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RELATIONS BETWEEN FLOWERING AND LEAF DEVELOPMENT, AND CAMBIAL REACTIVATION AND DIFFERENTIATION TIMES OF *ARMENIACA VULGARIS*

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ABSTRACT

In this study cambial activity and differentiation of *Armeniaca vulgaris Lam.* Which flowers early in spring were determined in a cross-sections taken from 1 year old shoots in seven days periods from February 1983 to June 1984. When these were compared with the date of flowering and leaf development in the same years it was seen that phloem differentiation tock place just after the cambial reactivation together with flowering. Xylem differentiation occurred after the completion of leaf development. The fact that flowering occurred before the development of leaves, and the correspondence of this to the same time of phloem differentiation suggests that gibberellins might be playing an important role in this phenomenon.

INTRODUCTION

The radial growth of woody plants due to division and differentiation of cambial cells is an important phenomenon in both plant's life and from an economic point of view. The formation and the structure of wood is an important subject upon which great emphasis has been focused. The studies upon this subject go long way back. Fahn (1953) investigated the development of annual wood rings in some maquis. The same worker examined the development of *Quercus infectoria* and *Pistacia lentiscus* in 1955. Later, Evert (1960) studied radial growth of the phloem structure and seasonal variation in *Pyrus communis.* He also investigated the cambial development of *Pyrus communis* (Evert 1961) and studied *Pyrus malus* (Evert 1963). Evert and Kozlowski (1972) examined the effect of phloem accumulation upon cambial development in sugar maple. Algan (1977) determined the periods of activity and differentiation in early and late *Malus silvestris* and *Pyrus domestica* varieties and compared them each other.

It is well known that plant development and product formation take place with the aid of plant growth substances. These substances are also known to have an important roles in radial growth as well as in apical growth of woody plants. The cambial activities of woody plants have been shown to be under the control of hormones depending upon the environmental conditions (Wareing 1951, Digby and Wareing 1966b, Shininger 1971, Dalessandro 1973).

The effects of hormones upon the differentiation of dividing cambium cells have also been the subject of many investigations (Bradley and Crane 1957, Wareing, Hanney and Digby 1965, Waisel at al. 1966, De Maggio 1966, Digby and Wareing 1966a, 1966b), Shininger 1970 and 1971 Whitmore and Jones 1972, Harrison and Klein 1979). These studies showed that auxin and gibberellic acid, which carry out important roles in differentiation, have somewhat different effects on cambial activity. Auxinis believed to cause xylem differentiation while gibberellins effects the phloem formation. Some workers believe that these two compounds determine the ratio of xylem to phloem.

Therefore it can be concluded that cambial activity and differentiation is an indication of endogenous hormones in the plant. Another phenomenon under the control of plant growth substances is flowering. At first, the compound synthesised in the leaves, called florigen, was believed to cause flowering, but later, some workers claimed that gibberellins would cause flowering and showed that in some plants gibberellins caused flowering under certain conditions (Sato 1963, Pharis and Morf 1968, Abbas and Abu Tabik 1975, Minter and Lord 1969). Some workers, on the contrary, applied gibberellins to the plants in order to retard flowering (Corgan and Widmayer 1971, Guerriero Loretti and Vitagliano 1971). These workers proved that flowering was retarded by externally provided GA.

Cambial reactivation and differentiation times and dates of flowering and leaf development have not been jointly investigated. On this study the periods of cambial activity and differentiation were compared with the times of flowering and leaf development in order to evoluate and relation which might exist between them.

MATERIAL AND METHOD

The plant chosen was the domestic variety of *Armeniaca vulgaris Lam.* trees widely grown in Anatolia. The developments of the chosen trees were followed between 1983 and 1984 and their phenological features such as flowering and leaf development were determined. Samples were taken from one year old shoots at seven day intervals between February and June in 1983 and 1984. Sections were prepared by staining cross –sections with safranin–fast green (Algan and Toker 1981). Sections were examined to determine the times of initiation of cambial activity, and both xylem and phloem differentiation.

These determinations were carried out using Evert's methods (1960, 1971 and 1963). The average amount of increase in phloem and xylem were also graphically tabulated.

