Topic 8

“Environment Safety and People Health Protection and Welfare”

Oral Presentation

Foliar application of nematodes for noctuid moths control in spinach with traditional boom sprayer

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Abstract
The biological control of spinach noctuids moths can be accomplished through the use of the entomopathogenic nematodes (EPNs). The nematodes are generally distributed with traditional boom sprayers, though specific references about possible damage of these living organisms due to the action of the mechanical components of the sprayer are not available.
This work aims to evaluate the effects of a spray application, with a conventional hydraulic sprayer on the viability of *Steinernema carpocapsae* (Weiser). Field trial with applications of EPN alone and in a mixture with *Bacillus thuringiensis* Berliner (Bt) were carried out for evaluating their level of control against noctuid moths in spinach and the effects of distribution on the nematode viability. The results demonstrate that the survival of nematodes was not affected by the spray application and furthermore the treatment with EPN alone and the mixture EPN+Bt showed no significant differences with respect to the control. These treatments were not significantly different from the chemicals ones.

Keywords: application technique, biological control, environmental health

Introduction
In Europe, Italy is the largest producer of spinach for industrial use (FAO, 2009). Among the major insect pests in this crop, noctuid moths are considered the most important (Lanzoni and Burgio, 2010). The control of these pests can take advantage of biological organism application in relation to the reduction of pesticide formulations availability, the selection of resistance to chemicals, and the respect of latency period. The entomopathogenic nematodes (EPNs) may therefore represent an effective solution for the control of noctuid moths in this crop.

Application is usually done with existing spray technologies but its efficacy could be affected by equipment characteristics and operating conditions (Fife et al., 2003; Shapiro et al., 2006). Spray application of EPNs, utilizing the sprayers commonly employed for chemical pesticides, can induce a variety of physical stresses on the organisms due to variations in pressure inside the spraying machine and while passing through the pump and nozzles (Nilsson and Gripwall, 1999; Brusselman et al., 2010). Further physical stress may be caused by the effect of agitation inside the tank (Nilsson and Gripwall, 1999; Łaczyński et al., 2004) and by the rise in temperature produced by the recirculation system (Łaczyński et al., 2006; 2007; Brusselman et al., 2010). However, studies on the reduction in viability of the nematodes following mechanical distribution do not provide uniform results.

Preliminary laboratory tests have been performed in order to exclude the possible reduction of viability of the nematode due to physical stress induced by the passage through

the equipment. Particularly the effect of static pressure, passage through the nozzles and recirculation effect were considered. These studies (Ade et al., 2010) have demonstrated that a strong action of the mixing inside the tank can produce a reduction in viability of nematodes. Starting from these results, the research has been extended to field trials to validate in real conditions the efficacy of the distribution of EPNs.

In Italy spinach is cultivated mainly on small farms where, in order to contain costs, it is necessary to use conventional spraying equipment that is economical and versatile and able to deliver both chemicals and living organisms. Also, alternative equipment such as row application and localization systems (Brusselman et al., 2012) seem inappropriate in relation to the spinach crop configuration.

This paper reports the results of mechanical application of the nematode *S. carpocapsae* with conventional hydraulic equipment for the control of noctuid moths in processing spinach in the open field. The efficacy of *S. carpocapsae* was also evaluated, either alone or in a mixture with *B. thuringiensis* (Bt).

Materials and methods

A field trial was conducted in autumnal spinach in Forlì-Cesena province, northern Italy. Commercial formulation of *S. carpocapsae*, i.e. NemoPAK-SC® (Bioplanet, Italy), containing 50 million IJs in an inert carrier and *B. thuringiensis* subsp. *Aizawai* as the commercially available formulation XenTari® (Sumitomo Chemical Italia, Italy) were used.

After emergence, plots (8×20 m) were assigned to the following treatments: 1- entomopathogenic nematodes (EPN); 2- entomopathogenic nematodes combined with *B. thuringiensis* (EPN + Bt); 3- *B. thuringiensis* (Bt); 4- chemical; 5- control (Table 1). Treatments 1 and 2 were repeated twice, with a time span of 14 days. Treatment 3 was repeated weekly, while the insecticide application (treatment 4) was performed in the presence of noctuid larvae. Each treatment had four replicates in a randomized block design.

Table 1. Application parameters

Control agent	Application rate (l/ha)	Flow rate (l/min)	Forward speed (m/s)	Pressure (bar)	Dose		Number of applications	Date
S. carpocapsae	1650	1.93	0.39	2	30	Ijs/cm^2	2	23/09-07/10
S. carpocapsae + *B. t. aizawai*	1650	1.93	0.39	2	30 1	Ijs/cm^2 kg/ha	2	23/09-07/10
B. t. aizawai	625	1.93	1.03	2	1 1.5	kg/ha kg/ha	2 2	23/09-30/09 07/10-14/10
Chemicals:	625	1.93	1.03	2				
- delthametrin					0.5	kg/ha	1	22/09
- indoxacarb					0.15	kg/ha	1	07/10
- delthametrin					0.5	kg/ha	1	09/10

The spray application was performed with a conventional boom sprayer, removing the filter between the tank and the pump. The spray boom was equipped with 16 ISO 06 flat fan nozzles at a pressure of 2 bar. The flow-rate of the ejector mixer was 23,9 l/min. All treatments were applied after 4 p.m. to minimize the influence from UV light. To facilitate the maintenance of an adequate moisture level on the leaf, *S. carpocapsae* and the nematode-Bt mixture were applied at an application rate of 1650 l/ha. The chemicals and Bt were applied at 625 l/ ha.

To evaluate nematode viability and concentration during spraying, liquid samples were taken from the spray tank immediately after suspension preparation and at the outlet of the nozzles during spray application. The latter were collected at successive intervals corresponding to each of the four replicates of the treatments with nematodes.

For nematodes relative viability evaluation a sample of 100 ml was taken in each test and for each treatment. Three sub-samples of nematodes (1 ml each) were extracted from each of the collected 100 ml samples and diluted with 3 ml of distilled water. The sub-samples, were placed in Petri dishes with a grid base, and the living nematodes were counted with a binocular microscope. Nematodes were considered dead if they did not respond to prodding stimulation. Relative nematode viability Vr was calculated as the percentage of living nematode.

Noctuid larval populations were sampled within each treatment plot using a hand-held vacuum suction device (Figure 1) 4 and 13 days after each nematodes application. Collected larvae were reared on an artificial diet in a climatic chamber for 4 days. Afterwards each larva from EPN and EPN + Bt treatments was dissected to assess nematode penetration.

Figure 1. Larval sampling with vacuum device

The STATISTICA software for Windows STATSOFT Inc. (2011) was used for all analyses. *S. carpocapsae* concentration and percentage viability (arcsine transformed) data were submitted to analysis of variance. Differences between treatment means were estimated by Fisher's LSD test ($P < 0.05$). The comparison of noctuid larval infestation between treatments in the field experiment was performed using Kruskal-Wallis test ($P < 0.05$).

Results

The survival of the control agent sampled in the liquid distributed in the various intervals of time (Fig. 2) resulted as comparable to that found inside the tank just after suspension preparation, without showing significant differences in either of the treatments EPN or EPN + Bt. Moreover, the concentration of nematodes also remained constant in relation to time.

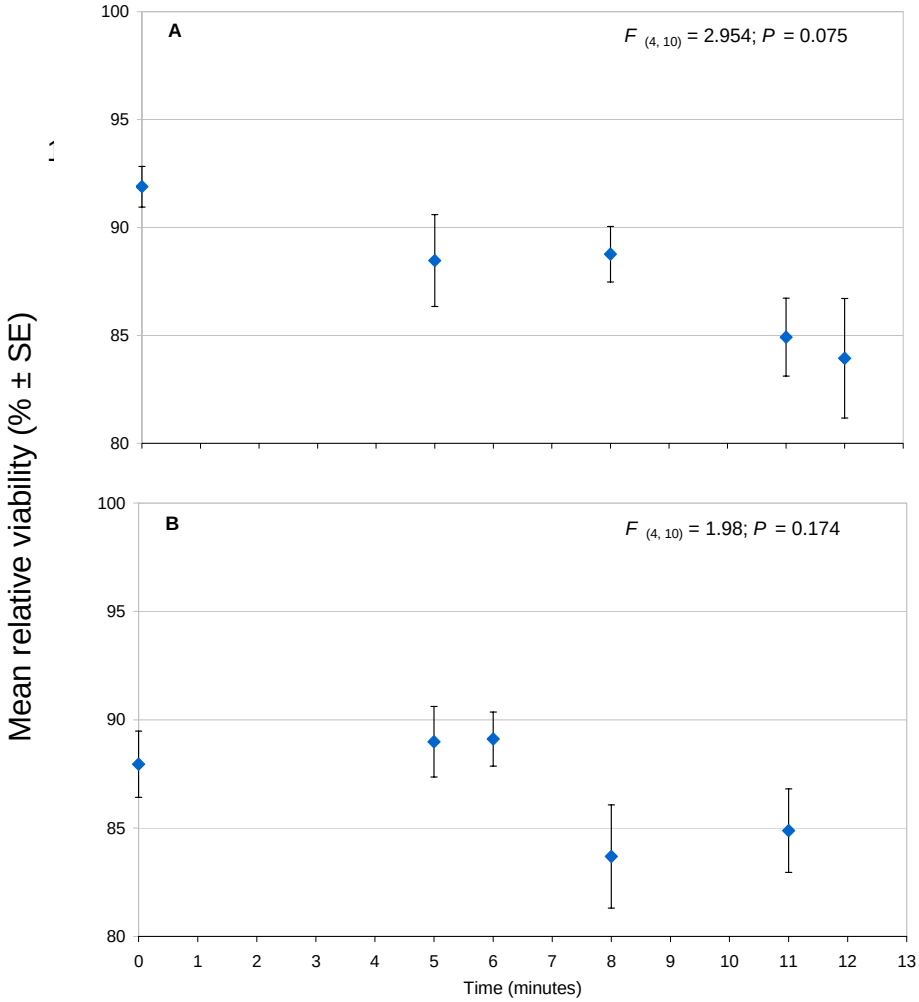

Figure 2. Viability of *S. carpocapsae* measured inside the sprayer tank (time 0) and in relation to distribution time in the treatments EPN (A) and EPN + Bt (B)

The control with EPN alone and with the mixture EPN + Bt showed no significant differences, with respect to the control, on the number of larvae in the samples taken after both treatments. Moreover, with the exception of one larva sampled 4 days after the second nematode spraying in the EPN + Bt treatment (corresponding to 20% of the total larvae sampled on 11/10/2010 in this treatment), none of the noctuid larvae sampled were infected with nematodes.

Nevertheless, the treatments with *S. carpocapsae* alone and with *S. carpocapsae* + Bt have demonstrated, from the middle of the crop cycle to the harvest, a reduction in the number of noctuid larvae, compared to the control (Fig. 3). However, this reduction did not result as being significantly different from that of the plots treated with chemicals. Lastly, the number of larvae sampled in the chemical treatment, excluding the first sampling date, was always significantly lower than the control.

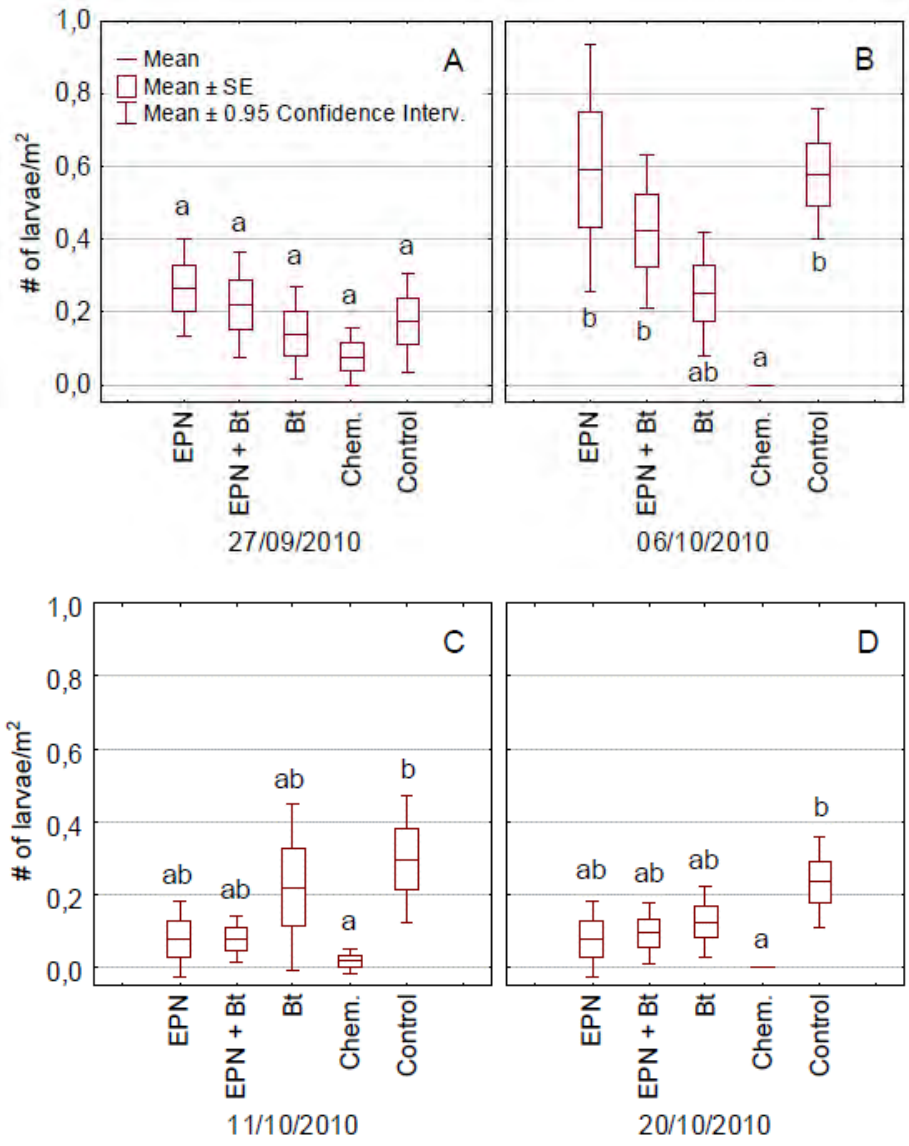

Figure 3. Number of noctuid moth larvae sampled in each treatment 4 (A) and 13 (B) days after the first distribution and 4 (C) and 13 (D) days after the second distribution of *S. carpocapsae* alone (EPN) or in association with *B. thuringiensis aizawai* (EPN+Bt). On each sampling date, different letters show significant differences among treatments (Kruskal-Wallis test, *P*<0.05).

Conclusions

The tests on recirculation showed that repeated passages of the nematodes in the hydraulic system did not affect their viability. Actually the differences were never significant, even varying the intensity of the agitation. The concentration of nematodes did not alter in relation to the distribution time, indicating that the level of remixing applied avoided the nematodes being deposited at the bottom of the sprayer tank.

Lastly, from a physical-mechanical point of view it can be attested that the traditional boom sprayers, even without modifications, if operating at low pressures, can be safely used for the distribution of *S. carpocapsae* for the levels of agitation tested.

In the field experiment chemicals proved to be effective in noctuid moth larval population control. Indeed only chemical treatment was significantly lower than the control. The low efficacy showed by the *B. thuringiensis* when utilized alone may be related to the high rainfall that could have washed away the product reducing the period of activity, since not even the increase of the dose resulted in a better pest control.

The absence of sampled noctuids infected by nematodes can be due to the fact that the larvae normally die two days after infection. Considering that vacuum aspirator is not able to capture the dead larvae, it was not possible to find infected larvae making the sampling four days after treatment.

Nowadays the application technology, as this study suggest, and EPNs formulations availability make nematodes applications feasible also against some foliar pests. However, since the low pest control efficacy of EPNs alone or mixed with *B. thuringiensis*, new studies have to be carried out to determining optimal biocontrol agents concentrations, water volume and treatment timing to coincide at best with susceptible host stages.

References

Ade G., Lanzoni A., Martelli R., Pezzi F. 2010. Influence of Mechanical Aspects of Distribution on Viability of the Biological Control Agent *Steinernema carpocapsae*. International Conference Work Safety and Risk Prevention in Agro-food and Forest Systems, Ibla Campus Ragusa, Italy, September 16 – 18, 2010.

Brusselman E., Moens M., Steurbaut W., Nuyttens D. 2010. Evaluation of hydraulic, pneumatic and mechanical agitation for the spray application of *Steinernema carpocapsae* (Rhabditida: Steinernematidae). Biocontrol Science and Technology, 20,339-351.

Brusselman E., Beck B., Pollet S., Temmerman F., Spanoghe P., Moens M., Nuyttens D. 2012. Effect of the spray application technique on the deposition of entomopathogenic nematodes in vegetables. Pest Management Science, 68, 444-453.

Food and Agricultural Organization, FAOSTAT 2009. http://faostat.fao.org

Fife J. P., Derksen R.C., Ozkan H. E., Grewal P. S. 2003. Effect of pressure differential on the viability and infectivity of entomopathogenic nematodes. Biological Control, 27, 65–72.

Łaczyński A., De Moor A., Moens M., Sonck B., Ramon H. 2004. An application technique for biological plant protection products containing entomopathogenic nematodes. In: Bateman, R.P., Cooper, S.E., Cross, J.V., Glass, C.R., Robinson, T.H., Stock, D., Taylor, W.A., Thornhill, E.W., Walklate, P.J. (Eds), International Advances in Pesticide Application 2004. Aspects of Applied Biology 71. Association of Applied Biologists, Warwick, UK, pp. 489–493.

Łaczyński A., De Moor A., Dierickx W., Moens M., Darius P., Sonck B., Ramon H. 2006. The effect of hydraulic spraying on the viability of the nematode *Heterorhabditis bacteriophora*. Crop Protection, 25, 1135-1141.

Łaczyński A., Dierickx W., De Moor A. 2007. The effect of agitation system, temperature of the spray liquid, nematode concentration, and air injection on the viability of *Heterorhabditis bacteriophora*. Biocontrol Science and Technology, 17, 841-851.

Lanzoni A., Burgio G. 2010. Contro le nottue dello spinacio si parte dal monitoraggio. L'Informatore Agrario, 4, 57-60.

Nilsson U., Gripwall E. 1999. Influence of application technique on the viability of the biological control agents *Verticillium lecanii* and *Steinernema feltiae*. Crop Protection, 18, 53–59.

Shapiro-Ilan D. I., Gouge D. H., Piggot S. J., Fife J. P. 2006. Application technology and environmental considerations for use of entomopathogenic nematodes in biological control. Biological Control, 38, 124-133.

Management of pesticide distribution remnants in italian glasshouses and vineyards

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Abstract
With the aim to collect some information about the present procedures adopted by italian farmers concerning the management of pesticide distribution remnants, two surveys were conducted. The first one involved 160 glasshouse farms located in Liguria region (North Western Italy), the second survey involved about 170 wine farms representing all the Italian regions.
In glasshouse almost all operators (92%) clean the empty pesticide containers and add the cleaning water to the pesticide mixture to be applied. Empty containers are delivered to specialised collecting centres (34%), thrown in dumping grounds (48%), burned (9%), or stored in the farm (9%). Most farmers (94%) use to clean the spray equipment after each pesticide application and with water only (98%). Average amount of water used for the equipment cleaning is 42 L. Rinsing water is drained on the ground (53%), sprayed on the crop (33%) or thrown in the sewers (14%).
In vineyard 73% of farmers rinse the external surface of sprayer after each pesticide application with, on average, 107 L of water and 100% of farmers rinse also the internal part of the tank and the hydraulic circuit with, on average, 120 L of water. Sprayers external cleaning is carried out in the farm court (91%), always in the same area (97%), that is not a paved area (therefore the rinsing water cannot be collected and is drained into the soil). When internal rinsing is carried out directly in vineyard (54%), rinsing water is sprayed on the crop (79%) or drained on the ground (21%).

Keywords: water, pollution, PPP applicaton

Introduction
Use of pesticide in agriculture should always be made with an adequate management of all phases of their use, from spray mixture preparation to disposal of wastes at the end of the application, as chemicals may be very toxic for humans and animals (Drummond, 1998; Mc Allan, 1998; Balsari e Marucco, 2001).
According to some studies carried out in United Kingdom (Carter, 1999), in fact, a considerable percentage of water pollution with pesticides is related to incorrect practices of spray remnants disposal. In details, it was pointed out that applying 2.5 kg of active ingredient per hectare, on average 7 g of a.i. reached the ground water table and 10% of this amount came from sprayer cleaning operations. This is due to the fact that the area on which the sprayer is usually cleaned is often the same in the farm court and has generally a limited surface (10-20 m^2). As the European Water framework Directive (60/2000/EC) establishes that the amount of pesticide a.i. in drinkable water must not exceed 0.1 µg/L, it means that to dilute 1 gram of active ingredient 10 million liters of water are necessary. These figures put into evidence the necessity to consider in an appropriate way, at national level, the problems

related to sprayers cleaning and to the areas where these operations are made, in order to promote actions aimed at reducing environmental pollution risks.
In order to get an overview about the present situation in Italy concerning sprayers cleaning practices and spray remnants disposal, specific surveys were carried out in protected crops farms, where a high number of spray application is made every year, and in vine farms, that are very important and widespread on the national territory.

Materials and methods

Surveys were carried out in 160 horticultural and floricultural farms located in Liguria region and in 170 vine farms representing all the Italian regions; a specific questionnaire concerning cleaning and management of the empty pesticide containers and management of the waste water contaminated with pesticides was submitted to the farmers.

Results

Glasshouses

The cultivated surface involved in the survey amounted to about 200 ha, where 60 hectares were in glasshouses; the average farm surface resulted 1.22 ha, with 0.35 ha in glasshouses. 62% of the farms examined were mainly addressed to flowers production, while the remaining 38% were more focussed on horticultural production. The number of pesticide distribution carried out per year resulted very high, especially in the floricultural farms where in 46% of cases more than 40 applications are made in one year; on the other hand, in the horticultural farms, only 13% of the farmers interviewed declared to make more than 30 treatments per year.

Spraying equipment mostly used resulted short spray lances fitted with a large spout (n°1 in Fig. 1, 35% of cases) and long spray lances, (n° 2 in Fig. 1 - 31% of cases); especially in the floricultural farms located in the province of Imperia, spray lances fitted with three nozzles resulted very much spread (58% of cases) (n°3 in Fig. 1). The lance age ranged from 1 to 25 years, with an average of 6 years.

Figure 1 – Main types of lances and spray guns for pesticides application used in the surveyed farms.

94% of farmers interviewed declared to clean regularly their spraying equipment at the end of each application (87% of cases) or when the type of pesticide is changed (7% of cases, Fig. 2). Cleaning was mostly carried out employing just clear water (98% of cases), seldom adding cleaning agents or soda. The amount of water used for cleaning the sprayer was very variable depending on the accuracy of the cleaning and on the size of hoses. On average it amounted to 42 litres. Washings were often disposed directly in the ground (53% of cases) or on the crop (33% of cases), but sometimes they were also directly poured in the sewers (Fig. 3). 64% of farmers declared to have not any pesticide mixture residue at the end of the

treatment, while 30% declared to apply it directly on the crop, 3% declared to pour it on the ground and 3% to leave it in the sprayer tank for reuse in the next application. When making the cleaning of PPP cans, 92% of farmers declared to add the washings to spray mixture. Emptied PPP cans were delivered to specialised disposal companies in 34% of cases, or put in the urban wastes containers (48% of cases), or they were stored in the farm (9% of cases) or even burned (9% of cases).

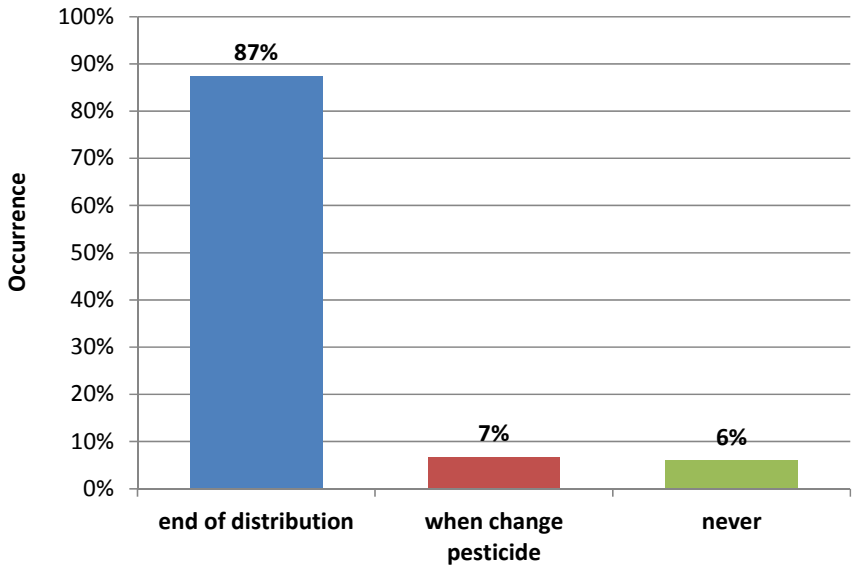

Figure 2 – Glasshouse: frequency of sprayer cleaning.

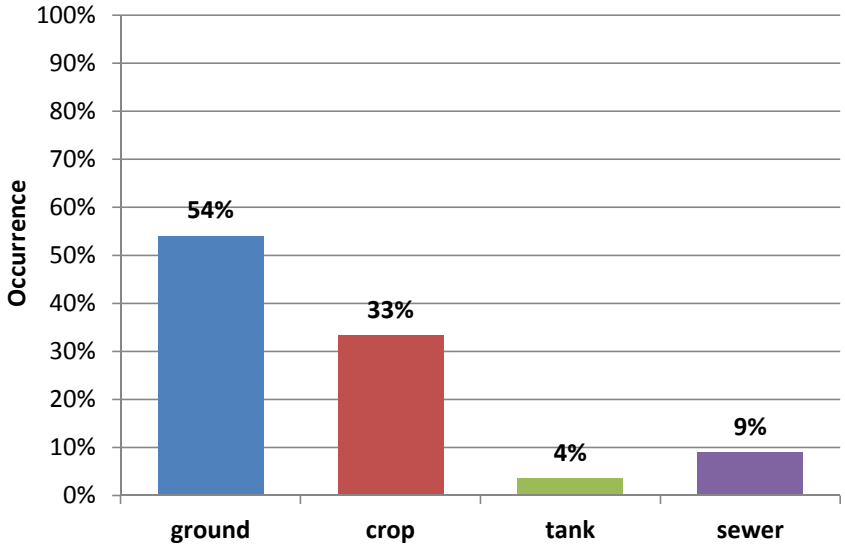

Figure 3 – Glasshouses : washing water destiny.

51% of farmers interviewed declared that while making the sprayer washing they wear protective gloves: in 60% of cases gloves were impermeable but it was not possible to establish if they were impermeable to chemicals or only water proof. It is important to notice that the use of cotton or latex gloves, does not protect the hands against chemical agents. Protection from PPP inhalation was adopted in 33% of cases: For the protection of the body (43% of the farmers interviewed declared to consider it) the most spread solution is to wear

impermeable overalls, even if, as already mentioned about the gloves, it was not possible to state their effectiveness in preventing from PPP contact. Also the disposable overalls, do not represent a guarantee in terms of operator safety, as their effectiveness depends on the material they are made of. In any case it is recommended to avoid the use of textile overalls which can absorb the chemicals and therefore increase the PPP dermal exposure for the operator (Fig. 4).

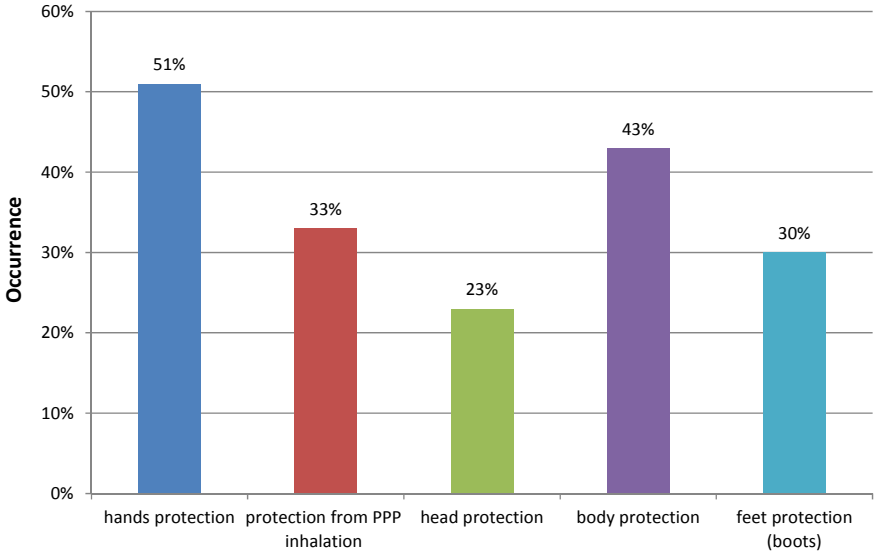

Fig. 4 – Greenhouses: protection of the farmer during sprayer cleaning.

Vine farms

The sample of vine farms selected at national level where the survey was conducted presented on average a farm surface of 40 ha (the total surface of the farms examined was over 4000 ha). In 56% of cases air-assisted sprayers equipped with hydraulic nozzles were used, in the remaining cases pneumatic sprayers were employed.

Farmers declared that the spray mixture residue in the tank at the end of the application amounted, on average, to 8 liters, but in some cases (5% of total interviews) spray residues exceeded 20 liters (Fig. 5). 28% of vine farmers declared to dilute the spray residue unsprayed and to apply it in the field but higher percentages of interviewed farmers declared to store the spray residues temporarily in the sprayer tank (35%), or in other container (37%).

79 % of sprayers examined resulted equipped with a rinse water tank which enables to carry in the field some clear water for cleaning the internal parts of the sprayer (washing the internal parts of the tank, diluting the spray residue, rinsing the hydraulic circuit and applying the diluted spray mixture directly on the crop) as well as the sprayer external surface, by using a spray lance. Nevertheless the availability of the rinse water tank was not related to the practice of cleaning the sprayer directly in the field, as 46% of interviewed farmers declared to carry out the sprayer internal cleaning in the farm court and 91% of farmers also made the sprayer external cleaning in the farmyard, where, generally, there was not any equipped area for preventing the dispersion of pesticide contaminated water in the environment.

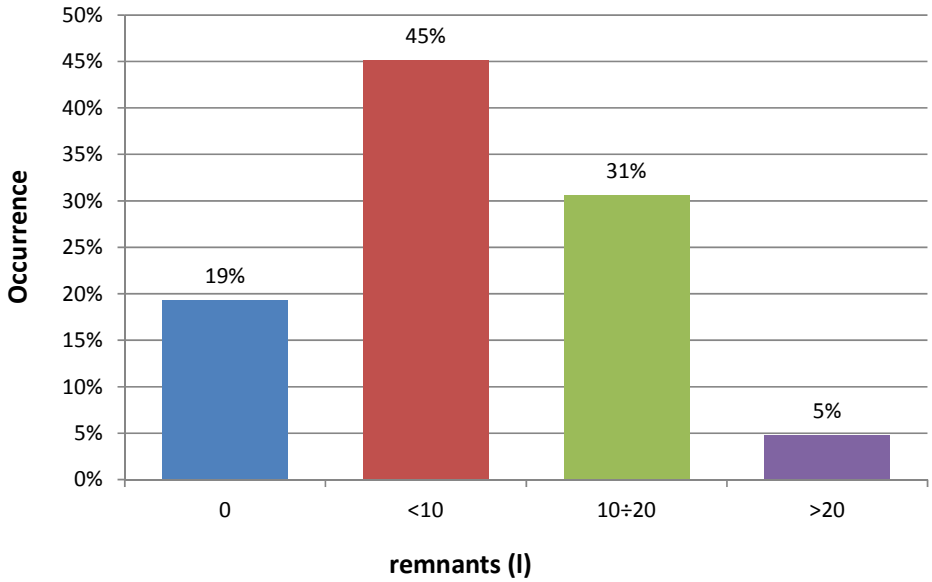

Fig. 5 – Vine farms: spray mixture residue in the tank at the end of application.

Internal sprayer cleaning resulted always carried out, even if with different modalities and frequencies. 79% of farmers made the internal sprayer cleaning at the end of each spray application (Fig. 6), in 90% of cases rinsing either the tank or the hydraulic circuit. Average amount of water used for sprayer internal cleaning resulted 120 liters, sometimes it was over 200 liters (28% of interviewed farmers, Fig. 7).

All farmers declared to carry out the external sprayer cleaning, especially at the end of the application (73% of cases, Fig. 6), often (80% of cases) employing a high pressure cleaner. Water consumption for this operation resulted 107 liters on average and it exceeded 200 liters in 20% of cases (Fig. 8).

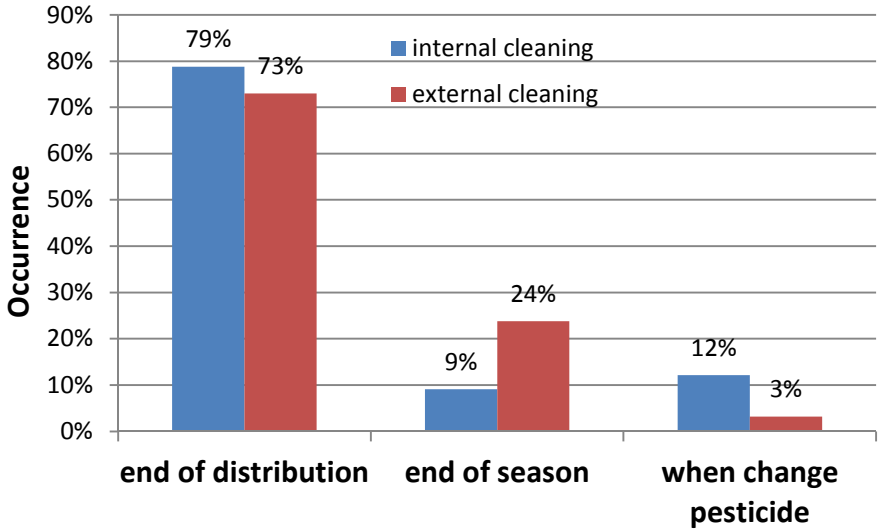

Fig. 6 – Vine farms: frequency of internal and external sprayer cleaning.

