MATERIALS FOR COVERING PECAN BUDS AND GRAFTS

MATERIALS FOR COVERING PECAN BUDS AND GRAFTS

By

LEIGHTON PEDDY

Bachelor of Science

Oklahoma Agricultural and Mechanical College

Stillwater, Oklahoma

1932

Submitted to the Department of Horticulture

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

1938

APPROVED:

H. B. Cordner
In Charge of Thesis

H. B. Cordner
Acting Head of the Department of Horticulture

Dean of the Graduate School

TABLE OF CONTENTS

PREFACE

Pecan propagators have lost valuable time and money through the use of unsatisfactory covering materials for pecan buds and grafts. Some of the commercial budding and grafting compounds on the market are entirely unsatisfactory as they contain substances toxic to the pecan, or for other reasons do not meet the requirements of a satisfactory covering for pecan buds and grafts.

Some of the successful grafting wax formulae used in the north are unsatisfactory when used under southern climatic conditions.

Part of this investigation was carried out in the writer's pecan grove at Ardmore, Oklahoma, and part in the College pecan grove at Stillwater, Oklahoma.

The covering materials used by many leading nut tree propagators were investigated and an effort was made to determine the relative value of each.

INTRODUCTION

The grafting wax formula consisting of 4 parts resin, 2 parts beeswax, and 1 part tallow has long been standard in the north for grafting apples and other tree fruits. It has been successfully used as a covering for nut tree grafts and is recommended by more propagators than has any other formula. However, in the south the high temperatures necessitate an increase in the resin in proportion to the tallow, and many of the propagators recommend a wax containing 5 parts resin, 1 part beeswax, 1/4 part linseed oil, and 1/2 part lampblack. In warm climates powdered asbestos has been found better than the lamp black, the latter being objectionable due to the added heat absorption by the black substance. Interviews with various propagators indicate that many different proportions of the above ingredients are used in grafting waxes. Resin in the formulae ranges from 2 parts to 16 parts. Beeswax varies from 1 to 3 parts. Paraffin is often substituted for all or part of the beeswax. Tallow and linseed oil are used sparingly because they are toxic under conditions of high temperature.

It is evident that in the preparation of a grafting wax one must consider the climatic conditions under which it is to be used. A successful formulae in the north may be entirely unsuccessful in the south.

Water soluble asphalts are used to some extent. Dark colored asphalt preparations obviously have been less successful than those of lighter hue. A combination of paraffin and pick-up gum (a resin-

ous product), have been used successfully by various propagators. From 4 to 5 parts paraffin to 1 of pick-up gum seem to be most successful.

The majority of the pecan propagators use wax cloth as a covering for buds. Many different formulae are suggested for making a successful type of waxed cloth.

The purpose of this investigation is to study some of these formulae as applied to pecan grafting under Oklahoma conditions and to endeavor to work out more desirable formulae.

REVIEW OF LITERATURE

A pecan specialist from Texas A. and M. College was hired by Jack Carman of Bristow to demonstrate the latest in pecan grafting in Mr. Carman's grove. Mr. Carman has successfully topworked extensive native pecan groves using the covering materials recommended by the specialist from Texas A. and M. College.

The above method of covering pecan grafts is as follows: A wax cloth cap is placed over the stub and fitted around the scion. The graft is then given an additional coat of wax. The cloth is prepared by dipping sheeting or muslin material in a melted mixture of resin, 2 pounds; beeswax, 3 pounds; tallow, 1 pound.

The wax used as a paint over the wrapped graft consists of resin, 3 pounds; beeswax, 2 pounds; tallow, 1 pound.

Mrs. C. E. Ringer* and Bill Ringer* or Ardmore also use this method of covering pecan grafts, which was related to them by Mr. Carman. They have obtained good results with this method and like it much better than their former method, which involved the use of melted paraffin as a covering material for pecan grafts.

Dr. W. B. Coffee* of Ardmore, Oklahoma is using the side graft method in pecan propagation. He ties the graft with string, then paints over the graft with a wax consisting of equal parts of resin and beeswax. He reports that very satisfactory results are obtained by this method.

George Dyer* of Ardmore, Oklahoma uses wax cloth caps as a covering for grafts. As a covering for buds he uses wac cloth strips.

---

* Personal interview.

Lyman Coe* of Bartlesville, Oklahoma uses melted paraffin as a covering for grafts. He uses cloth dipped in paraffin as a covering for buds.

The ingredients used in each grafting wax formula will be in the order of (1) resin, (2) beeswax, (3) tallow (measured in pounds), (4) linseed oil, and (5) lampblack (measured in pints). If celite is used instead of lampblack it will be designated by name. Paraffin will be called by name when it is used in the formulae and will be listed in the place of beeswax or following beeswax if both are used.

A 4-2-0-$\frac{1}{2}$-$\frac{1}{2}$ formula would contain 4 pounds resin, 2 pounds beeswax, no tallow, $\frac{1}{2}$ pint linseed oil and $\frac{1}{2}$ pint lampblack. The standard fruit tree grafting wax consisting of 4 pounds resin, 2 pounds beeswax and 1 pound tallow will be designated as 4-2-1 wax.