RESULTS

Phenological observations: Buds started to form in spring 1983 when the temperatures rose above 0 °C and reached a maximum of 16.8 °C in March 19th. The flowering, which started in March 21st, was completed by March 28th. The trees which shed their flowers completed their leaf development on April 11 th. Flower buds started to swell in February 22nd 1984 due to a mean temperature above zero throughout the month. The minumum temperature, which went down below zero in March, cause buds remain undeveloped untill March 22nd. First flowers were observed on this date when the maximum temperature reached 13 °C. Flowering was complete on March 29th. The trees which shed their flowers within a week started to develop leaves on April 5th.

Microscopic examination of sections: Cross–sections of the twig samples taken from the beginning to March 1983 were cambially inactive (Figure 1). Cambial cells were showed significant enlargement in the samples taken on March 14th. Most of these cells, which had been preparing for division, dividing by March 21st (Figure 2). Cells yet to divide are indicated with an arrow.

Sieve–tube and other phloem cells differentiated on March 28th reached a thickness of 4–5 layers at the time when all the flowers had bloomed. In the samples of March 4th diyiding cells were observed to reform phloem, but there was no differentiation of xylem (Figure 3). In samples dated 11 April 1983, a differentiated layer of wessels was observed at the time corresponding to the leaf development (Figure 4).

The differentiated phloem reached a diameter 45μ and xylem 80μ in the cross–sections taken on April 18th. Differentiated xylem incre-

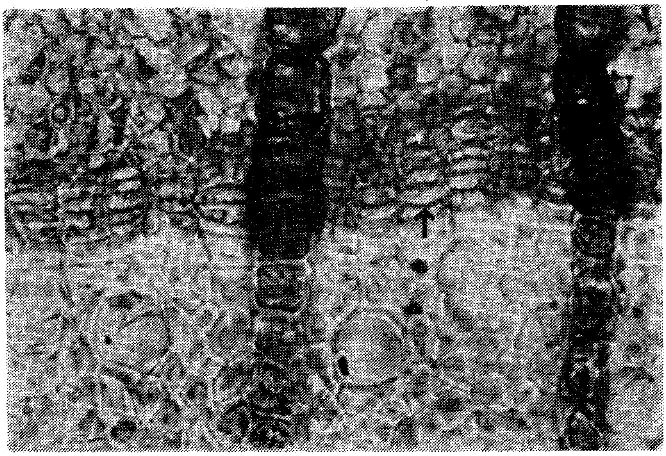


Figure 1. The enlarging cambial cells in the cross-section of the sample taken on 14th March 1984. x 400.

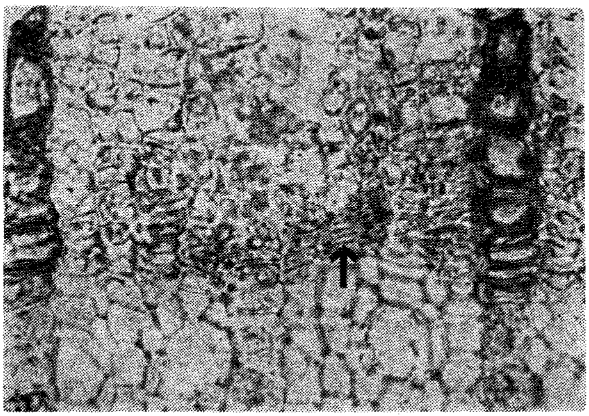


Figure 2. The cross-section of the samples taken on 21st March 1983. The cambial cells which has already divided are shown with an arrow. x 400.

ments started on that date and continued at the maximum level throughout May. The numbers which started to differentiate starting from March were tabulated in Figure 5.

The cambium was inactive in the samples taken in 1984 up to March 22nd. In samples taken on 29 March 1984, 3–4 layers of phloem cells were differentiated at the same time as the tree was in full flower.

