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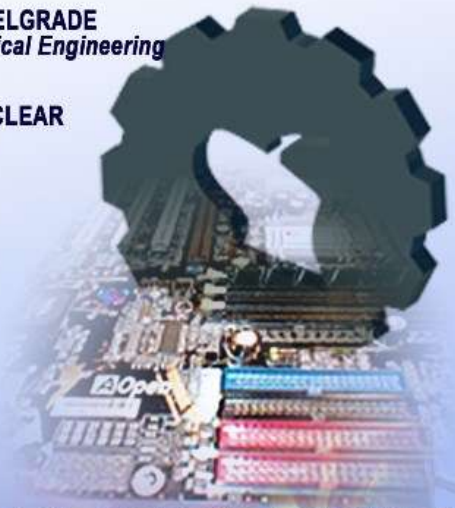

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PREFACE

After the successful First and Second International Symposium on Agricultural Engineering ISAE 2013 and ISAE 2015, that were held in Belgrade at the Faculty of Agriculture, thanks to our colleagues we are organizing The Third International Symposium on Agricultural Engineering – ISAE 2017. Together with the University of Basilicata, School for Agricultural, Forestry, Food and Environmental, Sciences (Potenza, Italy), University of Sarajevo, Faculty of Agricultural and Food Sciences (Sarajevo, Bosnia and Herzegovina), Aristotle University of Thessaloniki Faculty of Agriculture, Thessaloniki (Greece), University of Belgrade, Faculty of Mechanical Engineering, Belgrade (Serbia), Vinča Institute for Nuclear Science, Belgrade, Serbia and thanks to the Ministry of Education, Science and Technological Development, Republic of Serbia, support of the EurAgEng and the AMAPSEEC, and sponsor and donors, we have managed to organize the presentations of the 34 papers that were submitted to the Scientific Committee of the ISAE 2017 Symposium. We have arranged them in to eight sections and categorized them as Original scientific papers, Scientific review papers, Firs (short) communications, Case studies, Professional (Expert paper) and Popular papers. All papers within the Proceedings of the ISAE 2017 were reviewed by the members of the Scientific Committee and kind assistance of some members of other Conference bodies.

Book of Proceedings of the ISAE 2017 International Symposium has 324 pages and it is organized in eight thematic sections. Section I – Crop, Fruit and Vegetable Production Systems (13 papers); Section II – Livestock Farming Systems and Equipment (1 paper); Section III – Power and Machinery; Diagnostics and Maintenance of the Agricultural Machinery (4 papers); Section IV – Post Harvest Technology, Processing and Logistics; measuring, Sensing and Data Acquisition in Agriculture (6 papers); Section V – Information Systems and Precision Farming; Modelling, Predicting and Optimal Control in Agricultural Engineering (2 papers); Section VI – Soil and Water Use and Environment (1 paper); Section VII – Energy, biomass and bio recourses in Agriculture (2 papers); Section VIII – Agricultural Policies, Sustainable Agriculture, ergonomics and Safety in Agricultural Machinery Exploitation (5 papers).

We wish to thank to all the authors for their contribution to the ISAE 2017 Symposium and to the all the Institutions, Associations, Universities, Sponsors and Donors for the contribution in ISAE 2017 Symposium organization.

ISAE-2017 Proceedings

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CONDITION OF THE HORIZONTAL BOOM SPRAYERS IN PART OF THE MEDITERRANEAN REGION IN THE REPUBLIC OF MACEDONIA

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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 member country. One of the areas covered by the Directive relates directly to the introduction of mandatory monitoring and inspection of pesticide application equipment. Considering that the Republic of Macedonia does not have a compulsory inspection, and as an EU candidate member country, is bound to harmonize its regulations, the basic aim of this research is to determine the current condition of the horizontal boom sprayers. The survey was conducted in a part of the Mediterranean region in the Republic of Macedonia, i.e. the municipality of Sveti Nikole and Stip. In this research 43 machines were visually and operationally checked. The results of this research will be a good basis for further research and implementation of mandatory inspection of these machines in the Republic of Macedonia.*

Key words: *plant protection, pesticides, inspection, visual flows, sprayers*

1. 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 people suffering from pesticide contamination. 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.

With the new law on plant protection, the agricultural policy of our country pays special attention to the protection of agricultural land from pollution and to the principles of

environmental protection. 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, the outdated machines in Macedonia [5], 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.