J. E. Bailey and J. C. Woodruff (2)of Georgia recommend the following formulae:

1. Formula for hand wax: 4-2-1.

2. Brush wax: 5-1-0-$\frac{1}{2}$-$\frac{1}{2}$.

3. Paraffin is applied with brush at a temperature of 160°F.

4. Budding cloth is made by dipping strips of cloth in a mixture of 4 pounds resin, 2 pounds beeswax, and 1 pound tallow. Pull the cloth between two flat pieces of wood to squeeze out excess wax.

J. A. Neilson (28) recommends water soluble asphaltic emulsions as a grafting compound. The material is made by several concerns and appears on the market under trade names, such as "Tree Seal", "Tree Heal", and "Braco Tree Emulsions". The asphaltic emulsions are

---

* Personal interview.

usually black but may be obtained in red, green, or gray color if desired.

Mr. Neilson attributes the ready development of callous tissue on the margins of cut surfaces when asphalt emulsions are used to the preservation of moisture rather than to any stimulative effect of the emulsion upon cell development. He also recommends the use of melted paraffin as a covering for grafts, buds, and nursery stock.

Dr. Robert T. Morris (25) recommends the use of Clark's Parapin wax made by Walter E. Clark and Son, Box D, Milford, Conn. Dr. Morris says that parapin used in thin layers as a covering for grafts or buds will not crack in cold climates or melt and run off in warm climates. This paraffin protects the grafts from desiccation until good union of the stock and scion is made.

J. T. Rosenborough (35) states that many types of covering materials are used with satisfaction. He says that melted paraffin, prepared grafting and budding wax, wax cloth, all have some advantages and it is questionable as to which is best. He also quotes various growers as follows:

J. D. Jowers, Gonzales, Texas: "We tie the buds with carpet warp and seal them with melted paraffin".

Mrs. John Kemper, Denison, Texas: "I tie grafts and buds with cotton cord, then seal them with melted paraffin."

R. L. Odom, Jasper, Texas: "We use raffia for tying the buds and cover with melted paraffin."

E. Guy Risien, San Saba, Texas: "I simply dip some rather finely woven cloth in pure beeswax, and squeeze it a little with a potato masher and tear off strips some 1/4 inch in width."

S. J. Greer and W. T. Mallory (15) recommend the following formulae for pecan propagation: 1. Grafting wax: 4-2-0-1. 2. Wax cloth: sheeting dipped in a melted wax consisting of equal parts by volume of beeswax and resin with a small amount of linseed oil added. When the cloth is thoroughly saturated, remove and draw between the edges of two smooth boards.

R. W. Fair, quoted by Reed (32), reports that linseed oil in any mixture has been found detrimental to nursery grafts in Texas and should be avoided. The 4-2-½ formula has proven very satisfactory to Mr. Fair. For use on cold days a small quantity of wood alcohol is added.

F. F. Ramsey, quoted by Reed (32), concludes that wood alcohol is unsafe in grafting preparations and that grain alcohol alone can be used with safety in these materials.

C. Woolsey and William G. Amstein (44) recommend the following formulae for pecan propagation: Grafting wax: 4-2-1; alcohol wax: 2-1-0-2/5 pt. grain alcohol; melted paraffin: for a covering material; brush wax: 6-1-0-1, with charcoal or powdered asbestos added to give texture and toughness.

G. H. Blackmon (4) recommends the standard 4-2-1 grafting wax. Cloth is dipped into this mixture for waxed patches.

During the spring of 1935 Herman Hinrichs used the standard 4-2-1 wax in slot grafting pecans in the college orchard at Stillwater with excellent results. The following year emulsified asphalt as a covering for slot grafts resulted in only five per cent of successful grafts. Grafts treated with Tremco compound were sixteen per cent successful.

Tables I and II summarize the recommendations of leading propagators for pecan and fruit tree grafting wax formulae.

TABLE NO. I.

Formulae Recommended for Pecan Grafting.

Grafting Wax Formulae for Pecan Trees	Recommended by
Wax cloth cap made by dipping cloth in a mixture of 2-3-1 wax. The wrapped graft is painted over with 3-2-1 wax.	Jack Carman, Bristow. Mrs. C. E. Ringer, Ardmore. Bill Ringer, Ardmore.
3-3-0 grafting wax.	Dr. W. B. Coffee, Ardmore.
Melted paraffin.	Lyman Coe, Bartlesville. (2), (25), (28), (35), (44)*.
Parapin wax.	(25).
4-2-1 wax.	(2), (44), (4), (32).
4-2-0-1 wax.	(15).
4-2-$\frac{1}{2}$ wax.	R. W. Fair, Texas.
5-1-0-$\frac{1}{2}$-$\frac{1}{2}$ wax.	(2).
6-1-0-1 wax.	(44).

* Refers to literature cited.

TABLE NO. II.

Formulae Recommended for Fruit Trees or Grafting in General.

