SATURDAY AFTERNOON SESSION

October 15, 1960

Mr. Louis LeValley, Head of the Department of Ornamental Horticulture, Fresno State College, Fresno, moderated the Symposium Chairman LeValley introduced Mr. Lloyd Joley, Director, U S D.A. Plant Introduction Station, Chico, California.

EXPERIENCES WITH PROPAGATION OF THE GENUS PISTACIA

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INTRODUCTION

Your program committee asked me to discuss our experiences concerning the propagation of *Pistacia* at the U.S. Department of Agriculture, Plant Introduction Station, Chico, California, particularly as these experiences relate to *P. chinensis.*

Interest in the genus *Pistacia* is rapidly increasing throughout much of this country Thus far this attention has centered on *Pistacia chinensis* Bunge, a fall coloring shade tree, and on *P vera* L., which produces the edible pistachio nut of commerce Additional species such as *P atlantica* Desf, *P. intergerrima* Stewart, *P. Lentiscus,* L., *P. terebinthus* L, and some hybrids of these are also promising as shade trees or for rootstocks

Most of our research with *Pistacia* has been concerned with *P. vera* as a potential new crop for this country. To a lesser extent this research has also included work with *Pistacia* species and hybrids as rootstocks for *P vera,* and with *P. chinensis* as an ornamental shade tree Although there are problems in propagation peculiar to each species the principles that apply to one are applicable to the others. The notes and data presented are by no means a complete review of the subject, but they do cover many of the problems commonly encountered

VEGETATIVE PROPAGATION

References in the literature concerning the vegetative propagation of *Pistacia* are often sketchy and conflicting Propagation by cuttings is seldom mentioned and generally unfavorable. In the past 25 years attempts have been made at Chico to root cuttings of *P. vera, P. chinensis, P. lentiscus* and other species. Seldom has there been more than 5 percent rooting of the hundreds of cuttings set and usually less regardless of the time of year the cuttings were taken. We have not thoroughly tested all species under mist but one trial of *P. lentiscus,* an evergreen shrub, was unsuccessful.

Budding and grafting are the methods most commonly used for vegetative propagation of *Pistacia* species other than *P. lentiscus.* Budding is apparently more widely practiced than grafting In Iran (1, 3,

9) the ring-bud and shield or T-bud are favored, but bark and cleft grafts are also used. Better results were obtained from ring grafting than any other method at the Nikita Botanical Garden in the Crimea (7). In Turkey (2, 3, 4, 9) and other pistachio nut producing areas of southern Europe the T-bud is preferred. Bark grafting was more successful than cleft grafting in some early work at Chico (9) but over the years the T-bud has consistently been the most successful An orchard planting of over 100 seedling rootstocks near Red Bluff and a smaller nursery planting near Walnut Creek, California, were topworked in the spring of 1957 by experienced grafters using the whip graft. In both instances the grafts failed completely. On the other hand, two growers near Bonsall and Elsinore, California, have had better results from grafting. These differences suggest need for further research on this problem.

While propagation by budding is generally successful for all species except *P. lentiscus* (which incidentally is propagated chiefly from seed) enough failures have occurred to suggest that possibly *Pistacia* can be as variable and uncertain at times as walnuts. Some of these failures are probably due to the propagator, but undoubtedly more are due to the environment and to the condition of the budwood and rootstock Holmes (5) has reported that at the Mt. Arbor Nurseries, Shenandoah, Iowa, budding of stone fruits is stopped when temperatures reach 95° F In Uzbekistan, U S S.R., (8) maximum results were obtained when pistachio buds were set between 5 and 8 a m and 6 to 8 p.m

At Chico, from August 14 to 28, 1958, well-grown vigorous buds of *P vera*, taken from a single tree, were set on seedling rootstocks of *P. atlantica* and *P. terebinthus* During this period daily temperatures ranged from 85 to 105° F but were below 96° on only three days. By the time the budding was completed an undetermined but small percentage of buds were showing various stages of injury that seemingly indicated they had been overheated. However, most buds remained plump and firm until mid-September when losses rapidly increased By late October this loss was so heavy that an inventory was taken. It became apparent there was a close correlation between the condition of the rootstock and the loss of buds for the better each rootstock had grown the higher the take of buds. This correlation was such that the loss and take of buds could be estimated with surprising accuracy by noting the growth and condition of the seedling rootstock.

Opinions differ as to the best time of the year to set *Pistacia* buds. Some references consider that April and May are the best months whereas others believe buds take better in late summer or early fall. Data Dr. Whitehouse and I published (10) indicate that at Chico buds set in March and early April take poorly, if at all, but there is a marked increase in bud take as the time of budding is extended through the summer and fall. This failure of buds in early spring can be anticipated if the weather is rainy or cool but in a couple of instances bud take in April was high during extended periods of warm, sunny weather.

