It is quite apparent that the theme of many of our presentations here at these meetings has been centered around sanitation.

It has been referred to directly during the current sessions by Jack Hill who emphasized the need for cleanliness in and around our propagating facilities. The removal of wastes, debries, and general decontamination procedures have been highlighted as being very important factors contributing to the success of any one particular propagation sequence.

Dr. Richard Hampton, in his excellent presentation on *Prunus* viruses and their relationship to propagation techniques also referred to the need for sanitation and clean scionwood Carnation growers in Colorado have done essentially the same thing in producing disease free cuttings, a process conducted through the culturing and isolation of disease-free stock plants.

Sanitation has also come to light more or less sub rosa; Bill Flemer referred to it in pointing up the nematode problem. Harvey Gray has mentioned it in his cesspool reference, Fred Galle has referred to it in connection with soil sterilization to eliminate weeds and pathogens in transplant beds

When one becomes older he has a tendency to reminisce. On this subject of sanitation I think back to my Professor, Teacher and friend, Steve O'Rourke, who on the first day in his propagation course passed out a one sheet dissertation on sanitation Here he pointed out one fact, i.e , the propagation house is like a maternity ward, keep it clean.

All in all the reasons for these precautions are the elimination of failures and the increase of propagation efficiency.

Dr. J. P. Mahlstede presented his prepared address entitled, "Graft Failures in Apple Stions" (Applause)

GRAFT FAILURES IN APPLE STIONS*

J. P. Mahlstede
Department of Horticulture
Iowa State College
Ames, Iowa

INTRODUCTION

Ever since man first began grafting plants there have been failures. In some years a nurseryman might have unusual success and have a 80 or 90 per cent take Other years, with the same understock and the same scion variety, handled under what the propagator considered identical conditions, stands of 50 or 60 per cent might be realized.

The essential aspects of understock culture of the common red cedar have received particular attention in recent years, since this material is the most commonly used stock for junipers and has given the most trouble to propagators of evergreens. Frequent transplanting to promote the formation of a liberous root system, and a good sanitation program are considered requisite to an acceptable, commercial stand

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Melhus and Maney (1921), working on the control of crown gall in apple grafts, suggested the feasibility of dipping the grafts in a bordeaux mixture of an 8-8-50 composition. It is quite apparent that sanitation is quite important to successful propagation, regardless of the technique of reproduction employed In 1953, Louis Vanderbrook outlined his program for rooting hardwood cuttings of deciduous shrubs before the Plant Propagators Society One of the salient features of this discussion was the step he referred to as the most critical operation, namely the placement of the 3½ inch cuttings on a screen and their subjection to a water spray under considerable pressure Before placing the cuttings in the rooting medium it was noted that the basal end was immersed in a sulphur, fungicide dust

To leave the question of sanitation for a moment, it would be well to briefly review some of the other theories of causes for graft failures of apple, since this material has received the greatest attention in the past.

In 1929, R H Roberts of the Wisconsin station noted that in apple grafts made from material having different diameters, the position of the top bud was important to successful grafting. The theory here was that the top bud should be directly above the matched tongues of the graft, since it starts growing most readily, and therefore should be in a direct vertical line with the point of callus union. Here it was suggested that the sap rises readily, but its lateral distribution is quite slow If the top bud is not matched on different diameter scion and root combinations then, this may be one factor contributing to some of the losses.

Some propagators believed that only the whole root graft should be used, while others preferred the long root, short scion, or still others the long scion, short root. One year the whole root graft would give the best stands, in other years the short root, long scion would give better results, and so forth It has since been fairly well established that the long scion, short root method is about as effective as the whole root method, and, of course, is more economical of propagating stock.

Crown gall in apples became an important consideration for nurseries at the turn of the century. Von Schrenk and Hedgcock (1906) suggested that the excessive callusing of apple grafts at the point of union might be due to an infection by fungi or bacteria. A year later Smith and Tonsend (1907) established that crown gall was caused by a bacterium *Agrobacterium tumefaciens.* Von Schrenk, et al suggested the use of cloth and wax to keep whatever was causing the damage from entering the union. Based on this research the cloth nursery tape currently being used today for grafting was developed Again, sanitation has been emphasized as being highly important.

