PLANT AND SOIL NEMATODES

THE BENEFITS OF CROP ROTATION AND COVER CROPPING IN VEGETABLE PRODUCTION SYSTEMS

Crop rotation and cover cropping should be an integral component of all vegetable production systems. This fact sheet explains why these practices are important, and the benefits they provide.

Soil health and disease control benefits from rotation and cover crops

Soils used for vegetable production are managed much more intensively than those used for other crops, as they are frequently tilled, receive high fertiliser inputs, are usually irrigated, and polyethylene mulch is often used to control weeds and modify soil temperatures. Collectively, these practices have a serious negative impact on soil health and ecosystem services, a situation that is made worse by the fact that vegetable crops return very little organic matter to the soil.

Crop rotation and cover cropping play a vital role in overcoming this problem. Provided suitable crops are chosen and they are managed appropriately, these practices will decrease erosion, reduce compaction, improve soil tilth, increase water infiltration, maintain or increase levels of soil organic matter, provide some weed control, recycle nutrients (particularly nitrogen), decrease nutrient leaching, improve the habitat for beneficial microorganisms, and provide some control of soilborne diseases.

There is a huge body of evidence from local and overseas studies to indicate that these practices are an important component of any vegetable production system.

Use of cover crops in vegetable production

Cover crops are usually integrated into vegetable production systems in one of the following ways.

- As an **off-season crop.** The cover crop is grown in winter in southern Australia and summer in tropical and subtropical regions, as those periods are outside the main vegetable production season.
- As a **companion crop.** The cover crop is planted between rows of the cash crop.
- As a **rotation crop.** A non-vegetable crop is grown during the period when the main vegetable crop is normally grown.

A huge range of crops can be used as cover crops. Various grasses, legumes and brassicas are commonly used, either individually or as a component of mixtures containing many plant species. Most cover crops are annuals, but perennials are used when a forage crop is required for several years. The crops chosen in a particular situation will be influenced by many factors, but particularly the environmental conditions under which the crop is to be grown, the way the cover crop will be integrated into the vegetable production system, and the outcomes being sought by the grower.

Effects of cover crops on soil health

In a review which compared three practices that improve soil health in intensive vegetable cropping systems, Norris and Congreves (2018) found that cover cropping reduced the risk of nitrate leaching, increased soil carbon levels and suppressed weeds. However, soil amendments and reduced tillage also provided benefits and so the authors hypothesised that the greatest improvements in soil functionality could be achieved by systematically combining these management practices.

There are many overseas examples where multiple practices have been integrated into vegetable production systems, but one of the first published studies in Australia was done on a farm in north Queensland where tomatoes were being produced for the fresh market (Rogers et al. 2004). A tropical legume (*Centrosema pubescens*) and a C4 grass (*Bothriochloa pertusa*) were grown as cover crops over summer and after they were terminated with glyphosate, the residues were left on the soil surface as mulch. Tomato seedlings were planted through the mulch and after the crop was harvested, crop residues were macerated with a flail mulcher and the following cover crop was direct seeded through the mulch residues. Data collected over five years indicated that the cover crop/no till/mulched system produced similar yields to the conventional polyethylene mulched system but improved the soil's aggregate stability,

reduced its bulk density, increased the number of earthworms in the upper 10 cm of the soil profile, and improved microbial activity.

Crop rotation for soilborne disease control

Crop rotation is the premier tactic for managing soilborne diseases and was used extensively in the vegetable industry before the advent of pesticides. Crops typically host a different suite of pathogens, so rotating crops from different plant families helps break the disease cycle by reducing the amount of inoculum in soil. The longer the gap between similar types of crop, the less chance there is of developing a soilborne disease problem.

Rotational cropping is particularly successful for managing pathogens that only survive on certain hosts. For example, various sub-species and races of *Fusarium oxysporum* cause fusarium wilt in vegetables, but if a resistant rotation crop such as forage sorghum is grown, the level of disease inoculum will decline because the host has been removed. However, when crop rotation is being used against relatively host-specific pathogens, it is important to recognise that closely related crops will often allow such pathogens to persist. For example, tomatoes, capsicum, and eggplants belong to the same plant family (Solanaceae), and all are hosts to *Ralstonia solanacearum*, the cause of bacterial wilt.

Crop rotation is less successful with fungi that have good survival mechanisms, a capacity to survive as saprophytes on decomposing organic material, or a wide host range. Examples include S*clerotinia*, which forms resting bodies that enable it to survive for long periods, and *Rhizoctonia*, which uses living root tissue and other sources of organic matter as a food source, and also produces spores and long-lived vegetative structures. Another potential problem with rotation crops is that their undecomposed residues are a substrate for the saprophytic growth of pathogens such as *Pythium* and *Rhizoctonia*, and some *Fusarium* species.

Rotation crops for reducing populations of root-knot nematode

Forage sorghum has proved useful for managing root-knot nematode, one of the most important pests of vegetable crops. It grows readily at most times of the year; competes well with weeds; produces large amounts of biomass in 2-3 months; and most cultivars have some resistance to all widely distributed *Meloidogyne* species. Experience over many years with forage sorghum cv. Jumbo, for example, has shown that when it is well-managed, nematode populations are consistently reduced to levels that will not damage the following vegetable crop. However, forage sorghum is ineffective in situations where weed hosts such as nutsedge (*Cyperus* spp.) and volunteer vegetable plants are present, as they carry over the nematode to the next crop.

Another option is to grow a rotation crop that produces a marketable product. Peanut is one option as it is resistant to all warm-climate species of root-knot nematode. However, one disadvantage is that peanut seedlings are likely to become weeds in the following vegetable crop. Soybean and sweet corn are other options, as some cultivars have moderate levels of resistance to some *Meloidogyne* species.

A forage sorghum rotation crop is a good way of producing the biomass needed to improve the organic matter status of a vegetable-growing soil and reduce numbers of root-knot nematode. The most sustainable option is to retain the residues on the soil surface and plant vegetable seedlings into the mulch. However, it is important to check whether this option is viable, as nitrogen drawdown may occur if the C:N ratio of the residue is too high.

Literature cited

Norris CE, Congreves KA (2018) Alternative management practices improve soil health indices in intensive vegetable cropping systems. A review. *Frontiers in Environmental Science* 6, article 50, 1-18.

Rogers GS, Little SA, Silcock SJ (2004) No-till vegetable production using organic mulches. *Acta Horticulturae* 68, 215-223.

Further information

A huge amount of information on cover cropping and crop rotation that is relevant to vegetable production systems in Australia can be found in extension publications produced by universities in the United States. Similar extension material has been produced in Australia and the following are two of many Fact sheets that vegetable growers may find useful.

- Cover crops for Australian vegetable growers. Hort Innovation, 2020
- Managing soilborne diseases in vegetables. DPI Victoria, 2010.

Information on the resistance of various crops to root-knot nematode can be found on pages 39-43 of the following publication.

Hay F, Stirling GR et al. (2014) Management of root-knot nematode in vegetable crops. Horticulture Australia Limited booklet from project MT09967

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