13 h. From September to March, days are short (shortening from 22 September to 21 December and getting longer from 22 December to 21 March); From March to September days are long (lengthening from 22 March to 21 June and getting shorter from 22 June to 21 September).

The general observations on the behavior of the plants obtained from the different sowing dates are the following:

- Whatever the sowing dates, tuber initiation occurred between 4 and 6 weeks after sowing. Under short days flowering and tuberization are induced at the same time.

- Pod setting and filling as well as tuber bulking needed short day conditions with day length inferior to 12 hours.

- Day length superior to 12 H promoted shoot development and inhibited flowering and tuber growth.

- The cycle of the plant might be considered as achieved after pod dryness but as the shoot remained still functional, tuber kept on growing until complete shoot dieback.

The patterns of development were different according to the sequences of

the photoperiodic changes encountered during the cycle of the plant.

- Plants from February sowing had met successively short, long and short day conditions. Short days (February and March) had induced a first flowering and tuber initiation. The next long and increasing days (May through July) inhibited pod setting and stopped tuber growth, turned the plant back to the vegetative state and promoted shoot development. A second floral initiation occurred under following short days with the resumption of the bulking of the tuber. The cycle reached ten months.

- The growth of plants from May sowing began with a strong promotion of vines under long days. Floral and tuber induction occurred under the following short days.

- The whole cycle of the plants from October and December sowings took place under short days. The development of the axillary buds leading to vines, observed under long days, was inhibited so they looked like dwarf plants. Flowering and tuber initiation were early, pod setting and tuber growth competed immediately with the development of the aerial parts. As a consequence, cycle duration was short, not longer than 5 months.

Effects of the sowing dates on the aerial parts

Figures 1 and 2 showed the comparative evolution of the dry matter accumulated in the leaves and stems plus petioles. October and December plants, which had undergone short day conditions during their whole cycle, stored little dry matter in the two organs. So did the plants from February sowings which met the same condition during the first stage of their growth. After floral initiation, a rapid formation of leaves occurred during the development of inflorescence stalks which led to the accumulation of leaf and stem matter until the beginning of blossoming. For October and December plants no other matter accumulation took place in the vegetative organs. In the February plants the next long days caused the abortion of all the flowers and turned the plants back to the vegetative state, with the promotion of vine and new leaf development. The following sequence of growth was similar to what was encountered on plants from May sowings which expressed the shoot promoting influence of long days. During our period of observation they gave the highest dry matter in the leaves as well as in the stems.

Effects of sowing dates on the underground parts

The evolution of the dry matter in the tuberous root is shown in Figure 3. For all the plants, whatever the sowing dates, the active tuber growth always started at the appearance of the first floral buds. Under long days the induced tuberous root did not expand but lengthen with a very low accumulation of storage compounds. After floral induction the active tuber bulking began, then stopped from the blossoming to the end of grain filling. This phase was indicated by a plateau on the curves except for that of December. Tuber growth resumed afterwards up to the shoot dieback. It is important to notice in yam bean that the maturation and dryness of the pods did not end the cycle of the plant.

At the end of the period of observations, October and December plants had achieved thoroughly their cycle, May plants were pod setting grain

filling. As for February plants, flowers were blossoming. For both May and February plants the plateau phase was running. Tuber weight was determined at the end of the cycle of May, October and December plants. The average weights were 2480, 1200 and 620 g respectively.

Effects of sowing dates on the ratio: Aerial parts/underground parts

The evolution of the ratio for different sowing dates is shown in Figure 4. When the plant developed its whole cycle under short days as did October plants the ratio rose during the setting of the aerial parts, peaked early, then decreased progressively. The peak always occurred after floral induction.

