Posters

A new test-bench for the inspection and the adjustment of the sprayers employed in the mediterranea tree cultures

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DOI 10.5073/jka.2012.439.021

Summary
The present study relates about the structural characteristics of a trailed test bench prototype suitably designed for the adjustment of the sprayers used for expanded canopy fruit-growing. This test bench is equipped with a droplets intercepting patternator, that can be folded on the bottom of a road trailer during the transfers, through manually operated hydraulic systems.
Furthermore the test bench is equipped with a computerized measure system realized by a measure bench, a computer and an ad hoc software.
Preliminary tests of useful effectiveness were carried out with the still droplets intercepting patternator, through surveys of some fluid dynamic characteristics, very important for the evaluation of the transversal patterns of distribution produced by air assisted sprayers (air-convection or pneumatic sprayers).
On the ground of the obtained results, the patternator is suitable for the evaluation of the transverse patterns of distribution produced by sprayers at present used for treatments to tree cultures 3.5 m high.

Introduction
As known, the new 2009/128/CE Directive presses the Member States for setting up the National Action Plans, directed towards the sustainable use of chemicals, to reduce risks and impacts of pesticide use on human health and the environment (2009/128/CE).
Particularly in Southern Italy, the establishment of „systems which allow the recurring inspection of equipment in use" meets with a widespread indifference, emphasized by the high price of such a service (Severini & Biocca, 2003).
In fact, the inspections of the pesticide application equipment in professional use employed for the main mediterranean crops (e.g. table grapes and olive trees) require suitable test benches, complex preparations and tiring assemblies, high times for carrying out the routine tests (Pascuzzi & Guarella, 2008).
At different time, the Department of Agricultural and Environmental Science of the University of Bari (Italy) planned and built innovative test-benches, suitable for "tendone" trained vineyards (table grapes), for "controspalliera" (espalier) trained vineyards (wine grapes) and for expanded canopy fruit-growing (olive trees, almond trees, and so on) according to these common guidelines (Guarella & Pascuzzi, 2000, 2002):
a) quickness use (fixed point or decentralized service), through the realization of one base common to all the preparations (type-approved road trailer, equipped with the instrumentation for the inspections according to the direction of the ENAMA protocols) (ENAMA, 2010).
b) to be able to place on the afore mentioned base different droplets intercepting patternators, suitable for each one of the orchard vegetation shape and productive area, with the aim to evaluate and to adjust the transverse patterns of distribution produced by the sprayer.
c) speeding up of the phases connected to set up the test-bench, to carry out the inspections and to make the adjustment by means computerization of the surveys and removal of workers' weariness (Pascuzzi et al., 2010).
The present study relates about the structural characteristics of a trailed test bench prototype suitably designed for the adjustment of the sprayers used for expanded canopy fruit-growing. This test bench is equipped with a droplets intercepting patternator, that can be folded on the bottom of the road trailer during the transfers, through manually operated hydraulic systems.

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The droplets intercepting patternator

The droplets intercepting patternator is constituted by a vertical metallic outline, that simulates the vegetative and productive area of a tree culture with a training form comparable to a continuous vertical wall.

The bearing structure of the patternator is a rectangle of dimension 1450x3670 mm, realized by a 30x30x3 mm stainless steel square tube, on which sexteen intercepting tools are assembled. Each one of these tools is formed by a set of thin sheets steel, which are planned and inclines in such way to maximize the contact surface with the wet air flow produced by the sprayer.

The intercepting tools have a length of 800 mm, less than the bearing structure witdh (1450 mm), in order to reduce the unavoidable interferences between the wet air flow and the patternator. Really at the side of each one of the afore mentioned tools there is a free window-space for the undisturbed crossing of the wet air flow (Fig. 1). The intercepting tools are then assembled alternatively adjoining to the left and right edges of the bearing structure.

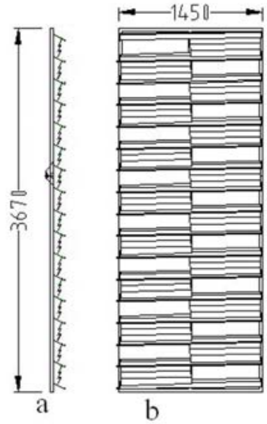

Fig. 14. The droplets intercepting patternator: a.lateral view; b. front view (dimension in mm).

The thin sheets steel of the intercepting tool are assembled so as the intercepted water droplets slide along their surface, flowing into stainless steel manifold and the drain pipe.

These manifolds are designed so that to minimize the drag during the crossing of the wet air flow produced by the sprayer and to drain all the intercepted water, without any overflow of the liquid. The manifolds are sixteen and they are mounted with a distance of 250 mm between each other.

The patternator can be folded for facilitating the transport operations; this characteristic has been obtained dividing the bearing structure into two parts, connected by hinges.