When making the cleaning of PPP cans, 100% of farmers declared to add the washings to spray mixture. Emptied PPP cans were delivered to specialised disposal companies.

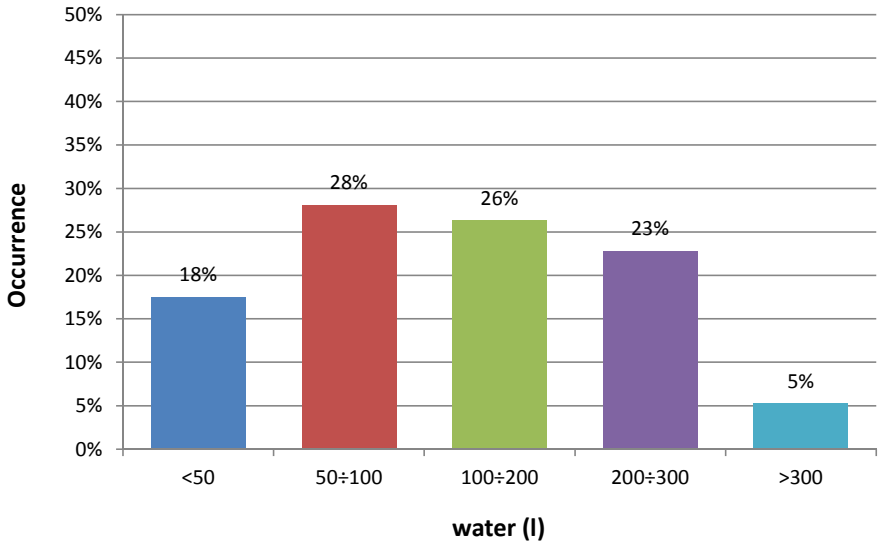

Fig. 7 – Vine farms: amount of clear water used for internal sprayer cleaning.

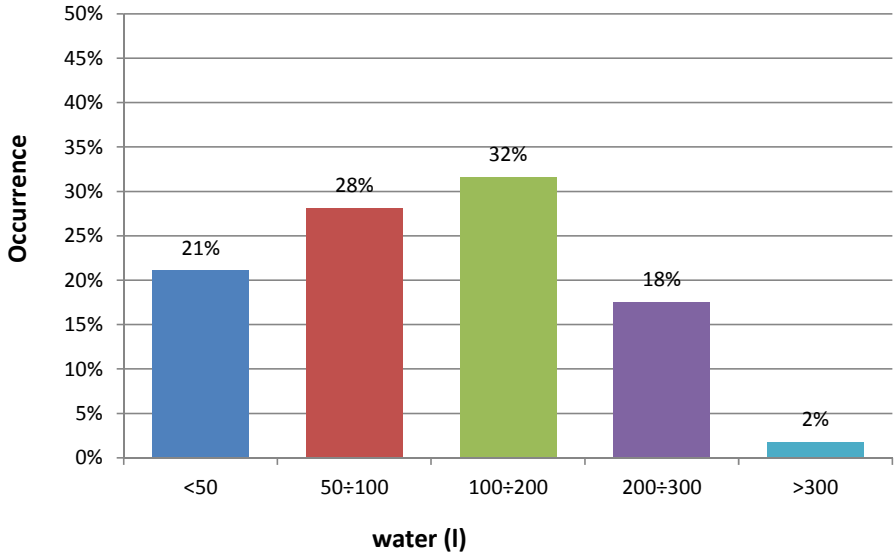

Fig. 8 – Vine farms: amount of clear water used for external sprayer cleaning.

Conclusions

The management of PPP wastes in glasshouse is often carried out not properly. If we consider that an average of 42 liters of clear water are employed for cleaning the equipment and that 40 treatments are made each year, then the farmers has to manage 2 m^3 of washings containing PPP, that, as pointed out by the survey, are usually poured on the ground, typically always in the same place of the farm, therefore generating PPP point sources.

Also in vine farms results of the survey conducted pointed out some defects in the management of spray remnants at the end of treatments. Considering that, on average, 10

spray application are made every year, 80 liters of remnants are generated in one season and the amount of clear water used for cleaning sprayers amounts to more than 2200 litres. Therefore it can be assumed that, every year, a medium size vine farm has to dispose about 2300 litres of water contaminated with pesticides. Even considering only a 0.1% PPP concentration in these waste liquids, the total amount of a.i. that is usually poured every year on a limited farm court surface is about 2.3 kilograms. If the washing place is not protected and it is close to a water course or to a well or to a conventional sewer, than risks of environmental pollution are considerably high.

In order to improve this situation it is therefore necessary to inform and train farmers and advisors about the importance to adopt appropriate technical solutions enabling to minimize risks related to PPP point sources (e.g. use of certified sprayers equipped with rinse water tanks and by-pass valves in the hydraulic circuit; sprayer cleaning preferably carried out in the field; installation of paved filling and cleaning places in the farm court, equipped with collecting systems and storage tanks for contaminated waste water).

Most of these solutions are reported among the Best Management Practices defined in the ambit of Life-TOPPS European Project (www.topps-life.org, Balsari et *al*., 2008; Balsari and Marucco, 2010; Debaer et *al*., 2010) and will be included in the National Action Plan that is going to be issued for the acknowledgment of the European Directive on the Sustainable Use of Pesticides (128/2009/EC).

References

Drummond C. J. 1998. Good farm practice – prevention, minimisation and treatment of waste through adopting an integrated approach. Proceedings of "Managing pesticide waste and packaging", 41-48.

Mc Allan J. 1998. Pesticide waste – practical prevention, minimisation and handling on the farm. Proceedings of "Managing pesticide waste and packaging", 59-64.

Carter A. 1999. Pesticide contamination of water sources and the monitoring data cross the EU in: Human and environmental exposure to xenobiotics. LA GOLIARDICA PAVESE, ITALY. 11:20

Balsari P., Marucco P. 2001. Le nuove esigenze ambientali legate all'uso delle macchine irroratrici. Informatore fitopatologico n°11, 13-18.

Balsari P., Marucco P. Oggero G. 2008. Uso sicuro e sostenibile degli agrofarmaci: le linee guida Topps per la prevenzione dell'inquinamento puntiforme da agrofarmaci. DEIAFA PUBLISHERS.

Balsari P, Marucco P. 2010. Il lavaggio interno ed esterno delle macchine irroratrici. DEIAFA PUBLISHERS

Debaer C. Balsari P. Marucco P. 2010. Sistemi di gestione dei prodotti reflui del trattamento fitoiatrico. DEIAFA PUBLISHERS.

European Parliament. 2009. Directive 2009/128/EC of the European Parliament and of the council of 2l October 2009 establishing a framework for community action to achieve the sustainable use of pesticides.

Revegetation through hydroseeding in degraded Mediterranean areas

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Abstract

Hydroseeding is a technique increasingly used to establish vegetation on degraded areas in order to perform environmental protection.

The objective of this paper was to evaluate the effectiveness of four different hydroseeding methods on a degraded artificial slope in the southern Mediterranean area determining total vegetation cover, hydroseeding vegetation cover, hydroseeding success index (HSI), natural and hydroseeded vegetation height. The test area does not allow the use of any operating machine for soil and vegetation management, the only applicable technique is therefore hydroseeding. After hydroseeding was applied (December 2010), 21 checks were carried out every 15 days (from January 2011 till December 2011) to verify the occurrence and development of the hydroseeded species in order to evaluate the effectiveness of the different hydroseeding techniques in the study area.

The results of the first experimentation performed in Sicily show that hydroseeding has good prospects of application on degraded areas in semiarid Mediterranean environments.

In our study HSI > 0.8 was obtained only in test 2 (thick hydroseeding, period February-June 2011) where there was the contemporary presence of earthworm humus and mulch in addition to the components present in the other tests.

Keywords: vegetation cover, restoration, semiarid climate

Introduction

Hydroseeding is a technique increasingly used to establish vegetation on degraded areas in order to perform environmental protection; it 's primarily used for embankments and slopes consolidation and also for the recovery of abandoned quarries and landfill sites and for the plant of lawns. The traditional sowing, in fact, would be ineffective in some particular areas difficult to recover and here the use of hydroseeding would represent a valid option within soil bioengineering.

Many experimental studies have been conducted on hydroseeding technique and its applications especially in Spain, but few cases are related to sites located in Italy and no researches have been performed in the southern Mediterranean area.

An hydroseeding application in Italy was carried out in northern Appennine region in the context of reclamation and revegetation of former quarry land (Muzzi et al., 1997) obtaining poor results in terms of ground cover, species, runoff and erosion. Other studies performed in Italy describe the functionality of hydroseeding machines with reference to the nozzle type and the homogenization of the mixture inside the tank (Balsari et al., 2005) as well the vegetation cover costs obtained by three different hydroseeding machines (Balsari & Manzone, 2006).

In this study we present the first results of a research made in Sicily, in Mediterranean semi-arid environment, in order to experiment the revegetation of degraded slopes using hydroseeding and different types of implementation. The objective of this paper was to

evaluate the effectiveness of four different hydroseeding methods on a degraded artificial slope in the southern Mediterranean area determining total vegetation cover, hydroseeding vegetation cover, hydroseeding success index, natural and hydroseeded vegetation height.

Materials and methods

Site description

The tests were performed December 2, 2010 in the territory of Sciacca, Italy (longitude 13° 5' E, latitude 37° 33' N). Autumn hydroseeding was expected to produce better plant establishment (Alday et al., 2008; Cano et al., 2002) so we considered it as the best time to carry out the experiments. Vegetation sampling was carried out from January 2011 till December 2011. The test area is exposed to east and the altitude is about 160 m above sea level; the distance to the Mediterranean sea is about 1.5 km. The land is irregular and with a uniform slope of about 35°. It is a highly degraded area as it does not allow the use of any operating machine for soil and vegetation management, where the only applicable technique is therefore hydroseeding. Preliminarily to the tests, an annual study was conducted aimed at identifying the native plant species. Their percentage distribution in early May 2010 was: 60% *Avena barbata*, 30% *Hedysarum coronarium*, 10% the rest.

The evolution of the main weather-climatic parameters (temperature, relative humidity, precipitation) was studied in the period before the intervention (01/11/2008 - 31/11/2010), in order to assess any critical points in the seed germination and subsequent growth of plants and also monitored after the intervention till December 2011(data provided by the fixed meteorological station of the local government agency SIAS – Sicilian Region).

Soil was sampled using a soil auger to a depth of 0.10 m before hydroseeding; soil was taken at three random points inside the study area, then bulked and composited to obtain a representative soil sample. The soil physico-chemical properties are shown in Table 1.

Table 1. Soil physico-chemical properties. Numeric values are means ± standard error.

Sand [%]	14±0.88
Silt [%]	20±0.67
Clay [%]	66±0.33
pH	7.54±0.04
Electrical conductivity [mS cm^{-1}]	7.9±0.02
Salinity [mg kg^{-1}]	2.2±0.01
Total $CaCO_3$ [%]	32±1.10
Active $CaCO_3$ [%]	6.7±0.02
Organic carbon [%]	0.19±0.01
Total organic matter [%]	0.32±0.01
Exchangeable potassium (K_2O) [mg kg^{-1}]	305±11
Total nitrogen (NH_4^+) [mg kg^{-1}]	363±10
Available phosphorus (P_2O_5) [mg kg^{-1}]	7.3±0.02

Hydroseeding machine

The machine used for hydroseeding, model 500L by Agrotec, Padua, Italy, consists of a steel frame with a polyethylene tank with a capacity of 500 L having a mechanic system to shake the mixture, a pump, a motor for the pump and a system for distributing the mixture mounted on. During the tests the machine was placed on a trailer trained by a tractor located

on the field side. The mixture distribution was carried out through a 30 m length pipe equipped with a fan nozzle.

Experimental design and hydroseeding mixtures

After studying the geomorphologic, soil and climate characteristics of the area, we identified five experimental treatments. Three 9 m x 21 m blocks were located and divided into five subplots, 3 m x 7 m each, where the treatments were randomly performed (Fig. 1). An untreated strip 1 m width was left around the subplots. The following treatments were applied:

- Test 1, bonded fiber matrix hydroseeding: water (8 l m^{-2}), Dung fertilizer (470 g m^{-2}), Idrostart fertilizer (15 g m^{-2}), Biosol organic fertilizer (120 g m^{-2}), Soilguard Hydromat biomat (400 g m^{-2}), seed mixture (30 g m^{-2})
- Test 2, thick hydroseeding: water (9 l m^{-2}), Dung fertilizer (200 g m^{-2}), Idrostart fertilizer (15 g m^{-2}), Biosol organic fertilizer (400 g m^{-2}), earthworm humus (400 g m^{-2}), Full-tack adhesive (15 g m^{-2}), seed mixture (30 g m^{-2}), mulch (200 g m^{-2})
- Test 3, reinforced hydroseeding plus water retention: as following test 4 plus Idrogel water retention (5 g m^{-2})
- Test 4, reinforced hydroseeding: water (3 l m^{-2}), Dung fertilizer (95 g m^{-2}), Biosol organic fertilizer (80 g m^{-2}), Full-tack adhesive (10 g m^{-2}), seed mixture (30 g m^{-2}), mulch (95 g m^{-2}).
- Test 5, control (no hydroseeding).
-

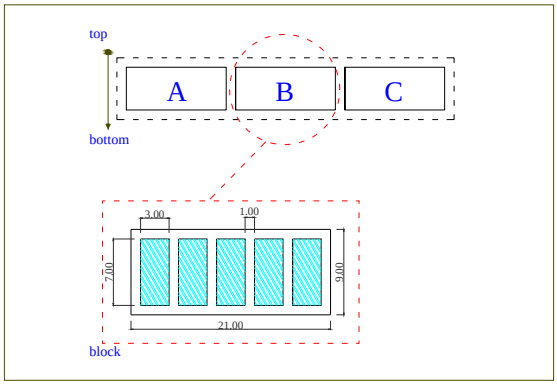

Figure 1. Experimental design. The three 9 m x 21 m blocks were randomly established; each block contained the five randomly assigned treatments performed on five 3 m x7 m subplots. An untreated strip 1 m width was left around each subplot.

The species composition of the commercial seed mixture used in the hydroseeding treatments is shown in Table 2.

Table 2. Composition of the seed mixture used in the hydroseeding treatments.

Family	Species	% of seeds
Gramineae	*Lolium perenne*	30
	Festuca arundinacea	25
	Cynodon dactilis	10
	Paspalum notatum	5
Laguminosae	*Trifolium repens*	15
	Vicia villosa	10
	Lotus corniculatus	5

Vegetation sampling

After hydroseeding was applied (December 2010), 21 checks were carried out every 15 days (from January 2011 till December 2011) to verify the occurrence and development of the hydroseeded species in order to evaluate the effectiveness of the different hydroseeding techniques in the study area. The observations were performed in three 1 m x 1 m squares in each of the replicated treatments. All the parameters were calculated as the mean of the three replicates in each test.

The vegetation cover due to all of the species present in each plot (total vegetation cover) and the cover of the hydroseeded species were visually estimated by the same observer (Alday et al., 2008; Garcia-Palacios et al., 2010; Martinez-Ruiz et al., 2007; Matesanz et al., 2006).

The hydroseeding success index (HSI, ranging from 0 to 1) of Matesanz et al. (2006) was used to determine the relative contribution of hydroseeding to the community as:

$$HSI = HydC/TC$$

where HydC is the absolute cover of hydroseeded species and TC is the total vegetation cover of the plot in percentage.

Statistical analysis

The effects of block, check date and test and their interactions on hydroseeded vegetation cover, total vegetation cover and HSI, were analyzed by a general linear model (GLM). All the analyses were performed with the statistical software package Statgraphics centurion, version XV, Statpoint inc., USA, 2005.

Results

Meteorological data

Mean monthly temperature and relative humidity (maximum and minimum) and total monthly precipitation derived from the Sicilian Region database (SIAS) in the period 11/01/2008 – 11/30/2010 before the intervention and 12/01/2010 - 12/31/2011 after hydroseeding application referred to Sciacca weather station, are shown in Fig. 2.

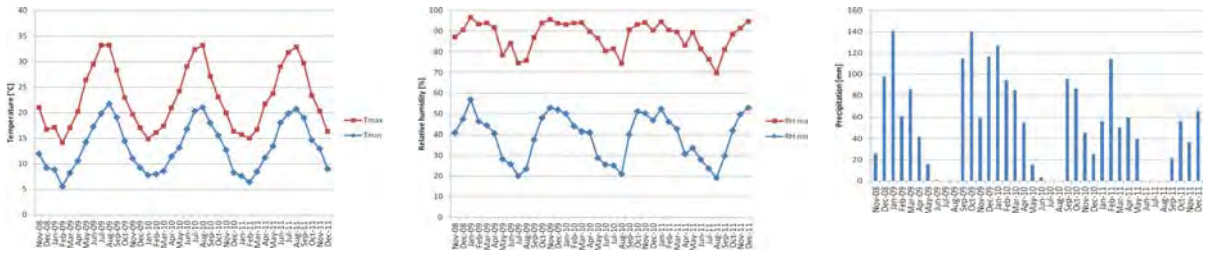

Figure 2. Mean monthly temperature (minimum and maximum), relative humidity and total monthly precipitation in the period 11/01/2008 - 12/31/2011.

Hydroseeded vegetation cover

Hydroseeded vegetation cover (%) was monitored for the four hydroseeding types applied (Fig.3). The highest values of this parameter were obtained in test 2 where thick hydroseeding was performed. In particular, in the period from February to May 2011, 80% of coverage was due to the hydroseeded species. Test 1, bonded fiber matrix hydroseeding,

shows the second best result as it reaches the value of 50% coverage due to hydroseeding but only in correspondence of the control performed on March 24, 2011. Subsequently it sharply decreases to 10% in April-May 2011. Tests 3 and 4 gave very similar results; in the period from February to May 2011 the hydroseeded vegetation cover is 30%. The R-Squared statistic indicates that the GLM model as fitted explains 98.8282 % of the variability in hydroseeded vegetation cover.

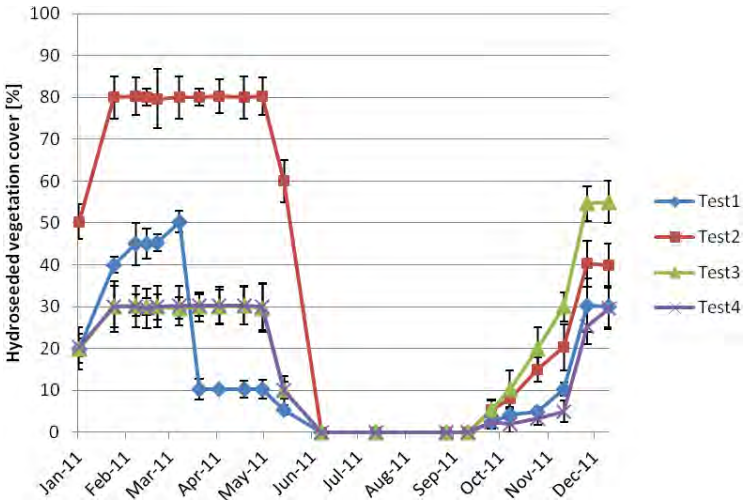

Figure 3. Hydroseeded vegetation cover during the period of observation (January 2011 -December 2011) in test from 1 to 4.

Total vegetation cover

The values for total vegetation cover (%) observed in the monitoring period for the five tests are shown in Fig. 4. Total coverage includes both natural than hydroseeded vegetation. At the beginning of the monitoring period, December 2010, total vegetation cover gradually increases and reaches 100% in the period between February and May 2011. Between June and September, the plant cover disappears, and then comes back with increasing trend until the end of the observation period. The R-Squared statistic indicates that the model as fitted explains 99.7339% of the variability in total vegetation cover.

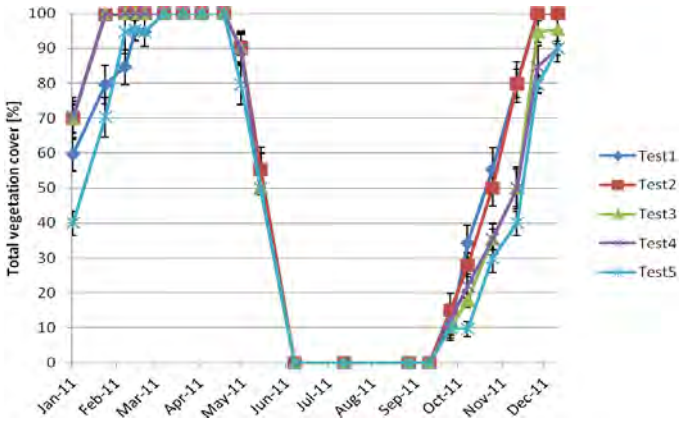

Figure 4. Total vegetation cover during the period of observation (January 2011 - December 2011) in test from 1 to 4.

Hydroseeding Success Index (HSI)

HSI gives information about the effectiveness of hydroseeding because it relates the hydroseeded vegetation cover to the total cover which allows to highlight the role played by hydroseeding on the restoration process of the study area. From the observations it emerges (Fig. 5) that the most successful test in the period January-June is test 2 (thick hydroseeding), while tests 3 and 4 show lower success in the same period. Test 1 is placed in intermediate position between the two previous. In the period from October to December HSI increases and reaches 0.60 only in test 3, while test 2 is merely 0.4. The success of tests 1 and 4 is quite modest. The GLM analysis explains 96.3078 % of the variability (R-Squared statistic) in HSI.

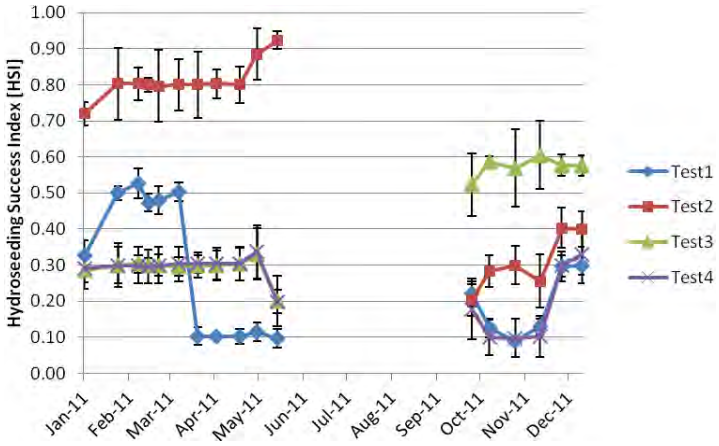

Figure 5. Hydroseeding Success Index during the period of observation (January 2011 - December 2011) in test from 1 to 4.

Conclusions

The results of the first experimentation performed in Sicily show that hydroseeding has good prospects of application on degraded areas in semiarid Mediterranean environments.

In our study HSI > 0.8 was obtained only in test 2 (thick hydroseeding, period February-June 2011) where there was the contemporary presence of earthworm humus and mulch in addition to the components present in the other tests.

Hydroseeding is applicable with satisfactory results in Sicily, where there is a typical southern Mediterranean climate characterized by mild winters and dry summers. This allows to recover all those highly degraded areas on which traditional machines trailed by or mounted on a tractor for soil and vegetation management cannot be used.

The study revealed that hydroseeding success is conditioned by the choice of the mixture components. In fact, on equal terms, mixture including earthworm humus and mulch provided the best results in terms of vegetation cover. Regarding the mixtures that have not provided satisfactory vegetation cover, irrigation is essential as stated by other authors (García-Fayos et al., 2000; Tormo et al., 2006).

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The authors are grateful to Mr. Federico Tecchio by "Full Service" Company (Saletto, Padua, Italy) for giving all the components for the hydroseeding mixtures and assisting during the tests execution. They also thank "Vivai Ciaccio" Company (Sciacca, Agrigento, Italy) for providing the hydroseeding machine used to perform the experimental tests.

References

Alday, J.G., Marrs, R.H., Martinez-Ruiz, C. 2008. The influence of aspect on the early growth dynamics of hydroseeded species in coal reclamation areas. Applied Vegetation Science, 11, 405-412.

Balsari, P., Manzone, M., Audisio, I. 2005. Macchine per l'idrosemina. Confronto per valutare la funzionalità. Sherwood, 117, 29-34.

Balsari, P. Manzone, M. 2006. Macchine per l'idrosemina. Confronto per valutare i costi di inerbimento. Sherwood, 118, 19-22.

Cano, A., Navia, R., Amezaga, I., Montalvo, J. 2002. Local topoclimate effect on short-term cutslope reclamation success. Ecological Engineering. Ecological Engineering 18, 489–498.

García-Fayos, P., García-Ventoso, B., Cerdà. A. 2000. Limitations to plant establishment on eroded slopes in southeastern Spain. Journal of Vegetation Science, 11, 77–86.

García-Palacios, P., Soliveres, S., Maestre, F.T., Escudero, A., Castillo-Monroy, A.P., Valladares, F. 2010. Dominant plant species modulate responses to hydroseeding, irrigation and fertilization during the restoration of semiarid motorway slopes. Ecological Engineering, 36, 1290–1298.

Martìnez-Ruiz, C., Fernandez-Santos, B., Putwain, P.D., Fernandez-Gomez, M.J. 2007. Natural and man-induced revegetation on mining wastes: Changes in the floristic composition during early succession. Ecological Engineering, 30, 286-294.

Matesanz, S., Valladares, F., Tena, D., Costa-Tenorio, M., Daniel Bote, D. 2006. Early Dynamics of Plant Communities on Revegetated Motorway Slopes from Southern Spain: Is Hydroseeding Always Needed? Restoration Ecology, 14, 2, 297–307.

Muzzi, E., Roffi, F., Sirotti, M., Bagnares, U. 1997. Revegetation techniques on clay soil slopes in northern Italy. Land Degradation & Development, 8, 127-137.

Tormo, J., Bochet, E., García-Fayos, P. 2006. Is seed availability enough to ensure colonization success? An experimental study in road embankments. Ecological Engineering, 26, 224–230.

Development perspectives of electronic systems in pest control strategies

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Abstract
The codling moth, *Cydia pomonella (L.)* (Lepidoptera Tortricidae), is a key pest in apple and pear trees and requires an effective pest management. Integrated pest management (IPM) represents among the pest control strategies adopted in the years one of the most diffused methods and it requires sex pheromone traps regularly checked by the farmer for pest monitoring. IPM is currently applied also in the monitoring and control of stored products insects and in general in the food industry. An automatic electronic trap designed to monitor the flight of codling moths, able to identify the pest and to forward the information on males caught has been developed. The electronic device was designed basing on the commercial Carpotrap. Modifications carried out on the standard sticky trap did not affect the performance of the trap in catching the male codling moths. The images sent to a remote unit allowed an easy identification of the moth. Current activity is in progress in order to apply the same approach to a standard sticky trap used in the food industry to monitor Plodia interpunctella (Hubner) and Ephestia kuehniella Zeller, very common pests of dry plant produce, especially cereals, and found around the world.

Keywords: pheromone trap, codling moth, pest management

Introduction
The Integrated Pest Management (IPM) requires the integration of multiple disciplines and control measures to achieve a management aimed at prevention of pest damage before reaching the threshold of economic damage. The implementation of IPM foresees assessment of factors that regulate the systems involved, the monitoring of insect populations and the availability of historical data to define appropriate measures to manage infestations (Trematerra, 2012).

IPM approach is used in orchard crops protection but it starts to be applied also in stored agricultural products and in food industry.

In pest protection of apple fruits impressive progress has been observed in monitoring populations of *Cydia pomonella* (L.) the Codling moth. Pest monitoring allow improving insect control, by using biological, chemical or physical treatments, and decreasing the impact of pesticides on environment, crops, operators and consumers.

Use of sex pheromone traps in IPM refers mainly to the overcoming of the economic damage threshold evaluated by counting the trapped males. In Emilia Romagna region (Italy) the treatments against codling moth are fixed overcoming two males captured per trap in a week (ERMES, 2011). Two/three traps per hectare of orchard surface are the standard in normal operation, checked once or twice per week by technicians to verify the males caught so as to decide the spraying date.

Codling moth (Fig. 1) has been monitored using sex pheromone traps in apple and pear orchards since the beginning of the '70s. This was due to the discovery of the Codlemone (Roelofs et al., 1971; McDonough and Moffitt, 1974), component of the natural pheromone released by the codling moth female.

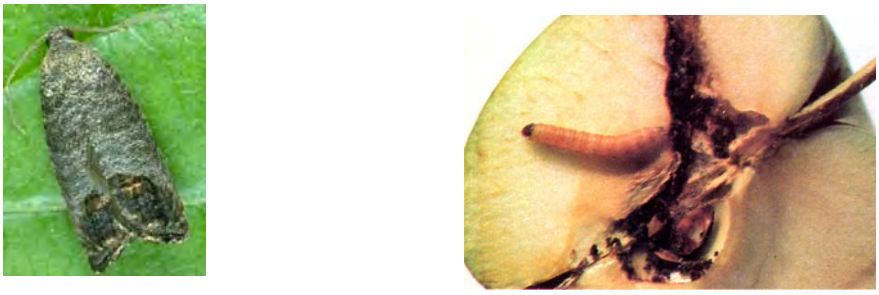

Figure 1. Codling moth: adult and larvae

The trap shape and the dispenser type, together with the trap opening width, are the key factors for trap efficiency. Various researchers have demonstrated that a reduction of the width allows an increase in the number of captured males (Madsen and Vakenti, 1973; Charmillot et al., 1975). The increase of the effectiveness of the codling moth traps has been achieved obtaining a thin wake of pheromone in output from the trap, combined to a small opening, so as to increase the difficulties in flight out (Accinelli et al., 1998).

Nonetheless the codling moth remains the most damaging pest on apples and, among the control strategies currently evaluated by various researchers, there is a physical system of control, the "Alt'carpo" system (Fig. 2). It consists in a barrier made of nets enclosing the single row or the complete apple orchard for avoiding the contact of the moth with the fruit (Severac and Romet, 2008). In this enclosed environment, mainly when it is extended to all apple orchard, sex pheromone traps could be used as safety system to check the efficiency of the protecting nets.

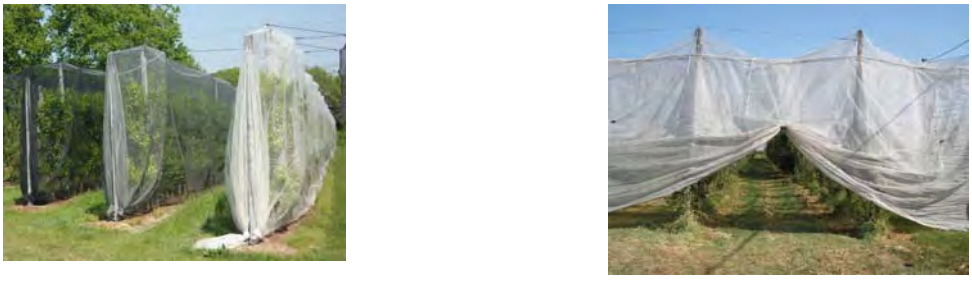

Figure 2. Alt'carpo system to protect apple rows and orchards

In addition, new environmental friendly techniques are used to control the codling moth by spraying not only chemical insecticides, but also releasing beneficial insects and microbial preparations, the latter usually less persistent in time with respect to conventional insecticides. Therefore, an efficient monitoring with pheromone traps becomes even more important in order to match the treatment to the flight start (Maini, 2007).

A further application of the sex pheromone traps is in the food industry for monitoring the insects damaging the stored products, either raw products and processed ones. IPM concept applied to stored products requires the definition of the tolerance thresholds for the different pests (Trematerra, 2012). This is due to the fact that in the case of stored raw

products is acceptable the presence of a limited number of pests, on the contrary in the phases of product transforming and preparation of food products, as in their packaging, the economical threshold becomes close to zero. In any case the pheromone traps could be used to check the presence of the insects and to evaluate the dimension of the population to carry out targeted treatments only when strictly necessary. Traps used in stored products monitoring are often similar to the sticky traps applied for the codling moth, but there are also traps differently shaped to prevent the escape of trapped pests. These have been developed based on empirical and their performance are still affected by this factor (Barak et al., 1990).

Ephestia kuehniella Zeller and *Plodia interpunctella* (Hubner) (Fig. 3), both moths of the family Pyralidae, very common pests of the stored products, are monitored by means of sticky traps similar those used for the codling moth.

Figure 3. The larvae of *Plodia interpunctella* Zeller and the damage on a chocolate piece.

The necessity of higher efficient monitoring of the pests associated with more frequent controls allowed for the development of monitoring systems with different solutions of automation.

Pest detection and monitoring systems, based on acoustic transducers for sensing the sound of the insects, able to send electronic signals to identify the locations of the traps have been developed (Beroza, 2002). Other systems based on an automatic counting of the captured insects were fitted with crossing transducers (Kliewe, 1998). A different approach has been implemented with automatic record systems using a camera designed to record the periodicity of pheromone trap catches (Kondo et al. 1994) or to automatically transfer the images to a computer where an image processing technique counts the insects (Shimoda et al., 2006). Technologies of identification and classification of the insects were also developed as demonstrated by specific researches and patents (Wen, et al., 2009; Landwehr and Agudelo-Silva, 2005).

The availability of electronic technologies on the market and a progressive cost reduction make it possible to adapt commercial solutions to the aims of pest monitoring, in the crop production in open field and in food industry. The paper report the results, already presented (Guarnieri et al., 2011), obtained with a prototype of an automatic electronic trap designed for monitoring the Codling moth.

Currently a new prototype of electronic trap for monitoring the moths damaging the products in the food industry is in development. As first step, the focus are *P. interpunctella* and *E. kuehniella.* The results will be discussed in a future paper.

Materials and methods

On the basis of the IPM approach a first prototype of the electronic traps has been designed modifying a commercial trap (Pomotrap, Sumitomo Chemical Italia, Milan, Italy) specific for the *C. pomonella.*. The Pomotrap consisted of an envelope with a defined shape in which a sticky pad and the pheromone dispenser were inserted. Two side openings in the trap allowed male moths to enter. The Pomotrap was modified for fitting the electronic devices (Fig. 4).

