BREEDING OF VINING PEA CULTIVARS FOR NEW ZEALAND

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ABSTRACT

Because of the serious losses that have been caused in peas in New Zealand by bean yellow mosaic virus, **Fusarium** wilt, and pea top yellows virus, a comprehensive programme to breed resistant cultivars is maintained at Lincoln.

Recently five cultivars Poha, Patea, Puke, Piri and Pania have been released. These have multiple disease resistance and are specifically adapted to the requirements of the processing industry.

INTRODUCTION

The rapid expansion of the freezing pea industry in the 1960's revealed several disadvantages in the canning pea cultivars which were being used for freezing and canning. Flavour and appearance requirements are much stricter for freezer peas because of the differences in methods of processing. For efficient operation mobile mechanical viners require plants with blunt pods, peas not tightly held in the pods, and medium length vines without excessive leaf. Most importantly, to obtain maximum yields for processing the plants must mature as many pods as possible at the optimum tenderometer reading of 105.

In addition, the cultivars must be resistant to **Fusarium** wilt and pea top yellows virus, and for growing in Hawke's Bay must be resistant to bean yellow mosaic virus (BYMV). Screening of 38 cultivars of processing and field peas (Crampton, 1965) showed that very few possessed the desired combinations of disease resistance and other qualities, and indicated the need for a comprehensive breeding programme.

METHODS

After initial screening of cultivars which possessed one or more of the necessary factors required in the ideal processing pea, nine cultivars were chosen as parents for a breeding programme. They were intercrossed in single combinations over several years, and in the hope of producing the most favourable combination over half of the possible crosses were made.

Most of the crosses were made in the glasshouse, and to obtain as large an increase as possible, and to gain a year, all F_1 plants were normally grown in the glasshouse. In succeeding generations, through to about F_8, selection was carried out for plant type and disease resistance.

Bean Yellow Mosaic Virus (BYMV)

This aphid-transmitted disease is rarely seen as far south as Canterbury but damage can be severe in the major northern pea-growing region, Hawkes Bay.

Diseased plants are stunted, have mottled lower leaves, set fewer pods, and mature late. Even moderate infection can result in a significant reduction in yield. Resistance to BYMV is controlled by one gene which is dominant, but with incomplete penetrance, at low temperatures and is recessive at high temperatures (Schroeder and Provvidenti, 1964). In crosses involving a susceptible parent, testing at F_2 is carried out in the glasshouse so that only homozygous resistant plants are selected. Plants are sap-inoculated, using carborundum powder to obtain cell penetration. At this stage plants are selected only for blunt pod and green cotyledon characters.

Fusarium wilt (Fusarium oxysoprum var. pisi Race 1)

This soil-borne disease is less of a problem because most cultivars are resistant. However, the disease can survive in the soil for many years so it is important that new cultivars are resistant to it. Cultivars such as Greenfeast W.R. have been selected for resistance (Yen and Cruickshank, 1957), and wilt resistant lines of Onward (Yen and Casey, 1960) and William Massey (Yen and Crampton, 1964) were produced by the backcross method.

A disease nursery was inoculated with soil from infected fields, and the level of infection built up by growing several successive crops of a susceptible cultivar. Infection is maintained by planting alternate rows with a susceptible cultivar each year. Resistance to wilt is controlled by a single dominant gene. If one of the parents used in a cross is susceptible to wilt then the progeny of the cross are grown in the disease nursery as single plant progenies for several generations, until all the susceptible plants have been eliminated. Testing normally commences at the F_2 generation unless BYMV testing is required also, in which case testing is delayed until the F_3 generation.

Because testing for wilt resistance occurs over the generations in which the maximum segregation is occurring, some selection for plant type is carried out. However this is of limited value because continuous cropping reduces soil fertility and there is generally an uneven infection of pea top yellow virus.

Pea Top Yellows Virus

Pea top yellows virus was first recognised in New Zealand in 1959 (DSIR Annual Report 1960). Infected pea plants are stunted and their lower leaves turn pale while the tops generally become yellow. Severe chlorosis results in early death while the less heavily infected plants are rapidly overgrown by the crop, and may set no pods. If pods set they are small,

and contain mainly small, under-developed seeds. The disease is transmitted only by aphids. Control of the vector, by spraying crops or using soil-incorporated insecticides, proved unsatisfactory because of the high degree of primary infection (unpublished data).

It is now believed that in New Zealand, unlike overseas, pea top yellows is produced by infection with one or both of two viruses: pea leaf roll virus (PELRV) and subterranean clover red leaf virus (SCRLV). Wilson and Close (1973) found that it was not possible to distinguish between these viruses on infected pea plants, and used subterranean clover as a test plant. They also showed that **Mysus persicae** was the vector of PELRV and **Aulacorthum solani** was the principal vector of SCRLV.

Immunity to top yellows virus has not been found in peas, and hence breeding for specific resistance is not possible. Instead, the breeding programme aims for a high level of generalised resistance. Crampton and Watts (1968) showed that all the cultivars used in their work possessed genes for both susceptibility and resistance. Because of this a backcross programme is not practicable, as large populations would have to be screened over several generations before each further backcross could be made.

