Research notes on weather and wicking beds

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Introduction

These notes have been put together to let my friends at the Farmland Irrigation Research Institute know what is happening with developments in Australia. I thought many other people who access my web may be interested so I have made them public.

It may look as though we are having serious problem with wicking beds in extreme rain; however this needs to be put in perspective. The classic wicking bed, probably better called a wicking box works fine even in extreme rain provided there is adequate drainage and the side wall protect the soil from being washed away.

There are some questions about green matter that has not been properly broken down affecting germination of some plant types, but apart from these minor issues the wicking boxes have proved very successful.

Part of the success is undoubtedly due to the improvement in soil quality from the soil biology.

However the world population has now passed the 7 billion mark, available land is steadily being reduced from urbanisation and there is an increasing desire to protect natural forests which are now seen as providing one of the most effective weapons in fighting climate change.

We must face the challenge of producing more food from limited land areas. The aim is to utilise the technology which makes wicking boxes so effective on a large scale, we are talking millions of hectares.

Many people view wicking beds as simple way of saving water. I take a different view; the key is the improvement in soil quality from the soil biology. Again there is a common view that bacteria and fungi are indestructible. My experience is different, soil biology is delicate and has to be looked after continuously maintaining a moist environment with plenty of food. If you look after the soil biology the plants automatically grow well.

A mushroom ring on my block. A single mushroom will fire off spawn when the temperature and humidity is right so forming a ring of new mushrooms.

Notice the how green and verdant the vegetation is in the ring as the hyphae penetrate the soil and improve its texture and makes water and nutrients more available to the plants.

The new approach to a system for large scale agriculture may look exciting. However the next stage is to test these ideas. This is a research project and at this moment there is no question of promoting a mature technology, as can be done for wicking boxes.

Weather at the Gin Gin test site.

I should start by making a few comments about the weather at the test site in Gin Gin. This is at 25 degrees, this puts it at exactly the same latitude as the major deserts of the world with no reliable rainfall, most of the rain occurs in the so called wet season, which is not wet in the sense of the equatorial belt where it rains virtually every day. Our normal wet season has hot dry sunny days most of the time, but when a cyclone from the North wonders of course we can get major tropical rains e.g. 200 mm in a day. But traditionally these are infrequent and we may have none, one or two storms a year.

When we do get these major rains, 200 mm in one day from the tail end of a cyclone the soil is generally dry so much of the rain is absorbed into the soil without major problems from run off or soil erosion.

For the twelve years before 2011 Australia suffered a major drought with rainfall well below average. The predominant problem was water shortage and how to get plants through the long dry which could last up to nine months without rain. Naturally the major focus of the wicking beds trials was to store and save water.

In January 2011 the drought broke bringing a very different weather pattern, it rained virtually every day, rainfall was significant often 50 mm per day. This did not cause major problems in itself but the soil became totally saturated. Then in February we suffered a major rainstorm with some 200 mm falling onto saturated soil in one day. The results were devastating with major flooding in many river basins, houses and cars were swept away, there was significant loss of life and billions of dollars of damage to infra-structure and crops.

However after the main flood the rain continued so our test site was under water for a long time with many plants dying from being submerged.

I should point out that the test site in on a flood plain just about 20 metres from a normally dry creek (stream) bed. In the rains the dry creek became a major river and there was simply nowhere for the water in the test site to drain into.

While this broke many records it was assigned a one in five hundred year occurrence and was loosely linked to climate change. Most people thought it just a one off and that it would not happen again in their life time.

However in this year, 2012 we have experiences similar pre cyclone rains, often 50 mm overnight so the soil is now totally saturated. There have been some dramatically heavy rains, for example 25 mm fell in 7 minutes in a close by area. That is almost 4 mm per minute - serious rain.

But so far we have avoided the cyclonic deluge, if that were to occur there would be serious damage and flooding. It is clear that there are two conditions necessary for major damage, there must be a long period of heavy rains to saturate and soften the soil followed by an extreme rain with large high speed rain drops.

No one knows for sure whether this exceptional weather is a part of climate change or just one of the freak events that happen without apparent reason. It is however disconcerting when you think about two extreme wet seasons in a row and the extensive flooding which is occurring elsewhere in the world.

It is just a sensible precaution to look at how to protect wicking beds from these extreme weather events.

Research into the next generation of wicking beds

The traditional wicking box, built on top of the ground is intrinsically well protected from flooding. It is above ground, the bottom 300 mm forming the water reservoir is protected from small flooding and if needed they are easily raised even higher.

The side walls protect the soil from washing away and provided there is good drainage they are pretty robust in heavy rain.

My 5000 m2 strawberry greenhouse

The problem is that the traditional wicking box would be expensive to use on a large agricultural scale. However they are being adopted around the world for high value horticulture. This picture shows a significant strawberry farm in Iran using wicking boxes.

