BUILDING A DATABASE OF PLANT PROTECTING AGENTS FOR AQUAPONIC SYSTEMS - BASIC CONCEPTS

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Abstract

The paper gives an overview on the progress of the construction of a database of the pesticides that pose minimum risk when applied in an aquaponic system. Aquaponics is a developing food production system that integrates recirculating aquaculture (raising fish and other aquatic animals in closed systems) and hydroponics (plant production in water culture without soil) by using the fish waste as plant nutrient. Fish are highly sensitive to their environment, especially toxic chemicals: pesticides and other pest-controlling agents causing minimum perturbation in aquaponic systems have to be selected with an ecotoxicological approach.

Keywords: *aquaponics, fish toxicity, pesticides, plant protection*

Introduction

Aquaponics is a developing food production system that integrates recirculating aquaculture (raising fish and other aquatic animals in closed systems) and hydroponics (plant production in water culture without soil) by using the fish waste as plant nutrient (Junge et al., 2017). In addition to fish and plants, microbial communities play a major role in aquaponic systems: they converting the toxic fish metabolite ammonia to virtually non-toxic nitrate and decomposing solid waste to soluble plant nutrients. As a result of their complex food web, maintaining the stability of aquaponic systems is a difficult task. This is especially true when plant protection problems caused by pests and diseases break out (Pilinszky et al., 2015).
Unfortunately, vast majority of the commercially available chemical pesticides cannot be used in aquaponic systems because of their fish toxicity and environmental persistence. The aim of our work was to categorize pesticides based on their above properties and select the least toxic and least persistent ones that

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have a potential for use is aquaponic systems. We wish to emphasize the importance of the integrated pest management (IPM) approach when dealing with pests: pesticides can be used only after all alternatives were tried without achieving the threshold limits of control. Methods of IPM are founded on the prevention, supervising and rapid recognition of the pest(s) and disease(s), and their swift suppression. IPM demands an in-depth understanding of the biology of the crops as well as their pests and diseases, and also a knowledge of all the plant protection techniques (Pilinszky et al., 2015). In case a plant disease or a pest invasion breaks out in an aquaponic system it has to be controlled promptly by applying a combination of all possible techniques, beginning with the least risky ones (considering the health of the workers and the aquaponic system, and the quality of the food and the environment). At a certain point the use of a pesticide may be inevitable. In such a case instructions on the label of the formulated product should be thoroughly examined and can only be applied if the crop plant appears on it and "toxic to fish" warning is not posted on it. Obviously, during the application the amount of pesticide reaching the water has to be kept at minimum (Pilinszky et al., 2015).

Materials and Methods

In order to build an up to date aquaponic pesticide database toxicity and ecotoxicity data for all registered pesticides will be searched in commonly available databases (e.g., the European Chemicals Agency [ECHA] of the European Union, the ECOTOX knowledgebase of the Environmental Protection Agency [EPA] of the USA, the Pesticide Action Network [PAN] Pesticide Database, Pesticide Properties Database [PPDB] of the University of Hertfordshire, UK). Toxicity information will also be obtained from Material Safety Data Sheets of the individual formulated products. Only those chemicals will be listed that are applicable against pests and diseases relevant in aquaponic technology.

The final version of the database will be made publicly available on the web through a URL and it will be presented in the format of a searchable spreadsheet.

Herbicides

Under typical aquaponic conditions weeds are excluded from the system and cannot be a problem. However, growth of algae can be a disturbing development, especially, if preventative actions are not taken. If not properly controlled, algae can impact the oxygen status, the plant nutrition, the pH of system and may lead to the formation of toxic secondary products (Conn et al., 2013). Although aquatic herbicides control algae with high efficacy, we do not recommend their use because of their plant toxicity. Consequently, our database will be restricted to fungicides and insecticides.

Fungicides

Fungal pathogens, such as powdery mildew, downy mildew, *Alternaria, Cercospora, Phythophthora,* etc. reproduce and disperse by spores (air, water, and *via* humans as well). Aquaponic systems are somewhat protected against the outbreak of fungal diseases (for example, root rot caused by the soil-borne pathogen *Pythium* spp. fungi) (Somerville et al., 2014) because of the competitive presence of beneficial microorganisms in the circulating water. No efficient chemical fungicides are available for the control of fungal diseases in aquaponic systems. Typically, removing the plants from the growing area as soon as symptoms are verified is proposed to combat any fungal diseases.

Insecticides

Insect pests represent the most difficult plant protection problems in aquaponic systems. They could be harmful in a number of ways, e.g. by chewing on leaves, stem, and fruit, sucking plant sap, boring tunnels in plant tissues, creating galls on plants, contaminating crops with their waste, removing parts of plants for their nests or shelter, carrying or protecting pests, and transmitting plant diseases. Therefore, protecting plants in aquaponic systems against insect pests is the greatest challenge.

Database structure

The database will contain two datasets: 1) a list the common name and the IUPAC chemical name of the active ingredients of the chemical and botanical pesticides. In addition, it will include common name and the scientific name of the pest or the disease-causing organism against it can be used, and a recommendation will be given for the circumstances of the possible way of application, and 2) a list of common and scientific names of the biological control agents as well as common name and the scientific name of the pest or the disease-causing organism against it can be used, and a recommendation will be given for the circumstances of the possible way of application (examples are shown on Tables 1 and 2). Fish toxicity data will be collected from the scientific literature and available databases.

Table 1. *Example for an entry in the chemical database.*

Pesticide		**Pest or disease**	
Common nome	Chemical name (IUPAC)	Common name	Scientific name
Silafluofen	(4-ethoxyphenyl)[3-(4-fluoro-3-phenoxyphenyl)propyl](di-methyl)silane	Greenhouse whitefly	*Trialeurodes vaporariorum*

Table 2. *Example for an entry in the database of biocontrol agents.*

Pesticide		**Pest or disease**	
Common nome	Scientific name	Common name	Scientific name
Predatory mite	*Phytoseiulus persimilis*	Spider mite	*Tetranychus urticae*

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