Studies reported from Russia (6, 11) indicate it is better to remove the wood from the bud shield before setting the bud. Likewise, a few

California growers and nurserymen have reported better bud takes following removal of the wood. At Chico, (10) no particular benefit was obtained from this practice. However, when the bark is slipping easily the wood tends to slide out during insertion of the bud, in which case the wood is usually removed.

Experience has shown the importance of using well-grown budwood from vigorous current season's growth, produced either as water-sprouts or as strong terminal growth. One way to produce good budwood is to cut back one or more limbs on a tree in early spring forcing out new growth. Cutting back insures a greater supply of vegetative buds since many of the lateral buds on the current season's growth of mature trees are flower buds. Flower buds on most species can usually be recognized in early summer by their plumpness and increased size. Flower bud shields may unite with the stock, but the buds drop out either before or after flowering. In case of doubt one can use the vegetative terminal buds of *Pistacia*.

A rubber budding strip has, until now, been our favorite material for tying *Pistacia* buds At Chico the 3/8 x 8 inch size is preferred because it handles easily and effectively covers the wound made to insert the larger *Pistacia* bud. In 1959, a non-adhesive vinyl nursery tape became available in local garden shops Limited tests of this material as a tie for buds appeared favorable. In September 1959 an experimental pistachio rootstock block was topworked, tying 126 buds with vinyl tape, 120 buds with rubber strips and 95 buds with nursery tape The last tape, a combination adhesive and cloth-backed material, was included because a grower had reported very favorable results from its use.

Bud takes of 92.9 and 92.5 percent for vinyl tape and rubber strips were so nearly identical as to suggest they can be used interchangeably. Lack of stretchability makes handling of the vinyl tape somewhat awkward at first but one soon becomes as adept with it as with rubber strips. The chief fault of vinyl tape is its inability to decay readily in sunlight thus requiring considerably more time to cut loose. Besides contributing to a lower take of buds (71 6 percent) nursery tape is difficult to apply as it tends to stick and tangle unless kept taut and straight It is also difficult to remove and has a tendency to peel off the outer surface of the bark.

SEED PROPAGATION

All *Pistacia* species are dioecious, that is, the male and female flowers are borne on separate trees. No positive way has been found to determine the sex of a *Pistacia* tree prior to its flowering. To produce seed for propagation purposes a staminate, or pollen tree, must be planted near the pistillate or seed tree and then flowering should coincide to insure a good seed harvest. It is feasible to topwork a staminate limb into a pistillate tree to conserve space, but the male limb will overgrow the tree unless it is kept in balance by pruning. Most *P. chinensis* trees presently sold by the nursery trade are seedlings, approximately half of which are females. Since the more vigorous, non-seeding males are preferred for street and lawn planting, interest in the development

and use of clonal selections of *P. chinensis* and other species is increasing.

The time for gathering *Pistacia* seed varies with the species and individual clones within the species. At Chico, seed of *P. integerrima* and *P. wenmanifolia* Poiss, matures in July and August, *P. vera* varies from late August to late September: *P atlantica, P. mutica Fisch* and *Mey*, and *P. terebinthus* late September to early October, *P. chinensis* late September and throughout October and *P lentiscus* in December. *Pistacia* seed should be gathered as soon after full maturity as is practicable Maturity of fertile seed can be determined by the color of the external hull or epicarp For most species the epicarp turns blue or green at maturity except *P lentiscus*, which turns black, and *P vera*, that turns whitish and softens to the point where it slips off easily when squeezed between the fingers

Pistacia seed are knocked off the tree with poles or a power shaker and collected on canvas sheets spread underneath. The soft outer hull may inhibit or cause reduced germination if left on the seed. Immediate removal of this hull is preferable while it is easily rubbed off for seed dried with the hull intact requires a few hours soaking in water in order to soften and loosen it again. Immediate cleaning of the seed also discourages storage insect infestation. At Chico, we use a mechanical seed cleaner similar to a vegetable peeler but *Pistacia* seed can also be rubbed and washed on a coarse screen. Freshly cleaned seed should be dried rapidly to avoid danger of molding, preferably at temperatures below 100° F. Blowing air over and through damp seed with a fan or spreading them out in a thin layer on screens raised off the ground and held in the shade is an easy way to accomplish this rapid drying.

