

# Tolerance to PCN



As part of the Scottish Government-funded PCN project, Vivian Blok, John Jones, and Glenn Bryan from the James Hutton Institute produced a review about tolerance to PCN which is summarised below. The full report is available here [Tolerance review\\_final draft.pdf](#)

To manage potato cyst nematodes (PCN), there are two key genetic traits that should be considered – **tolerance** and **natural resistance**. These two properties are different and unrelated but there is frequently confusion between them and what they mean.

**Tolerance** is the ability of the plant to **withstand damage by PCN** and **avoid the reduced growth and yield** that is normally associated with PCN infection. **Tolerance does not restrict the multiplication of PCN**. Although yield may be protected in a tolerant variety compared to an intolerant variety, PCN multiplication is frequently higher on tolerant varieties. Use of tolerance in the absence of resistance may allow very high (unmanageable) populations of PCN to build up.

Natural **resistance restricts or inhibits the multiplication of PCN** on the plant and occurs due to host resistance genes. Natural resistance is well understood at a mechanistic level and a variety of potato resistance genes against different PCN pathotypes have been characterised. Although PCN multiplication is suppressed in resistant plants, **resistance does not necessarily mean that yield is protected when PCN is present**, particularly at high levels.

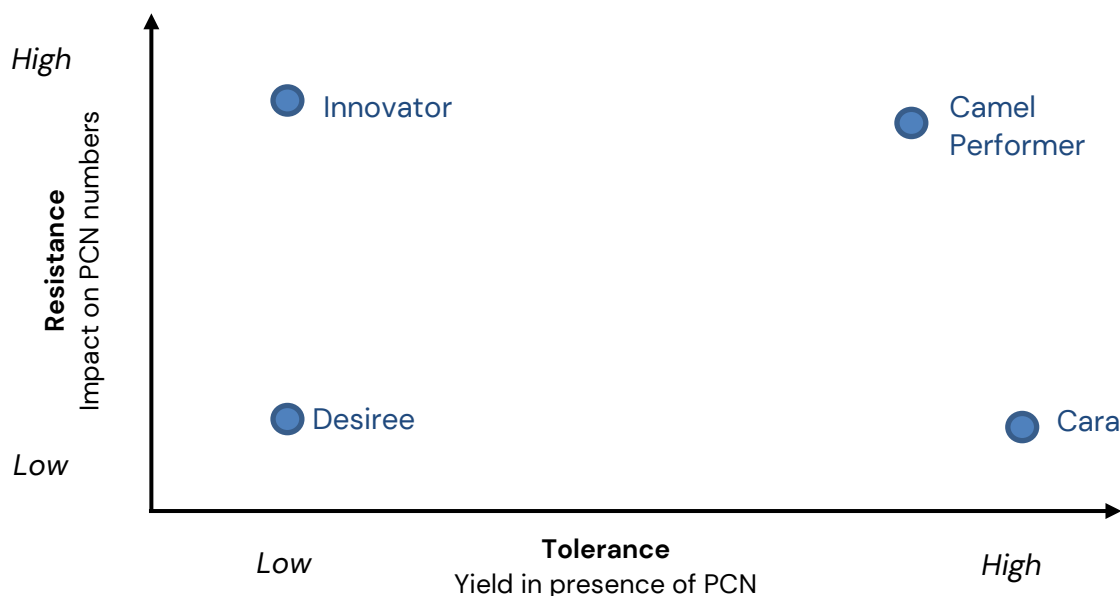


Figure 1: Examples of varieties with extreme tolerances and resistances. Other varieties could fall somewhere between these extremes. Resistance in this example relates to *G. pallida*.

As shown in Figure 1, growing crops of **potatoes that are both susceptible and tolerant in PCN infested land** (e.g., Cara in a *G. pallida* infested area) **can lead to large increases in nematode populations**, while still producing acceptable yields.

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As well as yield losses, the damage caused by PCN may include a smaller root system, poor top growth, reduced ground cover and earlier haulm senescence. Infection and invasion of PCN damages the root system which impacts moisture and nutrient uptake. A consequence of this is reduced top growth of the plant and therefore yield. Tolerant cultivars can recover from damage and achieve the expected level of top growth with a relatively minor delay.

### Assessing tolerance

Tolerance can be determined by growing potatoes in a uniformly nematode infested field and comparing yields and plant growth to those in non-infested soil. In practical terms this is usually a comparison of crop performance with and without an effective nematicide treatment. Assessments in the field, at several sites and over several growing seasons, are required to robustly assess this trait.

Tolerance is heavily influenced by environmental conditions and robust data on the tolerance of established cultivars is not always available. Current breeding is primarily focused on resistance. Recently there has been increased emphasis on the requirement for tolerance to PCN in new varieties however, the genetic or phenotypic basis for tolerance is not clear. Combining both resistance and tolerance traits into new cultivars will be challenging as they are independent of each other.

### Relationship between tolerance and determinacy

Determinacy relates to the growth habit of plants and is a trait that could be linked with tolerance. A fully determinate potato variety will cease leaf production after it has initiated its first flower, whereas an indeterminate variety can continue to produce tiers of leaves and flowers until curtailed by decreasing day length or frost.

Genetic studies on the mechanisms that control determinacy are in progress. Analysis of the potential relationship between tolerance and determinacy for different potato cultivars is occurring in this project.

### Conclusions

Few cultivars are available that combine tolerance with high levels of resistance. Reliable phenotyping of tolerance is a major problem which restricts the advice that can be given to growers on the tolerance properties of cultivars, and also prevents this trait being incorporated into the early stages of the breeding process.

Work is underway to understand how tolerance can be more rapidly determined, and the genetic control of determinacy. This has the potential to speed up the incorporation of determinacy, and tolerance to PCN infection in potato breeding programmes.