

Nucellar Seedlings

may permit development of disease-free citrus varieties

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Establishment of disease-free citrus lines from infected lines may be possible by means of nucellar seedlings.

As citrus varieties become older they tend to acquire more and more virus diseases—including scaly bark, quick decline, and stubborn disease.

As a result it becomes increasingly important to use disease-free material for propagation of new trees.

Nucellar embryos in citrus arise directly from cells of a maternal tissue in the ovule—the nucellus. Sexual reproduction is not involved in their formation and the resulting seedlings therefore regularly reproduce the seed parent variety.

Seedlings that originate from the nucellus, without sexual reproduction, exhibit a remarkable increase in vigor. The cause of this invigoration is not known but it is a well established fact that certain virus diseases are eliminated and that this accounts for some of the favorable effects.

Characteristics

Sexual seedlings are variable because in each one the factors—genes—which determine their characteristics have been rearranged.

Nucellar seedlings, on the other hand, are very uniform because the factors which determine their characteristics usually remain unchanged.

The principal distinguishing characteristics of young nucellar seedling lines are vigorous growth, thorniness, slowness to come into fruiting and some tendency to biennial bearing. These characteristics usually are common also to hybrid—sexual—seedlings, except that the growth of hybrids often is weak due to unfavorable hereditary combinations.

The thorniness of young citrus seedlings can be reduced by the use of thornless budwood.

Varieties Tested

An experiment to compare old lines of several citrus varieties with their nucellar seedling progeny is underway at the Riverside Citrus Experiment Station.

The varieties include Valencia and Washington navel oranges, Eureka and Lisbon lemons, Satsuma mandarin and others.

Nucellar seedlings of each variety have been obtained and comparable buddings made from these young lines and from the old-line parent trees in each case onto a single rootstock variety.

In almost every case the trees budded from the nucellar lines are larger than those from the old-line parent trees.

Vigorous Growth

Four rootstocks are included in the experiment: Sweet and sour orange, trifoliolate and Cunningham citrange.

It appears from these trials that the great vigor in the young lines is not primarily dependent upon rootstock.

All of the trees have been examined for disease. The old-line Valencia and the old-line King have psorosis-A, and the old-line Eureka has shell-bark. As far as can be determined, the three respective young lines are free of these diseases and this can account for their more vigorous growth.

In the other varieties no disease is evident either in the old or young lines.

It may be that unrecognized disease is present in these old lines and has been eliminated in the process of embryo formation, or it may be assumed that rejuvenescence of itself is responsible for the size differences. It may be that the two explanations are not entirely distinct.

The young-line trees are now all about 30 years removed from seed and represent the second budded generation from the original nucellar seedlings.

Limited data on yield and some other characteristics are available for some of the varieties in the trials.

For the Washington navel orange the

total average yield per tree for eight seasons has been 688 pounds for the old line—two trees—and 1,058 pounds for the young line—four trees.

Yields for the Valencia orange for seven seasons show a total of 648 pounds per tree for two old-line trees—diseased by psorosis—and 936 pounds for three young-line trees.

The young-line Ruvel orange—a navel type—regularly has yielded higher than the old line at Riverside.

The yield of two trees of the Frost Eureka—a nucellar lemon—has been much higher than that of the parent old line which carries shell-bark disease. The yield of the nucellar Lisbon lemon in this trial is not superior to that of the old line.

Promising Variety

One of the most promising nucellar varieties in the present trial is the Satsuma mandarin. Over a period of eight years, and for the last two seasons separately, each of two young lines has averaged about twice as high in yield as the parent line. The percentage of fruits well-colored at early maturity also has been higher in the young lines.

If nucellar seedling lines are desired for fruit production, the elimination of weak and off-type seedlings is not enough because some sexual seedlings are vigorous and closely resemble the parent.

To make certain that all sexual seedlings can be recognized it is necessary to perform controlled pollinations using pollen from a distinctly different parent—such as the trifoliolate orange—which trans-

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Trees of the Kara mandarin budded. Left from a thornless shoot and Right from a very thorny shoot from the same parent tree.

RANGELAND

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employment of irrigated pastures in recent years and in some cases, at least, such use of land has proven highly profitable.

The evergreen brush species, if kept down to a point where they do not use up the stored water of the soil, maintain succulence and continue growth through the long summer.

Browsing Qualities

Some of the species are reported to have rather remarkable value as feed.

If any highly nutritious and palatable species could be grown without irrigation on a considerable fraction of the brush-covered country, it would add enormously to the carrying power of the ranges.

