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The development of the husk tomato plant (*Physalis ixocarpa* Brot.). I. Aerial vegetative parts

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Abstract

The growth of various vegetative parts of the husk tomato cv. 'Rendidora' has been studied. The samples for dry mass determination were taken every 1-2 weeks. The life cycle of a plant was divided into 4 phases according to the developmental stages of the leaf area. The plants of cv. 'Rendidora' show 2 main types of growth: prostrated and erect. The plants of the last type showed a tendency to grow less and to initiate their senescence later.

Key words: life cycle, ontogenesis, developmental stages

Resumen

Se presenta el crecimiento en masa seca de partes vegetativas aéreas del tomate de cáscara cv. 'Rendidora', en base a muestreos destructivos repetidos cada 1-2 semanas. El ciclo de la vida de la planta fue dividido en 4 fases conforme al desarrollo del área foliar, ya que éste es el factor primordial del cual depende el crecimiento de todas las otras partes. De los 2 tipos de plantas que componen el cv. 'Rendidora' aquellas erectas crecieron menos pero mostraron tendencia a empezar su senescencia más trade que las rastreras.

INTRODUCTION

The husk tomato is widely cultivated in Central Mexico for its fruits which are used mostly for the preparation of sauces with hot pepper

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(Saray 1977). Its consumption in central Mexico amounts to about 10% of that of the red tomato (*Lycopersicon esculentum* Mill.). Nevertheless, only a few studies have been done with this species. Some years ago, a new cultivar 'Rendidora', more productive and having relatively large fruits, was introduced into cultivation and is widely accepted by the growers (Saray et al. 1978, Cárdenas 1981). The general description of the development of the husk tomato cv. 'Rendidora' was given by Saray (1977, 1982) and by Saray and Loya (1978). More details concerning the development of the aerial part and of the root system of this plant were provided by Mulato et al. (1985, 1986).

Development is considered in this paper as a concept comprising growth, differentiation, and even senescence, abscission and the death of a plant or its organs (see Loomis 1953, Listowski 1970, Wareing and Phillips 1970, Moore 1979, Jankiewicz 1979).

The description of a life cycle of a plant may be facilitated by dividing it into phases (periods). This also makes possible comparing the results obtained under various climatic conditions (Hanway 1963). Different systems of dividing the life cycle of a plant have been proposed. Aitken (1977) suggested 3 periods (phases) for annual plants: 1) "vegetative" (from the sowing to floral initiation), 2) "early reproductive" (flower initiation to flowering), 3) "late reproductive" (flowering to the formation of dry seed). On the other hand, Tanaka and Yamaguchi (1972) proposed 4 phases for corn: 1) "early vegetative" — in which the dry mass production is slow, leaves appear and start to develop; it terminates with the initiation or early differentiation of reproductive organs; 2) "active vegetative" in which the culm and the leaves develop, and the primordia of reproductive parts are formed; it ends with the emission of stigmas; 3) "initial filling of the grain" — dry mass of the stem and of the leaves augment, the bracts and the raquis are growing, the dry mass of the seeds increases slowly; 4) "active filling of the grain" — is accompagned by a slight decrease of the dry weight of leaves and stem. There are also some other systems, for instance, that of Hanway (1963) for corn, comprising 10 phases, etc.

The purpose of this study was to describe the development of the aerial, vegetative parts of cv. 'Rendidora' on the basis of their dry mass.

MATERIAL AND METHODS

The experiment was localized in the Agricultural Experiment Station (Campo Agrícola Experimental) of Zacatepec, Morelos in central Mexico. It was performed during the dry period of the year (1982.10.31-1983.02.13). The average weekly temperature during the performance of the experiment was 17-22 C. The soil was loamy clay, more than 85-100 cm deep, very homogenous over all of the field. The field was furrow irrigated, initially weekly, then at larger intervals toward the end of the experiment. The field was divided into 8 plots, each with 240 pairs of plants, planted in rows 1 m apart with a distance of 50 cm between pairs.

