Sustaining Vegetable Production with Subsoil Manuring

Research Summary

National Vegetable Extension Network
TASMANIA

Introduction

Subsoil manuring (SSM) is the process of placing organic amendments into the upper layers of hostile subsoils in order to improve soil structure, biological activity, water holding capacity, and ultimately, crop yield. Hostile subsoils are described as those that are resistant to root growth. They may be sodic, but a common characteristic is a dense clay layer underlying a lighter textured soil such as silt loam, loam or sand. Such soils are generally referred to as texture contrast or duplex soils. SSM is likely to have the most beneficial impact on soils with a shallow topsoil, generally less than 300 mm in depth.

In the grains industry, research has shown significant improvements in crop performance for several years after application of organic amendments through SSM (Gill et al., 2012; Gill et al., 2009; Gill et al., 2008). The concept has been proven in dryland cereal production on duplex soils, but had not been tested in irrigated vegetable production prior to this project.

The Project

The project was a collaboration between the Tasmanian Institute of Agriculture (TIA) and Tasmanian Agricultural Productivity Group (TAPG), to investigate the benefits of sub-soil manuring (SSM) in irrigated vegetable production.

Table 1: Six field sites, crop and establishment dates.

SITE	SOWING DATE	CROP
Woollen Park	1/02/2015	Carrot Seed
Bluegong	11/02/2015	Processing Peas
Armidale	18/02/2015	Processing Beans
Formosa	13/04/2015	Processing Peas
Mayfield	15/04/2015	Processing Peas
Rannoch Park	5/06/2015	Processing Potatoes

Image 1: Establishing sub-soil manuring trial sites at 'Formosa' (left) and 'Rannoch Park' (right).

Six field trial sites were established on commercial farms (Table 1). A sub-soil manuring ripper was assembled from pre-existing components. This machine allowed placement of organic amendments into the upper layers of the sub-soil at depths of approximately 300 mm. Of the six field sites established, four had soils which exhibited production constraints in the form of dense clay subsoils, and two were on deep sands. A number of soil and crop factors were monitored over the course of one growing season including:

- Soil moisture
- Soil test analysis
- In-field soil biological activity
- Crop yield

Key messages

- **Data analysed from this trial concluded no short term benefits from SSM . However, there may be longer term benefits in some situations.**
- **Uptake of SSM likely to be influenced by a range of factors including the availability and cost of amendments and availability of equipment.**

This fact sheet has been compiled by VegNET Tasmania. VegNET is a project funded by Hort Innovation, using the vegetable research and development levy and contributions from the Australian Government. Hort Innovation is the grower- owned, not-for-profit research and development corporation for Australian horticulture.

Five different organic materials (chicken manure, poppy seed meal, poppy marc and two different composts) were used across the field sites, although only two (chicken manure and poppy seed meal) were used at all sites. All organic materials were analysed for chemical properties, and application rates were selected to provide, as close as possible, a common rate of organic carbon was applied to all sites (Table 2).

Treatments used at each site included:

- 'Business as usual' – Management practices relevant to the farm without deep ripping or the addition of organic material
- Deep ripping with two to three subsoil amendments, depending on availability, with chicken manure and poppy seed meal common to all sites as shown in Table 2.
- Deep ripping with no organic material added

The third treatment listed above (deep ripping with no organic material added) allowed us to separate the potential effect of ripping from the effect of organic amendments.

Table 2: Application rates (m^3/ha) of various amendments used at sub-soil manuring sites.

SITE	CHICKEN MANURE	POPPY SEED MEAL	MACQUARIE OIL COMPOST	FEEDLOT COMPOST	POPPY MARC
Woollen Park	25	17			
Bluegong	35	20			
Armidale	35	30			
Formosa	35	25	35		
Mayfield	35	10		30	
Rannoch Park	40	10			35

Results and Discussion

In this trial, SSM in irrigated vegetables did not deliver the benefits found in previous research conducted in grains in the Victorian High Rainfall Zone (HRZ). This may be because the growing environments are very different, with grain production reliant on rainfall, and vegetables being irrigated, and generally not resource limited. It may also indicate that the soils might not be as hostile to root growth as those used for dryland cereals.

