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QUALITY EVALUATION OF WORKING WITH DRIFT GUARD NOZZLES AND AIR INDUCTION NOZZLES IN MAIZE SPRAYING

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Abstract: The subject of the performed experiments comprised standard XR 110 02, XR 110 04 nozzles, TT 110 02, TT 110 04 nozzles and AI 110 02, AI 110 04 air induction nozzles. The working speed of spraying was v_p = 7 km/h. Each nozzle was tested at the following three levels of working pressures: p_1 = 0.2 MPa, p_2 = 0.4 MPa ad p_3 = 0.6 MPa. The spray liquid was pure water at the temperature of 20°C. The plant coverage was determined: s_k – spray coverage, n_k – number of droplets per 1 cm^2. The analysis of results of maize spraying showed that both standard nozzles and both TT nozzles achieved better results with number of droplets and degree of surface coverage for each of applied operating pressure. The lowest results from all examined kind of nozzles for number of droplets achieved injector nozzles (AI). For operating pressure 0.4 MPa nozzles fulfilled agrotechnical requirements for using insecticids, herbicides and fungicides.

Key words: low drift nozzles, spray coverage

INTRODUCTION

There is a lot of kinds and species of nozzles designed for many kinds of chemical procedures but farmers still uses standard (XR) nozzles which produces relatively small droplets. Such nozzles are used when the weather is not windy.

Otherwise nozzles producing big droplets resistant to drift are adviced to use. They decrease pesticide losses thus lower the costs of spraying and reduce the ecological threat for people, animals, water, soil and air (Hołownicki 2001). Using standard nozzles causes the risk of damage of neighbouring fields. According to EPA (Environmental Protection Agency) off-target spray can affect human health and the environment. Spray drift can result in pesticide exposures to farmworkers, children playing outside, and wildlife and its habitat. Drift can also contaminate a home gardens or another farmer's crops, causing illegal pesticide residues and/or plant damage (EPA

1999). Choosing the nozzles designed for working in difficult meteorological conditions can prevent such risk of damage. Low drift nozzles and, in particular, air-induction nozzles produce much larger droplets than standard nozzles (Gajtkowski 1999). Large droplets have higher weight and, therefore, do not easily undergo drifting to neighbouring fields but they cover plants much worse.

The appropriate selection of many parameters must be done in order to achive proper effectivenes of treatment. Improperly selected doses of pesticide or nozzles can lead to necessity of repetition of treatment. The quality of the applied treatment depends on the appropriate adjustment of nozzles and selection of the applied pesticide, according to the specificity of the crop plant to be protected. Meteorological conditions during the agrophage control (Bojarski and Wachowiak 1988), the working speed of the sprayer (Trunecka 1995), the value of the working pressure, height of nozzle setting over the sprayed surface, operating speed and physical properties of the spray liquid (Gajtkowski 1985) also affect the process.

The objective of this research project was to evaluate and compare the spraying quality of systems working with standard nozzles, drift guard nozzles and air induction nozzels in maize spraying.

The TT and AI nozzles produce large droplets which are resisted on drift. Such big droplets are generated in the nozzle due to its special technical construction. Those large droplets are produced in called expansion chamber, where the pressure of the water is being reduced. Therefore, the Air Induction nozzles include Venturi vacuum system, which enables the air to be sucked into stream of water. Water and air are being mixed in the special chamber. Produced droplets are significantly larger due to big outlet hole of nozzles and because of decrease of pressure value between expansion chamber and outlet hole (Gobel 2002). Droplets filled with air bubble break into many small droplets after falling on the leaf surface.

MATERIALS

The tests were carried out on a field of maize of a Matilda variety. The treated maize was at the 3–5 leaf stage. The average height of plant was about 50 cm and there were 12 plant per meter in the plant row.

The sprayings were carried out using the RAU P-400 sprayer coupled with the C 360 tractor. The XR110 02, XR 110 04, TT 110 02, TT 110 04 and AI 110 02 i AI 110 04 nozzles type produced by the Spraying Systems Co. were used.