After preparing the furrows, 20-30 seeds were deposited at each point of sowing. The seeds germinated 5-7 days later. The first fertilization was done 10 days after emergence (AE), i.e. 17 days after sowing, with the proportions of NPK 60:40:00. The other half of the nitrogen (60 kg) was applied on the 46th day AE. The fertilizers ammonia sulphate and superphosphate were given in the vicinity of the seeds. Fourteen days AE, the first thinning was carried out leaving 5-6 plants in one place. During the 2nd (and last) thinning, 25 days after emergence, only 2 plants were left in each place. At the 45th day AE the plants were attached to strings which were placed 30 cm and 60 cm above soil level. The day after, the second dose of nitrogen (60 kg) was given in the form of a line on one side of each row of plants.

In order to control insects like *Trialeurodes vaporarum* West and fruit boring caterpillar (*Heliothis suplexa* Guenee) and diseases (*Oidium* sp.), pesticides: Lannate, Dipel, Morestan and Benlate were applied periodically. A microelement preparation Microquel was also applied periodically. In addition to the insects reported in literature, we have encountered a caterpillar boring the stem inside and causing wilting of a plant. We have also observed the attack of a fungus, *Fusarium* sp., which could be controlled by Benlate $1\ g \times dm^{-3}$ at the root neck.

The plants of cv. 'Rendidora' need cross pollination. They are genetically heterogenous from the morphological and physiological point of view. There are 2 distinct forms among them: prostrated and erect with some per cent of intermediate plants. Up to 5th week AE it was not possible to discern among them.

Our investigation was based on destructive sampling performed weekly during the first part of the experiment, and afterwards every 2nd week (with the exception of the 2 last samplings which were separated by a week). Initially, we collected 4 plants from each of the 8 plots. When it became possible to descern the erect and prostrated forms of the plants we chose 15 plants of each form (prostrated and erect) in each plot. During each next sampling we chose among them, at random, 2 erect and 2 prostrated plants for dry mass determination. During the last samplings (9th-14th week AE) it was possible to analyse only half of a plant due to its large size. During the last sampling date (14th week AE) there were many plants infected with a viral or mycoplasmal disease known by the growers as "chino", causing a light coloration of young leaves and their deformation.

For this reason, the plants were not chosen completely at rondom during this last sampling.

The plants were dried at 70°C for at least 3 days. The leaf area was determined with a leaf area meter LI-COR, LI-3000 (LAMBDA — Instruments Corporation, Lincoln, Nebraska — USA).

The equations of regression were obtained separately for the prostrated and erect plants, from averages of each variable against time. The method of minimum squares was applied without transformation of the data, using the SAS (Statistical Analysis System) for computer calculations. The polynomial functions chosen were of the 3rd and 4th grade.

RESULTS

The development of different parts of the husk tomato plant is presented with regression curves, or, when necessary, also with curves derived from the averages of the real data (real curves). For leaf area and total dry mass, the "combined curves" were applied: the initial sector of the curve, up to the 6th week AE, is based on the real data and the remaining part derives from the equation of regression. The reason for doing this was that the regression curve partially went down below 0 during the period 0-6th week AE. A similar procedure was applied by Zavala (1982).

The leaf area increased exponentially up to the 6th week AE. Dividing the life cycle of a husk tomato into phases, we considered this period as a phase "a" (see the bottom of the Fig. 1). Next came phase "b" with maximal increments of the leaf area, of a rectilineal chracter (6th-9th week AE). The next phase, "c", of diminishing leaf area increments occurred between the 9th and 11th week AE; the maximum leaf area was observed at the end of this phase. During phase "d", (11th-14th week AE), the leaf area decreased due to the abscission of older leaves. The plants showed symptoms of progressing senescence. At the 14th week AE, some of the plants were already yellow. The differences between the prostrated and erect plants concerning leaf area were not significant in particular dates but the curve for the prostrates plants is situated above that for the erect plants (during the period between 6th and 13th week after emergence). This suggests that the growth of the leaf area in the prostrated plants was more vigorous.

The dry mass of the leaves (Fig. 2) — the curves which represent this quantity have a similar form to those of the leaf area development however, the maximum for the erect plants came not at the 11th, but at the 12th week AE. The same was observed for the number of leaves (Fig. 3). In both of these cases, the erect plants showed lower values.