Image 2: Excavations showing placement of poppy seed meal at 'Woollen Park' (left) and chicken manure at 'Mayfield' (right).

A review of the analysed data indicates no significant differences in soil biology or crop yield. This is with the exception of an increase in sub-soil arthropods following poultry manure application. There were some statistically significant differences in soil chemical test results, mostly related to minor nutrients but the importance of these is not clear.

Although the data indicate no obvious short-term benefits from this trial, there may be longer term benefits and/or benefits in other seasons / soils / crop situations.

There are at least two factors that will influence uptake of SSM, if it is shown that there are benefits, including:

- Availability and cost of organic amendments – transport costs of organic amendments tend to limit the distance from the source that makes their use viable. Further, it is often the case, and this is certainly the case in the northern midlands of Tasmania, that the area of land that would benefit exceeds the quantity of material available. However, there may be opportunities for targeted applications in paddocks with spatial variation in soil types and constraints.
- Development of application equipment – the machinery used in this project is limited in its capacity to treat large areas due to limited operating width and hopper capacity. To date, there has only been one commercial sized machine built, for one enterprise in Victoria. At this time, there are no established manufacturers of the machine.

Image 3: Subsoil Manuring implement

Questions remaining include:

- What are the required application rates to provide an overall benefit?
- Which organic materials could be cost-effectively supplied in northern Tasmania?
- What, if any, are the longer-term benefits?
- Would it be effective to grow green manure crops in-situ for incorporation into the subsoil? (This is currently being explored in the grain industry and may have an influence on the adoption of SSM.)

Conclusion

- Data from this 2015 trial indicates no obvious benefits to crop yield in the next crop. However, there may be longer term benefits and/or SSM may be beneficial in only some situations depending on the crop, soil, season etc.
- Soil chemical and biological data show minimal differences with the exception of an increase in sub-soil arthropod abundance following poultry manure application.
- Uptake of the innovation is likely to be influenced by a range of factors, including: availability and cost of organic amendments, availability of commercially viable application equipment that will handle the types of organic material used and the required application rates.

More information about the project can be found on the TAPG website: http://tapg.net

Acknowledgements

Australian Government

This resource is a summary of 'Sustaining vegetable production with controlled traffic and subsoil manuring' report published by the Tasmanian Agricultural Productivity Group (TAPG) and Tasmanian Institute of Agriculture (TIA). This project was funded by the Australian Government, Caring for our Country, Innovation Grants Program.

References

Gill, J.S., Clark, G.J., Sale, P.W., Peries, R.R., Tang, C., 2012. Deep placement of organic amendments in dense sodic subsoil increases summer fallow efficiency and the use of deep soil water by crops. Plant and Soil 359, 57-69.

Gill, J.S., Sale, P.W.G., Peries, R.R., Tang, C., 2009. Changes in soil physical properties and crop root growth in dense sodic subsoil following incorporation of organic amendments. Field Crops Research 114, 137-146.

Gill, J.S., Sale, P.W.G., Tang, C., 2008. Amelioration of dense sodic subsoil using organic amendments increases wheat yield more than using gypsum in a high rainfall zone of southern Australia. Field Crops Research 107, 265-275.

Further Reading

Subsoil manuring: an innovative approach to addressing subsoil problems targeting higher water use efficiency in Southern Australia, Southern Farming Systems. Access here: http://www.sfs.org.au/trial-result-pdfs/Trial_Results_2013_TAS/2013_SubsoilManuring_TAS.pdf

Subsoil manuring - can the successful agronomic and economic impacts be extended to the moderate and low rainfall zones?, Grains Research and Development Corporation. Access here: https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2015/02/subsoil-manuring

VIDEO: Grains Research Updates 2015, Adelaide, Subsoil manuring in drier zones, Grains Research and Development Corporation. Access here: https://www.youtube.com/watch?v=dA0ZSAKa9PQ