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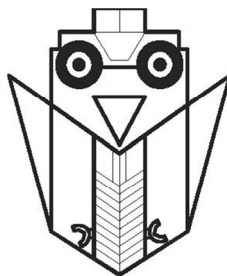


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ZAVOD ZA MEHANIZACIJU POLJOPRIVREDE
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UNIVERZA V MARIBORU FAKULTETA ZA KMETIJSTVO IN
BIOSISTEMSKE VEDE
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NACIONALNI INSTITUT ZA POLJOPRIVREDNU MEHANIZACIJU -
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PRIČA O TRAKTORU S NASLOVNICE

WATERLOO BOY N – TRAKTORSKA LEGENDA

Waterloo Boy model N je status traktorske legende zaslužio zbog događaja povezanih s povijesnim razvojem traktora. Tvrtka Deere & Company, neuspješna u razvoju vlastitog traktora, odlučila je 1918. godine preuzeti proizvođača traktora Waterloo Gasoline Engine Company čiji je osnivač bio John Froelich. Deere & Co. je u početku traktore proizvodio pod imenom Waterloo Gasoline Engine Co., a ime John Deere je na traktorima prisutno od 1923. godine. Povjesničari s područja traktorske tehnike su uglavnom suglasni da je Froelich-ov traktor (preteča Waterloo boy-a) začetnik povijesti traktora i njihovog korištenja u poljoprivredi, kao prvi tehnički zadovoljavajući traktor s motorom s unutarnjim izgaranjem. John Froelich 1893. osniva u Waterloo-u, Iowa, tvrtku Waterloo Gasoline Traction Engine Company, no zbog slabe prodaje traktora proizvodnju fokusira na stacionarne motore s unutarnjim izgaranjem, te se 1895. tvrtka preimenuje u Waterloo Gasoline Engine Company. Jedan model stacionarnog motora iz 1905. godine nazvan je Waterloo Boy, a 1911. započinje proizvodnja traktora pod tim imenom. Na temelju prethodnih modela je 1916. nastao Waterloo Boy model N, koji je do 1924. proizveden u više od 20.000 primjeraka.

Waterloo Boy traktore su pogonili dvocilindrični motori snage 12 KS / 8,9 kW (na poteznici) i 25 KS / 18,6 kW na pogonskoj remenici (za pogon poljoprivrednih strojeva, priključno vratilo se na traktorima pojavljuje kasnije) pri nazivnih 750 o/min. Zanimljivo je da je na Nebraska testu traktora utvrđena snaga veća od deklarirane od strane proizvođača, na poteznici je izmjereno 15,98 KS / 11,9 kW, na pogonskoj remenici 25,97 KS / 19,4 kW. Svi glavni sklopovi traktora bili su pričvršćeni na čeličnom nosivom podvozju, karakteristično za sve traktore do 1917. godine i fordovog traktora Fordson koji je imao samonosivu konstrukciju. Waterloo Boy je za gorivo koristio petrolej, paljenje gorive smjese iskom osiguravao je visokonaponski magnetni uređaj, a podmazivanje je riješeno jednostavno zapljuskivanjem. Traktor je imao jedan stupanja prijenosa za vožnju naprijed i jedan nazad, najveća brzina iznosila je gotovo 5 km/h (3 mph).

Upravo je Waterloo Boy N bio 1920. godine prvi traktor na svijetu ispitan na Nebraska testu traktora, koji je iste godine uveden kao obaveza da bi se uveo red na američkom tržištu traktora. Zakonom je bilo utvrđeno da se traktor koji ne zadovolji minimalne propisane kriterije ne može prodavati u Nebrasci. Kvaliteta ispitivanja obavljanih na Nebraska testu imala je velik utjecaj na industriju traktora u SAD, a kasnije i svijetu. Proizvođači traktora počeli su poštivati zahtjeve testa pri razvoju traktora, što je kupcima pri nabavci novog traktora pružalo veću sigurnost u istinitost karakteristika deklariranih od strane proizvođača. Ovlasti za provođenje testiranja dobila je nezavisna institucija, Nacionalni laboratorij za testiranje traktora (NTTL), Lincoln, Sveučilište u Nebrasci. U Europi je 1959. godine po uzoru na Nebraska test uveden OECD protokol za ispitivanje traktora koji se kontinuirano dopunjuje te danas obuhvaća i traktore za šumarstvo.

Tekst: Viktor Jejič

Slika na naslovnici: Dušan Jejič, ulje na platnu

IN MEMORIAM

Prof. dr. sc. Zlatko Gospodarić (1948.-2016.)



