Research

The impact of growing season and cultivation systems on the dissipation of profenofos and λ- cyhalothrin on *Brassica juncea*: a comparative study

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Abstract
This study was conducted to contour dissipation patterns of two pesticides (profenofos and λ-cyhalothrin) on *B. juncea* (green mustard) grown under green house (G.H.) and open field (O.F.) during dry and wet season. The dissipation data of studied pesticides were fitted into the first order kinetic equation. Based on the dissipation rate constant, k obtained, profenofos dissipates faster than λ-cyhalothrin regardless of growing system and season. The dissipation of both pesticides were found to be more rapid during dry season compare to wet season. Growing system however displayed a rather contradictory results for profenofos where during dry season, faster dissipation took place in O.F., while during wet season rapid dissipation took place in G.H. λ-Cyhalothrin on the other hand exhibits faster dissipation in G.H. during both seasons. The half-lives obtained for profenofos and λ-cyhalothrin in *B. juncea* were 0.66–1.8 days and 1.18–3.7 days, respectively. Based on this experiment, terminal residue obtained for profenofos and λ-cyhalothrin for *B. juncea* were lower than the stipulated MRL. This work was momentous to guide appropriate applications and establishment of accurate PHI of pesticides in *B. juncea* that will benefit farmers in a country with humid tropical climate.

Keywords Profenofos · Dissipation · Vegetables · Green house · Dry season · Wet season

1 Introduction

Mustard plant is a cruciferous vegetable [1], its color varies i.e., yellow, green, red, and brown due to phytochemicals compositions such as minerals, vitamins, chlorophylls, dietary fiber, polyphenols, glucosinolates and volatile components (3-butyl isothiocyanate, allyl isothiocyanate, etc.) [2]. In Asian countries, *B. juncea* is used as food and folk medicine. *B. juncea* productivity is improved by the usage of organic fertilizers (green manure) or chemical fertilizers [3]. It contains seeds and leaves and is widely used in Asian food products or as a traditional medicinal plant [4]. *B. juncea* leaves are more popular and contained high phenolic content [5] which is responsible for biological activities i.e., antioxidant [5], antimicrobial [6], anticancer [7], and anti-hyperglycemic [8].

Continuous and intensive cropping often led to excessive build-up of pests and diseases in vegetable

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production areas [9]. Nowadays pesticides are common for the protection of plants, fruits, vegetables and turfs from numerous fungal diseases, and pathogens infections and to improve the productivity and quality of crops [10]. *B. juncea* is a common plant for pest attacks, which is the main cause of the reduction in productivity [11]. Apart from fertilizers, pesticides were also used to improve crop productivity [12, 13]. Unfortunately, the injudicious use of pesticides by farmers led to the presence of unwanted residues in crops produced which may pose risks to human health [14, 15]. Besides, extensive violation of pesticide usage may also cause deleterious effects on the environment. Pesticides that entered the soil *via* spray drift, wash-off from plant and soil drenching had been reported to cause environmental problems such as water contamination and alteration of soil natural properties [16]. The pesticides of choice mostly belonged to the organophosphorus (OP) and synthetic pyrethroid (Py) groups. According to the World Health Organization, profenofos and λ-cyhalothrin specifically belong to Class II respectively [17].

Numerous studies had been reported on the dissipation and residue levels of profenofos and λ-cyhalothrin in different types of vegetables (i.e., kumquat onions, and tomatoes) in USA, Italy and China [12, 18–20].

Nevertheless, based on our literature studies, no research is available in the literature on the comparative dissipation of profenofos and λ-cyhalothrin in *B. juncea* in the open field (O.F.) and green house (G.H.) under humid tropical climates. There are many different aspects and processes that influence pesticide dissipation rate. For example, the frequency and rate of application, pesticide formulation, crop morphology and weather conditions. Therefore, the pesticide dissipation needs to be evaluated individually on specific crops and under specific growing and environmental conditions through field trials [14].

The present study aims to investigate the influence of different growing systems and seasons on the dissipation rate of two different types of heavily used pesticides namely profenofo**s** (1) and λ-cyhalothrin (2) (Fig. 1**)** on *B. juncea*. Half-life values obtained from this study will be used to estimate a suitable pre-harvest interval for profenofos and λ-cyhalothrin in *B. juncea*.

2 Materials and methods

2.1 Reagents and materials

Commercial profenofos, ELAK 45 EC (profenofos 45% w/w), commercial λ-cyhalothrin and ALERT 2.8 EC (λ-cyhalothrin 2.8% w/w) were purchased from the local market. Profenofos standard (98.2%) was obtained from Sigma Aldrich, Steinheim, Germany. λ-cyhalothrin (purity 98.2%) standards were obtained from Dr. Ehrenstorfer GmbH, Ausburg, Germany. Acetonitrile, dichloromethane, n-hexane, glacial acetic acid, sodium chloride, and anhydrous magnesium sulfate were purchased from J.T. Baker, Philipsburg, USA. The silica gel and primary-secondary amine (PSA) were purchased from Merck, Darmstadt Germany and Varian, California USA, respectively.

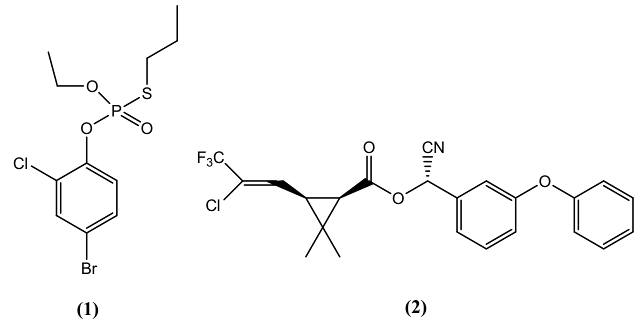

Fig. 1 Pesticides profenofos (1) and λ-cyhalothrin (2)

2.2 Experimental details

Field trials setup and sampling for *B. juncea* followed as it is from earlier paper [21]. Homogenized sample (10 g) was weighed into a 50 mL Teflon centrifuge tube. Acetonitrile (15–20 mL) containing acetic acid (1%) was added to the sample and for 1 min it the sample extract was vigorously shaken by hand. Sodium chloride (1.5 g) and anhydrous magnesium sulfate (5–6 g) were added to the sample. The sample extract was vortexed and centrifuged at 2500–3000 rpm for 1 min each. The supernatant was transferred into another Teflon centrifuge tube, shaken with anhydrous magnesium sulfate (3 g), vortexed and centrifuged at 3000 rpm for 1 min. The extract (2 mL) was taken and eluted through activated silica gel (0.2 g packed in a 2 mL glass Pasteur pipette). The eluate was left in the fume hood to dry, makeup with 2 mL n-hexane and injected into a gas chromatograph-electron captured detector (GC-ECD) for qualification and quantification of λ-cyhalothrin.

For profenofos determination, extract was eluted through primary-secondary amine (PSA), 0.2 g packed in a 2 mL glass Pasteur pipette. The eluate was left in the fume hood to dry, makeup with 2 mL acetonitrile and injected into a gas chromatograph-flame photometric detector (GC-FPD) qualification and quantification.

Moreover, the pH and salinity are not suitable for this type of study. The field trials (green house, open field) and lab experimental as a control study were conducted to address the pesticides residue problems from the two commonly used pesticide in vegetables planted by farmers in the reported location which is the main supplier to