Grafting Wax Formulae for Fruit Trees in General.	Recommended by.
Asphalt emulsions.	(26)*.
Melted paraffin.	(28).
Paraffin, 4 parts; pick-up gum, 1 part.	(18).
4-2-1 grafting wax.	(1), (10), (18).
4-1-0-1-1 oz. lampblack.	(16).
5-1-0-$\frac{1}{2}$-$\frac{1}{4}$ part lampblack.	(1).
7-2-1 grafting wax.	(1).
16-0-1-8 parts wood alcohol.	(1).
16-4-0-$\frac{1}{2}$ pt. linseed oil-1/8 lb. lampblack.	J. F. Jones, Pennsylvania, quoted by (32).

* Refers to literature cited.

COMMENTS ON FORMULAE INVESTIGATED: Most of the grafting wax formulae recommended for grafting pecan or fruit trees contained either tallow or linseed oil. Since linseed oil and tallow have proven toxic as constituents of grafting wax and budding cloth for the writer during periods of extremely high temperatures in southern Oklahoma, an effort was made to find a substitute for linseed oil or tallow.

Some of the formulae recommended lampblack which is undesirable in Oklahoma due to the excess heat absorbed. Celite (powdered asbestos) would be better for the south as suggested by Armstrong of Oklahoma A. and M. College.

Paraffin is used as a covering for pecan grafts by some workers. However, during periods of high temperature melting of the paraffin results. Therefore an effort was made to combine paraffin with resin formulae to raise the melting point. Paraffin of higher melting point also was obtained.

MATERIALS AND METHODS.

The wound covering and budding experiments were performed on small native pecan trees ranging in size from one to three inches in diameter. The first wound covering experiments consisted of 12 wounds per treatment; the growth hormone wound treatment included six wounds per treatment.

The grafting stock ranged from small trees two inches in diameter in which one scion was inserted to large trees in which many scions were inserted.

The scions were cut from budded and grafted trees in the writer's grove at Ardmore. The wood for storage was cut into six inch lengths, painted with a thin coat of melted paraffin, tied into small bundles, and packed in a box of damp sawdust. The box of scions was stored in an iceplant at Ardmore.

The varieties used in grafting were Success and Squirrels Delight.

In grafting the slot bark method was used. The scions were nailed in with small "sprig" nails. Grafting is started each year as soon as the bark starts slipping in April. Fifty grafts per treatment were considered in each experiment.

The covering materials used by many leading nut tree propagators were investigated to determine the relative value of each.

Nine experiments were conducted using several of the following covering materials in each experiment:

1. Grafting wax (4-2-1 tallow).

2. Liquid roofing asphalt (sold in small cans at lumber yards).
3. Waterglass.
4. Shellac.
5. 121 waterproofing compound (an emulsified asphalt manufactured by Tremco Manufacturing Co., Cincinnati, Ohio).
6. Tremco budding and grafting compound (Manufactured by the same company as No. 5).
7. Grafting wax (4-1-1 paraffin-1 tallow).
8. Waxed cloth (4-2-1 wax) and waxed cloth made from resin, 2 parts; beeswax, 5 parts; paraffin, 1 part; and tallow, 1 part.
9. Lanolin (a wool fat).
10. Parafilm budding tape (Manufactured by Parafilm Co.)
11. Growth hormone substances--Indoleacetic acid and Phenylacetic acid.

These materials were applied to wounds, buds, or grafts as described under each experiment.

EXPERIMENT NO. I.

LIQUID ROOFING ASPHALT COVERING.

Liquid roofing asphalt is often used as a covering for wounds made in pruning by some not knowing the nature of this material. Some asphalt was applied to pecan grafts on April 25, 1936 to determine its effect and possibilities as a covering material for grafts or wounds.

Twenty native pecan trees were grafted and the wounds painted with the liquid asphalt. All of the scions and the stubs were killed, suggesting that this material is very toxic to tissue. Either the nature of the solvent or the coal tar products present makes this material entirely unsatisfactory for painting any kind of tree wounds.

EXPERIMENT II.

WOUND COVERING DURING SUMMER OF 1936 AT STILLWATER.

This experiment was conducted to determine the possibilities of various materials as coverings for wounds or grafts. Small vertical strips of bark were removed from shoots of the current season (12 per treatment) during July, 1936, and the wounds painted with various covering materials. The materials used and the results secured follow:

1. Waterglass proved to be entirely too thin to make a satisfactory wound covering. Furthermore, tissues treated with waterglass were badly eaten by grasshoppers.

2. A drying of the tissue resulted from the use of shellac, which indicates this material is also unsatisfactory as a covering material.

3. Twelve wounds treated with Tremco budding and grafting compound were enlarged, presumably due to the penetration of oil into tissue adjacent to the wound. This corroborates results of other propagators using Tremco grafting compound at Stillwater.

4. Paraffin as used in this study had no toxic effect on pecan tissue and was effective in the prevention of drying from the surface it covers. However, in warm climates it has a tendency to melt and run. Morris (25) states that this factor may be prevented by the addition of stearic acid. Paraffin may also be obtained with a high melting point. In cold climates paraffin has a tendency to crack and flake off. According to Neilson (26) this is best prevented by adding pick-up gum and applying in a thin coat.