The experiments were carried out in the second decade of June 2004 on a farm near Wrocław. The weather during researches was sunny with the air temperature 20°C, relative air humidity of 65% and wind velocity fluctuating from 0–2 m/s.

METHODS

The measurements were done using a water-sensitive paper placed on the maize leafs with ordinary paper clips in the way to keep the natural shape of a plant. Six patches were randomly selected in the maize field and the water sensitive papers were placed in it. Water-sensitive papers were placed at the following two different levels:

1 – on the soil,

2 – about 25–45 cm above soil (central part and the top part of the plant).

Each nozzle was tested at three levels of working pressure: $p_1 = 0.2$ MPa, $p_2 = 0.4$ MPa, $p_3 = 0.6$ MPa and the spray liquid was water at the temperature of 20°C. The operating speed of the sprayer during the experiments was $v_p = 7$ km/h.

The following index values of plant spraying quality were determined: s_k – spray coverage (%), and n_k – number of droplets per 1 cm^2 of the leaf. Water-sensitive papers were scanned at 800 x 600 resolution and the obtained imges were fed into a computer equipped with software capable to perform image analysis – MultiScanBase.

It allowed to compare the obtained results to some agrotechnical requirements concerning quality of plant spraying that should be fulfilled. According to Gajtkowski (2000) the value of the extent of surface coverage should exceeds 15% and the number of droplets depends on the performed treatment and can range from 20–30 droplets/cm^2 in the case of insecticides, 20–40 droplets/cm^2 – for herbicides and 50–70 droplets/cm^2 – for fungicides (Syngenta).

RESULTS

The number of droplets depending on the on operational pressure and on the kind of nozzle for 110 02 species is presented in Figure 1. The agrotechnical requirements are fullfilled for p = 0.2 MPa pressure and standard nozzles (XR). Recorded results equal to about 100 pcs/cm^2 for both levels. Other results are $n_k = 150$ pcs/cm^2 for p = 0.4 MPa and $n_k = 230$ pcs/cm^2 for p = 0.6 MPa for soil level and 150 pcs/cm^2 for second

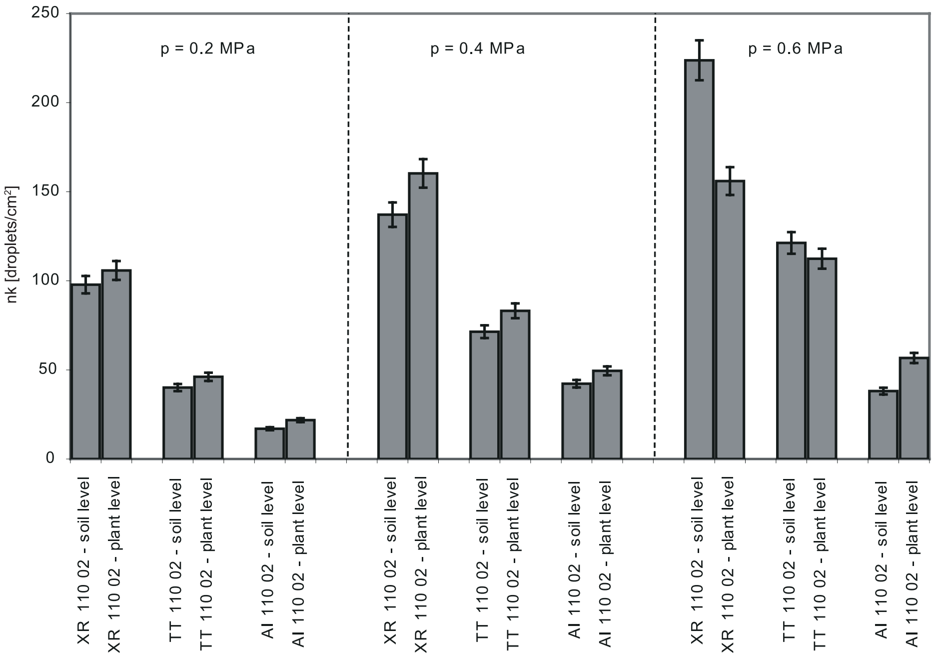

Fig. 1. Dependence of number of droplets on operational pressure and on the kind of nozzle for 110 02 species

