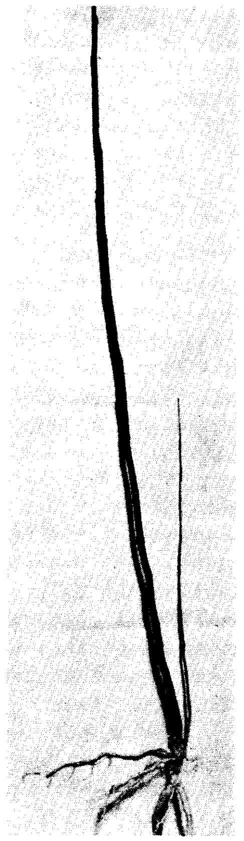

Fig. 5. — Overground part of plants (Sumach tree).

stronger, supplying it with nutrious ingredients and receiving from it necessary assimilates. This fact is proved, according to available literature by the method of radio-isotopes.

Summarizing the above quoted observations one may say that the application of the group seeding method quite a number efficient and useful things are obtained in the practice of afforestation as well as from the purely biological standpoint of view many interesting various relations of competition among species.

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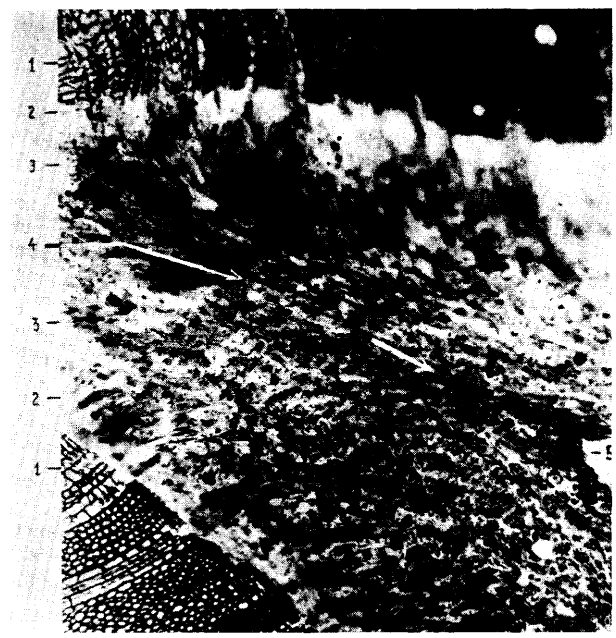

Fig. 6. — Cross section of coalesced roots. — 1. Secondary tree. — 2. Camibum zone. — 3. Elements of primary and secondary bark. — 4.' Zone of coalescence. — 5. Beginning of the coalescence.

Initiation and Development of Graft Incompatibility Symptoms in Douglas-fir[1])

By DONALD COPES

Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Portland, Oregon

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Introduction

Incompatibility problems have plagued grafters for centuries. Most past reports of grafting difficulty came from the pomology literature, but grafting incompatibility has now become a serious problem to some workers in forest genetics. In the late 1950's, grafted clonal seed orchards were started for Douglas-fir *(Pseudotsuga menziesii* (MIRB.) FRANCO) on the west coast of North America. Some graft incompatibility first became evident 12 months following grafting. A survey of 3,059 grafts (4 to 8 years old) from three seed orchards in Oregon and Washington revealed that only 54% were alive in 1966 and more seemed destined to die. The grafting problem has become so severe that the practicality of establishing future grafted Douglas-fir seed orchards has been seriously debated.

Graft incompatibility has been reported in many species of fruit and forest trees. The general subject was reviewed

[1]) This paper summarizes one section of the author's Ph. D. thesis which was submitted to the University of Idaho in 1967.

for fruit trees by MOSSE (1962). Graft incompatibility symptoms in Douglas-fir were briefly described by DUFFIELD and WHEAT (1964). The xylem union was apparently perfect, but a "phloem block" was thought to be present, presumably because of stock-scion interaction.

The following paper describes a study of initiation and development of internal incompatibility symptoms in Douglas-fir graft unions from 2 days to 4 years after grafting.

Materials and Methods

A greenhouse study was established in which graft unions were sectioned for microscopic study at 2, 4, 7, 10, 14, 17, 21, 24, 28, 35, 42, 49, 56, 70, 84, 105, 170 to 180, 220 to 230 days, and 13 to 14, 15, 17, and 19 months after grafting. One additional source of grafts for study was seed orchard-grown grafts which were dead or dying of incompatibility at the time of collection. Orchard grafts ranged in age from 1 to 4 years. Sample sizes for each graft collection ranged from seven to 150 grafts.

