THE STUDY OF THE POTATO'S LIFE-CYCLE PHASES IMPORTANT TO THE INCREASE OF THE INDIVIDUAL VARIABILITY

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Abstract. The authors describe the practical importance of the knowledge of the potato's life-cycle phases. There was made a research about the life-cycle of some varieties created at the Potato Research and Development Station Targu-Secuiesc, aiming at the proper management of the crop care, the irrigation and fertilization of the crops, depending on their objective.

The varieties *Redsec*, *Ioana*, *Luiza* and *Star* are semi-late maturing varieties, with a vegetative period of 80 – 110 days, each of them displaying certain specific features during the growth and development period that are highlighted in the present research paper.

Keywords: potato, life-cycle, variability, production

INTRODUCTION

The growth, development and tuber formation processes that govern the potato yields are genetically controlled. They are permanently developed under the influence of the environmental factors as well as under applied technological practices. In this regard, the strategy that aims high potato yields requires very good knowledge of the biological processes that develop in potato plants as well as the factors that are closely related and govern them [1].

Due to the fact that some potato varieties do not produce flowers or even if they do, they do not bear fruits, with no correlation between bud formation and beginning of first tuber formation, the potato vegetation phases are not developed in terms of generative propagation stages but depending on growth of aerial and underground vegetative organs [2] (**Fig. 1**).

As usual, the potato is propagated vegetativelly, by tubers; the propagation by seed is used only in the experimental work. The vegetative propagation takes place in the following way: first sprouts are formed from the buds of the eyes on the tuber, before or after the planting. Then from the sprouts formed in optimal conditions of temperature and humidity there grow roots and stems. The stems reach the soil surface (the plants sprout in light, as well); they photosynthesize, turn green and grow leaves. The stems continue growing during the leaf formation and get to maximum growth at flowering [3].

On the underground part of the stem there grow roots and stolons. As their vegetation advances, the stolons ends thicken, forming tubers. As a rule, tubers grow after the aerial parts have stopped growing, and they reach maturity at the same time as the aerial part.

The potato's growth and development period can be divided into four main phases:

a. Vegetative growth, which starts with the formation of sprouts and lasts until 8 – 12 leaves are grown (the radicular system and the stolons are formed in this stage)

b. Tuber initiation, from the emergence of tubers on the ends of the stolons to the leaf system's complete development;

c. Tuber growth, in this stage it is registered a significant increase of the tuber production as a result of tuber size growth while the vegetative parts and the root system cease growing;

d. Maturing starts with the physiological aging of the leaf system and finishes with the tuber skin's thickening.

From phenological and phytotechnical point of view, the potato's growth and development period can also be divided into the following phases of vegetation (**Fig. 2**).

From the planting to the sprouting of the plants: it is the period when the sprouts and roots grow, mainly due to the reserve substances in the mother tuber.

This period lasts for about 25-40 days and it is determined by the temperature of the soil. Under the Targu-Secuiesc cultivating conditions the duration of this phase is of 33-34 days in the case of the *Redsec*, 28-29 days in the case of the *Ioana*, 30-31 days in the case of the *Luiza* and 31-33 days in the case of the Star varieties. In this phase the crop needs less water and nutritive elements, but requires more heat. The negative temperatures of -2 or -3°C do not harm the tubers or the sprouts, as these are protected by the ridge's soil layer. Depending on the region and the year's weather conditions the average daily water consumption is 0.5 – 3.0 mm. In this phase the tubers are extremely sensitive to water excess.

Before the potato is sprouted there takes place a re-ridging to obtain a big ridge, and preemergence herbicides are applied to control the sprouted weeds or the ones that are just sprouting.

Between sprouting and blossoming, when the main stems and the leaf system start growing there emerge the stolons and the tuber initiation starts. The plants grow fast and they require nutritive elements, water and temperature.