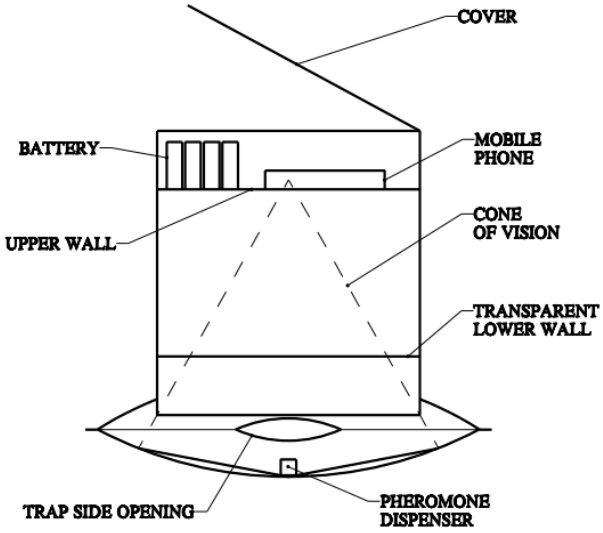

Figure 4. Layout of the electronic trap.

To realize the electronic trap, a commercial acquisition and data transfer system using wireless technology was selected. The system was composed of a programmable Smartphone, with an integrated camera of 3 Mpixel and the Symbian operating system.

To allow for a sufficient autonomy of the system, the Smartphone was integrated with an external power management unit.

To adapt the system to the monitoring needs, the software modules were realized. A temporized storage of the photos, in order to connect the camera at defined intervals, to fix the parameters in function of the brightness conditions and to memorize the photos was provided. A data sent on an EDGE/GPRS network to periodically transmit the data to a remote server, to save a local copy of the data and to resend the data missed in case of a temporary network breakdown was also realized.

The power management system allowed for a reduction of the Smartphone power consumption.

After a preliminary check of the functionality and the autonomy of the monitoring electronic system, two electronic trap prototypes were built. Field tests were performed in an apple orchard (variety: golden; planting layout: 4.0 x 2.5 m) of the Bologna University Experimental Farm. The traps were placed on the trees at a height of 1.7 m from the soil. On the 3rd row, two traps, one traditional Pomotrap (Trap A) and one electronic trap prototype (Trap B) were placed at a reciprocal distance of 60 m and both at a distance of 10 m from the orchard borders. On the 8th row, in the opposite positions with respect to the previous traps, were placed the second electronic trap prototype (Trap C) and the traditional Pomotrap (Trap

D). All the traps were placed with the openings oriented in the same direction, to reduce the effect of the wind direction on the captured moths (Fig. 5).

The tests were performed between April 12 and August 29, 2010. Treatments against the codling moth were not performed during this period, to assure a high infestation of the moth. The electronic system was set to acquire a daily photo at 8.30 am and to send it immediately to the remote server for a visual evaluation of the captured moths. This adjustment was defined considering a normal operating condition of an electronic trap for the codling moth management. The visual inspection of the traditional traps was performed weekly, as in the normal practice when commercial pheromone traps are used, while the exchange of the sticky pad and pheromone dispenser was carried out monthly in all the four traps.

Figure 5. Standard Pomotrap and electronic prototype trap.

Basing on the previous experience and taking into consideration the application of the electronic concepts to the monitoring needs of the food industry, the second prototype is currently in development for the control of insects as the *P.interpunctella* H and *E. kuehniella* Z.. The trap is designed on the commercial sticky trap used for the moths. In this second prototype a simplification of the electronic devices and power management unit is foreseen with respect to the typical conditions of the operating environment. Indeed the prototype will not be exposed to environmental conditions and to spray applications.

Results

During the field tests the different components, such as software, hardware and the external envelope, worked properly. The exposure to the environmental conditions did not affect the performance observed in the preliminary laboratory checks.

The images of the captured moths arrived daily at the remote server (Fig. 6).The traps captured other insect species as flies and midges, but with a dimension and a shape perfectly identifiable in the images.

The weekly control demonstrated a perfect agreement between the captures registered through the evaluation of the photos transferred to the remote system and those checked during the visual control on the field. The males captured were always located in the cone of vision of the camera. The results of the moths caught in the electronic traps and in the standard ones, cumulated in the test period, show that the modifications introduced on the external envelope of the traps did not influence the capture efficiency of the electronic traps (Fig. 7). In total 325 males of codling moths were trapped in the four traps and in particular Trap A: 94 samples (29 %); Trap B: 88 samples (27 %); Trap C: 69 samples (21 %); Trap D: 74 samples (23 %). In total 325 males of codling moths were trapped in the four traps and in

particular Trap A: 94 samples (29 %); Trap B: 88 samples (27 %); Trap C: 69 samples (21 %); Trap D: 74 samples (23 %).

Figure 6. Images of the trapped insects. On the left camera cone of vision with the sticky pad and the pheromone dispenser in evidence. On the right two males trapped.

The very high number of males captured, as a consequence of the conditions of the test orchard and the absence of specific treatments, allowed for an accurate adjustment of the electronic system.

The moths captures started from the middle of April to the end of August.

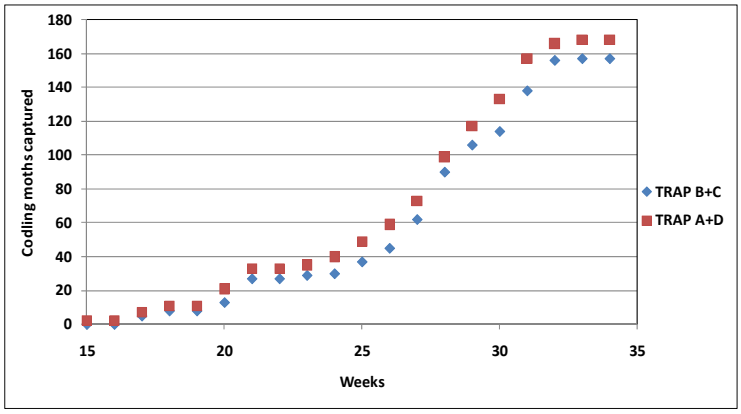

Figure 7. Accumulation of the codling moths captured in the electronic traps (Trap B + C) and in the commercial ones (Trap A + D).

Electronic monitoring of Codling moth can be a valuable method to obtain effective treatments by means a more accurate choice of the treatment time. The results obtained demonstrate that the electronic trap can also represent a valid support for territorial authorities to better calibrate the forecast models.

Conclusions

The electronic trap efficiency, verified on the field with the codling moth in terms of number of insects captured, images transferred and easy identification of the moths, allows to widen the applicability of the system to other kinds of traps, like those used in the food

industry context. The automatic monitoring could permit a reduction of staff costs due to a lower control of the traps.

The system flexibility also permits an increase of the monitoring frequency to use the system not only for field analyses but also for research investigations (as a better identification of hours for male flights in case of application of mating disruption, etc.).

Technical and operating characteristics of the automatic trap allow to consider the development of commercial systems with a wide potential market, also favoured by the continuous updating of electronic technologies, their availability on the market and progressive cost reductions.

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References

Accinelli G., Maini S., Capizzi A. 1998. Effetti del tipo di trappola e dell'innesco feromonico sulla cattura di *Cydia pomonella*. Informatore fitopatologico, 48 (1-2), 70-75.

Barak A.V., Burkholder W.E., Faustini D.L. 1990. Factors affecting the design of traps for stored-product insects. J. Kansas Ent. Soc., 63, 466-485

Beroza M. 2002. More efficient and environmentally-desiderable means of detecting insects entering lure-baited traps or attractive areas. U.S. Patent No. 0144452.

Charmillot P. J., Baggiolini M., Murbach R., Arn H. 1975. Comparison de differentes pieges à attractif sexuel sinthetique pour le controle du vol du carpocapse (Laspeyresia pomonella L.). Schweizerische Landwirtschaftkiche Forschung, 14(1), 57-69.

ERMES. 2011. Disciplinari di produzione dell'Emilia Romagna. http://www.ermesagricoltura.it.

Guarnieri A., Maini S., Molari G., Rondelli V. 2011. Automatic trap for moth detection in integrated pest management. Bulletin of Insectology, 64 (2): 247-251

Klieve V. 1998. Elektronisch gesteuerte zeitfalle zur untersuchung der tageszeitlichen aktivitat von bodenarthropoden. Beitrage zur entomologie, 48(2), 541-543.

Kondo A., Sano T., Tanaka F. 1994. Automatic record using camera of diel periodicity of pheromone trap catches. Japanese Journal of Applied Entomology and Zoolog, 38(3), 197-199.

Landwehr V. R., Aguledo-Silva F. 2005. Method and system for detecting and classifying objects in images, such and insects and other arthropods. U.S. Patent No. 0025357.

Madsen H. F., Vakenti J. M. 1973. The influence of trap design on the response of Codling moth (Lepidoptera Olethreutidae) and fruittree leafroller (Lepidoptera Tortricidae) to synthetic sex attractants. J. Ent. Soc. Brit. Columbia, 70, 5-8.

McDonough L. M., Moffit H. R. 1974. Sex pheromone of the codling moth. Science, 183: 978.

Maini S. 2007. Nuove applicazioni dei feromoni per la lotta integrata nei frutteti. Frutticoltuta, 2, 48-56

Roelofs W. L., Comeau A., Hill A., Milicevic G. 1971. Sex attractant of the codling moth: characterization with electroantennogram technique. Science, 174, 297-299.

Severac G. and Romet. L. 2008. Alt'carpo, una rete contro la carpocapsa del melo. L'Informatore Agrario, 43, 47-49

Shimoda N., Kataoka T., Okamoto H., Terawaki M., Hata S. 2006. Automatic pest counting system using image processing technique. Journal of the Japanese Society of Agricultural Machinery, 68(3), 59-64.

Trematerra P. 2012. Riflessioni sui feromoni degli insetti ifestanti le derrate alimentari. Atti Accademia Nazionale Italiana di Entomologia, Anno 59,2011: 83-89.

Wen C., Guyer D. E., Li W. 2009. Automated insect classification with combined global and local features for orchard management. ASABE Paper No. 095865. St. Joseph, Mich.: ASABE.

Innovative strategy and machines for non chemical management of weed seed-bank and actual spontaneous flora in turf grass

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Abstract
Weed management is a major issue not only in agriculture but also in cities and in public and sport turfs. As a matter of fact, in the latter case an effective control of weed flora is needed in order to maintain a high quality and functionality of the turf. Actually, weed control in turfs is performed by means of very high amount of herbicides. This kind of management is very dangerous as it is connected with very high risks of environment pollution and consequently for operators and citizens safety and health. In this context, public concern about agrochemical use in turf is more and more increasing and there is a clear need to define and use alternative and non chemical methods of weed control in turfs. This paper aims to summarize the main results achieved by the University of Pisa in about three years of research carried out on the possible application of thermal weed control in turfs.

Keywords: Flaming, steaming, turf

Introduction
Weed management is a major issue not only in agriculture but also in cities and in public and sport turfs. Weed development often generates negative aesthetic effects, a sense sloppiness, mechanical damages to hard surfaces, the reduction of visibility for drivers, the reduction of the quality of the quality of the turf, and can make difficult for pedestrians to walk.

In this context, public concern about agrochemical is more and more increasing, thus alternative means for weed control are needed (Kristoffersen et al., 2004; Larsen et al., 2004).

This paper aims to summarize the main results achieved by the University of Pisa on thermal weed control in urban hard surfaces and turfgrasses.

Methods
Concerning with thermal weed control in turf-grasses, both steaming and flaming (Fig. 1) were tested and compared to herbicides application in order to achieve the complete control of an old lawn composed by Lolium sp. and Festuca sp. aiming at a replacement with a Cynodon hybrid obtained with an innovative sod planting technique (Fig. 2). For this purpose, innovative machines designed and realized at the University of Pisa were used. Moreover, the application of activated steam by means of a very innovative self-propelled machine, able to well control weed seed bank, was tested before the planting of a warm season turf-grasses on tilled soil.

Figure 1. Operative machines for flaming and steaming applied on turf.

Figure 2. Planting of pre-cultivated warm season turfgrass species

Results

The results of these experiments showed that thermal treatments realized applying both steam and open flame at different doses allowed to obtain levels of weed control comparable to those reached by herbicides application, stressing the very good future perspectives of these innovative techniques in order to guarantee environment safety in high quality functional turfs.

References

Larsen, S.U., Kristoffersen, P., Fischer, J. (2004) Turfgrass management and weed control without pesticides on football pitches in Denmark, Pest Management Science, 60, 579-587

Kristoffersen, P., Larsen, S.U., M□ller, J., Helse, T. (2004) Factors affecting the phase-out of pesticide use in public areas in Denmark, Pest Management Science, 60, 605-612

Medical geology and assessing effects of radioactive contamination on human health

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Keywords: medical geology, radioactive contamination, hazard index, cancer, Iraq

The hazard index (H) of the radioactive contamination from Uranium, Thorium and Potassium in soils and surface sediments and its impacts on human health were highlighted in this study. The anthropogenic source of the contamination was due to an accident case during 2003 at a U-radioactive Waste Grave 40 km West of Mosul city at Northern Iraq. Surface soil and sediment samples were taken from locations around the contaminated site and within the site itself it in addition to samples from Tel-Serwal and Al-Ragrag Villages. The both villages were Hydro-geologically located down stream next to the contaminated site.
The calculated hazard index (H) result values shows that the impacts of the radioactive contamination advanced through out the surrounding area specially down stream positions, and reaches a secondary school at Tel-Sarwal village. This note were supported by a local hospital which documented that two pupils of the secondary school died suffering from cancer, in addition to the abnormal increasing in cancer cases after the contamination event in 2003 in the both villages.
The hazard index values rated from less than (0.01) in positions up stream the contaminated site, and maximum (5.5) down stream. Six localities shows hazard index value more than (1.0) which is the normal case for safe or the accepted level of contamination in soils according to the international regulations.

Implementation of a system for evaluation risk and management safety in an Italy farm

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Abstract
In Italy accidents in agriculture are a major part of total accidents at work.
The aim of this study is to develop and apply tools for the analysis of risk assessment and its use of integrated methods aimed at security management in the Azienda Agraria Didattico-Sperimentale of Università Politecnica of Marche. In order to analyze the risks assessment, a mechanism based on some indicators was planned. The measurements were carried out "in field", through inspections, not neglecting, however, the news gleaned from the documentation provided by the Azienda Agraria itself, and interviews with workers.
To evaluation risks a database and checklists to gather data were created and were used.
The measurements on the structures, areas, machinery and equipment company were made. The results were elaborated and organized to quickly identify risks. The elaborated data show risks arising from physical agents such as noise and vibrations, UV, manual handling of loads and risk from carcinogenic and mutable agents. The most obvious deficiencies are in fact mainly due to the lack of systematic checks on plants and equipments: the Azienda Agraria is directed to enhancing the training and information plans about safety and health in agriculture and measures inspection of facilities and equipment to avoid a deterioration of the safety conditions within the Azienda Agraria.

Keywords: agriculture, risk assessment, prevention and protection's measures

Introduction

Agriculture is one of the most hazardous occupations worldwide. In several countries the fatal accident rate in agriculture is double the average for all other industries.

The intensive use of machineries and of pesticides and other agrochemicals has raised the risks. In fact the most frequent risks in agriculture are related to machinery such as tractors, trucks and harvesters, and cutting and piercing tools, to chemicals, to toxic or allergenic agents, to carcinogenic substances or agents, to UV radiations, to transmissible animal diseases, to confined spaces such as silos, to pits, cellars and tanks, to noise and vibration, to ergonomic risks and to extreme temperatures due to weather conditions.

According to INAIL data, in Italy accidents in agriculture are a major part of total accidents at work (INAIL, 2010). In 2008, for example, there were 125 deaths among agricultural workers, the 11% of total fatal workplace accidents of all other activity sectors (ISTAT, 2010). In this research an analysis of risk assessment for safety and health in the Azienda Agraria was developed and applied. The survey was performed in the years 2010-2011 in the Azienda Agraria Didattico-Sperimentale of Università Politecnica of Marche. The collected informations and the carried out processing highlight the critical points and identify risks. The necessary improvements are presented to restore the optimal security conditions.

Materials and Methods

The Azienda Agraria Didattico-Sperimentale

The Azienda Agraria Didattico Speriementale was created on 1993 to conduct research and development field projects on behalf of the Università Politecnica delle Marche. The Azienda Agraria's mission was extended to the students of all the regional school (didactic farm) and to the farmers (extension service). Landscape management and maintenance of the entire University campuses was also included in the activities.

Research activities include grapevine, olive and fruit trees (apple, pear, peach, plum, apricots, cherry), strawberry, durum wheat, sunflower, barley, corn, sorghum, beans, chick peas breeding, variety evaluation, cultural practices, fertility and weed, insect and disease control. The organization remains true to its broader mission in support of Marche agriculture while creating the research base for programs and initiatives to boost Marche's economy and conserve the region natural resources. Sod seeding, minimum tillage, low impact management techniques, soil protection against erosion and loss of organic matter, integrated pest control, organic (biological) production are some of the studied sustainable approaches. Its recent research accomplishments include: to develop of practical, environmentally friendly ways to grow fruits, olives and vegetables; to recover the fruit germplasm of the region; to work on a wide range of climate-related issues that can affect Marche agriculture, recreation and tourism; to create a botanical garden with hundreds of plant species and varieties; to innovate pruning and training systems; to breed new strawberry varieties; to improve energy biomass production. The Azienda agraria leases 75 ha in Agugliano, ruled as integrated production, and 73 ha in Gallignano, managed as organic production, botanical garden and forest. All the land is available for research and demonstration projects.

The analysis of risk assessment for safety and health in the Azienda Agraria was developted in three phases:

- risk analysis
- risk evaluation
- identification of necessary measures to reduce the risk levels

Risk analysis

This risk analysis can be divided into two phases: the risk individuation and the risk description. Risk identification sets out to identify the Azienda's exposure to risks. Risk identification was approached in a methodical way to ensure that all significant activities within the Azienda Agraria were identified and all the risks flowing from these activities defined. All associated risks related to these activities were identified and catalogued. Instead the objective of risk description is to display the identified risks in a structured format, for example, by using some tables. The use of a well-designed structure is necessary to ensure a understanding risk identification, description and evaluation process. So in this study a database and checklists to gather data were created and used to the risks individuation and to the risk description.

The checklists are instruments for self evaluation which permit to verify carefully the status of implementation of health and safety in the environment, in the spaces and the quality standards of the equipment. The checklists examined the risks factors presented in Azienda Agraria, the organizational and normative aspects related to the workers health. The sources of risk in agriculture are numerous and diverse and the risk factors examined were the organizational risks, the physical risks and the dangerous substances. The risk analysis was done in according to D.Lgs 81/2008. The measurements were carried out "in field", through inspections in Azienda Agraria included the all workplaces, the frameworks, the equipments,

the car fleet. The measurements of the temperature, of the noise, of the relative humidity and of the illuminance in the structures were carried out and used to create a database. The measurements on the equipments were used to created tables organized for typologies and manufactory year spotlighting the technical weaknesses and behavioral shortcoming due to workers' behavior observed directly in the field.

During this analysis phase were collected the news gleaned from the documentation provided by the Azienda Agraria itself such as the register of accidents, the plant check documentations and protection documentation against lightning, the certifications of installers, and everything else needed to define the level of safety not neglecting, however interviews with workers.

Risk evaluation

Risk estimation can be defined in terms of the probability of occurrence and the possible consequence. Probability may be high, medium or low and requires a definition in respect of risks. The result of the risk analysis process can be used to produce a risk profile which gives a significance rating to each risk and provides a tool for prioritising risk treatment efforts. This process allows the risk to be mapped to the area affected, describes the primary control procedures in place and indicates areas where the level of risk control might be decreased. Risk evaluation therefore, is used to make decisions about the significance of risks to the Azienda and whether each specific risk should be reduced or, if it is possible, removed.

In order to analyze the risks assessment, were used the checklists, the measurements, the documentations provided by the Azienda Agraria and the interviews with workers and a mechanism based on some indicators was planned. The evaluation methodology was done in according to D.Lgs 81/2008 (Orientamenti sulla valutazione dei rischi; Sicurezza e salute sul luogo di lavoro, 1993; ISPESL Linee Guida per la "Valutazione del Rischio" - Decreto Legislativo 81 del 2008).

To develop the risk profile, the risk and the risk evaluation were defined.

The risk was defined as the combination of the probability of an event and its consequences (ISO/IEC Guide 73). The risk evaluation was defined as the evaluation process of the possible extent of the damage for safety and health of the workers. The risk level "R" was estimated using a matrix in which the input values were the probability "P" and the produced damage index "M".

A theory of probability connects the mathematics of probability, which is the set of consequences of the axioms of probability with the real world of observation and experiment. According to the subjective theory of probability, probability "P" is a number that indicates if there are some possibilities that an event will occur. The number is on a scale of 1 to 4, with 1 indicating that the risk is negligible with low probability to have a damage for workers, and 4 indicating that there is a high probability that damage will occur to workers.

Table 1. Probability (P)

PROBABILITY (P)		
Level	*Definition*	*Value*
unlikely	The risk is negligible with low probability to have a damage for workers and it won't increase in the future	1
not much likely	A damage may occur to workers in some specific and rare situations	2
likely	There is a certain probability that damage will occur to workers and it could increase in the future	3
much likely	There is a high probability that damage will occur to workers	4

The same criterion was utilized to quantify the damage "M". Damage "M" is a number that measures how strongly we believe a damage will occur. The number is on a scale of 1 to 4, with 1 indicating that the damage is very light, and 4 indicating that the damage is very grave.

Table 2. Damage (M)

DAMAGE (M)		
Level	*Definition*	*Value*
light	The damage level is very light, almost absent, and it could involve a reversible illness or accident in little time	1
not grave	The damage level is not grave and it could involve a reversible illness or accident	2
grave	The damage level is grave, it could increase in the future and it could involve a partial permanent disability	3
very grave	The damage level is very grave and it involves a permanent disability or death	4

The "R" function was represented by a matrix given by the following product:

$$R = M \cdot P$$

The risk levels "R" are shown in Table 3.

Table 3. Risk level

RISK		
Level	*Definition*	*Value*
slow	No actions are required	R=1
medium	It is necessary to plan and realize in a short time the actions to reduce the risk	$2 \leq R \leq 3$
hight	It is necessary to plan and realize urgently the actions to reduce the risk.	$4 \leq R \leq 8$
very hight	It is necessary to plan and realize immediately the actions to reduce the risk.	R>8

In this way at every risk sources were correlated the risk levels and the consequent actions. For every Azienda Agraria's frameworks and equipments the risks for the safety and health of workers were estimated quantitatively and the technical, organizational and formative actions were planned to reduce the risk levels and to get better the safety conditions.

Results

From the risk evaluation were come out the criticalities and their evaluations. In Table 4 are shown the "R" values about the Azienda Agraria's workplace, frameworks and equipments.

Table 4. Risk levels "R" in Azienda Agraria

	RISK LEVEL
ORGANIZATIONAL RISK	
Interference	R = 1
Organization	R = 1
Emergency management	R = 1
Formation and information	R = 1
Maintenance	R = 1
Health supervisory	$2 \leq R \leq 3$
Work correlated stress	R = 1
Workplaces	$2 \leq R \leq 3$
Safety signs	R = 1
Individual protection devices	R = 1
Manual handing of loads	$2 \leq R \leq 3$
Video display terminal	R = 1
Electric equipments and systems	$2 \leq R \leq 3$
Technical systems	R = 1
Machinery and equipment	$2 \leq R \leq 3$
PHISYCAL RISK	
Noise and vibrations	$2 \leq R \leq 3$
Lighting	$2 \leq R \leq 3$
Microclimate	$2 \leq R \leq 3$
Electromagnetic field	R = 1
Artificial optic radiations	R = 1
UV exposure	R = *
Ionize radiations	R = 1
DANGEROUS SUBSTANCES	
Chemical risk	$2 \leq R \leq 3$
Blaze risk	$2 \leq R \leq 3$
Carcinogenic and mutagen agens	$2 \leq R \leq 3$
BIOLOGICAL AGENS	
Biological risk	R = 1
ESPLOSIVE ATMOSPHERES PROTECTION	
Esplosive atmospheres	R = 1

*under evaluation

These results were used to do a risks reporting and communication. In all cases in which the risk level is $2 \leq R \leq 3$ a plan of the actions to decrease the risk levels was implement.

For example to decrease the risks caused from the manual handing of loads, the workers were informed about this risk and its consequences on health and about obligation not to move manually heavy loads. Below are shown, for example, some results of the noise levels measured on the equipments used in Azienda Agraria. Every machine was directly analyzed and measured to establish the produced noise level according to the laws in force. With the collected data it was possible to establish the maximum exposure times for every instrument. All instruments, equipments, structures were measured during the regular working activity.

The measurements showed that the sound instantaneous weighted pressure levels in frequency- C are smaller than 135 dB(C).

Table 5. Examples of measured noise levels

Machine – equipment	L_{eq} *dB(A)*	L_{eq} *dB(C)*	P_{peak} *dB*
Chain saw Efco 132	93,8	95,2	114,7
Chain saw Efco 140	98,8	100	117
Chain saw Still MS 200T	101,9	101,9	121
Grass cutter Efco 8400	94,1	95,5	122,6
Grass cutter TBC 441 IS	97,2	98	122,4
Hedge Trimmer Tanaka TBC EH 2ST2	91,3	99,2	130
Hedge Trimmer Tanaka HTD 253 OPF	101,4	104,4	125,3
Grass shredder Benassi Ft155 special	84,5	89	104,1
Grass shredder Orec HR801	89,6	93,9	113
Grass mover Tanaka HTD 253 OPF	94,2	95	110,7
Grass mover Orec GRH 535	84,9	89,6	117,4
Tractor Castle Garden XX 220 HD	97,4	98	118
Wood chipper Cipper 04 TPS	89,8	96,9	114,5
Rotary tiller Benassi MC2300	87,7	91,8	115,7
Tractor with grass shredder Orsi WH01800	84,8	88,3	104,7
Leaf cleaning blower Dolmar PB 250.4	83,5	87,8	108,6

The noise pressure levels using the personal protective equipments were valued in according to UNI EN ISO 4869-2. In particular the SNR method (single number method) was utilized.

Using the personal protective equipments the personal exposure level were smaller 80,0 dB(A). The measures to decrease the risk levels due to physical risks are the maintenance efficiency of the machineries and equipments respecting maintenance programs provided by the manufacturers, the supply of individual protection devices and an appropriate restriction on the time use of machineries or equipments which transmit noise and vibration.

Conclusion

With new globalization trends, quality management standards and quality product standards implicitly include improvements in working conditions. Working conditions in agriculture can be significantly improved in a viable and cost-effective way through safety and health measures. Investment on occupational safety and health also provides higher labour productivity and healthier labour relations. The adoption of adequate labour legislation and social protection measures are major steps in that direction.

Risk management is a central part of any Azienda's strategic management. It is the process whereby organisations methodically address the risks attaching to their activities with the goal of achieving sustained benefit within each activity and across the portfolio of all activities. The focus of good risk evaluation is the identification and treatment of these risks.

Its objective is to add maximum sustainable value to all the activities of the organisation. Risk analysis and risk evaluation should be a continuous and developing process which runs throughout the Azienda's strategy and the implementation of that strategy. It should address methodically all the risks surrounding the Azienda's activities past, present and in particular, future. For all these reasons the risk analysis and its use of integrated methods aimed at security management in the Azienda Agraria Didattico-Sperimentale of Università Politecnica delle Marche were done.

The carried out risk analysis reveals a situation generally acceptable. The most obvious deficiencies are in fact mainly due to the lack of systematic checks on plants and equipments.

To restore the optimal security conditions the Azienda Agraria will develop some information and formation plans about safety and health in agriculture, it will improve the safety systems, it will carry out some inspections on systems and equipments to avoid a decay and worsening of safety conditions within it.

References

Istituto Nazionale per l'Assicurazione contro gli Infortuni sul lavoro. 2010.www.inail.it

Istituto Nazionale di Statistica. 2010.www.istat.it

D.Lgs. 81 /2008.

Orientamenti sulla valutazione dei rischi (Comunità Europea DG V/E/2 unità medicina e igiene del lavoro-CEE).

Sicurezza e salute sul luogo di lavoro (Guida ad uso delle PMI - Commissione delle Comunità Europee - CEE) 1993.

ISPESL - Linee Guida per la "Valutazione del Rischio" - Decreto Legislativo 81 del 2008.

UNI EN ISO 4869-2: "Stima dei livelli di pressione sonora ponderati A quando i protettori auricolari sono indossati, 1998.

Innovative strategy and machines for physical weed control in agriculture and urban areas

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Abstract
Weed control represents a serious problem in both agriculture and urban areas. The need of replace the use of herbicides with more sustainable weed control techniques encouraged the definition of innovative physical weed control strategies. Mechanical and thermal means were used to control weeds, both before and after sowing or transplanting, on the main herbaceous and vegetables like fresh market spinach, processing and fresh market tomato, cabbage, greenhouse cultivated leaf beet, garlic, chicory, fennel and carrot. For urban areas are available on market flaming machines fed by LPG that allow controlling weeds in small and large surfaces.
The physical weed control strategies are able to control weed as well as herbicides, present the relevant advantage to safeguard the environment and the human health and represent the only solution that can be used in organic agriculture. Moreover, common means to control weed in urban areas like mowing resulted ineffective.

Keywords: physical weed control, mechanical weed control, thermal weed control, environment safeguard, sustainability

Introduction

In agriculture, weed competition, especially within the crops row, is considered one of the major limiting factors to obtain high productions (Bond and Grundy, 2001; Van der Weide *et al*., 2008). Weed control is particularly difficult in organic agriculture and in vegetable crops because of the low competitive ability characterizing these crops and the lack of registered and effective a.i. (Bàrberi, 2002; Fennimore, 2008). It is therefore necessary the adoption of physical weed control techniques that replace the use of herbicides (Peruzzi *et al*., 2006). Moreover, physical weed control techniques are becoming increasingly important legislative level and are promoted in order to ensure lower environmental impact and the health of consumers and operators (Council Regulation (EC) No 73/2009; Directive 2009/128/EC).

Weed presence in urban areas also represents a problem because it can cause damages to the city structures (i.e. roads, squares, walls, footpaths, cycleways, etc.) and complementarily alter its aesthetic sense. The damage, which consists in the disintegration of the building materials not resistant (i.e. plaster, asphalt, etc.), is a consequence of the weed's root systems and vegetative structures (i.e. rhizomes, stolons, tubers, bulbs, etc.) enhancement and the release of acids by root tips (Peruzzi *et al*., 2009). To contrast the development of weeds are commonly used herbicides and mechanical mowers that are not effective and thus able to maintain low levels of weed cover and present high risks for human health and environment safety. An alternative to these practices is represented by the strategies of

mechanical and thermal weed control that can be successfully used in all urban and sub-urban area contexts (Peruzzi *et al*., 2009).

The aim of this paper was to present innovative strategies and machines for physical weed control successfully tested on vegetable crops and hard surfaces in urban areas.

Methods

Since more than 20 years, many innovative operative machines for physical weed control were projected, fully realized, tested and optimized by the University of Pisa. They are based on different working principles (mechanical and thermal means in agriculture and only flaming in hard surface in urban areas).

On-farm experiments were carried out from 1990 firstly on herbaceous crops (winter cereals, maize, soybean, etc.) and successively on vegetables (carrot, spinach, tomato, cabbage, leaf beet, garlic, etc.).

Only the case of study concerning with the application of physical weed control in processing tomato during a 3-year experiment (2006-2008) carried out near Pisa, Italy, is reported in this paper (Raffaelli *et al*., 2011). The strategy used for physical weed control includes the depletion of weed seedbank by means of the application of the stale seedbed technique realized with two passes of a rolling harrow (Peruzzi *et al*., 2011) (Fig. 1) and a pass of a the flaming machine (Peruzzi *et al*., 2010a) (Fig. 2) before tomato transplant. After transplant two treatments with a precision hoe properly adjusted to work between and in the twin rows and between and in the rows of tomato were performed (Raffaelli *et al*., 2011) (Fig. 3). Chemical management included the distribution of four herbicides a.i. Pendimetalin of 317 g ha^{-1} plus a.i Oxadiazon of 341 g ha^{-1}, a.i Metribuzin of 87.5 g ha^{-1} and a.i. Rimsilfuron of 10.0 g ha^{-1}. The experimental design was arranged in a randomized complete block with four replications. Weed biomass at harvest and tomato yield were subjected to Standard ANOVA and Fisher's Protected LSD test was used with α=0.05 to describe differences between means.

A current study on physical weed control strategies concern the application of activated steam in bands of soil (band-steaming) in the middle of which the crop is sown aiming to a very high control of weed seed bank (till a depth of 7-8 cm) and thus giving a relevant competitive advantage to the crop seedlings. An innovative machine for band-steaming was developed and currently being tested by the University of Pisa (Fig. 4). The machine is composed by a steam boiler and eleven working units that allow a proper distribution and incorporation of steam and CaO into the soil aiming to prolong the heating of the soil and directly kill weed seeds. The machine has a large working width (5.2 – 5.6 m) that reduces the relevant operative times needed to perform the steaming treatments.

Figure 1. Rolling harrow, designed, tested and patented at the University of Pisa used to perform the stale seedbed technique on processing tomato near Pisa, Italy.

Figure 2. Flaming machine, designed and tested at the University of Pisa, used to perform the stale seedbed technique on processing tomato near Pisa, Italy.

Figure 3. Precision hoe, tested and optimized at the University of Pisa, used in post-transplant weed control treatments equipped with "V"-shape element in order to open the twin rows of processing tomato near Pisa, Italy.

Figure 4. Operative machine developed at the University of Pisa (Italy) to perform band-streaming and incorporate CaO into the soil.

Concerning with weed management in urban areas, at the University of Pisa were projected, realized and tested different flaming machines in order to control weeds in small and large surfaces (Fig. 5). All the machines (actually available on the market) use LPG to feed very innovative rod shape open flame burners.