One of the areas covered by the *Directive 2009/128/EC* relates directly to the introduction of mandatory monitoring and inspection of pesticide application equipment [2], [5], [6], [7], [8], [9]. Considering that in the Republic of Macedonia the inspection is not mandatory, and as a country candidate it is bound to harmonize its regulations, the main goal of this research is to determine the current condition of the pesticide application equipment. The results are a good basis for further research and an opportunity to apply standardized procedures for mandatory inspection of machinery for pesticide application.

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.

Because of that, within the Phytosanitary Administration are established committees whose objective is to work on alignment of the law and on collecting experiences from other member states of the European Union that have undergone this process or are at an advanced stage. This year in collaboration with the Phytosanitary Administration were organized several meetings with farmers, with the distributors of pesticides as well as with economic operators who sell machines for pesticide application. The goal is to consider all aspects for optimizing the new laws and regulations, and in terms of machinery for pesticide application, establishment of monitoring and rapid onset of inspections.

2. MATERIAL AND METHODS

The research was conducted in the eastern part of the Mediterranean region of the Republic of Macedonia embracing the several villages of the municipalities Sveti Nikole and Stip. The instrument used during the field research was the questionnaire including data divided into three groups:

a) General information about the owner,

b) General information on the (*PAE*) pesticide application equipment,

c) Visual and operational flaws of the horizontal boom sprayers.

3. RESULTS AND DISCUSSION

Mediterranean region in Macedonia is one of the major agricultural regions in the Republic of Macedonia, where crops, vine crops, fruits and vegetable are grown. In the several villages of the municipalities Sveti Nikole and Štip, where the research was conducted crops are prevalent and recently, new vineyards and orchards are renewed and raised.

The objective of this research is to determine the current condition of the horizontal boom sprayers and to learn how many of them correspond to the requirements of the *European Standard EN 13790* and the new *EN ISO 16122*, which relate directly to the inspection of machinery and equipment for application of pesticides.

Table 1 provides general information about farmers who own equipment for application of pesticides. According to the data in the table it can be concluded that most of the farmers 25 (44.64%) are not registered and most farmers have secondary education (69.64%).

The fact that all surveyed farmers have not attended any training on quality and on handling PAE (pesticide application equipment) is worrying. This means that these machines are used according to their personal experience or according to the experience of their relatives and friends which is often misleading and unsafe. In this part of the municipality, the most common are field crops.

Tab. 1. General data on farmers and agricultural surfaces

Total number of interviewed person	Registered farmers			Education of the farmer/manager			Attendance on trainings for PAE	
	Yes	No	Enterprise	Primary	Secondary	High	Yes	No
56	22	**25**	13	9	**39**	8	/	**56**
%	**39,29**	**44,64**	**23,21**	**16,07**	**69,64**	**14,29**	**0**	**100**

Tab. 2 shows machines for application of pesticides that are most common in the eastern Mediterranean region. According to the data we can conclude that *Aromehanika Kranj* 36 (42.86%) is the most common brand of machines for application of pesticides. The fact that these machines are old, frequently between 10-20 years (15 or 17.86%) and 24 over 20 years (28.57%) is worrying. If these machines are not properly maintained and used, they can be major contributors to increased pollution of the environment. As a result of the aid and subsidies that farmers receive for the purchase of new machinery in the last 7-8 years we have notices an increased number of new machinery for pesticide application - 28 machines (33.33%).

Tab. 2. General information on PAE in part of the Mediterranean region

Pesticide application equipment								
	Brand	Number of machines	Age				Functioning properly	Malfunctioning
			0 -5	5 -10	10 -20	> 20		
1.	Morava	20	2	3	3	12	16	4
2.	Agromehanika Kranj	**36**	15	10	6	5	36	/
3.	Mitterer	4	/	/	1	3	4	/
4.	Metalbraneks prokuplje	2	1	1	/	/	2	/
5.	Sprayer	1	1	/	/	/	1	/
6.	Sampo 20	1	/	/	1	/	1	/
7.	Leško	4	1	1	2	/	4	/
8.	SVL aseta	1	/	/	/	1	1	/
9	Agrin	1	1	/	/	/	1	/
10	Agrimir Vistula	1	/	/	/	1	1	/
11	Agroproizvodzac	1	/	/	1	/	1	/
12	TCM	1	/	/	/	1	1	/
13	Evrotech	1	/	/	1	/	1	/
14	Agron Nis	7	7	/	/	/	7	/
15	Fisher	1	/	/	/	1	1	/
16	Vrecek Kranj	1	/	1	/	/	1	/
17	Atomizatori	1	/	/	/	1	1	/
Total		**84**	**28**	**16**	**15**	**24**	**80**	**4**
%		100	33,33	19,05	17,86	28,57	95,24	4,76

Table 3 shows only the number of the horizontal boom sprayers by way of hitching to the tractor. According to the table the most common are carried horizontal boom sprayers for application of pesticides for agricultural crops - 41 (95,35%).