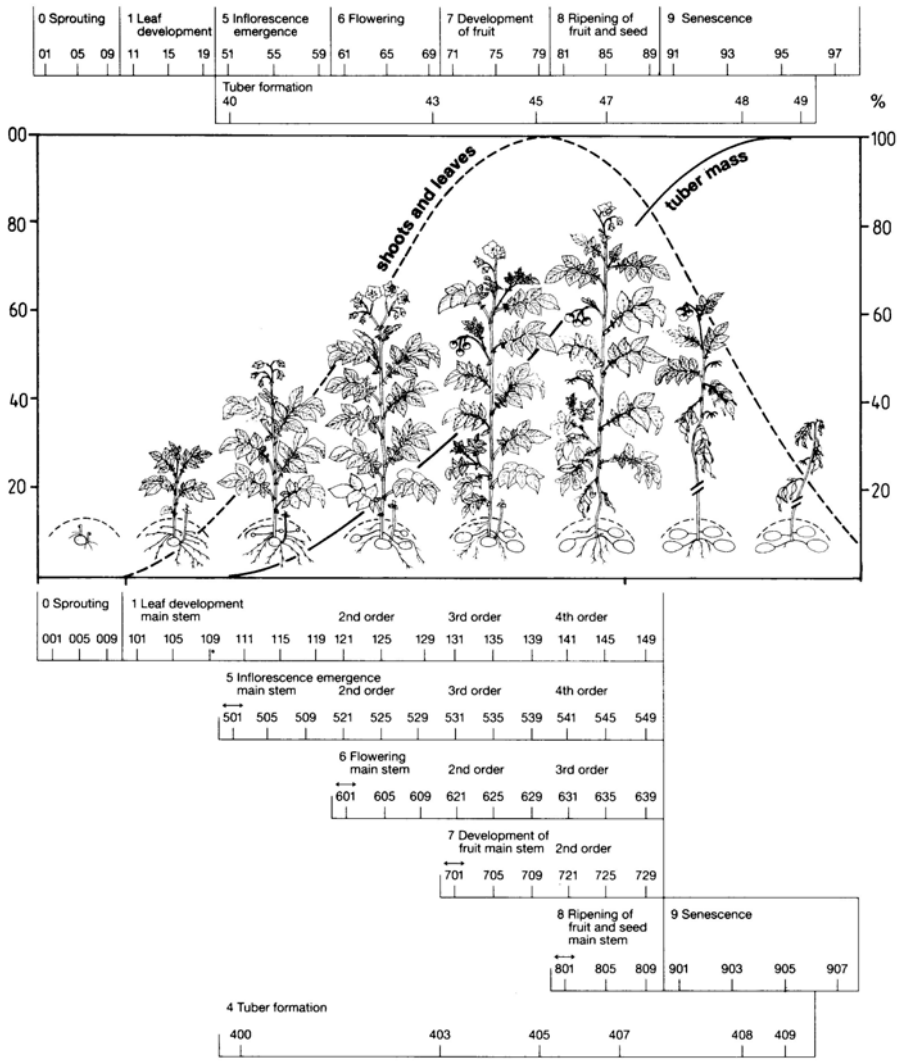

Figure 1. Potato vegetation stages [BBCH Monograph]

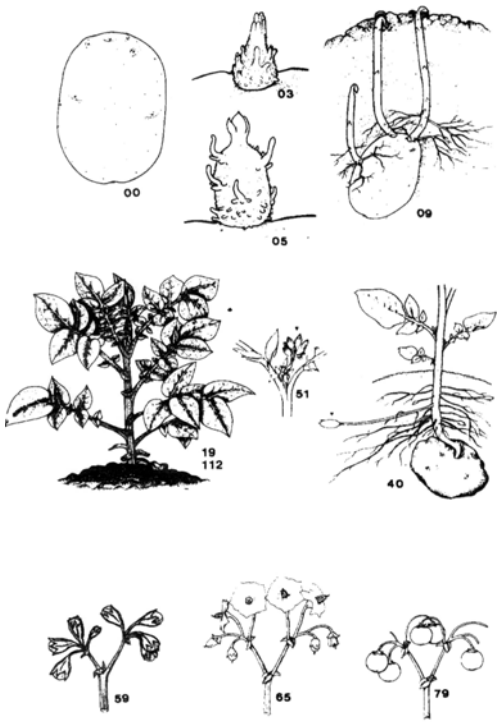

Figure 2. The potato's main phenological and phytotechnical vegetation stages [BBCH Monograph]

This phase lasts for about 20 - 25 days. Under the Targu Secuiesc cultivating conditions it usually takes place between May 1-10 and 20-30. The average daily water consumption reaches 2.0 – 3.5 mm.

In this period a postemergence application of herbicides can take place to control the annual and perennial monocotyledonous weeds producing shots from seeds or rhizomes. Treatments are applied to control the Colorado beetle (*Leptinotarsa decemlineata*).

From blossoming to maximum flowering: it is the period when the number of tubers per planting hole reaches its final value, the maximum leaf surface is developed and the aerial parts and the roots stop growing.

This phase lasts for about 15 – 25 days, and it takes places 1 June – 10July. At the end of this phenophase the maximum leaf area index must be realized, having a value of approximately 2 – 3 m^2/m^2. The water consumption reaches the average values of 3.0 – 5.0 mm / day. At the beginning of the phenophase the tuber production starts slowly and then it increases. As it is usually in this phase, when the late blight of potato emerges, the treatments for its control must be started. If needed, the treatments for the control of the

Colorado beetle are continued. The leaf fertilization starts.

It is known that the production increases according to the number of tubers per surface unit area. On the other hand, the number of tubers formed per planting hole is proportional to the number of main stems developed. On a main stem there can be formed 2 – 5 tubers on average. The optimal number of main stems is between 200 000 and 300 000 per hectare, depending on the aim of the potato culture, the variety and the agrotechnical conditions. Above 300 000 main stems per hectare the plants lengthen, the number of lateral ramifications reduces and the production gets limited, after which it decreases in parallel with their growth.

