The RHEA airblast sprayer: studies on a continuous mixer for the VRA.

First RHEA International Conference on Robotics and associated High-technologies and Equipment for Agriculture
Hosted by the University of Pisa
Pisa, Italy, September 19-20-21, 2012

TOPIC n° 1.3

The RHEA airblast sprayer: studies on a continuous mixer for the VRA

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Keywords: Pesticides mixing, dosage group, reduction risk operator

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Abstract: The agrochemical dispersion may affect the environmental compartments such as: air, water, soil, due to surface runoff phenomena, leaching, volatilization, degradation and adsorption of pesticides in the soil. These processes involve health risks for workers, for all those that living near agricultural areas and, of course, are causes to environmental contamination. The increasing attention of public institution to the promotion of production processes at low environmental impact, it's progressively influencing the implementation of new devices to minimize the environment pesticides losses and the risks for the operators. The objective of this study, concerns the possibility of realization of a device prototype for the instant mixing of pesticides during application phase, with particular reference to the correct dose of distribution, the homogeneity of the mixture, the savings in pesticide quantity and the operator safety involved in the mixing. The use of this technology, combined with the other tools already available for the VRA pesticide application, represents an evolution in the control of the agriculture pesticide problems, in agreement with the new European laws.

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1. Introduction

The application of plant protection products has an important role in agricultural production processes. With current pesticides management, a huge amount of them are applied to worldwide orchards. The pesticides use imply some negative consequence: increase production cost thus limiting a company's profitability, reduction of food quality and creation of potential environmental contamination, also exposure of the operators to the chemical risk. On the other hand, the current economic structure of rural society do not permit losses in yield and in the quality of crops due to pests.

These conditions require to find solutions aimed to realize both an eco-friendly environmental management and the reduction of drift, leaching and the related risks.

Current pesticides application operative procedures involve a discontinuous stages of pesticides mixtures preparation developed at the farm center; one or more qualified workers that provides to refill the sprayer and cleaning of all devices.

The second phase occurs normally many time for each treatment. This type of management and logistics introduces potential risks of contamination of workers and environmental more in case of accidental spillage during transfers.

A different problem is the limited timeliness in the treatment period and so in the phase of mixture preparation depending on the types of orchard, training systems and used products (pesticides and/or foliar fertilizers).

But the problem of modulate mixture preparation it is essential in the variable rate application (VRA) on which it is not possible to know how many mix may be necessary in the field; a precise application depends on the canopy density and characteristic and this it is variable in function of canopy type, season trend, soil features, growth stage and crop management.

The main focus of this investigation was on assessing the feasibility of continuous mixing and direct injection for pesticides and foliar fertilizer application using a system that could avoid mixing and delay time problem as in the realized injection systems.

2. Materials and methods

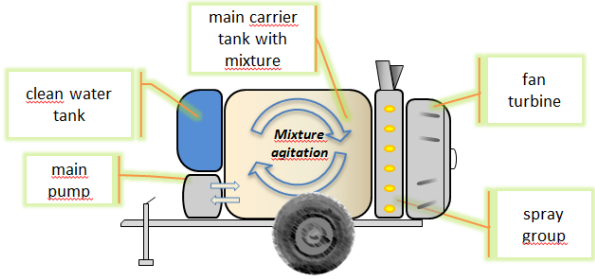
The standard configuration of a sprayer includes a single main carrier tank with mixture storage function and other tanks such as these for clean water for operator safety and for washing. Other mixing auxiliary devices are today available to aid operator to better and in more safe way prepare the mix. Although the advantages achieved with the integration of them on sprayers, their diffusion is hindered by the need of more in the equipment and further costs.

Other technological gap, is the lack of devices able to handling in variable and continuous way the contemporary pre-mixing of liquid and solid pesticides. In fact, the only available system provide the use, only for the liquid products, of piston or peristaltic pumps that inject the product in the water delivery main line mainly at low pressure. For the powdery and granular pesticides there aren't currently available solutions. Today, these technologies allow us only to manage the flow pump/s but do not allow proper formulations mixing. Moreover, in arboriculture and in the specific case of the orchard, are generally used many types of products for the pest control, characterized by different physical characteristics (liquid, powder, granular) usually at high concentration.