Due to the number of escapes, the difficulties involved in using an aphid vector and the large numbers of plants which must be tested over several generations, glasshouse testing is impractical in a breeding programme. Field infection at Lincoln however is normally epiphytotic and few plants escape infection. Sowing is carried out in September to catch the heavy aphid flights in October. In addition, the incidence of disease is greatest in the 0.6 m rows in which the early generation hybrids are grown. The risk of selecting plants that have escaped infection is overcome by a pedigree method of selection.

Selection

If testing for BYMV or wilt is not required the F_2 seed is sown at 0.1 m plant spacing in rows 0.6 m apart. Plants are selected only from plots which show a consistently superior level of virus tolerance as well as good plant type. In succeeding generations 50 seeds from each selected plant of the previous generation are sown separately in wide rows. Further selections are carried out at each generation in superior progenies until obvious segregation has ceased, usually at about F_6. At this stage the material from each surviving cross is reduced to about five of the most promising lines, which are harvested separately. Each line is then drilled in a single 50 m row. Inferior lines, including those low in seed yield, are eliminated, leaving perhaps three lines which are harvested separately.

Quality and Yield Testing

The remaining lines are placed in a drilled-plot vining trial with standard cultivars. Plots are threshed in a small static viner as near as possible to the optimum tenderometer reading of 105. Green pea yields are obtained and a sample of each line is frozen for quality evaluation. A taste panel is held at one of the local processing factories. Each sample is scored for colour, appearance, texture and flavour. Seed of acceptable lines is then allocated to the processing firms and the Ministry of Agriculture and Fisheries for larger scale regional yield and quality trials. Lines shown to be superior to commercial control cultivars are then increased for release.

Results

From the original crosses made, four new cultivars with resistance to the three diseases have been released: Poha (Crampton, 1970), Patea, Puke and Piri (Crampton and Goulden, 1974).

Poha, selected from a cross between Greenfeast 68 and Victory Freezer, was released in 1970. It is a mid-season cultivar, flowering at the 14th node. It was bred to replace the cultivar Victory Freezer which is susceptible to bean yellow mosaic virus.

Patea was selected from a cross between two early cultivars, Jade and William Massey. This is the earliest maturing of the releases. Flowering at the 12th node, it produces high-yielding early-season crops, and also competes well with the mid-season cultivars when sown later.

Puke results from a cross between the cultivars Jade and Small Sieve Freezer. Flowering at the 14th node, it is a high-yielding cultivar containing 7 or 8 seeds per pod.

Piri was selected from a cross between Victory Freezer and a selection from the cultivar Dark Skinned Perfection, and flowers at the 14th node. It stands up well to dry conditions and low soil fertility.

Early in the programme it became obvious that a valuable stock of germplasm was being developed. Although many of the crosses made did not meet the industry's quality and processing standards, they could provide a source of multiple disease resistance. In addition, inter-crossing among these unreleased lines and the released cultivars could further increase resistance to pea top yellows virus. This was begun early in the programme with a cross between William Massey and Victory Freezer, which although highly resistant to top yellows virus, did not meet quality and yield requirements.

Since the commencement of the programme over five hundred crosses have been made. Many cultivars which have proved successful overseas, but have shown deficiencies when grown in New Zealand, have been introduced into the programme and crossed with promising lines. It is from such a cross that a fifth cultivar, Pania, was released (Crampton and Goulden 1974).

Pania was selected from a cross between Poha and an unnamed cultivar used to improve green pea colour and for its resistance to top yellow virus. It is a mid-season cultivar which performs well in the Hawkes Bay region.

At the present stage of the programme intercrosses are being made among the last four cultivars released, and with several other lines that have reached advanced quality and yield evaluation. In these crosses disease resistance is a relatively minor problem, being related only to top yellows virus. Much more emphasis can now be given to improving the components of yield, reducing the maturity difference between first and last pods, and improving pea colour and quality.

REFERENCES

Crampton, M.J. 1966: Disease-resistant pea varieties. N.Z. Journal of Agricultural Research 9: 152-6.

Crampton, M.J. 1970: New pea for processing. N.Z. Journal of Agriculture 121 **(13):** 31-33.
Crampton, M.J. and Goulden, D.S. 1974: New virus-resistant pea varieties. N.Z. Journal of Agriculture 129 **(2):** 37-38.
Crampton, M.J. and Watts, L.E. 1968: Genetic studies of pea leaf-roll (top yellows) virus resistance in Pisum sativum. N.Z. Journal of Agricultural Research **11:** 771-83.
Schroeder, W.T. and Provvidenti, R. 1964: Evaluating Pisum sativum for resistance to pea mosaic 1. New York State Agricultural Experiment Station Bulletin 806.
Wilson, J. and Close, R.C. 1973: Subterranean clover red leaf virus and other legume viruses in Canterbury. N.Z. Journal of Agricultural Research **16:** 305-10.
Yen, D.E. and Casey, R.J. 1960: Wilt resistant Onward peas. N.Z. Journal of Agriculture **101:** 565-6.
Yen, D. E. and Crampton, M.J. 1964: Wilt-resistant William Massey peas. A new Crop Research Division release. N.Z. Journal of Agriculture **108:** 383.
Yen, D.E. and Cruickshank, I.A.M. 1957: Wilt-resistant Greenfeast peas. N.Z. Journal of Agriculture **94:** 149.