Tukey and Brase (1945) suggest that in certain apple scion-stock combinations, failures or uncongenialities could be attributed to somatic variations, viruses, or physiological disturbances which were carried through the grafting operation. Other failures may also be due to poor mechanics, such as the mismatching of cambium layers, insufficient pressure at the point of union, and excessive gumming All things considered, there may be another reason why grafts might fail, a cause

which might explain, in part, the variation from year to year, and from season to season.

Because of the losses that are incurred in bench grafted apples between the time they are grafted until they become established in the field, an experiment was designed to investigate the possibility of the influence of the included bud and its microflora on the stands of grafts Since it had already been established by Keener (1950), that many fungal spores and hyphae could be contained in and on bud scales, it appeared that poor union and complete failure of grafts might be the result of fungi invading the graft union during the hot or cold callusing sequence, or even after the grafts had been placed in the field. This invasion might be favored by wrapping the union with tape or polyethylene sheeting, thus creating a microenvironment quite favorable to the development of certain fungi and bacteria Furthermore, in mismatched unions or grafts having roots and scions of different diameters, larger cavities would be left in the vicinity of the graft union because of the difficulty in taping The type of growing season before scionwood collection, the incidence of disease organisms during and after bud development, storage environment and the method of handling scionwood and grafts are a few of the more important factors which will ultimately determine the success of any grafting operation, in any given year.

METHODS AND MATERIALS

The results are based on an experiment conducted with apples. using dormant scionwood of the variety Red Delicious, containing three buds, and 4 inch piece roots of Washington grown seedlings. Scions collected for the check or control treatments came from a scion block which had been very carefully sprayed at regular intervals during the course of the growing season. Scionwood for all the remaining treatments came from trees which received no fungicidal or bacterial sprays during the progress of the season. Treatments for comparison included the following:

	Scion Source	Scion Treatment	Stock Treatment
1	Sprayed scion block	None	None
2	Sprayed scion block	10 min soak in 1% $KMnO_4$ plus Captan dust after drying	None
3	Non-sprayed scion block	None	None
4	Non-sprayed scion block	$KMnO_4$ soak plus Captain dust	None
5	Non-sprayed scion block	$KMnO_4$ soak plus Captain	$KMnO_4$ soak plus Captan dust
6.	Non-sprayed scion block	None	$KMnO_4$ soak plus Captan dust
7	Non-sprayed scion block	Disbud graft bud No fungicide	None
8	Non-sprayed scion block	Disbud graft bud $KMnO_4$ soak plus Captan dust	$KMnO_4$ soak plus Captain

The common whip graft was used to combine the stock and scion components. All unions were taped with cloth grafting tape. Immediately after grafting, five replications, containing 20 grafts per treatment were individually packed in moist sphagnum moss, wrapped in polyethylene sheeting, and hot callused for 10 days at a temperature of 65° F The grafts were then held for a period of 4 weeks at a temperature of 40° F and subsequently field planted on May 15, 1956. Records on field stands were then taken at two week intervals during the growing season

RESULTS AND CONCLUSIONS

From Figure 1 it is quite apparent that scionwood that was sampled from scion blocks which received a regular disease and insect spray

