TECHNICAL BRIEF

November 2016
The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

Improving the quality of irrigation water

A recently-completed Water Research Commission (WRC) study has explored options for the on-farm treatment of irrigation water.

Background

Recent research has shown that the microbiological quality of South African rivers has become a reason for concern.

Insufficient sanitation facilities and inadequate sewage treatment works throughout South Africa have often been implicated as the primary sources of pollution. Farmers are often dependent on these rivers as their only source of irrigation water, and thus their use poses a possible health risk to farm workers and consumers alike.

Focus of the WRC study

The extent of this pollution and the link with food safety was investigated in a five-year WRC study, which emphasised that many rivers were of an unacceptable microbiological standard and did not meet international faecal guidelines for safe irrigation water.

This presents the scenario where consumers unknowingly face a high risk of being infected with harmful organisms when consuming fresh produce. One only needs to recall the tragic outbreak of E.coli in Germany in 2011 to realise the potential risks.

Prevention of river and irrigation water pollution would be the ultimate solution, but in the interim cost-effective treatment techniques for irrigation water are required to ensure food safety. Several disinfection techniques exist that are currently used on-farm.

These are generally classified into one of three categories, namely: chemical (chlorine, bromine, hydrogen peroxide, peracetic acid or ozone based), mechanical/physical (filtration) and physical/photochemical (ultrasound, UV) disinfection.

The effectiveness of these treatments depends on parameters of water quality, including total dissolved solids, turbidity, pH, total suspended solids and chemical oxygen demand.

Therefore, the aim of this project was to conduct a scoping study on different on-farm treatment options to reduce or remove the high levels of potentially pathogenic microorganisms from irrigation water.

Methodology

The above aim was achieved by:

- Conducting a comprehensive literature study and survey of potential on-farm treatment options for irrigated water contaminated with high levels of microorganisms to enable a treatment option to be selected for the trials in an exploratory study;
- Conducting an exploratory study of an on-farm treatment option (in this case, ultraviolet (UV) light) by monitoring the water quality throughout the irrigation

water cycle;
- Determining the efficacy of different treatment options on different E.coli strains at laboratory-scale and river water in a custom pilot-scale irrigation water test unit.
- Proposing the most appropriate treatment options and requirements for further research.

Main results

The results from the scoping study indicated that resistance variation between strains were evident for all the treatments (chemical and UV). It was also observed that environmental strains (isolated from rivers and fresh produce) were in general more resistant than reference strains.

This once again illustrates the ability of bacteria to adapt to environmental stress.

Treatments tested on river water samples did also indicate that disinfectant efficacy for all treatments was greatly influenced by river water quality. Water quality, measured in terms of physico-chemical parameters, had a direct influence on the available chlorine, and peracetic acid levels during disinfection, as well as one the degree of photo reactivation that can occur after UV irradiation.

The chemical treatments (chlorine and peracetic acid) also had disadvantages in terms of their range of efficacy, concerns about the safety and effect on the environment, microbial resistance, cost, long contact times and overall carbon footprint. However, UV was shown to have potential as an environmentally friendly and safer disinfection treatment for polluted irrigation water.

Conclusions and way forward

Certain factors still need to be considered, based on the limitations of this scoping study. One of the most important issues to be addressed is how effective UV disinfection of water from other rivers with other physico-chemical properties (than the river tested in this study) would be.

Another important question is what would the maximum tolerated limits be for quality parameters such as COD, UVT%, TSS with which optimum UV disinfection (with minimum photo recovery) can be achieved. The use of specific pre-treatment technologies to achieve water with quality parameters below these limits should also be considered for severely polluted rivers.

This scoping study focused only of the microbial standards established for water intended for irrigation of fresh produce by the World Health Organisation and the Department of Water and Sanitation. From a food safety perspective the effect of disinfection on other important food pathogens linked to fresh produce, such as Salmonella, Listeria, entero-haemorragic E coli., protozoan pathogens and viruses also needs to be considered.

Included in these considerations is the effect of photo reactivation and dark repair, and how it is minimised by pre-treatment technologies and increased UV dosages. From a practical point of view, it is also important to be able to better collate UV disinfection trials done at laboratory-scale on a collimated beam with what dosages are required in pilot and full-scale systems.

Therefore, the use of UV treatment of irrigation water to ensure food safety should be further researched by conducting a study on the technical and financial requirements for an on-farm irrigation water UV treatment system to ensure food safety.

Further reading:

To obtain the report, *coping study on different on-farm treatment options to reduce the high microbial contaminant loads of irrigation water to reduce the related food safety risk* (**WRC Report No: 2174/1/16**), contact Publications at Tel: (012) 761-9300; Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.