Self-inspection of sprayers and seed treatment machines in Poland – proposal of instruction manual

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Summary

The long period of 5 years between the purchase of plant protection equipment and the first mandatory inspection, and then 3 or 5 years between the follow-up inspections, as practiced in Poland, may result in considerable deterioration of technical condition of the machines, and in consequence in the increased risk for the operators and the environment. This risk may be mitigated by regular self-inspections of such equipment performed by the users themselves. In order to promote such good practice and help the operators to carry out their own inspections of sprayers and seed treatment machines two dedicated manuals were developed and approved by relevant authorities. In these manuals the procedures of self-inspection are outlined in form of check-list of control points followed by relevant illustrations and comments on evaluation criteria. Only basic tools and a calibration kit are needed to carry out the self-inspection. The manuals also include a lot of additional information making them valuable training materials.

Introduction

In Poland the mandatory inspection of plant protection equipment covers field and fruit crop sprayers, railway sprayers, aerial spraying systems and other sprayers with tanks of volume greater than 30 l, as well as greenhouse equipment, seed treatment machines and granule applicators (Dz.U. 2016 r. pos. 760). Handheld and knapsack sprayers have been exempted from the inspection by way of derogation from art. 8 of the Directive on Sustainable Use of Pesticides (EU 128/2009/EC, hereinafter: SUD). This was possible after reporting the results of research on risk assessment for human health and the environment, and the assessment of the scale of the use of this equipment (Godyń et al., 2010; Bańkowski et al., 2013). According to the SUD the exemption of small equipment from mandatory inspection has to be followed by providing the users with information materials on the use, maintaince and specific risk linked to the equipment. Such materials must be available to operators who are trained for the proper use of the equipment. Thus, the manual including the required information plus instruction of self-inspection of handheld and knapsack sprayers has been developed and made available to the operators. The concept and the contents of this manual was presented and discussed at the 6th SPISE Workshop (Godyń et al., 2016).

According to the regulations regarding mandatory inspection of plant protection equipment in Poland (Dz.U. 2016 r. pos. 760) the first inspection of brand new machines is required not later than 5 years after the purchase. The follow-up inspections of field and fruit crop sprayers have to be made in time intervals not longer than 3 years, while the seed treatment machines have to be inspected not later than every 5 years. The 5 year period for the initial inspection represents 70% of the normal depreciation of the plant protection equipment or 50% of the normal use period assumed for such equipment in the economic analysis of the farm management. During such long periods between the inspections the intensively operated machines may get significantly used and if they are not properly diagnosed and maintained there is a high risk of considerably reduced technical efficiency, reliability and capacity of the machines. This in turn poses high risk for the operators and the environment due to possible contamination by plant protection products.

The most common faults identified during the inspections concern worn, clogged or damaged nozzles, defective manometers, worn or damaged liquid hoses and leaking connections in the spray liquid circuit. All these items may easily be checked and repaired by the sprayer operator himself in the course of self-inspection of the equipment that can be performed with simple methods and basic tools available on the farm. In order to provide the users of field and fruit crop sprayers, and seed treatment

machines with an instruction for such self-inspection two dedicated manuals were developed in INHORT-Skierniewice. They follow the concept of the earlier manual on self-inspection of handheld and knapsack sprayers, and have been approved by the Polish Ministry of Agriculture and Rural Development as an official instructional and promotional material.

Approach and scope of self-inspection

The main objective of the self-inspections is to maintain the technical condition of plant protection equipment and by that ensure that it does not pose risk for the humans and the environment. An operator performing the inspection himself has an opportunity to better learn about the machine he operates and about the demands imposed on it. He gains skills that may be used in case of emergency and need for repair of the equipment. Thess skills also allow appropriate preparation of machines for the successful mandatory inspection.

The self-inspection is recommended to be carried out at least once a year, preferably before the first sprayer use at the start of plant protection season. It should be considered a good practice being an introduction to calibration of the equipment. Therefore the procedure of the self-inspection only requires use of basic tools and the standard calibration kit. No professional diagnostic equipment is needed because most of the inspected items are evaluated visually or checked for functionality. The sparse measurements are simplified and they only apply to the size of manometer, the flowrate of nozzles, boom height in three points to check its straightness, or driving time and distance to determine the driving speed of sprayer. In case a calculation is needed to evaluate stability and repetitiveness of pressure, driving speed, or deviation of nozzle flowrate the formula is given in a straightforward form.