5. Twelve wounds painted with emulsified asphalt filled in with callous tissue and healed nicely. The rapid healing seemed to be brought about by the conservation of moisture which is a very important factor in callus formation, as stated by Eames and MacDaniels (13). Therefore this material appears to be an excellent covering material for wounds.

6. A standard 4-2-1 grafting wax was used at various temperatures. The wax was heated in the wax melter to temperatures ranging from 140°F to 220°F and applied to the wounds with a brush as would be used under ordinary budding conditions. No injury was apparent when the wax was applied at a pot temperature 200°F or below. Wax applied from the pot at temperatures of 200°F to 220°F resulted in a slight browning of the wounded tissue. A decrease in viscosity of the wax with a rise in temperature results in a thinner coat being applied to the wounds. The rapid cooling of this thin coat compensates in part for the higher pot temperature, in reducing the possibility of serious injury. Neilson (26) states that paraffin should be applied from 170°F to 175°F to get a thin, even coat of paraffin.

In budding or grafting one is not likely to injure the tissue where a thin coat of wax or paraffin is used by getting the wax too hot. However, it is advisable to apply the wax at a temperature just high enough above the melting point to insure a thin, even coat of the wax. For 4-2-1 wax around 155°F seemed to be very satisfactory.

EXPERIMENT III.

BUDDING DURING SUMMER OF 1936.

Four covering materials were used in budding to determine the effectiveness of each. The four materials were wax cloth, 4-2-1 grafting wax, Tremco budding and grafting compound, and 121 waterproofing compound. The treatments and results are shown in Table III.

TABLE NO. III.

Treatment	No. buds set. (August, 1936)	No. buds alive or growing. (April, 1937)
Wax cloth.	12	6
Tremco compound.	12	0
4-2-1 grafting compound.	12	6
121 waterproofing compound.	12	0

The wax cloth and 4-2-1 grafting wax were satisfactory covering materials for buds. These two materials were not harmful to the tissue in any way and fulfilled the requirements of being airtight and waterproof. A greater percentage of the buds probably would have grown had the summer not been so dry.

The Tremco budding and grafting compound proved to be entirely unsatisfactory as evidenced by no buds living. On examining the buds, the compound was found to have soaked through the bark and killed the tissue of the bud and stock beneath the bud.

This corroborates results obtained by other workers and Tremco budding compound is therefore not to be recommended under Oklahoma conditions due to the toxic effect on the tissue of the wood and bark.

The black 121 waterproofing compound, an asphaltic emulsion, was unsatisfactory as a covering for buds, since none of the buds lived when covered with this material. This material seems to be very satisfactory when used as a wound covering but has proven unsatisfactory as a covering for buds.

The wax cloth used in this experiment consisted of resin, 2 parts; beeswax, 3 parts; paraffin, 1 part; tallow, 1 part.

EXPERIMENT IV.

PECAN GRAFTING, SPRING OF 1937.

The scions used in this study were cut during February, covered over with melted paraffin, and put in a box of damp sawdust. They were placed in storage and removed as needed. Although the sawdust became rather dry at times the scions remained in excellent condition during the grafting season. Morris (22) states that it is best to keep the medium rather dry as undesirable chemical action takes place when the wood is stored too wet. Morris (22) recommends dipping the ends of each bud stick in melted paraffin. Neilson (27) recommends coating the entire scion with paraffin for storage. Grafting was started in April, using the slot graft method, and continued until the last of May.

The grafts were covered with standard 4-2-1 wax. The bud scales burst and growth started after the scions had been set about a week, but after about two weeks the wax had a tendency to check. In order to prevent drying of the grafts all parts were later painted over with 121 asphalt waterproofing compound.

The asphalt was applied immediately after painting the wound with 4-2-1 grafting wax to all grafts set after May 25, 1937. This procedure was also successful as evidenced by the rapid forcing out of the grafts. At the time these results seemed to show that a combination of the 4-2-1 wax and asphalt compound were perfect graft covering materials.

However, on rechecking the work in July it was found that the

grafting done during the last week in May had failed.(See Table IV) The black color of the asphalt absorbed so much heat that the tallow in the wax melted and was soaked up by the tissue. The work done prior to this time was still in good condition as healing took place during the cooler weather. Morris (22) states that difficulty may be encountered by using black colored materials in warm climates. Cardinell (8) has been successful with asphalt emulsions in Michigan.

TABLE NO. IV.

Grafting Results.

Date	No. Set	No. starting growth	No. alive	Percent of No. set.	Percent of No. starting growth.
April 23-30.	50	46	40	80	81.2
May 25.	50	40	4	8	80.0

The asphalt emulsion is a very good wound covering material, but it should not be used as an immediate covering for grafts when the temperature is likely to rise into the nineties before the scion is thoroughly established to the stock.