Finally, the patternator allows the adjustment of both pressure driven and pneumatic sprayers, through the analysis of the transverse patterns of distribution produced by the spray tips, or by the diffusers, symmetrically assembled on the right and left sides of the sprayer.

The test bench

The intercepting patternator has been assembled on a road trailer, so that to realize a test bench easily transportable; during the transfers, in fact, the patternator is folded on the bottom of the trailer (Fig. 2a). Instead, the operations of the adjustment of the sprayers are carried out with the patternator placed vertically as shown in the Fig. 2b. In this condition the trailer stability is assured by four manually controlled additional stabilizers, placed at the corners of the trailer (Fig. 2b).

The actions of the patternator take place by means of a manually controlled oleo dynamic servomechanism.

The test bench is equipped with a computerized measure system realized by a measure bench, a computer and an ad hoc software.

The measure bench is made of a stainless steel welded frame with 16 plexiglas containers for the collection of fluids hydraulically connected to an equal number of pressure transducers (Fig. 3). The data processing is carried out by means a software specifically made to manage the test bench.

Fig. 2. The droplets intercepting patternator: a. folded on the bottom of the trailer; b. placed vertically.

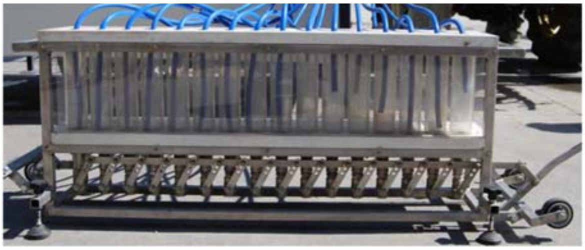

Fig. 3. Front view of the measure bench.

The tests carried out

Preliminary tests of useful effectiveness were carried out with the still droplets intercepting patternator, through surveys of some fluid dynamic characteristics, very important for the evaluation of the transversal patterns of distribution produced by air assisted sprayers (air-convection or pneumatic sprayers).

Particularly, the patternator assembled on the road trailer has been subjected to droplets intercepting tests with an air convection sprayer in order to evaluate the liquid amount intercepted by each one of the intercepting tools and the overall efficiency.

The overall efficiency E_c% has been measured evaluating the amount of the overall intercepted liquid by the patternator Q_r as regards to the liquid amount delivered by the sprayer Q_e (Balsari & Tamagnone, 1997):

The per cent liquid amount C_c intercepted by each one of the intercepting tools has been evaluated by the following ratio: :

$$E_c = \frac{Q_r}{Q_e} \times 100$$

with

Q_c = liquid amount intercepted by each one of the intercepting tools

$$C_c = \frac{Q_c}{Q_r} \times 100$$

The first manifold of the patternator was at 950 mm from the ground of and the highest one at 4950 mm.

The machine employed during the test was a mounted traditional sprayer, Agrimaster Mod. AP355 ALBA, equipped with an axial fan having these main specifications: impeller nominal diameter: 550 mm; distance between the ground and the centre of impeller: 1052 mm.

During the test the sprayer worked at 540 rpm of the tractor power take off and at an operative pression of 2 MPa. Furthermore this machine was equipped with n. 5 spray tips (full cone) simultaneously working, placed on its left side. During the experimental campaign the spray tips inclination has been the same and the fan velocity was constant.
Finally, during the tests the sprayer was stopped and placed so that its rolling axis was 1630 mm from the patternator.
Initially we have collected the liquid delivered by the n.5 spray tips of the machine during a working period of 60 s.
Subsequently the amount of the liquid intercepted by each one of the intercepting tools was measured during a working period of the sprayer of 60 s. This test has been repeated three times (Fig. 4).

Fig. 4. The droplets intercepting patternator under test.

In a second time the velocity of the air flow produced by the fan was measured at points placed at different height from the ground, in front of and behind the patternator. The position of the sprayer as regard to the patternator was just the same of the previous tests.
The evaluation of the three perpendicular vectorial components of the air velocity was made using a Gill Instruments Limited 'Windmaster' ultrasonic anemometer, with the following main technical specifications (Fig. 5): measure range: 0-45 m/s; measure resolution: 0,01 m/s; measure accuracy: 1,5%; direction range: 0-359°; direction resolution: 1°; direction accuracy: 2°.
The measure of the air velocity has been measured in n. 15+15 points vertically placed and spaced 250 mm each other, starting at an height from the ground of 1050 mm: n.15 points were placed in front of the patternator and n.15 points were placed behind the patternator (Fig. 6).

Fig. 5. Evaluation of the air velocity near the patterantor.

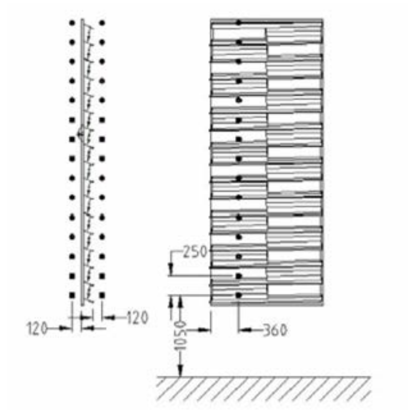

Fig. 6. Measure points of the air velocity (dimension in mm).

