# NURSERY PAPERS

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## Do herbicides applied in production nurseries have the potential to leach and accumulate in water storages?

The use of pesticides (herbicides, insecticides and fungicides) are an integral part of containerised plant production. They are used to assist nursery managers in maintaining a clean, healthy growing environment, while reducing labour to manage pests and weeds. In this Nursery Paper, NGINA Industry Development Officer Michael Danelon summarises the findings of a research project looking into "Herbicide residues in nursery dam water: A pilot monitoring program report" conducted by the Department of Employment, Economic Development and Innovation (DEEDI) Queensland.

Dam at Scotts Tubes

# Do herbicides applied in production nurseries have the potential to leach and accumulate in water storages?

Many production nursery businesses rely on the use of herbicides to assist in the management and control of weeds in their nurseries. The specific use of herbicides will vary according to the:

- type and location of weeds in relation to the crops grown
- type of production facilities
- potential exposure to people, animals and the broader environment.

The pilot monitoring program conducted by DEEDI aimed to determine whether herbicides are being washed from production nursery growing areas and whether they are accumulating in on-site dams to reaction threshold concentrations. In addition, the program considered ways to limit chemical leaching and decrease the potential for chemical residues in irrigation runoff with these recommendations outlined later in the nursery paper.

There are a multitude of registered herbicides permitted for use within a production nursery to assist the manager at various stages of crop production. Where pesticides are registered, they have undergone specific testing by the Australian Pesticides and Veterinary Medicines Authority (APVMA). If the pesticide/product works as intended and the scientific data confirms that when used as directed on the product label it will have no harmful or unintended effects on people, animals, the environment or international trade, the APVMA will register the product.

When using any pesticide the product label and material safety data sheet (MSDS) should be referred to as they provide valuable information on how to use, handle and store the product. Unfortunately, it is rare that any specific long term precautionary information is provided by the chemical manufacturer/company or APVMA as it may not exist or be known to be an issue in all applications of the product. An example for some pesticides is the absence of 'frequency of use' information on the label.

The most common usages of herbicides are in: management of production beds, paths and roadways and in containers (potted crops) or in-ground production systems. There are situations where pesticides are applied to the container and growing media surface during or near time of potting or during production to act as a weed suppressant (pre-emergent). The formulation of the herbicides in use can be liquid, powder or granular.

### Is there a reason to be concerned about long term use of herbicides?

The prolonged use of herbicides in plant production and their potential for physical displacement and/or perceived ability to leach active ingredients has been questioned by some within the nursery industry and regulatory authorities responsible for the management of pesticides and the environment. Prior to the pilot monitoring program there was little information to substantiate:

- what is actually washed from the growing beds due to rain events or irrigation,
- do herbicides accumulate in collection dams, and if so, what affect does this have?

Reducing or preventing herbicides from entering and accumulating in these systems could help to reduce the impacts and rehabilitation costs in other areas, as well as reducing the input costs of the nursery. The leaching of chemicals from production areas is thought to be highly dependent on a number of factors, including production bedding material, drain construction, irrigation scheduling, type of herbicide used and application method. Adjusting these factors in the production process can help to reduce costs and the potential for chemical leaching.

### Nursery profile

The DEEDI identified seven (7) NIASA accredited nurseries, following discussions with Nursery and Garden Industry Queensland (NGIQ),

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to represent a cross-section of the industry. The 7 NIASA accredited nurseries were located throughout Brisbane and they all captured and reused irrigation runoff. These nurseries represented a cross-section of industry production styles, ranging from small, condensed, hard surface growing areas, some with protected cropping structures, through to large-scale operations with open earthen collection drains. Growing bed materials also varied, with weed mat and gravel being the most popular.

Dam water quality varied in all dams, with some nursery managers commenting on problems with duckweed and algal blooms. Vegetation around the dams varied greatly, from bare earthen banks to dense vegetation with an abundance of natural flora and fauna. General nursery litter was present on the banks of several nurseries.

Some nurseries used remediation methods in order to reduce algal growth or water losses. (i.e. Some form of aeration was used to circulate the water to abate anaerobic conditions, or a synthetic liquid was used to prevent evaporation.) All nurseries used some form of water filtration, primarily sand filters and a disinfestation system to treat irrigation water prior to use.

## How were the herbicide levels in nursery dams determined?

The nurseries had a single representative sample of their nursery dam water sampled once per fortnight for a four-month period. For nurseries with secondary dams, two samples were collected on alternate sample rounds to determine if chemical residues were being translocated during water transfer.

Sampling of the nursery dam/dams commenced at the end of May 2010 and continued until September 2010 to coincide with later autumn to the beginning of spring.

Water samples were collected approximately 50 cm below the surface and transferred to a sterilised 500 ml plastic bottle supplied by the NATA accredited testing laboratory in accordance with Australian Standards for:

- guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples and
- guidance on sampling from lakes - natural and man-made.