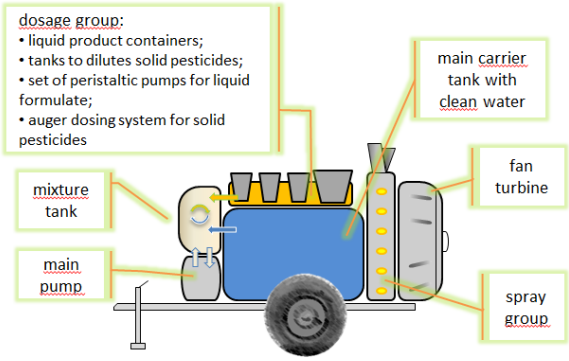
Therefore it could be hypothetical to develop a new "concept" with a different scheme of the sprayer plant with the introduction of a principal tank that it is not the bigger that has the function of the current standard one and more it is refilled in continuous by water and chemicals.

For the development of the pesticide instant mixing device, it was hypothesized a new sprayer architecture, as in figure 1, characterized by additional dosage group with respect to the conventional airblast sprayer.

This dosage device it is composed by auxiliary rechargeable or replaceable tanks for liquid and solid formulations and a correspondent set of peristaltic pumps for liquid formulate and a cochlea od lamellae system for dust or granule.



Current configuration of air blast sprayer



Hypothesis of new architecture of air blast sprayer

Figure 1: new concept air blast sprayer

The interchangeability of the commercial preparation containers, already available in some Countries as USA, is an essential feature to allow widest employ versatility, the variation of the number and capacity installable tanks to differentiate and accommodate the variation requests in different phenological stages and crops. The possibility of removable tanks increase the safety for the workers due to the minimal exposure to chemicals and potential risks in the refilling phases from the packaging inside the sprayer.

All complementary tanks used, should have a trapezoidal shape to avoid air intake when the mixture and the protection product reach the minimum level.

System architecture includes a control unit installed on board the tractor that allows to set the volume that must be distributed, the

type and the number of commercial products necessary for the treatment. The products and the water, by means of peristaltic pumps and the other system for dust, running in phase, are charged inside the mixing main tank that ought have a capacity of few tens litre (40-50 L). Here the commercial preparations are mixed by turbulent mixing due to the main pump like in the conventional sprayer and with a flow rate that it is very much greater. The refilling could be continuous or discontinuous: in this second case during the spraying progressively the mixture level in the tank decreases up to a minimum (e.g. 15 L) monitored by a level sensor: at this moment, the level sensor generates a signal which acts simultaneously the battery of dosing pumps and systems bringing again the level to established level in the mixing main tank (e.g. 40 L).
The use of turbulent mixing device ensures a quickly and efficient mixing, consequently a continuity of the system by solving critical which would result at the time that mixture runs out in the dosage group and began again the preparation process. These would results in an inconsistency of the mixture ratio of commercial products .

3. Consideration

The concept of the pesticides instant mixing device allows the operator to work in high safety conditions, reducing the contact risks from the active substances during the auxiliary phase and, simultaneously, eliminating the possibility of error during the calculation of doses to be used at each refuelling sprayer. Electronic auxiliary systems, might be able to store various phenology application programs, automatically setting the dosages of pesticides used and leaving to the operator only the supply of water in the sprayer, ensuring the maximum efficiency.
The advantages of a continuous mixer with direct chemical injection systems are:

- main carrier tank is loaded with clean water, not mixed with chemicals;
- concentrated liquids and solid chemicals are accurately stored in a safe way and used when and if necessary:

unused concentrated chemical remains safe and secure in a dedicated holding tank.

- operator exposure to chemical concentrates it is reduced;
- there is no pre-mixing of chemicals in the main carrier tank with reduced spillage risk;
- there is no or limited amount of mixed product at the end of the treatment also in the VRA spraying operations;
- The operator can quickly change from one chemical product to another without cleaning and rinsing the main carrier tank.
- chemicals use and concentration could be varied in accordance with prescription maps.

This concept offers an opportunity to reduce potential risks of contamination of workers and environmental and also, introduce a potential efficiency improvement in the use of pesticides.

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