Five of the most compatible and 15 of the least compatible clones known to Oregon and Washington seed orchard workers were cleft-grafted in March 1965 and March 1966. The stocks grafted were potted 2—0 seedlings grown from seed collected at 4,000 feet on Mt. Adams, Washington (1965 grafts) and from lower elevations in the Willamette Valley of Oregon (1966 grafts). Also, 30 autoplastic grafts were made by cutting off the tops of the stock plants and immediately regrafting the severed tips on the same stems. Two or more autoplastic grafts were included in each collection period.

The grafts were made in the greenhouse and grown from 2 days to 19 months. In addition, dead or dying grafts, ranging from 1 to 4 years old were collected from commercial seed orchards.

Grafts were killed and fixed in FAA or Craf's chromic acid fixative, dehydrated in tertiary butyl alcohol, embedded in 62° C paraffin, soaked for 2 days in an acid-alcohol softening solution (GIFFORD, 1950) and 2 days in a soap-glycerin solution (ALCORN and ARK, 1953), and sectioned. Cut sections were then double stained with safranin and fast green. Standardized procedures and bulkbasket staining methods permitted uniform tissue staining within and between collection dates. Seed orchard-grown grafts were prepared for observation in a similar manner, except no paraffin embedding was done.

Results

Collections of 2-day- to 8-month-old Grafts (Suberin Zones)

There was no evidence of internal symptoms of incompatibility before 84 days. The first symptom appeared at 84 days in one of 11 grafts sampled and at 105 days in one of 14 grafts. The two incompatible grafts developed abnormally stained tissues within cortex areas where scion and stock cells merged. The abnormal structures appeared to be deposits formed on outer cortex walls and in intercellular spaces *(Figures 1 and 2)*. Comparison of safranin staining of suberized periderm layers and incompatible symptom areas indicated a similar staining reaction. Acid destaining of safranin from the lignified tissues showed that the incompatible zones were not lignified, but they retained a red tint as did suberized periderm layers. The substance was not identified chemically, but position, structure, and staining reaction suggest that the substance was suberin.

No difference was apparent between suberin-free homoplastic grafts (intraspecies grafts with stock and scion of different genotypes) and autoplastic grafts (intraspecies grafts with stock and scion of identical genotype). Point of suberin initiation in affected homoplastic grafts was always the cortex *(Table 1)*. At the time of suberin zone identification, most grafts had well-formed unions, with up to 50 tracheids across the graft area developed in radial tiers.

Some autoplastic and homoplastic grafts showed a type of suberin zone development which was not caused by incompatibility. The suberin zones in those grafts were probably identical to zones formed in incompatible grafts in all but two characteristics. First, suberin zones in incompatible grafts were initiated in all graft areas where stock and scion cortex cells merged, but autoplastic grafts and compatible homoplastic grafts developed suberin zones only in grafted areas where poor grafting techniques had caused irregular union healing. It was typical for a graft of this type to have one or two grafted areas which formed suberin zones, and the remaining grafted areas to be free of suberin. Second, suberin zones in incompatible grafts later developed in the interior bark tissues when the grafts grew older, while suberin zones in autoplastic grafts and compatible homoplastic grafts soon ceased to enlarge and failed to form in the interior tissues. Graft-technique-caused suberin zones did not result in incompatibility or later graft failure. With the two characteristics, it was possible to differentiate grafting-technique-produced zones from those resulting from incompatibility.

Many 6- and 8-month-old homoplastic grafts contained incompatible-caused suberin zones. The zones were present in an increasingly higher percent as graft age increased. At the end of 8 months, 83% and 86% of the compatible and incompatible clones, respectively, contained suberin zones *(Table 1)*. No autoplastic graft formed incompatible-caused suberin zones during the first year.

Through the first 6 months, no difference in depth of suberin differentiated compatible from incompatible clones, but a difference was found in 8-month-old grafts. Deeper suberin development occurred in incompatible clone grafts. Fifty-four percent of the grafts of incompatible clones were found with suberin in the phloem or cambium, but only 8% of the compatible clones had developed suberin as deeply *(Table 1)*.

