If we have bermudagrass or johnsongrass, we find that discing the ground deeply every five or six days will give satisfactory control. Let me emphasize that the hotter and drier it is, the more effective is this treatment.

Once crop areas are clean, it is important not to let weeds in non-crop areas grow and produce seeds to re-infest them. Roadsides, ditches, meadows, and turnrows can be troublesome. These areas can be mowed easily with a bush hog, or they can be disced. A spray rig equipped with a boom can be used to apply paraquat for a good quick kill on annual weeds. If the temperature is high, weeds will be killed in 3 or 4 hours. Remember, your objective in all of this is to eliminate seed production.

SUMMARY: If management develops a program, commits the program to writing, and makes certain personnel are working the program, the objective of a clean nursery will be achieved.

LITERATURE CITED

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THE ROLE OF SCHOOLS IN TRAINING PLANT PROPAGATORS

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What is the role of schools in training plant propagators? Unfortunately, there is no authority to say, "This should be taught. That should not." Even when curriculum guides are followed, there is question as to what should be emphasized. Each propagation situation is different, and the most used knowledge or skill in one will not often be the same as that most helpful in a different nursery, greenhouse, outdoor field, or inside lab. However, there should be certain basic concepts and skills that would be important to an individual learning specific requirements for a particular environment. What are these basics?

A representative sampling of propagators was asked to rate certain basic principles, technical knowledge, and applied skills as to their importance. A form, given as Figure 1, was sent to the propagators with the request that each one circle the 10 items most important for an individual interested in becoming a

propagator. Each was asked to indicate valuable supplementary material with an "X" and to write in other important items that might have been omitted. Finally, each was asked if college training was necessary.

Below is a list of knowledge and skills that may be needed by professional plant propagators. Please circle the 10 items you consider most important for inclusion in a course of study. Put an "X" by any others you feel should be covered, but less thoroughly. This person would be one who could eventually serve in a responsible position concerned with all phases of the propagation operation.

Plant information

Plant identity and nomenclature

Plant structure (anatomy and morphology of leaves, stems, roots, flowers, fruits, seeds)

Plant function (uptake and translocation of water and nutrients, photosynthesis, respiration, growth and development)

Plant nutrition

Plant growth substances and hormones

Plant reproduction, asexual and sexual

Technical information and skills

Media components and mixing

Water — components and control of various systems

Fertilizing methods and how to choose, how to formulate and apply, deficiency and toxicity symptoms

Containers — how to choose, how to fill

Heat requirements and methods of providing

Propagation information and skills

Seeding
- Dormancy and pretreatment methods
- Sowing

Cuttings
- Choice, preparation and storage of materials
- Preparation and use of hormones
- Sticking — field and indoor
- Aftercare

Grafting — choice of material, techniques of budding, techniques of grafting, aftercare

Layering

Other methods, such as division, use of bulbs, rhizomes, tubers and other specialized structures

Micropropagation (tissue culture)

Other knowledge or skills
- Knowledge of business and economics
- Ability to work with people

Is college training necessary?

Figure 1. Form used to survey professional plant propagators' priority ratings of employee skills and knowledge.

In Table 1 the top 10 items are arranged by rank based upon the percentage of respondents circling each one. Those remaining are arranged in Table 2 by rank according to the percentage considered in the top ten.

Table 1. Plant Propagation Knowledge and Skills. Top Ten Priority Items.

Rank		Basic Information	Technical Information or Skill	Percent of Respondents Top Ten	Percent of Respondents No. 1
1-4	Ability to work with people		X	81	31
	Plant nutrition	X		81	
	Fertilizing methods		X	81	
	Preparation of cuttings		X	81	
5	Plant function	X		69	
6	Watering systems		X	63	
7-8	Hormone preparation and use		X	56	
	Aftercare of cuttings		X	56	
9-13	Plant growth substances	X		50	
	Plant structure	X		50	
	Plant identification and nomenclature	X		50	
	Seed dormancy and pretreatment	X	X	50	
	Media components and mixing		X	50	

Table 2. Plant Propagation Knowledge and Skills. Remaining Items by Order of Priority.