level. The TT nozzles fulfilled the agrotechnical recuirements for insects and weed controlling during p = 0.2 MPa. The n_k inicator equals about 40 pcs/cm^2. The number of droplets equals n_k = 75 pcs/cm^2 for operating pressure p = 0.4 MPa on soil level and 80 pcs/cm^2 for second level which fullfilled the agrotechnical requirements in case of fungicides. For operating pressure p = 0.6 MPa number of droplets for both levels equals above 100 pcs/cm^2. In case of injector nozzles (AI) n_k indicator equals about 20 pcs/cm^2 for operating pressure p = 0.2 MPa which fulfills reqirements about insect controll. For bigger operating pressure p = 0.4 MPa the n_k inicator equals 42 pcs/cm^2 on the soil level and 50 pcs/cm^2 on the second level. Weed controll requrements are fulfilled. Requirements in case of using fungicides are fulfilled durin the highest operating pressure when n_k indicator equals 56 pcs/cm^2 on the second level.

The number of droplets depending on the on operational pressure and on the kind of nozzle for 11004 species is presented in Figure 2. All agrotechnical requirements were realized for 11002 species standard nozzles (XR) for the lowest operating pressure (n_k = 90 pcs/cm^2). The TT nozzles met reqirements for insects and weed controlling for operating pressure p = 0.2 MPa whereas requirements in case of using herbicides were met for p = 0.4 MPa. The injector nozzles (AI) for the lowest operating pressure fulfilled requirements about insects contolling whereas the pressure was getting higher to p = 0.4 MPa all of requirements were fulfilled. There was bigger number of droplets on the soil level than on the second level for operating pressures 0.4 MPa and 0.6 MPa.

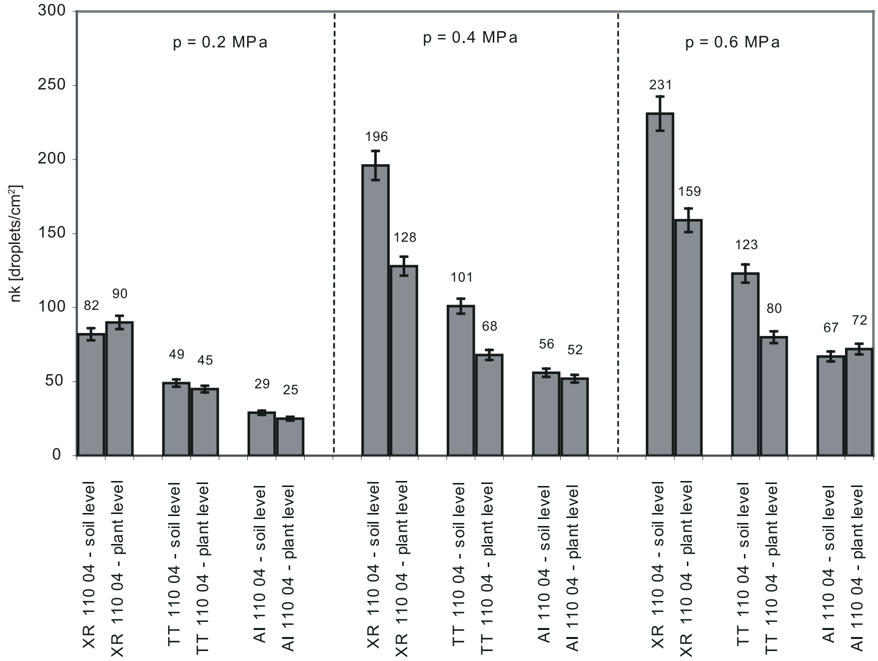

Fig. 2. Dependence of number of droplets on operational pressure and on the kind of nozzle for 11004 species