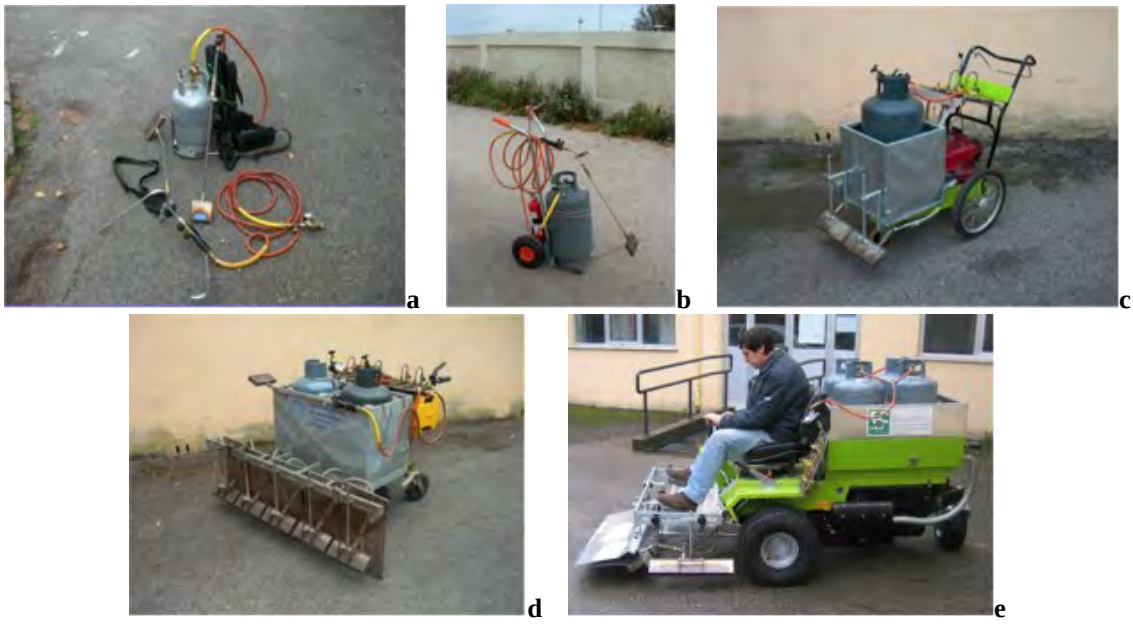

Figura 5. Flaming machines projected and fully realized at the University of Pisa to control weed in urban areas: a) knapsack flamer; b) trolley flaming machine; c) small self-propelled machine; d) large wheel-barrow self propelled machine; e) "rider" machine with sitting operator.

Experimental trials in urban area were carried out in several sites of the Municipalities of Pisa and Livorno (Central Italy). Only the main results of a 3 year experiment (2006-2008) concerning with weed control in the urban area of Piazza San Paolo a Ripa d'Arno (ancient Pisa cathedral characterized by a sandstone block surface) is reported in this paper (Peruzzi *et al*., 2010b). In this research flame weeding at low frequency (5 treatments years^{-1}) and high frequency (10 treatments years^{-1}) performed with the trolley flaming machine (Fig. 5b) was compared to an untreated control and to mowing treatments (4 treatments years^{-1}) performed with a standard string trimmer.

Moreover, the application of thermal weed control in sub-urban area was tested on a vertical surface (a historical stone wall with a high very density of *Parietaria officinalis* L.) in San Giuliano Terme Pisa, Italy, during 2009-2011 using the knapsack flamer (Fig. 5a). Also in this experiment flaming was compared with mowing performed with a standard string trimmer.

Results

Regarding the trials on processing tomato there were no significant difference in weed dry biomass at harvest between chemical and physical weed management systems with the exception of 2008 when was determined a lower value in the case of herbicide application. Increases in yield were obtained in the case of the use of physical management in 2006, 2007 and 2008 (Table 1).

Table 1. Comparisons between yield and weed biomass at harvest obtained using physical and chemical weed management of processing tomato. In each column means followed by the same letter are not significantly different at $\alpha \leq 0.05$ (LSD test).

	Yield (Mg ha^{-1})			Weed dry biomass (g m^{-2})		
Weed management system	**2006**	**2007**	**2008**	**2006**	**2007**	**2008**
Chemical	59.4 b	54.1 b	51.7 ns	102.9 ns	2.1 ns	5.1 b
Physical	72.1 a	61.9 a	52.1 ns	126.1 ns	21.9 ns	56.0 a

The preliminary results of the use of band-steaming showed an encouraging reduction in weed emergence into the soil bands treated with steam and CaO (Fig. 6).

Figure 6. In the red quadrat carrots grown undisturbed by weeds into the band where band-steaming was performed; in the inter band-steaming strips (white quadrat) the presence of weeds appear visibly higher (on the left). Untreated control (on the right).

Concerning with the experiment carried out in urban areas at Piazza San Paolo a Ripa d'Arno (Pisa, Italy) only high frequency flaming allowed to maintain a properly low weed cover (less than 10%) during the whole period (2006-2008) (Fig. 7). Moreover the cost of physical weed management was highly lower than that of mowing.

a **b**

c **d**

Figure 7. Details of the sandstone block square (Piazza San Paolo a Ripa d'Arno) in March 2008 after different treatments a) high frequency flaming; b) low frequency flaming; c) mowing; d) untreated control.

Finally, in figure 8 is shown the effect of flaming application on a very high density of *Parietaria officinalis* L. colonizing the stone wall of San Giuliano Terme (Pisa, Italy).

a **b**

Figure 8. Stone wall located in San Giuliano Terme, Pisa, Italy. a) wall before thermal weed control; b) wall after thermal weed control. The high part of the wall represents the untreated control.

Conclusions

According to the results obtained in long term experiments carried out since 1990, the application of physical weed control strategies is able to control weed as well as (and sometime even better of) herbicides. The physical weed control is cheap, easy to apply and present the relevant advantage to be safe for the environment and human health and thus to guarantee a very high degree of environmental safety in both agriculture and urban and sub-urban areas management.

References

Bàrberi, P. 2002. Weed management in organic agriculture: are we addressing the right issue? Weed Research, 42, 177-193.

Bond, W., Grundy, A.C. 2001. Non-chemical weed management in organic farming systems. Weed Research, 41, 383-405.

Council Regulation (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers, amending Regulations (EC) No 1290/2005, (EC) No 247/2006, (EC) No 378/2007 and repealing Regulation (EC) No 1782/2003.

Directive 2009/128/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides.

Fennimore, S.A. 2008. Introduction: the challenges of minor crop weed control, future directions. Weed Technology, 22, 363.

Peruzzi, A., Carpi, G., Fontanelli, M., Frasconi, C., Ginanni, M., Raffaelli, M., Sorelli, F. 2010a. Strategie e macchine innovative per il controllo fisico della flora spontanea su pomodoro e cavolo coltivati nella bassa Valle del Serchio. Stylgrafica Cascinese. [In Italian]

Peruzzi, A., Cloutier, D.C., Leblanc, M.L., Van der Weide, R.Y. 2011. Secondary tillage, In: Physical weed control: Progress and challenges. Topics in Canadian Weed Science, Volume 6. Pinawa, Manitoba: Canadian Weed Science Society – Société canadienne de malerbologie. 21:34.

Peruzzi, A., Ginanni, M., Mazzoncini, M., Raffaelli, M., Fontanelli, M., Di Ciolo, S., Fantoni, E., Costa, I., Di Colo, M., Boschetti, I. 2006. Il controllo fisico delle infestanti su spinacio in coltivazione biologica ed integrata nella bassa Valle del Serchio. Stamperia Editoriale pisana. [In Italian]

Peruzzi, A., Lulli, L., Fontanelli, M., Frasconi, C., Ginanni, M., Raffaelli, M., Sorelli, F. 2010b. Innovative strategies for physical weed control on hard surfaces in central Italy: results achieved in two different cities. XVII World Congress of the International Commission of Agricultural Engineering (CIGR). Québec City, Canada, 13-17 June 2010.

Peruzzi, A., Lulli, Raffaelli, M., Del Sarto, R., Frasconi, C., Ginanni, M., Plaia, C., Sorelli, F., Fontanelli, M. 2009. La gestione fisica della flora spontanea in area urbana. Felici Editore Srl. [In Italian]

Raffaelli M., Fontanelli M., Frasconi C., Sorelli F., Ginanni M. 2011. Physical weed control in processing tomatoes in Central Italy. Renewable Agriculture and Food System, 26, 95-103.

Van Der Weide, R.Y., Bleeker, P.O., Achten, V.T.J.M., Lotz, L.A.P., Fogelberg, F., Melander, B. 2008. Innovation in mechanical weed control in crop rows. Weed Research, 48, 215-224.

Appropriate devices choice for the application of low environmental impact of pesticides in agriculture and urban areas

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Keywords: pesticides control, innovative technologies, natural pesticides, sensor systems

The use of pesticides represent a factor of considerable significance in agricultural activities. In fact, it is estimated that in the world are distributed annually to crops, about 2.5 million tonnes (source: The Pesticides Trust, UK). However, the problems caused by distribution techniques involve considerable pesticides drift. In fact, in 1964 research by Brown (Brown & Pal, 1971) noted that, in the use of the pesticides, only 0.1% of the chemical was effectively absorbed from the insect. Recent research on the pesticides tree application have shown that on average there is a dispersion of product from 50 to 75% divided in: 5-15% for drift, 20-60% loss waste (Doruchowski et al, 2009). The processes of dispersion may affect the environmental compartments such as: air, water, soil, due to surface runoff phenomena, leaching, volatilization, degradation and adsorption of pesticides in the soil. These processes involve risks to the health of the workers and those living near agricultural areas and, of course, are causes to environmental contamination.
The increasing public attention to the search and consumption of low environmental impact products and of high quality, are progressively influencing the differentiation of pesticides production to pesticides of natural origin, which differently from conventional pesticides require, for an optimal effectiveness, targeted distribution and uniformity over the canopy. Thereby the principles of pesticides correct application, always been studied for several years, become decisive in the use of natural pesticides to ensure the success of treatment. Among the commercially available solutions for the optimization of the spraying of pesticides with regard to the open field and tree crops it is possible consider all those types that allow the near approach of nozzles to the canopy: sprayers such as sprayer system with independent modules, in tangential fan and recycling sprayer. In the urban areas is however desirable to introduce those solutions for the substitution of manual devices, providing significant efficiencies and some examples are applied by spraying modules mini-dumper or pick-up can provide a wide versatility of use. Current commercially available technologies for the pesticides management are built in many configurations, allowing a wide range of regulation, which however must be accompanied by technical and operational skills of the user. This condition introduces risk variables in relation to the proper configuration of the spray machine and the correct mode of distribution, problematic, some of which may now be solved by the introduction of sensor systems and operational monitoring tools to assist the operator work.
In the present paper we report the technological advances in the fields of agriculture and urban pesticides control with particular attention to experiences conducted in recent years by the DEISTAF research unit.

Monitoring technique for vitamin B_2 and water content in plants for producing vegetables

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Abstract

Optical sensing techniques have become important tools in agricultural engineering to enhance human health and welfare by increasing farm productivity and controlling agronomic practices. If nutrients needed for human health could be monitored in real time, the amount of these nutrients contained in vegetables could be controlled to some extent by adjusting the growth conditions in green houses or open fields.

The authors have developed viable methods to detect the water and vitamin B_2 content in living plants using optical reflection, absorption, or fluorescence monitoring. Compact and mobile equipment has also been developed for this purpose. The equipment consists of light emitting diodes (LEDs), a compact spectrometer, and a fibre optic system with a lens. The optical reflection from, absorption in, or fluorescence from growing leaves were monitored under LED illumination, and the water or vitamin B_2 content could then be measured in growing vegetables. The vegetables used were mainly Jew's mallows (*Corchorus olitorius*) and leaf lettuces, which were grown in our laboratory atmosphere.

The applicability of these techniques to growing vegetables to benefit human health and welfare is demonstrated in this paper, based on practical data.

Keywords: optical sensing, fluorescence, green house

Introduction

Various kinds of optical equipment and systems have been introduced into agricultural fields and used practically to benefit human safety, health and welfare. Light detection and ranging (LIDER), for example, is used to estimate harvest timing or to monitor stones and large holes in crop fields in combination with differential GPS systems. In addition to these applications, optical sensing can possibly be used to increase the harvest of crops and the nutrients in vegetables, and thus contributes to the enhancement of human health and welfare. Many examples of optical sensing in plants have been reported for monitoring of the sugar content in fruit (G. G. Dull et al., 1989; S. Kawano, et al., 1993; D. C. Slaughter et al., 1996) and other measurement applications (Shyam N. Jha & T.Matsuoka, 2004,; Tian Hai-qing et al., 2007; D.C. Slaughter et al., 2008).

Among these examples, we have already reported vitamin-B_2-content monitoring using fluorescence spectra and water content sensing by monitoring optical reflection in growing plants (M. Fukuda et al., 2008; K. Sasaki et al., 2010). The water supply in green houses and open fields can be controlled precisely if the water content in the plants is monitored. Plant behavior can be studied under various environmental conditions if the water content is precisely monitored. If the content of vitamin B_2 content can be monitored in growing plants, the final content can then be controlled. In this paper, we demonstrate the applicability of

these monitoring techniques for vitamin B_2 and water content of plants based on practical data.

Materials and Methods

The Optical characteristics to be monitored, which can be applied to monitor the internal information in growing plants, are optical reflection and scattering, optical absorption, and fluorescence excited under light illumination. These characteristics should be selected while taking the properties of the plant of interest into consideration. If a certain nutrient in a plant has a peculiar absorption wavelength, then the optical absorption monitoring technique can be applied to quantify the content level of that nutrient. If fluorescence emission at a certain wavelength band is generated by the nutrient under light illumination, its intensity is a measure of the nutrient content level in the plants. The change in refractive index within plants can be also calculated by monitoring the change in optical intensity of reflected light. By combining these monitoring techniques, the nutrient content or the growth status of plants can be monitored precisely. Among these optical techniques, we present two techniques, fluorescence intensity monitoring and refractive index monitoring, for plant growth state monitoring applications.

Fluorescence intensity monitoring

The optical system used in this study was designed to be compact and mobile to enable easy monitoring of vitamins in all parts of vegetables (see Fig. 1). The optical source is a light-emitting-diode (LED) emitting 365-nm-band UV light, and the fluorescence emitted by vitamin B_2 and the other components contained in the leaf was coupled into a silica optical fiber and guided into a spectroscope (USB2000, Ocean Optics) to monitor the spectrum. The spectroscope was compact (weighing less than 200 g) and was controlled with a personal computer. The light passing through the leaf consisted of fluorescence and the excitation light. A UV-cut filter (ITY430, ISUZU GLASS) was therefore inserted between the sample and the silica optical fiber. We selected Jew's mallow (*Corchorus olitorius*) as a plant sample because of its relatively high vitamin B_2 content (0.42 mg per 100 g of edible portions of the plant).

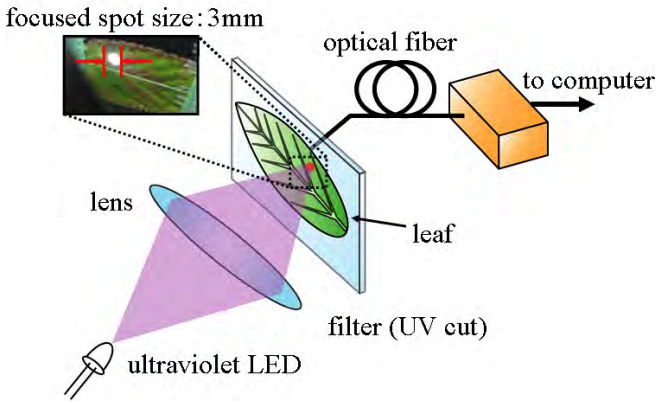

Figure 1 Fluorescence measurement system. The UV-light emitted from the LED is focused on a leaf to be monitored, and the fluorescence spectrum is measured with a computer-controlled spectrometer.

Refractive index monitoring

The refractive index change in plants is monitored by using optical fiber system shown in Fig. 2. A laser diode lasing at 650 nm was used to eliminate optical absorption of the water and sugar contained in plants. The output light from the laser was guided into a fiber with a lens and then into an optical fiber probe. The fiber probe was made of conventional 125 μm diameter multimode silica fiber, and the fiber tip was cleaved into a flat mirror. The guided light was partially reflected at the fiber tip in accordance with the reflectivity determined by the refractive index difference between the fiber and the material of the plant into which the fiber was inserted, as shown in Figs. 2 and 3.

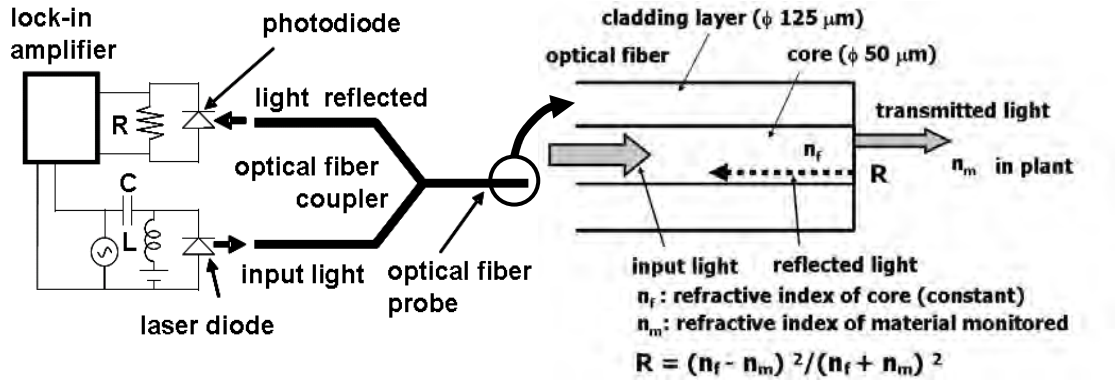

Figure 2 Measurement system for refractive index of inner parts of plants. The fiber probe tip is inserted into a plant, and the amount of back-reflected light is monitored with a photodiode. The amount of back reflection depends on the reflectivity R determined by the refractive index of the fiber and the plant ,aterial.

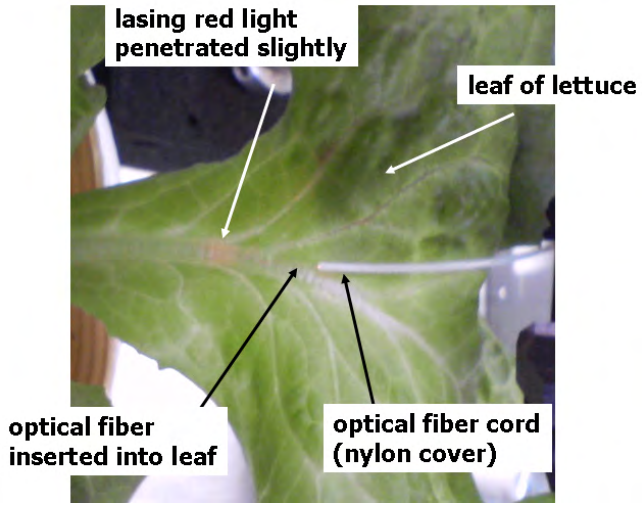

Figure 3 Optical fiber probe inserted into a lettuce leaf. The lasing light at 630 nm is observed at the tip of the probe in the leaf.

The reflected light, which is determined by the reflectivity, R, was guided again through the optical fiber was detected using a photodiode. The optical signal is converted into an electrical signal, which was amplified using a lock-in amplifier and then recorded. The vegetable samples used were commercially available leaf lettuces. These lettuces were set in an apparatus composed of a chamber, a CO_2 monitor, and a thermocouple. The fiber tip of the monitoring system was inserted into a leaf, and the inserted part was immediately closed and sealed with an organic material to prevent water evaporation.

Results

Fluorescence intensity monitoring

Figure 4 shows the fluorescence spectrum from the Jew's mallow sample measured using the experimental system shown in Fig. 1. The vertical axis is normalized with respect to the maximum fluorescence intensity at a wavelength of 687 nm. The light at wavelengths lower than 400 nm was filtered out with the UV-cut filter shown in Fig. 2.

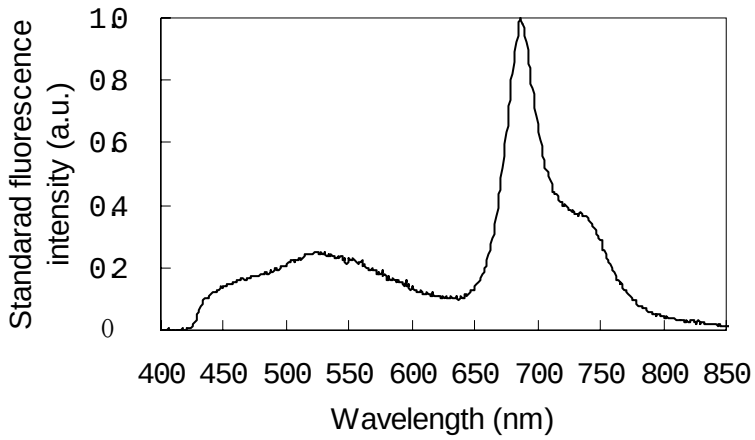

Figure 4. Fluorescence spectrum from Jew's mallow.

In Fig. 4, three fluorescence peaks can be observed, a broad peak centered at a wavelength of 530 nm, a sharp peak at 690 nm, and a broad peak between 700 and 740 nm. Two fluorescence peaks in 690 nm and between 700 and 740 nm originate from chlorophyll. The fluorescence peak at 530 nm was observed in the fluorescence spectrum of living leaves gathered from various part of a Jew's mallow plant. The peak wavelength at 530 nm was estimated to be the fluorescence of vitamin B_2.

However, Jew's mallow contains other fluorescence compounds that have the same fluorescence band as vitamin B_2, such as β-carotene. The experimental system shown in Fig. 2 could also detect β-carotene's fluorescence. The c β-carotene content is approximately 25 times higher than that of vitamin B_2 in Jew's mallow. However, even with this content ratio, the fluorescence intensity of vitamin B2 was approximately 20 times larger than that of β-carotene. Therefore, the β-carotene fluorescence intensity contribution could be ignored in the fluorescence spectrum. The relationship between the peak fluorescence intensity in the spectra and the contents of the Jew's mallow was also confirmed by using high-performance liquid chromatography.

This technique was extended to the monitoring of vitamin B_2 in leaves at various growing stages. Figure 5 shows the fluorescence spectra of young, green, and senescent Jew's

mallow leaves under ultraviolet illumination at 365 nm, and that of a vitamin B_2 solution as a reference. To compare the vitamin B_2 spectra of the leaves, the fluorescence intensities were normalized at 620 nm because this wavelength was not affected by the fluorescence of vitamin B_2 (at 530 nm) and chlorophyll (at 680 and 740 nm). A peak was observed at 530 nm in the fluorescence spectra of both the young and the green leaves, and the fluorescence intensity was lower for the young leaves than for the green leaves. There was no peak at 530 nm in the spectrum of the senescent leaves. These results show that young leaves contain less vitamin B_2 than green leaves, and that senescent leaves do not contain a detectable level of vitamin B_2. These results clearly show that the optical system developed in this study can be applied to monitor vitamin B_2 in living plants and can contribute to human health and welfare by control of the growth conditions and harvest time of crops and by increasing their nutrient content.

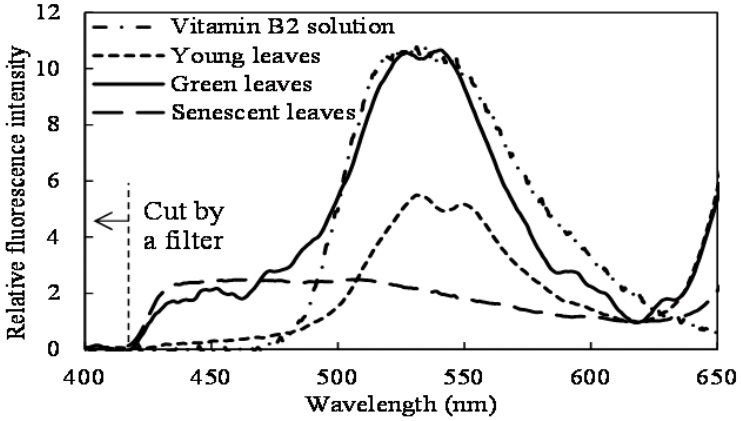

Figure 5: Fluorescence spectra of young, green, and senescent Jew's mallow leaves, and of vitamin B_2 solution as reference.

Refractive index monitoring

A typical change in refractive index in a leaf lettuce is shown in Fig. 6 as a function of elapsed time. Here, the refractive index is translated into water content using the Clausius-Mossotti relation under the assumption that only water content changes (Fukuda M. et al., 2008). The leaf lettuce was set in a dark chamber at room temperature. Before monitoring, the lettuce remained in the chamber for 48 hours without a water supply or light illumination. The water content in percentage units was calculated from the refractive index change, which was calculated from the change in magnitude of optical feedback. At this point, we hypothesized that the refractive index in plants is proportional to the concentration of liquid in the plants and the minimum value of the refractive index is 1.332 corresponding to pure water. This hypothesis can be used with any normal solution, such as a sugar solution.

The water content in the leaf lettuce was nearly constant after monitoring started, and it quickly increased after a certain time period (about 45 min after supplying water). The increase in the water content became saturated after the quick increase. The time interval between the water supply and the change in the water content corresponded to the time taken for the water supplied from the roots to reach the monitoring point in the leaf. When the water reached the monitoring point, the reflectivity at the fiber tip increased because the refractive index in the lettuce leaf decreased. This behavior corresponds to the change in the refractive

index and the water content in the leaf. These results demonstrate that the optical back-reflection monitoring method is sensitive to refractive index change and thus to the water content of the leaves.

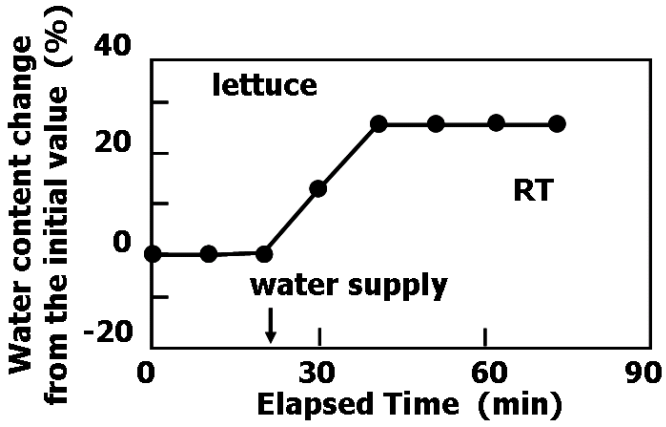

Figure 6 Change in water content in leaf lettuce. The refractive index monitored and is translated to water content.

Conclusions

We have developed techniques to monitor nutrient levels and water content of growing vegetables and have confirmed their applicability to living crops. The systems using our technique will help to produce nutrient-rich vegetables in green houses and/or fields and enhance human health and welfare. This system will be also useful for determination of optimal harvest times by monitoring the nutrient contents of growing vegetables and will therefore assist the work of farmers.

References

Dull G. G., Birth G. S., Smittle D. A., Leffler R. G. 1989. Near infrared analysis of soluble solids in intact cantaloupe. J. Food Science, 54, 393-395.

Kawano S., Fujiwara T., Iwamoto M.1993. Nondestructive determination of sugar content in Satsuma mandarin using near infrared (NIR) transmittance. J. Japan. Soc. Hort. Sci., 62, 465-470.

Slaughter D. C., Barrett D., Boersig M.1996. Nondestructive determination of soluble solids in Tomatoes using near infrared spectroscopy. J. Food Science, 61, 695-697.

Jha S. N. and Matsuoka T. 2004. Non-destructive determination of acid-brix ration of tomato juice using near infrared spectroscopy. *International journal of Food Science and Technology*, *39*, 425-430.

Hai-qing, T., Yi-bin Y., Hui-shan L., Xia-ping F., Hai-yan Y. 2007. Measurement of soluble solids content in watermelon by Vis/NIR diffuse transmittance technique. *Journal of Zhejiang University SCIENCE B, 8(2)* 105-110.

Slaughter D.C., Obenland D.M., Thompson J.F., Arpaia M.L., Margosan D.A. 2008. Non-destructive freeze damage detection in oranges using machine vision and ultraviolet fluorescence. *Postharvest Biology and Technology, 48* 341-346.

Fukuda M., Matsuo A., Farzana I., Utsumi A. 2008. Novel optical sensing technique for water contentin plants. Proceedngs on CD-ROM International Conference on Agricultural Enginnering Crete, 23-25 June 2008.

Sasaki K., Yamaguchi K., Yogo K. and Fukuda M. 2010. Vitamin B2 Detection in Lived JEW's Mallow (Corchorus Olitorius) Using UV-Excited Fluorescence Monitoring. Proceedngs on International Conference on Agricultural Enginnering Clermont-Ferrand, 6-8 September 2010.

Topic 8

“Environment Safety and People Health Protection and Welfare”

Poster Presentation

Entomofauna harmful and useful study of some agricultural seed lots depending on the chemical treatment against pests from NE Moldavian's climatic conditions

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Abstract
Maize is widely cultivated throughout the world, and a greater weight of maize is produced each year than any other grain. Our aim is to demonstrate that the use of bio-products in pest of corn, giving positive results.
The research is aimed at achieving a study on harmful and useful Entomofauna in some agricultural crops seed located in the territory of NE Moldavian's climatic conditions.
In this research, we try to determine entomofauna useful and harmful entomofauna of corn seed lots, but here we present strict pest Ostrinia nubilalis

Keywords: maize,trap,control

Introduction

Corn *(Zeea Mays)*occupies third place in importance among the world's crop. This position, in terms of agriculture, is motivated by a number of features, as follows: Has a large production capacity, with about 50% higher than other cereals; Has a high ecological plasticity, which allows a wide distribution area, giving high yields and relatively constant, less influenced by climatic deviations; Is an herb hoe, good run for most crops;Supports monoculture years; Has a high breeding ratio (150-400); With a later planting in the spring, allows a better staging of agricultural work; Culture is 100% mechanical; Harvesting is done without danger of shaking; Leverage highly organic and mineral fertilizers and irrigation water; Options for recovery of production are so varied. (Muntean, L.S, 2003).

Given that today is Romania (geographic, climatic and economic), to obtain higher crop quantity and especially quality, is very important. Is directly proportional to the difficulty that can achieve these quality products. Combating diseases and pests is through preventive and curative methods, taking into account the biology of plants, varieties of pesticides, pest biology agents.

Losses in agricultural crops vary as follows: cereals ranges from 27-36% to reach 46% grain legumes, potatoes are 45% sugar beet is 27%, for sunflower are 30% of the pests return between 8-15% it. (Tălmaciu M., 2005).

Materials and Methods

The experience was carried out in 2011-2012 in Trifesti - Bivolari microzone. The research was done and these stages of vegetation of corn.

In 2011, entomofaunei collection was done using pitfall traps were placed in 4 of 4 meters and the net entomilogic. Traps were placed in six groups of seeds that we will call Lot A, Lot B, Lot C, Lot D, Lot E and Lot F was determined status of species and number of

samples collected from groups A, B, C , D, E, F. Collections will be made and in 2012, in all phases of maize vegetation

In modern agriculture is a greater emphasis on pest control becasuse production obtained is dependent on resolving this problem.

These studies have taken place in all phases of maize vegetation.

The study took place in 10 plots of corn. Here we present the results of the 6 groups, named group A, B, C, D, E, F. In particular, we followed the evolution of *Ostrinia nubilalis* reaching this: In groups A, B, C where using a treatment based on Zenon Karate not find any harmful of *Ostrinia nubilalis* and in groups D, E, F where using a treatment with a bio-based *Bacillius Ahuringiemsis* duplicate were collected.

Results

The conclusion we can draw is that biological bio-products are effective in the future should put more emphasis on their use

As perspective, we appreciate the fact that more farmers will use organic products for pest control

Corn borer, Euopa widespread in Asia, North Africa and America, a leading ese culture pests of corn.

In Romania registers powerful attacks in northern Moldavia and the Danube Plain. The larvae fruit floral organs of male inflorescence and one of the epidermis and leaves parnenchimul. Larvae can locate and stalk or cobs. (Talmaciu, M., 2005)

Table 1. Statement of species and number of specimens collected in group A seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	1	0	0	0	0	0	1	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								0	1,5
2012	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	0	0	0	0	0	0	0	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								0	

Table 1 shows that in group A, where treatment was performed with Zenon Karate notice that was not collected any copy Ostrinia nubilalis Hb, but in 2011 a specimen was collected Agriotes spp.

Table 2. Statement of species and number of specimens collected in group B seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	0	0	0	0	0	0	0	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total		0	0	0	0	0	0	0	0
2012	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	0	0	0	0	0	0	0	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								0	

From Tables 2 and 3 shows that neither in 2011 no in 2012, in groups B and C, where treatments were performed with Zenon Karate were not seized copies of Ostrinia nubilalis Hb,

In 2012, the trap number 6, in group C were captured two copies of Agriotes spp average two years was 1.5.

Table 3. Statement of species and number of specimens collected in group C seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	0	0	0	0	0	2	2	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								2	1
2012	Ostrinia nubilalis Hb	0	0	0	0	0	0	0	
	Agriotes spp.	0	0	0	0	0	0	0	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								0	

Table 4. Statement of species and number of specimens collected in group D seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	2	1	0	3	0	1	7	
	Agriotes spp.	1	0	0	2	0	0	3	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								10	7
2012	Ostrinia nubilalis Hb	0	0	1	0	1	0	2	
	Agriotes spp.	0	2	0	0	0	0	2	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								4	

From Tables 2 and 3 shows that neither in 2011 no in 2012, in groups B and C, where treatments were performed with Zenon Karate were not seized copies of Ostrinia nubilalis Hb,

In 2012, the trap number 6, in group C were captured two copies of Agriotes spp average two years was 1.5.

Table 5. Statement of species and number of specimens collected in group E seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	2	1	0	1	0	1	4	
	Agriotes spp.	1	0	0	1	0	0	2	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								6	5
2012	Ostrinia nubilalis Hb	2	0	1	0	0	2	4	
	Agriotes spp.	0	0	0	0	0	0	0	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								4	

Table 6. Statement of species and number of specimens collected in group F seed corn, the average of the years 2011-2012 About Astra Trifesti

Year	Name of species	Number of copies trap						Number of copies species	Total copies-Average 2011/2012
2011	Ostrinia nubilalis Hb	0	1	2	1	0	1	5	
	Agriotes spp.	1	0	0	0	0	0	1	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								5	5
2012	Ostrinia nubilalis Hb	0	1	0	1	1	1	4	
	Agriotes spp.	0	0	0	0	1	0	1	
	Scotia segetum Schiff	0	0	0	0	0	0	0	
Total								5	

Conclusions

Conclusions That Can be drawn has the best results compared with classic fertilization unfertilized variants, But Which variants HAS Been Shown That have Been used in organic products, significantly higher production WAS Than the unfertilized variant.