Management

Management is fully as important as is fundamental knowledge of the range plants and their growth habits, on which management must rest.

Correlations of range burning with good management means usually that the brush must be controlled in rather small units. There is considerable advantage in rotating burning over a range so that the rancher shall have different pastures in different stages and so can move his stock around as conditions demand.

Promising attempts to obtain a cover of perennial and annual forage plants on brush burns have been carried out recently.

The plants used were rye grass—annual and perennial—harding grass, tall oat grass, tall fescue, smilo, stipa spp., orchard grass, burr clover, rose clover, yellow sweet clover, alfalfa burnet and others.

The plants seeded in—by offering competition—decidedly retard reinvasion by the brush.

It is not established which perennials do best in different conditions and more investigation is required.

Returning Brush

Many annuals start from seed more quickly than perennials do and may therefore offer more effective competition to the returning brush than perennials.

Harding grass and other perennials have proven valuable for reseeding. They provide exceptionally good forage, stay green late into the summer and hold their ground, increasing year by year. But the seed is expensive and its use is uneconomical on some ranges.

Success in getting a stand in a reseeding program depends on seeding promptly after a burn.

Returning brush either through seedlings or sprouts remains an obstacle to success in establishing perennial pastures.

The simplest way of preventing the return of brush would be to chop it, but hand work and other mechanical means are much too costly on most ranges.

Herbicides

A good prospect seems to be in the use of selective herbicides.

In places where burning in dry times may be too hazardous, brush first killed with herbicides could be burned clean in periods too humid for the fire to spread beyond the area of dead brush.

Herbicides may be of extraordinary value in removing sprouts and seedlings from previously burned areas.

Although many problems require further study for the best utilization of brush lands, there is an especial need for an over-all coordinating agency to expedite these studies.

A brushland utilization board should be established with full power to set up committees on special aspects of brush management or control. The board could study directly or through committees the needs of brush management and/or control and recommend measures to be taken.

Recommendations

The recommendations made may be summarized:

1. That comprehensive experiments designed to determine the effect of vegetation on water supply be set up in areas representative of the chief types of brush and woodland grass—and perhaps of forests—over the state.

2. That research into the ecology of the brush species and their interrelations be expanded.

3. That studies be made of the beneficial and harmful wild mammals and birds on brush lands.

4. That the ablest and most experienced wood technologists and cellulose chemists be obtained and put to work on the separate brush species with a view of ascertaining the properties of their wood and fiber—mechanical and chemical.

5. That a comprehensive study be made of the forage value of the brush forming species. This should be widely comparative and include both nutritive value and palatability to animals.

6. Thorough investigation of means of increasing promising native range plants and of improving the quality thereof.

7. Long and careful study of the management of selected brush ranges similar to that which has been given to the San Joaquin Range.

8. That research in reseeding cleared brush ranges be continued and broadened including both annuals and perennials.

9. That additional steps be taken to make available seed needed by ranchers and to improve the quality of the seed.

10. That an investigation of the relation of burning to seed germination be undertaken.

11. That experiments with herbicides be continued and expanded with a view of finding their proper place in the range improvement program.

12. That a Brushland Utilization Board be set up.

NUCELLAR

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mits an easily recognized character to its hybrid progeny.

The nucellar seedling itself is seldom satisfactory as an orchard tree. In most varieties it will produce a rank, upright and thorny growth, and will be very slow to come into fruiting. It may in many instances take 10 years or more to get a good crop.

Budwood

Desirable nucellar seedlings may be used as sources of budwood but because of the uncertainty as to performance from a commercial standpoint, it is advisable to obtain buds from a nucellar line which has been established long enough to come into fruit and demonstrate its value.

It should be emphasized that any nucellar seedling line must be subjected to extensive trial before it can be recommended for propagation.

Still Experimental

Although some lines show distinct promise, the fact alone that they are of nucellar origin is not a guarantee of superiority. The comparisons reported here have been only with the parent old lines; the performance of the young lines relative to other vigorous strains of the same variety is not established, although one of the lines—the Frost Eureka—is under study.

One of the important uncertainties in the whole problem is how long the vigor of nucellar lines may persist. The possibility of reinfection with virus must be considered as well as the chance that new virus diseases transmittable through the seed may appear in citrus.

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The above progress report is based upon Research Project No. 261. The experiments reported were initiated by H. B. Frost, of the Division of Plant Breeding, about 1918, and were carried on by him until recently. The studies with the Frost Eureka lemon are being made by Professor L. D. Batchelor, Director of the Citrus Experiment Station, Riverside.