At all graft ages, development depth varied between and within individual grafts. Within a graft, deepest development usually occurred in disorganized bark tissues which were originally caused by poor matching of the cambial edges at the time of grafting.

Little difference existed between compatible and incompatible clones in ability to form cambial unions or in extent of vertical disorientation of the tracheids *(Table 2)*. Xylem disorientation referred to a graft condition where tracheids in developing graft areas became oriented nonparallel to axis of the stem. Parallel orientation was the normal condition for xylem tracheids in nonunion areas. Transverse sections of disoriented tracheids within union areas showed oblique views of side and end walls. No apparent correlation existed between suberin initiation and tracheid orientation. A vascular union was not a necessary prerequisite for suberin formation. Suberin zones were also detected opposite grafted areas where only cortex tissues connected stock and scion tissues.

Table 1. — Percent of grafts having symptoms of incompatibility, by graft age, clone type, penetration of suberin zones, and wound-xylem areas.

Graft age and clone type	Number of grafts	Penetration of suberin zones: Cortex only	To phloem boundary	Into phloem	To and into cambium	Total suberin zones initiated	Wound-xylem areas (15 months or older)
2 to 105 days:							
Compatible and incompatible	150	1.5	0	0	0	1.5	0
6 months:							
Compatible	8	25	37	0	0	62	0
Incompatible	15	6.5	20	0	6.5	33	0
8 months:							
Compatible	12	33	42	0	8	83	0
Incompatible	29	14	18	18	36	86	0
13 to 14 months:							
Incompatible	32[1])	9	0	0	91	100	0
15 months:							
Compatible	3	33	0	0	0	33	33
Incompatible	4	75	25	0	0	100	50
17 months:							
Compatible	4	25	50	0	0	75	0
Incomptabile	10	50	30	0	0	80	40
19 months:							
Compatible	7	71	0	0	15	86	14
Incompatible	13	55	15	0	15	85	31
1- to 4-year-old seed orchard grafts:							
Compatible and incompatible	28[1])	0	0	0	100	100	100

[1]) Grafts were dead or dying when collected.

Table 2. — Percent of grafts showing xylem and cambial structure by graft age and clone type

Graft age and clone type	Number of grafts	Union zones with completed cambiums	Vertically disoriented tracheids
2 to 105 days:			
Compatible and incompatible	150	[1])	[1])
6 months:			
Compatible	8	87	30
Incompatible	15	93	28
8 months:			
Compatible	12	91	26
Incompatible	29	77	51
13 to 14 months:			
Incompatible	32[2])	70	64
15 months:			
Compatible	3	100	50
Incompatible	4	80	12
17 months:			
Compatible	4	100	50
Incompatible	10	92	36
19 months:			
Compatible	7	93	46
Incompatible	13	93	36
1- to 4-year-old seed orchard grafts:			
Compatible and incompatible	28[2])	53	68

[1]) Data not recorded .
[2]) Grafts dead or dying of incompatibility at collection.

Collections of 13- to 14-month-old Grafts (Dead or Dying When Collected)

External symptoms of incompatibility were first visible after 12 months. They appeared as needle chlorosis and needle drop. During the following 4 to 8 weeks, these and some other grafts were collected in a dead or dying condition. Internal anatomy examination revealed all grafts to

Table 3. — Early graft incompatibility losses in 13th month after grafting by clone.

Clone No.	Grafts living December 27, 1965	Grafts dead or dying by April 26, 1966	Incompatibility loss
I. Incompatible clones			
	No.	*No.*	*Percent*
24	10	8	80
5	16	4	25
56	3	3	100
55	1	1	100
60	12	7	58
9	16	2	12
14	10	3	30
175	7	2	29
Others	17	0	0
		Weighted average =	34
II. Compatible clones			
34	4	1	25
Others	29	0	0
		Weighted average =	3
		Weighted average of incompatible + compatible clones =	25

have initiated suberin zones *(Table 1)*. Fewer cambial unions were found than in living grafts of earlier collections. Tracheid disorientation was greater in dead or dying grafts than in living grafts collected during the first year *(Table 2)*. Incompatibility loss at this stage was 25% of all homoplastic grafts living after December 27, 1965, or 34% of the incompatible clones and 3% of the compatible clones *(Table 3)*. No autoplastic graft died at this time.

