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Seasonal changes in soluble nitrogen and some free amino acids content in the buds and spurs of biennially bearing apple trees

U. DZIĘCIOŁ and M. BIELIŃSKA-CZARNECKA

In the paper of Dzięcioł and Bielińska (1962) a distinct interrelation between fruiting and soluble nitrogen content in spurs has been demonstrated. In the present paper the changes in content of the soluble nitrogen fraction and of some of its components will are shown, on the basis of separate analyses of flower-buds, leaf-buds and of current and last year's growth of spurs.

EXPERIMENTAL

Materials and sampling

Buds and spurs (of current and last year's growth) of both fruiting and non-fruiting of fifteen-years-old apple trees, were studied at the Experimental Orchard at Dabrowice (central Poland). The sampling was done during two consecutive seasons, from spring 1960 to spring 1962, fourteen times on twelve trees of the variety 'Macoun' and during one season, from spring 1961 to spring 1962 (seven times) of the variety 'Boiken'.

Weather conditions

The spring 1961 was earlier than usual, warm and dry. May 1962 differed from average conditions by a high amount of rainfall.

Chemical analysis

The following nitrogen compounds were determined: soluble nitrogen fraction, arginine, glutamic and aspartic acids, glutamine and asparagine.

Extraction. Lyophilized and pulverized material was extracted with ethanol and water, according to Reuter (Przybylska 1963). The extract was used for determinations of soluble nitrogen and low-voltage electrophoretic fractionation.

Soluble nitrogen and some amino acids electrophoretic estimations were made identically as described in a previous paper (Bielińska 1966). Glutamine and asparagine contents were calculated from the differences between the results of electrophoretic estimations before and after hydrolysis with 1N HCl (3h at 100°C).

RESULTS

1. Nitrogen compounds content in buds

As well in flower as in leaf buds the highest content of soluble nitrogen could be found immediately before blooming. In this period flower buds had a much higher nitrogen content than leaf buds. In the remain-

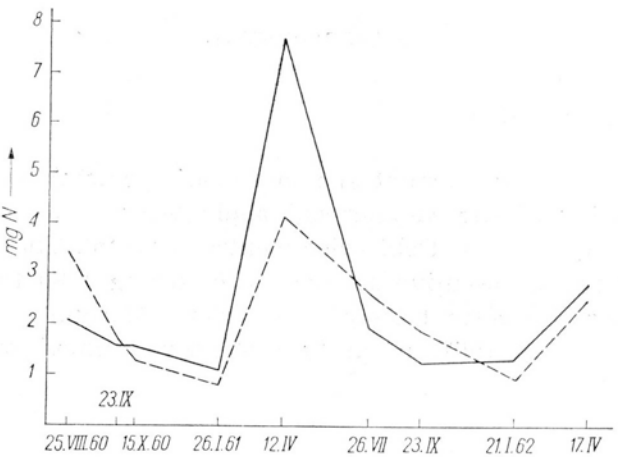

Fig. 1. Content of soluble nitrogen in flower-buds (continuous line) and leaf-buds (dashed line) of 'Macoun' var.

ing part of the year the soluble nitrogen content was much lower; the differences between flower and leaf buds were also smaller and from July to late autumn the nitrogen content of leaf buds was slightly higher than that of flower buds. In Fig. 1 are shown changes in soluble nitrogen and in Fig. 2 changes in arginine content in the flower and leaf buds of the variety 'Macoun'. The changes in the content of other

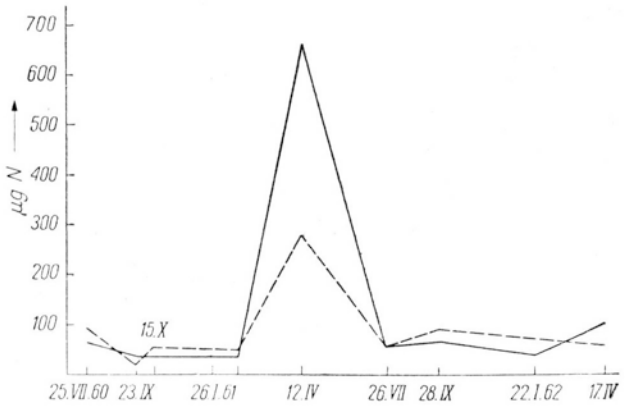

Fig. 2. Content of arginine in flower-buds (continuous line) and leaf-buds (dashed line) of 'Macoun' var.

nitrogen compounds (glutamic and aspartic acids before and after hydrolysis) and the changes in the buds of variety 'Boiken' were of the same type.

