Field grafting

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California Ponderosa pine

In the California area, the principal method now used for field grafting of ponderosa pine involves the grafting of actively growing scions to succulent (actively growing) rootstock. This method replaces an older one of wood grafting dormant scions that was used at the Foresthill Divide Seed Orchard in the recent past. In 1968 to 1970. wood grafting of dormant scions here proved completely unsatisfactory, as graft take ranged from 5 to 10 percent (table 1). During this same period, our initial experience with wood grafting of active scion material produced good unions in 22 to 36 percent of the grafts made within a few months after grafting. Further, an initial attempt at succulent grafting of scions in the pinfeather stage made in 1970 resulted in a 27 percent graft take. These results led us to discontinue the grafting of dormant scions (and the related problems of dormant scion collection and storage) altogether in favor of grafting scions in active stages of growth. This article reports results obtained in 1971 and 1972 at Foresthill with both wood and succulent grafting of active scions, and the effect of short-term storage of active scions on grafting success. The method used for field grafting ponderosa pine is described by Mergen and Rossoll[2] in their publication on "How to Root and Graft Slash Pine." The section on grafting with succulent tissue is augmented in this article.

TABLE 1. Grafting success (percent)[1] in ponderosa pine at the Foresthill Seed Orchard, by scion condition, graft type, and year

Year	Graft Type: Wood — Dormant	Graft Type: Succulent — Scion Stage: Bud active—pinfeather	Graft Type: Succulent — Scion Stage: Pinfeather Only
1968	10 (81)	36 (28)	—[2]
1969	6 (1,130)	—[2]	—[2]
1970	5 (1,338)	22 (280)	27 (406)

[1]Number of grafts is shown in parenthesis.
[2]No grafting done.

Methods

The Seed Orchard Site. This orchard is located about 60 miles northeast of Sacramento. in the northern Sierra Nevada. The site is a ridge top of gently rolling topography averaging 4.000 feet in elevation, and lies within the mixed conifer type. The soil is a deep, fertile Aiken loam. There is no irrigation system. From May through October the only rainfall is from infrequent thunderstorms. Evaporative stress is high: Day temperature normally rises to 90°F and humidity frequently drops as low as 10 to 20 percent.

When completed, this orchard will represent more than 250 ortets, and contain about 3.000 grafted trees.

Terminology. The following definitions apply to this study:

a. Wood graft - Last year's growth of the scion is grafted into last year's growth on the rootstock. The scion can be dormant or actively growing.
b. Succulent graft - Current growth of the scion is grafted into current growth of the rootstock.
c. Dormant scion - Scions are collected in winter: the cambium is not active.
d. Bud active - Scions are collected in spring, the cambium is active, and buds are in elongating, candle, or pinfeather stages.
e. Candle - The current season's internode has elongated, but the needle bud scales are appressed.
f. Pinfeather - The candle is evident. and needle buds are expanded to 1 centimeter in length.
g. Hardening - The current season's internode is begin

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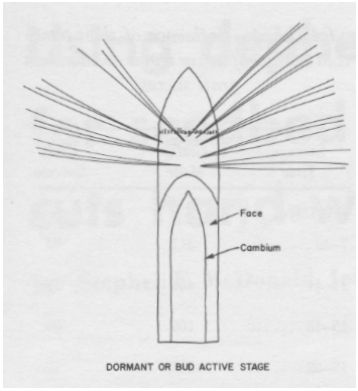
[2]Station Paper No. 46, Southeastern Forest Exp. Stn USDA Forest Service, 1954.



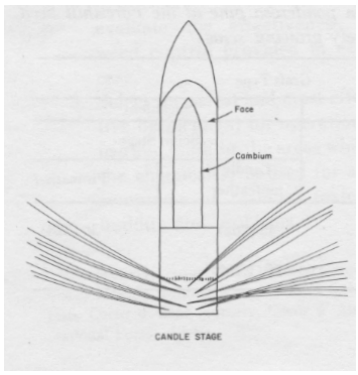
DORMANT OR BUD ACTIVE STAGE

ring to develop woody tissues, and the needles are over 2 centimeters long.