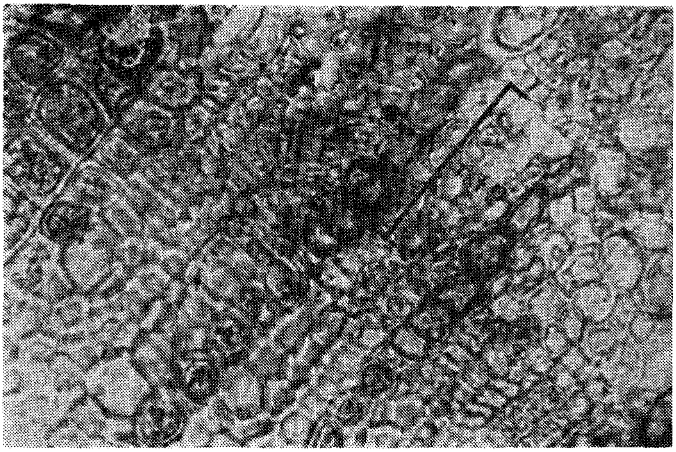


Figure 3. The newly-formed phloem region in the cross-section of the sample taken on 4th April 1983. nfp = newly formed phloem. x 400.

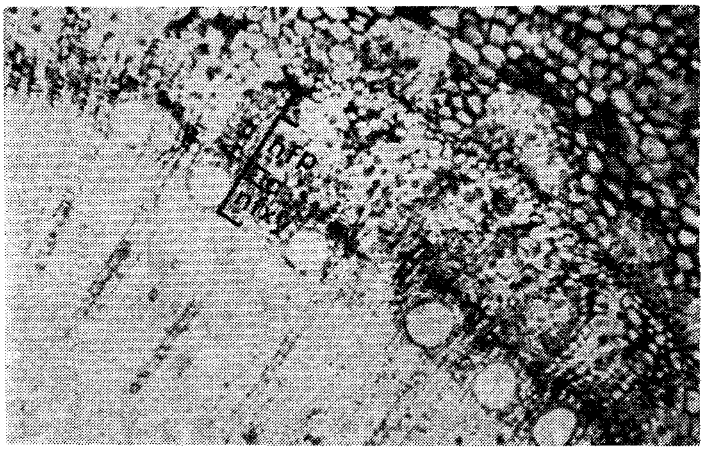
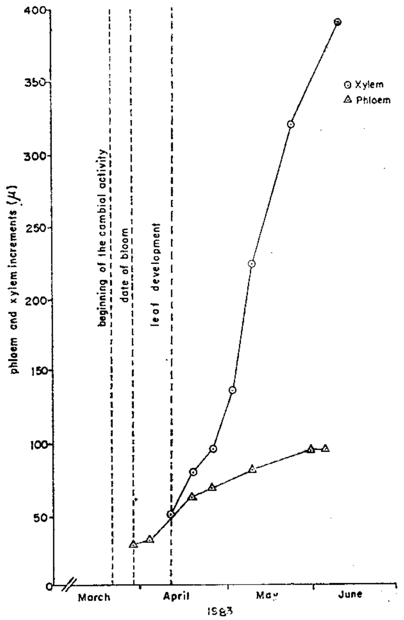


Figure 4. The newly-formed phloem and xylem cells in the cross section of the sample taken on 18th April 1983. x 100. nfp = newly formed phloem: nfxy = newly formed xylem.

The first layer of vessels in the xylem region observed to be differentiating trees which had started to develop leaves on April 5th. The differentiated amount was measured to be 48μ in phloem region and 32μ in xylem region. The maximum cell division observed in the samples dated 3 May 1984 caused the phloem and xylem reach 80μ and 90μ respectively. From that date there was observed no significant increase in the differentiation of phloem while the xylem continued differentiate rapidly. The amount of differentiated xylem reached 320μ in the samples dated 6 July 1984 (Figure 6).



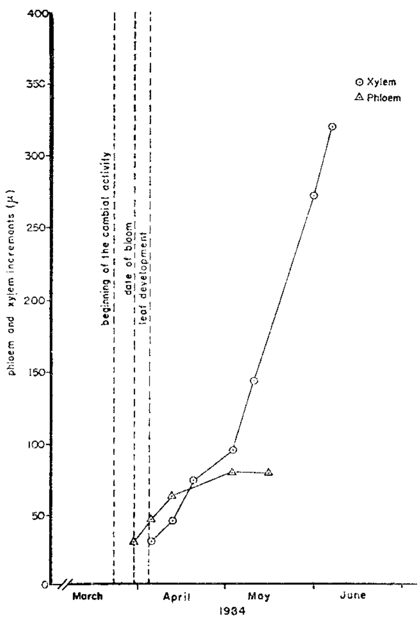


Figure 5,6. The comparision of the increase in the amounts of phloem and xylem with the cambial activity initation and flowering date in 1983 and 1984.