	Basic Information	Technical Information	Percent of Respondents
Knowledge of business and economics		X	37
Grafting		X	31
Plant Reproduction	X		31
Micropropagation (tissue culture)		X	25
Cuttings — field and indoor sticking		X	19
Heat		X	12
Division; use of specialized structures		X	6
Containers		X	0
Seed sowing		X	0
Lavering		X	0

The results of this survey brought out several interesting points. Only 3 of the 23 items were not circled by any respondent as being of top priority. One of these was *layering*, a second was *seed sowing*, and the third was *containers*. The omission of layering is not surprising since it is seldom used as a commercial propagation method. However, air layering is fairly widespread in areas where foliage plants are the major crop and deleting it entirely might not be justified. The omissions of seed sowing and container information are harder to explain. Dormancy and pre-treatment of seed appeared in the list; apparently the sowing process was not considered critical when using seeds of woody material. A group of professional bedding plant producers might reverse the position of these two items. It would be hard to explain the lack of concern with containers. Many nurseries have tried and abandoned several designs that proved unsatisfactory. Other low priority items were the technique of *division*, *heat* (another surprise), *sticking cuttings* and *micropropagation*. Seven of the top ten subjects concern technical information or skills; five cover basic background information; while one, seed dormancy and pre-treatment, includes both principles and practices.

In Table 3 all the 23 items are ranked by order of priority as good supplemental material. Only *plant nutrition* was not included. However, 81 percent of respondents had considered nutrition high priority. *Fertilizers*, *watering systems* and *ability to work with people* were low here, but very high among the top 10 items. Additional suggested material was *light*, *disease*, *regional adaptation*, *efficient work habits* and the *ability to instruct others*. All are important; the last two would no doubt be priorities.

Obviously, the next question is, "Where should prospective plant propagators obtain this information?" Fifty percent of those surveyed felt 4 years of college work was at least desirable (Table 4); 25 percent indicated intensive 2 year community college was adequate or would substitute for a 4 year curriculum.

The remaining 25 percent did not specify a source of training. Some of the comments are worth noting: "It helps most, but ruins a few! Good information is available elsewhere if an individual is interested in obtaining it." College is desirable but not absolutely necessary. The best propagator I know has not completed high school." "Two year, if any. On the job training is best."

Since there seemed to be agreement that college was not absolutely necessary, let us consider other options. Certainly nothing can replace on-the-job training if the novice is fortunate

Table 3. Important Supplementary Plant Propagation Knowledge and Skills Ranked by Percent

Rank		Basic Information	Technical Information	Percent of Respondents
1	Heat		X	56
2	Containers		X	44
3	Plant reproduction	X		37
4	Grafting		X	31
4a	Knowledge of business and economics		X	31
4b	Seeding — dormancy and pretreatment methods		X	31
4c	Plant identity and nomenclature	X		31
4d	Plant structure	X		31
5	Cuttings — aftercare		X	25
5a	Media		X	25
5b	Division; use of specialized structures		X	25
5c	Plant growth substances	X		25
6	Cuttings — field and indoor sticking		X	19
6a	Cuttings — preparation and use of hormones	X	19	
6b	Layering		X	19
6d	Plant function	X		19
6e	*Seed sowing*		X	19
7	Ability to work with people		X	12
7a	Fertilizing		X	12
7b	Water		X	12
8	Preparation of cuttings		X	6

Table 4. Source of Training Preferred

Type of School	Percent	Comments
Four year college	50	Helps most. Ruins a few. Yes, but not absolute. Some good ones without high school.
Two year college	25	Intensive one would be as good as four year. On the job best, two year next.
Vocational - Technical		None indicated vo-tech as a possibility.
Unspecified	25	

enough to work with an experienced skillful propagator. However, in today's mass production programs, it is difficult to allow for the time required and the resulting production drop when the propagator becomes teacher. Although most industries plan for a short period of orientation, many do not want to spend several, or many, months for the intensive training that would be needed to give new personnel even the minimum priority information. Training would be oriented to specific requirements of the firm — an advantage to the company, a disadvantage to the trainee.

