THE APPLICATION OF TECHNIQUES AND SYSTEMS USED IN THE RAISING OF GLASSHOUSE AND OUTDOOR VEGETABLE CROPS TO NURSERY STOCK PRODUCTION

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We can consider outdoor vegetable and protected crop plant raising under two main headings — *vegetative methods* and *propagation from seed.*

Vegetative Methods. Not many temperate vegetables are propagated vegetatively under commercial conditions — notable exceptions being rhubarb, asparagus, artichokes and, of course, potatoes. On the other hand, many of the important glasshouse ornamental plants are propagated in this way; chrysanthemums, carnations, poinsettias, alstroemerias and all the bulbs are good examples. In all instances the propagators pay great attention to the following points:

1. *Virus elimination* — using heat treatment, meristem culture and, subsequently, mother plant maintenance.
2. *Clonal performance indexing*
3. *Production of uniform propagules (cuttings/bulbs) by rapid multiplication techniques*
4. *Provision of production and crop programming advice for their customers*

Certainly points 1 to 3 also apply in the case of rhubarb and potatoes where the production of virus-free propagation material is controlled by the Nuclear Stock Association.

I feel, however, that the best examples of vegetative propagation systems and those which are most applicable to nursery stock producers are to be found in the area of glasshouse ornamentals propagation. Production of cuttings, whether rooted or unrooted, on a programmed basis is rarely done today by the producer of the finished, saleable plant. For a number of years now this aspect of crop production has largely been carried out by specialists. The techniques mentioned earlier are standard practice and closely controlled environmental conditions are used. A number of firms supply cuttings of glasshouse ornamentals and recently we have seen tissue culture techniques used by a commercial firm to propagate plants in this country. In the Netherlands tissue culture propagation of plants like an-

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thuriums and gerberas is well advanced and there are plans for a State tissue culture laboratory where commissioned work will be undertaken. In this aspect it was interesting to hear earlier Dr. Howard's contribution on the possible use of such propagation methods for fruit crops.

If such a propagation system can work in the case of glasshouse ornamentals is there not a place for programmed, pre-ordered supply of uniform cutting material from specialist propagators to the finished nursery plant producers? One has heard a number of objections to such a scheme. "The nursery sector is not big enough either in the numbers of plants of a particular type produced or in their financial value." "The transport of rooted or unrooted cuttings cannot be satisfactorily arranged." But perhaps the biggest objection usually goes unsaid. As a spectator one gets the impression that the propagation of nursery stock is surrounded by a kind of "mystique" which has been built up over the years and handed down from father to son. Are the problems of putting roots on particular subjects really that difficult that only nurserymen do it or is this just a defensive shield behind which they hide?

Is it not possible for specialist propagation nurseries to supply a particular range of material to the final producers? Of course, one does not visualize a single unit which will supply propagation material to the whole of the United Kingdom nursery industry but units which supply, for example, Erica cuttings should be possible. It may be that one of the existing propagators of glasshouse ornamentals would be interested in such a project. After all, they already have most of the facilities which would be required. Reference to date has been directed towards cuttings but one wonders if bench-grafted material could not fit into the same system.

Co-operation and confidence between the propagators and the final producers would be absolutely essential — this is one of the cornerstones on which chrysanthemums and carnation cutting production and supply is based. In the first instance it is likely that at least some of the technical propagation expertise will have to be supplied to the new propagators. The eventual "spin-off" could, however, be very great indeed. It would allow the growers to concern themselves with growing and marketing while the propagators would supply the starting material. If existing specialist propagation companies became interested in such a project then the necessary hardware would already be available in the form of propagation benches, cold-stores for holding cuttings and nurseries overseas to supply good quality cuttings in our poor light periods. Their existing computer based distribution and order processing facilities

should enable them to cope readily with new lines. Yet another benefit could arise from the routine virus-testing of material which tpese firms already carry out. They have the facilities for heat treatment and meristem propagation of their existing lines and there could be a number of interesting developments if these virus clearance techniques were applied to nursery stock.