Necrotic areas of suberized cells were complete from periderm to cambium in bark areas of dead grafts, and were also extensive in bark areas of dying grafts. General suberization of union and nonunion scion tissues occurred shortly before scion death *(Figure 3)*. General suberization of nonunion bark tissues was not a symptom of incompatibility but was a normal plant response to the presence of dead or dying tissue.

Collections of 15- to 19-month-old Grafts (Living When Collected)

A high percentage of all second-year homoplastic grafts contained incompatible-caused suberin zones. No autoplastic graft developed any suberin zones or other incompatibility symptom previously described. As in the 1st-year grafts, little or no difference in percent initiation of suberin zones separated compatible from incompatible clones. The percentage of homoplastic grafts containing suberized tissue was approximately the same as observed in 8-month-old grafts *(Table 1)*.

Second-year suberin zone development in the inner bark areas was nearly equal for compatible and incompatible clones. Slightly deeper development by the incompatible clones was observed in 18-month-old grafts, but the difference between clone types was not a pronounced as in 8-month-old grafts.

Some grafts developed tangentially oriented periderm layers which separated suberized and nonsuberized cortex tissues. The new periderms were thought to be wound periderms. Cortex tissue on the exterior side of the wound periderms died. Thus, suberin zones formed during the preceding were sometimes eliminated from cortex tissues of union zones, but grafts did not remain free of suberin deposits. New suberin zones always formed below the wound periderms.

Wound-Xylem: — The second internal symptom characteristic of incompatibility in Douglas-fir was detected in all 15-month or older collections. This symptom will be called a wound-xylem. Wound-xylem areas, as seen in transverse view, developed in grafted areas where stock and scion cambial cells met *(Figure 4)*. The areas were typified by the following characteristics: lignified callus cells, which had dark-stained cell contents; necrotic areas of crushed, suberized cambial and phloem tissues; short, vertically disoriented xylem tracheids. Each area appeared as a small island of abnormal cells which was surrounded on both the stock and scion sides by normal cells *(Figures 4 and 5)*.

Wound-xylem areas formed only at the interface where the stock and scion cells merged. The wounds formed only in grafts with deeply developed suberin zones.

Lignified callus was the first cell type to be formed in wound areas. An iodine test showed it to be very high in starch *(Figure 6)*. It stained similar to xylem ray cells.

Later differentiation of the regraft callus resulted in the formation of a new cambium. Cells produced by early cambiums were short, vertically disoriented tracheids and ray cells. As the growing season progressed, the cambium zones matured and normal or near-normal tracheids were produced.

Wound-xylem areas are not specific to grafts of just the incompatible clones, but also occur in all incompatible grafts of the compatible clones. The one characteristic which differentiates compatible from incompatible clones is the quantitative difference in percentage of grafts of each clone type which form wound-xylem areas. For example, in the 15-, 17-, and 19-month collections, only two of 14 compatible clone grafts formed wound-xylem areas, but 10 of 27 incompatible clone grafts wounded.

Development of cambial zones and xylem disorientation showed no differences between clone types. Within a graft, larger wounds and deeper suberin zone penetration were observed in union areas with the most xylem and cambial disorganization.

Seed Orchard Grafts, 1 to 4 Years Old (Dead or Dying at Collection)

All dead or dying seed orchard grafts showed suberin development to the cambium *(Table 1)*. Grafts which grew into or beyond the 2d year developed wound-xylem areas at the start of the 2d year in every union area where stock and scion cambiums joined. Grafts 3 to 4 years old developed wound-xylem areas at the start of each year's growth *(Figure 4)*. Size of individual wound areas often varied from year to year. No graft that was free of wound xylem the 2d year began wounding the following years, and no graft showing wound xylem at the start of the 2d year reverted to a nonwound condition the following years. If grafts were incompatible enough to cause wound-xylem formation, they started the process the 2d year and continued it each year thereafter until finally no cambial union was formed. Graft death occurred 1 to 2 years later. Scion overgrowth normally preceded scion death in 3- to 4-year-old grafts.