The next possibility would be training at the secondary school level. There has been an amazing increase in the amount of horticultural training given in high schools. Some schools include horticulture subjects in a general agriculture curriculum, but many offer specialized courses of study. Often students spend several hours each day in these programs. Ordinarily they begin in their eleventh grade and continue through the twelfth. Some school districts have area vocational schools serving several high schools. Material given here is more in-depth although most of the alloted time is still spent in practical application. In Florida, curriculum guides are furnished each district by the state for optional use in either high school or post-secondary classes. A side effect from this increase has been that teaching presently has more employment potential for college graduates than any other segment of horticulture

By contrast, 2-year post-secondary training opportunities are limited. Table 5 gives information on high school, post high school vocational and community college programs. Florida, Georgia, North Carolina, South Carolina and Virginia have horticulture at the 2 year college level. Louisiana has 1 post high school vocational curriculum. The Florida program is seemingly the most widespread and intensive, followed by North Carolina, South Carolina and Georgia. The Georgia program at Abraham Baldwin Agricultural College, Tifton, Georgia offers several courses that are given very favorable rating as to depth of content. A thorough post high school vocational horticulture curriculum is available at a post secondary technical school in Clarksville, Georgia.

Table 6 summarizes the responses from 4 year college or university instructors who were asked to comment on their plant propagation courses. Only Cal-Poly at San Luis Obispo presently offers more than one course in propagation. At one time an advanced course was offered at Auburn. However, it was found to be an unaffordable luxury and was discontinued several years ago. *Plant Propagation: Principles and Practices*, by Hartmann and Kester, was used as the advanced text. It is

Table 5. Vocational or Community Colleges with Horticulture Curricula.[1]

State	Secondary	Post-Secondary Vocational	Post-Secondary College	Course Content
Alabama	50	none	none	Extensive applied program 11th and 12th graders.
Florida	210 total secondary and post-secondary			5 options. Course based on comprehensive industry survey. Mostly technical.
Georgia	72	1	1	One intensive technical program; one through two year curriculum.
Louisiana	40	1		Fairly comprehensive.
North Carolina	128	7	15	Thorough. Many areas covered. Most emphasize technology.
South Carolina	56		4	2 offer ornamental. Comprehensive. Supplementary related courses available. Clemson University advises.
Tennessee	25	none	none	Excellent on production technology. Based on survey of area industry needs.
Virginia	50 area vocational		2	Adult classes only at colleges. Offering very limited. High schools give intensive application.

[1] Information obtained from state departments' personnel or individual instructors.

now used for the courses in all of the southeastern area schools. Table 7 summarizes the contents of this text.

If we look at the material presented and recall the top 10 priority items, it seems that students in a class using this text should have at least an exposure to the priority information. Plant function would rarely be covered at high school level or at post high school vocational centers. It might be at 2 year colleges. Although hormone preparation and use would be included in vocational curricula, related background information and theory would not be. The same is true of fertilizing and nutrition. The technology would be given but basic principles would rarely be presented.

We could summarize all of this information as follows:

(1) The majority of propagators in the survey indicated that more than just technology was important.

(2) Four year colleges are not the only places to learn, however.

(3) When the total list of top 10 priority items of information and skill are considered, the subjects are more readily available here than from on-the-job training.

(4) Although junior colleges may offer fairly complete curricula, the number offering horticulture is limited.

Table 6. Four Year College Propagation Courses.[1]

School	Text	Comments
Alabama (Auburn)	Hartmann and Kester	All chapters assigned. Some economics. Short on commercial practices. Should balance science and art.
California (Cal Poly)	Hartmann and Kester	Two courses. Practical but more than just preparatory.
Florida	Hartmann and Kester	Administration favors research. Community colleges better for industry training.
Georgia	Hartmann and Kester	Too much for one quarter. Emphasize observation and interpretation of results. Some economics.
Louisiana	Hartmann and Kester plus handouts.	Text adequate except on spores. No economics. Should not be expected to provide all the needed experience.
Oklahoma State University, (Stillwater)	Hartmann and Kester	Much time on grafting and budding. Lecture emphasizes theory.
South Carolina (Clemson)	Hartmann and Kester	Lectures give research to support lab practices. Two-thirds asexual propagation procedures.
Virginia (VPI, Blacksburg)	Hartmann and Kester	Too much for one quarter. Should not concentrate on research only. Develop critical thinking.

[1]Information obtained from individual instructors.