Water samples were analysed, both unfiltered and filtered, using a 0.45 micrometer filter as per standard laboratory operating procedures. Due to the turbidity of many of the samples, the lab conducted a second unfiltered analysis test using the remaining raw portion of the samples to determine whether any active ingredients that may be bound to particulate matter were being removed during the filtration process.

## Target chemicals and analysis

The Nursery and Garden Industry of Australia (NGIA) and NGIQ representatives selected herbicides commonly used in container production nurseries for targeted analysis – refer to Table 1. The products mentioned in Table 1 represent only some of those available on the market.

| Chemical class | Active ingredient | Product names | Mode of action |
|---|---|---|---|
| Phosphonoglycine | Glyphosate | Roundup | Inhibits EPSP synthase enzyme |
| Triazine | Atrazine | Aatrex, Aktikon, Alazine, Atred, Atranex, Atrataf, Triazine, Simazine | Photosynthesis inhibitor |
| | Simazine | Aquazine, Caliber, Cekusan, Cekusima, Framed, Gesatop, Primatol S, Princep, Simadex | |
| Diphenyl ether; phenoxyphenyl | Oxyfluorfen | Goal, Koltar and RH-2915 | oxidase inhibitor |
| Dinitroaniline; dinitrobenzenamine | Oryzalin | Surflan | Root inhibitor; affects cell division |
| Bipyridylium, dipyridylium | Paraquat | Gramoxone, Cyclone, Marman, Surefire, Dextrone | Affects photosynthesis |
| Nitrile | Dichlobenil | Casoron, Sierraron G | Cell wall biosynthesis inhibitor |
| Pyridazinone | Oxadiason | Ronstar | Protoporphyrinogen oxidase inhibitor |

NB: The list of product names is not comprehensive and is listed for reference purposes. Inclusion or exclusion of brand names in this list does not indicate any preference for or against these or any other products available.

**Table 1: List of chemicals targeted for detection**

All water samples were analysed using gas chromatography and interpreted by the laboratory manager using chemical reference tables to allow for the detection of any active ingredients within the chemical classes identified.

A detection limit of 10 micrograms per litre (µg/L) was used for the analysis to provide an indication of the presence or the absence of the herbicide's active ingredient and to also highlight any chemical concentrations possibly posing a health risk to nursery staff, which would need further investigation. This detection limit was recommended by the testing laboratory as it is the reference concentration used to identify the presence of chemicals in drinking water and human consumables. Lower detection concentrations are used to identify specific chemicals in sensitive environments. The pilot monitoring program report did not discuss the potential effects of herbicide residues on nursery staff.

## Results and discussion

Although most nurseries conducted regular herbicide spray programs during the spring and summer months when weed species are actively growing, six of the seven nursery managers did not expect to find herbicide residues during the winter months as no herbicide spray program was active. However, residues of several herbicides were detected in the nursery collection dam/dams.

The most common active ingredient chemical residues detected were oxyfluorfen and oryzalin (Rout) which were found at all nurseries.

Monitoring water quality – NIASA accredited Wariapendi Nursery.

The use of clean growing media free of weeds and weed propagules is critical to reducing the reliance of herbicides in a nursery – NIASA and EcoHort® accredited Grange Growing Solutions.

Simazine, a component of several herbicides, was found at four nurseries and oxadiazon (Ronstar) and dichlobenil (Casoron and Sierraron G) were detected at three nurseries. Glyphosate was only found in samples from one nursery as were the residues of atrazine and paraquat which are components of several commercial products – refer to Table 1.

A lack of herbicide residue detection does not necessarily mean there are no herbicide residues present in the nursery dam water samples. More correctly, the results indicate that no herbicide residues above the detection limit of 10 $\mu$g/L were detected. In some cases, residues detected in unfiltered samples are reduced or not detected in filtered samples. This highlights that several herbicides are bound to soil particles and are translocated with these soil particles during erosion via runoff water.

The amount of chemicals entering collection dams or waterways appears to be dependent on a number of factors: including bedding material (gravel or concrete), drain construction, presence of vegetation in the drainage system, irrigation scheduling, timing of rainfall post herbicide application, application method and the type or form of the chemical.

The type of chemical refers to its structure and solubility, while the form of the chemical refers to whether it is liquid or granular. All of these factors will influence whether the herbicides are dissolved in irrigation water or bound to soil particles and how easily they are translocated into collection dams or vulnerable to enter the local environment by discharge off the site. Note – in certain jurisdictions, the movement of pesticides/chemicals off the nursery is an offence and needs to be managed to avoid prosecution.

In the pilot monitoring program, the concentrations of herbicides found in nursery dams were considered as relatively low when compared to the terrestrial and aquatic toxicity levels stated in the MSDS provided by the chemical supplier for each active ingredient (product) detected. The low levels of herbicides detected at all nurseries may be attributed to this monitoring program being conducted during the winter months when herbicide applications are reduced, and may also have been influenced by the composition of the growing beds.