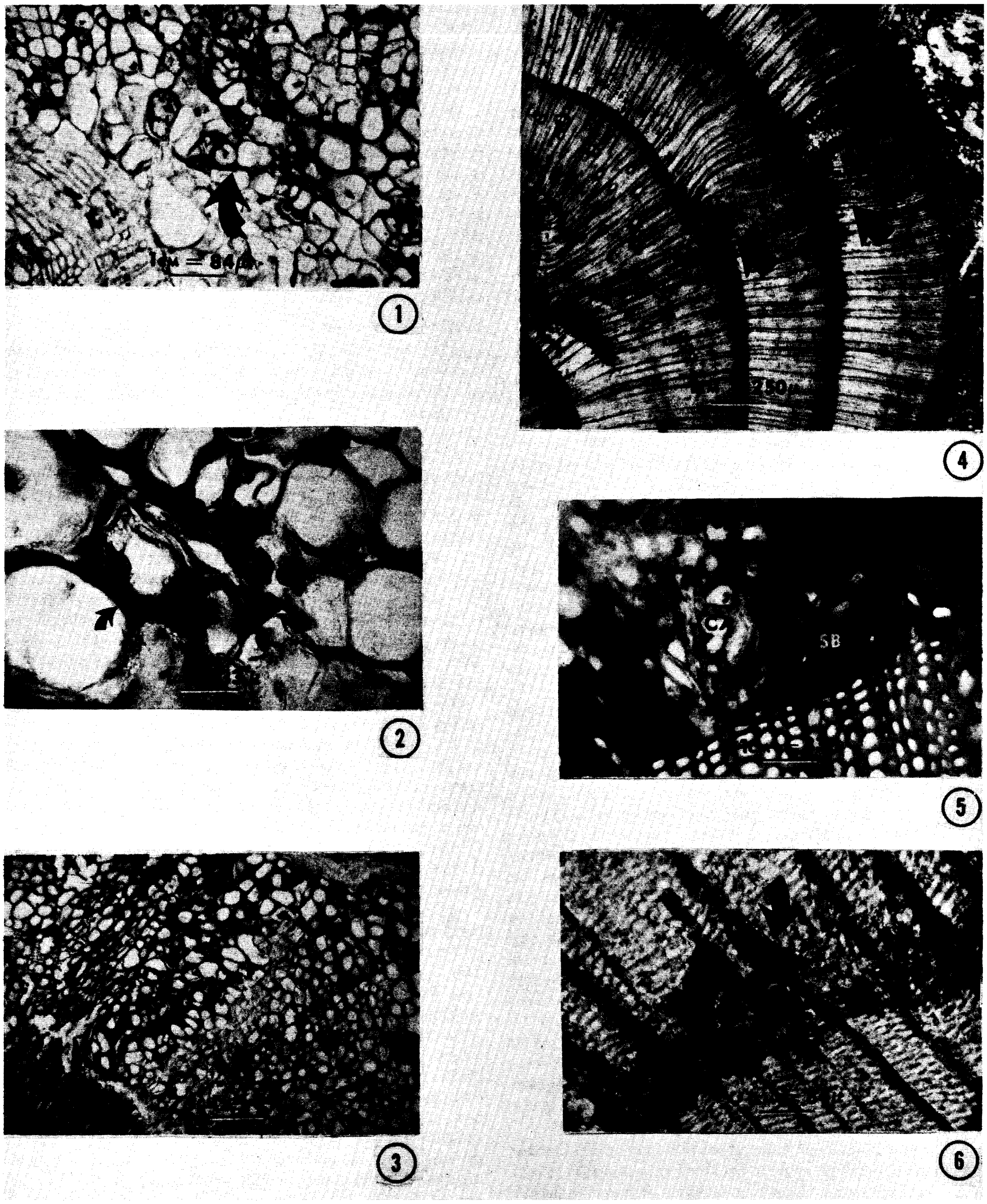
Age when regraft failure occurred, prior to graft death, varied between grafts and also within the individual union areas of each graft. In one example, a 4-year-old overgrown graft with four grafted cambial areas, as seen in transverse view, failed to regraft one area at the start of the 2d year, failed to regraft two additional areas the 3d year, and then lost its last connecting cambium the 4th year.

Discussion

Suberin Zones

Grafts of both incompatible and compatible clones initiated areas of suberized cortex cells in developing unions. Early suberin initiation was detected in a small percentage of the grafts at 84 and 105 days. No earlier detection of symptoms was possible as was done with peach grafts at 2 weeks (Fletcher, 1964). The seasonal trend in initiation of suberin zones was for more grafts to be affected as the growing season progressed.