Seed of *Pistacia* species can be planted from late fall to early spring, but fall planting has consistently given better germination Another excellent aid to germination is the use of a planting mixture of 5 parts sand and 2 or 3 parts of peat by volume. This mixture can be used in flats, greenhouse benches, and ground beds In the nursery, a ½ inch or more layer of the mixture can be spread in the bottom of the seed trench, the seed planted and then covered with another layer of the mixture before filling the trench with soil

It is very important that the germination medium be kept damp and free of crusting throughout the germination period. A mulch is very helpful in reducing evaporation Materials such as sand, sawdust, leaf mold, newspapers, polyethylene or anything that shades the soil can be used With newspapers or other similar shading materials, an opening to the light must be made as soon as the young plants appear

A series of germination tests made at Chico several years ago indicated that most *P. atlantica, P. chinensis, P integerrima* and *P. lentiscus* seed would germinate without any pregermination treatment other than soaking in water for 2 or 3 hours This soaking becomes more helpful when seed planting is delayed until late March or early April.

For some unexplained reason our particular strains of *P. terebinthus* are somewhat variable in their germination response, especially if planting is delayed until March or April. One treatment that helps is to soak the seed in water 2 or 3 hours, drain and then keep them con-

stantly moist at approximately 70° F. until germination starts, which is usually within 2 weeks.

In addition to fall or winter planting, an effective way to stimulate germination of *P vera* seed is to soak the seed in water held at 40° F. for 2 weeks prior to planting. In one variation of this treatment used in Turkey the seed is put in a burlap bag, soaked for 1 or 2 days in cool preferably running water, drained and the sack of seeds stored and kept damp in a cool, shady spot until germination starts

Early planting of seed, combined with careful watering and regular applications of nutrients, is essential for maximum first-year growth of *Pistacia* seedlings. Early planting also gets the young seedlings off to a good start before growth is slowed down during the heat of July and August The first 2 or 3 months is a critical period in the life of the *Pistacia* seedling. It is a period when care must be exercised to make sure the young seedlings are not over-watered lest damping-off and "wet-feet" problems develop. Slight mounding of the soil beside each seedling helps in keeping free water away from the crown. Should sudden blackening and death of seedlings occur from injury in the crown or roots, withhold water and let the soil dry and aerate. Thrips sometimes become very active around the terminal growth of young seedlings and cause both malformation of the expanding leaves and dwarfing of the plants. These insects are easily controlled by spraying.

Young *Pistacia* seedlings growing under a relatively low nitrogen level may grow only 2 or 3 inches then form a rosette of leaves and cease growing. This semi-dormant condition may persist for several weeks or even months if no treatment is given, but can generally be broken by application of a side-dressing of some nitrogenous fertilizer.

Pistacia species seedlings tend to suffer considerably from shock in transplanting. The roots are also very sensitive to air and will not withstand exposure without danger of damage. High loss after transplanting is a hazard that is ever present for the nurseryman producing them as well as the grower purchasing bare-rooted trees. Some aids for reducing this danger are transplanting as soon as possible after leaf-fall in December or January,transplanting as quickly as possible after lifting the seedlings,and holding the roots in damp soil or sawdust while transporting from the nursery to the planting site Thorough watering of each tree also helps to compact the soil around the roots and prevent air pockets.

Production as container-grown plants apparently has become standard procedure for marketing *P. chinensis*. The wisdom of using gallon cans appears doubtful for a tree so definitely taprooted, but growth in a container does assure that it can be transplanted at any time with little danger of loss. We suggest to growers interested in producing rootstocks for the pistachio nut that one very satisfactory method is the use of a soil tube 4 or more inches in diameter and a minimum of 18 inches but preferably 24 inches tall to accomodate the long tap root. By planting the ungerminated seed or transplanting young germinating seedlings into each tube of soil it is possible to grow a large number of seedlings in a compact space. These tubes can be made of black felt building or sheating paper or even heavier material cut to length and

formed around a piece of pipe of the required diameter Each tube is held together by tacking or stapling the seam to a wood strip or by sealing with some waterproof adhesive such as hot tar or plastic glue.

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CHAIRMAN FOWLER. Is it necessary to bud a male branch into every female *Pistacia vera* tree to insure fruiting? If not, what percentage of male trees is necessary in an orchard?

MR. JOLEY: Our general recommendation for the Pistachio nut in commercial production is one male to every 10 or 12 females How many males one should use depends on weather conditions during the time of blossoming The poorer the conditions for pollination, the more males one should use All *Pistacia* are wind-pollinated and it is important that you locate the pollinator tree so that the pollen will drift to the female trees. If you have only one or two trees, I would graft a pollen-bearing variety onto a limb of one. If I had 10 trees, I would use one tree as a pollinator. You will use the equivalent of one tree, no matter how you do it. It is more efficient if you use one tree than if you graft limbs, because there is a tendency for the male limb to overgrow the tree.

CHAIRMAN FOWLER: You indicated that poor results were obtained when *Pistacia* were budded in the spring. Did orientation of the bud on different sides of the stock have any effect on the results?

