PLANTS AS BIO-INSECTICIDES IN THE SERVICE OF THE SUPPRESSION OF POTATO TUBER MOTH IN STORAGE

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Abstract: *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae), is economically very important pest of potato and other solanaceous plants in the field and warehouse. Frequent and excessive use of insecticides leads to development of insects resistance, environmental pollution, and lives residues in food. All this implicated as a obligatory applications of botanical insecticides. Research in this area is increasingly attracting attention as the kingdom of plants is an inexhaustible source of active ingredients with insecticidal properties. This is the only way in the registration and appropriate use of eco-friendly active ingredients as pesticides.

Key words: botanical insecticides, *Phthorimaea operculella*, control, suppression

Background

Potato tuber moth (PTM), *Phthorimaea operculella*, (Lepidoptera: Gelichiidae) is one of the serious worldwide pest of potato (*Solanum tuberosum*, Solanaceae) native in South America (Picard, 1912). This pest by making irregular tunnels leaves excreta behind and led to a considerable yield loss (Herman et al, 2005). It causes serious damage to potato crops in fields and storage (Arnone et al, 1998). Presence of PTM in storage causing yield losses up to 100% (Joshi 1989; Rondon, 2010).

Bio-insecticide against Chemical

Present of harmful insects in storage demands constant regulation measures. Applications of insecticides represent frequent method in pest population control. (Kljajić and Perić, 2004). Excessive and permanent use of chemical insecticides resulted in the appearance of resistant insects, contamination of ecosystems, and food and feed (Kljajić and Perić, 2004). Insecticides can have economic and environmental consequences (Kljajić and Perić, 2004). Destruction of beneficial insects is a consequence of applications insecticides in unauthorized quantities leads to the (Vučinić et al., 2011). All this rising need to find bio-insecticides which would be reliable for environmental protection and food safety (Pavela, 2008; Vučinić et al., 2011). There is

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also a public pressure to reduce the use of toxic substance. This indicates the reel need to test plants as potential insecticides and their application in the control or suppression with insects as pests (Kljajić and Perić, 2004).

The plant kingdom offers unlimited resources of different insecticide. According to Sharma (1979), plant products can be considered as environmentally acceptable or friendly. The plant can be use as one alternative method in crop protection with one of the main role in the pest management (Pandey et al., 1979). It has been proved that secondary metabolites, extracts and essential oils from a large number of plants have insecticidal properties (Shayaa et al., 1997; Rice et al., 1998). Many chemicals derived from the plant parts have been tested as promising insect control agents as a pyrethrums, synthetic pyrethroides and rotenone (Abdullah et al., 1986). Active substances extracted from plants may not only act as insecticides, but also as insect growth regulators (Bowers et al., 1972), as repellents or synergists (Su and Harvort, 1981; Burfield and Reekie, 2005) or as phagodeterrents (Meisner et al., 1982)

Plant in service of control PTM

Results of many investigation (Raman and Booth, 1984; Raman et al., 1987; Lal, 1987) shows that PTM tuber infestation can be reduced covering the tubers whit weeds *Lantana camara* L., *L. aculeata* L. and *Eucalyptus globulus* Labill.

In Nepal 324 plant species are recognized to have pesticide properties. During their research , Kennedy (1984), Pradhan (1988), Rivera and Retamazo (2000), reported that some plants and weeds like Muna (*Minthostachys* spp), Eucalyptus *(globulus*), Chilca (*Baccharis* spp), Curry plants, Indian pivets, *Lantana camera*, Pangam leaves, *Chenopodium botrys*, *Mentha arvensis, Artemesi vulgaris*, *Lycopersicon hirsutum* are efficient to PTM control.

Dried powders of five different plants, rhizomes of *Acorus calamus*, leaves of *Melia azedarach*, ripened berries of *Piper longum*, leaves of *Prunus persica* and ripened fruit of *Lindera neesiana* were tested as treatments for the control of PTM in laboratory (Niroula and Vaidya, 2004). In the end of research, *L. neesiana* and *A. calamus* have been showed as best alternative of the chemical pesticides for the control of PTM in storage potatoes (Niroula and Vaidya, 2004).