Little difference between compatible and incompatible clones existed in initiation of suberin zones, but a major difference was found in depth of development in 8-month-old grafts. The development pattern up to 6 months showed nearly equal behavior of grafts of both compatible and incompatible clones; but at 8 months, equality of development no longer existed. Incompatible clone grafts had deeper affected tissues in a higher percent of grafts than did compatible clone grafts. Necrosis of cells near the suberin zones was also evident. Similar development of necrotic tissues in cambial unions was found in pear or quince unions (Mosse and Scaramuzzi, 1956).



Figures 1—6. — *Fig. 1.* — Abnormal suberin zones developed in the cortex of a 105-day-old incompatible graft. The arrow points to one of the many suberin deposits. — *Fig. 2.* — Suberin deposits were located on the outer cell walls, middle lamellas, and intercellular spaces. The arrow indicates the location of suberin deposits. — *Fig. 3.* — Necrosis and general suberization of scion tissues occurred in a dead 13-month-old graft. The arrow points to a wound periderm which formed on the stock side of the union. — *Fig. 4.* — Wound-xylem areas formed in all union areas at the start of the 2d and 3d year's growth. The arrows point to the location of xylem-wound areas. — *Fig. 5.* — Wound callus cells indicate where they bridged over a suberized zone of dead bark tissue. Dark-stained cells above the engulfed area bark are callus cells with high starch contents (callus cells, *ca;* suberized bark tissue, *sb*). — *Fig. 6.* — A positive starch test on a wound-xylem area. Dark stained cells in the wound area and in nearby rays were cells which had high starch contents. The arrow points to a wound-xylem area.

Suberin formation during the second season followed a pattern which was similar to that observed in the 1st year. Suberin depth was less the 2d year during periods of active cambial growth (13 to 15 months), but deeper development occurred as cambial activity slowed in late summer and early fall (17 to 19 months). It is hypothesized that during active periods of growth, the formation of new phloem cells helped displace or restrict suberin zones to the cortex, but when cambial growth slowed, suberin was formed in the interior phloem and cambium. Another possibility is that physiological or biochemical conditions during active growth periods were not favorable to suberin development in the interior tissues, but when slower growth occurred, the restricting conditions were no longer prevalent (Mosse and Scaramuzzi, 1956).

Wound-Xylem Areas

Incompatible Douglas-fir graft unions were not "essentially perfect" as reported by Duffield and Wheat (1964). Defective xylem, called wound-xylem areas, was detected first at 15 months. This symptoms of incompatibility occurred in incompatible grafts of both compatible and incompatible clones. Horticulturists have found similar areas in grafts of other species (Bradford and Sitton, 1929; Herrero, 1951; Mosse and Scaramuzzi, 1956). Occurrence of wound-xylem areas in Douglas-fir was always associated with the presence of suberin zones which had advanced from the cortex to the cambium. Within a collection, wound-xylem developed only in homoplastic grafts which had developed the deepest suberin zones. A similar correlation between bark and wood symptoms was found for pear and quince grafts (Mosse and Scaramuzzi, 1956). Wound-xylem areas never occurred in grafts free of suberin zones and never occurred in autoplastic grafts.

Second-year collections made of living incompatible grafts showed that newly formed cells had penetrated the suberized tissues and had formed new connecting zones of living cells. The first response of these living grafts was for terminal xylem parenchyma, xylem and phloem rays, phloem parenchyma, and undifferentiated cambial derivatives to become meristematic. Mitosis resulted in the production of many callus cells on both sides of the former union areas. If the incompatible grafts were to survive, the callus cells had to force through the suberized and necrotic tissues and form a continuous bridge of living tissue. A similar regrafting of tissues was reported for apple and pear grafts (Bradford and Sitton, 1929). No xylem symptom of incompatibility occurred in Douglas-fir grafts where suberin zones did not develop in the inner phloem or cambium.

Death at 13 to 14 months resulted from the inability of the incompatible grafts to regraft after suberin development in the inner phloem or cambium. Externally, regrafting could be detected in surviving incompatible grafts through a 1- to 2-month delay in vegetative bud burst.

Cell types similar to those produced soon after grafting were also formed in regraft areas of incompatible grafts. Both formed callus cells which later became lignified. Disoriented tracheids developed in both areas, usually some suberized phloem and cambial tissues were engulfed. Iodine staining showed the callus cell types of both to have high starch contents. From comparisons of cell types, tissue organization, position in the union, correlation with suberin zones, and starch reaction, it can be safely assumed that natural regrafting had occurred in the surviving incompatible grafts. Bradford and Sitton reached a similar conclusion after studying wound areas in apple and pear grafts (1929).