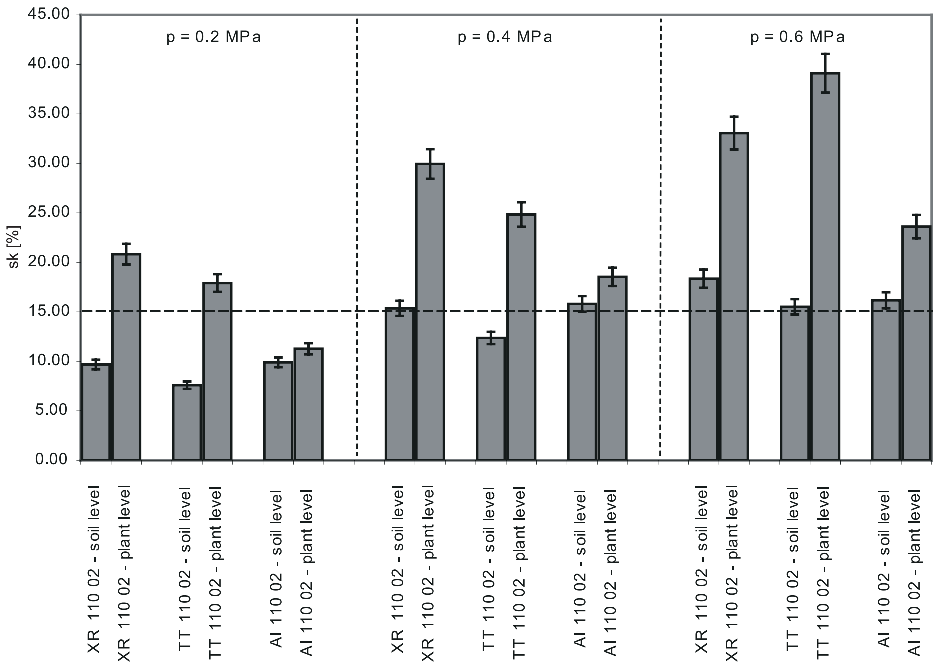

Fig. 3. Dependence of the spray coverage (s_k) on operational pressure (p) for 110 02 nozzles

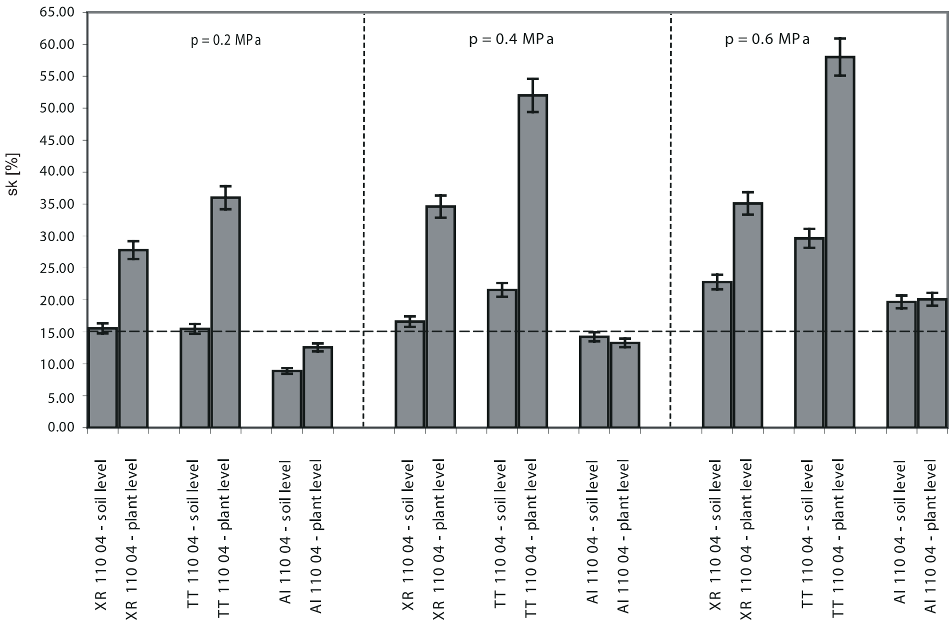

Fig. 4. Dependence of the spray coverage (s_k) on operational pressure (p) for 110 04 nozzles

The change in spray coverage (s_k) depending on the pressure (p) for 110 02 and 110 04 nozzles are presented in the Figure 3 and Figure 4 respectively. The agricultural requirement for 15% extent of surface coverage by droplets fulfilled for each kind of pressure and all kind of nozzles.

