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**CONTENT**

**Emilija Arsov, Galina Ivanova, Sasa Mitrev,**
Multigene characterization of '*Candidatus phytoplasma solani*' in pepper and tomato plants in the Republic of Macedonia ..... 7

**Biljana Balabanova, Trajče Stafilov, Robert Šajn, Claudiu Tănăselia**
Bioindication abbility of *Hypnum cupressiforme* and *Homolothecium lutescens* for determination of arsenic distribution in environment ..... 15

**Olivera Bicikliski, Krste Tashev, Fidanka Trajkova, Ljupco Mihajlov, Liljana Koleva Gudeva**
Comparative analysis of capsaicin content in peppers (*Capsicum annuum* L.) grown in conventional and organic agricultural systems ..... 27

**Zoran Dimitrovski**
Inspection of pesticide application equipment ..... 37

**Zoran Dimitrovski, Dimitrov Sasko, Kukutanov Risto**
Condition of air assisted sprayers in Shtip region and possibility of applying European standard EN 13790 ..... 45

**Violeta Dimovska, Fidanka Ilieva, Sanja Kostadinovic, Ljupco Mihajlov**
Physical and chemical characteristics of pomegranate fruit (*Punica granatum* L.), of cv. Karamustafa ..... 53

**Sanja Filipovska, Darko Andronikov, Aco Kuzelov**
Chemical and fatty acid composition in meat of young chickens different hybrid lines ..... 61

**Natasa Gunova, Dusan Spasov, Biljana Atanasova, Dragica Spasova, Mite Ilievski**
Correlation between population dynamics of *Tuta absoluta* (Lepidoptera: Gelechidae) and climate, at tomato in protected area ..... 69

**Verica Ilieva, Natalija Markova Ruzdik, Ilija Karov, Ljupco Mihajlov, Mite Ilievski, Biljana Kovacevik**
Genetic variability for yield and some yield-related traits in rice (*Oryza sativa* L.) ..... 75

**Dijana Indzhelieva, Katja Velkova-Jorgova, Darko Andronikov, Aco Kuzelov**
The influence of starter culture of lactic- acid bacteria and bifid bacteria over the sanitary- hygienic, sensor and physical – chemical indicators on the re – boiled – smoked durable sausage ..... 81

**Viktorija Maksimova, Liljana Koleva Gudeva, Rubin Gulaboski, Maja Shishovska, Zorica Arsova Sarafinovska**
Capsaicin and dihydrocapsaicin variability in *Capsicum* sp. cultivars from Republic of Macedonia revealed by validated HPLC method ..... 89

**Ivana Velesanova, Fidanka Trajkova, Liljana Koleva Gudeva**
Micropropagation of ornamental species *Brassica oleracea* cv. Kyoto red given and *Ageratum* sp. ..... 97

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Review paper

# INSPECTION OF PESTICIDE APPLICATION EQUIPMENT

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**Abstract**

The Directive 2009/128 / EC of the European Parliament establishes a framework for the implementation of National Action Plan referring to the sustainable use of pesticides in every country in EU. One of the areas covered by the Directive relates directly to the introduction of mandatory monitoring and inspection of pesticide application machines using standard EN13790 and new one EN 16122. In the Republic of Macedonia at the end of 2014 began a process of harmonization of the old law for plants protection with new rules and regulations required by the European Commission. The new rules and regulations, inter alia, pay special attention to the pesticides application equipment and to their mandatory inspection at specific time intervals, protection of agricultural land from pollution and to the principles of environmental protection.

**Key words:** EN 13790, spray scanner, pressure gauge, agitator, flow nozzle

## INTRODUCTION

The overuse and misuse of pesticides pose a threat to the environment and health hazards for the farmers in the agricultural production. Pesticide residues in food affect directly the health of consumers and the increasing number of infected people. In addition, exporters of food must comply with the standards on the minimum allowed presence of residues in processed foods, fresh fruits and vegetables. The non-compliance with these standards can have catastrophic effect on the increasing of export, which is one of the primary economic objectives of our country.