Table 1 shows the average number of main stems and tubers formed per planting hole according to the size of the planting material in the case of the varieties created at the Potato Research and Development Station, Targu-Secuiesc:

Table 1. The number of main stems and tubers formed per planting hole according to the size of the planting material

Variety	Potato seed 1.1811 – 1.7717 in		Potato seed 1.7717 – 2.1654 in	
	No. stems/ planting hole	No. tubers / planting hole	No. stems / planting hole	No. tubers / planting hole
Redsec	4.8	14.6	7.6	17.2
Ioana	**4.2**	**8.1**	**4.9**	**11.6**
Luiza	**3.8**	**7.0**	**4.2**	**10.2**
Star	**4.0**	**7.6**	**4.8**	**10.2**

The productive varieties form more main stems and a larger number of tubers per planting hole.

The period between maximum flowering and the beginning of the physiological maturation of the plants lasts for about 40 – 65 days and it takes place between June 10 – 20 and August 20 – September 10. It is the most important period for the accumulation of the production, when there takes place an intense growth of the tubers. The average daily increment may reach values of 600-1200 kg/ha/day. The water consumption reaches the maximum values of 5.0 – 7.0 mm/day. The plants respond with a maximum sensitivity to the water deficit and the deficit of nutritive elements, the lack of these elements may limit the production considerably. Drought and high temperatures occurring in this period cause the climatic degeneration of the tubers. The late blight of potato may destroy the leaf surface completely, so treatments are made extremely attentively and punctually. The leaf fertilization is continued.

In the case of potato cultures that are to be consumed in summer the harvest starts before the physiological maturation of the plants, approximately at the end of July – beginning of August, depending on the variety and the accumulated production.

The phase from physiological maturation to harvest lasts for about 15 – 20 days, between August 20 and September 10 – 20. In this phase the growth of the tubers stops, the solids from the leaves and stems are translocated to the tubers, and the aerial part of the plant dries. The tubers ripen, their skin thickens by suberization and they enter dormancy. The culture's need of water decreases, as the plants no longer consume actively, but the average daily water consumption maintains at values of 2,0 – 3,0 mm due to the water evaporation on the uncovered soil surface and due to the consumption of the weeds. In this period the soil humidity is an important factor in assuring turgescence of the tubers and favourable harvest conditions.

Under conditions of dry soil and high temperatures, if the harvest is delayed, the production may decrease with up to 20% by of the tubers' dehydration. In this period may also emerge a massive weed growth, which makes the harvest process difficult. The optimal moment for starting the harvest is after the vines have dried, and the tuber skin is suberized enough to undergo machine harvesting without serious damage. As figure 3 shows, during the potato's vegetation period there is a strong relationship between the dynamics of foliar surface (IF), the number of tubers formed (N) and the total production (P).

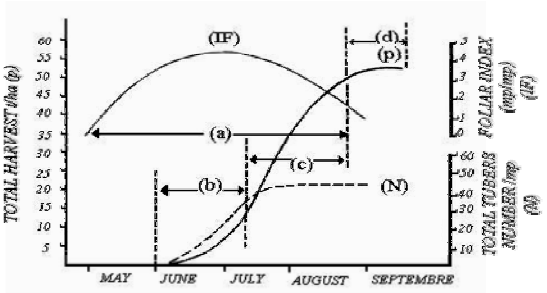

Figure 3. Relation between the dynamics of foliar surface formation and potato yield

Tuber initiation starts only after the leaf area index has almost reached its maximum. After initiation, phase (b), the number of tubers increases until the moment when the leaf area index reaches its maximum value, then it remains approximately constant until the end of the vegetation period.

In phase (c) the leaf system starts to decline and it is gradually reduced. After tuber initiation, in phase (b) the production increases slowly, and the production increment is mainly due to the increase of the tuber number, respectively to the multiplication of the tuber cells. In the phase of intense accumulation (c) the production increment is due to the increase of the tuber weight, caused by the increase of the cell volume. This phase starts when the leaf surface reaches its maximum and it lasts until its complete decline, respectively until the leaves and the vines turn yellow and dry.

In the last phase (d) the production accumulates slowly again, and it is mainly due to the solids translocated from the vines and leaves to the tubers. At the complete disappearance of the vegetation it is reached the maximum biological production

accumulated under the given circumstances. From that moment on the tubers stop growing and start maturing, their skin starts suberizing. 10 – 15 days after the maturation the harvest may start. If the weather is warm and droughty after the leaf system has dried, in the case of harvest delay the tubers may dehydrate in the soil.

CONCLUSIONS

- The knowledge of the vegetation phases is extremely important to the potato cultivation technology.
- The knowledge of the interval between planting and sprouting helps to establish the crop tending works and the moment of herbicide application
- If the number of days between sprouting and tuber formation (tuberization) is known, irrigation and nitrogen excess are avoided in this stage, which reduce the number of tubers or prolong tuberization; the nitrogen excess may also determine the resorption of certain stolons and tubers; in addition, for a good tuberization soil subsidence must be avoided
- After tuber formation, until the shrubs stop growing irrigation and fertilization are very important to the increase of the efficiency per hectare
- After the shrub has stopped growing the level of minimum irrigation may be decreased

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