However, the 121 asphalt compound appears to be all right to use in combination with 4-2-1 wax early in the spring or to be used as tree surgery material for stub protection after the scion is established. When temperatures are too low for optimum healing, the asphalt is beneficial in maintaining a higher temperature, according to Sitton (39).

Surveying the observations in this experiment it seems that a wax consisting of 4 resin, 2 beeswax, 1 tallow may be used successfully

when applied by itself or in combination with the 121 asphalt compound during cool weather. Warm weather (in June), however, melted the tallow and injury resulted. Consequently the black colored asphalt compound should not be used during the late grafting season in warm climates as an immediate covering for grafts.

It should be understood that the poor results obtained late in May were partly due to the fact that conditions are less favorable to healing on account of high temperatures and decreased amount of moisture. Although an excellent covering material is used, for best results grafting should be done shortly after the bark begins to slip in the spring.

EXPERIMENT V.

GRAFTING ON PERSIMMONS DURING SPRING OF 1937.

Scion wood was cut from six nursery Japanese persimmon trees while pruning them for planting. The wood was coated with paraffin and placed in storage in damp sawdust. The slot bark graft and the cleft graft methods of grafting were used. Twenty-four grafts (12 for each kind of graft) were inserted during the third week of May.

The grafts were covered with grafting wax (4 resin, 1 beeswax, 1 paraffin, and 1 tallow), and 121 waterproofing asphalt compound was applied over the wax. Ninety per cent of the buds on the scions burst their bud scales and started to grow.

The asphalt compound proved undesirable during the high temperatures in June. The higher temperature brought about by the asphalt melted the tallow which penetrated into the tissues. The injury appeared to be caused primarily by the tallow but callus formation was probably checked by the high temperatures. Morris (22) and Sitton (39) state that high temperatures interfere with callus formation.

By July 4, 1937 only ten of the scions were living with the slot bark grafted scions having an advantage of two to one over the cleft graft method. Much better results probably would have been obtained had the 121 asphalt compound been left off.

TABLE NO. V.

Results of Persimmon Grafting.

Date set.	Number set.		July 4, 1937. Number alive.	
	Slot graft method.	Cleft graft method.	Slot graft method.	Cleft graft method.
May 21, 1937	24	24	10	5

EXPERIMENT VI.

PARAFILM BUDDING TAPE.

Parafilm budding tape, manufactured by Menasha Products Co., Menasha, Wisconsin, was used as a covering for pecan buds in the College pecan grove on Cow Creek. Fourteen buds were set on June 8, and 36 buds were set on June 12, 1937. Cloudy weather prevailed from June 8 to 15, with the maximum temperature ranging between 79°F on the eighth to 86°F on the fifteenth. Clear weather prevailed from June 16 through June 22, with the temperature climbing from 86°F on the sixteenth to 99°F on the twenty-second.

During the cool, cloudy weather the parafilm remained intact nicely, but when the clear weather, with temperature in the nineties, set in, the parafilm melted, leaving the buds exposed to the sun. However, they were immediately covered with wax cloth to prevent injury. One day of clear weather, with the maximum temperature at 99°F was sufficient to melt the parafilm.

Similar results occurred on a series of buds set a little previous to this time by Professor Frank Cross. However, these buds healed up before the parafilm was melted.

A tougher sample of the parafilm tape was sent to Professor Cross from the Parafilm Company. This sample was thicker and was red in color. Some of the red parafilm was put on and observed the following day. It was found to be badly eaten by grasshoppers. The grasshoppers seemed to be attracted by the red color. Before this form of covering material may be recommended it will be necessary to raise the melting point and leave out the bright conspicuous coloring matter.

EXPERIMENT VII.

GROWTH HORMONE BUDDING.

Efforts were made to stimulate callus formation through the application of growth hormone substances. The hormone substances were applied to the cut surfaces of the wound before wrapping with waxed cloth. Four series of treatments were made as follows:

TABLE NO. VI.

Treatment	June 8-12, 1937 No. buds.
1. Lanolin-indoleacetic acid, covered with waxed cloth.	12
2. Lanolin-phenylacetic acid, covered with waxed cloth.	12
3. Plain lanolin and waxed cloth.	12
4. Waxed cloth only.	12

In this experiment all buds were wrapped with wax cloth as used in commercial practice.

The buds were set on June 8 and June 12, 1937 at Stillwater. The above dates are considered late for this section and demonstrate the possibility of late budding, using cold storage buds.

A period of cloudy to partly cloudy weather prevailed from the eighth to the fifteenth of June. The maximum temperature ranged from 79°F, on the eighth, to 86°F on the sixteenth. The temperature range during this time was very close to the optimum growth temperature for callus formation as determined by Sitton (39).

All of the buds healed exceptionally well and the bark was alive

on all except one on June 27, most of the buds having started growth by this date. However, the young shoots were severely defoliated by grasshoppers and walnut datana caterpillars. Under normal conditions this new growth would have been sufficient to carry through the winter.

The difference between the callus formation on the checks and on the buds treated with growth hormones was not significant enough to recommend their use in budding. The lanolin materials are excellent to prevent drying of tissue but where the buds are covered with a good type of covering material this factor does not enter in as was evidenced by the satisfactory healing of the checks.