Precise application of pesticides is equally important for environmental reasons, the effectiveness of chemical protection as well as the need to reduce the input in production. By achieving greater precision of the application and thus the full effectiveness of the protection procedures, plant protection machines (sprayers, sprinklers) must have structural and technical correctness to achieve a suitable working potential (McFadden-Smith, 2003). Given the above mentioned facts, the laws on compulsory inspection of plant protection products under Directive 2009/128 / EC and 2006/42 / EC, which are based on EN 13790 (Rotteveel, 2012), are introduced in EU countries. This standard is currently under revision, as CEN (European Committee for Standardization) proposes standardization at the International Standardization Organization (ISO), Polveche (2014), so that a technical review will be carried out according to ISO 16122 in the future.

In the Republic of Macedonia at the end of 2014 began a process of harmonization of the old law for plants protection with new rules and regulations required by the European Commission. The new rules and regulations, inter alia, pay special attention to the pesticides application equipment and to their mandatory inspection at specific time intervals, protection of agricultural land from pollution and to the principles of environmental protection (Dimitrovski et al 2016). The law deals with the economic, health, environmental and social role of agriculture and establishes the principle of agricultural policy measures that are to be aimed at encouraging sustainable agricultural activities. The measures are aimed at maintaining the diversity of animal and plant species, conservation of soil and of its fertility and protection of natural conditions necessary for life in soil, water and air.

However, today the outdated technology in Macedonia, worn and poorly maintained machinery and pesticide application equipment cause directly the increased number of treatments, poor protection and uncontrolled spread of diseases and pests in the agricultural production.

## PREVIOUS RESEARCH

At the end of the eighties a check on the proper operation of the pesticide application equipment and nozzles in the European Union began. The conducted tests showed which parts are most susceptible to defects.

Most researchers dealing with the issue of pesticide application equipment state that a technically correct machine can greatly contribute to reducing the risk of additional ecosystem pollution because all constituents are correct and work in the given criterion (Wegner, 2014, Tadic, 2013). Also, the authors (Almbauer et al., 2014) state that with a correct and properly calibrated machine the pesticide drift can be greatly reduced, i.e. loss of evaporation and wind.

Tests in Germany showed that the majority of defective pesticide application machines were due to defective nozzles. Out of 70000 tested pesticide application equipment, 19% of them, or 13,300 machines, showed that the nozzles were not proper (Reitz, S., Gamzlemeier, H., 1998). In Belgium between 1995 and 1998, 17466 machines were tested, of which 86% or 14895 machines were defective due to a defect in the manometer and nozzles (Langenakens, J., Pieters, M., 1999).

If the distribution of the fluid is incorrect, then there is a great chance for the appearance of pests, which causes additional economic costs and environmental problems. In Italy, a national law has not yet been adopted, which regulates the review, regulation and control of pesticide application equipment. Only in some Italian regions are guidelines issued by local governments. In most AAMS (Belgium) for review of pesticide application equipment and some solutions that comply with EN 13790 have been developed. The inspection of machines in use takes place in accordance with the European Norm 13790, which is in force since 2003, and is divided into EN 13790-1, which refers to boom sprayers and EN 13790-2, which refers to air assisted sprayers. European Norm 13790 contains rules and guidelines for determining the correctness and procedure of inspections of pesticide application equipment.

More serious testing of pesticide application machines in the Republic of Croatia was carried out at the end of the last decade, and bad results of the surface distribution of fluid in the operation of pesticide application machines were immediately noticed. (Banaj, Dj., Duvnjak, V., 2000). The failure of the nozzle is most likely due to the increase of the flow, i.e. the excess of the material due to the long-term use, which in the end causes unusual surface distribution of fluid (Tadic et al., 2010). The problem is more pronounced in nozzles with smaller ISO numbers, and Duvnjak et al. (1998) state that nozzles with a smaller aperture are more quickly consumed than nozzles with a larger aperture, and that the nozzles discharged have a much greater fluid flow in the nozzle center than the new nozzle. Even so, a big problem are installed nozzles of the non-recognizable producers. Because the flow in the new nozzle largely deviates from the ISO 10625 standard and the exploitation of technically obsolete machines that should already be replaced by new ones.