Before the peak, shoot was the main user of the assimilates. After the peak, the rate of assimilate allocation to the shoot decreased for the benefit of the tuber. On the curves of December and February plants the phase of increasing ratio disappeared, indicating a limited formation of the aerial parts, with a reduced potential of photosynthesis during tuber bulking. But for the February plants, the abortion of flowers and the return to the vegetative state restarted the formation of aerial parts with a new rise of the ratio which lasted as long as what observed on May plants. The normal pattern of the ratio evolution is rise, peak and decrease but according to sowing dates one of the phases can disappear as on December curve or two identical phases can occur in the same cycle as on the February plants because of the two flowerings.

DISCUSSION AND CONCLUSIONS

When the whole cycle of the plant was allowed to develop under short days, the climatic conditions undergone by the plant were suitable to the production of marketable tubers. They limited the lengthening of the cycle and thus the enlargement of the tuber which was beet-shaped. The optimal yield would be obtained with sowing period ranging from August to late October. The same sowing period had been recommended to the mexican growers by Cortes (1970). In the Caribbean region, near the Equator, where the short days prevail, yam bean could be grown all year long and two crops are possible a year.

The active growth of the tuber seemed to be under the control of the flowering process which managed the distribution of the assimilates towards the storage sites instead of the shoot. As short days were favorable to pod setting and grain filling as well as tuber expansion, competition occurred between the two storage organs which suspended the allocation of matter to the tuber. When tuber production was only needed, Zepeda recommended the removal of the flowers twice or three times after the flowering. Only one intervention was sufficient if the cutting off took place after the development of the spikes and before the pod setting. Zinsou et al. (1987) also reported that GA3 treatment increased tuber yield and reduced grain formation.

When the vegetative phase took place in long days (May sowing), although tuberization was initiated; tuber bulking was stopped and the assimilates were allocated for the shoot and root development. Tuber growth and floral

initiation occurred during the next short day period. The potential of photosynthesis of the aerial parts is now very high due to the important development of the shoot. The breaking of the competition between the tuber and the grains led to a high yield which can be improved by staking as shown by a combined treatment of flower removal and staking. A separated experiment on plants from June sowing, of which growth and development were comparable to plants from May sowing showed that flower removal was more efficient than staking (Table 1).

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Table 1 - Effects of staking and spike removal on the fresh tuber weight and yieldof yam bean (Pachyrhizus erosus Urban) from June sowing. The values are averages of weights of 50 tubers.

TREATMENTS	CONTROL	STAKING	CUTTING	STAKING + CUTTING
TUBER WEIGHT (g per plant)	1400	2700	3300	6300
ESTIMATED YIELD (T/ha)	24	50	60	110

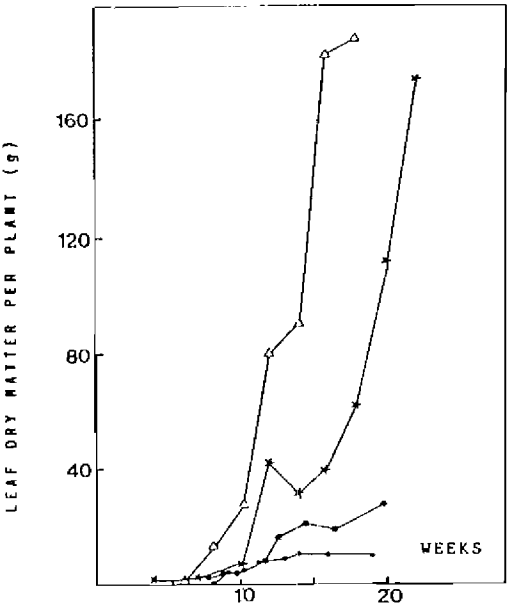

Fig. 1 –EVOLUTION OF DRY MATTER PER PLANT ACCUMULATED IN THE LEAVES OF PLANT FROM SOWINGS OF FEBRUARY (★), MAY (△), OCTOBER (✱) AND DECEMBER (●).