The main conclusion is that the treatments made chemicals give good results, and biological treatments are positive.

Taking into account environmental protection and use organic products tend abundantly recommend using these products.

Acknowledgements

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References

Muntean, L.S., Borcean, I., Axinte, M., Roman, G.V., 2001.Fhytotechny, Ed. „Ion Ionescu de la Brad" , Iaşi, 409-412

Talmaciu, M.,, 2005. Agricultural Entomology, Ed. Ion Ionescu de la Brad, Iasi, 3-5

Talmaciu, M.,, 2005. Agricultural Entomology, Ed. Ion Ionescu de la Brad, Iasi, 126-127

Research regarding the influence of some organic products on potato yield in an environment from NE Moldavian's climatic conditions

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Abstract
In this paper we propose to determine the three varieties of potato production, making a comparison between conventional and organic fertilization.
The experience was located within Agricole Society Trifesti Astra, company standard of agriculture in Romania.
From a climate perspective, the area is characterized by cold winters and hot summers.
It was installed on trifactorial experiences in 3 repetitions of the type 4Ax3Bx2C, being studied five varieties of potato. In this paper we present partial results of three varieties
In Romania in 2010 cultivated area reached 246,982 ha, but in 2009 was peaked at 260,317 ha.
In to the production is noted that in 2010 3,283,870 tons were produced in 2009 was peaked at 4,003,980 t. Main aim is to highlight the importance of organic products.(www. fao.org)
In this study we are trying to prove the necessity, usefulness and positive influence resulting from the use of organic products, considering the fact that the EU attaches special attention regarding the use of these products

Keywords: soil fertilization, ecological treatment

Introduction

Potato (*Solanum tuberosum L.)* are of special importance in the diet people, animal feed and industrial processing. It is grown on every continent, but particularly in Europe, which has about 50% of the world. (Bîlteanu Gh, 2001)

Potatoes are used in food, resulting in dry products: flour, flakes, dehydrated meals, toasted products: potato chips (thin slices fried in oil, crunchy), "pommes frittes" (frozen potatoes), French fries. Starch and alcohol industry, a ton of tubers obtained 140 kg potato starch and the food people use fresh or dried form and cooked. The basic and complementary food for much of the population of Europe and other countriesand the food people use fresh or dried form and cooked.

The basic and complementary food for much of the population of Europe and other countries.

Because taste, digestibility and high nutritional value of potato preparations meet food requirements of all categories of population, which is consumed boiled, baked or fried, as soups, salads, smoothies and bread often replacing the irreplaceable as food diet.

The potato is high energy, due to its high starch and other substances such as proteins, fats vitamins (especially vitamin C). Annual consumption per capita potato directly in different countries varies between 44 and 140 kg: Ireland - 140 kg, Netherlands - 138 kg,

Germany - 130 kg, Spain - 120 kg, Belgium - 118 kg, 108 kg ¬ France, England - 95 kg, Switzerland - 87 kg, Italy - 65 kg etc. Annual consumption per person in Romania is about 100 kg tubers. (Muntean, L.S,2003)

Materials and Methods

The experience was carried out in 2011-2012 in Trifesti - Bivolari microzone, who are in an area with temperate climate conditions and is characterized by cold winters and hot summers, with irregular winds, most common in north-west and north - winter and southeast and east - especially in spring, with sufficient rainfall - especially in early summer.

It was installed on trifactorial experiences in three replications of the type 4Ax3Bx2C, being studied three varieties of potato. The treatments are: A – Foliar fertilizing, with graduations, a_1- not fertilized, a_2 – NPK, a_3- ECO 1, a_4- ECO 2, B – the variety: b_1 - Velox, b_2 - Volumia E, b_3- Red Scarlet A, C – vegetation treatment with organic herbicide: c_1- treatment with Novodor (4l/ha) ,c_2 treatment with NeemAzal (2l/ha).

The interpretation of results was done using analysis of variance.(Jitareanu G.,1994)

In Figures 1,2 and 3 is presented the plan to experience the three varieties.

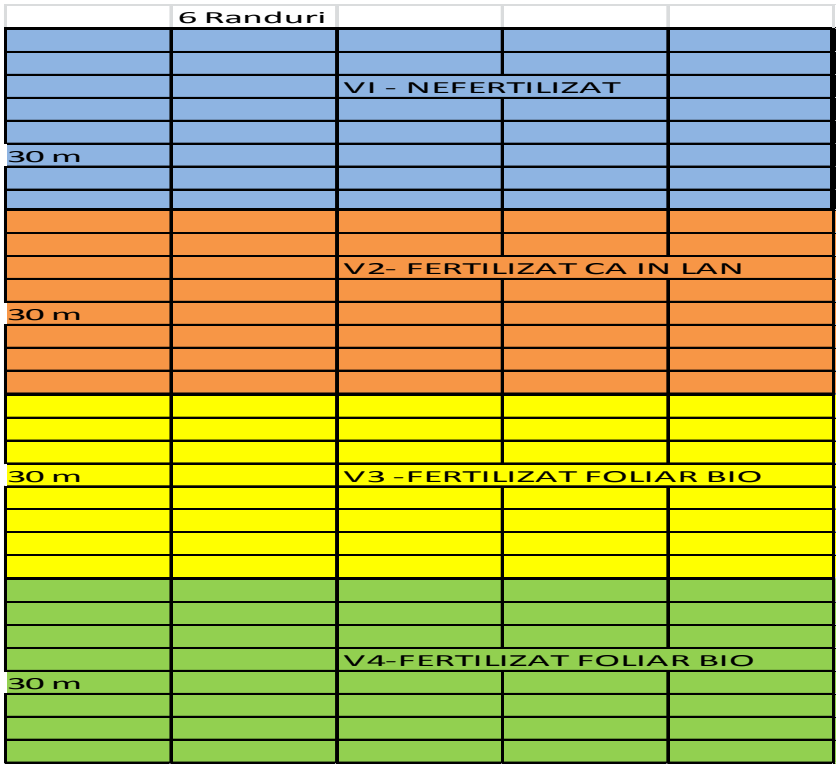

Figure 1. The plane to experience the variety Red Scarlet

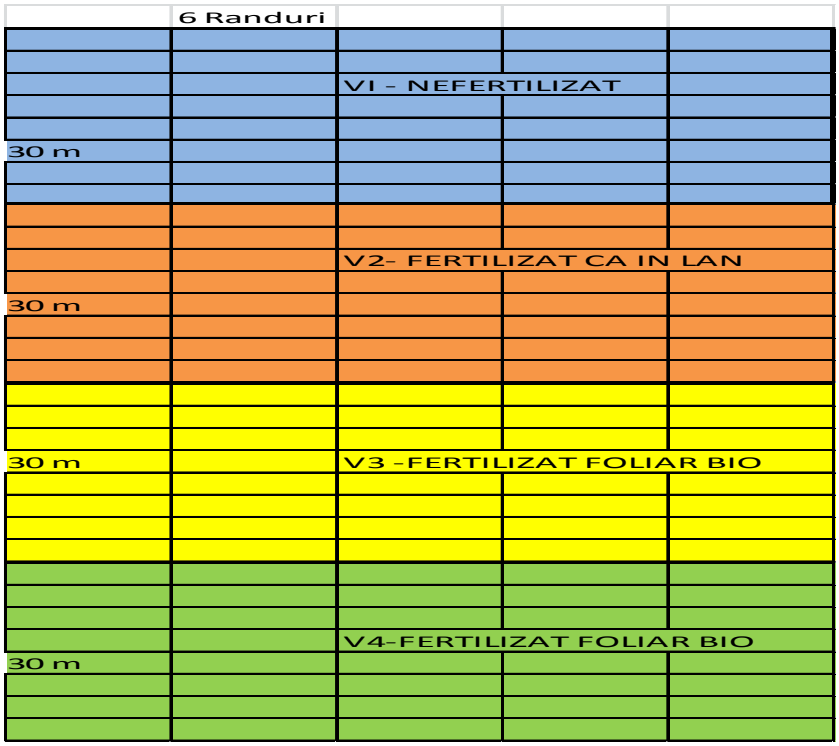

Figure 2. The plane to experience the variety Volumia E

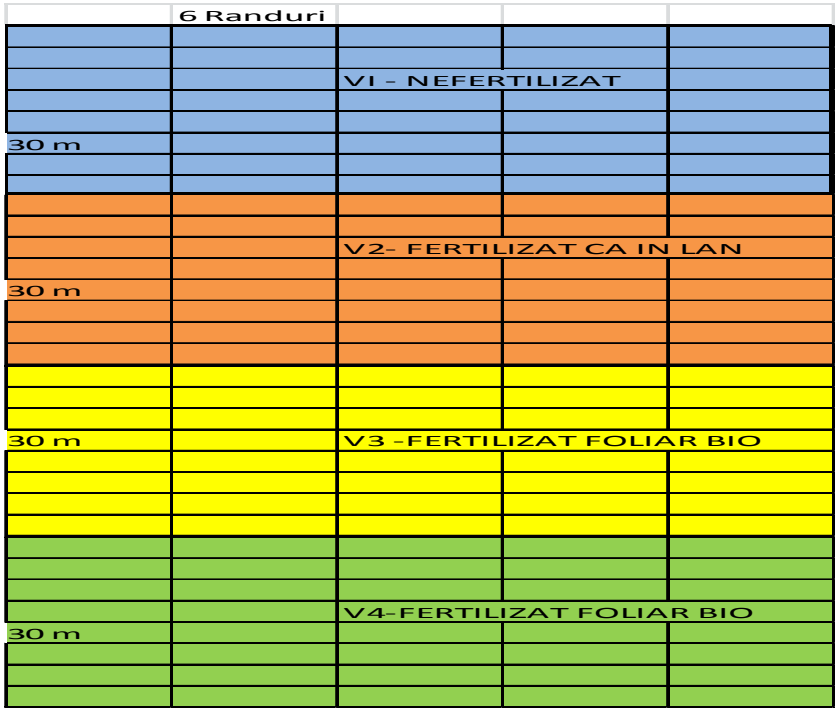

Figure 3 . The plane to experience the variety Velox

Results

Analyzing the influence of fertilization treatments and find that the biggest variety production recorded the variant fertilized classic variety is the difference from the control volume is 179.47%.

When referring to fertilization with organic products, draw the following conclusion: using environmental product ECO1, tubers production increased very significantly from the control,% from the control was 163.48%.

With regard to organic fertilization, it appears that in both where they used these products have obtained very significant production increases, respectively, where we used variants ECO 1, volume is the variety were obtained 30444, and the version used where ECO 2, the variety were obtained volume is 29305 kg / ha, compared to version control VELOX.

Regarding the influence of potato varieties in Table 1 note variety the Volumia E the was poductiv, obtaining the to 29,177 kg / ha, difference from control was 118,66%.

Interaction influence relating to fertilization and variety on production tooth, seen from the table two, that the ECO version 1, the Volumia E is variety, were obtained 30346 kg / ha, the difference from the witness being 162.84%

Table 1. Influence of variety on potato production in 2011

Variety	Production kg / ha	Compared to the control %	Differences (kg/ha)	SSignif ficance
Velox	**24588**	**100,00**	**control**	
Volumia E	29177	118,66	8316,2	***
Red Scarlet	24731	100,58	3870,4	***

Dl 5%= 302,9 kg/ha, Dl 1%= 403,4 kg/ha, Dl 0,1%= 522.1kg/ha,

Table 2. Influence of fertilization on potato production in 2011

Dosage the fertilizer	Production kg/ha	Compared to the control %	Differences (kg/ha)	SSignif ficance
Nefertilizat	**20861**	**100,00**	**control**	
NPK	30231	144,92	9370,3	***
ECO 1	28472	136,49	7611,8	***
ECO 2	25098	120,31	4237,1	***

Dl 5% = 637,3kg/ha, Dl 1% = 882,6kg/ha,Dl 0.1% = 1217,8kg/ha

From Table 2, we see that the organic fertilized ECO version 1, or obtained 28472 kg / ha from unfertilized variant where or obtained 20861 kg / ha, the difference from the witness being 136.49%. In Table 3, we studied the influence of fertilization and variety on potato production and is seen as ecological fertilizer production has brought significant gains to the version control, fertilization, such as observing the volume is its variety performed best yielding to 30,346 kg / ha, the difference from the witness being 162.84%.

Table 3. Influence the interaction between fertilization and variety on potato production in 2011

Fertilizer	Variety	Production kg/ha	Compared to the control %	Differences (kg/ha)	SSignif ficance
	Velox	**18635**	**100,00**	**control**	
Nefertilizat	Volumia E	24927	133,77	6292,4	***
	Red Scarlet	19020	102,07	385,1	
	Velox	28466	152,75	9830,8	***
NPK	Volumia E	33033	177,26	14397,6	***
	Red Scarlet	29195	156,67	10559,9	***
	Velox	26914	144,43	8279,3	***
ECO 1	Volumia E	30346	162,84	11710,6	***
	Red Scarlet	28158	151,10	9522,9	***
	Velox	24339	130,61	5704,5	***
ECO 2	Volumia E	28402	152,41	9767,4	***
	Red Scarlet	22552	121,02	3916,9	***

DL 5% =878,8kg/ha, DL 1% =1194,1kg/ha, DL 0.1% = 1598,3kg/ha

Conclusions

Conclusions can be drawn are that fertilization classic best results compared with unfertilized variants, but has been shown that variants which have been used in organic products, production was significantly higher than the unfertilized variant.
Of the three varieties used in experience, we see that kind volume is best performed

Acknowledgements

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References

Bîlteanu, Gh., 2001. Fhytotechny vol 2, Ed. Ceres, Bucureşti,215-217

Jitareanu,G., 1994.Experimental Technique,Course lithographs USAMV Science.,25-35

Muntean, L.S., Borcean, I., Axinte, M., Roman, G.V., 2003.Fhytotechny, Ed. „Ion Ionescu de la Brad" , Iaşi, 409-412

Food and Agricultural Organization.2012. www.fao.org

Effect of Na_2SO_4 on the behavior of *Atriplex halimus*

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Keywords: *Atriplex halimus*, sodium sulphate, growth

Objectives

Overgrazing, climatic constraints and the lack of rational routes of herds led to a sharp deterioration in *Atriplexies*. It require the implementation of a policy of stocking of good resistance to salinity genotypes with high biomass production and good palatability. In this context we undertook this study with the aim to define the tolerance limits of *Atriplex halimus* in respect of sodium sulphate.

Methods

We propose in this work an experimental study in semi-controlled conditions of laboratory (*in vitro*) to test the effect of the high concentration of Na_2SO_4 on the germination, the ability to rooting and growth of *Atriplex halimus*. This study also allows us to see the quantitative variations of Na^+, K^+, Ca^{++} based on external concentrations of sodium sulfate.

Expected Results

The results show that the seeds of *Atriplex halimus* are characterized by their rapid germination and low sensitivity to high concentrations of Na_2SO_4. The tolerance limit, corresponding to a decrease of 25% germination and 15.52 g/ l of Na_2SO_4. The sensitivity threshold of the dry matter production of the aerial part is between 10 and 12 g/l Na_2SO_4.
The concentration of 8 g/ l of Na_2SO_4 stimulate the growth of *Atriplex halimus*. From 12 g/ l Na_2SO_4, plant growth decreases considerably.
The absorption of sodium sulfat by *Atriplex halimus* plants vitro results in an enrichment of tissues with sodium and a decrease in potassium and calcium. This accumulation of Na^+ in the plant causes a drop in production from biomass.
These results show that the *Atriplex halimus* can be grown in saline environments unsuitable for most crops.
This species may be particularly in arid and semi-arid means of development and fight against desertification.

Effects of tillage and oilseed rape cultivar (*Brassica napus* L.) on soil physical properties and yield

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Abstract
Winter oilseed rape (*Brassica napus* L.) became one of the most important crops grown in north-eastern Romania. The objectives of this research study refer to creating technological options adapted to local conditions for farmers in the area and assessing tillage effect on soil physical properties and rapeseed yield in three different locations. Soil bulk density (BD), penetration resistance (PR) and hydric stability of aggregates (HS) were determined at different rapeseed fenological stages in moldboard (MT), chisel (CT) and disk-harrow (DT) tillage treatments. No significant differences existed among tillage treatments concerning BD and HS. PR determined at plant full growth was significantly higher in DT in two out of three locations. Yield varied with tillage, with no significant differences between MT and CT, but was lower in DT (p=0.05).

Keywords: bulk density, penetration resistance, aggregate stability, cropping system

Introduction

Soil degradation, decrease in soil's actual and potential productivity owing to land misuse, is a major threat to agricultural sustainability and environmental quality (Lal, 1993). Intensive tillage has worldwide resulted in soil degradation, causing a long term threat to future yields (D'Haene et al., 2008). It is generally accepted that practices such as minimum tillage reduces the environmental impact of cultivation. Many research studies have shown that conversion to such practices preserves and improves soil physical properties with little or no impact on yield.

Soil bulk density is probably the most frequently measured soil quality parameter in tillage experiments (Ozpinar and Cay, 2006) and a useful parameter in studies of soil and crop responses to machinery traffic in agriculture (Diaz-Zorita, 2000; Yavuzcan, 2000). Penetration resistance can also be used to highlight differences between tillage systems; when accurately determined, it is a more sensitive measurement of soil compaction than bulk density. Soil structure is a key factor in the functioning of soil, its ability to support plant and animal life, and moderate environmental quality (Bronick and Lal, 2005). Water stability of aggregates is often the most used parameter to characterize soil structure (Young and Young, 2001; Six et al., 2000) and it is sensitive to soil management practices. Conventional tillage disrupts soil aggregates and compacts soil (Plante et al., 2002) while applying reduced and no-till management systems resulted in more stable aggregates (Filho et al., 2002).

In north-eastern Romania winter oilseed rape crop (*Brassica napus* L.) is of great importance for farmers because it requires relatively low technological costs and guarantees profit even at medium yield levels. Determining various agronomical properties including soil physical parameters for enhanced oilseed rape (*Brassica napus* L.) yield with low technological impact on the environment can be of both economic and ecological great importance.

Materials and methods

Experimental design and procedure

The research started in august 2010, when field trials have been setup in three locations from Central-Northern Area of Moldavian Plateau (north-eastern Romania): Agricultural Research and Development Station (ARDS) Suceava, ARDS Secuieni – Neamț county and ARDS Podu-Iloaiei – Iaşi county. In the first location (Suceava) the soil is a cambic phaeozem (Romanian Soil Taxonomy System - 2003) with 31.6% clay in 0-20 cm soil layer, 5.6-5.8 pH units and 3% humus content. The soil from Secuieni is a loamy cambic chernozem, 2.4% humus content and 6.2 pH units. The cambic chernozem from Podu-Iloaiei has 423 g clay, 315 g loam and 262 g sand/1000 g of soil, and around 3% humus (table 1).

Table 1. Soil and climate conditions

Location	Soil	Multi-annual mean temperature	Multi-annual mean rainfall
Suceava	cambic phaeozem (loamy, moderate acid, medium humus content)	7.8^{o}C	586.8 mm
Secuieni	cambic chernozem (loamy, slight acid, medium humus content)	8.6^{o}C	576.9 mm
Podu-Iloaiei	cambic chernozem (clay-loamy, slight acid to neutral, medium humus content)	9.6^{o}C	542.0 mm

The trials were arranged as split-plot on the basis of completely randomized block design. The main plots were tillage systems: conventional tillage using moldboard plow (MT) and minimum tillage using chisel (CT) and disc-harrow (DT); 50 winter oilseed rape (*Brassica napus* L.) cultivars in three replications were assigned to the subplots. The cultivars were selected from the comercial offer of companies such as Pioneer Hi-Bred, Monsanto, Dieckmann, Euralis, Biocrop etc.

Each subplot included eight 8 m rows with 25 cm inter row spacing and 1 m inter plot spacing. Each main plot had 150 sublopts (50 cultivars x 3 replications/cultivar) covering a cultivated area of 4800 m^2/location. Tillage was made in early august 2010, and in early september, the rapeseed cultivars were sown using a plot seeder – Plotseed XL (Wintersteiger), after complete P and K fertilizer application with seedbed preparation. Weeds were controlled using pre- and post-emergent herbicides. The entire dose of N fertilizer was applied in early spring 2011, when rapeseed resumed growth, and pests were chemically controlled during the growing season.

Soil and yield measurements

Soil physical properties were determined as follows: bulk density (BD) was determined using undisturbed soil samples collected from nontrafficked areas with steel rings (100 cm^3) from different depths – 0-10 cm, 10-20 cm, 20-30 cm, and 30-40 cm – right after sowing, before wintering and right after crop harvesting, from every main plot (tillage system) in at least 3 replications. The samples were oven-dried at 105^{o}C to constant weight and BD was calculated by dividing the weight of the dried soil to the volume of the steel ring. Penetration resistance (PR) of soil, also known as „cone index", was measured at the beginning of plant flowering (early mai 2011) using a digital penetrologger (Eijkelkamp Equipment, 2006). Measurements were made a few days after significant rainfall, when soil moisture was close to field capacity. At least ten penetration resistances were taken from each tillage treatment, up to 50 cm depth,

measurements being made every centimeter. The penetrologger had a 30^o cone and a base area of 1 cm^2, and the penetration speed was 2 cm/s. Hydric stability (HS) of aggregates resulted according to Kemper and Rosenau (1986), a standard method (Nimmo and Perkins, 2002). Disturbed soil samples were taken from different depths (0-10 cm, 10-20 cm, 20-30 cm) right after crop sowing, before wintering and right after harvesting, from every main plot (tillage system) in at least 3 replications. The samples were air-dried for several days, then sieved with AS-300 dry-sieving machine (Retsch) to extract the aggregates with 1-2 mm in diameter; 4 g from the resulted samples were processed with Wet-Sieving Apparatus (Eijkelkamp Agrisearch Equipment) for 3 mins. in distilled water to eliminate the soil without water stability (diameter < 0.25 mm). The soil with stability was then separated from the sand particles and plant debris by sieving the same sample in aqueous solution of NaOH 2‰ for 5-8 mins. Hydric stability was determined according to relation:

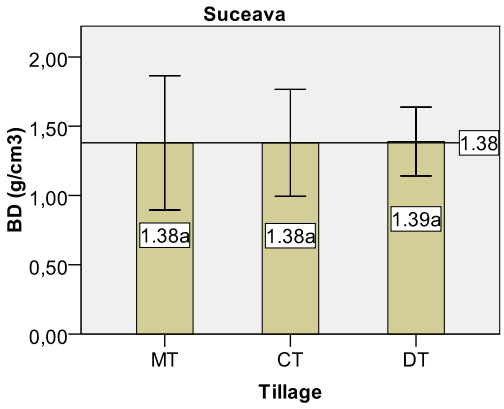
$$HS\ (\%) = B \times 100 / (A + B) \qquad (1)$$

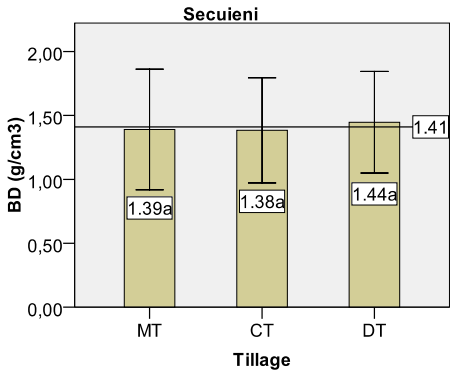
where A is the soil without stability from the sample (g), and B the soil with stability from the sample (g).
Seeds from every sub-plot were harvested using a plot combine – Classic (Wintersteiger) and weighed with Grain Gage (Juniper Systems), a weighing system mounted on the combine.
Statistical analysis of results was performed using the ANOVA procedure and multiple comparisons method (Duncan test) for α=0.05 in SPSS (v. 17.0, IBM SPSS Statistics).

Results

Effect of tillage on soil physical properties

In 2010/2011, averaged over the entire growing season, lowest values of BD in 0-40 cm soil horizon were in MT (1.38 g/cm^3, 1.39 g/cm^3, and 1.32 g/cm^3) and highest in DT (1.39 g/cm^3, 1.44 g/cm^3, and 1.39 g/cm^3) in all three locations, with insignificant differences (p=0.05) between tillage treatments as shown in Figure 1, probably due to soil recompaction tendency after tillage operations (Lampurlanes and Cantero-Martinez, 2003) and under the effect of rainfall.





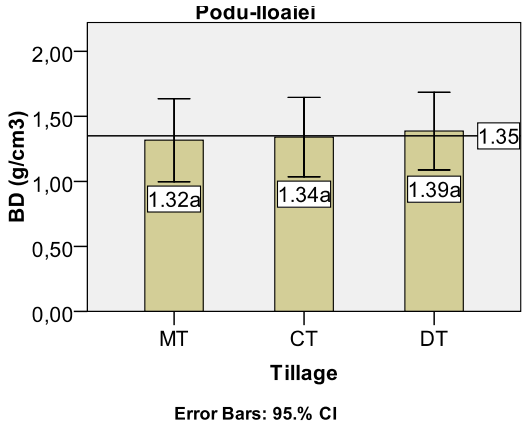


Figure 1. Effect of different tillage systems on soil bulk density

Meanwhile, PR determined at maximum plant growth (early mai 2011), showed more significant differences (p=0.05), as it is a more sensitive indicator of soil compaction in different tillage systems than BD (Canarache, 1990). PR was significantly higher in DT in two out of three locations: 1.27 MPa at Suceava and 1.52 MPa at Podu-Iloaiei, while at Secuieni, the highest value was in MT (1.48 MPa), probably because of the plow pan formed at 20-30 cm (Figure 2). PR varied also with depth, with the highest values in the subarable horizon: 20-30 (35) cm in MT, 15-30 (35) cm in CT, and (5) 10-35 cm in DT in all locations, influencing root penetration capacity under the arable horizon.

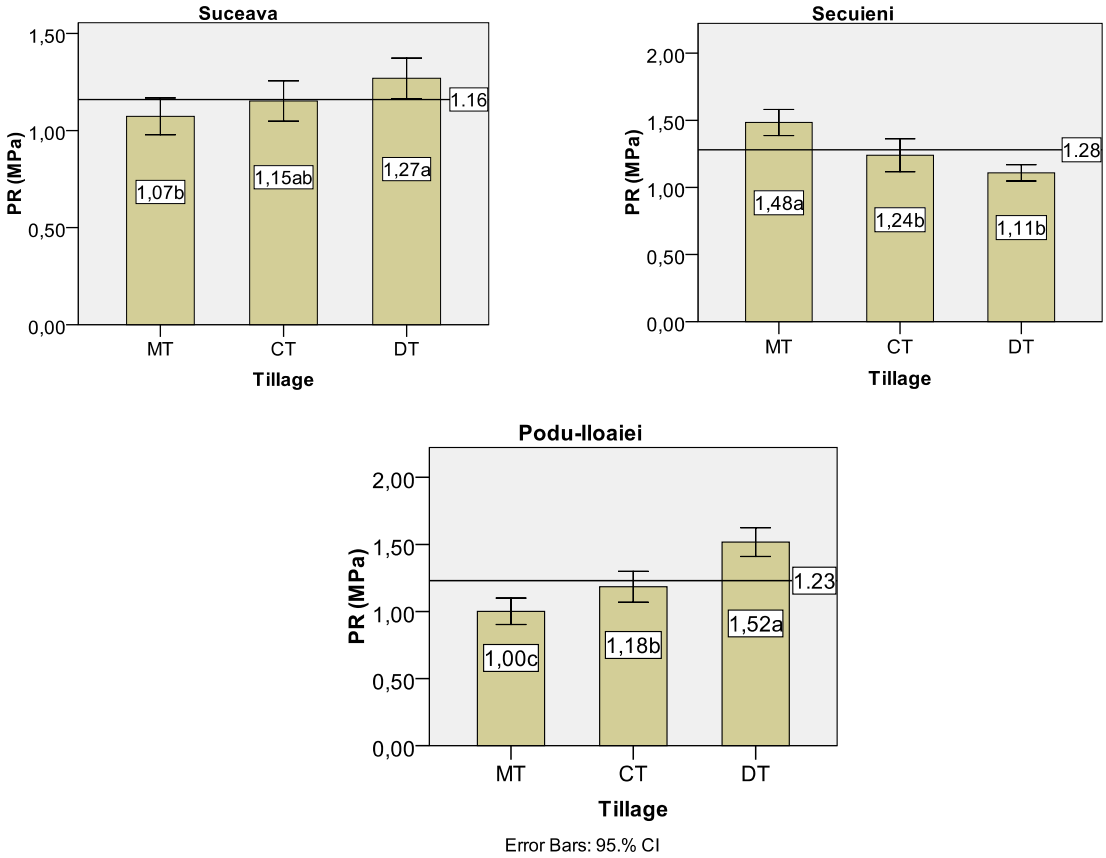


Figure 2. Effect of different tillage systems on soil penetration resistance

In 2010/2011, the 0-30 cm soil layer of CT had the highest proportion of water stable aggregates (Figure 3): 66.8% - Suceava, 68.8 % - Secuieni, and 70.1% - Podu-Iloaiei, proving that this tillage treatment had the least impact on soil structure, although differences from other systems were insignificant (4.2%-9.8% for p=0.05).

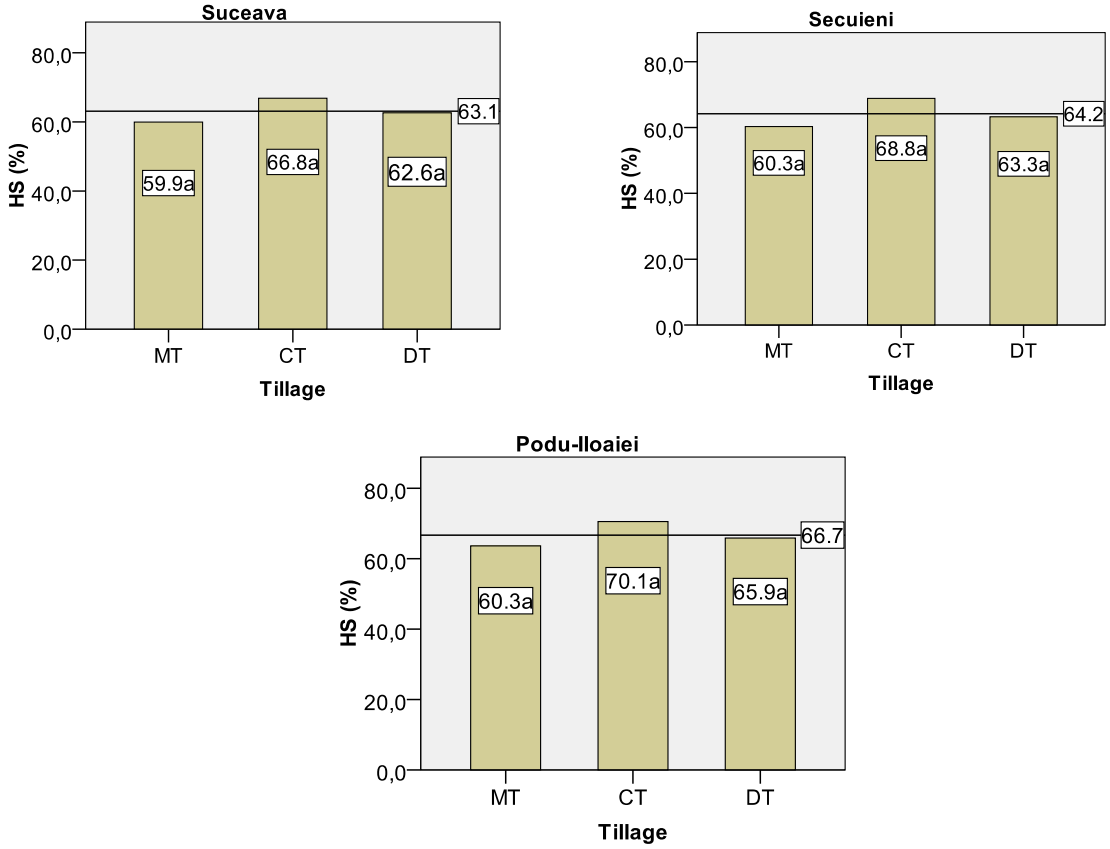
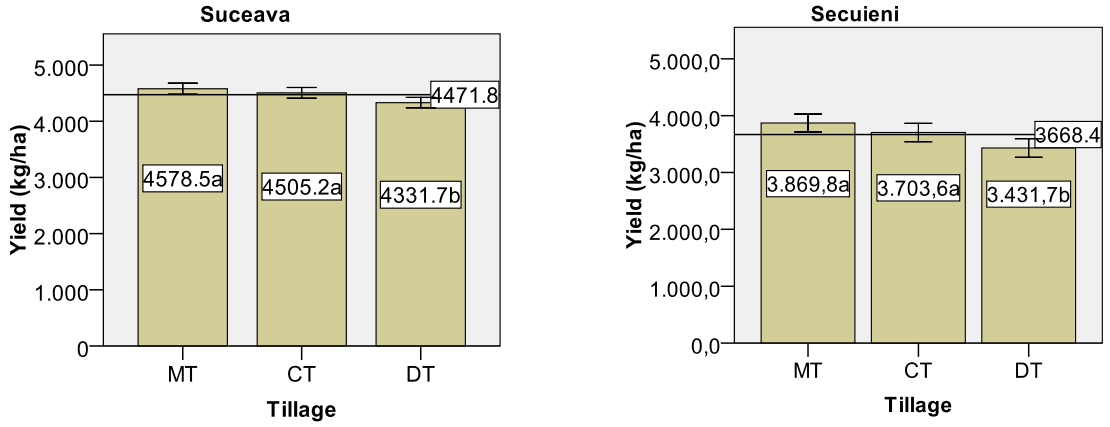


Figure 3. Effect of different tillage systems on aggregates hydric stability

Effect of tillage on yield

The mean winter oilseed rape yield, resulted from 150 individual values (50 cultivars x 3 repetitions/cultivar), varied with tillage, as shown in figure 4.