Propagation from Seed. While vegetative propagation of vegetables and glasshouse ornamentals is almost exclusively carried out by specialists who are not the final plant producers, propagation from seed in these two sectors of our horticultural industry is nearly always done by the final producer. There are exceptions, however, and it is interesting that these are tending to increase in number. Brassica plant raisers are an accepted part of the production chain in Lincolnshire, the West Midlands and Kent; tomato and cucumber plants are raised by specialists in a number of important production areas while we have recently seen the development of a lettuce plant propagation unit on Humberside. Once again one is tempted to ask if the nursery stock producers have anything to learn from the glasshouse and outdoor vegetable producers.

There are advantages in obtaining planting material from specialist plant raisers. The specialists are able to develop the expertise and skills associated with a particular stage of a plant's life while the "grower" concentrates on others. This encouragement to develop specialist skills should lead to the production of standard, uniform plants. The plant raiser is able to invest in specialist equipment and facilities which are relevent to his particular crops. Examples include growing rooms for bedding plants and lettuce, supplementary lighting units for tomatoes, cucumbers and lettuce, and specialist precision seed drills for brassica plants. The "grower" can now devote more of his time to growing and this may allow a more intensive throughput of finished plants since labour and facilities are not involved in plant raising. One hesitates to mention the fact that it might also allow more time to be devoted to selling the final product.

No situation in this world is Utopian and here also there may be disadvantages in taking the plant raising out of the hands of the finished plant producers. There could be a reduction of staff interest. Propagation is a "plum" job on many nurseries and if it were taken away life might be more mundane. There would, naturally, be a dilution of control. Some would argue that fewer hours of sleep are lost if everything is under the direct control of the nurseryman. It is not always immediately clear, however, if blissfully peaceful nights are also equitable with maximum nursery efficiency! Yet another problem which the final producer must come to terms with is that

of being ready to accept delivery on a pre-stated date. Plant raisers also have a business to run and they need the space for the next crop which has, no doubt, also been ordered.

In many cases, vegetable farmers supply the seed to the specialist plant raisers and pay a mutually agreeable rate for plants to be ready for a particular planting date. Meanwhile the plant raisers produce an annual programme which allows them to make maximum use of their growing structures. An additional problem, of course, with nursery stock subjects is the longer period of time required to produce a transplant. It requires careful planning but, once again, I see the need for more specialist producers of nursery stock transplants from seed. In the first instance, it may be that these plant raisers work in conjunction with groups of nurserymen in particular geographical areas or who have particular production schedules.

Meanwhile we must consider the accepted techniques of vegetable plant production and then look at what is new in this field. Vegetable production has undergone a marked change during the last ten years. Today there is an increased demand for vegetables of a particular size to be grown to a predetermined programme. Supermarket claims require pre-stated quantities of particular sizes and types of vegetables which are often grown under contract. Processors have similar requirements for freezing, canning and accelerated freeze drying. The underlying factors of importance are:

(a) programming

(b) precision and, of course,

(c) quality

The least precise method of raising vegetable plants is by thick-line or thin-line sowing. Traditional seed rates are used and no assessment is taken of germination percentage. (We are fortunate that in the case of vegetable and glasshouse seeds the percentage germination and purity of a particular sample can be obtained). Thick or thin-line sowing is, therefore, a non-precision technique. Crop production from these methods of sowing can be made more precise by subsequent thinning of the crop to produce the required spacing within the rows. This is time consuming and highly labour intensive, besides which plant competition has already taken its toll of optimum growth. Very little actual broadcasting of seed now takes place in vegetable growing although thick or thin-line sowing of closely spaced crops like radish is not far removed from broadcasting.