As far as the scope is considered the self-inspection follows closely the procedure of the mandatory inspection as determined by two decrees of Minister of Agriculture and Rural Development: (i) on requirements regarding technical condition of plant protection equipment (Dz.U. 2016 r. pos. 760); (ii) on validation of technical condition of plant protection equipment (Dz.U. 2016 r. pos. 924). Both decrees were elaborated in the year 2013, so in the part regarding sprayers they were based on the standards EN 13790:2003 (Part 1 and 2), currently amended by the standards EN-ISO 16122:2015 (Part 1, 2 and 3). Thus, the proposed self-inspection covers the condition and performance of all components of sprayers and seed treatment machines that are contained in legal regulations related with the inspection of plant protection equipment.

The self-inspection is carried out based on the check-list of questions (table 1 and 2). Each question is followed by relevant illustration, brief explanation of the meaning of the inspected item, technical requirements, possible malfunctions and instruction how to check and ensure that it meets the required criteria. The whole material is elaborated in form of manuals of best practices (Godyń et al., 2017a; Godyń et al. 2017b). In order to broaden the knowledge and skills of the intended recipients, being mainly the users of sprayers and seed treatment machines, the manuals include also discussion of legal regulations and standards that are relevant with regard to the inspection of plant protection equipment, information on construction, operation and common faults of this equipment, instruction on its calibration, as well as risk to humans and environment, and personal protection equipment to be used during inspection, calibration and repair of the machines.

Field and fruit crop sprayers

The manual of self-inspection of sprayers (Godyń et al., 2017a) includes the check-list of control points as presented in table 1. It applies to all types of field and fruit crop sprayers that are subject to mandatory inspections.

The manual of A5 format has 88 pages with 139 illustrations (Fig. 1). It is available as PDF file at:

http://www.inhort.pl/files/sor/technika-ochrony-roslin/badanie-sprawnosci-technicznej/Broszura-DOBRA_PRAKTYKA-Samodzielna_kontrola_opryskiwaczy_polowych_i_sadowniczych.pdf

Table 1. Check-list of questions for self-inspection of field and fruit crop sprayers

FIELD CROP SPRAYERS	FRUIT CROP SPRAYERS
GENERAL OVERVIEW	
Is the housing of PTO (power-take-off shaft) complete and properly fitted?	
Is the sprayer properly and safely aggregated with the tractor?	
Are components of the sprayer in good shape?	
Are tank(s) and liquid circuit tight?	
Is the sprayer clean?	
TECHNICAL CONDITION OF SPRAYER COMPONENTS	
Pump	
Is the pump tight (no liquid and oil leakage)	
Is the oil level in accordance with manufacturer's recommendation?	
Is the pressure pulsation dumping system working properly?	
Is the hydraulic agitation system working properly?	
Main tank	
Is the cover of filling hole in good shape and properly fitted?	
Is the air valve for in-tank pressure compensation working properly?	
Is the strainer the filling hole in good shape?	
Is the liquid level indication visible and readable?	
Is the drain valve working properly, ensuring complete empting of the tank?	
Are rinsing devices in good shape and working properly?	
Are mixing and filling devices in good shape and working properly?	
Are container flushing devices in good shape and working properly?	
Measuring and control devices	
Is the manometer of appropriate size (diameter)?	
Is the reading range of manometer adapted to the nozzles used and the graduation in accordance with requirement ?	
Is the pressure indication on manometer stable?	
Is the manometer of reacting for pressure change?	
Is the pressure indication repetitive after turning off and on the main liquid valve?	
Are the pressure compensation valves working properly?	
Is the measurement of driving speed correct?	
Liquid circuit	
Are the components of the liquid circuit in good shape, tight and tightly connected?	
Are the components of sprayer protected from being sprayed on?	

Table 1. (continuation)

FIELD CROP SPRAYERS	FRUIT CROP SPRAYERS
Filtration Is the filtration system complete? Are the filters in good shape?	
Field boom 2.6.1. Is the boom stable and in good shape? 2.6.2. Are the boom folding elements working properly? 2.6.3. Is the transport position of the boom properly secured from unfolding? 2.6.4. Is the precise boom height adjustment possible and working properly? 2.6.5. Is the boom straight? 2.6.6. Are the nozzles installed properly? 2.6.7. Are the boom breakaway hinges working properly? 2.6.8. Are the boom stabilization and damping systems working properly? 2.6.9. Are the anti-drip valves working properly?	**Spray sections** 2.7.1. Are the nozzles installed solidly on both sections? 2.7.2. Are the anti-drip valves working properly?
2.8. Nozzles on field boom 2.8.1. Are the nozzles clean, in good shape and all of the same type, size and material? 2.8.2. Are all the nozzle filters of the same type and size? 2.8.3.1. Is the spray curtain smooth and even? 2.8.3.2. Is the nozzle flowrate correct?	**2.9. Nozzles on spray sections** 2.9.1. Are the nozzles clean, in good shape and installed symmetrically on both sections regarding type, size and material? 2.9.1. Is the nozzle flowrate correct?
2.10. Fan on field boom 2.10.1. Are the fan and the air-sleeve in good shape and working properly (adjustments)?	**2.11. Fan on fruit crop sprayer** 2.11.1. Is the fan in good shape and working properly (transmission, adjustments)?