It appears to be more advantageous to do the spring budding earlier in the spring to give the young shoots a start on the natural enemies and secure better ripened wood by fall, or to patch bud in late July or August allowing the buds to remain dormant until spring.

The lanolin materials at least were not toxic in any way. The benefit in this particular case was not significant over the checks, though in some instances its use may be advantageous where the covering material was less satisfactory than in this study.

Wounds on some branches heal sooner than others. This is probably due to leaf area and other physiological factors concerning individual branches. This factor is probably one of the principal reasons for the inconsistency in healing from the different substances applied.

EXPERIMENT VIII.

GROWTH HORMONE WOUND COVERING.

As a result of the foregoing experiment it was decided to try a wound covering experiment with all four cuts in the series on the same branch or trunk to avoid the individual limb differences in healing factor.

Patches of bark were removed with the Jones Patch Budder from limbs and trunks of pecan trees, ranging in size from one inch to two inches in diameter. Four cuts were made on the same trunk or limb on six different trees. To one wound in each series plain lanolin was applied; another was covered with lanolin-indoleacetic acid; a third was covered with lanolin-phenylacetic; and the fourth was an uncovered check.

In nine days a layer of callous tissue covered the entire surface of the wounds where the lanolin and lanolin-hormone mixtures were used as coverings. There was not a significant difference between the lanolin and lanolin-hormone mixtures, but there was a very distinct difference between these covering materials and the check. On the check the exposed xylem tissue had dried out and only a little callus was formed at the edges of the bark. Most of the other cuts were entirely filled up. The lanolin seems to form a non-drying film over the wound, protecting the tissue from desiccation, and allowing the unimpeded formation of callus.

The lanolin-indoleacetic acid seemed to have a slight but not significant advantage over the other lanolin coverings. It was evident that lanolin or the lanolin hormone mixtures are very satisfactory as a wound covering.

EXPERIMENT IX.

LANOLIN AS SUBSTITUTE FOR TALLOW.

During the summer of 1937 at Stillwater lanolin was tried as a substitute for tallow in grafting wax formulae. Various mixtures of resin, paraffin, and lanolin were made.

Lanolin was mixed with resin in proportions ranging from 1 part resin, 1 part lanolin to 5 parts resin, 1 lanolin. The lanolin has a low melting point, around 100°F. It was found to increase the sticky nature of the wax preparation. The 1 resin, 1 lanolin mixture does not harden at room temperature which was 93°F at that time. The 2 resin, 1 lanolin was also very viscous just hardening at room temperature. The 3 resin, 1lanolin mixture hardened at room temperature but was too sticky for a good grafting wax.

Paraffin (melting poing about 160°F) was added to reduce the stickiness of the mixture, and was found to be ideal in this respect. A 4 resin, 2 paraffin, or 2 beeswax, 1 lanolin mixture is an excellent combination for grafting wax. The brush temperature would be around 160°F.

The melted wax from the various formulae was painted on blocks and exposed to the sun to test their possibility as a covering for grafts. The wax consisting of 4 parts of resin, 2 parts of paraffin, and 1 part of lanolin seemed very satisfactory. This wax was used as a covering for grafts during the 1938 grafting season. A little of the previous season's 4-2-1 wax was also used for comparison.

The lanolin wax covered grafts averaged 90 per cent living scions to 70 per cent living scions on the 4-2-1 wax. The scions were set

during the last week in April.

The significant difference was in the condition of the covering materials. The second wax of which tallow was a constituent showed considerable checking and during a warm spell in May melted enough to expose a portion of some of the wounds. Harmful absorption of tallow occurs when a wax with tallow as a constituent softens or melts to some extent.

The lanolin wax did not check, melt, or leave the wound exposed in any way. After receiving numerous setbacks with tallow and linseed oil as constituents of grafting wax and budding cloth formulae, lanolin is welcomed as a successful substitute for tallow or linseed oil in grafting wax formulae.

DISCUSSION.

Many formulae that are used successfully in the north are unsuccessful when used in the south because of the high summer temperatures.

In order to have a grafting wax that will give good results, several requirements must be fulfilled by the wax. The following requirements are necessary in a satisfactory grafting wax: (1) It must seal the wound air tight and be water proof. (2) The melting point of the wax must not be too low or in warm climates it will melt and leave the wound exposed or some of the melted ingredients may penetrate and kill the scion and surrounding tissue. Tallow and linseed oil are the ingredients which may cause trouble in warm climates. (3) The melting point must be low to avoid injury to the tissue if the material is to be applied with a brush. In warm climates dark colors may absorb enough heat to be harmful. (4) The ingredients of the wax must not be toxic to the tissue. (5) The ideal wax does not check, flake off or attract insects.

Resin is one of the basic ingredients of most grafting wax formulae. When it solidifies it is hard and brittle. The brush temperature of resin was found to be 214°F. This temperature would be a little hot to apply to live tissue. Since resin alone does not stick to fresh cuts very well when the sap is flowing it is necessary to add other ingredients to make the mixture more plastic and adhesive and lower the melting point. These factors are corrected by most workers by the addition of beeswax and tallow or linseed oil to the resin to make a satisfactory grafting wax.