The research aim has therefore been to develop wicking beds so they can be used on a large agricultural scale. The concept was to create the water reservoir by digging a hole in the ground and raising the growing area by up to 300 mm above the natural soil level. It was thought that raising the growing area above the soil level would prevent problems from excess water.

This type of bed has been installed in both the Farmland Irrigation Research Institute in XinXiang and Gin Gin. The beds in XinXiang was the first to show problems with heavy rains with the soil level dropping so it was barely above the natural ground level with disappointing growth from excess water.

Initially there were no problems with the Australian bed. This was first installed about four years ago so there was plenty of time for the soil to settle during the dry period and this was topped up from time to time. Some raised beds on our test site are over ten years old and while they have dropped over time they are still above the natural soil level.

When I returned from a three month visit to China the raised wicking bed was covered in weeds but otherwise seemed to be fine.

I cleared the weeds away and then the rains came, beating on the bare exposed soil which smoothed the whole area so the bed itself was now only just above the rest of the soil. Obviously the weeds had been protecting the soil. It is clear that the beds have to be topped up on a regular basis; the question is what it the best way.

The beds inside the greenhouse, with shade cloth sides had no problems with the soil sinking but again there were masses of weeds. I cleared these and laid them on top of the bed and covered with mill mud (organic waste product from the sugar mills).

When I reseeded I felt that the germination rate was not as good as normal and had a suspicion that the new green material from the weeds may be inhibiting germination.

This raises the question of the best way to top up the beds as the organic material decomposes and shrinks.

I had also set up experiments with open wicking beds e.g. just a narrow channel with the water wicking out sideways to irrigate the surrounding area. I was looking for a cheap alternative to a pipe which on a large scale would be expensive. I used some four different systems which all worked well when first installed. Initially the best system appeared to be having sticks wrapped in polythene film. However after the rains they had all silted up and were a clear failure.

However one experiment was used a bed on a slope. I cannot claim this was part of some clever plan; it was simply that the mango trees were already planted on a slope and having a sloping wicking bed was the only way to irrigate. However there was some terracing to provide a local water reservoir.

To be honest this was not expected to be very successful but sometimes in life you just have to give things a try, even though they do not look to promising.

However I was really surprised when I returned from China. The mango trees were really healthy and had put on a lot of growth.

The organic material had shrunk leaving a small channel like a spoon drain. This had worked exceedingly well with the water flowing down the spoon drain without problems, far from deteriorating with time as the organic decomposed they actually improved.

It appears that spoon drains may be a very simple and effective solution to water transport.

A very encouraging sign was the quality of the soil in all the various types of channels, even the ones that had silted up. They may not have worked as a cheap flow system but they certainly worked extremely well in providing a climate for soil biology to thrive. The soil texture had excellent texture and was full of worms, always a good indicator of soil health. It seems that the wet and dry cycle is very effective in producing good soil – one of the key targets.

Next trials

While the experiments look a little disappointing they identified three key problem issues

- The compaction of the soil on the raised beds
- The silting up of the channels with time as the organic material decomposes
- Question of how best to build up the beds with further organic material

But as often happens problems led to a new approach which has the potential to be much simpler and easier to maintain.

In essence the idea is to make wicking beds (I will call them wicking furrows) which are lined with a polythene film and filled with soft organic material. This if formed to create a simple spoon drain about 300mm wide but only 100 mm deep. Being shallow they are very easy to make.

Currently the existing wicking beds are in the process of being converted to this new wicking furrow.

Obviously we won't know if they work as well as expected until properly trialled, which cannot happen until the rainy season has finished and we are back to the normal dry.

When the organic material has properly decomposed it can be easily raked up to the top of the raised bed. By that time is should be well matured so there should be no concerns about growth retarders coming from composted raw organic material.

Flow is regulated to each bed by a simple restrictor; the tap is used to adjust the flow when beds need different amounts of water.

However there is an issue as there is a need for a continuous supply of organic material. On a small scale this is not a problem as it can be brought in from outside sources, but what would happen on a large scale.

I was therefore decided to experiment with growing on site. I have therefore planted an Easter Cassia (senna pedula var. glabrata), tree at the beginning and end of every row. I selected Easter Cassia because it is fast growing, a legume, and therefore will contribute nitrogen and also like many Australian natives has deep roots and is extremely efficient at extracting phosphorous from the soil. Most Australia soils are deficient in phosphorous.

These can be simply pruned and then the prunings run over with a catcher mower to produce a good mulch with both grass cuttings and Cassia leaves.

Some time ago I also planted a number of Bolivian beeches, again these are fast growing and produce large amounts of mulch.