Seed treatment machines

The manual of self-inspection of seed treatment machines (Godyń et al., 2017b) includes the check-list of control points as presented in table 2. It applies to the devices being subject to mandatory inspections, i.e. that are used at farms for the farmers' own purposes and for local services. The industrial systems for seed dressing are excluded from the plant protection equipment inspection scheme. They should be inspected by a qualified service rather than by the users themselves.

The manual of A5 format has 48 pages with 103 illustrations (Fig. 2). It is available as PDF file at:

http://www.inhort.pl/files/sor/technika-ochrony-roslin/badanie-sprawnosci-technicznej/Broszura-DOBRA_PRAKTYKA-Samodzielna_kontrola_zaprawiarek_do_nasion.pdf

Table 2. Check-list of questions for self-inspection of seed treatment machines

GENERAL OVERVIEW
Are the housings of moving and rotating elements complete and properly fitted?
Is the tank for seed dressing clean and securely fitted?
Are the structural and electric elements complete, undamaged and properly fitted? Is the machine clean?
Are tank(s) and liquid circuit tight?
Is the sprayer clean?
TECHNICAL CONDITION OF MACHINE COMPONENTS
Tank for seed dressing or product solution
2.1.1. Is the cover of the tank and drain valve undamaged and properly fitted?
Measuring and control devices
Are the valves and control devices undamaged and working properly?
Are the systems of automatic cutting-off seed or dressing flow undamaged and working properly?
Are the control devices (eg. manometer) undamaged and working properly?
Liquid circuit
Are the components of liquid circuit tight, undamaged and properly fitted?
Are the external parts of the machine protected from being contaminated by seed dressing?
Filtration
Are all required filters in place, undamaged and working properly?
Are the dust extraction units undamaged and working properly?
Wetting/Mixing chamber
Are the wetting/mixing chambers working properly?
Is the dosing device for seed dressing or product solution undamaged and working properly?
Is the chamber discharge unit working properly?
Agitation
Is the agitator undamaged and working properly?

Conclusions

The good practice manuals on self-inspection of sprayers and seed treatment machines are to help the users to maintain their plant protection equipment in good technical condition during long periods between mandatory inspections and in consequence to reduce risk linked with the use of this equipment for human health and environment. They complement the instruction manuals on

professional inspection of plant protection equipment and with their contents and illustrations may well be used as training materials for advisors, machinery dealers and students.

The presented manuals follow the earlier developed manual on self-inspection of handheld and knapsack sprayers. There are also in preparation manuals on self-inspection of railway sprayers, aerial spraying systems, greenhouse equipment, and granule applicators.