The grafting wax compound of 4 parts resin, 2 beeswax, and 1 tallow formulae has long been used successfully in grafting apples in the north. Consequently it has been applied to nut trees with a great amount of success under most conditions. However, in some instances in the south the high temperatures are sufficient to soften the wax and allow the tallow to be absorbed by the tissue. This is undesirable as the melted tallow is injurious to the tissue. Lanolin may be substituted for the tallow and eliminate this trouble.

The black color contributed by lampblack or asphalt is undesirable under Oklahoma conditions due to the excess heat absorbed during the hot summers.

Some commercial budding and grafting compounds are unsatisfactory under Oklahoma conditions because of the high summer temperatures which cause an absorption of oil or other toxic substances. Tremco budding and grafting compound proved to be in this class of undesirable commercial compounds.

Paraffin may be obtained with a melting point above 130°F, (the temperature at which ordinary paraffin melts is 130°F) which makes it more satisfactory in warm climates whether it is used in a grafting wax formulae or used alone.

A grafting wax consisting of 4 parts resin, 2 parts beeswax, 1 part tallow or 1 part lanolin has a higher melting point than a wax in which ordinary paraffin is substituted for the beeswax. Under the extremely high temperatures which frequently occur in southern states it may be better to use beeswax in the formulae than ordinary paraffin.

Parafilm budding tape in its present consistency was found to be

unsuccessful as a covering for buds because its melting point is too low and it is also attractive to insects.

Waxed cloth seems to be one of the most widely used covering materials for buds. Many formulae were suggested, the most common being standard 4-2-1 wax for making the cloth.

It was found that lanolin may be successfully substituted for tallow and linseed oil in grafting wax formulae. The following formulae for these lanolin grafting waxes are recommended:

Resin, 4 lbs.		Resin, 4 lbs.
Beeswax, 2 lbs.	or	Paraffin, 2 lbs.
Lanolin, 1 lb.		Lanolin, 1 lb.

If checking should occur in cold climates add 1/10 lb. of celite (powdered asbestos.

The following formulae for waxed cloth are suggested:

Resin, 4 lbs.		Resin, 3 lbs.
Beeswax, 2 lbs.	or	Paraffin, 2 lbs.
Lanolin, 1 lb.		Beeswax, 1 lb.
		Lanolin, 1 lb.

The advantages of adding growth hormone to lanolin to stimulate callus formation were not significant. The lanolin did greatly aid callus formation by preventing desiccation of the tissue.

Grafting should be done soon after the bark begins to slip in the spring for best results.

Budding should be done early in the spring to allow the wood to mature before winter or during late July or August, allowing the buds to remain dormant until spring.

SUMMARY.

1. Black colors are undesirable in grafting wax formulae in warm climates.

2. Liquid roofing asphalt was found to be injurious when applied to pruning wounds.

3. Tremco budding and grafting compound is toxic to tissue; consequently it should not be used on buds, grafts, or wounds.

4. Shellac should not be used as a covering for pruning wounds.

5. 121 waterproofing compound was suitable as a covering for wounds but unsatisfactory as a covering for buds or grafts.

6. Waxed cloth seemed to be a suitable covering material for buds.

7. Parafilm budding tape in its present consistency is undesirable as a covering for buds.

8. Lanolin was an aid to callus formation when applied to wounds.

9. It was found that a more desirable grafting wax for southern climates may be prepared by substituting lanolin for the tallow and linseed oil. Formulae for the preparation of this superior wax are given.

10. Lanolin may be substituted for tallow and linseed oil in budding cloth as given in formulae for budding cloth.

BIBLIOGRAPHY

1. Autcher, E. C. and Knapp, H. B. Orchard and Small Fruit Culture. John Wiley & Sons, Inc., New York, 1931.

2. Bailey, J. E. and Woodruff, J. G. Propagation of Pecans. Il. Tabs. Diags, Ga. Agri. Exp. Bul. 172, 1-22, 1932.

3. Batchelor, L. D. Walnut Culture in California. Calif. Agr. Exp. Sta. Bul. 379, 1924.

4. Blackmon, G. H. Topworking Pecan Trees. Fla. Agr. Exp. Sta. Bul. 170, 1924.

5. Bradford, F. C. and Sitton, B. G. Defective Graft Unions in the Apple and Pear. Mich. Agr. Exp. Sta. Tech. Bul. 99, 1929.