Rootstock Stage for Succulent Grafting. To determine which growth stage of the rootstock is operationally the best. scions in the candle stage were collected in the orchard in 1971, and grafted to rootstock in the candle stage. the pinfeather stage, and the hardening stage.

The rootstock was 4 to 6 years old when field grafted at Foresthill. More important than age is the size of the new growth on the rootstock. 1.5 to 3.0 cm in diameter. 15 cm above last years growth.

In this, and for all other data, grafting success was based on the number of good unions evident in October-November. About 75 percent of the graft failures normally were evident by mid-July.



CANDLE STAGE

Scion Stages for Wood and Succulent Grafting. In 1971 and 1972, all scions were collected in active stages. The ortet age ranged from 60 to 100 years *with some 20 to 60 and some 100 to* 120. Depending on the length of its current growth. the scion was either wood-grafted or succulent-grafted. because at least a 5 cm wedge is cut on the scion for exposing cambium for the cleft-graft technique used, any scion that measures less than 10 cm (candle and bud) cannot be grafted into current internode. The scion cut from the ortet then must include last years internode, and the graft must be made in last year's internode on the rootstock, that is, wood-grafted.

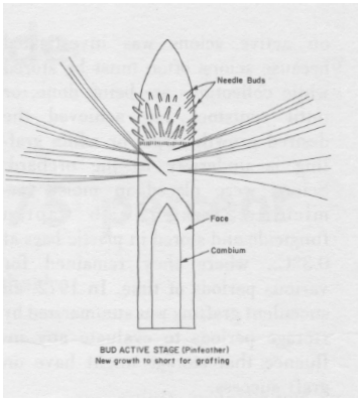
All three active scion stages were included in the wood grafting, as many ortets produced scions that had short candles, or were in the pinfeather stage with a very short candle.

In the succulent grafting. the scions were in candle and pinfeather stages. or in pinfeather alone, depending on the average acti%ity of the ortet when the scions were collected.

Grafting Techniques Used. The succulent scions were collected in the spring after elongation but before the needle buds had burst from the upper third of the crown. (We prefer to collect the scions with 2.5 cm of last sears needles for storage).

With succulent grafting, about 10 em of the bud was cut off and the wedge made so that 3-5 cm of straight cambium was exposed. The wedge was inserted into the cleft so that the cambiums matched along one side: if both sides match, it is better, but not essential.

The cleft was made approximately 15 cm above last year's growth. After the scion was tied in with budding strips, some of the last year's needles were brought up and enclosed in a polyethylene bag tied off at the bottom. A lath was tied to the rootstock so that the top was about 5 cm above the scion. A paper bag. with the corners cut out for air movement. was



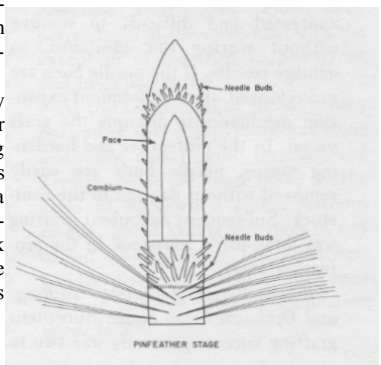
BUD ACTIVE STAGE (Pinfeather)
New growth to short for grafting

placed over the lath and plastic hag for shade. We have found that insulated paper bags made for ice cream hold up better than grocery bags).

Nothing was done for 6 weeks except checking for wind, cattle. or (leer damage to the paper bags. After 6 weeks. the bags were removed. the budding strips loosened on successful grafts. and the bags replaced. If the scion had 2 cm of new needle growth, the plastic bag was left open at the bottom or closed up if the scion was not growing but was still alive.

After 1 week with the plastic open, it was removed and the paper bag left on. One week later, the paper bag was slashed on the east. north. and west sides for aeration. The paper bag and lath were removed 1 week after .lashing. At all checks. the rootstock limbs were kept headed back so they did not overtop the graft.