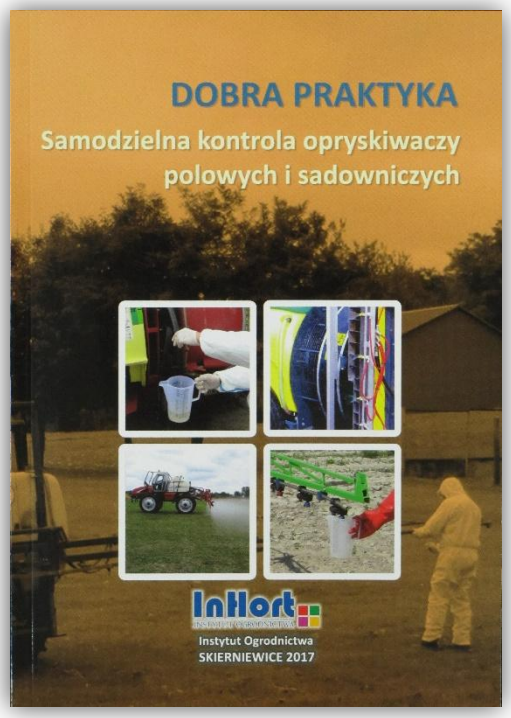

Figure 1. GOOD PRACTICE Manual

Self-inspection of field and fruit crop sprayers

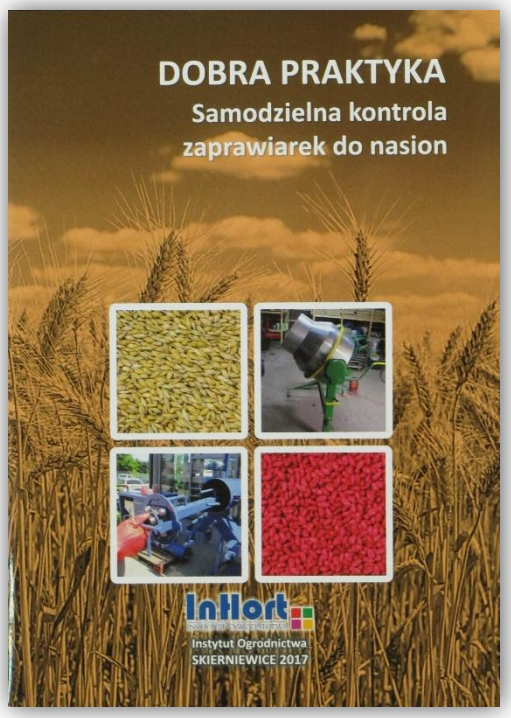

Figure 2. GOOD PRACTICE Manual

Serlf-inspection of seed treatment machines

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References

Bańkowski, R. , Wiadrowska, B., Beresińska, M., Ludwicki J. K., Noworyta-Głowacka, J., Godyń, A., Doruchowski, G., Hołownicki, R., 2013. Computer modelling as a tool for the exposure assessment of operators using faulty agricultural pesticide spraying equipmentRoczniki Państwowego Zakładu Higieny; 64(4): 271-6

Godyń,. A., Doruchowski,m G., Hołownicki, R. 2010. Potencjalne uszkodzenia opryskiwaczy ręcznych i plecakowych oraz ich wpływ na ekspozycję operatora opryskiwacza. Expertise for Polish Ministry of Agriculture and Rural Development, Research Institute of Pomology and Floriculture, Skierniewice 2010, 101 pp. https://www.gov.pl/documents/912055/913531/ekspertyza1.pdf/33e6b12b-abd8-f247-63d6-8aa5dda260a2

Godyń A., Doruchowski G., Hołownicki R., Świechowski W. 2016. Self-inspection of spraying equipment not covered by official inspection system in Poland. 6th European Workshop on Standardized Procedure for the Inspection of Sprayers in Europe – SPISE 6, Barcelona, Spain, September 13 - 15, 2016. Paolo Balsari, Emilio Gil, Hans-Joachim Wehmann [ed.]. ISBN: 978-84-491-1476-2, Deposito Legal: M-21532-2017, p: 161-168.

Godyń A., Hołownicki R., Doruchowski G., Świechowski W. 2017a. DOBRA PRAKTYKA - Samodzielna kontrola opryskiwaczy polowych i sadowniczych. Instytut Ogrodnictwa, Skierniewice 2017, ISBN 978-83-65903-07-5: 88 pp.

Godyń A., Hołownicki R., Doruchowski G., Świechowski W. 2017b. DOBRA PRAKTYKA - Samodzielna kontrola zaprawiarek do nasion. Instytut Ogrodnictwa, Skierniewice 2017, ISBN 978-83-65903-06-8: 48 pp.

Dz.U. 2016 r. pos. 760. Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 18 grudnia 2013 r. w sprawie wymagań dotyczących sprawności technicznej sprzętu przeznaczonego do stosowania środków ochrony roślin

Dz.U. 2016 r. pos. 924. Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 13 grudnia 2013 r. w sprawie potwierdzania sprawności technicznej sprzętu przeznaczonego do stosowania środków ochrony roślin.

EN 13790-1: 2003. Agricultural machinery – Sprayers – Inspection of sprayers in use – Part 1: Field crop sprayers.

EN 13790-2: 2003. Agricultural machinery – Sprayers – Inspection of sprayers in use – Part 2: Air-assisted sprayers for bush and tree crops.

ISO 16122-1: 2015 Agricultural and forestry machinery -- Inspection of sprayers in use -- Part 1: General

ISO 16122-2: 2015 Agricultural and forestry machinery -- Inspection of sprayers in use -- Part 2: Horizontal boom sprayers

ISO 16122-3: 2015 Agricultural and forestry machinery -- Inspection of sprayers in use -- Part 3: Sprayers for bush and tree crops