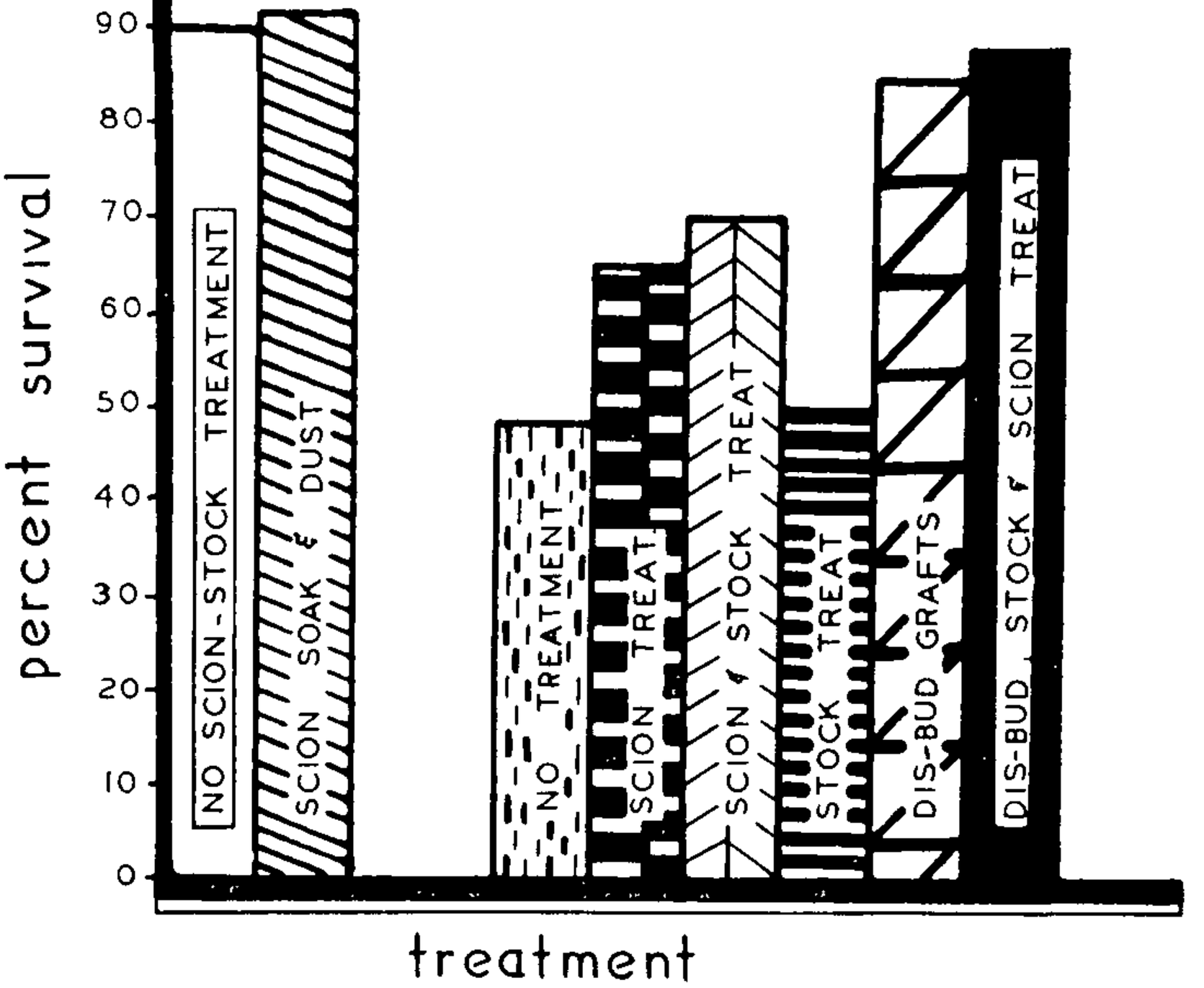

Figure 1. Effect of sanitation on the survival of apple grafts. Note the high survival percentages of grafts made from scions collected from regularly sprayed scion blocks and from non-sprayed scions having the graft bud removed.