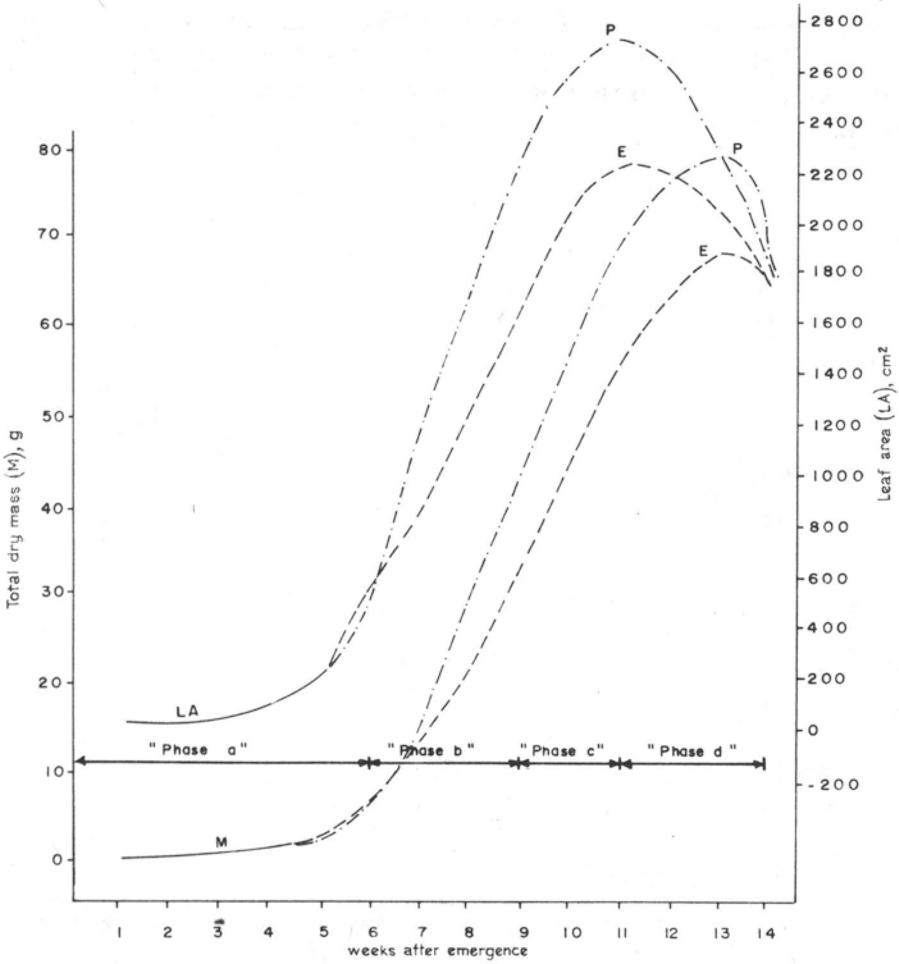

Fig. 1. Leaf area development and total dry mass in prostrated (P) and erect (E) husk tomato plants. The curves for LA and M are of the combined type (see the text). Up to the 5th week after emergence the prostrated and erect plants could not be discerned, so they are represented by a joint curve. The arrows at the bottom of the figure indicate the division of the plant life cycle into 4 phases, according to the changes in the dynamics of the leaf area development

The curves of the dry mass of the petioles were similar to those of the dry mass of the leaves for both types of plants (Fig. 4).

The curves for the total dry mass (Fig. 1) show great similarity to those of leaf area with the exception that their phases, although analogical to the phases of leaf area development, start and terminate 1-2 weeks later. Prostrated plants demonstrated higher values of dry mass accumulation than the erect ones.

The dry mass of the stem (Fig. 5) increased up to the 13th week AE in the plants of both types. Between the 13th and 14th weeks AE, there was a decrease in the prostrated plants which did not occur in the erect ones.