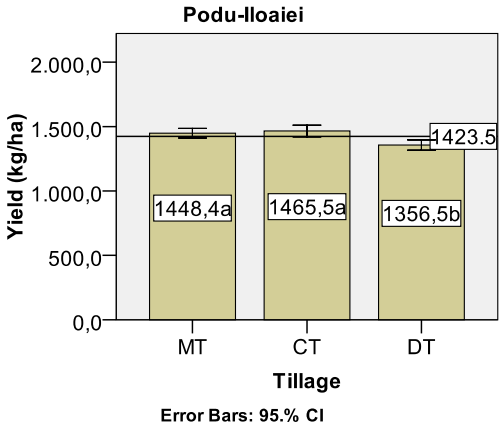


Figure 4. Effect of different tillage systems on winter oilseed rape yield

The highest yield was obtained in MT in two out of three locations (Suceava and Secuieni) and in CT at Podu-Iloaiei, although the differences between the two treatments were insignificant (p=0.05). DT gave significantly (p=0.05) lower yields in all locations (4331.7 kg/ha, 3.431,7 kg/ha, and 1356 kg/ha) compared to MT and CT, probably because of the poor crop establishment. The low yields (1423.5 kg/ha on average for the entire field) from Podu-Iloaiei showed once again the vulnerability of this crop to different climatic accidents – hail in this case – that occur from siliquae formation to crop harvest.

Conclusions

MT gave higher rapeseed yields in two out of three locations although not significantly different from CT, and had a more pronounced impact on soil physical state, while CT affected less soil compaction and structure indices. From all experimented tillage treatments, DT produced the most unfavorable conditions for crop establishment and growth, due to insufficient depth and to the aggressiveness of disks, which reflected in significantly reduced yields. Further research needs to be done to clearly establish the effect of experimented tillage systems on soil physical properties and rapeseed yield in north-eastern Romania.

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References

Bronick C. J., Lal R. 2005. Soil structure and management: a review. Geoderma, 124, 3-22.

Canarache A. 1990. PENETR-a generalized semi-empirical model estimating soil resistance to penetration. Soil Till.Res.,16, 51-70

D'Haene K., Vermang J., Cornelis W. M., Leroy B. L. M., Schiettecatte W., De Neve S., Gabriels D., Hofman G. 2008. Reduced tillage effects on physical properties of silt loam soils growing root crops. Soil Till. Res., 99, 279-290.

Diaz-Zorita M., 2000. Effect of deep-tillage and nitrogen fertilization interactions on dryland corn (*Zea mays* L.) productivity. Soil Till. Res., 54, 11-19.

Filho C. C., Lourenco A., Guimaraes M. D. F., Fonseca I. C. B. 2002. Aggregate stability under different soil management systems in a red Latosol in the state of Parana, Brazil. Soil Tillage Res., 65, 45-51.

Lal R. 1993. Tillage effects on soil degradation, soil resilience, soil quality, and sustainability. Soil and Tillage Research, 27, 1-8.

Lampurlanes J., Cantero-Martinez C. 2003. Soil Bulk Density and Penetration Resistance under Different Tillage and Crop Management Systems and Their Relationship with Barley Root Growth. Agron. J., 95, 526-536.

Nimmo J. R., Perkins K. S. 2002. Aggregate stability and size distribution, In: Methods of Soil Analysis, Part 4-Physical methods. SOIL SCIENCE SOCIETY OF AMERICA, USA. 317-328.

Ozpinar S., Cay A. 2006. Effect of different tillage systems on the quality and crop productivity of a clay-loam soil in semi-arid north-western Turkey, Soil & Tillage Research, 88, 95-106.

Plante A. F., McGill W. B. 2002. Soil aggregate dynamics and the retention of organic matter in laboratory-incubated soil with differing simulated tillage frequencies. Soil Tillage Res., 66, 79-92.

Six J., Elliott E. T., Paustian K. 2000. Soil structure and soil organic matter: II. A normalized stability index and the effect of mineralogy. Soil Sci. Soc. Am. J., 64, 1042-1049.

Yavuzcan H.G. 2000. Wheel traffic impact on soil conditions as influenced by tillage system in Central Anatolia. Soil Till. Res., 54, 129-138.

Young A., Young R. 2001. Soils in the Australian landscape. OXFORD UNIVERSITY PRESS. Melbourne.

Organic Plant Protection Treatments in Greenhouse and Open Field by an Electrical Prototype

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Abstract
Two different versions of the patented device designed and built by Section of Mechanics and Mechanization of DiGeSA have been used in distribution tests of natural enemies (*Phytoseiulus persimilis* and *Orius laevigatus*) on greenhouse vegetable and flower crops (bell pepper and chrysanthemum) and on open field strawberry crops. For both the enemies, manual and mechanized releases were compared.
The results of the preliminary laboratory tests prove that the dosage and distribution mechanism are suited to biological pest control strategies, both on greenhouse and on open field. These results encourage the diffusion of organic plant protection on vegetables in accordance with the recent European Directive 2009/128/CE.
With the version used on bell pepper the average time to turn the machine has been relatively high because of scanty manoeuvrability. With the version used on strawberry crops, set on a handle directly carried by the operator or mounted on a bar carried by a tractor, the device performance is improved both in distribution uniformity and in manoeuvrability. Also the version used on chrysanthemum, with three prototypes carried by a tool-bar applied on a trolley, has allowed to obtain a good uniformity distribution with rewarding work capacity. Thanks to the better results in terms of work capacity, costs would be contained when compared with those of manual distribution practiced so far.

Keywords: plant protection machines, sustainable pest management, horticulture

Introduction
Since the report of 2008 written by IFOAM (International Federation of Organic Agriculture Movements) and by FIBL - International Association of Organic Agriculture Research Institutes, it appears that Europe is in second place with 8.2 million hectares of organic crops, preceded from Oceania with 12.1 million hectares. In particular, in Europe, in the last years, there has been a steady increase of areas planted with organic crops. This is confirmed by the last report elaborated by Eurostat - Statistics in Focus, 10/2010 - that indicates an increase of 7.4% of the total area dedicated to organic crops between 2007 and 2008, with a total area of 7,6 million hectares, that is 4,3% of the agricultural area of the 27 EU countries.
In this context, Italy has an important role in the organic production sector, with over one million hectares cultivated by about 50.000 farms. In Italy, Sicily (218.647 ha) is the first region by number of hectares cultivated organically (vegetables, cereals and arable crops, olive groves, citrus, vineyards, meadows and pastures, uncultivated lands) (SINAB, 2009).
European Directive 2009/128/EC, imposing great changes on the use of pesticides. In fact, from January 2014 will be required to adopt integrated pest management strategies and to encourage low-input pest management pesticides.

The pest controls, which provide of manual auxiliary release on infested plants, however, involve a considerable employment of time and also do not ensure a uniform distribution. Several researches have been carried out to encourage the diffusion of organic and integrated production systems. For example in the eighties were made the first attempts with the use of small aircraft (Bouse and Morrison, 1985; Drukker et al., 1993; Maini et al., 1988; Pickett et al., 1987) or by air flow distributors drawn by tractors Gardner and Giles, 1997, Giles et al., 1995, Giles and Wunderlich, 1998). More recently have been implemented small portable machines, which perform the release due to a current of air generated by a small fan (Baraldi et al., 2006; Opit et al., 2005; Pezzi et al., 2002; Van Driesche et al., 2002). Also on the rose buds has been studied the effectiveness of treatments with Phytoseiulus persimilis released mechanically by means of a special dispenser (Casey and Parrella, 2005).
However, if in the greenhouses are well-established the biological and integrated pest control techniques on many vegetable crops such as tomato (Celli, 1998; Maranzoli and Benuzzi, 1995, Shipp and Wang, 2003), cucurbits (Conte and Dalla Monta, 2001; Ferrari et al., 1996, Lopes et al., 2010; Orlandini and Martellucci, 1997), bell pepper and aubergine (Benuzzi, 1996, Bosco et al., 2008; Santonicola and Milone, 1998), strawberry (Tommasini et al., 2001; Trumble and Morse, 1993), and also, after adjustment to agro-environmental situation, on flower crops (Buitenhuis et al., 2009, Chow et al., 2008; Opit et al., 2004), in open fields not yet found extensive applications.
In this context, at the Section of Mechanics and Mechanisation of the DiGeSA (University of Catania – Italy), have been built two versions and realized four applications of a prototype for the mechanical distribution of natural enemies, commonly used for biological control of horticultural and floricultural crops, in greenhouse and open field (Blandini et al., 2006; Blandini et al., 2007a, b, c; Blandini et al., 2010; Tropea Garzia et al., 2006).

Materials and Methods

The prototypes

Two different versions and four different applications of the prototype were used during the experimental tests in greenhouse and in open field.
The first version of the prototype (Figure 1) measures 36 cm long by 46 cm high with a mass of 4.17 kg excluding batteries. It is made by a steel frame with a "C" shape. On the upper arm of this frame a disc supporting a hopper is bolted. This, with conical shape and made of polypropylene, holds 2 dm^3 and is fixed along a loop of the supporting disc by means of a bushing which is screwed to the exit hole of the hopper. The top has affixed an electric motor which governs the rotation (30 rpm) of a helical distributor (doser), fixed along the vertical axis of the hopper. The product, thanks to the doser, falls onto distributor disc, that is mounted on the lower arm of the frame and turns (600 rpm) around its vertical axis by means of a direct-drive electric motor attached below the prototype. The distributor disc, made of PVC, has 20 cm diameter and 8 radial 7 mm high fins. The two electric motors are powered by continuous 6 V current (Blandini et al., 2006; Blandini et al., 2007c).
To vary the jet direction of the natural enemies onto the crops from the distributor disc, the supporting disc can rotate with respect to the frame around the same rotation axis of the distributor disc and the point of anchorage of the hopper can be changed along the loop of the supporting disc. Changing the diameter of the bushings, it is possible to regulate the amount of the product to be distributed.
In order to improve the uniformity of the product flow rate, the work width and its versatility a most recent version of the prototype was built (Figure 2) without changes in the functioning principle, but only in some of its components. The new version of the prototype is 42 cm long

and 43 cm high with a mass of 4.10 kg. The hopper is smaller (about 1.5 dm^3) than the previous version and is made of aluminium to permit better centring of the doser with respect to the exit hole for the product. The doser, rotating inside the hopper, is obtained from the tip of a drill for concrete, with the cutting elements at the end removed. The finned distributor disc has a diameter of 30 cm instead of the 20 cm of the previous version and it is made of aluminium (Blandini et al. 2008).

Figure 1. The first version of the prototype.

Figure 2. The most recent version of the prototype.

Four different applications of these versions were used for experimental tests: two on greenhouse vegetable and flower crops (bell pepper and chrysanthemum) and other two on open field strawberry crops.
The first version of the prototype was mounted on a two wheeled frame to manoeuvre it within a **bell pepper** greenhouse during experimentation tests. With this application the working height relative to crop height can be adjust and hold its position. The switchs to operate the electric motors are near the right handle (Figure 3).
To carry out the tests of distribution on **chrysanthemum** greenhouse, three prototypes were applied to a carrying bar. This is mounted on top of a frame with 4 wheels, driven manually, being 100 cm high and 100 cm long. The rut of the frame can vary between 85 and 150 cm and the distance separating each prototype can be regulated in function of the crop lay-out. The prototypes were connected electrically to one another in parallel, powered by a single 12 Ah rechargeable battery and commanded by a single switch (Figure 4).
Open field tests on two different **strawberry** fields were carried out. In the first field three prototypes mounted on a 3.2 m carrying bar and connected to three point linkage to a 2 WD tractor were used (Figure 5). As in chrysanthemum tests, the prototypes were connected electrically to one another and commanded by a single switch, positioned near the tractor driver. In the second strawberry field, the tests were carried out with the prototype applied to the bar carried directly by an operator with a shoulder strap and lateral handle (Figure 6).

The greenhouse tests
The tests were run in the Ragusa province (south-eastern of Sicily) in greenhouses cultivated with organic farming system. Manual and mechanised lot distribution were compared using the same rate. While running the both tests, the work times of distribution were recorded as indicated by CIOSTA (Comité International d'Organisation Scientifique du Travail en Agricolture) in order to calculate the work capacity (ha/h) of the prototype. Other results on biological control efficacy were produced by entomologist and reported on in printing papers.

Figure 3.The first version of the prototype applied to the wheeled frame.

Figure 4. The new prototypes applied to the wheeled frame.

Figure 5. The distribution with three new prototypes carried by a tractor.

Figure 6. The distribution with the new prototype carried by an operator.

Three releases were performed in **bell pepper** greenhouse of 1000 m^2. Only one distribution of *Phytoseiulus persimilis* was carried out whereas for *Orius laevigatus* a single distribution (normal) and a double distribution at six days interval was compared. In the case of manual distribution, the product was left on 4 – 6 plants in the same row, randomly chosen and equidistant. In the case of mechanical distribution, product was left on the whole lane or alternate lane. On every lane there were two rows of plants 0.7 m apart; the inter-row distance of two lane was about 1.20 m, and the plant density was 5 plants/m^2. The work width was 1 m in the first release and 2 m (single rate) and 1 m (double rate) in the second release. The prototypes were regulated at an average height of 0.9 m from the ground in *P. persimilis* release and 1.20 m in *O. laevigatus* release.
The releases of natural enemies on **chrysanthemum** greenhouse (1500 m^2) were carried out on two plots: one for mechanical release and the other one for manual release. On every plot there were 7 rows of plants 0.11 m apart; the distance of plants on the row was 0.10 m and the plant density was 90 plants/m^2. The work width was 4.8 m and the area considered for the experiments was about 160 m^2 and included a total of 21 ridges. Two releases were performed at seven days interval. On each of the two release dates, the two natural enemies (*P. persimilis* and *O. laevigatus)* were distributed separately.

The open field tests
The tests were carried out on two different strawberry fields (without and with cover tunnel in plastic film) located in the Syracuse province (eastern of Sicily) with two different applications of the prototype. The cultivation takes place on 0.8 m large ridges covered with black plastic film and the distance between two ridges was about 0.6 m.
The first tests were performed on *Camarosa* cultivar without cover tunnel (Tests 1). On every ridge there were two rows of plants 0.3 m apart; the inter-row distance of two plants was 0.25 m, so the plant density was 8 plants/m^2. The prototypes were regulated at an average height of 50 cm from the ground and at an inter-row distance of 1.4 m, so that each one was also positioned in correspondence of the centre line of each ridge. Consequently, the work width was 4.2 m. The area considered for the experiments was about 600 m^2 and included a total of 6 ridges. In this case only one treatment with both natural enemies was carried out.
The other tests were performed on *Carmela* cultivar with cover tunnel (Tests 2). In this case the inter-row distance was 0.2 m and consequently the plant density was 12 plants/m^2. The tests were carried out on a surface of 150 m^2 including 3 ridges and the prototype applied to the bar carried directly by an operator was used. In this case two treatments with both natural enemies a fortnight apart were carried out.

Results
The greenhouse tests
The greenhouse tests on **bell pepper** show the mean mechanised work capacities are always greater compared to the manual one, notwithstanding that treatment times strictly depend on dosages (Table 1). To carry out the distribution of the natural enemies at the fixed rates with the prototype on the wheeled frame it has been necessary to maintain the average advancement speed of about 1 m/s for *O. laevigatus* and of about 2 m/s for *P. persimilis*. The average time to turn the machine has been of about 9 s because of scanty manoeuvrability. In these conditions the work capacities were about 0.6 ha/h for *O. laevigatus* single rate and about 0.3 ha/h for *O. laevigatus* double rate; actual work capacity of about 0.7 ha/h has been recorded for *P. persimilis*.
In order to comply with the working conditions in **chrysanthemum** tests, it has been necessary to maintain the average advancement speed of about 0.10 m/s for *O. laevigatus* and of 0.14 m/s for *P. persimilis*. Therefore, it has been possible to obtain actual work capacities of about 0.18 and 0.24 ha/h, compared with a 0.14 ha/h capacity performed in manual distribution. Under this working conditions, the quantity of dispersal material correspond to 19 phytoseiids/m^2 and 9 anthocorid bugs/m^2: more than the rate recommended. This is because, in order to ensure a better pest control and avoid production losses, the whole content of packages employed during the test has been distributed.

Table 1. Performances of the distribution in the greenhouse tests: mean values

Tests	**Forward speed** (m/s)	**Mechanical Work Capacities** (ha/h)	**Manual Work Capacities** (ha/h)	**Product distributed** (g/m^2)	
				O. laevigatus	*P. persimilis*
Bell pepper	1 - 2	0.4 - 0.7	0.3	0.3	0.3
Chrysanthemum	0.10 - 0.14	0.18 - 0.24	0.1	0.4	0.6

A certain uniformity in the prototypes functioning is highlighted by the limited changes in the average flow in the two releases (0.17 and 0.18 g/s for *O. laevigatus*; 0.42 and 0.37 g/s for *P. persimilis*). The only noteworthy difference can be found in the rotational speed of the distributor disc, probably due to the level of battery power which was higher in the second release (Table 2).

Table 2. Distribution parameters in the chrysanthemum tests where three prototypes in parallel were used.

	Prototypes	**Distributor disk velocity** (rpm)	**Doser velocity** (rpm)	**Flow** (g/s)	
				O. laevigatus	*P. persimilis*
First release	1	534	30	0.20	0.47
	2	510	29	0.16	0.37
	3	501	29	0.16	0.41
	mean	*515*	*29*	*0.17*	*0.42*
Second release	1	552	30	0.20	0.31
	2	542	29	0.18	0.47
	3	524	29	0.17	0.41
	mean	*539*	*29*	*0.18*	*0.37*

The open field tests

The tests carried out with the three prototypes applied to the 2 WD tractor (Tests 1) permitted to obtain an effective work capacity of about 0.6 ha/h in the case of *O. laevigatus* and about 1 ha/h in the case of *P. persimilis*. The average forward speeds were 0.4 m/s and 0.6 m/s respectively (Table 3).

In the second strawberry field (Tests 2), using only one prototype applied to the bar carried by an operator, the work capacity were significantly lower (about 0.2 ha/h) than those obtained with the tractor carried prototypes. This result was due both to the effective work width of 1.4 m instead of 4.2 m with the tractor and to the lower forward speed, only 0.12 m/s, that was needed to keep the distribution of the packages on the established surface (Table 3).

Table 3. Performances of the distribution in the strawberry open field tests

Tests	**Forward speed** (m/s)	**Mechanical Work Capacities** (ha/h)	**Distributed product** (g/m^2)	
			O. laevigatus	*P. persimilis*
1	0.4 - 0.6	0.6 - 1	0.2	0.4
2	0.4	0.2	0.2	0.4

With respect to distribution parameters shown in Table 4, an increase in quantity was observed, particularly for *P. persimilis*, due to the spillage from the doser during turning manoeuvres caused by the vibrations transmitted by the tractor. In fact, the headlands were not large enough to allow the fast turning of the tractor equipped with the carrying bar.

The same increase in quantity was not recorded with the *O. leavigatus* because of greater dimensions of its dispersal material (buckwheat husks mixed with vermiculites).

Table 4. Distribution parameters in the first strawberry field where three prototypes in parallel were used.

Prototypes	Distributor disk velocity (rpm)	Doser velocity (rpm)	Flow (g/s)	
			O. laevigatus	*P. persimilis*
1	530	29	0.13	0.55
2	453	27	0.10	0.54
3	448	26	0.19	0.42
mean	*477*	*27*	*0.14*	*0.50*

Conclusions

As already shown in previous paper the distribution mechanism of the prototype is well suited to biological pest control strategies also in the open field in accordance with the recent European Directive 2009/128/CE. With the three applications of the new version of prototype, the manoeuvrability has been much improved and consequently better results can be obtained in terms of both work capacity and uniformity. In particular the prototype mounted on the carrying bar connected to three point linkage to a tractor could represent an suitable solution for the distribution of natural enemies in strawberry crops.
Also the work capacities show the advantage using the machine tested as opposed to the manual distribution generally adopted for biological and integrated crops.
From these experiences, mechanised distribution has clearly proved advantageous in terms of time and work especially when the time wasted in lane turnarounds, improving the limited manoeuvrability of the machine, were reduced.
Moreover, to increase the work capacity the headlands would be large enough to allow the fast turning of the tractor and the reduction of the stopping times of the prototypes, so to limit the product lost because of the not inconsiderable vibrations transmitted by the tractor.
At last, if there were no problems with turning, it would be possible to increase the work capacity by increasing the work width and consequently the bar length and thus the number of prototypes used.
It's important pointing out that on the basis of the information provided by the farmers hosting the tests, it would seem that the productive yield obtained with biological treatments and those with chemical treatments were comparable.

References

Baraldi G., Burgio G., Caprara C., Lanzoni A., Maini S., Martelli R., Pezzi F. (2006), Distribuzione meccanica di Phytoseiulus persimilis, Atti Giornate Fitopatologiche 2006, vol. 1, 563-570, Riccione (RN), 27-29 marzo 2006.

Benuzzi M. (1996), Peperone, le strategie di lotta biologica, Colture Protette, (11), 61-66.

Blandini G., Failla S., Manetto G., Tropea Garzia G., Siscaro G., Zappalà L. (2006), Prove preliminari di distribuzione meccanica di antagonisti naturali, Atti Giornate Fitopatologiche 2006, vol. 1, 557-562, Riccione (RN), 27-29 marzo 2006.

Blandini G., Emma G., Failla S., Manetto G. (2007a), Valutazione della distribuzione meccanizzata di antagonisti naturali nelle serre siciliane, Atti del Convegno Strategie di difesa biologica, 29-50, Hortomac, Cesena (FC), 8 febbraio 2007.

Blandini G., Emma G., Failla S., Manetto G. (2007b), Prototipo per la distribuzione meccanica di antagonisti naturali, Atti del Convegno Nazionale delle sezioni III, V e VI dell'AIIA Tecnologie innovative nelle filiere: orticola, vitivinicola e olivicolo-olearia, vol. 1, 48-51, Pisa-Volterra, 5-7 settembre 2007.

Blandini G., Emma G., Failla S., Manetto G. (2007c), A Prototype for Mechanical Distribution of Beneficials, Acta Horticulturae, n. 801, novembre 2008, vol. 2, 1515-1522.

Blandini G., Emma G., Failla S., Manetto G. (2008). A New Version of Prototype for Mechanical Distribution of Natural Enemies. In: Atti su CD-ROM International Conference "Innovation Technology to Empower Safety, Health and Welfare in Agriculture and Agro-food Systems".

Blandini G., Emma G., Failla S., Manetto G., Papa R. (2010), Assessment of Centrifugal Distribution of Natural Enemies for the Open Field, Atti su USB key International Conference on Agricultural Engineering, September 6-8 2010 Clermont-Ferrand France.

Bosco L., Giacometto E., Tavella L. (2008), Colonisation and Predation of Thrips (Thysanoptera: Thripidae) by Orius spp. (Heteroptera: Anthocoridae) in Sweet Pepper Greenhouses in Northwest Italy, Biological Control, 44, (3), 331-340.

Bouse L.F., Morrison R.K. (1985), Transport, Storage and Release of Trichogramma peritoneum, Southwest Entomol. Suppl. (8), 36-48.

Buitenhuis R., Shipp L., Scott-Dupree C. (2009), Dispersal of Amblyseius swirskii Athias-Henriot (Acari: Phytoseiidae) on Potted Greenhouse Chrysanthemum, Biological Control, 52, (2), febbraio 2010, 110-114.

Casey C.A., Parrella M.P. (2005), Evaluation of a Mechanical Dispenser and Interplant Bridges on the Dispersal and Efficacy of the Predator, Phytoseiulus persimilis (Acari: Phytoseiidae) in Greenhouse Cut Roses, Biological Control, 32, (1), 130-136.

Celli G. (1998), Introduzione: insetti dannosi, insetti utili, In: Gli ausiliari nell'agricoltura sostenibile, Calderini Edagricole.

Chow A., Chau A., Heinz K.M. (2008), Compatibility of Orius insidiosus (Hemiptera: Anthocoridae) with Amblyseius (Iphiseius) degenerans (Acari: Phytoseiidae) for Control of Frankliniella occidentalis (Thysanoptera: Thripidae) on Greenhouse Roses, Biological Control, 44, (2), 259-270.

Conte L., Dalla Montà L. (2001), L'impiego degli insetti utili nella difesa delle cucurbitacee, L'Informatore Agrario, (14), 81-82.

Drukker B., Yaninek J.S., Herren H.R. (1993), A packaging and delivery system for aerial release of Phytoseiidae for biological control, Exp. Appl. Acarol., 17, 129–143.

Ferrari R., Burgio G., Cornale R., Curto G. (1996), Difesa biologica-integrata di cocomero e melone, Colture Protette, (12), 33-36.

Gardner J., Giles K. (1997), Mechanical Distribution of Chrysoperla rufilabris and Trichogramma pretiuosum: Survival and Uniformity of Discharge after Spray Dispersal in Aqueous Suspension, Biological Control, 8, (1), 138-142.

Giles D.K., Gardner J., Studer H.E. (1995), Mechanical Release of Predacious Mites for Biological Pest Control in Strawberries, Transact. of the ASAE, 38, (5), 1289-1296.

Giles D.K., Wunderlich L.R. (1998), Electronically Controlled Delivery System for Beneficial Insect Eggs in Liquid Suspensions, Transact. of the ASAE, 41, (3), 839-847.

Lopes C., Spataro T., Lapchin L., Arditi R. (2010), Optimal Release Strategies for the Biological Control of Aphids in Melon Greenhouses, Biological Control, 48, (1), 12-21.

Maini S., Gattavecchia C., Libé A. (1988), Impiego di velivolo ultraleggero per i lanci di Trichogramma maidis Pint. e Voeg. contro Ostrinia nubilalis (Hb.), Atti Giornate Fitopatologiche 1988, vol. 2, 203-212.

Maranzoli G., Benuzzi M. (1995), Pomodoro in serra, lotta biologica e integrata, Colture Protette, (1), 41-47.

Opit G.P., Nechols J.R., Margolies D.C. (2004), Biological Control of Two Spotted Spider Mites, Tetranychus urticae Koch (Acari: Tetranychidae), using Phytoseiulus persimilis Athias-Henriot (Acari: Phytoseidae) on Ivy Geranium: Assessment of Predator Release Ratios, Biological Control, 29, (3), 445-452.

Opit G.P., Nechols J.R., Margolies D.C., Williams K.A. (2005), Survival, Horizontal Distribution, and Economics of Releasing Predatory Mites (Acari: Phytoseidae) using Mechanical Blowers, Biological Control, 33, 344-351.

Orlandini G., Martellucci R. (1997), Melone: lotta biologica all'Aphis gossypii, Colture Protette, (6), 33-36.

Pezzi F., Rondelli V., Baraldi G. (2002), Mechanical Distribution of Phytoseiids in Greenhouse Crops, Rivista di Ingegneria Agraria, 33, (3), 33-39.

Pickett C.H., Gilstrap F.E., Morrison R.K., Bouse L.F. (1987), Release of Predatory Mites by Aircraft for the Biological Control of Spider Mites Infesting Corn, Journal Econ. Entomol., 80, (3), 906-910.

Santonicola L., Milone M. (1998), Esperienze di lotta al tripide Frankliniella occidentalis (Perg.) su peperone, L'Informatore Agrario, (8), 98-100.

Shipp J.L., Wang K. (2003), Evaluation of Amblyseius cucumeris (Acari: Phytoseiidae) and Orius insidiosus (Hemiptera: Anthocoridae) for Control of Frankliniella occidentalis (Thysanoptera: Thripidae) on Greenhouse Tomatoes, Biological Control, 28, (3), 271-281.

Sinab (2009), Bio in cifre. www.sinab.it

Tommasini M.G., Funaro M., Montemuro S., Falco V., Palermo M.L. (2001), La difesa biologico-integrata della fragola nel Sud Italia, Frutticoltura, (1), 43-47.

Tropea Garzia G., Zappalà L., Siscaro G., Blandini G., Failla S., Manetto G. (2006), Mechanical Distribution of Beneficials: Laboratory Tests, Bulletin IOBC/WPRS Working Group Integrated Control in Protected Crops, Mediterranean Climate, 14-18 Maggio 2006, Murcia, Spagna.

Trumble J.T., Morse J.P. (1993), Economics of Integrating the Predaceous Mite Phytoseiulus persimilis (Acari: Phytoseiidae) with Pesticides in Strawberries, Journal Econ. Entomol., 86, (3), 879-885.

Van Driesche R.G., Lyon S., Sanderson J., Smith T., Lopes P., MacAvery S., Rusinek T., Couch G. (2002), Greenhouse Trials in Massachusetts and New York with Amblyseius cucumeris: Effects of Formulation and Mechanical Application, IOBC/wprs Bulletin, 25, (1), 273-276.

Development of a prototype for mechanical distribution of natural enemies

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Keywords: Facilitating machines, Centrifugal distribution, Plant protection

Aim

The European Directive 2009/128/CE involves, among other measures, the compulsory adoption of integrated control strategies starting from January 2014. Moreover, biological and integrated control measures are widely and effectively employed both on vegetable crops and on ornamental crops. The release of natural enemies on crops is carried out manually with a considerable work time and without a uniform distribution. Therefore, a prototype for mechanical distribution of natural enemies was developed and realised. This study refers on the improvement of the prototype carried out to make it adoptable both in greenhouse and open field and on the laboratory tests carried out to assess its performances.

Methodology

Several versions of the prototype were produced without changes in the functioning principle, but only in some of its components, in order to improve the prototype performance and the components coupling. All the improvements were evaluated by means of laboratory tests in order to assess direction of the jet, uniformity of the flow rate, operative width and uniformity of distribution both horizontal and vertical plane.

Results

In order to assess the applicability of the centrifugal action to the natural enemies distribution, laboratory tests were carried out with the first version of the prototype. The possibility to regulate direction of the jet and flow rate of the natural enemies released in accordance to the work conditions was assessed with the subsequent models of the prototype. Also the distribution, evaluated on a horizontal and vertical plane, seems to be suitable for applications in biological control programs. Furthermore, the versatility of the prototype to operate both in greenhouse and in open field has been verified.

Conclusion and Perspectives

A satisfactory flexibility of its use has been achieved with the last version of the prototype. In fact, it is applicable to a bar directly carried by an operator, to a frame or to a tool-bar applied to a tractor or a trolley and it can operate both in greenhouse and in open field. However, others evolutions could be useful in order to make constant the flow rate of the product also during the final empting phase of the hopper.

Methodological application to meet the health impact caused by the use of compost with POP

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Aim

Understanding the health impact of the POPs (Persistent-Organic-Pollutants) contents in the compost used as fertilizer on agricultural crops obtained from the segregation of organic urban waste.

Rate the normative content of POPs in environmental policy and health in Colombia.

Methodology

He developed a systematic review and an analytical study. For the first conduct a literature review of legal texts, by: 1) databases, 2) Google's-use-of–Boolean-operators; Regulators-texts-defined-as-standards-and-codes-on-wesites-of-the-Ministry-of-Environment-Health-and-Agriculture-Colombia. For the analytical study will be a cross-sectional survey using key informants technique by interview and application of the Delphi method.

Key informants will be selected according to the degree of interference you may have about the policy guidelines under study. The Delphi method allows assessing the barriers and opportunities for policy guidelines.

The populations under study correspond to: government managers, technicians, urban compost producers and users that use it for agricultural purposes.

The analysis variables focus on POP chemicals taken at different stages of production of compost.

Finally, the information gathered, conduct the analysis, interpretation of findings, conclusions and recommendations of the study.

Expected result

With the results were expected barriers and opportunities for Colombian legislation on environmental and health related to the establishment of permissible limits of POP in the compost used as an agricultural fertilizer and its effect on health.

The importance of regulating the content of POP is that organic compounds are stable and highly toxic to humans and the environment, they have a great power of bioaccumulation and biomagnification in the food chain.

Evaluation of the health risk for the farm workers operating in contaminated sites[1]

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Abstract
Organic and inorganic polluting substances contaminate a large number of agricultural areas in Italy. In these areas the workers' exposure to the aforesaid contaminants potentially can involve of the biological equilibrium with consequent poisonings and/or professional diseases. The aim of this paper is the evaluation of the sanitary risk for the agricultural employees that operate in a rural area of southern Italy in the Campania Region, characterized by the presence of agrarian crops in open fields and inside greenhouses. This area is also concerneded by the presence of pollutants released during the years by unauthorized dumps. The results point out that the hazard index *HQ* and the cancer increase risk *R* for the agricultural operators that work inside greenhouses or on open fields are widely below the legal limits. Furthermore the agricultural operators that work inside greenhouses, where the air replacements are produced by side and ridge openings and defective tightness of the covering, are exposed to a much greater sanitary environmental risk (*HQ* and *R*) than the labourers employed on open fields.

Keywords: contaminated agricultural areas, farm workers, health risk

Introduction
In Italy a large number of agricultural areas are placed in sites contaminated by organic and inorganic polluting substances. In these areas the farm workers can come into contact with the environmental contaminants through dusts and vapors inhalation and dermic contact (Cecchini *et al.*, 2010). The workers' exposure to those contaminants potentially can involve of the biological equilibrium with consequent poisonings and/or professional diseases (Barra et al., 2009).
In the aforesaid areas the health or sanitary risk produced by the possible presence of chemical contaminants in the soil and in the waters is added to the safety risk linked with the professional exposure (Cividino *et al.*, 2009).
This sanitary risk must be estimated and suitably considered in the evaluation of the chemical risk provided by the Italian law in force [law decree 81/2008]. This evaluation requires a complex operation because of the diversity of the chemical agents and of the variety of the harmful actions produced by each one of the agent (Romano *et al.*, 2011).
An up to date methodology for the numerical evaluation of the health risks produced by the exposure to the environmental contaminants is the site-specific sanitary environmental risk analysis, that is founded on the RBCA (Risk - Based Corrective Action) approach elaborated by the ASTM (American Society for Testing and Materials) and included in the Italian technical standard [UNICHIM,2002].