2. Nitrogen compounds content in spurs

The level of soluble nitrogen was higher in the current year's growth of spurs than in the preceding years growth, but in both the seasonal changes were similar, and a maximum was observed in spring, before blooming. The bearing spurs had a higher soluble nitrogen content than

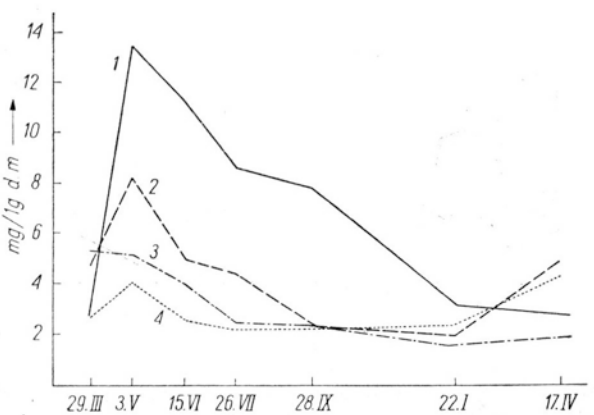

Fig. 3. Content of soluble nitrogen in spurs of variety 'Boiken' — mg/1 g d.m. Current year's growth of bearing spurs (*1*) and non-bearing spurs (*2*). Previous years growth of bearing spurs (*3*) and non-bearing spurs (*4*)

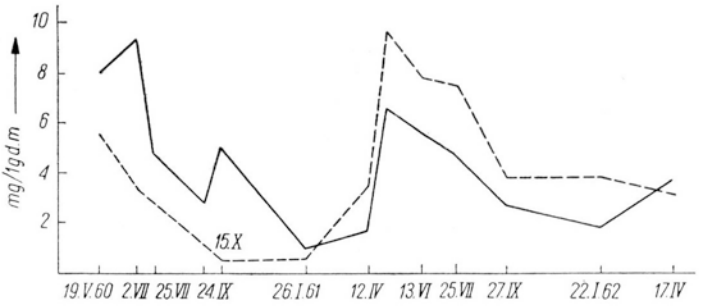

Fig. 4

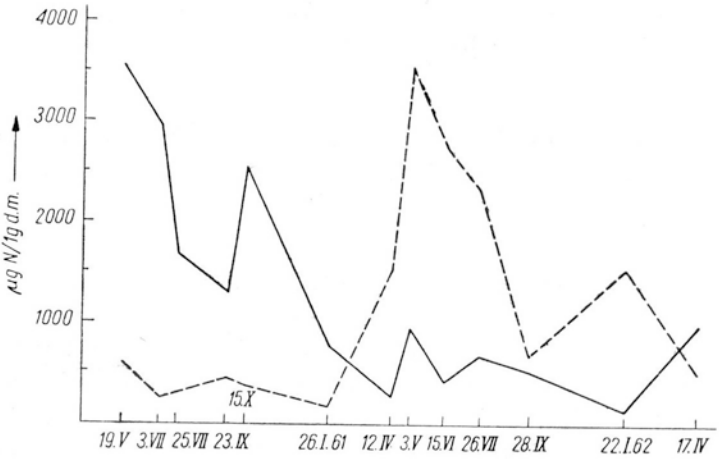

Fig. 5

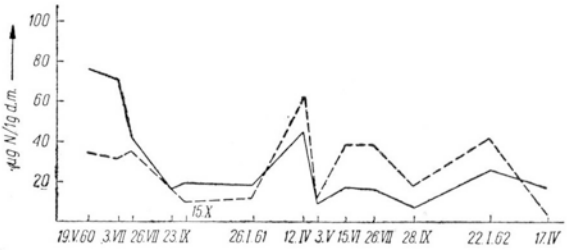

Fig. 6

Figs 4—9. Content of soluble nitrogen (fig. 4), arginine (fig. 5), glutamic acid (fig. 6), glutamine (fig. 7), aspartic acid (fig. 8), and asparagine (fig. 9) in the current years growth of spurs of 'Macoun' var.