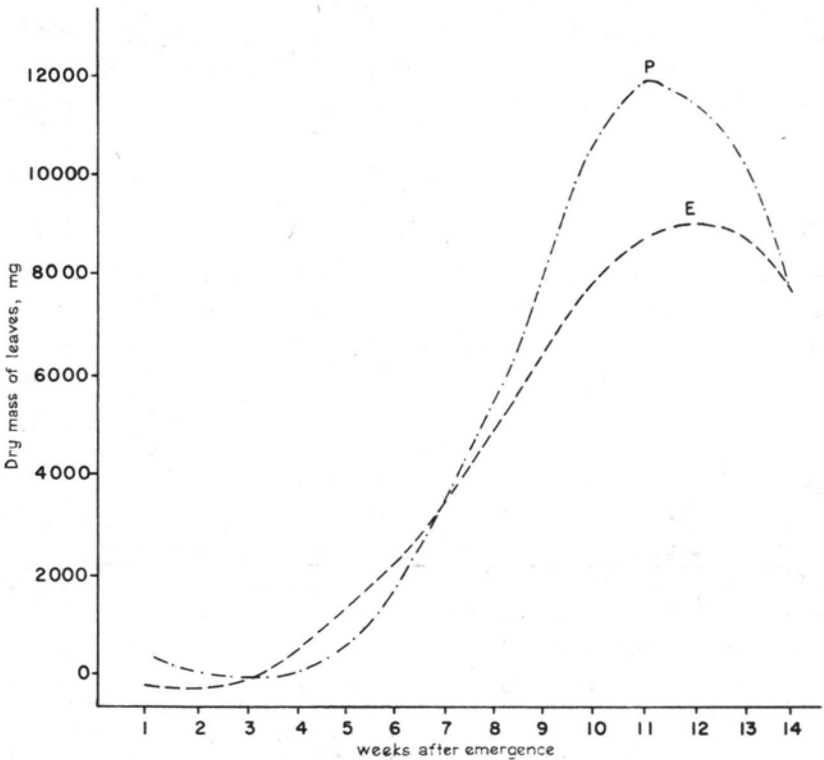

Fig. 2. Dry mass of the leaves. Regression curves. P and E — see Fig. 1.

The plants of the husk tomato produce new ramifications up to the end of their life (compare Mulato et al. 1985), therefore the number of youngest remifications (with internodes shorter than 1 cm classified in this paper as "apices") tended to increase constantly during the life of the plant as is seen in the erect plants (Fig. 6). In the prostrated plants, the dry mass of "apices" decreased between the 13th and 14th week AE, which may reflect the earlier senescence of prostrated plants and the death of some of their parts.

As was shown earlier (Mulato et al. 1985), the husk tomato plant shows dichasium type of ramifications, and almost each node forms

2 ramifications. Due to this, the level of ramifications of the plant is increasing constantly. In this experiment the highest level of ramifications was attained on the penultimate date of sampling (Fig. 6). Between the 13th and 14th week AE it decreased in the prostrated plants and was unchanged in the erect ones, indicating the tendency of earlier senescence