Dana 19. rujna 2016. godine napustio nas je umirovljeni profesor Zlatko Gospodarić, dugogodišnji djelatnik Agronomskog fakulteta Sveučilišta u Zagrebu. Prof. dr. sc. Zlatko Gospodarić rođen je 6. veljače 1948. godine u Zagrebu gdje je završio osnovnu školu i gimnaziju. Poljoprivredni fakultet Sveučilišta u Zagrebu, smjer Voćarstvo-vinogradarstvo-vrtnarstvo, završio je 1973. i iste godine se zaposlio u Institutu za mehanizaciju poljoprivrede, koji nakon integracije s Poljoprivrednim fakultetom 1978. godine mijenja ime u Institut za mehanizaciju, tehnologiju i graditeljstvo u poljoprivredi. Odmah po prelasku na fakultet uključuje se u nastavu i izvodi vježbe na više smjerova. Magistarski rad obranio je 1982. godine, a nakon izbora u znanstvenog asistenta 1984. godine uz izvođenje vježbi povjerena su mu i pojedina predavanja.

Jedno kraće vrijeme bio je i direktor Instituta za mehanizaciju, tehnologiju i graditeljstvo u poljoprivredi. Disertaciju je obranio 1993. godine, za docenta je izabran 1994. te postaje nositelj dva predmeta na studiju Bilinogojstvo. U zvanje izvanrednog profesora izabran je 2006. godine i u tom zvanju odlazi u mirovinu.

Tijekom svoje karijere na fakultetu objavio je više od 50 znanstvenih radova u domaćim i stranim časopisima i zbornicima radova, od čega 9 iz a1 kategorije, a objavio je i veći broj stručnih radova i studija. Do mirovine, uz obveze u nastavi, najviše se bavio uspostavljanjem i provođenjem sustava homologacije traktora u Republici Hrvatskoj, te prevodenjem i donošenjem hrvatskih normi u svojstvu predsjednika Tehničkog odbora 23 pri Hrvatskom Zavodu za norme. Višegodišnjim radom kao član uredništva doprinio je organizaciji međunarodnog simpozija „Aktualni zadaci mehanizacije poljoprivrede“, te je u razdoblju od 1994. do 2000. godine nekoliko puta bio glavni urednik zbornika radova ovog tradicionalnog skupa. Bio je vrstan praktičar, stručnjak za poljoprivredne strojeve i mjernu tehniku, a najviše je volio rad na terenu i svima koji su ga poznavali ostat će u trajnom sjećanju.

Zagreb, rujna 2016.

Prof. dr. sc. Dubravko Filipović
Predstojnik Zavoda za mehanizaciju poljoprivrede

PREDGOVOR

Povodom 45. obljetnice valja se prisjetiti da su za danas tradicionalni simpozij prije svega zaslužni tadašnji profesori Zavoda za poljoprivredno strojarstvo, Poljoprivrednog fakulteta Sveučilišta u Zagrebu, koji su daleke 1970. godine organizirali prvi međunarodni simpozij "Aktualni problemi mehanizacije poljoprivrede", a naravno i svi koji su kroz godine doprinijeli radu i napretku: autori, recenzenti, sponzori i kolege mehanizatori svjesni da je tehnološki napredak sredstava mehanizacije temelj unapređenja poljoprivrede. Pokroviteljstvo ovogodišnjeg simpozija od strane međunarodnih udruga poljoprivredne tehnike CIGR, EurAgEng, AAAE i ASABE, kao i činjenica da su od 1997. godine radovi objavljeni u Zborniku simpozija uvršteni u baze podataka Thomson Reuters: CPCI i ISTP, te CABI potvrda su kvalitete i priznanje dugogodišnjem ustrajnom radu na organizaciji simpozija.

Ovogodišnji zbornik radova sadrži ukupno 70 radova iz Austrije (3), Češke (1), Estonije (4), Filipina (1), Hrvatske (4), Italije (3), Japana (1), Litve (6), Makedonije (1), Njemačke (5), Rumunjske (31), Slovenije (5), Srbije (4) i Turske (1) Pristup web izdanju je besplatan na adresi <http://atae.agr.hr/proceedings.htm> od 30. ožujka tekuće godine. Na potpori posebno zahvaljujemo Ministarstvu znanosti, obrazovanja i sporta Republike Hrvatske i Zakladi Hrvatske akademije znanosti i umjetnosti. Svim sudionicima želimo ugodan boravak u Opatiji za vrijeme održavanja Simpozija.