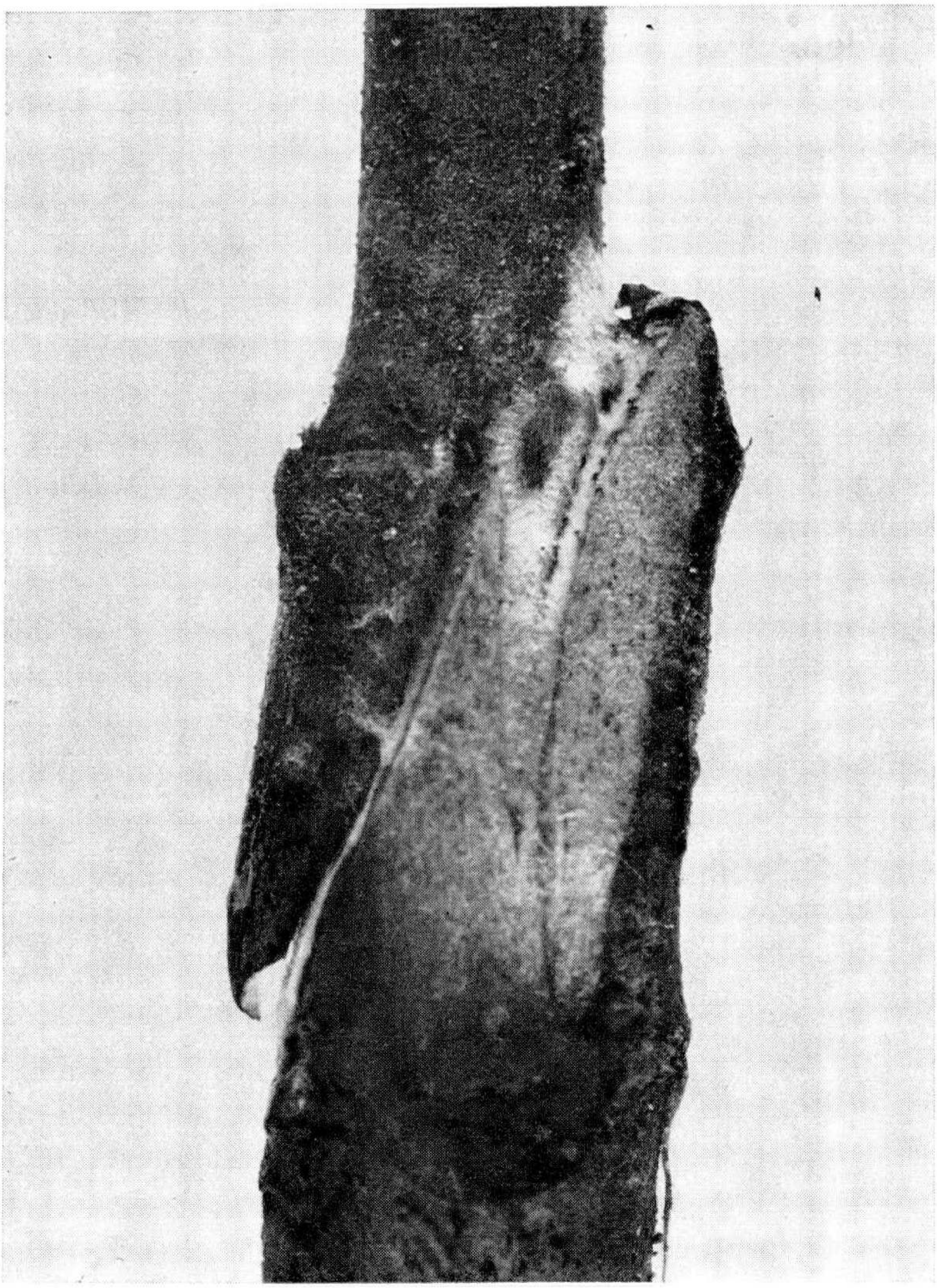

Figure 2. Closeup of a graft union with the grafting tape removed and a portion of the understock cut away to show fungus activity in the graft interfaces.

sequence during the season gave the highest survival percentages. Soaking the scions in a potassium permanganate solution followed by a fungicide dust treatment did little to improve the stands of grafts which made use of "clean" scionwood. The fact that removal of the graft bud, or bud which would normally fall on or close to the lip near the union resulted in stands nearly as good as those which made use of scionwood sampled from a regularly sprayed scion block, suggests that the included bud may have considerable influence in determining field

stands Microscopic examination of graft unions of combinations which periodically failed during the course of the growing season showed that, nearly always failures were accompanied by either fungal or bacterial activity. Naturally some of the grafts which failed, failed because of poor fits, insufficient pressure at the point of union, and/or some other reason which was not readily apparent.

The fact that treatment of scionwood which was collected from unsprayed scion blocks gave higher stands than those which were not treated, further points to the fact that sanitation is quite important in apple grafting Naturally, roots being the underground portions of the plant harbored relatively few organisms which caused graft failures This was evidenced by the very little increased survival in treatment 6 which made use of treated roots, compared to the control (treatment 3).

The results of this experiment further emphasize the need for a carefully planned sanitation program by propagators using this technique to propagate apples.

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MODERATOR WARNER: Thank you, Dr. Mahlstede. The next gentleman on our program is Mr. J. C. McDaniel, of the University of Illinois.

Mr. J. C. McDaniel presented his paper on "Procedures to Increase Take in Budding and Top-Grafting" (Applause)

MR. McDANIEL: I have in the back of the room a few copies of a leaflet from the University of Illinois on "Plastics Useful in Tree Budding." Also available from the University is a leaflet describing the plate bud technique of budding