In general plant kingdom is valuable source for new insecticides. Same of local used plants in different utility also represents pesticides. We will continue with the listing species as protection from PTM:

Allium sativum L. **-** Garlic (Liliaceae) **–** Presence of garlic in potato storage can be useful for reducing the contamination of PTM (Sen, 1954).

Cannabis sativa L. **-** Hemp (Urticaceae) **–** Testing the powder of dried leaves of *C. sativa* in India **(**Kashyap et al., 1992) shows that potato in storage was saved longer 120 days.

Eucalyptus globulus Labill. - (Myrtaceae) **–** Dry leaves and dry leaves in powder forms shows high efficiency in controlling the PTM damage in potatoes stored for 4 months in Peru (Raman et al., 1987).

Mentha longifolia L. - Horsemint (Labiatae) – The efficacy of powdered dry leaves of *M. longifolia* in India against the PTM in stored potatoes recorded a small infestation of only 6% (Kashyap et al., 1992).

Lantana spp. Lantana - (Verbenaceae) – Damage of PTM can be drastically reduced by covering tubers with small cover of leaves *L. camara* in India (Rahman, 1944; Lal, 1987, 1988). The same results in the suppression of PTM received in Peru (Anonymous, 1983,1984; Raman and Booth,1983, 1984), in Nepal by Pradhan (1987), in Sri Lanka by Wahundeniya (1989).

Leucaena ieucocephala - Soobabul (Leguminosae) - Rama (1989) in India observed that oil of *L. leucocephulu* showed both ovicidal and larvicidal properties against the PTM.

Citrus aurantifolia **Swingle -** Lime (Rutaceae) - Shelke et al. (1985) tested in the laboratory the effect of the peel extract and oil of C. *aurantifolia.* The peel extract shows as efficient against the PTM as opposed to the oil.

State of the art

Investigation in Egypt shows that oils of peppermint and camphor (natural oils) and eugenol and camphene (commercial oils) were repellent to the larvae and moths of PTM (Sharaby et al, 2009). In olfactory part of experiment strawberry and d-limonene oil were attractive to the larvae and moths of PTM i.e. represent a point in orientation and moving to the source of smelt (Sharaby et al, 2009). Dried parts (leaves, fruits and seeds) of 14 different plants were tested in different concentrations with talcum powder against oviposition. The results indicated that dried powders of *Allium cepa, Curcuma longa, Colocasia antiquarum, Ocinum basilicum, Dodonaea vicosa and Thuja orientalis* have highly significant role in reducing oviposition (Sharaby et al, 2009)

During their research Rafiee-Dastjerdi et al. (2014) were investigated ovicidal activity of essential oils (EOs) of basil, European pennyroyal, lavender, mint, oregano and oviposition-deterrent activity of methanolic extracts of fumitory, lavender, licorice and oregano on PTM. Analysis showed that EOs of *Lavandula angustifolia* had the highest larval activity and fumitory extract shows the highest effect in number of lied eegs.

Sisay and Ibrahim (2012) concluded that *Lantana camara*, *Eucalyptus globulus* and *Pyrethrum* flowers can be used to protect seed potatoes from PTM damage in storage.

Toxicity and biological effects of four plant crude extracts, *Avicennia marina* (Fam. Avicenniaceae), *Pulicaria incise* (Fam. Compositae), *Capparis aegyptia* (Fam. Capparaceae), *Cleome deoserifolia* (Fam. Cleomaceae) was investigated on all stages of PTM in laboratory. Ethanol crude extracts of *C. aegyptia* (leaves and fruits), *A. marina* and *C. deoserifolia* were the most effective extracts in suppression of every life stage. But, chloroform crude extract of *P. incises* was highly effective in suppression. All the tested plant crude extracts in different rate of concentration had obvious latent effects which were observed on larvae, pupae and adults (Soliman, 2012). There is positive correlation between applied concentration all this plant extracts and percentage of mortality of larvae. (Soliman, 2012)

Conclusion

It can be concluded that plants have high potential as natural protector to the stored potatoes against PTM. This is very interesting area and becoming necessarily in Serbia also.