DISCUSION

Auxin is believed to be synthesised in active buds and transferred basipetally to activate the cambium. But Wareing (1951) and Digby and Wareing (1966 b) reported that there would be enough auxin reserves in ring-porous plant to activate cambium in the early spring. Algan and Toker (1981) showed that the cambium was activated in *Malus silvestris* before bud swelling. The occurence of cambial activation in apricot, a ring-porous plant, before the development of the leaves supports the hypothesis, that hormone reserves may be present in the plant. Digby and Wareing (1966a). It was found in our study that cambial cell division reached a maximum level after the development of the leaves.

Evert found in his studies upon cambial activity and differentiation that xylem and phloem differentiation started at different times. It was also observed that some of the dividing cells immediately differentiated to form phloem upon the initiation of the division of cambial cells, a time that corresponded with the flowering date. Xylem differentiated upon the development of the leaves.

Bradley and Crane (1957) and Waisel et al. (1966) claimed that GA stimulates xylem formation. However many workers such as Wareing, Haney and Digby (1964), De Maggio (1966), Digby and Wareing (1966) GA stimulates xylem formation. However many workers such as Wareing, Haney and Digby (1964), De Maggio (1966), Digby and Wareing (1966) and Harrison and Klein (1979) showed that exogenous GA affects phloem rather than xylem formation. Wareing, Haney and Digy (1964) and Wareing (1966) also demonstrated that the increase in the amount of differentiating xylem is due to increased an auxin relative to GA. The fact that in this study xylem differentiation did not occur before the formation of the leaves implicates of auxin in this phenomenon. Also, the fact that the cells that divided just after the start of cambial reactivation differentiated as phloem and not xylem, shows that the GA synthesized in some part of the plant and kept as a reserve, has an important effect upon phloem differentiation.

In his studies upon gymnosperm flowering (Sato 1963) he showed that 50 to 500 ppm GA was enough to start flowering. Pharis and Morf (1968) claimed that gibberellins play an important role in the flowering of some plants especially of those the members of *Cupressaceae* and *Taxodiaceae*. Abbas and Abu Tabik (1975) found that exogenous GA_3 caused the flowering of *Vigna sinensis* one week earlier than usual.

Minter and Lord (1983) proved that GA enhanced the flowering in *Collomia grandiflora,* which has both cleistogamous and chasmogamous flowers and particularly increased the percentage of chasmogamous flowers. On the contrary, some workers applied GA in order to retard the flowering date. Among these Corgan and Widmoyer (1971) stated that the GA externally applied to peach tree caused the buds remain small and delayed the flowering by retarding microsporogenesis.

Guerriero, et al. (1971) claimed that GA retards flowering for only a short period. This short retardation can be attributed to the indirect affect of externally applied GA which cause changes in various metabolic processes.

The correspondence of flowering and phloem differentiation dates of Armeniace vulgaris suggests that both these phenomena are effected by the same compound. Also the fact that the activation of this compound depending upon the temperature shows that it was stored sufficiently as an endogenously. If the result obtained from the studies carried out upon this subject are taken into account one concludes that these can be gibberellins.

LITERATURE CITED

ABBAS, T. and H. ABU TABİK., 1975. The effect of kinetin and gibberellic acid on some morphological characteristics of *Vigna sinensis*. Bull. Soc. Hist. nat. AFr. Nord. Alger, t. 66, fasc. 1 et 2.

ALGAN, G., 1977. The Cambial Activity and Bark Structure of The Early and Late *Malus Silvestris* and Pyrus Domestica Grown Widely in Central Anatolia. Communications. Fac. Sci. Univ. Ankara 21: 43–76.

ALGAN, G. and C. TOKER., 1981. The Relaticnships Between the Cambial Rectivation and Bud Swelling in two Agricultural Forms of *Malus Silvestris*. Communications Fac. Sci. Univ. Ankara. 25: 1–13.