[1] *Each of the authors contributed in equal parts to this work*

Nevertheless such procedure doesn't consider the detailed characteristics of the agricultural work places and of the operators that labour on the open fields (outdoor) or inside environments: greenhouses, zootechnic breedings, and so on (indoor). The aim of this paper is the evaluation of the sanitary risk for the agricultural employees that operate in a rural area of southern Italy in the Campania Region, characterized by the presence of agrarian crops in open fields and insde greenhouses. This area is also concerneded by the presence of pollutants released during the years by unauthorized dumps.

Evaluation of the health risk

The assessment of the site-specific sanitary environmental risk caused by the inhalation of environmental pollutants present in the agricultural work places has been carried out by the calculation of the hazard index *HQ* [dimensionless] and of the cancer increase risk during life caused by the exposition to the polluter *R* [dimensionless] (ISPRA, 2008):

$$HQ = \frac{E}{RfD}$$

$$R = E \times SF$$

where: *E* [mg/kg·day] is the chronic effective daily exposure to contaminant; *RfD* [mg/kg] the daily reference dose; *SF* [kg·day /mg] is the carcinogenic potential for daily polluter dose unit (ISPRA, 2008; Gino, 2010; Cottica & Grignani, 2010). From toxicological point of view, each pollutant is characterised by the reference dose (*RfD*), that is an estimation of the average daily exposition non-producing adverse effects to the human organism during his life, and the carcinogenic potential (*SF*) (ISS/ISPESL, 2009; Cicero *et al.*, 2010).

The calculated *HQ* and *R* values must be compared with the threshold acceptability values in order to verify the healthiness of agricultural work places located in contaminated areas (Nano, 2010). The Italian law in force establishes that acceptable hazard index values are $HQ \leq 1$ and acceptable cancer increase risk values, related to carcinogenic substances, must be $R \leq 1x10^{-6}$ (Law n. 152/06).

The chronic effective daily exposure *E* is different according to the agricultural operators that work on the open fields or inside the greenhouses and depends on several parameters (U.S. EPA, 1997): the concentration of pollutants in the superficial soil, the superficial soil – air outdoor volatilization factor (open fields) or the superficial soil – air indoor volatilization factor (greenhouses), the hourly inhalation, the exposure frequency, the daily exposure frequency, the exposure period, the weight of human receptors, the exposure average time (ISPRA, 2008).

Materials and methods

The afore mentioned methodology has been applied in an agricultural area primarily employed to vegetable crops in open field and in greenhouses comprised in the Site of National Interest (SNI) "Flegreo Domitio Coast and Agro Aversano". The presence in the surrounding territory of plants, even not authorized, for the waste treatment, has produced in a period of years environmental pollution results. Really a part of the rural area in question is affected by localized contamination symptoms produced by indenopyrene (C_{soil} = 0,171 mg/kg_{soil}) and benzo(g,h,i)perylene (C_{soil} = 0,148 mg/kg_{soil}) (ARPA Campania, 2009). These concentrations have been evaluated through physical - chemical analysis carried out on superficial soil samples collected from study area by the Campania Regional Agency for Environmental Protection (ARPA, 2009).

The exposure to contaminants (*E*) of agricultural workers in outdoor environment (open field) and indoor environment (greenhouse) and, subsequently, the health risk (*HQ* and *R*) have been evaluated by applying the "Risk - net" Software (www.reconnet.it) developed by the "Tor Vergata" University of Rome (ISPRA, 2008; Verginelli, 2012).

Results and discussion

Figure 1 and Figure 2 show the results of the site-specific sanitary environmental risk analysis carried out for the agricultural operators that work in the study area either in greenhouse or on open fields. As you can see the hazard index *HQ* and the cancer increase risk *R* for the agricultural operators that work inside greenhouses or on open fields are widely below the legal limits. Therefore the superficial soil of the study area do not produce toxic and carcinogenic effects as the indenopyrene and benzo(g, h, i)perylene concentrations are very low. In any case the benzo(g, h, i)perylene has no carcinogenic effects and then the cancer increase risk is only caused by the presence dell'indenopyrene.

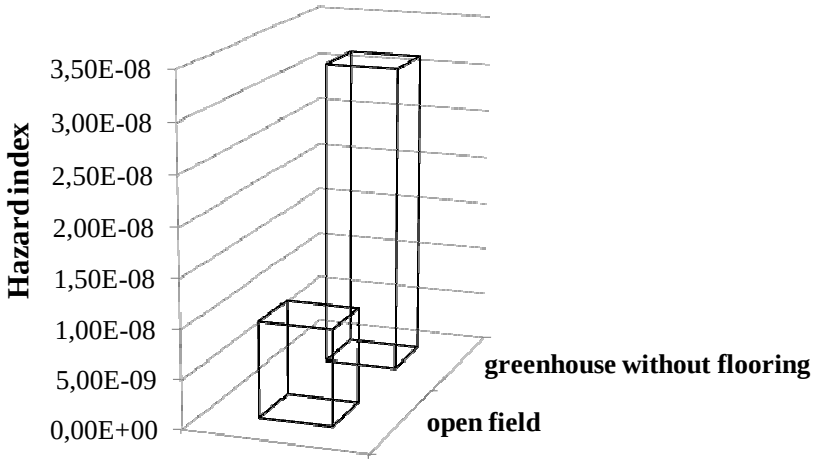

Figure 1 – Hazard Index (*HQ*) evaluated for the studied agricultural work places

Furthermore the agricultural operators that work inside greenhouses, where the air replacements are produced by side and ridge openings and defective tightness of the covering, are exposed to a much greater sanitary environmental risk (*HQ* and *R*) than the labourers employed on open fields.

In the study area, it is not necessary to introduce appropriate protective measures for the workers inside greenhouses, as the cancer increase risk is always below the law limits. Moreover inside the greenhouses pollutant concentrations do not produce an high sanitary environmental risk owing to the ventilation and the presence of flooring.

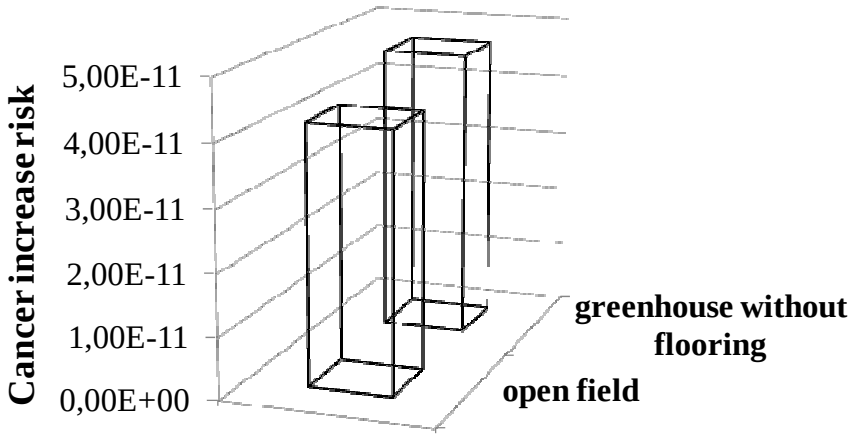

Figure 2 - Cancer increase risk (R) evaluated for the studied agricultural work places

Conclusions

The air scattered contaminants concentration outdoors (open fields) and indoors (greenhouses) have been evaluated for the rural area of the Site of National Interest (SNI) "Flegreo Domitio Coast and Agro Aversano", by means the site-specific sanitary environmental risk analysis methodology. This study points out that in this area there is a smaller concentration of pollutants on open fields than inside the greenhouses owing to the atmospheric scattering phenomenon. Furthermore the indoor and out air scattered pollutants concentrations (open fields and greenhouses) have allowed to evalutate the hazard index and the cancer increasing risk for the agricultural operators that work in the afore mentioned area.
The sanitary environmental risk analysis is a valid tool for the inspection of the healthiness of the agricultural work places and for the characterization of the possible precautionary and protective measures. The applied methodology, by means of its adaptability, can then be expanded to a large number of organic polluting contaminated agricultural areas and to different typologies of operative agricultural buildings in order to reduce the morbidity and the death-rate connected to the environmental pollution of the work places. Finally the sanitary environmental risk must be adequately assessed by direct measurement of pollutants concentrations in order to choose any suitable Personal Protective Equipment in the polluted areas where the hazard index and the cancer increase risk values exceed the law limits.

References

ARPA Campania, Monitoraggio ambientale zona acerrana, 2009.

Barra M.I., Ricciardi P., Terracina A., 2009. Agenti chimici e cancerogeni: rischi per la salute e malattie professionali. La valutazione del rischio chimico nei laboratori chimici di ricerca pura e applicata.

Cecchini M., Monarca D., Guerrieri M., Lingero E., Bessone W., Colopardi F., Menghini G., 2010. Dust exposure for workers during hazelnut harvesting. Proceeding on CD-ROM International Conference Ragusa SHWA2010, Ragusa, 16 – 18 september 2010.

Cicero M.R., Scaini F., 2010. Valutazione del rischio relativa ad una contaminazione diffusa di un litorale Italiano. Ingegneria Ambientale, 39,9.

Cividino S.R.S., Troccoli R., Collantoni A., Cecchini M., Monarca D., 2009. Implementazione di un sistema per la valutazione dei rischi e la gestione della sicurezza presso l'azienda agraria didattico-sperimentale "N. Lupori". Atti del IX Convegno Nazionale dell'Associazione Italiana di Ingegneria Agraria, Ischia.

Cottica D., Grignani E., 2010. Valutazione dell'esposizione ad agenti chimici: algoritmi e misurazioni, vantaggi e criticità. Giornale Italiano di Medicina del Lavoro ed Ergonomia, 32,4,113-116.

Italian Law Decree n. 81/2008

Gino G., 2010. Aspetti metodologici e normativi per l'analisi dei rischi chimici occupazionali. Giornale Italiano di Medicina del Lavoro ed Ergonomia 32,4,108-112.

ISPRA - Istituto Superiore per la Ricerca Ambientale, 2008. Criteri metodologici per l'applicazione dell'analisi assoluta di rischio ai siti contaminati.

ISS-ISPESL – Istituto Superiore di Sanità, 2009. Banca dati delle proprietà chimico – fisiche e tossicologiche dei contaminanti.

Nano G., 2010. Modelli per la valutazione delle esposizioni. Giornale Italiano di Medicina del Lavoro ed Ergonomia 32,4,121-124.

Romano C., Baeli C., Baratti A., Calò B., D'Errico A.,Fontana M., Grosso P., Palmas A., Pastore R., Perucca R., Riggio R., Sudano C., Ferraris F., 2011. Gli algoritmi per la valutazione del rischio chimico: l'esperienza della Regione Piemonte. Giornale Italiano di Medicina del Lavoro ed Ergonomia 33,3,282-287

U.S. EPA, Exposure factors handbook. Volume 1. General factors. EPA/600/P-95/002Fa, 1997.

UNICHIM, 2002. Suoli e falde contaminati – Analisi di rischio sito specifica – Criteri e analisi. Manuale n. 196.

Verginelli I., 2012. Il software di analisi di rischio "Risk net". Presentazione della Giornata di Formazione "RECONnet: il software di analisi di rischio Risk-net, D.Lgs. 152/06", 27.01.2012 Roma.

Workers' exposition to aerosol during the sowing operations with pneumatic precision drills

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Abstract
Pneumatic precision drills used in the sowing of dressed maize (*Zea mays* L.) seed contribute to the diffusion in the environment of dust containing pesticides. The environment and the operators can be exposed to abrasion dust during the sowing operations. The paper shows the first results of trials aimed at assessing the potential quantity of pesticide that an operator can inhale during the sowing operations of maize treated with the neonicotinoid insecticide clothianidin. The amount of inhalable dust was recorded by means of personal air samplers, applied to the operator during the operations of seed loading and sawing. In the meantime the dust drift was observed with air samplers placed at the field edge and on the tractor. The total amount of dust potentially inhaled by the operator during the entire sowing was about 2 ng min^{-1}, with a maximum of 25 ng min^{-1} during the loading of seed period. These data are relevant for risk assessment.

Keywords: dust, pesticides, aerosol particulate, operator exposure, safety

Introduction
In recent years it has been reported that pneumatic precision drills used in the sowing of maize (*Zea mays* L.) contribute to the diffusion in the environment of particulate matters derived from seed dressing (or coating) containing pesticides. The problem was particularly relevant for its effects on honey bees (*Apis mellifera* L.) and other pollinating insect populations (Apenet, 2011; Pochi *et al.*, 2012). On the other hand, the operators (and bystanders and residents as well) are potentially exposed during the sowing to abrasion dust, and this exposure is therefore relevant for risk assessment. It can occur differently, such as during the manipulation of dressed seed (opening seed sacks and filling the drill) or in field, during the sowing, at the tractor seat. Different factors can affect the magnitude of the phenomenon, such as the presence of a closed cab on the tractor or of devices reducing abrasion dust dispersion.
During sowing activities of treated seed, the main routes of exposure are dermal adsorption and inhalation. Dermal exposure to pesticides can occur during contact with the treated seeds and through contact with contaminated equipment or through deposition on the skin. Inhalation exposure may occur as a result of drift of particles abraded from seeds and additionally, from solid or dried pesticides from the treated seeds that become airborne or from soil contaminated with residues after the sowing with treated seeds. This secondary drift from contaminated soil is not considered relevant for the farmer exposure. Oral exposure may occur secondarily to dermal exposure, through hand to mouth transfer. This is especially relevant for infants or toddlers playing on contaminated surfaces. However, for farmers, the

maximum potential exposure by this route is generally assumed to be negligible in comparison with that via the skin and by inhalation.
The paper reports the results of first tests aimed at investigating the potential workers' exposure to chemical risk during the sowing of dressed maize.

Materials and methods

Seed
The trials were carried out using commercial maize seed (Pioneer Hybreed PR32G44) dressed with the insecticide Poncho™, a.i.: clothianidin and with a fungicide (Celest™, a.i.: fludioxonil and metalaxyl). According to the manufacturer, the quantity of clothianidin was 1.250 mg seed^{-1}. The seed was packed in sacks (25,000 seeds sack^{-1}). A total of 12 sacks, corresponding to 96 kg of seed, was loaded and sowed.
A six-row precision pneumatic drill "Gaspardo Magica" was employed. The drill was implemented with a prototype, developed at CRA-ING, consisting of an innovative air-recycling/filtering system (Apenet, 2011, Pochi *et al*., 2011), capable to significantly reduce the emissions of dust in the atmosphere respect to the conventional drill.

Field test
The trials have been carried out in the experimental farms of CRA-ING (around 42°5'51.26"; N 12°37'3.52"E; 24 m a.s.l.) on 12th July 2011. During the tests, the meteorological parameters were monitored with a portable weather meter Kestrel 4500, with a sampling rate of 1 min.
A plot of about 3 ha was sowed. Four air samplers (TCR Tecora mod. Bravo) were used to collect samples of the powder present in the air. The samplers were equipped with 0.45 µm PTFE Millipore diskette filters (diameter 47 mm). The air sampling height was 2.0 m. They were placed at a distance of 5 m from the edge of the field and spaced 10 m. Considering the prevailing wind direction at the beginning of the trial they were placed leeward. They were calibrated with a constant flow of 15 L min^{-1}. The time needed for the sowing was about 65 min. After the sowing, the samplers were maintained in use for an additional time of about 15 min in order to allow the dispersion and the deposition of most of the dust, so a total volume of about 1200 L of air was sampled. An additional portable air sampler (Supelco Pas 3000) operating at 2.4 L min^{-1} was placed on the tractor near the air inlet of the cab.
In order to detect the powder potentially inhaled by the operator, two portable samplers were applied to the operator, as showed in Fig. 1. The first (Supelco Pas 3000) was adjusted at an air flowrate of 2.7 L min^{-1}, and operated the sampling during the interval of time of 3 min required by the loading of the seed on the trolleys. The second sampler (SKC) was adjusted at an air flowrate of 2.25 L min^{-1}. In this case, the sampling lasted for the entire sowing operation, for a total time of 70 min. The three portable samplers were equipped with 0.45 µm PTFE Millipore diskette filters (diameter 37 mm).

Chemical analyses
The active ingredient determination in the filters was made at CRA-PAV. Active substances were extracted from the samples with acetonitrile. Solutions were sonicated in an ultrasonic bath for 10 min, then filtered with HPLC 0.45 µm filters. The analytical determinations were carried out by means of HPLC - ESI - MS – MS and the relative methods were validated in compliance with GLP procedures.

Results

The Table 1 shows the micrometeorological conditions recorded during the trial.

The pesticide residue concentrations in the air and the quantity of potentially inhaled clothianidin are shown in Table 2. The amounts potentially inhalable by the operator are reported separately, with reference to the above mentioned phases of seed loading and sowing in the field, and as total.

The use of the innovative prototype confirmed low values (0.097 ppb) of air concentration of the active ingredient, recorded at 5 m from the field edge. In fact, in previous studies carried out with the same dressed seed and with the same drill equipped with air deflector, the recorded values ranged from a minimum of 0.139 ppb obtained in field plot of 0.16 ha to a maximum of 0.445 in plot of about 3 ha (Pochi *et al.*, 2012).

Table 1. Micrometeorological conditions during the test

Operation	Air temperature [°C]	Relative humidity [%]	Wind speed [m sec^{-1}]	Prevailing direction of wind	Barometric pressure [mb]
Seed loading	31.6	43.2	0.4	SSE	1011
Sowing	32.6	41.4	1.1	SE	1011

Table 2. Air concentrations of clothianidin and amounts potentially inhalable by the operator.

Sampler location	Operation	Sampler flow [L min^{-1}]	Time [min]	Air concentration [ppb]	Total inhalable amount [ng]
Field edge	Loading and sowing	~ 15	82	0.097	-
On the tractor	Loading and sowing	2.40	55	0.111	-
Operator	Loading	2.70	3	2.861	75
Operator	Loading and sowing	2.25	70	0.240	147
Operator	Sowing	-	67	0.098	72 (*)

(*) The amount is calculated by difference between the total detected amount in the filter for the entire sowing and the amount in the filter for the seed loading operation only.

Conclusions

The amount of potentially inhalable dust containing clothianidin derived from the dressed seed of maize was assessed during field trials.

The results of the test showed the presence of low concentration of active ingredient in the air in the area leeward the test plot, as a consequence of the introduction of the CRA-ING prototype. Despite this, the analyses of the filters of the portable air samplers revealed appreciable amounts of active ingredients to which the operator was exposed by inhalation. The seed loading seems to be the most important phase, contributing to about 50% of the total powder inhalable by the operator, even if it takes only a few minutes. However, even during the sowing a fraction of dust reached the operator, despite of the presence of the cab.

These observations suggest that attention should be paid to the exposure of the operator to dust containing residues of pesticides under different conditions of work and to the potential

risks for the health from longer times of exposure. The reported values of inhalable dust are referred to a relatively short interval of time and to the presence of an effective device for the reduction of dust dispersion. They could significantly increase under real operative conditions in which, for example, a contractor performs the sowing of maize for at least 8 hours a day, for a period of two months a year, handling quintals of seed in the filling operations. Under these conditions, the use of DPI is appropriate, but probably they would not eliminate the exposure to dust and more effective devices reducing dust could contribute to reduce the risk, together with new techniques and procedures for the seed loading, capable to avoid the escape of the abrasion dust.

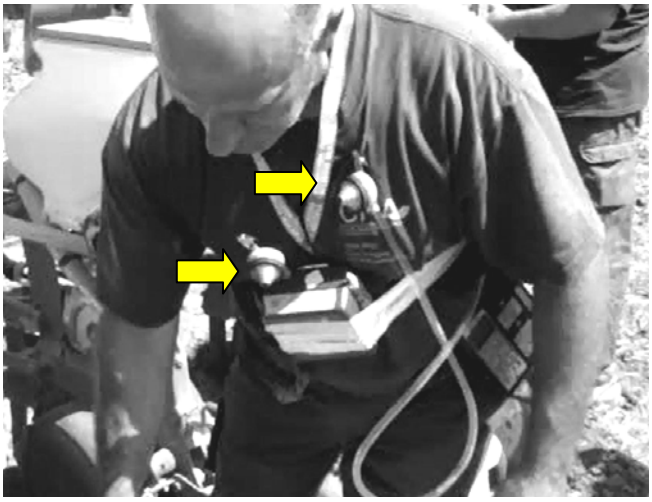

Figure 1. Position of personal samplers on the operator

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References

Apenet. 2011. Effects of coated maize seed on bees. Report based on results obtained from the first year of activity of the APENET project. Pag 30. Available at: http://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/1289. Accessed: May 25th, 2012.

Pochi D., Biocca M., Fanigliulo R., Gallo P., Pulcini P., Conte E. 2011. An innovative system to reduce dust drift during sowing of dressed seeds with pneumatic drills. Proceedings of XIV Symposium in Pesticide Chemistry, Piacenza (Italy) 30th August – 1st September 2011.

Pochi D., Biocca M., Fanigliulo R., Fedrizzi M., Conte E., Pulcini P., Grilli R., Gallo P., Imperi G. 2012. Deriva di polveri durante la semina del mais conciato e mezzi di contenimento. ATTI Giornate Fitopatologiche, 2012, 2, 51-58.

Pochi D., Biocca M., Fanigliulo R., Pulcini P., Conte E. (2012) Potential exposure of bees, *Apis mellifera* L., to particulate matter and pesticides derived from seed dressing during maize sowing. Bulletin of Environmental Contamination and Toxicology. DOI : 10.1007/s00128-012-0664-1.

Environmental management systems in sawmills in Calabria

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Abstract
In Calabria, timber processing employs over 20.000 labours (Istat, 2007), and it is mainly concentrated in the provinces of Cosenza and Reggio Calabria. Timber industries should ensure high quality products, services and processes to improve their competitiveness in the market. This might be achieved only by a proper management system. Therefore, any organization that produces goods and services is now required to consider and guarantee environmental quality. The present study aimed to create a new model for a preliminary review of Calabrian timber factories from an environmental point of view.
This research assessed environmental performances of the first and second timber processing in Calabria, using a checklist expressly created for this purpose.
The first part of the checklist permitted to analyse the structural and operative characteristics of the different factories. The second part, however, allowed to analyse the environmental situation of the factories, and to highlight the main areas of intervention. Environmental performances of Calabrian companies were valued according to EMAS regulation (Eco-Management and Audit Scheme), based on ISO 14001:2004. Besides, environmental aspects were analyzed through a checklist specifically developed from the Annex VI of the latest regulation.
The aim of the research was mainly to determine priority interventions on specific environmental aspects in view of a considerable improvement of the surveyed sector.
Collected data permitted to have an overview of timber sector in Calabria, describing environmental parameters already present, and determining those that still need improvement.

Keywords: environmental quality, EMAS, timber processing.

Introduction

The globalization of markets forces companies to be more competitive and to look for new productive methods taking care of the environment. It goes without saying that the necessity to meet environmental, economic and social requirements needs a wise management of natural resources. The European union has given companies the opportunity to promote an environmental activity on the market for ages: in fact this is the Environmental Management Audit called EMAS III.
This operating, voluntary system is realized by the company through an Environmental Management system. The SGA represents a procedure of assessment and control so as to achieve a constant improvement of the environmental performance.
The introduction of SGA in a company needs, as a first step, an exhaustive study of the problems of the impact and of the environmental performance called Starting Environmental Analysis (AAI). Not only this analysis checks the accordance with the law, but it also highlights and defines every detail of interaction between the production and the environment where it works. The sector of wood working is a specific sector where the environmental challenge is an important factor of competitiveness for the production value added.

Many chain wood working companies in Italy are investing in new productive methods at a low environmental impact. The wood working sector represents a good resource for the economy in Calabria. There, companies are based on a first and a second processing of wood working and they are mostly settled in the province of Cosenza followed by the province of Reggio Calabria which has a relatively high position , while the main city Catanzaro is placed in the middle of a series that decreases with the provinces of Vibo Valentia and Crotone (Zimbalatti *et al.*, 2009).
As far as the products realized in the first process system, 68% of wood working companies makes three kinds of products; 23% of them makes two different kinds of products while only 9% of them makes four or more different kinds of products. Companies produce boards, laths and pallets, woodwork products, scantlings and beams. The companies devoted to a second processing in wood working make especially chairs, tables, benches and doors; 40% of this output is absorbed in the national market (Toscana, Umbria, Lazio), 29% is absorbed in the regional market, 23% provincial market and only 8% in the local market (Zimbalatti G. et alt., 2005).
Environmental quality and Safety has become an imperative in Europe, in all aspects of the human life (Gubiani *et al*., 2009). A possible integration of Quality, Environment and Health & Safety Management represents an object of interest for scientific community, experts, category associations and companies (Monarca *et al*., 2008).
The aim of this study is to examine the production process of some companies in Calabria so as to check the impact on the environment in order to start a good environmental management and a constant improvement of environmental performance.

Materials and methods
The research was carried out from 2008 to 2011 in Calabria. It studied ten different companies here indicated by the letters "A", "B", "C", "D", "E", "F", "G", "H", "I" and "L". To realize this elaboration check-lists to gather data have been created and used. Check-list is an analysis model which provides a preliminary risk assessment by evaluating potentially susceptible aspects; the usefulness of the check-list in environmental research lies in the rapid assessment of the risk (pre-estimate), presenting the results in four risk categories identified by a score from 1 (highest level of danger) to 4 (optimal condition).
The survey card consists of two parts. The first part is cognitive and records general information regarding how the work is organized and production. Instead, the second part is more specifically operative; it analyses the environmental aspects intended as the "Elements of the activities, products or services of an organization that can interact with the environment", listed as follows: a) energy resources; b) atmospheric emissions; c) waste; d) water cycle (water resources and water discharges); e) noise: f) road impact; g) safety and fire risk; h) interaction with the landscape; i) dangerous chemical substances in the ground, atmosphere, etc; l) raw and auxiliary materials. Each of these aspects is examined in more detail in the check-list by means of specific questions. In order to make the results more explicit, the "Significance" was calculated, (an environmental aspect is significant if it is inferior to the "threshold", made up of the mean values of the environmental impacts of all the enterprises), by applying three parameters: 1) Relevance (R): the importance assumed by the environmental aspect within the productive cycle; 2) Management efficiency (E): the ability of the enterprise to manage the environmental aspects; 3) Socio-territorial awareness (S): the concern of authorities and the population towards the environmental aspect considered.

The answers were given a score from 1 to 4 and the average value per parameter of each environmental aspect was calculated so that each environmental aspect was represented for each enterprise by the relative values of relevance, efficiency and awareness. The values of all the enterprises were averaged in order to obtain a single value per aspect and per parameter. The next phase involved calculating the level of "Priority", intended as a time scale of the need for intervention according to the gravity of the situation. This was calculated in order to represent the mean situation of all enterprises as well as each individual firm in order to obtain a comparison. The values of the level of general Priority, ranging from 1 to 64, were given by the result of the values of the three parameters previously used to outline the trends according to the following formula: $P = R \times E \times S$.
Instead, to outline the situation of each enterprise taken individually, the result of the data of the parameters considered for each environmental aspect was calculated. Data processing was implemented using an Excel worksheet set up to calculate the statistical elaborations.

Results

The first part of the check list allows us to analyse the structural and operative characteristics of the different companies. We considered ten companies, six of them managed the second wood manufacturing only, three of them managed the first wood manufacturing while one of them managed with both the primary and second wood manufacturing. The companies have similar organization: the work cycle may start from sawn timber or semi-finished goods, bought from other. When the semi-finished good reach the factory, it goes to the pre-drying and ventilate zone for two weeks. It is placed under the shadow in order to lose 40-50% water. At the end of the pre-drying process the wood goes into a drying kiln under fresh and hot air, the temperature is settled to 50-60°C, therefore the wood lose 0.5% of humidity each day. The oven time is directly related to the wood thickness. The drying cycle stops when the wood reaches 9-10% humidity point. After that the boards are transferred in another hangar, remaining there for two days to readjust to the environmental temperature and followed by two stages joint working. They are respective the Cut stage performed with Band saw and Sanding stage performed with Sanders. After one factor carries out Sorting, Bond, Pressing, thickness sanding and a final sanding; the final product will be laminboard while the remaining companies are making assembly; the result will be furniture of various kinds (chairs, tables, doors, etc...). In the companies that managed with both the primary and second wood manufacturing goes addition an ulterior stage of cycle which consists of Debarking and to work the trunk to obtain planks. In the examined systems it is mostly carried out the working of Beech, Chestnut, Walnut and Ash. Data of the raw materials origin, related to the road impact generated by the factories, highlights the strong relationship between the territory and the supplying. In our case 8 companies out of 10 use to take the raw material from the calabrian forest, while one of them import the 60% of the timber from other regions and countries. The second part of the check-list allows us to analyse the environmental situation of the factories and to highlight the principal areas of intervention. The results regarding to the classification adopted (ranged from 1 to 4) presented medium-high values, so that the incidence on the environment was scarce. Just few values obtained were below 2. This can be seen from the figure 1.

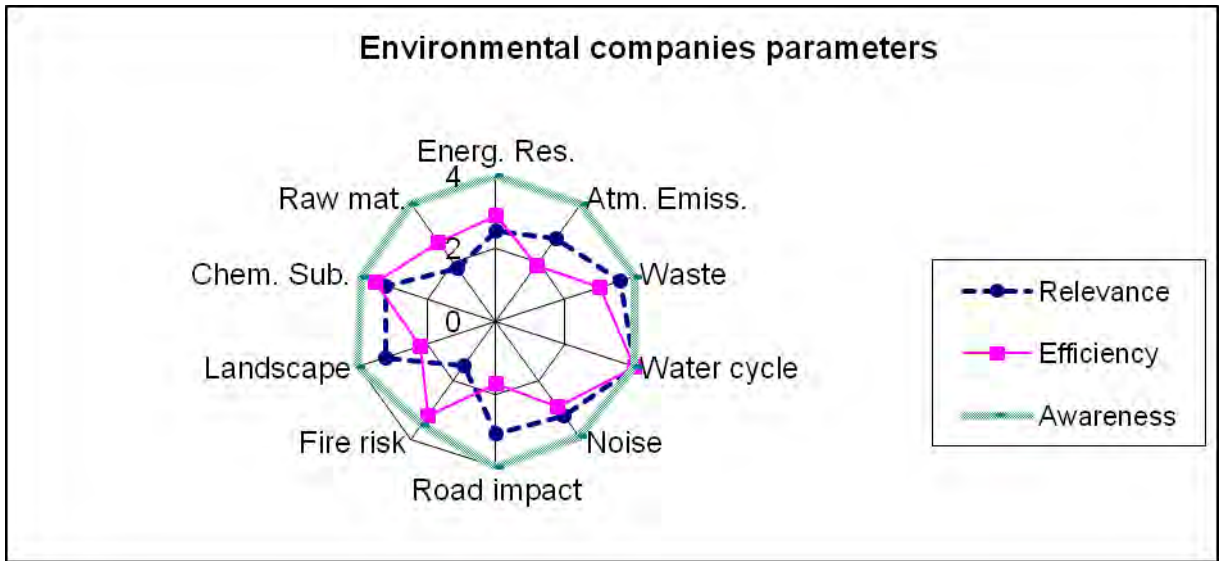

Figure 1: Average performance of environmental aspects in relation to the parameters considered.

It is indeed clear how socio-territorial awareness always achieves very high values; considering that organized complaints or criticisms against the transforming enterprises are all but absent. However, on the basis of research carried out on the population surrounding the production plants, it emerges that this derives more from the limited attention and information on the subject on the part of the population which, unaware of the problems that could be created by the inadequate environmental management of the productive activities, shows a complete lack of interest. Instead, the attention of the authorities concerned was found to be average. Another important aspect here evidenced, lies on the management of the road impact, landscape impact, raw materials and atmosphere emissions. In Figure 2, are comparing the mean values for each environmental aspect of each individual enterprise, with the general mean representative of all the plants examined in order to arrive at an evaluation of the significance of each impact for each enterprise, essential for providing each plant with precise indications on the aspects that need to be given priority.

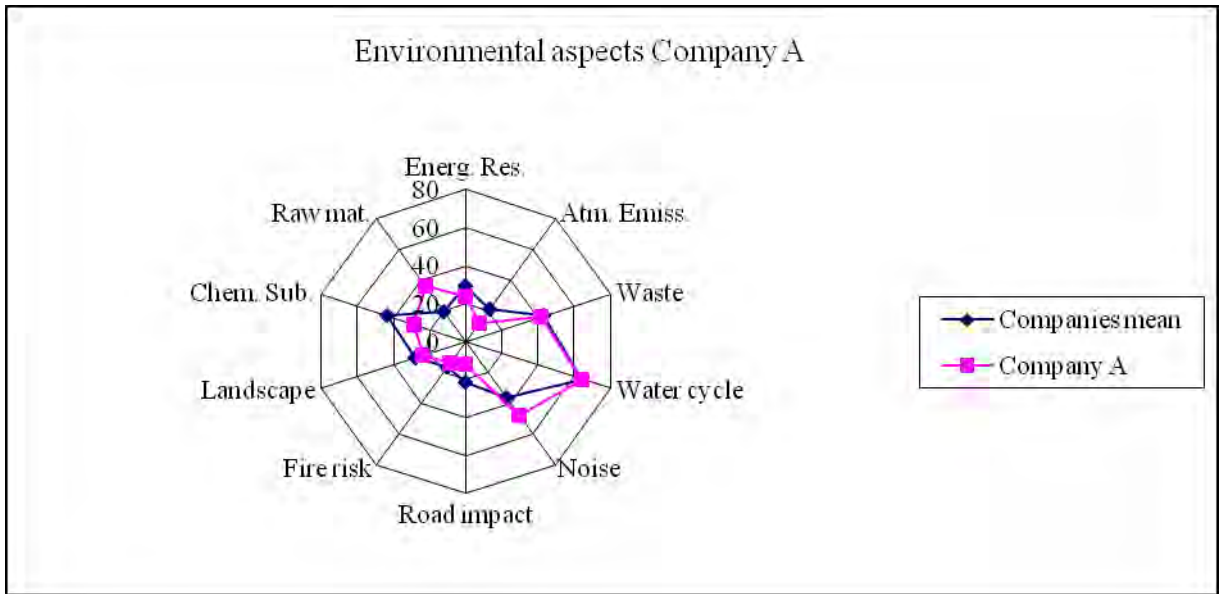

Figure 2 Comparison between general average and company A.