From this study we can draw conclusions, point out problems and consider improvements. There is a place for each learning method. Experience is still a must, with or without formal education. Vocational secondary programs provide a good introduction and may serve to screen out students who are primarily hobbyists. Training is mostly technical, but a good high school graduate could become a valuable employee. He might be preferable to a college graduate at the outset as he would have spent more time in applied techniques. He might also be more willing to start as a trainee. He would lack in-depth information. Vocational post-secondary training would be given to more mature individuals with a serious vocational interest. Maturity might be the major advantage for the person with this background. He might be more qualified to spot problems but possibly not too well prepared to solve them.

College preparation at 2 year institutions seems to offer real potential. Students have an opportunity to take some supporting courses as they do at 4 year schools. A person with solid 2 year college background should be able to help solve problems as well as recognize them and could compete favorably with a 4 year college graduate. M. J. Young, University of Florida,

Table 7. Plant Propagation - Principles and Practices, by Hudson T. Hartmann and Dale E. Kester. Summary of Contents

Chapter	Contents
1	Introduction
2	Propagating Structures, Media, Fertilizers, Soil Mixtures, and Containers
3	The Development of Fruits, Seeds, and Spores
4	Production of Genetically Pure Seed
5	Techniques of Seed Production and Handling
6	Principles of Propagation by Seeds, Germination Process, Dormancy, Environmental Factors
7	Techniques of Propagation by Seeds, Seed Testing, Pre-Conditioning, Disease Control, Seedling Production, Direct Seeding
8	General Aspects of Asexual Propagation The Clone, Genetic Variation, Pathogen-Free, True-to-Type Clones
9	Anatomical and Physiological Basis of Propagation by Cuttings
10	Techniques of Propagation by Cuttings Wounding, Growth Regulators, Environmental Conditions, Mist Systems
11	*Theoretical Aspects of Grafting and Budding* Healing Process, Polarity, Graft Incompatibility
12	Techniques of Grafting
13	Techniques of Budding
14	Layering
15	Propagation by Specialized Stems and Roots
16	*Aseptic Methods of Micro-Propagation*
17	Propagation Methods and Rootstocks for the Important Fruit and Nut Species
18	Propagation of Certain Ornamental Trees, Shrubs, and Woody Vines
19	Propagation of Selected Annuals and Herbaceous Perennials Used as Ornamentals

writes, "Because of administration attitudes (favoring research), low overall faculty interest in teaching vs research and more rigorous course requirements, our programs do not adequately prepare students to enter production agriculture without a considerable period of on-the-job training. Although their faculties and facilities are often limited, I believe Community Colleges are in a better situation to train students for production agriculture. Coming from California I am familiar with their system of a research-oriented University system and a network of applied colleges. It is a more realistic and workable system."

What then, is the role of a 4 year school? Graduates are not likely to have better technical skill. However, there are certain advantages. Students may gain exposure to new ideas that are being developed. Although modern nurseries also have extensive research in progress, their programs will not include the broad spectrum of activity found at the universities. In addition,

students will usually have an opportunity to acquire a broader background of information not only in horticulture and related sciences, but also in business, marketing, and personnel management.

It is doubtful that an inexperienced 4 year college graduate could compete successfully in the job market with a person having 4 years' practical propagation experience. However, in 4 more years the college graduate would be in a much more favorable position than the person with 8 years' experience. College background should enable him not only to spot problems but also to find reasons for and solutions to these problems. He should be able to set up reliable test situations that would give valid results both for solving problems and trying new techniques.

Several problems facing schools and instructors have been highlighted by this study. Without exception those contacted at the college level felt they were trying to cover too much material. Most of us have students from a wide variety of disciplines -- landscape architecture, agronomy, forestry, education and others. It is estimated that in Florida less than one-third will actually use the techniques as professional propagators. Some have had very little plant science background or practical exposure to plants. Students who have had an intensive 2 year high school course find the 2 year post high school curriculum repetitious. Similarly, those from good 2 year colleges feel the basic plant propagation course at 4 year institutions is elementary. Attempting to choose topics that will be of value and interest to all of these people is more than difficult. Air layering is fascinating to most students, yet it rated low on the list of priorities. Should it be taught? What can we eliminate and thus do a better job with what we are doing?

There is one serious fault in almost all of the training programs discussed here. In Table 1 you will note that 31% of the respondents indicated ability to work with people as the one single most important requirement for success, and 81% placed it in the top ten priorities. Yet we make very little conscious effort to help students learn to work well with others. More often they are competing with fellow classmates for grades in a tense environment. Somehow we should change our approach; the real training must come in everyday situations — not simply in classes such as personnel management where again students are competing more than cooperating.