Over the years, techniques have been developed which are far more precise right from the beginning. Spaced sowing or precision drilling ideally places one seed at every station where

a plant is ultimately required. Previous research will have determined the spacings necessary to produce crops of the required size. The problem is obvious — not all seeds germinate. When sown outside, vegetable crops such as certain brassicas, have a high percentage germination while others, such as celery, germinate very poorly. Once again the seedhouse will provide the percentage germination for a particular batch of seed and from the formula —

$$\frac{273 \times \text{number of plants required per square foot}}{\text{Number of seeds per ounce (in 1000's)} \times \text{percentage laboratory germination} \times \text{field factor}}$$

the amount of seed (in pounds) required per acre sown can be calculated. Adjustments need to be made if bed systems of growing are used but these were explained at the Cannington Conference in 1974 (P.D.A. McMillan-Browse, I.P.P.S. Annual Conference, Cannington, July 1974). Such a formula assumes, of course, that no other factors of production are limiting. Especially important in this context is the necessity for adequate weed control. There is little point using a theoretical plant spacing if weeds then interfere.

Having determined the spacing and seed rate it is now necessary to have the equipment to place the seeds as required. The earliest, and still most frequently used, precision drills depend on regular and constant seed size and shape. Thus they work best with spherical, graded seed (or seed which has been encased in pellets to produce regular spheres). Most vegetable seedhouses will supply both graded and pelleted seed on request. Pneumatic or vacuum drills have been developed recently to cope with irregular shaped seed which has not been graded. Their introduction allows at least two interesting developments. Firstly, it is now possible to precision drill irregular shaped seeds such as lettuce or carrot without the costly, and perhaps germination inhibiting, process of pelleting. Secondly, seed may now be graded according to different criteria from size. There are some indications that regular development of vegetable plants is better achieved by using seeds of similar density rather than those of similar size. Precision drills are expensive and sophisticated pieces of equipment which may be economically justified by the large scale vegetable produced but rejected by the nurseryman producing a few tens of thousands of tree seedlings. Think again of the specialists plant raiser who may be supplying seedlings or transplants to producers in his area. Is a precision drill a piece of equipment for him?

The latest development in the area of planned precision drilling has been the introduction of the concept of fluid drilling. The early work was done by the National Institute of Ag-

ricultural Engineering and the Weed Research Organization. They devised a scheme of drilling seed in an alginate gel which provided a micro-environment conducive to seed germination. The idea has recently been taken up and further developed by the National Vegetable Research Station where Drs. Bleasdale, Gray and Salter have largely been involved. Their work has been widely reported in N.V.R.S. Annual Reports, on the television programmes 'Gardeners' World' and 'Tomorrow's World' and in trade publications such as Horticulture Industry (March 1976). The original technique has now been refined to include pre-germinating or 'chitting' of the seed and also to allow ungerminated seed to be removed before drilling. For vegetables fluid drilling can best be illustrated by referring to celery seed. Field germination of celery is slow and usually very poor. Seed coat germination inhibitors are present which have a great influence unless they are regularly washed away from the vicinity of the seed. Usually there is insufficient moisture available in the soil for this to happen and the result is that celery tends to be transplanted rather than direct drilled. Facilities such as mist propagation benches in glasshouses can then be provided where the inhibitors are washed away. Pre-germination of celery seed involves 'chitting' the seed for about ten days either in a column of constantly flowing water (for large amounts of seed i.e. more than 0.5 ounces) or on constantly moistened tissue towels (small scale). Not all seeds germinate and for really precise drilling all sown units must be identical and capable of producing a plant. Ungerminated seed must not, therefore, be drilled. It is possible to separate germinated from ungerminated seed in a sloping tube down which a stream of water is gently flowing. Seeds with radicles behave like boats with sails and move quickly. The seeds with no "sail" are left behind and removed. "Chitted" celery seed can be cold stored for periods up to 14 days at temperatures of 0 to 1°C. For drilling, the seed is mixed with a suitable gel and squeezed through the nozzle of something equivalent to a toothpaste tube. A cake-icing bag may be used for small samples while special tractor-mounted equipment is necessary for field scale operations. A metering device is needed to ensure that the pre-germinated seeds are placed at regular intervals and obviously drying out of the seeds must be avoided.