In case of 110 04 requirement was fulfilled for XR an TT nozzles for the lowest pressure and for the AI nozzles for the highest pressure p = 0.6 MPa.

CONCLUSIONS

The analysis of results of maize spraying shows that both standard nozzles (XR) (110 02 and 110 04 species) achieved higher values of n_k index. Values were equalized for both levels. Values on the soil level were higher then on the plant level for the 110 02 nozzles for operating pressure 0.6 MPa and for 110 04 nozzles for 0.4 MPa and 0.6 MPa. It is important when weed control is implemented.

The TT nozzles achieved better results with number of droplets and degree of surface coverage for each of applied operating pressure. Similar values were recorded for both levels (soil and plant) and for 110 02 nozzle. It is important when fungal disease, insects and other diseases are controlled. Fifteen per cent degree of surface coverage was fulfilled for each kind of nozzles for each value of operating pressure.

The lowest results from all examined kind of nozzles for number of droplets achieved injector nozzles (AI). For operating pressure 0.4 MPa nozzles fulfilled agrotechnical requirements for using insecticids, herbicides and fungicides. The values achieved on the soil level and the plant levels did not differ significantly. The requirement about 15% degree of surface coverage was fulfilled for operating pressure 0.4 MPa with 110 02 nozzles an fo 0.6 MPa with 110 04 nozzles.

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POLISH SUMMARY

OCENA JAKOŚCI OPRYSKIWANIA KUKURYDZY ROZPYLACZAMI ANTYZNOSZENIOWYMI I EŻEKTOROWYMI

Opryskiwano kukurydzę odmiany Matilda. Do opryskiwania stosowano rozpylacze standardowe XR 11002, XR 11004, antyznoszeniowe TT 11002, TT 11004 oraz eżektorowe AI 11002, AI 11004. W czasie opryskiwania prędkość robocza wynosiła V_p = 7 km/h. Każdy z rozpylaczy badano przy ciśnieniach: p_1 = 0,2 MPa, p_2 = 0,4 MPa, p_3 = 0,6 MPa. Analizowano wartości wskaźników jakości opryskiwania roślin: stopień pokrycia powierzchni s_k(%) oraz liczbę kropli na centymetrze kwadratowym liścia n_k. Do określenia wymienionych wskaźników zastosowano papierki wodoczułe, które zostały umieszczone na plantacji w sześciu gniazdach na trzech poziomach (0 – gleba, 1 – środkowa część roślin, 2 – wierzchołki roślin) po sześć sztuk w sposób losowy.

Analizując dane otrzymane na podstawie badań rozpylaczy można stwierdzić, że podczas każdego ze stosowanych ciśnień, lepsze wyniki zarówno pod względem ilości kropel na cm^2 jak i stopnia pokrycia powierzchni liścia kroplami uzyskiwały rozpylacze XR zarówno odmiana 11002, jak i 11004 oraz rozpylacze TT 11002 i 11004. Wartości uzyskane podczas badań rozpylaczy eżektorowych dopiero przy ciśnieniu 0,4 MPa spełniały wszystkie wymagania agrotechniczne w odniesieniu do liczby kropel na cm^2 liścia czyli zwalczania szkodników, chwastów i chorób grzybowych.

Założenie dotyczące 15% pokrycia roślin kroplami w przypadku odmiany 11002 spełnione zostało przy ciśnieniu 0,4 MPa, a w przypadku odmiany 11004 dopiero przy p = 0,6 MPa.

Rozpylacze standardowe XR i antyznoszeniowe TT spełniają wymagania agrotechniczne już przy najniższym ciśnieniu, dlatego bezcelowe jest jego zwiększanie.