And, finally, many educators find themselves in a situation where the primary emphasis is research, yet most are sincerely interested in preparing students to face real life situations at the

end of 4 years. Yet it is difficult under present conditions to fit these two aspects of horticulture satisfactorily.

What is the role of schools? Certainly this study does not lay down guide lines; however, it would seem that two steps could be taken to improve our overall situation: (1). An advanced plant propagation class could be designed in a way that qualified students could be placed on their own to design and implement a program of value to them. This could be in the nature of an undergraduate research problem. Very little expense would be involved. (2). More 2 year college programs could be developed. Perhaps, a 2 year curriculum might be designed within an existing 4 year college. Students could be allowed to omit the more advanced theoretical courses. Ideally, instructors would work closely with industry to develop the curriculum. The cost of implementation would be less than that involved in setting up a new junior college facility.

I would like to close by quoting an educator and a professional propagator. Their viewpoints are amazingly similar. Dr. Kenneth Sanderson of Auburn says, "Regarding teaching vs. research, I'd vote for a balance. All commercial operators need to know how to evaluate their activities or results — this is research. Before an evaluation, a propagator needs to know the science and art of performing a task — this is commercial performance. From my recent talks, you must know that I feel that Universities are failing in teaching commercial practices whereas technical schools and junior colleges are failing in teaching the basic scientific reasons for practices. I feel that they are inseparable. Are we teaching managers or laborers? My major concern in teaching ornamental horticulture courses today is the sacrifice of technical, commercial courses and information for the teaching of general home horticulture. Easy horticulture is fine for the amateur; however, without the highly technical side there will be no information generated or plants propagated and produced in the future."

Richard Ammon, Ammon Garden Center and Landscaping, Florence, Kentucky, writes, "Many experienced propagators are skilled in basic knowledge only. They can propagate and do it quite economically but lack technical knowledge for improving their methods, such as understanding hormones and how they work, fertility and how it can be improved. Many of us can propagate, but don't really understand why things do work as they do.

"On the other hand many knowledgable students do not understand production and how to improve on producing for greater profits. They also tend to have limited knowledge on the whole nursery operation. Much of this is only obtained by ex-

perience and they must be made to realize they are much more valuable to a firm, once they are well rounded in *education* and *experience*, and up to that point their value is limited to the amount of skill and production ability they have."

There is no one best way to train individuals for any profession. The most important suggestion of all is to develop closer contact with the people hiring our graduates and discover how our product measures up.

ADVENTITIOUS ROOT FORMATION IN THREE CUTTING TYPES OF *FICUS PUMILA L*[1]

F.T. DAVIES, Jr.[2] and J.N. JOINER[3]

Abstract: Adventitious root formation was studied in juvenile and mature *Ficus pumila L.* (Creeping fig) using stem, leaf-bud and leaf cuttings to find the optimal type for root developmental sequencing research. Leaf-bud cuttings were superior to other types since mature leaf-bud cuttings responded positively to auxin treatment, adventitious rooting occurred *de novo* from internodal areas and rapid rooting was obtained to minimize environmental-physiological variables. Indole-3-butyric acid (IBA) was more effective than indole-3-acetic acid (IAA) in stimulating rooting of leaf bud cuttings.

Adventitious root formation (ARF) in woody plant materials has been studied in relation to application of exogenous growth regulators, endogenous biochemical levels and histological observations. Histological studies of stages in ARF have revealed information on effects of exogenous hormone application on physiological events (3,6,7). Plant material used in developmental sequencing experiments have been herbaceous annuals or hypocotyl cuttings. Biochemical (4) and histological (1,2) changes occur with maturity that decrease ARF so herbaceous materials may not adequately reveal physiological requirements of changing histological events in mature woody materials.

Ficus pumila L. (Creeping fig), a woody ornamental clinging vine was used in this experiment because it has juvenile and mature forms (Figure 1) with differing growth habits, leaf shapes and sizes. Juvenile stems have aerial roots in nodal areas and preliminary studies indicated differences in ARF between juvenile and mature cuttings.

Objective of one experiment was to establish optimal cutting types of *Ficus pumila* from stem, leaf-bud (LBC) and leaf

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