6. Brison, F. R. Topworking Pecan Trees by Inserting Patch Buds in Large Limbs. Amer. Fruit Grower, 48:38, March, 1928.

7. Burges, A. E. Something New in Pecan Culture. Country Gentleman 90:36, July, 1925.

8. Cardinel, H. A. A Preliminary Report on Asphalt Emulsions Used in Grafting. A. S. H. S. 34:285, 1936.

9. Chandler, W. H. Fruit Growing. Houghton Mifflin Co., Chicago, Ill.

10. Christopher, E. P. Grafting. R. I. Ext. Bul. 49, April, 1928.

11. Collins, J. F. Treatment and Care of Tree Wounds. U. S. D. A. Farmers' Bul. 1726, 1934.

12. Deming, W. C. A Troublesome Point in Black Walnut Grafting. Amer. Nut Journ., Nov., 1931.

13. Eames, A. J. and MacDaniels, L. H. An Introduction to Plant Anatomy. McGraw Hill Book Co., Inc., New York.

14. Evans, J. A. Propagation of Pecan by Budding and Grafting. Texas A. and M. College Bul. 55, 1920.

15. Greer, S. J. and Mallory, W. T. Report From the Natchez Brand Experiment Station on Pecan Work. Miss. Agr. Exp. Bul. 275:1-16, 1929.

16. Hansen, C. J. and Eggers, E. R. Propagation of Fruit Plants. Calif. Agr. Ext. Cir. 96, 1936.

17. Hitchcock, A. E. and Zimmerman, P. W. The Use of Growth Substances for Inducing Root Formation in Cuttings. A. S. H. S. 34:27-8, 1936.

18. Lewis, I. P. Grafting and Budding Fruit Trees. Ohio Bul. 510, Sept., 1932.

19. Marshall, Rush P. The Relation of Season of Wounding and Shellacking to Callus Formation in Tree Wound. U. S. D. A. Tech. Bul. 246, 1931.

20. Martin, J. N. Botany for Agricultural Students. John Wiley and Sons Inc., New York, 1920.

21. Morris, R. T. Unusual Methods of Propagating Nut Trees. Nor. Nut Gr. Assoc. Proc. 4:45, 1913.

22. Morris, R. T. Nut Growing. The MacMillan Co. Press of J. J. Little & Ives Co., New York.

23. Morris, R. T. Mediate and Immediate Grafting in Summer. Am. Nut Jour., July, 1929.

24. Morris, R. T. A Neatly Packed Box of Paraffined Clubs. Am. Nut Jour., March, 1929.

25. Morris, R. T. Paraffin Coating Solves Grafting Problems. Am. Nut Jour., March, 1929.

26. Neilson, J. A. Some New Grafting Compounds and Wound Dressings. Am. Fruit Grower 55:27, March, 1935.

27. Neilson, J. A. New Methods for Nursery Propagators. Am. Nut Jour., March, 1929.

28. Neilson, J. A. Present Status of Methods for Coating Trees. Am. Nut Jour., July, 1930.

29. Neilson, J. A. Nurserymen Commend Paraffin Tree Coating. Am. Nut Jour., Sept., 1930.

30. Oliver, G. W. Budding the Pecan. U. S. D. A. Bur. Plant Industry Bul. 30, 1902.

31. Priestley, J. H. and Swingle, C. T. Vegetative Propagation from the Stan dpoint of Plant Anatomy. U. S. D. A. Tech. Bul. 151, 1929.

32. Reed, C. A. Nut Tree Propagation. U. S. D. A. Farmers' Bul. 1501, 1926.

33. Reed, C. A. Pecan Culture: With Special Reference to Propagators and Varieties. U. S. D. A. Farmers' Bul. 700, 1922.

34. Roberts, R. H. A Third Experience in Producing Stock Effects with Ring Grafts. A. S. H. S. 34:296-7, 1936.

35. Rosenborough, J. F. Certain Methods of Topworking Pecan Trees. Am. Nut Jour., 30:36, Feb., 1929.

36. Schuster, C. E. Grafting and Budding. Ore. Agr. Ext. Bul. 384, Sept., 1925.

37. Shear, G. M. Lanolin as a Wound Dressing for Trees. A. S. H. S. 34:286-8, 1936.

38. Shuhart, D. V. Thousands Buds a Day by this Method. Am. Nut Journ. 23:7, July, 1925.

39. Sitton, B. G. Vegetative Propagation of the Black Walnut. Mich. Tech. Bul. 119, Sept., 1931.

40. Thornber, J. J. Walnut Culture in Arizona. Ariz. Agr. Exp. Sta. Bul. 76, 1915.

41. Ward, C. F. Pecans May be Successfully in Any Month. Amer. Nut Jour. 25:75, Nov., 1926.

42. Wilkinson, J. T. Real Pioneer in Northern Nut Propagation. Amer. Nut Jour., 33:49, Oct., 1930.

43. Willman, T. For Those Who Would Easily Propagate Pecans. Amer. Nut Jour., 32:23, Feb., 1930.

44. Woolsey, C. and Amstein, William G. Pecan Growing and Propagation in Arkansas. Ark. Ext. Circ. 228, 1932.

ACKNOWLEDGMENT

Grateful acknowledgment is due Professor Frank B. Cross, Dr. G. F. Gray, and Dr. H. B. Cordner, of Oklahoma Agricultural and Mechanical College, for helpful advice and suggestions. Acknowledgment is also due various propagators who willingly gave their methods of covering pecan buds and grafts.

Geneva Carberry, Typist
(Mrs. C. R.)