PREFACE

On the occasion of the 45th anniversary let us recall that the credit for today traditional symposium belongs to the professors of Agricultural Engineering Department, Faculty of Agriculture, University of Zagreb, who organized the first international symposium "Actual problems of agricultural engineering" in 1970, as well as all those who have contributed through the years to its work and progress: authors, reviewers, sponsors and colleagues from agricultural engineering profession aware that technological advances of mechanization recourses is foundation of agricultural development. Co-sponsorship of this year's symposium by CIGR, EurAgEng, AAAE and ASABE, and the fact that since 1997 papers published in the symposium Proceedings are included in the Thomson Reuters: CPCI and ISTP, and CABI is confirmation of the quality and acknowledgement of many years of persistent work in organizing the symposium.

This year's Proceedings contains 70 articles from Austria (3), Croatia (4), Czech Republic (1), Estonia (4), Germany (5), Italy (3), Japan (1), Lithuania (6), Republic of Macedonia (1), Philippines (1), Romania (31), Serbia (4), Slovenia (5) and Turkey (1). Access to the web edition is free at site <http://atae.agr.hr/proceedings.htm> from March 30th of the current year. Organizer especially thank the Ministry of Science, Education and Sports of the Republic of Croatia and Croatian Academy of Sciences and Arts for continuous sponsorship. We wish all participants a pleasant stay in Opatija during the Symposium.

Zagreb, siječanj – January 2017

Chief Editor
Doc. dr. sc. Igor Kovačev

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CONDITION OF THE PESTICIDE APPLICATION EQUIPMENT IN PART OF THE MEDITERRANEAN REGION IN THE REPUBLIC OF MACEDONIA

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SUMMARY

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. One of the areas covered by the Directive relates directly to the introduction of mandatory monitoring and inspection of pesticide application equipment (PAE). 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 pesticide application machines. 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. 84 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 Macedonia.

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

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, worn and poorly maintained machinery and pesticide application equipment (PAE) cause directly the increased number of treatments, poor protection and uncontrolled spread of diseases and pests in the agricultural production.

Last few years, the European Commission adopted a whole set of rules (directives) and broadened the scope of all those regulations. According to the guidelines presented in the directives, all national regulations in the Member States must be harmonized when the countries introduce new laws. The *Directive 2009/128/EC* of the European Parliament establishes a framework for the implementation of the National Action Plan in each country, which refers to the sustainable use of pesticides. One of the areas covered by the Directive relates directly to the introduction of mandatory monitoring and inspection of pesticide application equipment (PAE). 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 inspection. EU Member States several years ago introduced the mandatory inspection of pesticide application equipment [3], [5], [8], [9], [10]. Experience in Croatia shows that the entry into the EU, the introduction of compulsory inspection and use of standard *EN13790* is a legal obligation that must be carried out. Many scientists their research in the field of pesticide application equipment they used for the application of standard *EN 13790* and compulsory inspection in their countries [1], [10].

METHODS

The research was conducted in the eastern part of the Mediterranean region of the Republic of Macedonia embracing 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 pesticide application equipment (PAE)
- c) Visual and operational flaws of the machines

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 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 machines for application of pesticides 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 these machines 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. According to the data presented in the table it can be concluded that, in this part of the municipality, the most common are field crops (88.24%).

Table 1. General data on farmers

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

Table 2 shows machines for application of pesticides that are most common in the eastern Mediterranean region. According to the data we can conclude that the most common brand of machines for application of pesticides is Agromehanika Kranj 36 (42.86%). 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%).

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

Pesticide application equipment (PAE)								
Brand	Number of machines	Age				Functioning properly	Malfunctioning	
		< 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 the proportion of machinery for application by way of hitching to the tractor and the type of the machine. According to the table the most common are carried tractor machines for application of pesticides for agricultural crops 41 (48.81%). Certain gradual rise of the number of air assisted sprayers (machines for application with fan) for the growing number of vineyards and orchards is noticeable.

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.

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

Types of PAE	Carried		Trailerred	
	Horizontal boom sprayers	Air assisted sprayers	Horizontal boom sprayers	Air assisted sprayers
Total (84)	41	23	2	18
%	48,81	27,38	2,38	21,43

Table 4. Visual flaws of PAE in part of the Mediterranean region

Parts of the machine	Visual flaws of PAE		Total	%
	No parts	Modifications		
Chassis	/	11	11	14,29
PAE hitching device	/	1	1	1,30
Power take-off	/	0	0	0
Wheels / Tires	2	/	2	2,60
Tank	1	10	11	14,29
Agitator	/	/	0	0
Pump	/	2	2	2,60
Filters	4	/	4	5,19
Command valve	/	9	9	11,69
Pressure gauge	5	/	5	6,49
Hoses	/	8	8	10,39
Sprayer boom	/	15	15	19,48
Nozzles	1	3	4	5,19
Fan	/	5	5	6,49
Total	13	64	77	100
%	16,88	83,12	100	

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 sprayer boom or the part on which nozzles are placed. The sprayer boom was often altered from field crops to vine and fruit crops or reinforced due to kinking, cracking etc.