Obtained results
Tab. 1 shows the overall intercepting efficiency E_c% of the patternator, evaluated during the tests carried out.

Tab. 2. – Efficiency obtained by air-convection spraying machine under test

Test n.	1	2	3
E_c %	46	48	46

These values of E_c% are acceptable in that the intercepting tools do not fill the whole surface of the patternator, but only a part of it. Therefore there are a set of free windows crossed by the wet air flow without any liquid interception.
Fig. 7 shows the average quantities of the intercepted liquid by each one of the intercepting tools and the respective coefficient of variation (CV) has been always less than 10%. The repeatability of the results allows to evaluate in a positive way the reliability of the patternator.
The intercepting tools n. 14, 15, 16, respectively placed at 4450 mm, 4700 mm e 4950 mm from the ground, have not collected any amount of liquid. Probably this result is caused by the little sprayer fan capacity, that is not able to produce a suitable air flow (Fig. 7).
Fig. 8 shows the projection of air velocity vectors on a single vertical plane passing through the afore mentioned measure points, placed at different heights from the ground.
Referring to the measure points placed in front of the patternator, you can see that the horizontal velocity components allow the air flow to cross the patternator as far as an height from the ground of about 3500 mm.
The horizontal velocity component is greatly lower than the vertical one for heights more than 3500 mm. In that position, the most amount of the wet air flow is diverged upward and only a few quantity of it crosses the patternator. Owing to this the highest intercepting tools (n. 14, 15, 16) did not collected any amount of water during the tests carried out.
The analysis of the air velocity vector measured behind the patternator confirms this behaviour of the air flow.

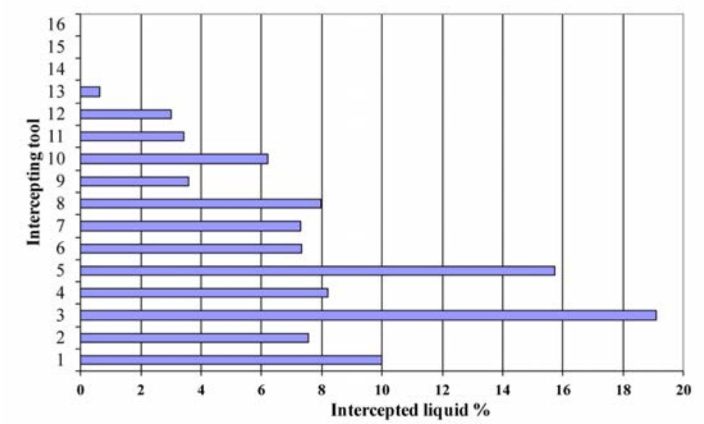

Fig. 7. Intercepted liquid percentage in each one of the intercepting tools.

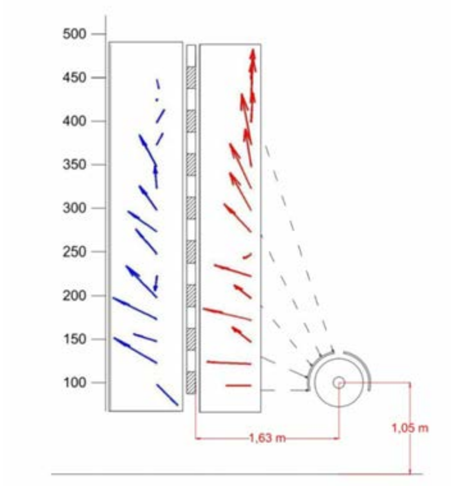

Fig. 8. Projection of air velocity vectors on a single vertical plane passing through the measure points.

Considerations and conclusions

The fulfilment of a test bench suitable for the adjustment of the sprayer machines employed for treatments in expanded canopy fruit-growing has required a closely study with the aim at the evaluation of the technical solutions which both assure the efficiency of the equipment and optimize its functionality.

On the ground of the obtained results, the patternator is suitable for the evaluation of the transverse patterns of distribution produced by sprayers at present used for treatments to tree cultures 3.5 m high.

Furthermore during the tests carried out all the manifolds and pipe drain have collected the liquid from the respective intercepting tools without any overflow.

The obtain results can also be satisfactory referring to the efficiency of the patternator E_c and the quality of the transverse distribution diagrams.

Other sprayer machines equipped with more capacity fan than the proved one will be tested in order to evaluate the intercepting functionality of the patternator at height more than 3500 mm. If also with these machines there will be not any amount of liquid collected by the highest intercepting tools, as occurred in the present tests, it will be necessary to design again their shape and sizes.

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