Continuous line — spurs bearing in 1960 and 1962, and non-bearing in 1961. Dashed line — spurs non-bearing in 1960 and 1962, and bearing in 1961

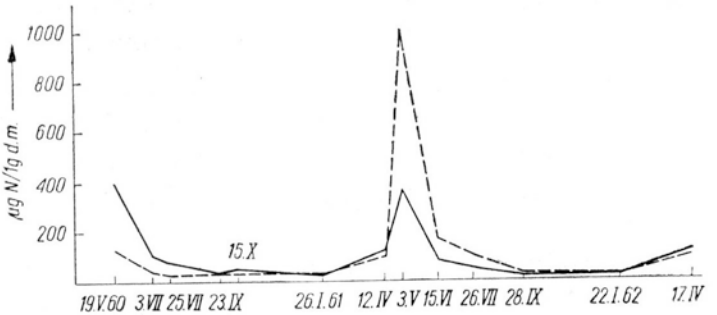

Fig. 7

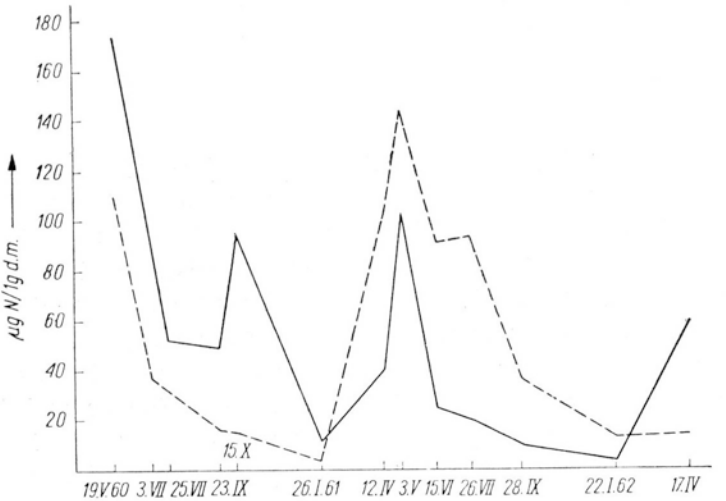

Fig. 8

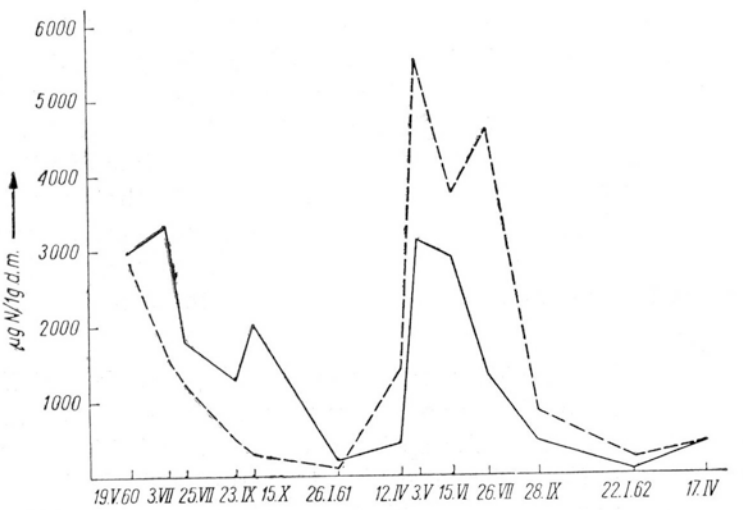

Fig. 9

non-bearing ones. This is illustrated in Fig. 3, for the 'Boiken' variety. Similar results were obtained for the variety 'Macoun'.

