ESTABLISHMENT OF *SOLANUM AVICULARE* FORST. AS A FIELD CROP FOR THE PRODUCTION OF PHARMACEUTICAL RAW MATERIALS

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Basic raw materials for the manufacture of steroid drugs, including reproductive hormones and cortisone types, are largely derived from botanical sources. At present the major source of raw material is barbasco, the root of a yam which is one of the species of *Dioscorea* which grows wild in the jungles of Central America. Although attempts have been made to grow the yam as a commercial crop it so far appears to be uneconomic as a 3 to 4 year growing cycle is required for the concentration of the steroid to build up in the root. Due to the depletion of naturally occurring barbasco root and an increasing demand for drugs of this type as a part of international birth control programmes interest has now turned to a number of alternative raw materials. These include cholesterol from sheep wool grease, bile acids obtained from animal slaughtering and an extract from African sisal.

Apart from direct synthesis, one of the most promising sources of raw material appears to be the New Zealand native plant *Solanum aviculare* Forst. The raw material found in the shoots and berries of the plants is a glycoside called solasonine which, when extracted and hydrolised to produce solasodine, a steriod highly acceptable for drug manufacture. Ivon Watkins-Dow Ltd., New Plymouth, has been carrying out a research programme with this plant for 10 years. The studies have included the selection of the suitable high yielding strains, establishment of propagation and growing techniques and the development of harvesting methods. The project is novel in that it involves starting with a wild plant growing in its natural environment and taking it through a programme of selection, breeding and development to produce a farm crop within a relatively short time. If it is possible to grow this plant as a crop the production of raw material for steroidal drug manufacture could be expanded to meet increases in world demand. It would also be a new crop for New Zealand and a contributor to our range of export products.

Description of the Plant. *Solanum aviculare* and the closely related species, S. *laciniatum*, are shrubby perennial plants found growing around forest margins and waste spaces. Their Maori name is poroporo and their common European name is bullibul. They grow 10 to 15' in height and are freely dispersed by birds who find their large orange or yellow berries attractive. S. *aviculare* is found in the North Island and in the warmer coastal

regions of the South Island. *S. laciniatum* is found throughout both islands.

The growing of *Solanum aviculare*. *Solanum laciniatum* has been grown for steroid drug manufacture in Eastern Europe. As a result of this, much of the initial research carried out by Ivon Watkins-Dow was with this species. It was found however that *S. aviculare* has a number of characteristics which make it more suited to development as a field crop. As a result, recent research has concentrated on this species. The advantages of *Solanum aviculare* over *S. laciniatum* are as follows: greater disease resistance both to *Phytophthora infestans* and viruses, a more sturdy structure with a greater degree of branching leading to a longer lived plant and a higher yield of solasodine contained in a smaller amount of dry matter.

The crop can be established by direct seeding or transplanting. Direct seeding is the most economic method of establishment but because of the slow growth rate of the seedlings, the lack of suitable wide spectrum herbicides safe with seedlings and variation in germination time, transplanting is also being considered.

Transplants can be raised in fumigated beds by methods similar to those used for bare root tomato transplants or tobacco. The plants are mechanically transplanted into the field (or direct seeded) in rows 18" apart, with a plant population of 13,000 per acre. Every fourth row is deleted to enable machinery to pass through the crop without damaging it.

The crop is established in late spring to early summer and reaches a height of 2' by mid-summer. The first harvest is carried out at this stage when 9" of shoot growth is removed from the top of the crop. The stubble then regrows and with each successive harvest a further 9" of shoot growth is removed. The crop is harvested three times in its first season, 5 or 6 times in its second and third seasons, and 4 times in its fourth season. The shoot material is chopped, dried and then further processed to extract solasodine.

Germination of *Solanum laciniatum* **seeds.** Initial research both in Eastern Europe and at Ivon Watkins-Dow Ltd. concentrated on *Solanum lacinatum*. It was established that it germinated most rapidly at a temperature of 25 to 30°C. Seed from fully ripe orange berries was found to have the highest viability. The berry pulp was found to contain an inhibitor which also inhibited the germination of lettuce seed. Of the range of treatments studied, which included gibberellic acid, potassium nitrate, light, acid soaking, mechanical scarification, hot water soaking, cool storage, stratification and prolonged rinsing — light and rinsing for 5 days in tap water were found to have the greatest stimulatory effect on the rate and final total seed germination. Storage studies also showed that viability increased with storage up to three years but decreased after this date.

Germination of *Solanum aviculare*. With the change to *S. aviculare* many of the germination studies carried out with *S. laciniatum* were repeated. It was found that washing with water at 30°C was more effective than with tap water. It was also found that the optimum washing period with *S. aviculare* was 9 days. Although there was often a small effect on germination percentage, the main response was in terms of increased germination rate. This increase in germination was still apparent after the seed was air dried and stored for 6 months.

The response to washing was observed in the field where it was found that washed seed began emerging in 15 days compared to unwashed seed which began emerging after 21 days. In both cases emergence was spread over a similar 3 week period. The growth of the plants from the unwashed seeds was faster, however, than those in the washed treatment which, after a period of two months, were a week behind the unwashed seeds in terms of growth. From this study is was concluded that washing seeds before sowing was not justified.

The Production of *Solanum aviculare* **by cuttings.** This technique is unlikely to be employed commercially for large scale plantings. Recent work by the DSIR at Otara has shown, however, that 12 to 18" long cuttings, with the aid of a rooting hormone preparation, can be established in the field with a success rate of the order of 60%. The main place for the propagation of cuttings is for the rapid multiplication of desirable clones for breeding and seed production. Cuttings are relatively easy to produce from *S. aviculare* as it has no unusual requirements. Cuttings can be taken at any time of the year, hardwood cuttings being preferred as they tend to be more resistant to disease. The position of the basal cut does not appear to be important as the cuttings can root from nodal or internodal sites. The cuttings are successfully rooted in a bed of sharp sand in full light under a mist propagator. A root inducing hormone preparation containing 0.6% indolebutyric acid is employed. Once the cuttings have rooted they are transferred to paper cups containing a standard potting mix and when extension growth of the new shoots has commenced they can be planted out in the field.

DISCUSSION AND CONCLUSIONS

Washing the seed of *Solanum aviculare* increases its rate of germination. The reason for this is unclear although it may be through the removal of an inhibitor or simply by enabling the process of germination to begin during the washing period. The practical advantages of this response have yet to be demonstrated and they may even be disadvantageous. As problems of weed control occur during the seedling establishment stage, use is made of

stale seed bed techniques — i.e. the dessication of weeds which strike prior to the emergence of the crop. As long as seedling emergence is relatively uniform, an extended period before emergence of the seedling allows for a more complete strike of weed seedlings before dessication. The rate of development of the seedlings once they have emerged is considered the most important subject for investigation at the moment although there are numerous germination promoting techniques yet to be fully investigated which may provide a field for fruitful study in the future.