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References

Anonymous (1983) Annual Report. International Potato Centre, Lima. Peru.

Anonymous (1984) Annual Report. International Potato Centre, Lima. Peru.

Arnone S., Musmeci S., Bacchetta L., Cordischi N., Pucci E., Cristofaro M., and Sonino A. (1998). Research in Solanum spp. as sources of resistance to the potato tuber moth Phthorimaea operculella (Zeller). Potato Research 41: 39–49.

Abdullah M.D., Kandif M.A., Farag A.A. (1986). Bioactivity of plant extracts against *Sitophilus granarius* L. and *Tribolium castaneum* Hbst. Bull. ent. 30c Egypt. Econ. Ser., 15 pp. 199–205.

Bowers W.S., Ohta T.,Cleere J.S., Marsella P.A. (1972). Discovery of insect antijuvenile hormones in plants yield a potential fourth generation insecticides, Science, 193, pp. 542–547.

Burfield T., Reekie S.L. (2005). Mosquitoes, malaria and essential oils, Int. J. Aromatherapy, 15 pp. 30–41.

Harvort Su. R. (1981). Isolation identification and insecticidal properties of *Piper nigrum* amides J. Agric. Food. Chem, 29 pp. 115–118.

Herman T.J.B., Clearwatwe J.R., Triggs C.M. (2005). Impact of pheromone trap design, placement and pheromone blend on catch of potato tuber moth. New Zealand Plant Protection 58: 219-223.

Joshi S.L. (1989). Comparative life cycle of the Potatotuber moth*, Phthorimaea operculella* Zell. (Lepidoptera: Gelechiidae) on potato tubers and foliage and its economic loss yield. Journal of entomological society of Nepal 1: 59-69.

Kashyap N. P., Bhagat, R. M., Sharma, D.C. and Suri, S. M. (1992). Efficacy of some useful plant leaves for the control of potato tuber moth, *Phthorimaea operculella* Zell. in stores. J. Ent. Res. 16*,* 223-227.

Kennedy G. M. (1984). 2-Tridecanone, tomatoes and *Heliothis zea* potential incompatibility of plants and antibiotics with insecticidal control. Entomol. Exp. Appl. 35: 305-311.

Kljajić P., Perić I. (2005). Rezistentnost skladištnih insekata prema insekticidima, Pesticidi i fitomedicina, 20(1), 9-28.

Lal I. (1987). Studies on natural repellents against potato tuber moth *(Phthorimaea operculella* Zeller) in country stores. Potato Res. 30 (2), 329-334.

Lal I. (1988). Potato tuber moth. *Phthorimaea operculella* (Zeller), in north-eastern hills region and a simple method for its control. Ind. J. Agric. Sci. 58: 130-132.

Meisner J., Fleischerand A., Elzick C. (1982). Phagodeterrency induced by (–) Carvon in the larvae of *Spodoptera littoralis* (Boisd) J. Econ. Entomol., 75 pp. 462–466.

Niroula S.P., Vaidya K. (2004). Efficacy of Some Botanicals against Potato tuber moth, Our Nature, 2:21-25.

Pandey N.D., Sudhakar T.R., Tripathi R.A. (1979). Possibility of plant materials in pest control. Abstracts of papers presented in the workshop 'Futurology on use of chemicals in agriculture with particular reference to future trends in pest control'. Coimbatore. India, 18 pp.

Pavela R. (2008). The plants used in folk medicine-new possibility for development of botanical insecticides. Journal of International Scientific Publications: Ecology and Safety, 2: 3-15.

Picard F. (1912). La teinge des pommes de terre (*Phthorimaea operculella*). Ann. Service des Epiphyties 1, 10&17h. In: Graf. J. E. (1077). The potato tuber moth, U.S. Dept. of Agriculture. Washington, D.C. Bulletin No. 427, 56 pp.

Pradhan R. B. (1988). Indigenous Weeds as Protectant against Potato tuber moth, *Phthorimaea operculella* Zeller, infestation under farmers potato storage condition. In Proceeding of National Conference on Science and Technology, April, organized by RONAST, Kathmandu, Nepal.pp 24-29.