Regular inspection of the pesticide application equipment is necessary in modern agricultural production, which uses pesticides on large surfaces (Sedlar, A., 2016). Djukic, N., (2016) states that in order to ensure the production of eco-food, safe and healthy environment and reduce production costs, it is necessary to ensure controlled application of pesticides. Such application is possible only with machines for the application of pesticides that are in perfect working condition.

## INSPECTION OF PESTICIDE APPLICATION EQUIPMENT BY APPLYING EN13790 STANDARD

Each technical inspection consists of a visual and operational test. Within the visual section, there are inspection of the PTO-s connection, the visibility of the mark on the fluid tank, the stability of the sprayer branch, the drainage of the fluid and the correctness of the valve. The operational test of the equipment includes test of the: Pressure gauge, pump flow and flow nozzle, liquid dispersion fluid, and fluid flow in the agitator.

The measurement of the correct operation of the pressure gauge is tested by a special

device, where the test gauge and pressure gauge are tested on the same device. According to the law all pressure gauges placed on pesticide application equipment must have a minimum diameter of 63 mm. Maximum breakthroughs that pressure gauge can produce by the standard is ± 0, 2 bar in the test range of 0 to 2bar, ± 10% in the test area more than 2 bar. Figure 1 shows the measuring device for the accuracy of the pressure gauge.

**Figure 1.** A measuring device for pressure gauge correctness

The pump capacity is measured using an electromagnetic fluid flow meter that fits into the valve construction and the pressure gauge. Each pump at the technical inspection has to have a capacity of 90% of the maximum capacity according to the factory data. Figure 2 shows the pump flow meter.

**Figure 2.** Electromagnetic device for pump flow measuring

Each nozzle according to ISO 10625 achieves its flow at a standard pressure of 2.76 bar. According to the technical inspection standard, each nozzle can achieve a deviation of ± 10% with respect to the nominal, in order to be correct. The nozzle flow measurement is distinguished by air assisted sprayers, which are made of stainless steel to which lenses are placed with a volume of 2000 ml. Liquid to the measuring bottle supplies plastic lines that are specially designed with buckles connected to the nozzles. The image of the device is shown in Figure 3.

**Figure 3.** A measuring device for mist blower nozzle flow

The nozzle flow measurement on the horizontal boom sprayers is performed by the individual digital meter shown in Figure 4.

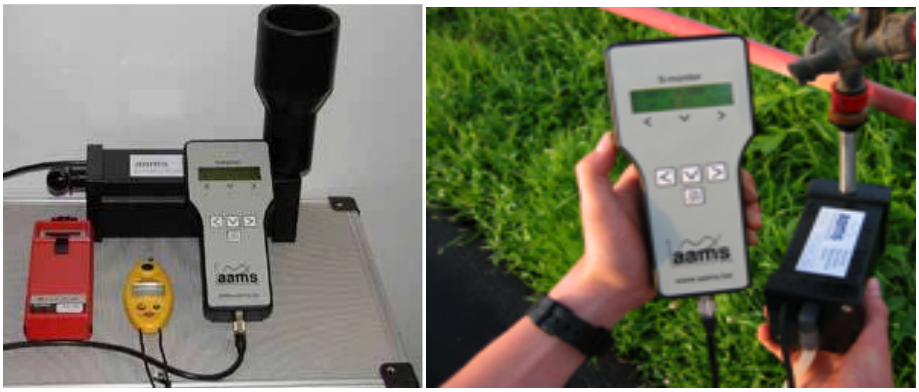


**Figure 4.** A measuring device for sprayer nozzle flow

Measuring of the liquid distribution is performed using a fully automated spray scanner. Newer versions of this device use a blue-tooth device to easily connect and manage real-time testing data. This device provides a very important liquid surface fluctuation coefficient, which should be below 20% of the total workflow of the sprayer by standard technical inspection. The image of the spray gun is shown in Figure 5.

For other equipment used for technical inspection, it is very important the test for surface fluid distribution is performed at wind speeds of less than 3 m / s. The PTO-s optical rotational speed gauges are also used, because the pump capacity testing is performed at 540 rpm. There are also mobile computers for enrolling machines in the database. The return of the fluid to the tank must be at least 5% from the volume of the tank and is measured by a flow meter (e.g. for a tank of 1000 l, the minimum return of fluid to the tank must be 50 l / min).