.Scion .Storage. The effect of storage



PINFEATHER STAGE

on active scions was investigated because scions often must be stored while collections are being done, or until rootstock, has achieved the desired growth stage. or while grafting is underway in the orchard. Scions were placed in moist vermiculite, treated with Captan fungicide and stored in plastic bags at 0.3°C.. where they remained for various periods of time. In 1972. all succulent grafting was summarized by storage periods to evaluate any influence that storage might have on graft success.

Results and Discussion

Optimum Rootstock Stage. The candle stage in the rootstock was clearly not an acceptable one for succulent grafting (table 2). Best results were obtained with rootstock grafted in the pinfeather stage. where 80 percent of the grafts formed unions.

TABLE 2.—Effect of rootstock growth stage on succulent grafting success

Rootstock Stage	Grafts Made	Graft Success
		Percent
Candle	25	4
Pinfeather ...	662	80
Hardening ...	494	67

In the candle stage. needle buds are appressed and difficult to remove without tearing the cambium, so damage results. If the needle buds are not removed. their subsequent expansion ntechanicall disrupts the graft union. In the pinfeather and hardening stages. needle buds are easily removed without damage to the rootstock. Subsequent succulent grafting was done using rootstock in the pinfeather stage.

Wood Versus Succulent Grafting. and Optimum Scion Stage. Succulent grafting success generally was two to three times better than wood grafting. In 1971, best results were obtained with succulent grafting of candlepinfeather scions (table 3). Graft success was 45 percent. compared to 14 percent with wood grafting, and 36 percent with succulent grafting of pinfeather scions.

Based on these results, a special effort was made in 1972 to narrow the active scion stages collected to mainly candle, where possible. Ortets were revisited when necessary to avoid collecting scions in a complete bud-elongating stage. and scions were collected before the ortet was in full pinfeather. Because many collections had to be made from ortets which mostly produced scions with too short current growth and bud length, considerable wood grafting was still necessary. Nevertheless. variability in scion growth stage was reduced for the better. Graft take was 76 percent with succulent grafts using candlepinfeather scions, and 38 percent with the unavoidable wood grafts (table 3).

Scion Storage. Storage up to 18 days apparently did not affect graft success (table 4). A longer storage seemed to reduce success by roughly 10 percent. However, the decrease may in part be attributed to the seasonal warming in climate at the orchard over the 2 week period that grafting was done. In am event, the decrease was not serious and storage of scions in the candle-pinfeather stages for up to 1 month is clearly possible.

TABLE 4.—Influence of short-term cold storage of active scions on succulent graft success

Storage Time	Grafts Made	Graft Success
Days		*Percent*
7–10	311	83
11–14	465	79
15–18	109	80
19–22	317	72
23–26	95	74
27–30	50	72

Summary and Recommendations

Four factors influencing the success of field grafting of actively growing scions of ponderosa pine were investigated: Type of graft (wood or succulent); stage of rootstock growth: stage of scion growth: and scion storage.

In California ponderosa pine, our current practice is to:

1. Collect scions in the candle stage.
2. Use a succulent graft whenever possible.
3. Graft the rootstock in the pinfeather stage.
4. Cold-store scions no more than 2~ weeks.

Experience confirms that the best success is consistently obtained by collecting scions in the candle stage, and grafting them on rootstock in the pinfeather stage. Storage of scions up to 18 days has no effect, and 30 day storage is possible. 0

TABLE 3.—Grafting success (percent) in ponderosa pine at the Foresthill Seed Orchard using actively growing scions[1]

Year	Graft Type		
	Wood	Succulent	
		Scion Stage	
	Elongating—pinfeather	Candle pinfeather	Pinfeather
1971	14 (286)	45 (262)	36 (223)
1972	38 (216)	76 (1,788)	—[2]

[1]Number of grafts is shown in parentheses.
[2]No grafting done.