CONTROLLING THE PESTS WITH THE HELP OF PLANTS IN ORGANIC VINEYARDS

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Abstract. The capability of plants of increasing the ecosystem resistance to pests and invasive species is a well-known ecosystem service. However, monocultures (including vineyards) do not exploit the potential of plant diversity. The aims of this research are to develop new viticultural systems based on increased plant diversity within (e.g., cover crops) and/or around (e.g., hedges, vegetation spots, edgings) vineyards by planting selected plant species for the control of arthropods, soil-borne pests (oomycetes, fungi, nematodes), and foliar pathogens. In order to control pests, plants species can either i) repel arthropod pests, ii) attract arthropod pests to a trap crop or iii) attract and/or conserve beneficials. An extensive systematic literature was performed to identify plant species suitable for repelling or attracting target pests - *Lobesia botrana Den & Schiff* or conserving and promoting beneficials (including parasitoids, such as ichneumonids, braconids and general predators, such as carabid beetles, ladybirds, hoverflies and spiders). Here we present the results of this literature review.

Key words: cover plants, repel, green pesticides, beneficials

INTRODUCTION

Plants have been used for thousands of years for various purposes, such as the food, pharmaceutical industry, alternative medicine and so on. There exists therefore a favorable perception for naturally occurring vegetal compounds. They are usually biodegradable and environmentally acceptable. Thus, natural antioxidants, antibiotics and plant protection products are in general perceived positively. Though well received by consumers for use against home and garden pests, these "green pesticides" can also prove effective on commercial farms, particularly for organic food production. In addition, while resistance development continues to be an issue for many synthetic pesticides, it is likely that resistance develops slower on natural, or essential-oil-based, pesticides due to the complex mixtures of components that characterize these oils. Finally, it is probably in developing countries, which are still rich in endemic plant biodiversity, that these pesticides may ultimately have their greatest impact in future organic and integrated pest management programs due to their inoffensiveness to non-target organisms and the environment (Koul, 2008).

In the viticultural ecosystem, forbs such as mustards, composites, and buckwheat serve in a wide variety of functions, e.g. C-sequestration (Brassica and Rhaphanus sp.), N-assimilation to prevent leaching during wet seasons (Phacelia sp.), suppressing nematodes and soil-born diseases (Tagetes sp., Brassica sp. Gisalba), improving the scenery, increasing biological diversity as well as creating a favorable environment for beneficial insects (various members of the family of Apiaceae and Lamiaceae).

MATERIALS AND METHODS

A large inventory of the literature was carried out- 40 scientific papers, selecting the relevant results for the control of pests by plants grown as green carpet or planted as living fences, etc.

RESULTS AND DISCUSSIONS

Lobesia botrana Den. et Schiff. is one of the most important pests of vineyards in Europe. Depending on the climate, this moths develops 2-4 generations the year, the larvae are attacking the flower buds as well as berries. It is present predominantly in the wine-growing regions of the Mediterranean and in the warm and dry regions. The economic importance consists, on the one hand, on a quantitative reduction of the harvest in spring due to the consumption of inflorescence sand, on the other hand, the infestation of berries over the summer, which enhance the risk of the development of pathogens such as *Botrytis cinerea* and in consequence decrease must and wine quality (Mondy, 2003). This insect is considered polyphagous, limited to a narrow range of plants belonging to different families, but it is particularly common on plants of the family Vitaceae (Stoeva, 1982).

It has been shown that there are many plant species that have insecticide or repellent properties on insect pests, including *L. botrana*. Organic viticulture uses for example Neem oil - a vegetable oil pressed from the fruits and seeds of the neem tree (*Azadirachta indica*) (Wagner et colab, 2010). Other potential species might be:

Chrysanthemum (*Tanacetum cinerariifolium* /Trevir./Sch. Bip.)