The determinations of individual amino acids and amides were performed only on the current year's growth of spurs. The results obtained indicate, that the content of all determined compounds increased in the end of the winter or in the beginning of spring, being more pronounced in the bearing than in the non-bearing spurs. To indicate the type of changes in the content of individual compounds in spurs, seasonal changes in the content of soluble nitrogen, arginine, glutamic and aspartic acids, glutamine and asparagine in the variety 'Macoun' are presented (Figs. 4—9).

DISCUSSION

The results obtained demonstrate the same type of seasonal changes in nitrogen compounds which were shown in previous papers (Dzięcioł and Bielińska 1962; Włodek and Bielińska 1963; Bielińska, Dzięcioł and Dawydko 1964). In the experiments described in the above cited papers, the nitrogen content was determined jointly in buds and spurs. In the present experiment the determinations were performed separately for the spurs (of the current and of the preceding year's growth) and the buds (flower and leaf). The existence of the same type of changes in the buds and in the spurs indicates that the changes in all investigated types of organs are due to the same cause.

The slightly higher soluble nitrogen content found between July and late autumn in leaf buds as compared to that in flower buds may be explained as follows: in the second half of the vegetation period the leaf buds develop on actually bearing spurs (the reverse is true for flower buds). In a previous paper (Bielińska 1966) it could be demonstrated that the developing fruit induces a flow of nitrogen compounds in the direction of bearing spur. It is likely that this flow causes a better nutrition of the leaf buds present on the bearing spur and this may be the reason why the leaf buds have in this part of the season a higher content of nitrogen compounds than those developing on non-bearing spurs.

Hołubowicz (1965), working on annually and biennially bearing apple trees, found a higher soluble nitrogen content in flower than in leaf buds at the time of the spring maximum, and Kazaryan and Karapetyan (1962) have shown that flower buds in the almond exhibit a higher amount and a higher number of free amino acids than

the leaf buds. This indicates a more general character of the facts observed.

To sum up, the results obtained seem to indicate that the metabolism of nitrogen compounds is more extensive in flower than in leaf buds. The same apears to be true for the spurs on which these buds are situated, in the period before blooming.

SUMMARY

The experiments were carried out on fifteen-years-old biennially bearing apple trees of two varieties: 'Macoun' and 'Boiken', from the spring of 1960 to the spring of 1962. Flower and leaf buds and spurs of the current and preceding year's growth were analysed separately for the content of soluble nitrogen, arginine, glutamic and aspartic acids, glutamine and asparagine.

The highest content of all these compounds was found in spring, before blooming. In the same period greatest differences between bearing and non-bearing spurs and between flower and leaf buds were found. All investigated compounds were found in higher amounts in flower buds and in bearing spurs.

The results seem to indicate a more extensive nitrogen metabolism in flower buds before blooming as compared to leaf buds and in bearing spurs as compared to the non-bearing ones.

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Sezonowe zmiany w zawartości rozpuszczalnego azotu i niektórych wolnych aminokwasów w pąkach i krótkopędach przemiennie owocujących jabłoni

STRESZCZENIE

Doświadczenie przeprowadzono na 15-letnich przemiennie owocujących jabłoniach odmian 'Macoun' i 'Boiken', w okresie od wiosny 1960 do wiosny 1962. Analizowano oddzielnie pąki kwiatowe i liściowe oraz przyrost bieżącego i ubiegłego roku na zawartość rozpuszczalnych związków azotowych, argininy, kwasów glutaminowego i asparaginowego, glutaminy i asparaginy.

Maksimum zawartości wszystkich tych związków w badanych organizmach wystąpiło wiosną, tuż przed kwitnieniem. Jednocześnie był to okres maksymalnych różnic w zawartości tych związków pomiędzy pąkami kwiatowymi i liściowymi oraz między krótkopędami owocującymi i nieowocującymi (badanych związków było więcej w pąkach kwiatowych i w krótkopędach owocujących).

Wyniki wskazują na wzmożony metabolizm związków azotowych w pąkach kwiatowych w okresie przed kwitnieniem, jak również w krótkopędach owocujących.