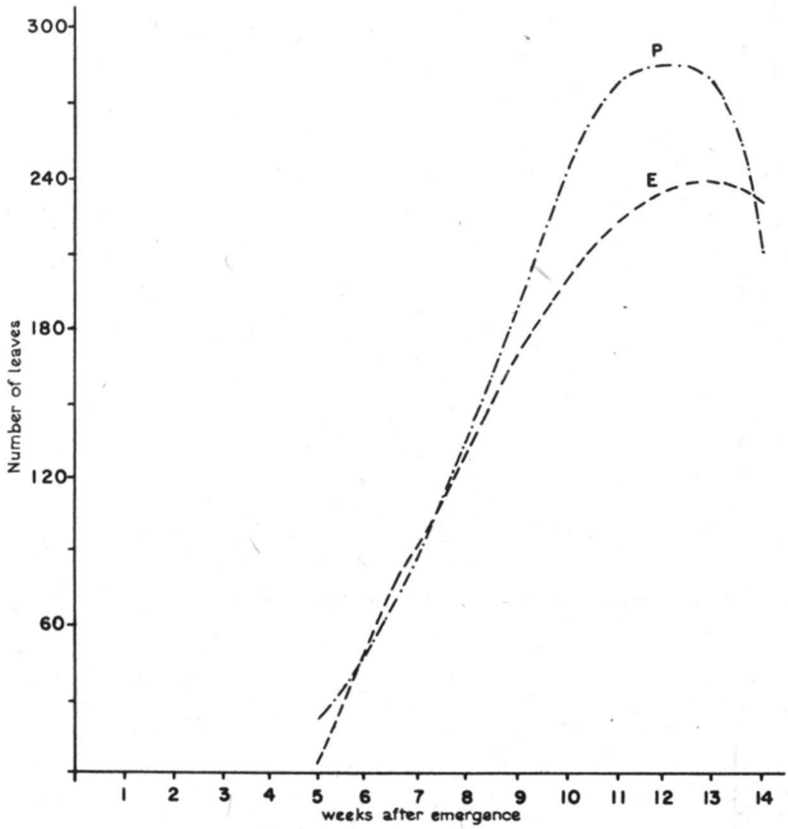

Fig. 3. Number of leaves. Regression curves. P and E — see Fig. 1

in the prostrated plants. The maximum level of ramifications was a little higher in the prostrated plants, but this difference was not proved statistically.

Total lenght of the apparent main branches (see also Mulato et al. 1985) (Fig. 7) reached the maximum during the penultimate date in both types of plants, and was a little less for the erect plants. The prostrated plants showed a more marked decrease of this characteristic between the 13th and 14th week AE.