Chrysanthemum or wild pyrethrum is a perennial herbaceous plant belonging to the family of Asteraceae. It is an endemic species on the eastern coast of the Adriatic Sea and its natural habitat extends from Italy to northern Albania to the mountainous regions of Croatia, Bosnia and Herzegovina and Montenegro. Flowers of Piretrum produce an important insecticide, pyrethrin. Pirethrin is mainly concentrated in the oil glands on the seed surface inside the well-closed floral peduncle. Can be found in other parts of the plant but in much lower concentrations. Pyrethrin exists as a combination of six active insecticidal ingredients: pyrethrin I, cinerin I, jasmolin I, pyrethrin II, cinerin II and jasmolin II, pyrethrin I and pyrethrin II present in higher concentrations (Casida, 1980). Pyrethrin is not toxic to mammals and other warm-blooded animals, it is unstable exposed to light, oxygen, water and at high temperatures and therefore highly biodegradable. Because of its vegetal origin and its environmentally inoffensiveness, it is authorised as an insecticide in organic farming systems (Casida, 1980). Floral peduncles contain most of the pyrethrin. Croatian wild populations contain about 0.60 to 0.79%, while clones from the breeding programs in Australia and Kenya contain up to 3.0% pyrethrin (Grdisa, 2009).

More than 30 chemotypes of pyrethrum are reported worldwide and they were determined according to their main constituents of monoterpenes and sesquiterpenes (Hendriks 1990; Holopainen et al., 1987). The repellent effect of plants that induce different behaviors has received increased attention in combating monophagous and polyphagous insects. It has been suggested that host-specific molecules as well as unspecific compounds are used by plant phytophagous insects to identify host plants (Finch, 1980). Bernard Bertrand et al. (2015) describe in their book "Plants to help other plants" bio-phytosanitary treatments with extracts from various plants, including pyrethrum. Piretrum is stated to have

properties against aphides, aleurods, mites, vermicelli, carrot flies…. In Romania, as in Bulgaria, there is evidence of species cultivation since 1940

Females of *Lobesia botrana* Den. et Schiff. are attracted by volatiles substances released by *Tanacetum vulgare*. Both *Tanacetum* flowers and their odor inhibit mating and oviposition behavior and reduce adult longevity. The mean number of eggs laid per female in presence of *Tanacetum* flowers was reduced by up to 50% during the 6 days of exposure. This reduction was maintained after the *Tanacetum* was removed. In the presence of *Tanacetum* essential oil, the egg-laying reduction ranged from about 30 to 80% according to the odor concentration (Gabel, 1992, 1994). Olfaction seems to play an important role in plant colonization patterns. Adult attraction is increasing in the proximity of fermented grapes and fruit smells (Feytaud 1914; Roussel 1964). In nature, the females are strongly attracted to the pyrethrum, *Tanacetum vulgare* L. (Gabel, 1992). This attraction appears to be sexually selective because males are rarely observed on these plants and this has been attributed to volatile oils emitted by flowers (Gabel 1991). However, pyrethrum is not considered as a host plant of the *L. botrana* moth and also no meeting place for mating (Gabel, 1992).

Mexican marigold (*Tagetes minuta* L.)

Another plant studied over the past is tagetes of the family of Asteraceae. Extracted essential oils rom this Kenyan plant showed repellent effects against *Phlebotomus duboscqi* vector, being stronger when the doses increased. *Tagetes minute* has been shown to have larvicidal and adulticidal effects on mosquitoes (Kimutai, 2017). Perich (1991) compared the biocidal effects of whole plant extracts from three species of *Tagetes spp.* and showed that *T. minuta* had the greatest biocidal effect on larvae and adults of *Aedes aegypt*i (L.) and *Anopheles stephensi* (L). Moreover, *T. minuta* is mentioned to have nematocidal properties due to sulfur compounds.

Tagetes minuta and its derived products have a long history in human uses for food, therapeutics and aromatherapy, which are all linked tp the plant's unique chemical composition and bioactivity. Among the bioactivities and therapeutic properties attributed to *T. minuta* essential oils are antihelminthic, carminative, sedative, antiseptic, diaphoretic, spasmolytic, germicides, stomachic, emmenagogues, antispasmodic, antiprotozoal, bactericidal, antiviral, microbicidal, fungicidal, weedicidal, nematicidal, insecticidal and arthropod repellency properties in a wide range of plant, human and animal pathogens, pests and parasites. The oil of *T. minuta* is therefore a useful agent for protecting food crops on farms, in storage and livestock, thereby enhancing food security and improving human livelihoods (Wanzala, 2016).