In company A (figure 2), the environmental aspects to be given the highest priority, that is placed below the mean values, in this case are those concerning: atmospheric emissions, road impact, fire risk chemical substance and interaction with the landscape.
The development of the overall average data allowed us to draw a general picture, although indicative of the environmental conditions of the companies monitored. An analysis carried out, unfortunately, is that at present among the companies surveyed only three companies with some specific measures which could achieve environmental certification EMAS. The non-implementation and non-application of the EMAS regulation puts a strain on the competitiveness of wood processing companies in Calabria and the environment, the safety of those working population and that in most cases is unaware of the dangers faced by.

Conclusions

The analysis of the wood section has represented a fine opportunity to investigate further the knowledge of a productive sector peculiar of the Calabrian territory, allowing to collect and compare several data both from the qualitative point of view, concerning the working strokes and the used technology, and quantitative one, regarding the inflows and outflows of materials and energy from the firms. Referring to the EMAS regulations, the study has allowed to create a check-list whose aim was to analyse the considerable environmental aspects inside any firms which operate in the first and second wood processing.
From the elaboration of the gathered data and the subsequent results, it came out how research represents a valid starting instrument for AAI to achieve an SGA. Applied to ten wood works, in a region like Calabria, characterized by a forestry vocation, this method allowed to underline the main environmental aspects of every firm which should be mainly improved to reduce significantly the environmental impact of every productive settlement.
In general, if you want to pursue a qualification and environmental development strategy of wood works, you must start by the constitution of a spinneret including all the levels which begins with a certification of Calabrian woods.
For Calabrian working wood firms, a strategy of "Eco-Management and Audit Scheme" cannot be individually applied, while it should find application in a very wide territory, to

create a trinomial territory-quality-environment, able to produce positive effects above a district of firms. The used methodology can be applied in all wood transformation settlements and can be easily adapted to all the operative specificities, constituting a sound foundation to face similar problems in other Italian regions.
Finally, after all these results, we can add on that, during the analysis we saw the inadequate sensibility towards environmental security; that probably prevents the achievement of best environmental standards. We can certainly try to find a solution to this question through actions of information and formation for the operators of this sector. The research, for its nature, had several limits and didn't deal with all the aspects of the problem, but certainly the work done will have positive repercussions above wood sector firms in Calabria.

The authors participated equally in all the phases of the present work

References

Conference Proceedings:
Gubiani R., Zoppello G., Vello M., Cividino S.R.S. 2009. Risk Perception in the forestry workers: first results of a survey made through check lists. Proceedings on XXXIII CIOSTA – CIGR V Conference, Reggio Calabria – Italy 17 – 19 June 2009.

Monarca D., Cecchini M., Colantoni A., Gubiani R., Vello M. 2008. I.S. Project: a methodology of evaluation for Integrated Systems: Safety in Agroindustrial sector. Proceedings International conference on Innovation Technology to Empower Safety, Health and Welfare in Agriculture and Agro-food Systems, Ragusa – Italy 15-17 September 2008.

Zimbalatti G., Proto A.R., Abenavoli L.M. 2005. Impianti e cicli produttivi in segherie calabresi, Atti del VIII Convegno AIIA L'ingegneria agraria per lo sviluppo sostenibile dell'area mediterranea, Catania 27-30 giugno 2005.

Zimbalatti G., Barreca P., Iannelli F., Giametta F. 2009. Environmental Quality in Timberland – The Case of Calabria, (XXXIII CIOSTA CIGR V Conference) Reggio Calabria, 17-19 Giugno 2009.

Website:
The National Institute for Statistics. 2007. *www.istat.it*

Assessment of the available databases on tractor fatal injuries to improve the accidents dynamic evaluation

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Abstract
An assessment on the databases of injuries occurred in agriculture was carried out in order to verify the number and severity of accidents related to the use of the tractor.
The study analysed the quality of the information available on the accidents to understand if the data were helpful to the accident dynamic characterization, mainly in terms of performance of the Roll Over Protective Structures (ROPS), so as to point out possible improvements for the prevention of the fatal injuries associated with the use of the tractors.
A survey on the data available at the Statistics Service of Italian Workers Compensation Authority (INAIL) and the Local Health Units (AUSLs) was carried out. The accidents were analysed in detail for the Provinces of Bologna and Reggio Emilia identifying the agent (tractor), the mode (rollover) and the geographical location of the event (municipality and altimetric area). The analysis of the accident data confirm that the fatal agricultural accidents involve mainly the tractor. However the data available did not point out the dynamic of the accidents.
A standard model for collecting the data is required to characterise the causes and the dynamic of the accidents. The standardisation in the data collection will give the required information for evaluating if updated solutions are required to improve the operator safety in the use of the tractor.

Keywords: rollover, safety, ROPS

Introduction

A growing interest for safety and health in work environments led to the development of increasingly stringent legislation and standards (Fargnoli et al., 2010) that have proved effective, but, at the same time, compliance with new safety requisites has become more difficult, particularly for small and medium sized enterprises, where safety regulations are more difficult to be applied, thus leading to strong heterogeneity (Brugnoli, 2001; Cargioli and Monti, 2004). This fact is evident in the Emilia Romagna region, one of the most active areas of Italy in agriculture, and this combined with the strong geographical differences of the land makes the evaluation of the differences of frequency and severity of accidents in two of the most important provinces of the region: Bologna and Reggio Emilia worthy of interest.

Tractor accidents and especially those due to rollover represent a primary cause of death or serious injury in agriculture (Cargioli and Monti, 2004; Myers, 2000; Myers et al., 2009; Pessina et al., 2010), (Fig. 1). Despite the fact that the use of Roll Over Protective Structures (ROPS) is mandatory, widely implemented and effective, operator safety is still at risk (Guzzomi et al., 2009). In fact the management of agricultural activities is hard to deal with considering the technical obsolescence of machines, the change of workplace and a large variety of activities. Moreover the number of workers specifically trained for the use of

tractors and agricultural machinery is very small (Bartoli and Bartoli, 2011a,b); in fact a considerable number of casualties are hobbyists, part time workers and pensioners (Fargnoli et al., 2010).

Figure 1. Tractor overturn is responsible of severe injuries in agricultural

Since the application of the European Commission Directive 74/150/EEC tractors have been fitted with ROPS to provide the driver with a survival volume in case of tractor rollover. These devices have proved to be effective in reducing fatal injuries to the operator but recently some questions related to their performance regarding the modern tractor evolutions have been raised (Jarèn et al., 2009; Rondelli and Guzzomi, 2010).

The aim of this study is the evaluation, based on available accidents databases, of the tractor accidents frequency. Moreover a critical approach has been adopted to evaluate whether the data collected by institutional sources are suitable for safety analysis, or whether improvements in the acquisition of accidents data may be suggested. In detail the main goal is to evaluate the tractor rollover accidents in order to understand whether the high mortality could be related to non-compliance with tractor safety legislation or tractor misuse or an one-off accident or finally, if the current safety requirements are not completely respondent to the normal operations of the modern tractor. These details allow us to predict measures for improving, if necessary, operator safety. In fact worker safety condition is a crucial issue, not only for the operators health but also for economic reasons. Avoiding accidents can save financial costs like medical expenses, payment of sick benefits, damage to property, lost income and production (Monk et al., 1986).

Materials and methods

The analysis was performed with the aim to quantify accidents evaluating the frequency of occurrence and severity of the event: fatal or non-fatal. In detail, the rollover accidents related to the use of the tractor were considered.

Data on injury events in the agricultural sector together with the number of fatalities for the years 2004-2010 were collected for Italy and the provinces of Bologna and Reggio Emilia on the database of Italian Workers Compensation Authority (INAIL).

In order to analyze accidents in the two provinces more thoroughly an analysis at municipal level was carried out. Since INAIL does not provide these territorial details, this was obtained from Local Health Units (AUSLs). The injury data, aggregated at the municipal level, have been implemented in a GIS database including boundaries of the municipalities

provided by the National Institute of Statistics (ISTAT). For Bologna Province data considered was related to the period 2003 to 2009. The Bologna AUSL database identifies injuries in agriculture on the basis of codes of ESAW (European Statistics on Accidents at Work) which provides a description of the mode of occurrence of occupational accidents (European Commission, 2001).

Agriculture injuries data related to Reggio Emilia territory were provided by AUSL and are referred to fatal accidents occurred since 1994 till 2011.

Risk frequency was assessed quantifying the hazard quotients calculated as the ratio of annual number of injuries multiplied by 1000 and the corresponding number of employees, derived from the official ISTAT data.

Results

Data provided by INAIL included injuries related to the use of tractors in the national territory divided by age and sex of victims. These data allowed us to observe how the greatest number of accidents occurred to workers aged between 35 and 64, and to men rather than women, depending on the fact that tractor driving is an activity performed mainly by men. It is interesting to note that for men the values are slightly higher in 34-49 range, while for women in 50-64.

National and provincial data were compared considering that hazard quotients were calculated as a relationship between the number of accidents and number of employees.

The two provinces had higher values than the national data in terms of total agricultural accidents. For agricultural fatal accidents, instead, the hazard quotient was significantly higher than the national average for Bologna and lower for Reggio Emilia (Fig. 2).

Considering only tractor accidents the hazard quotient is slightly higher than the national average for Reggio Emilia and considerably higher for Bologna (Fig. 3). Even in case of fatal accidents with tractors the hazard quotient for Bologna is considerably higher than the national average (Fig. 3). It has to be pointed out that INAIL considers the number of fatal accidents associated with tractors zero in the province of Reggio Emilia.

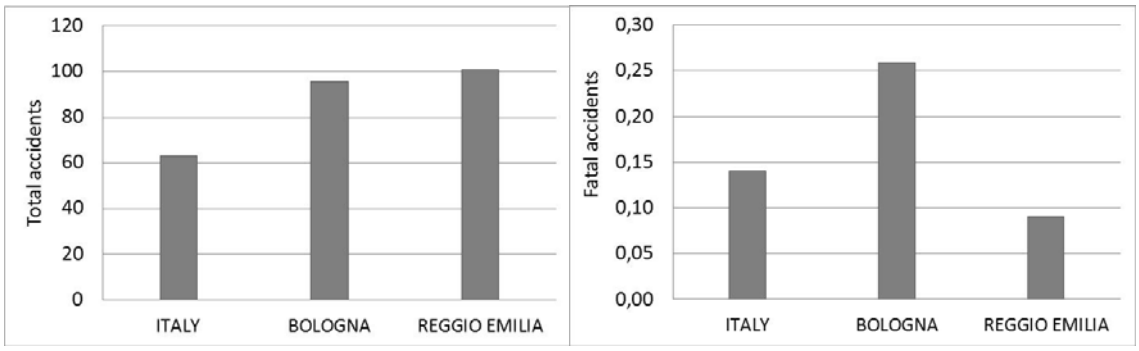

Figure 2. Hazard Quotients in agriculture for total and fatal accidents, mean values of the period 2004-2010.

Considering the occurrence of accidents involving tractors compared to the total number of accidents in agriculture values of 6, 8 and 4 percent respectively for Italy, Bologna and Reggio Emilia were obtained. Analysing only fatal accidents in agriculture the percentages of fatal accidents related to the use of the tractor increase significantly, at a national level (13%) and for the province of Bologna (17%). For Reggio Emilia instead the percentage is equal to zero, as a consequence of the data shown in Figure 2.

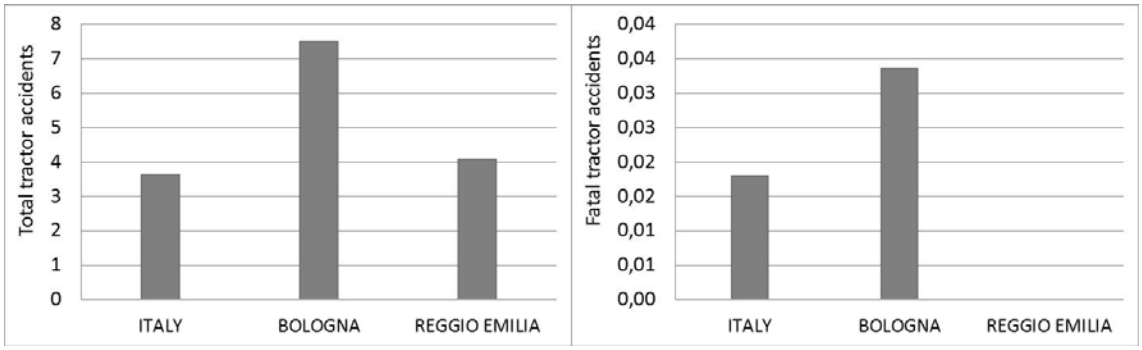

Figure 3. Hazard Quotients for total and fatal tractor accidents, mean values of the period 2004-2010.

Accidents in agriculture, associated with the use of the tractor were assessed at the municipal level for the two provinces of Bologna and Reggio Emilia on the basis of data provided by the Local Health Units.

The database analysed for the province of Bologna covered events related to the years 2003-2009 and these were classified according to the ESAW encodings. For the province of Reggio Emilia, instead, data referred only to events involving fatalities and over a period of 17 years (1994-2011).

Figure 4 shows the territorial distribution, for the province of Bologna, at the municipal level, of the percentage of accidents related to use of the tractor with respect to the total number of accidents in agriculture. The data show that the municipalities with the higher percentage of tractor accidents are randomly distributed in the province without correlation with altimetric areas.

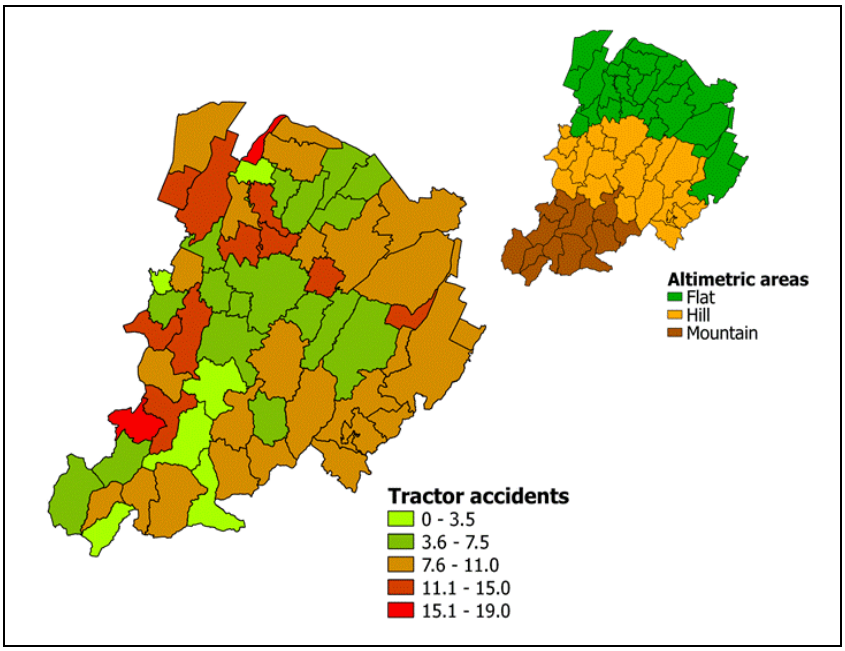

Figure 4. Province of Bologna, comparison between the altimetric areas map and tractor accidents map. The index represents the percentage of tractor accidents in respect to total accidents in agriculture (2003-2009 years).

A higher frequency of accidents in hill and mountain areas would be expected because of the increased risk of overturning due to the slopes (Springfeldt, 1996). Possible explanations of such distribution could be the higher concentration of tractors in flat area, which can compensate the lower risk due to geographical morphology (Tab. 1).

Tab. 1 Province of Bologna, number of tractors and percentage of tractor accidents in respect to total accidents in agriculture.

Areas	Tractor (n)	Tractor accident (%)
Flat	18211	9.2
Hill	7148	7.7
Mountain	2579	8.0

Data regarding the Reggio Emilia province included fatal cases only; therefore the number of data is necessarily quite small, even if a significant period of time is evaluated. However the classification, given by the AUSL, made it possible to identify unequivocally accidents due to rollover among accidents which involved tractors.

The number of fatal accidents due to rollover is related to altimetric areas. In fact for mountainous, hilly and flat areas the percentages of tractor accidents, compared to agricultural ones, are respectively 85, 53 e 44 percent. With reference to tractor rollover the percentages are 54, 32 and 20 respectively. In Figure 5 the municipalities in which 100% of the accidents are due to tractor rollover are showed.

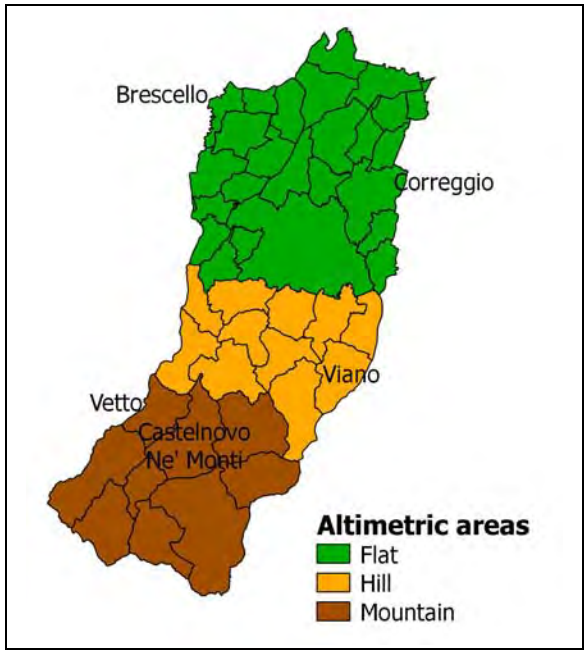

Figure 5. Province of Reggio Emilia, altimetric areas map. Named municipalities had all fatal accidents due to tractor rollover.

Moreover 57% of agricultural fatalities in the whole provincial territory are caused by tractor accidents and 32% are due to tractor roll over. This points out the high risk associated

with tractor use. Indeed among fatal accidents the most relevant, statistically, are the ones due to rollover.

It's interesting to note the discrepancy between data processed by INAIL and those provided by AUSL of Reggio Emilia. Fatal accidents associated with the use of the tractor in the period 2004-2010 amounted to zero in the INAIL database and to 8, of which 6 caused by rollover, in the AUSL database.

Conclusions

The analyzed data confirm that the tractor is still a major cause of risk in agriculture both in terms of frequency of occurrence of accidents and the severity of the consequences (Dioguardi and Ariano, 2009). The tractor accident data collected show different classification methods in relation to the Organization providing the data. Specifically, INAIL database, which cataloged the events according to the ESAW encodings, allowed the identification of tractor related injuries but did not allow us to establish with certainty whether the accident could be attributed to tractor rollover. Moreover the databases consulted sometimes provided conflicting data. This could be easily explained in relation to the different methods of data collection responding to different purposes of the subjects assigned to the database, but fatalities data with tractors for the province of Reggio Emilia are too discordant. Indeed, while the source INAIL reports zero events in the period 2004-2010, Reggio Emilia AUSL data show 8 fatalities with tractors.

The work, aimed at the analysis of accidents due to tractor rollover and the evaluation of the safety equipment of the machine and its state of use at the time of the accident, partly achieved its objectives. In fact the databases did not provide information on the type of tractor involved, the presence of safety devices (ROPS and seat belts) and the configuration of use (machines connected and the presence of ballasts). In particular it would be important to understand the dynamics of the occurrence of the event to verify if the accident occurred in conditions of normal operation or it was an unusual event, often caused by incorrect use of the tractor.

It is hoped to standardize the method for accident data recording and to implement the information collected so as to assess if the modern tractor is updated in terms of safety equipment to the evolution that characterized it in design and use in respect to.

Acknowledgements

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References

Bartoli V., Bartoli L. 2011a. Un'analisi statistica degli infortuni nell'agricoltura italiana tra il 2005 e il 2009. Agriregionieuropa, 24, 1-6.

Bartoli V., Bartoli L. 2011b. Caratteristiche e conseguenze degli infortuni sul lavoro: un'analisi delle recenti statistiche italiane. Agriregionieuropa, 26, 1-7.

Brugnoli A. 2001 Con le mappe di rischio prevenzione più agevole. Agricoltura, 11, 33-35.

Cargioli G., Monti F. 2004. Gli infortuni in Emilia Romagna. In: Supplemento N.23 Rivista di Agricoltura, La sicurezza sul lavoro, 5-6.

Dioguardi L., Ariano E. 2009. Analisi delle dinamiche di infortunio come strumento per la programmazione di interventi di prevenzione in agricoltura. Atti del IX Convegno Nazionale AIIA, Ischia Porto, 12-16 settembre 2009.

European Commission, 1974. Directive 74/150/EEC. http://ec.europa.eu/enterprise/sectors/automotive/documents/directives/directive-74-150-eec_en.htm

European Commission, 2001. European statistics on accidents at work (ESAW). Methodology 2001 E Doc. ESTAT/E3/HSW/2001/1130.

Fargnoli M., Laurendi V., Tronci M. 2010. A risk assessment procedure for the users of narrow track tractors. Proceedings of International Conference Work Safety and Risk Prevention in Agro-food and Forest Systems, Ibla Campus Ragusa, Italy, September 16–18, 2010.

Guzzomi A. L., Rondelli V., Guarnieri A., Molari G., Molari P. G. 2009 Available Energy during the rollover of narrow-track wheeled agricultural tractors. Biosystem Engineering, 104, 318-323.

ISTAT. http://www.istat.it

Jarèn C., Alfaro J. R., Arazuri S., Ponce de Leòn J. L., Arana J. I. 2009. Assessing roll-over safety provided by ROPS tests SAE J1194 standard versus OECD Code 4, Transactions of the ASABE, 53(5), 1453-1459.

Monk A. S., Morgan D. D. V., Morris J., Radley R. W. 1986. The cost of accidents in agriculture. J.Agric.Engng Res, 35, 245-257.

Myers M. L. 2000. Prevention effectiveness of rollover protective structure. Journal of Agricultural Safety and Health, 6, 29-70.

Myers M. L., Cole H. P., Westneat S. C. 2009. Injury severity related to overturn characteristics of tractors. Journal of safety research, 40, 165-170.

Pessina D., Facchinetti D., Belli M. 2010. Definition of unambiguous criteria to evaluate tractor rops equivalence. Proceedings of International Conference Work Safety and Risk Prevention in Agro-food and Forest Systems, Ibla Campus Ragusa, Italy, September 16–18, 2010.

Rondelli V., Guzzomi A. L. 2010. Selecting ROPS safety margins for wheeled agricultural tractors based on tractor mass. Biosystem Engineering, 105, 402-410.

Springfeldt B. 1996. Rollover of tractors-international experiences. Safety Science, 24, 95–110.

Engineering and technical labor safety provision in AIC(Agro-Industrial Complex) in the Russian Federation

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Keywords: safety, AIC (Agro-industrial complex), engineering and technical provision

Research objective

In published strategy of the European Union (the EU) for the period of 2007-2012 in the sphere of health care and industrial safety agriculture is determined as "the most dangerous" sectors of economy. It is actual for Russia too, where according to data of Rostrud (Federal Service on labor and occupation) industrial injuries including lethal is higher in comparison with countries of the EU in average 2-2.5 times. Leaders of the country, the President and the Head of government worry about the formed situation, when 3\4 of total violations in the sphere of labor relations are connected with labor safety and their number practically does not decrease. In 2010, in the Russian Federation about 6145 persons (including lethal as well) were injured, among them 1730 women and 47 teenagers.

Economic activity in agriculture and forestry is also conducted by high level of injuries. The most trauma-dangerous branches are supposed to be animal industry and plant - growing, where suffered number totaled 3122 and 1667 respectively, among them women 1151 and 459 and teenagers 9 and 3, respectively. Modern technical methods, means and practices on trauma precautions are quite ineffective, and need to be improved.

In this connection more than half of injuries in AIC are connected with applied techniques, arises the necessity of improvement among existing organizational and technical precaution labor safety activities by methods and means of engineering technical safety provision of agrarian technologies (animal husbandry, plant growing, fruit growing, transport, repair-mechanical and etc.)

Research objective –is development of engineering and technical methods and precaution means of injuries and professional diseases in AIC.

Research methods

Main components of engineering technical reasons of injuries are: lack, imperfection and low reliability of dangerous zones protection means, insufficient development and lack of safety block systems, imperfection of block system constructions, discrepancy to requirements of standard safety system demands (SSSD and ISO) designing of series of systems, units and machine mechanisms, inadequate registration of biological peculiarities (animals, plants) and work technology with them while basing, developing, projecting, designing and making the means of mechanization, electrification, automation processes and etc.

Foundation of engineering and technical means and methods precautions of injuries is the principle of trauma dangerous zone elimination due to stopping of mechanism running while it's appearing, person's inadmissibility to this zone as being of no use there, automatic block system of situation which eliminates injuries and breakdown.

To eliminate operators injuries automatic clutch devices are offered, which exclude the necessity and opportunity of person's presence in trauma dangerous zone.

On fig.1a,b automatic coupling for tractors (truck tractors) are demonstrated.

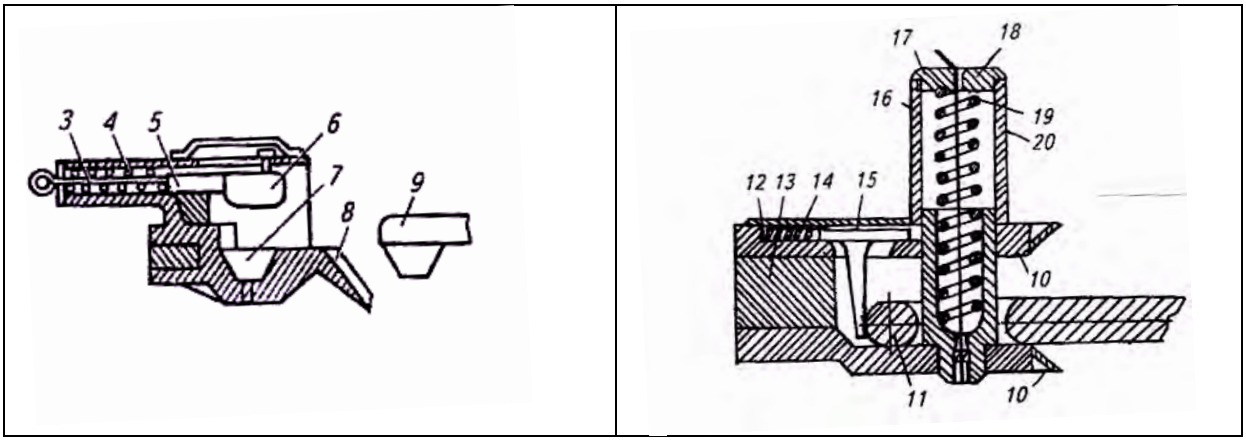

Figure 1.-automatic coupling for tractors, truck tractors and agricultural machines: a- for powerful tractors and truck tractors; b- for tractors and truck tractors of low and average power.

The construction according to the scheme 1a functions the following way. While tractor (automobile) movement backwards joining mechanism 9 slides along directing slot of tractor body 8 and transfers fixed support 6 left. When joining mechanism under it's own mass will be lowered to socket 7, so the spring 4 will move support together with traction 5 into extreme right position, providing tough fixation of joining mechanism. For machine disconnection the operator from the cabin influences the traction 3, moving support 6 into extreme left position. While machine moving joining mechanism goes out of socket and agricultural machine is disconnected from tractor.

The construction according to scheme 1b functions the following way. For connection of truck tractors with trailers (agricultural machines) an operator influences from the cabin on cable 16 and rises pin 20 in inner space of guide 17. The locking device 15 under spring 14 moves along axe direction and fixes connecting pin 20 in upper position. Tractor, moving backwards, goes to cross-beam 13 of mounted link. Joining mechanism 11 hits into catcher 12 and moves to clutch body, influencing the support of locking device 15, transfers it, compressing the spring 14. Connecting pin is released and under it's own mass and the spring 19 moves down, fixing mechanism 11 in body 10. For aggregate's disconnection an operator under condition of fully stopped tractor moves pin 20 up by the cable, providing disconnecting. While tractor moving connection mechanism goes out of clutch body. Guide 17 has cover 18. Penetration of soil particles and plants into device is eliminated due to cover 12.

Absence of operator in trauma dangerous zone of coupling- uncoupling excludes injuries opportunity.

Aggregate overturning is prevented by special mechanisms. This mechanism with electrical drive (fig.2) works the following way. While machine inclination on angle more than determined to this or other side we can see electrical connection of central ⊥ shape electrode with one of the lower lateral ones, due to which power is directed on sound 8 and light 4 signals, which warn operator about dangerous (from point of view of it's overturning) situation.

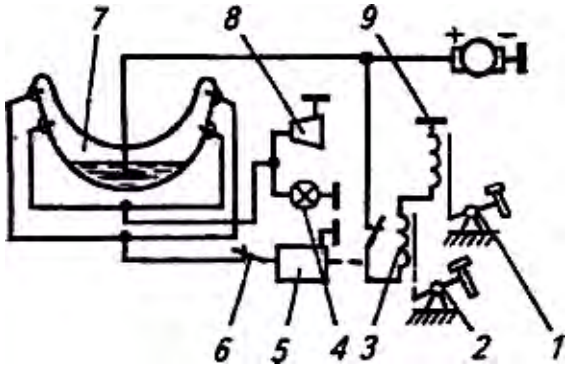

Figure 2.-Mechanism for overturning prevention of mobile aggregates with electric drive: 7, 2- levers; 3,9- solenoids; 4-light signal; 5- intervening relay; 6- switch; 7- position sensor; 8- sound signal.

Further machine inclination provides electrical connection of central ⊥ shape electrode with one of upper lateral ones, that leads to power supply on intervening relay 5, which snaps into action and power contact is locked. Electric current flows through solenoids 3 and 9 and core pulling-in occurs; meanwhile double armed levers 2 and 1 move clutch and brake pedals respectively to shutting-off (clutch) and switching on (brakes).

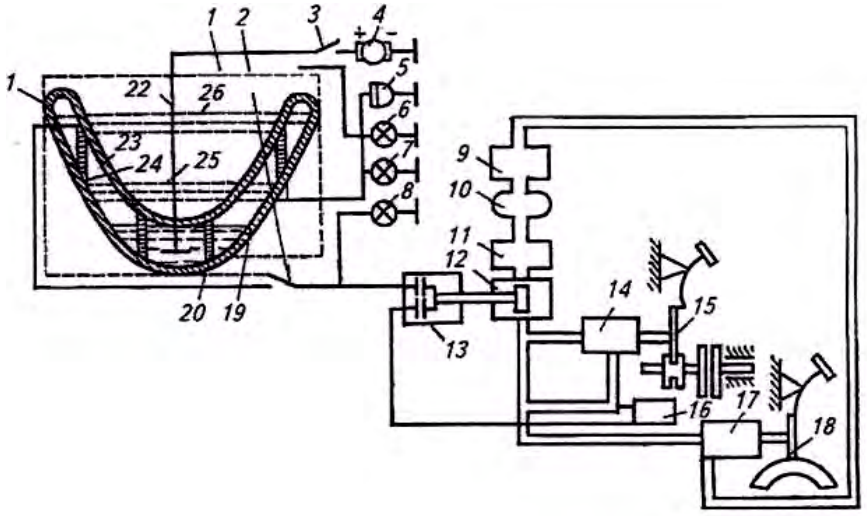

Figure 3- Device for overturning preventing of mobile aggregates with a drive from water systems: 1- sensor; 2,3-switches; 4-current generator; 5-sound signal; 6…8- respectively green, yellow, red lamps; 9-oil tank;10- water pump; 11-distributor; 12-valve body; 13-electromagnetic valve; 14,17-water cylinders; 15,18- clutch pedals, brakes;16-safety valve; 19,23- bowls; 20,24-oscillation reducers; 2-connecting ring; 22-central electrode; 25, 26-lateral electrodes.

Analogical mechanism, but with drive from machine water system is presented on fig.3. It differs from the previous one that sensor 1 is made in the shape of bowls put one into another 19 and 23 (of low conducted material), connected at the top by ring 21 so, that in lower part we can see clearance, which is filled by mercury. Lateral electrodes of sensor 25 and 26 are made in the shape of rings on different height. Sensor with central electrode 22 has

attenuators 20 and 24, made in the shape of cylinders of no current conducted material. Electro magnetic valve 13 snaps into action under current while sensor inclination and transfers valve in the body 12 in such position, which opens way to oil from oil tank 9, water pump 10 and distributor 11 of tractor water system into water cylinders. One of them- water cylinder 14 is connected with pedal 15 of clutch, another-17- with brake pedal 18. While influencing the brake pedals, water cylinders stop the tractor.

Research results

Mentioned above mechanisms eliminate the possibility of tractors, truck tractors, auto tractor trains from overthrow.

Labor safety scientific school at Saint-Petersburg State Agrarian University by experimental and theoretical research proved fundamental opportunity on liquidation of industrial injuries in AIC due to innovative technical solutions. Novelty of engineering technical problem solution is confirmed by 160 patents on various inventions.

Preparatory groundwork for a safety management system for urban green areas

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Keywords: green maintenance, model, risk analysis

Objectives

Urban forestry works and urban green areas maintenance are high-risk activities and usually source of injuries. The management issues are quite complex, influenced not only by the characteristics of environment and high risk level of some tasks but also by companies' policies in terms of safety management and human factor. When planning and carrying out these activities the professional arborists or gardeners will be faced with a number of health and safety tasks that have to be tackled, such as protecting public health and safety and setting out safe working procedures.

Methods

In this paper we provide the preparatory groundwork for a model useful for describing the real risk level of a job site and giving positive feed-backs for crew leaders and safety coordinators to make decisions and to organize open air activities. We start from data field of 80 job sites of North-East Italy regions and, first of all, gives us a measure of risk in terms of injuries frequency and severity.

Expected Results

The results of risk analysis have underlined the riskiest activities and seasonal variations in incidence rate for difference types of accidents/injuries have been observed. The comparison for all tasks inquired highlights that the behaviour of workers and company safety policies are weak contexts. Indeed the most worrisome values assigned to these activities for lack of identification and reduction of human-related risk. It will be implemented and validated in the future by a large scale investigation, with the goal to begin a complete safety management system (GreenSafety SMS) for urban green areas works.