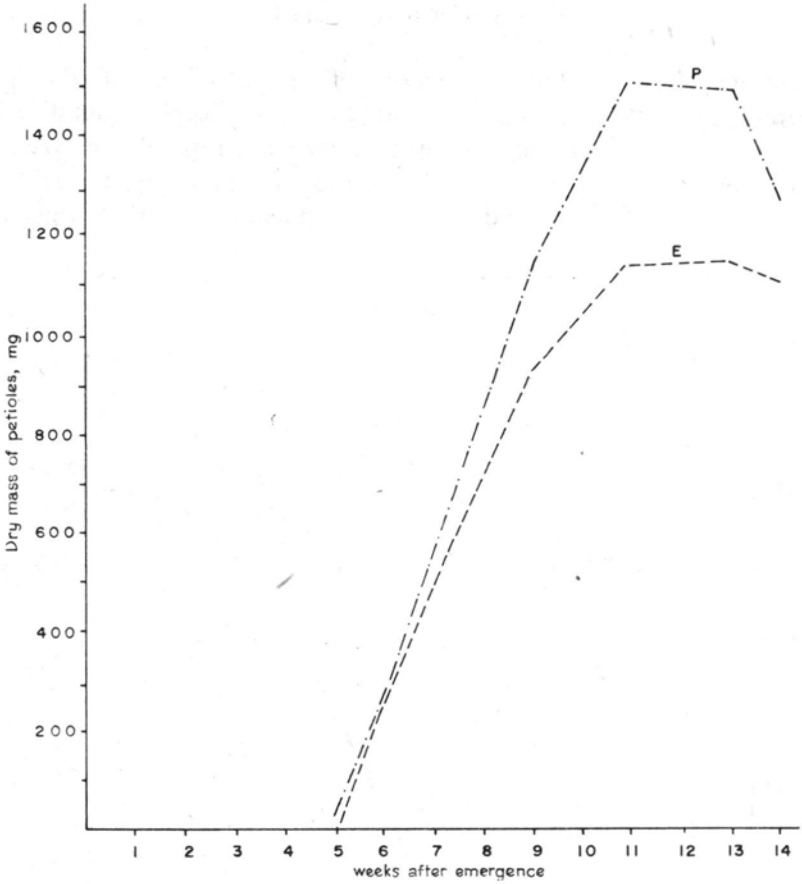

Fig. 4. Dry mass of petioles. Regression curves. P and E — see Fig. 1

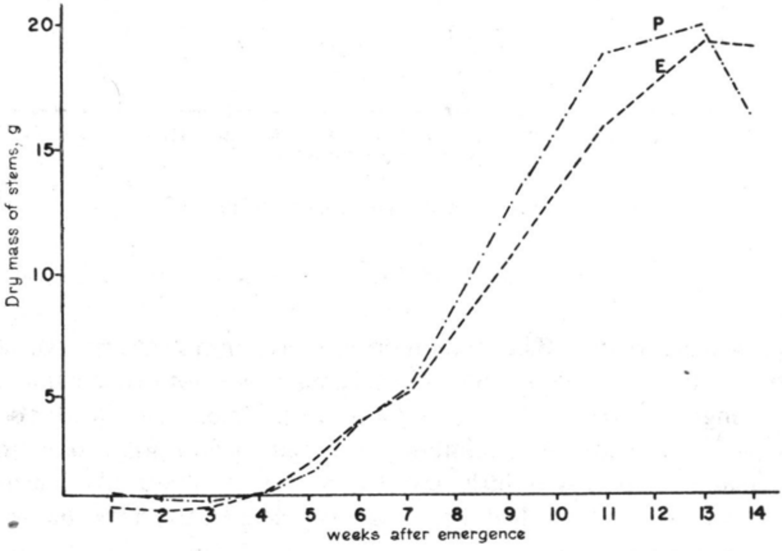

Fig. 5. Dry mass of the stems. Regression curves. P and E — see Fig. 1

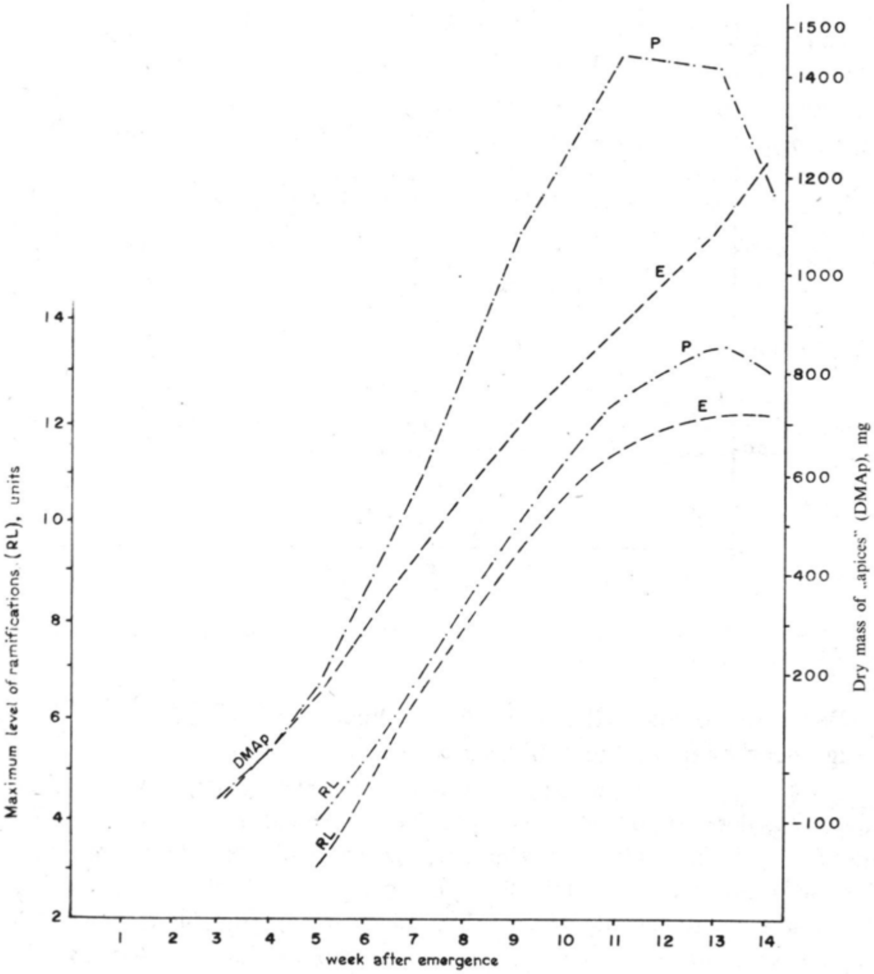

Fig. 6. Dry mass of "apices" (as the apices we considered the youngest ramifications having internodes shorter than 1 cm) and maximum level of ramifications. Regression curves. P and E — as in Fig. 1

DISCUSSION

The aerial part of the husk tomato has been little investigated and we are not aware of papers in which its development is described using the dry mass quantification.

The leaf area attains its maximum about 2 weeks before the maximum of the dry mass of the plant. Similar differences may be encountered in many other papers (compare Hunt 1982 — Fig. 1.1, Solórzano 1980). Sometimes the interval between these 2 maxima is very large, as in sorgo — about 40 days (Zavala 1982).