**Figure 5.** A measuring device for horizontal liquid distribution – spray scanner

## CONDITIONS TO BE MET BY STANDARD EN 13790

For the practical application of the standard in the European Union it is necessary to establish central, regional and mobile laboratories, equipped with necessary instruments, which inspect the machines and appropriate software for collecting and analyzing data.

The task of the central laboratory is:

- Control of regional laboratories
- Issue of certificates for tested machines Writing annual reports on conducted inspections
- Training and issuing certificates to regional laboratories for each cycle of testing of three (five) years

In the composition of the central laboratory there are also adequate equipment consisting of:

Basic equipment consisting of: spray scanner, vertical partenator, instrument for measuring the flow of the spray fluid, Equipment for calibration of machines and software.

Regional laboratories perform the following tasks:

- Control of pesticide application equipment that are in use every three (five) years
- Prepare an inspection plan that is submitted to the Central Laboratory at the beginning of each year and requires certificates based on the report of the performed control
- Participate in the training organized by the Central Laboratory on the field.

These laboratories possess the following instruments: spray scanner, pump tester, instrument for measuring fluid flow of the sprayer and software.

Mobile laboratories are needed to test the pesticide application equipment in areas with inaccessible terrain, and they are also supplied with the same instruments.

Effective application of the standard allows:

- Easier access to the new markets
- Reducing the time to market exit and increasing its stake in it
- Bring new technologies to the market
- Financial risk management related to innovation
- Acceptance of innovations by clients and those who perform public procurements
- Technology transfer from developed countries in developing and transition countries
- Better assessment of new technologies

In addition, standards eliminate barriers to trade, support development, promote innovation, ensure product quality, increase safety and security, enhance visibility and enhance reputation, improve technical regulation, and foster national and international competition among suppliers the same economic branch.

The application of international, i.e. European standards has greatly contributed to the increase of competitiveness of the agricultural producers that apply them, in two ways. Firstly, the application of these standards in itself improves competitiveness because they have high international reputation and give confidence. Secondly, the application of these standards brings significant benefits to domestic and foreign suppliers as they make technical specifications in contracts more precise and clearer.

## CONCLUSION

The production of healthy food is a basic task for modern agricultural production. According to the standards of the European Union, it is necessary to optimize the consumption of pesticides and to reduce their harmful impact on the environment, human health and animals. For this reason it is obligatory for every farmer in the European Union to make a technical inspection of the pesticide application equipment.

There is still no legislation in the Republic of Macedonia that prescribes the standards for inspection of pesticide application equipment. Therefore, at the end of 2014 began a process of harmonization of the old law for plants protection with new rules and regulations required by the European Commission. The law plans to draw up a national action plan based on the European directive 2009/128, which should include clearly defined objectives, measures and a timeframe for reducing the risk and impact of the use of pesticides on human health

in the shortest possible time. It is necessary to apply the European directive EN 13790, which prescribes the methods and equipment for plant protection machines to be inspected. In this way, the control over food production in the Republic of Macedonia will increase, and the country will be included in the countries where production of a healthy and safe food.

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## ИНСПЕКЦИЈА НА МАШИНИТЕ ЗА АПЛИКАЦИЈА НА ПЕСТИЦИДИ

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**Резиме**

Директивата 2009/128/ЕС на Европскиот парламент воспостави рамка за имплементација на Национален акционен план кој се однесува на одржливо користење на пестицидите во секоја земја на ЕУ. Една од областите која ја покрива Директивата се однесува директно на воспоставување на задолжителна инспекција на машините за апликација на пестициди со примена на Стандардот EN13790 и новиот Стандард EN16122. Во Република Македонија кон крајот на 2014 година започна процесот на хармонизација на стариот Закон за заштита на растенијата со воведување на новите правила и регулативи според Европската комисија. Дел од новите правила и прописи директно се однесуваат на машините и опремата за апликација на пестициди, задолжителната инспекција во одредени временски интервали и заштита на земјиштето од загадување почитувајќи ги принципите за заштита на животната средина.

**Клучни зборови:** *директива EN 13790, спреј скенер, манометар, мешалка, проток на млазници*