Effect of nozzle type on pesticide residues on fruits

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Introduction

Pesticide residues per fruit weight unit are dependent on three processes, i.e. variation in initial spray deposit, physical decay due to weather factors and growth dilution. Variability in residues between individual samples is inevitable, partly because it is impossible to achieve an uniform spray deposition of pesticides. Application technique, crop architecture and growth stage have all been shown to affect variability in initial deposit. One of the most important factors influencing pesticide residues is the canopy structure. Many studies showed the importance of canopy structure in affecting initial deposit concentrations (e.g. Xu *et al*., 2006; Rawn *et al*., 2007); usually fruits in the top and outside regions are likely to receive more deposits than those inside the canopy. Also, in many practical situations the initial deposit is influenced by spray technology (i.e. sprayer type, sprayer settings and nozzle type). Large variability in the level of residues exists between individual sample units or composite samples. There are internationally agreed standards for monitoring pesticide residues and for assessing risks of consumer exposure. In general pesticide levels in EU fruit are below the maximum residue level (MRL) (EU Commision 2009).
In the ISAFRUIT project a sprayer is developed that minimizes spray drift by nozzle size (droplet size) selection and air support settings, and by the use of ultrasonic sensors that recognize the shape of the trees, thereby adapting spray volume to tree canopy volume, and ultimately a sensor that can recognize a disease. Altogether should minimize the use plant protection product (PPP) and therefore of residues. However, will it affect the residues in the apples as well? In practice coarse droplet applications might results in more visible residue spots on apples and pears. However, it is unknown if this also effects the residue levels of PPP's as well.

Experiments

In this paper we present and discuss the results of experiments on pesticides residues on apples, sprayed with different nozzle types. In a field trial in 2007 the effect of droplet size (nozzle type) was evaluated in a commercial orchard. The spray applications for the reference situation were performed with Albuz ATR brown hollow cone nozzles (7 bar spray pressure) and for the low-drift situation with venturi hollow cone nozzles (Albuz TVI 80-015 at 6 bar spray pressure). Spray applications were carried out in the same orchard (apple variety Jonagold), with the same spray machine (Munckhof cross flow sprayer with eight opened nozzles at each side) at a spray volume of approximately 200 l ha^{-1} for the Albuz ATR brown nozzles and 400 l ha^{-1} for the air induction nozzles, and a driving speed of 8 km h^{-1}. The orchard was divided in two experimental plots. Each plot was sprayed for the whole season with one (the same) nozzle type, according to a standard commercial spraying scheme with insecticides and fungicides, following label directions.
The canopy effect was evaluated by dividing the apple tree (spindle type) into four distinct zones: top, middle, lower outside and lower inside. Four apples were collected from five trees per nozzle type and tree zone. Selection of the trees and apples per zone was randomized out of a tree row in the middle of the experimental plot. A few days before the start of commercial harvest, single fruit samples were taken from five trees for each zone and nozzle type. The total weight of each individual apple was determined before the residue analysis.
Total residues levels (e.g. captan, bupirimate, pyraclostrobin and boscalid) per fruit and residue concentrations (mg kg^{-1}) at harvest were determined according to standard analyzing procedures and methods (GC-MS-MS and LC-MS-MS) in the laboratory, and expressed for individual fruits and mean values per nozzle type and tree zone.

Results

In general, the mean residue levels (average of 80 fruits) for the coarse and fine droplet applications did not differ significantly. However, large variations in residue levels were observed between the individual apples, either sprayed with coarse or fine droplets. These large variations were also present between fruits within the different zones. Apples from the middle or lower outside position showed the highest residue levels. The results indicated that the residue levels appeared to be independent of fruit size or weight. Figure 1 shows the results for boscalid, component of a fungicide sprayed against post-harvest or storage diseases.

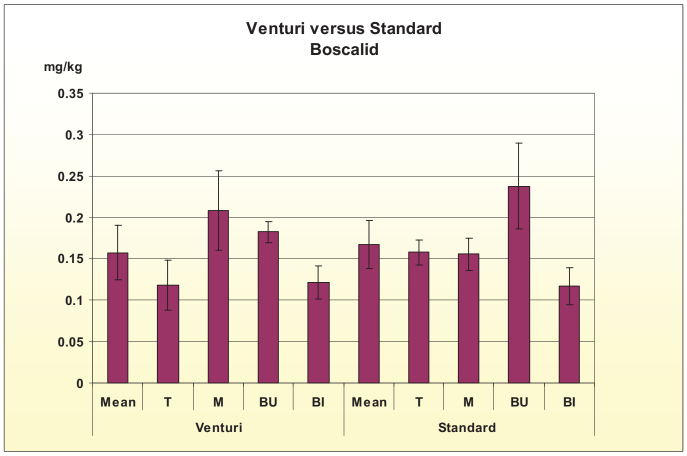

***Figure 1**: residue levels of boscalid for apples from different zones in the tree for two nozzle types. Zones: top (T), middle (M), lower outside (BU) and lower inside (BI). Mean value of 20 fruits per position. Venturi = coarse droplet application (Albuz TVI 80-15, venturi nozzle); Standard = Albuz hollow cone ATR brown nozzle.*

Compared to the standard nozzle type the residu levels for boscalid on apples of the venturi nozzle types were:

- less in the top section,
- higher in the middle section,
- less in the bottom outside section,
- equal in the bottom inside section,
- equal for the mean of the tree sections.

Conclusion

Based on the experiments it can be concluded that:

- No differences exist in average residue levels between fine and coarse droplet applications.
- Large variations exist in residue levels between individual fruits, independent of droplet size.
- Difference in maximal concentration compared to mean concentrations are between order magnitudes of 2-5 times.

References

EU Commission (2009) *2007 Annual Report on Pesticide Residues according to Article 32 of Regulation (EC) No 396/2005. http://www.efsa.europa.eu/EFSA/efsa_locale-1178620753812_1211902667778.htm*

Rawn, D.F.K., Quade, S.C., Shields, J.B., Conca, G.C., Sun, W.F., Lacroix, G.M.A., Smith, M., Fouqout, A., Bélanger, A. *(2007)Variability in captan residues in apples from a Canadian orchard. Food Additives and Contaminants **24** (2): 149 – 155.*

Xu, X., Wu, P., Thorbeck, P., Hyder, K. *(2006) Variability in initial spray deposit in apple trees in space and time. Pest Management Science **62**: 947 – 956.*