The survey of the pesticide application equipment included the determination of visual and operational flaws of the machines. The flaws of the machines were determined and are presented in Tables 4 and 5.

Tab. 3. Data on PAE in part of the Mediterranean region

Way of hitching	Carried	Trailered
Types of PAE	Horizontal boom sprayers	Horizontal boom sprayers
Total (84)	**41**	**2**
%	**95,35**	**4,65**

According to the data in the table 4 it can be noted that upon the visual inspection of the machines most defects and modifications are present in the machine's hoses. The hoses were often changed with not original parts.

Tab. 4. Visual flaws of horizontal boom sprayers in part of the Mediterranean region

Parts of the machine	Horizontal boom sprayers		Total
	No parts	Modifications	
Chassis	/	7	7
Hitching device	/	1	1
Power take-off	/	0	0
Wheels / pneumatic tires	1	/	1
Tank	1	8	8
Agitator	/	/	0
Pump	/	2	2
Filters	4	/	4
Command valve	/	7	7
Pressure gauge	3	/	3
Hoses	/	12	12
Sprayer boom	/	5	**5**
Nozzles	1	2	3
Total number of visual flaws	**10**	**44**	**54**
%	18,18	81,82	**100**

Tab.5. Operating flaws of horizontal boom sprayers in part of the Mediterranean region

Parts of the machine	Current state of the parts of the machines				
	Functioning properly	Malfunctioning	Functioning properly with modification /leaking	No parts	Total number of machines with operating flaws
Chassis	36	0	7	0	7
Hitching device	42	0	1	0	1
Power take off	43	0	0	0	0
Wheels/ Tires	1	0	0	1	1
Tank	36	0	6	1	7
Agitator	43	0	0	0	0
Pump	37	1	5	0	6
Filters	39	0	0	4	4
Command valve	36	0	7	0	7
Pressure gauge	32	8	0	3	11
Hoses	31	4	8	0	12
Sprayer boom	35	1	7	0	8
Nozzles	33	2	7	1	10

Analyzing the current state of horizontal boom sprayers it can be concluded that the most common malfunction in machines is determined in the hoses – 12 machines. The great pressure and the quality of hoses affect directly the length of their use and the need for replacement. The second common malfunction was pressure gauge – 11 machines, and three machines did not have any pressure gauge at all (Table 5). It should be noted that this instrument directly shows the operating pressure in the system and is one of the main control tools for proper and quality application of pesticides

During the conversation with the farmers about their experience the most common defects and problems encountered when using these machines were discussed. According to the results of the research it can be concluded that most defects occur in the hoses 18 (33, 33%) and pump 15 (27, 78%) of the pesticide application equipment from the total number of defects (54). A smaller number of defects are observed on nozzles (7), and on sprayer boom and filters (4).

4.CONCLUSIONS

Unfortunately, according to the first results, we can conclude that a large number of controlled machines can not meet the requirements of *European Standard EN 13790* and the new *EN ISO 16122*. All surveyed machines have only one tank and many of them have modifications that are not in accordance with the above mentioned standards.

According to the survey results it can be concluded that the number of registered and non-registered farmers is almost the same and most of the farmers have secondary education. The fact that all surveyed farmers have not attended any training on quality and safe handling of these machines is worrying.

The most represented brand of pesticide application machine is *Agromehanika Kranj*. Many of these machines are 15-20 years old and even more than 20 years old. If they are not properly maintained and used, they can be major contributors for the increased pollution of the environment.

The visual inspection of the machines showed that most common malfunction in machines is determined in the hoses. The great pressure and the quality of hoses affect directly the length of their use and the need for replacement. The second common malfunction was pressure gauge – 11 machines, and three machines did not have any pressure gauge at all.

Analyzing the current state of the functioning of the pesticide application equipment, it can be concluded that the most common malfunction in machines is in the hoses and pressure gauge. The great pressure and the quality of hoses affect directly the length of their life and the need for replacement.

During the conversation with the farmers they declared that from their extensive experience most failures occur in the hoses and pumps of pesticide application equipment. All farmers, owners of these machines have said that they would like to expand their knowledge by attending training for proper and safe exploitation.

In the Republic of Macedonia there is no compulsory inspection of pesticide application equipment. But as a candidate country, Macedonia is bound to apply and harmonize its laws and standards with the European Union laws and standards. The introduction of mandatory inspection, as well as other laws regarding the proper use and handling of waste pesticides affect directly the protection of the environment and human health.

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