BRADLEY, M.V., and J.C. CRANE., 1957. Gibberellin-stimulated Cambial activity in stems of apricot spur shoots. Science 126: 972–973.

CORGAN, J.N. and F.B. WIDMOYER., 1971. The effect of Gibberellic acid on flower differentiation, Date of Bloom and Flower Hardiness of peach. Amer. Soc. Hort. Sci. J. 9: 54–57.

DALESSANDRO, G., 1973. Interaction of auxin, Cytokinin and Gibberellin on cell division and xylem differentiation in cultured explants of Jerusalem artichoke. Plant Cell Physial. 14: 1167–1176.

DE MAGGIO, A.E., 1966. Phloem differentiation: Induced stimulation by gibberellic acid. Science 152: 370–372.

DIGBY, J., and P.F., WAREING., 1966 (a). The effect of applied growth hormones on cambial division and the differentiation cambial derivatives. Ann. Bot. 30: 539–548.

———, and———. 1966 (b). The relationships between endogenous hormone levels in the plant and seasonal aspects of cambial activity. Ann. Bot. 30: 607-622.

EVERT, R.F., 1960. Phloem structure in *Pyrus Communis* L. and its seasonal changes. Univ. Calf. Publ. Bot. 32: 127–194.

————, 1961. Some aspects of the cambial development in *Pyrus communis*. Amer. J. Bot. 48: 479–488.

————, 1963. The cambium and seasonal development of the phloem in *Pyrus malus*. Amer. J. Bot. 50 (2): 149.

———, and T.T., KOZLOWSKI., 1972. Influence of Phloem blockage on cambial growth of the sugar maple. Amer. J. Bot. 59: 623.

FAHN, A., 1953. Annual wood ring development in maquis trees of Israel. Palest. J. Bot. 6: 6: 1–26.

————, 1955. The development of growth ring in wood of *Quercus infectoria* and *Pistacia lentiscus* in hill region of Israel. Trop. Wood. 101: 52–59.

GUERRIERO, R., F. LORETTI, and C. VITAGLIANO., 1971. The effects of Growth Regulators on Peach Flowering Date. Hort. Abstr. 41: 8405.

HARRISON, M.A., ana R.M., KLEIN., 1979. Role of Growth Regulators in initiation of secondary Xylem and Phloem cells. Bot. Gaz. 140 (1): 20–24.

MINTER, T.C., and E.M., LORD., 1983. Effect of water stress, Abscisic acid and Gibberellic acid on flower production and differentiation in the cleistagamous species *Collomia grandiflora* Dougl. Ex. Lind. (Polemoniaceae) Amer. J. Bot. 70 (4): 618–624.

PHARIS, R.P., and W. MORF., 1968. Physiology of Gibberellin induced flowering in Conifers in "Biochemistry and physiology of plant growth substances" (F. Wightman, and G. Setterfield, eds.) 1341–1356 Runge press, Ottawa.

SATO, K., 1963. Some physiological actions of gibberellins on forest trees. Proc. World. consultation Forest. Genet. Tree Improvement, FAO, II: 5–2.

SHININGER, T.L., 1970. The production and differentiation of secondary xylem in *Xanthium pensylvanicum* Amer. J. Bot. 57: 767–781.

————, 1971. The regulation of cambial division and secondary differentiation in *Xanthium by* auxin and gibberellin. Plant physiol. 47: 417–422.

WAISEL, Y., U., NOAH, and A. FAHN., 1966. Cambial activity in *Eucalyptus cameldulensis* Dehn. II. The production of Phloem and Xylem elements. New phytol. 65: 319–324.

WAREING, P.F., 1951. Growth studies in woody species IV. The initiation of cambial activity in ring-porous species. Physiol. Plant. 4: 546–562.

————., C.E.A. HANNEY, and J. DIGBY., 1964. The role of endogenous hormones in cambial activity and xylem differentiation. "The Formation of Wood in Forest Trees" (M.H. Zimmermann, ed.) 323–344 Academic Press. New York.

WHITMORE, F.W., and B.M. JONES., 1972. Alterad auxin-gibberellin ratios in abnormal vascular development of peach. Plant Physiol. 49 (suppl.) 32.