Pradhan R. B. (1987). Control of Potato Tuber Moth by Weed. Report of National Potato Development Program (HMGINISATA). Lalitpur, Nepal. 18 pp.

Rafiee-Dastjerdi H., Khorrami F., Hassanpour M. (2014).The toxicity of some medicinal plant extracts to the potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), Archives of Phytopathology and Plant Protection, Volume 47, Issue 15: 1827-1831.

Rahman K. A. (1944) Prevention of damage to stored potatoes by the potato tuber moth. Curr. Sci. 13, 133-134.

Rama H. N. (1989). Study on the toxic effects of plant seed oils against the potato tuber moth. *Phthorimae operculella* Zell. (Lepidoptera: Gelechiidae). Mysorr J. Agric. Sri. 23, 568-569.

Raman K. V., Booth R. H. (1983). Evaluation of technology for integrated control of potato tuber moth in field and storage. International Potato Centre, Lima, Peru. Technical evaluation series No. 10:1-18.

Raman K. V., Booth R. H. and Palacios M. (1987). Control of potato tuber moth *Phthorimaea operculella* (Zeller) in rustic potato stores. Tropical Sci. 27, 175-194.

Raman K. V., Booth R.H. (1984). Integrated control of potato moth in rustic potato stores. Proc. Sixth Symp. Inter. Sot. Trap. Root Crops International Potato Centre, Lima, Peru. pp. 509-515.

Rice M. J., Legg M., Powell K. A. (1988). Natural produkts in agriculture-a view. Pesticide science 52(2): 184-188.

Rivera N. C., Retamozo R. C. (2000). Potato Moth control with local plants in the storage of potato. In Natural Crop Protection in the Tropic (Ed. G. Stoll), Margraf Verlag P.O. Box.1205, Weikersheim pp 313-320.

Rondon S.I. (2010). The potato tuberworm: a literature review of its biology, ecology, and control. Am. J. Pot. Res. 87: 149–166.

Sen A. C. (1954). Keep the potato moth out. Indian Fmg. 4, 9-10.

Shaaya E., Kostjukovski M., Eilberf J., Sukprakaru C. (1997). Plant oils as fumigants and contact insecticides for the control of stored-product insects. Journal of Stored Prod. Research, Volume 33:7-16.

Sharaby A., Abdel-Rahman H., Moawad S. (2009). Biological effects of some natural and chemical compounds on the potato tuber moth, *Phthorimaea operculella* Zell. (Lepidoptera: Gelechiidae), Saudi Journal of Biological Sciences, Volume 16:1-9.

Sharma R.N. (1979). Plant products in the development of new pest control strategies. Abstracts of papers presented in the workshop on 'Futurology on use of chemicals in agriculture with particular reference to future trends in pest control'. Coimbatore, India. p. 17.

Shelke S. S., Jadhav L. D., Salunkhe G. N. (1985). Ovipositional and adult repellent action of some vegetable oils/extracts against potato tuber moth. J. Maharashtra agric. Univ. 10: 284-286.

Sisay A., Ibrahim A. (2012). Evaluation of some potential botanicals to control potato tuber moth, *(Phthorimaea operculella)* under storage condition at Bako, Western Ethiopia, International Journal of Phytopatology, ISSN:2312, 1.1 (2012): 14-18.

Soliman M. M. M. (2012). Toxicity and Biological Effects of some Wild Plant Extracts against Potato Tuber Moth, *Phthorimaea operculella* (Zeller) (Lepidoptera: Gelechiidae), Egyptian Journal of Biological Pest Control, 22(1): 19-25.

Vučinić M., Nedeljković J., Trailović S., Ivanović S., Milovanović M., Krnjaić D. (2011). Karvakol kao ekološki insekticid i akaricid od značaja za humanu i veterinarsku medicine. Vet. glasnik 65(5-6):433–441. DOI: 10.2298/VETGL1106433V

Wahundeniya I. (1989). Effect of botanicals for the control of potato tuber moth *(Phthorimaea operculella)* in storage. In: Integrated Pest Management in Tropical and Sub-Tropical Cropping Systems (Summaries), 8-15 February, Bad Durkheim, Germany, p. 90.