Horticulturists have pointed out the possibility of screening graft combinations at an early age (Mosse, 1958 and 1960). A similar method of determination of incompatibility in Douglas-fir uses two observations on number of grafts: those which died of early incompatibility and those which developed wound-xylem areas. This technique is described in detail by Copes (1967). The incompatible clones, as a group, were 63% incompatible and the compatible clones were 23% incompatible. It should be remembered that the study clones had originally been selected as being the most or least compatible clones known to Oregon and Washington seed orchardists. A nonselected group of clones should have an intermediate value.

Dead or Dying Seed Orchard Grafts

Grafts made and grown under field conditions developed both suberin and wound-xylem areas. No difference existed in anatomical symptoms between greenhouse and field-grown grafts.

The reason for regraft failure in older incompatible grafts of Douglas-fir may be simply a mechanical effect caused by changes in bark structure. Failure could result from the formation of thicker bark tissues which contain rhytidome zones. Also, physiological or biochemical changes associated with aging could occur over the years, and this also might reduce regraft ability. A particularly unfavorable summer for extensive cambial growth the year before failure might favor the development of extensive suberin zones which could not be penetrated by adjacent callus tissue. Failure of Douglas-fir scions to regraft as they grew older followed a pattern previously reported in apple and pear grafts (Bradford and Sitton, 1929).

Size of wound-xylem areas, as seen in transverse view, varied between years. Environmental effect on cambial growth probably influenced development and therefore had a direct influence on the size of the annual regraft areas. Since completing this study and having examined several thousand additional grafts, I have found regrafting can occasionally occur one year and not the next. Grafts of this type are characterized by development of suberized tissues near the cambium during year of good cambial growth, but suberin zones do not quite reach the cambium; thus, no wound-xylem areas form the following year. During years of poor cambial growth, suberin zones develop in the cambium and wound-xylem areas form the following year.

If this view of environmental influence on suberin development and the dependence of wound-xylem on suberin penetration is correct, some cultural practices might reduce graft losses that presently occur in seed orchards. For example, early summer droughts reduce cambial growth and possibly promote deeper suberin penetration. Summer irrigation would allow trees to continue cambial growth until factors other than water caused growth to cease and, as a result of continued cambial growth, suberin zones would not be able to develop as deeply as occurred under drought conditions. This technique would not eliminate all incompatible losses, but it might reduce the overall losses which now occur without irrigation.

Influence of Xylem and Cambial Structure on Symptom Development

Xylem and cambial structure was not correlated with suberin initiation, but it was correlated with depth of suberin development in the bark. Incompatible grafts developed suberin zones regardless of the xylem orientation or the presence or lack of connecting cambiums. All that was necessary for suberin formation was the existence of cortex-to-cortex contact between stock and scion. Better grafting techniques would probably have permitted some incompatible grafts, which died during the 13th and 14th months, to live and continue growth into the 2d year. But in later years, the grafts would still die of delayed incompatibility after regrafting failed.

Grafting techniques which result in less tissue disorientation or produce more connecting cambium between the stock and scion will result in incompatible grafts temporarily living longer. Whether temporary survival of incompatible grafts is desirable is yet uncertain.

Summary

Internal symptoms of graft incompatibility were studied in 2-day-old to 4-year-old grafts of Douglas-fir. Scion material for grafting came from clones which had previously been classified by seed orchardists as most compatible or incompatible. No incompatibility symptoms were found in autoplastic grafts, but two internal symptoms of incompatibility were found in homoplastic grafts. One incompatible symptom, suberin zones, was initiated in cortex cells of the union and became first visible during the summer of the year of grafting. Suberin zone development into the phloem and cambium generally occurred during the fall and winter months. The second symptom, wound-xylem areas, formed only in union zones where suberin had previously developed into the inner phloem or the cambium. The wounds developed in union areas of incompatible grafts at the start of the 2d, 3d, and 4th years. Wound-xylem areas resulted from a natural regrafting of stock and scion tissues at the start of each growing season.