Rosemary (*Rosmarinus officinalis* L.) and **lavender (*Lavandula angustifolia* Mill.)**

Both species belong to the family of Lamiaceae, which consists of approximately 3500 species centered mainly in the Mediterranean area, although some species have local distribution in Australia, South-West Asia and South America (Kokkini 2003). Essential rosemary oil has been studied worldwide, demonstrating its repellency to insects (JiSen 2005) as well as insecticidal contact properties on insects (Papachristos 2003). The same,

lavender oil has also been reported to have repellent or toxic effects to insects (Regnault-Roger 1993).

Wormwood (*Artemisia absinthium* L.)

Wormwood or absinthium is a species of the genus *Artemisi*a belonging to the family of Asteraceae. It is an important perennial plant, originating from temperate regions of Asia, Europe and North Africa, but it is also found in the US and Canada. The genus comprises over 500 species distributed in Europe, North America and Asia and some of its plant species are cultivated in temperate climatic zones (Bora, 2011). This genus is a rich source of plant-derived plant protection products (Duke et al., 1988).

Artemisia absinthium is a highly aromatic plant with numerous oil-producing glands that are located on the stem, in the leaves as well as on the inflorescences (Chiasson 2001; Mihajilov-Krstev 2014). Essential oil and other forms of herbal preparations are traditionally used in ethno-pharmacology and ethnomedicine (Abad 2012, Bora 2011).

Products derived from *A. absinthium* are obtained from fresh or dried plant parts or whole plants. Components can be extracted in water, ethanol or other organic solvents, as well as supercritical CO_2 techniques. The composition of the essential oil of *Artemisia absinthium* and its biological effects have been studied extensively (Bailen 2013, Dane 2016, Judzentiene 2012). Essential oils have for exemple larvicidal effects on mosquitoes (Duke 1988; Govindarajan 2016), mites (Chiasson 2001) as well as insect repellency (Croom 1981; Mihajilov-Krstev 2005). In addition, these essential oils may also have fungicidal (Umpierrez 2012) and antimicrobial properties (Erel 2012; Mihajilov-Krstev 2014).

Mustard (*Sinapis alba* L.)

Mustard is an annual plant of the family of Brasicaceae. It is cultivated on organic farms as cover crop with a green fertilizer effect. Many cover crops help in improving soil structure, but plants that have taproots may also assist in creating large soil macropores thereby improving water infiltration and root penetration in the soil for successive crops (McGourty, 1994).

Brassica plants have the potential to release compounds or metabolic products that act as bio-toxins against bacteria, fungi, nematodes, weeds and insects (McGourty, 2004) and in vineyards, they can even quadruple the larvae parasitism of *Lobesia botrana* (Leius, 1967).

Others

In peanut cultures, many types of pests affect production. They can easily be controlled by herbal treatments such as extract of ginger roots against aphids. Ginger (*Zingiber officinale* Roscoe), Garlic (*Allium sativum* L.) and chili (*Capsicum annuum* L.) extracts can be used to control corn worms. Garlic oil is used to control crickets, whereas

coriander seeds and basil leaves are used to control mites. The garlic bulb extract controls tripping. Garlic oil and neem oil are effective in combating white musk (Bissdorf 2009). Moreover, crops sprayed with garlic solution had 100% aphid mortality after 12 days (Mhazo 2011). Studies on the effect of phyto-insecticides on *Bemisia Tabaci* focus particularly on the use of various essential plant oils such as *Thymus vulgaris, Allium cepa, Allium sativum, Satureja hortensis, Achillea biebersteinii, Cinnamomum verum, Syzygium aromaticum, Alkanna strigosa, Galium longifolium, Lepidium sativum, Peganum harmala, Pimpinella anisum, Ruta chalepensis, Retama raetam* or *Urtica pilulifera* and frequently 60-100% mortality were reported (Regnault-Roger, 1993).

CONCLUSIONS

1. This systematic literature **cites nearly 40 different publications** identifying plant species suitable to repel or attract grape moth as well as conserve and promote beneficials, such as predators, parasitoids and pollinators.
2. As a result of the literature research, plant species such as ***Tanacetum cinerariifolium***, ***Tagetes*** sp., ***Brassica hirta, Artemisia absinthium***, ***Lavandula angustifolia*** will be tested for their repellent effects on *Lobesia botrana*.

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