UNDERSTANDING SOIL HEALTH AND IT'S IMPLICATIONS FOR THE PHASE OUT OF METHYL BROMIDE

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Despite the enormous amount of research into alternatives to methyl bromide worldwide, most industries are adopting or appear set to adopt soil disinfestation practices based on either chemical fumigation or in some cases, steam and solarisation.

Many researchers, however, believe chemical fumigants no longer have a role in agricultural production as they upset the natural balance in soils, and create too much risk to both the environment and the user. Others support the need to find replacements of any sort (chemical or non-chemical) provided that productivity and economic returns to growers are maintained. Perhaps the majority would support the view that whatever the method chosen it must provide an integrated production system that is sustainable, highly productive and produces healthy food and clean crops. But how do the researchers, and to a greater extent, the growers, decide on future methods of soil disinfestation and what influence will this have on future production systems?

The Solution: Chemical fumigation or new production systems?

In the past, growers have been able to produce healthy crops in soil fumigated with methyl bromide without too much consideration for the sustainability of their soils, knowledge of the pathogens they aim to control or knowledge of many of the nutrient interactions that affect crop yield. The impending phase out of methyl bromide has forced industries and researchers to consider whether soil disinfestation is an appropriate way to grow crops and this is having a significant impact on future production practices. In addition, market pressures against pesticides (nil tolerance for residues) and consumer demands for organic foods are also forcing growers to rethink production strategies. For instance, in the strawberry industry, plug plant production of nursery runners is increasing in many countries and this will satisfy the high health requirement for nursery runners; and, substrate production of tomatoes, capsicums and cucurbits in greenhouses is becoming more acceptable as the future production method for these crops. These practices avoid the need for fumigation. Will this trend continue?

Importance of soil disinfestation on soil health and plant growth

What is soil health? To a grower, it is the alteration of the microbial and nutrient balance in soil so that crop yields are maximised; to an environmentalist it is the natural balance in soil required to maintain a biodiverse ecosystem. (Fig 1.).

In the last few years, research in Australia has been aimed at identifying how changes in nutrient and microbial biomass in soil after fumigation affect crop production. For intensively cultivated horticultural crops, such as strawberries, the destabilized equilibrium in soil (lower microbial biomass) and altered nutrient status after fumigation leads to increases in crop yields at the expense of soil health.

Our research has shown that yields of strawberries, flowers and wheat are improved by up to 70% in MB fumigated soils. Without fumigation, strawberry fruit production may be reduced by an average of 17% and 36% in sub-tropical and temperate Australia respectively. This increased growth response (IGR), has not just been attributed to the control of soil-borne pests and pathogens, but also to changes in the availability of certain plant nutrients and changes in the microbial populations in soils.

Our studies, and many others, have consistently shown that soil fumigation increases ammonium nitrogen in soil, mainly as a result of death of microorganisms and a decrease in the rate of mineralisation and nitrification. This ammonium is available for plant growth and can be utilised as a source of nitrogen by some plants. It has also been shown that fumigated soils are rapidly re-colonised by gram-negative bacteria. These organisms may play a key role in plant growth by either slowly converting ammonia into nitrate (as with a slow release fertiliser) or by plant growth promoting bacteria (ie. PGPR's). Both of these would lead to an IGR. Changes in the concentration of many other nutrients, EC and pH also occur in fumigated soils and although these factors probably have an impact on plant growth, the exact relationship is still being investigated.

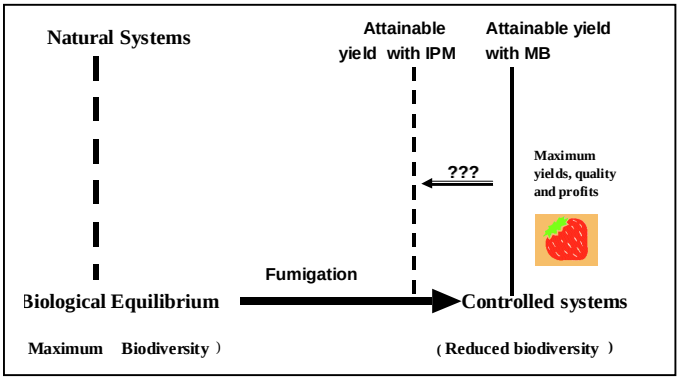

Figure 1. Relationship between soil biodiversity, plant production systems and crop yields.

Conclusion

How will growers in an environmentally conscious society in the 21st century cope with alternatives to methyl bromide. There are three solutions, one is to keep growing crops in soils which are routinely disinfested, the second is to develop IPM systems for field grown produce and possibly accept lower crop yields, and the third is to utilise production systems which maximise yields, such as soilless systems in greenhouses. Under these systems yields can be maximised by controlling the environmental and crop inputs (fertilisers, water, etc.). In the last decade in many countries, a massive expansion has occurred in the area and number of crops grown in protected cropping systems using either sands or other soilless cultures as growing medium. Is this the future trend for the rest of the world?