Both compatible and incompatible clones developed some incompatible grafts, but severe incompatibility symptoms occurred more frequently in grafts of incompatible clones. Symptoms of early or delayed graft loss were found in 23 percent of the compatible clone grafts and 63% of the incompatible clone grafts.

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Buchbesprechung

Mechanismen der Vererbung. Von Franklin W. Stahl, Rochester, Oregon. Übersetzt von Hanna und Franz Schwanitz. (Grundlagen der modernen Genetik, Band 3.) 1969. IX, 162 Seiten, mit 73 Abb. Gustav Fischer Verlag, Stuttgart. Flex. geb. DM 19,—.

Der vorliegende Band 3 der „Grundlagen der Modernen Genetik" ist eine Übersetzung des 1934 bei Prentice verlegten Buches des gleichen Verfassers mit dem Titel „The Mechanics of Inheritance". Im gleichen Jahr wie die von Frau Hanna Schwanitz übersetzte deutsche Auflage erschien die zweite Auflage des Originalwerkes in wesentlich erweiterter Form (232 S.) zum Preis von DM 33.60. Das vorliegende Buch behandelt in 10 Kapiteln die Mechanismen der Übertragung genetischer Information von Generation zu Generation, beginnend bei den einfachsten Mikroorganismen und schließend mit dem Chromosomenapparat diploider höherer Pflanzen und Tiere. Das Buch ist recht einfach geschrieben, wobei aber natürlich an die Vorkenntnisse des Lesers einige Anforderungen gestellt werden. Jedem Kapitel ist die wichtigste Literatur angefügt, wobei erfreulicherweise bei jedem Literaturtitel angegeben wird, auf welches Spezialgebiet es sich bezieht. — Ein kleiner Anhang zu jedem Kapitel enthält Prüfungsfragen, die besonders für das Verständnis der Methoden relevant sind, wie überhaupt die Methoden einen großen Anteil des Buches einnehmen. — Das vorliegende Werk stellt eine Bereicherung des genetischen Schrifttums in deutscher Sprache dar. Es enthält alles, was ein Student der Biologie oder ein in biologischen Fächern graduierender Student anderer Disziplinen über genetische Mechanismen wissen sollte. In der gleichen Reihe wird es ergänzt durch die bereits erschienenen Bände von Swanson über Zytogenetik, von Hartmann und Suskind über die Wirkungsweise der Gene und von Jinks über Extrachromosomale Vererbung. K. Stern

Referate

Castellani, E., e Cellerino, G. P.: **Cinque anni di osservazioni sul comportamento di vari cloni di pioppi verso la Marssonina brunnea.** (Fünfjährige Beobachtungen über das Verhalten verschiedener Pappelklone gegenüber M. b.) Cellulosa e Carta **20**, 3—16 (1969). *[Ital. m. franz., engl. u. dtsch. Zsfg.]*

Diese Beobachtungen wurden in verschiedenen Gebieten Norditaliens durchgeführt. Zur Verfügung standen dafür 163 Klone (zum Teil noch Versuchsanbauten) verschiedener Pappel-Sektionen. Bei der Auswertung der Daten interessierte besonders die Befallsstärke der Klone in den Monaten der Blattentfaltung. An allen Beobachtungsorten wurde sie auf diejenige des Klones 'I-214' am gleichen Platz bezogen. 'I-214' ist überall verbreitet und gilt als mäßig anfällig. Der Vergleich ergab für die Klone einen Anfälligkeitsindex. — Es konnten neben extrem und wenig anfälligen Klonen auch resistente (z. B. 'I-63/51', 'I-69/55', 'I-72/58') gefunden werden, die inzwischen in Großvermehrung genommen wurden, da sie auch andere wertvolle Eigenschaften hatten. Andere resistente Klone sollen als Kreuzungspartner dienen. Seitz

Chalupa, V., and Fraser, D. A.: **Effect of soil and air temperature on soluble sugars and growth of white spruce (Picea glauca) seedlings.** Canad. J. Bot. **46**, 65—69 (1968).

Sämlinge von *Picea glauca* wurden nach Anzucht im Gewächshaus fünf Monate hindurch bei einer Bodentemperatur von 50—100° F (10—38° C) und einer Lufttemperatur von 70° F (21° C) unter Hinzugabe von Licht kultiviert, zusätzlich in einer Versuchsserie bei 34° F (1° C). Dabei ergaben sich signifikante Unterschiede im Sproß-