What are the possible uses of fluid drilling for the nursery stock producer? Clearly "chitted" seed could be sown in outside seedbeds, always assuming that the required spacing had been determined beforehand. Little work appears to have been done on the effects of different seed spacings on the production of seedlings of different sizes for particular purposes. A more likely use for the nurseryman would be to sow "chitted" seed

into isolated growing units such as peat blocks. Machines already exist for precision sowing of non-germinated seed into containers (lettuce plant production and bedding plant sowing). It would not seem to be too difficult to adapt this equipment to put one "chitted" seed into each container.

So much for the present; now what of the future? Growers of some vegetable crops, and lettuce is again the chief example, are moving away from direct drilling and returning to transplanting even for field production during the summer months. The expense of F_1 hybrid seed has also forced some brussels sprouts producers to move back to transplanting. The problem of lettuce is, again, one of precision. The large supermarket stores require supplies regularly to satisfy a programme. Drilled lettuce develops irregularly due to a number of factors and more control of crop maturity is achieved by planting lettuce in peat blocks. The production of such plants is very much a factory-type process with seedlings of a given size being produced in blocks at pre-determined times. These are currently transplanted with adapted glasshouse lettuce planting machines but the future promises automatic, unmanned planting machines.

Much of what I have said about vegetable propagation assumes a ready, but not guaranteed, supply of seed. British vegetable producers are very fortunate. They can ring up a seedhouse, or their representative, and the required seed will arrive within a few days complete with a percentage purity and germination statement. Nursery stock producers do not have that facility. Much of the seed is imported; time of arrival is uncertain and ultimate performance cannot be ascertained from the seedsman. Home-based assessments of viability and germination are, therefore, needed before any meaningful calculation of sowing rates can be done. This situation is the status quo but surely it is only second best. Why not a British woody plant seed organization. Firms in Germany, Austria, Italy, Hungary, etc. use casual labour such as school children or family groups to collect their seed. Surely we could do something similar in Britain. Perhaps I.P.P.S. can co-ordinate collection of seed in this country. The organization in particular areas could be in the hands of Research Stations and educational institutions such as University Departments and County Colleges. Staff and students could rapidly accumulate information such as the location of good specimens of particular trees and when they are carrying good seed crops. Seed could be collected by students or even school children directed by local education authority staff. Schools are always looking for projects for their Rural Studies groups. A central I.P.P.S. group could then process the seed for distribution to members and, who knows, it may ulti-

mately be possible to get an existing home-based seedhouse interesting in doing the processing once the collecting has been done.

HOW TO TEACH ONE'S OWN SKILLS TO MEMBERS OF STAFF

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THE NEED. The title I shall discuss is concerned with training, an integral part of the management function in a business. If the training function is to be effective, it must be based on the needs of the company and industry. This conference has highlighted some excellent examples of needs justifying planned training and these new techniques and information have to be transferred to those who are paid to apply them.

The examples of training need include —

i) New propagation techniques

ii) New information concerning growth regulants

iii) The new entrant and casual worker who frequently enter a business with little or no related skill

iv) The member of staff already employed whose output/quality of work is not quite in line with the company's standards. For instance, budding rates and percentage take can vary quite dramatically within a gang of staff working in the same field.

As a Training Board, we have evidence that a three-day training course can very quickly improve the rate of work and the percentage take. As a trainer I see training as an economic activity — not just a social duty, and management effort in this direction should result in —

— extension of staff knowledge

— developed ability and, above all, an attitude to work that produces satisfaction to both staff and the boss.

I have tried to put the title of the talk into perspective. Clearly the teaching of practical skills to one's own staff is just one part of an overall training policy based on the needs of the company. This is a vitally important part, particularly in an industry that uses a large number of casual labour and young entrants.