Comparative studies suggest a combination of granular herbicides and gravel growing beds reduce the potential for chemical leaching as the gravel can retain the granules (acting as a sump) and restrict the movement of chemicals away from production beds.
The herbicides detected were mainly pre-emergent granular herbicides and all but one nursery sampled predominantly had growing beds consisting of gravel over weed mat. The one nursery that had the most herbicides detected was also the only nursery that had concrete growing beds and concrete collection drains. However, higher concentrations cannot be solely attributed to the concrete growing beds and drainage system. They may be due to a higher or more frequent application of herbicides, age of the site and lower volume of water contained in the nursery dam.

Investigations as to the frequency and application of herbicides used within the test nurseries indicated that the presence/detection of chemicals in the nursery dams was not solely associated with applications in the nursery. One nursery discovered that seedlings relocated from another nursery had been treated with the particular herbicide detected. The herbicide was now being leached from these transferred containers into their dam. Another nursery manager identified that runoff from a neighbouring commercial property could be channelled into their dam during intensive rain events which may have explained why particular chemicals were detected in the samples that were not being used within their nursery.

This possible contamination of nursery irrigation water from outside sources highlights the need for nursery managers to be aware of all possible inflow sources and the benefits of a water quality monitoring program. An understanding of how these herbicides react to irrigation and rainfall as well as the factors that influence their movement or degradation, will help nursery managers to monitor and control the release of these compounds from production areas.

Herbicides in liquid form are more likely to be translocated than granular forms particularly when the active ingredient does not have a strong bond to soil particles and hard, non-porous surfaces or high flow irrigation are used.

Unfortunately, no information was available that discussed the interaction of paraquat with organic growing media or whether this herbicide is still active when applied to organic growing media. It is important to note that dichlobenil may be soluble in water and that it could be masked or bound to other chemicals or soil particles that were removed during the filtering process. Once again, there is very limited information relating to how dichlobenil is affected by other compounds and further research on the interactions and synergies of paraquat and dichlobenil, as well as other herbicides, would need to be conducted to determine the full extent of these possible interactions.

Simazine, applied in liquid form, is reported to be persistent in soil for a period of 36 to 234 days and 30 days in water. It is feasible that the simazine residues detected in the unfiltered samples were bound to soil particles and flushed from the nursery due to a variety of localised rain events and suspended in the water column which were removed during the filtering process and hence not present after filtering.

The lowest detection of herbicides was associated with sites which had a high level of hygiene maintained on site, the small importation of plant material from outside the nursery and the implementation of a pro-active weed management program.

### Conclusion/summary

The most common chemical residues detected during this monitoring program were oxyfluorfen and oryzalin (Rout), which were found at all nurseries. Simazine, a component of several herbicides, was found at four nurseries, while oxadiazon (Ronstar) and dichlobenil (Casoron and Sierraron G) were detected at three nurseries. Glyphosate, which was used by most nurseries, was only detected at one nursery, as were residues of atrazine and paraquat.

Appropriate herbicides need to be selected for effective control and management of nursery weeds

Overall, there were no herbicide concentrations that were considered dangerously high, with all concentrations being below the toxicological or reaction threshold recommendations for both terrestrial and aquatic organisms as listed in the individual MSDS from the chemical supplier/ manufacturer.

Concentrations of the unfiltered samples were generally higher than those of the filtered samples, indicating that chemical residues were bound to particulate matter within the water column. Some chemical residues, such as simazine, can persist within the growing beds longer than expected. For example, simazine residues were detected 4 months after applications had ceased at one nursery. This highlights the need for managers to not only be aware of the physical properties and longevity of the chemicals being used, but also of any possible offsite inflows that could contaminate their irrigation supply, particularly if soil sediment and debris is washed from other commercial properties.

Further, growing bed materials and runoff drain construction will influence whether herbicide residues are washed into dams. Concrete growing beds and collection drains are believed to facilitate herbicide transportation compared to growing beds comprised of gravel over weed mat.

Although the concentrations detected in nursery dam samples collected during this project were below the reaction thresholds for each chemical, it may be possible to reduce or stop chemical residues being washed into nursery dams by using vegetative buffers. These buffers would slow down runoff, allowing soil or organic particles containing chemical residues to drop out of suspension and be degraded by natural processes. However, further research would be needed to determine the most appropriate method for each situation, and whether all chemicals can be intercepted in this manner.

Where nurseries maintain a clean nursery, dispose of material that could cause disease or weed outbreaks and monitor growing areas for weed incursion there is a link to reduced potential for accumulation of herbicides in nursery dams.

All nurseries should integrate a wide range of management techniques for weed control and not rely on herbicides as the sole mechanism for controlling weeds.

## Acknowledgments

David, D. and Dembowski, B. 2010 "Herbicide residues in nursery dam water: A pilot monitoring program report". Department of Employment, Economic Development and Innovation (DEEDI)

## References

Neal, J.C. and Gordon, I. 2003 "Common weeds of container nurseries and their control". The University of Queensland, Australia