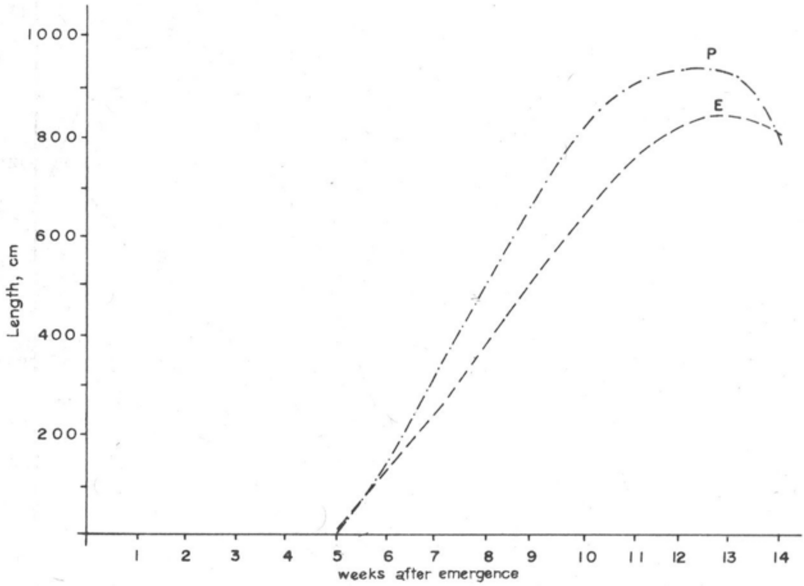

Fig. 7. Total length of the apparent main branches (regression curves). P and E — as in Fig. 1

We have divided the life of the husk tomato plant into 4 phases using the growth of the leaf area as the phenomenon of reference. Doing this, we have taken into account that the development of all other parts of a plant depends on the photosynthetic production of the leaves. Dividing the life cycle according to the changes in leaf area development, phases can be obtained in which the physiology of a plant differs markedly (see Cartujano et al. 1986). The division of the plant life cycle into 3 phases as done by Aitken (1977) cannot be adapted satisfactorily to the husk tomato, since in this species, flowering starts very early, and afterwards, flower buds, flowers, and small and large fruits occur simultaneously on the plant up to its senescence. The division of Tanaka and Yamaguchi (1972) seems not to be applicable to the husk tomato either, although it probably fits well for maize. We will use the division applied in this paper, based on the changes in leaf area development, in the further consideration of husk tomato development (Cartujano et al. 1986). We hope that this division may find application in other species of plants, although it can be used only retrospectively and only in experiments in which destructive sampling is applied. According to Anderson et al. (1978) the phase of development (developmental stage) refers "to a definable and usually observable period during which one type of tissue or cell production is dominant (e.g. the period of grain or seed development)". Our division is different since it takes physiological phenomena as a base to determine the phases.

The prostrated plants generally show more vigorous growth. This is reflected by all of the characteristics reported in this paper. In all cases the curves for the prostrated plants are situated above those for the erect ones during the period 7-13 weeks AE. This observation corroborated the opinion of growers, however, statistically these differences were not proved using the method of paired observations. The prostrated plants also show a tendency to terminate their growth earlier but also in this case we were not able to prove this difference statistically.

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Rozwój miechunki skórzastej (Physalis ixocarpa Brot.). I. Rozwój nadziemnych części wegetatywnych

Streszczenie

Badano rozwój nadziemnych części wegetatywnych miechunki odmiany 'Rendidora'. Suchą masę poszczególnych części roślin oznaczano na podstawie próbek ścinanych co 1-2 tygodnie. Na podstawie rozwoju powierzchni liściowej podzielono cykl życiowy rośliny na 4 fazy. Wzięto przy tym pod uwagę, że rozwój powierzchni liści jest w znacznym stopniu czynnikiem pierwotnym, od którego zależy wzrost innych części rośliny. Z dwóch typów roślin, które składają się na odmianę 'Rendidora', rośliny wyniosłe rosły słabiej lecz wykazały tendencję do późniejszego rozpoczęcia procesu starzenia niż płożące się rośliny.