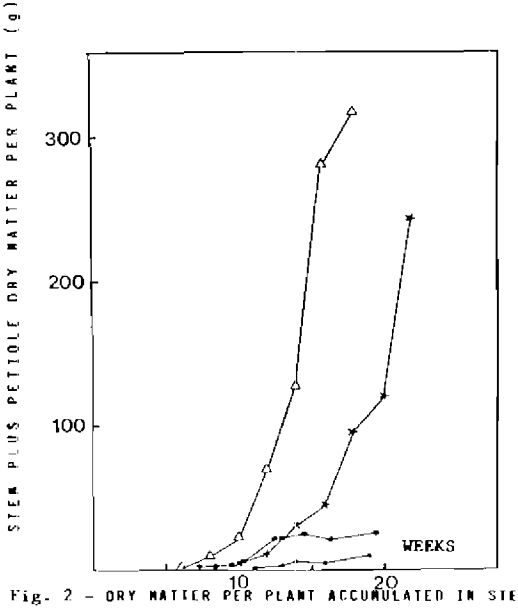

Fig. 2 – DRY MATTER PER PLANT ACCUMULATED IN STEM PLUS PETIOLES OF PLANT FROM SOWINGS OF FEBRUARY (★), MAY (△), OCTOBER (✱) AND DECEMBER (●).

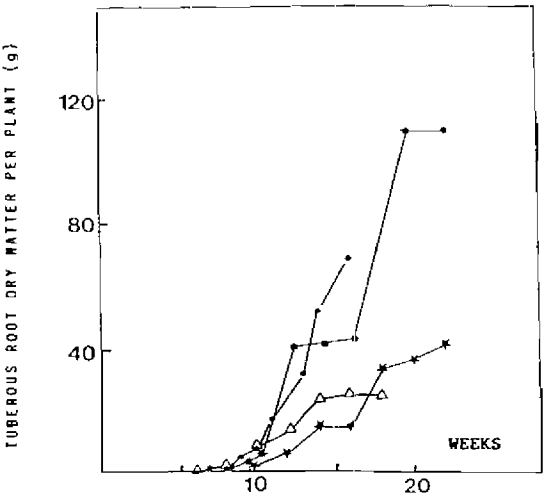

Fig. 3 – DRY MATTER PER PLANT STORED IN THE TUBEROUS ROOT OF PLANTS FROM SOWINGS OF FEBRARY (★), MAY (△), OCTOBER (✱) AND DECEMBER (●) . TUBERIZATION WAS INITIATED BETWEEN 4 AND 6 WEEKS WHATEVER THE SOWING DATES.

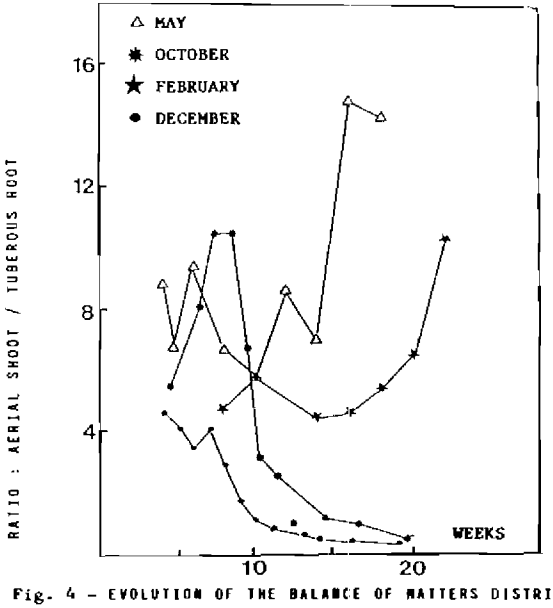

Fig. 4 – EVOLUTION OF THE BALANCE OF MATTERS DISTRIBUTED BETWEEN SHOOT AND TUBEROUS ROOT EXPRESSED AS A RATIO. A RISE INDICATES A PREFERENTIAL ALLOCATION TO THE SHOOT, A DECREASE AN ACTIVE GROWTH OF THE TUBER.