MR JOLEY: I do not know if there is an effect on bud take due to season of budding and compass position of the bud on the rootstock. Data Dr. Whitehouse and I published only covers buds set in September and for one year. The data do not indicate any definite effect, there

being a maximum range of 4 percent between the compass positions with highest and lowest bud takes. I have not observed a different trend or effect for buds set at other times of the year but in the absence of data this cannot be interpreted to mean the effect is not there. On the other hand there is an abstract of a Russian report (see No 8 under literature citations) which mentions that *Pistacia* buds set on the south side took better during the hottest summer months than did those set on the north side. One other interesting item in that report is the suggestion that bud injuries and failures during very hot weather may be due to the heat of the sun melting and setting turpentine free from the gum formed around the bud wounds. This turpentine then penetrates underneath the bud-shield injury the tender cambium tissues of both the bud and the rootstock

CHAIRMAN FOWLER: Do female trees always have yellow fall color?

MR. JOLEY: I have checked some 350 mature *P. chinensis* seedlings and the answer is no Color variation is genetic I believe . Among the population of seedlings available for study some trees have yellow leaves, some have red leaves, while others are combinations of these. It does not seem to make much difference whether the tree is male or female. However, there appears to be more uniformity of coloring from year to year in the male than in female trees Color of the female tree may vary depending on the set of fruit, the heavier it sets seed the less it may color but when it does color it is similar to what it was in preceding years

CHAIRMAN FOWLER: What do you mean when you say the roots of *Pistacia* are sensitive to air? Why, more so than other plants?

MR. JOLEY: That is my way of defining the fact that *Pistacia* roots will not stand exposure to air for more than a very short period of time As I said this afternoon we were evaluating the roots of several *Pistacia* species and hybrids for root-knot nematode susceptibility. We had about 200 seedlings ready for this evaluation. It was a cool, rainy day and seemingly ideal for examining roots without danger of their drying. Some roots were exposed to the rain for approximately 3 hours but others were exposed less than an hour All but a very few died after transplanting. This is not an isolated observation: other staff members have observed the same reaction at different times and under different conditions. In fact it was first noted on *Pistacia* seedling roots heeled in sand beds containing sand of plastering grade and size. Patches of gum form on the roots and wherever this gum occurs the bark tends to die and slough off On the other hand I have stored *Pistacia* seedlings in damp sawdust well over a month at 40° F with very good survival after transplanting.

CHAIRMAN FOWLER: Do the roots have a mycorrhize complex that you know of?

MR. JOLEY: I do not know of any nor have I read of any mycorrhize complex on *Pistacia* roots. This is a good question.

CHAIRMAN FOWLER: Are larger size *Pistacia* easy to move with a ball of soil?

MR JOLEY. When they are grown in containers it is easy to move large size *Pistacia* seedlings I have planted moderately large, dormant, bare-rooted seedlings in 5 gallon cans in early March and later moved these to the field the following August and September without apparent injury or shock as long as the ball of soil remained intact. Furthermore, there is a commercial planting of several thousand seedlings under way that were grown in soil tubes and transplanted during the heat of July, August and September with almost no losses from transplanting shock

Chairman LeValley introduced Mr. Dwight Long, Street Tree Foreman, Modesto Parks and Recreation Department.

BUDDING AND GROWING PISTACIA CHINENSIS FOR STREET TREES

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The *Pistacia chinensis* has great possibilities as a street tree in all but the coldest climates, even in narrow planting spaces. The Pistacia becomes more value when budded from selected males on rootstock that has been selected for type and vigor. The best techniques for budding, growing and training have not, as yet, been fully established The City of Modesto Parks and Recreation Department, in the last five years, has tried a number of ideas with encouraging results.

We use the shield bud and have had the best success with using buds that have not pushed or enlarged, and the wood mature enough to be firm This selection has given about a 96% take, whether budded in spring or fall, or at what height the bud is placed on the seedling stem

In growing the Pistacia, we have tried several methods and are still using or testing three. They are described as follows:

1. Plants are field grown and bare root transplanted.
2. Plants are field grown and bare root transplanted to five gallon cans for the second year growth in the nursery.
3. The seeds are started in small, bottomless containers and when about five inches high, they are placed on top of five gallon, soil filled, bottomless cans to complete growth in the nursery.

Three root prunings are performed. They are listed as follows:

1. The root is cut 9″ below surface when the seedlings are from 3″ to 5″ high and the small tap root is 12″ to 20″ deep. With container grown plants, the root is pruned when plant and container are being moved to larger containers.
2. The second root pruning is done at the end of the first season's growth, just in time to check and harden tender tip growth and to confine winter storage of plant food. Roots of container grown plants are cut just under the large container. Roots of field grown plants are cut about 15″ below ground level with power-drawn tree digger