Analysing the current state of pesticide application equipment it can be concluded that the most common malfunction in machines is determined in the pressure gauge 20 machines (23,81%), and three machines did not have any pressure gauge at all (Table 5). It should be noted that this tool directly shows the operating pressure in the system and is one of the main control tools for proper and quality application of pesticides. Regarding the modifications of these machines they are usually observed in the hoses 40 (47,62%) of the total number of machines. The great pressure and the quality of hoses affect directly the length of their use and the need for replacement.

Table 5. Operating flaws of PAE 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 oil	%	No parts	%
Chassis	77	91,67	/	0	7	8,33	/	0
PAE hitching device	78	92,86	/	0	5	5,95	1	1,19
Power take off	78	92,86	1	1,19	4	4,76	1	1,19
Wheels/Tires	13	68,42	3	15,79	2	10,53	/	0
Tank	80	95,24	/	0	4	4,76	/	0
Agitator	80	95,24	4	4,76	/	0	/	0
Pump	70	83,33	2	2,28	12	14,29	/	0
Filters	78	92,86	5	5,95	/	0	1	
Command valve	67	79,76	7	8,33	10	11,90	/	0
Pressure gauge	61	72,62	20	23,81	/	0	3	3,57
Hoses	42	50,00	2	2,28	40	47,62	/	0
Sprayer boom	61	72,62	5	5,95	16	19,05	2	2,28
Nozzles	69	82,14	3	3,57	11	13,10	1	1,19
Fan	27	84,38	5	15,63	/	0	/	0

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).

CONCLUSIONS

Unfortunately, according to the first results, it can be concluded 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 defects and modifications are present in the sprayer boom of the machine in the part on which nozzles are set. The sprayer

boom is usually altered from field crops to vine and fruit crops or it is reinforced due to kinking, cracking etc.

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 manometer. Regarding the modifications of these machines they are mostly observed in the hoses and the sprayer boom of the machinery. 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. The presented data will be very important when Macedonia is to adapt European laws and measures in agriculture, which will have to implement Ministry of Agriculture Forestry and Water Economy.

REFERENCES

1. Banaj, Đ., Tadić, V., Jurković, D., Seletković, N. (2010): Površinska raspodjela tekućine s ratarskim mlaznicama, 45. hrvatski i 5. međunarodni simpozij agronoma, Opatija 2010., 1214 - 1218.
2. Braekman, P., Huyghebaert, B., Sonck, B., 2004: The Belgian way of organising a compulsory inspection of sprayers. I European Workshop, Standardized Procedure for Inspection of Sprayers in Europe/ SPISE, Braunschweig- Germany 5 pp.
3. Directive 2009/128/EC – Framework Directive on the Sustainable Use of Pesticides
4. Declercq, J., Nuyttens, D., Huyghebaert, B., 2012: An overview of the defects on orchard sprayers in Flanders. (Belgium). Communication presented during the Spise IV in Lana 2012.
5. Dimitrovski Z., Dimitrov S., Cvetkov S., Jakimovska S. 2016, An overview of the pesticide application equipment in Ovcepole region in Republic of Macedonia, 6th European workshop on standardised procedure for the inspection of sprayers in Europe September 13-15, 2016 Barcelona
6. EN 13790 (2003) Agricultural machinery – Sprayers – Inspection of sprayers in use
7. Gil, E., 2006: The Spanish perspective on pesticide application issues on international standards and regulatory demands. Aspects of Applied Biology 77, 2006, International advances in pesticide application 2006, 51-62.
8. Gil, E., Gracia, F., 2004: Compulsory inspection of sprayers in use: Improving efficiency by training and formative aspects. In First European Workshop on Standardised Procedure for the Inspection of Sprayers in Europe – SPISE, ed. H. Ganzelmeier and H. J. Wehmann, 114-119.
9. Harasta P. 2012., New regulation concerning inspection intervals and exceptions of pesticide application equipment Fourth European Workshop on Standardised Procedure for the Inspection of Sprayers – SPISE 4 –, Lana
10. Leskosek, G., Bernik, R., Lakota, M., Simoncic, A., (2004) An overview of the situation in the field of devices used for the application of plant protection products in Slovenia, - SPISE 1- pp 157

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