

## **SURFACE TENSION OF SPRAY LIQUIDS (FUNGICIDES, INSECTICIDES) AND MINERAL FERTILIZERS DEPENDING ON THE COMPONENTS AND WATER QUALITY**

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### **ABSTRACT**

The objective of this study was to determine and compare surface tensions of fungicides (Antracol WP-70 and Dithane M-70), insecticides (Actellic-50 and Confidor 200-SL), mineral nutrients (Ferticare I, Ferticare II, Ferticare III /FI, FII and FIII, respectively/ and Wuxal Super) and their mixtures (two and three components) in waters differing in quality (tap water and well water). Surface tension was determined by means of a tensiometer (Lecomte du Nouy), immediately after mixing and after a resting period of 24 hours (at 20°C). Differences were observed in surface tension due to water quality. Increased tension in the well water was registered for Antracol WP-70, FIII and Dithane M-70. Increased tension in the tap water was registered for Wuxal Super and Dithane M-70 + Confidor SL-200+ FIII.

**Key words:** surface tension, spray liquids, fungicides, insecticides, mineral nutrients

### **IZVLEČEK**

#### **POVRŠINSKA NAPETOST ŠKROPIV (FUNGICIDOV, INSEKTICIDOV) IN RAZTOPIN RUDNINSKIH GNOJIL V ODVISNOSTI OD SESTAVIN IN KAKOVOSTI VODE**

Namen raziskave je bil določiti in primerjati površinsko napetost fungicidov (Antracol WP-70 in Dithane M-70), insekticidov (Actellic-50 in Confidor 200-SL), raztopin rudninskih gnojil (Ferticare I, Ferticare II, Ferticare III /FI, FII in FIII ter Wuxal Super) in njihovih dve- in trikomponentnih mešanic v vodovodni vodi ter vodi iz vodnjaka. Površinsko napetost smo določevali s tenziometrom (Lecomte du Nouy), in sicer takoj po mešanju in 24 ur pozneje (20 °C). Kakovost vode je vplivala na razlike v površinski napetosti. Večjo površinsko napetost raztopin v vodi iz vodnjaka smo ugotovili pri fungicidih Antracol WP-70 in Dithane M-70 ter raztopini rudninskega gnojila FIII, pri vodovodni vodi pa pri raztopini rudninskega gnojila Wuxal Super in mešanici fungicida Dithane M-70, insekticida Confidor 200-SL in raztopine rudninskega gnojila FIII.

**Key words:** površinska napetost, škropiva, fungicide, insekticidi, rudninska gnojila

## **1 INTRODUCTION**

Wettability is a property of pesticidal active liquids to form a thin but satisfactorily persistent layer on the surface of treated plant parts. Wettability level determines the

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surface tension of active liquids. The objective of this study was to determine and compare surface tensions of fungicides (Antracol WP-70 and Dithane M-70), insecticides (Actellic-50 and Confidor 200-SL), mineral nutrients (Ferticare I, Ferticare II, Ferticare III /FI, FII and FIII, respectively/ and Wuxal Super) and their mixtures (two and three components) in waters differing in quality (tap water and well water). Physicochemical properties of mixtures of insecticides and fungicides, and of their mixtures with mineral nutrients, are the basis for the estimation of compatibility, not disregarding a possibility that compatibility may also be affected by water quality. Comparative values of surface tension for mixtures and their components may be useful in estimating the physicochemical compatibility of mixtures.

## 2 MATERIALS AND METHODS

Surface tension was determined by means of a tensiometer (Lecomte du Nouy), immediately after mixing and after a resting period of 24 hours (at 20°C) (Šovljanski *et al.*, 2002). Measurements were replicated three times. Surface tension was expressed in  $\text{mJ/m}^2$ , with the accuracy of  $0.1 \text{ mJ/m}^2$ .

## 3 RESULTS AND DISCUSSION

The obtained values of surface tension, which varied independence of the components and water quality, are shown in Graphs 1 to 5.

Graph 1 shows that individual components (Antracol WP-70, Actellic-50, Confidor 200-SL and FI) and their mixtures in well water exhibited a slight increase of surface tension 24 hrs after mixing in comparison with the values registered directly after mixing (0 hrs). In the tested waters, the surface tension of Antracol WP-70 ranged from 44 to 48  $\text{mJ/m}^2$ . Wettability was reduced after 24 hrs in well water, as indicated by the increase in surface tension to 51  $\text{mJ/m}^2$ . In the case of the insecticide Actellic-50, surface tension ranged from 32 to 33  $\text{mJ/m}^2$ , with slight changes during the observed 24 hrs. Actellic-50 tended to reduce surface tension in binary mixtures while Antracol WP-70 increased surface tension in tap water and decreased it in well water. The solutions of Confidor 200-SL in tap and well water had the surface tensions of 45  $\text{mJ/m}^2$  and 44  $\text{mJ/m}^2$ , respectively. The surface tension of the mixture of Confidor 200-SL and the mineral nutrient FI had a similar value as the insecticide component and the nutrient component Ferticare, i. e., an additive effect was expressed.

Surface tensions of the mixtures of the insecticide and the fungicide with FII and FIII (Graphs 2 and 3, respectively) were similar to that shown in Graph 1, in spite of differences among the mineral nutrients FI, FII and FIII. Surface tensions of the binary mixtures had similar values to that of the insecticide component, i. e., wettability of the mineral nutrients was improved when they were mixed with the insecticide and the EC formulation. It was observed that the values of surface tension of the emulsion Actellic-50 and its mixtures with the mineral nutrients were similar regardless of the mixture in question and kind of water used. An exception was observed in the case of FIII, which had an increased surface tension, and thus lower wettability, in well water. In the case of the triple mixtures, the lowest surface tension was registered in the mixture Antracol WP-70 + Actellic-50 + FII. The mixture with FIII had a lower value than the mixture with FI.

Wuxal Super had a much higher surface tension in tap water than in well water, over 60  $\text{mJ/m}^2$  and over 50  $\text{mJ/m}^2$ , respectively, while it exhibited a slight increase in wettability in relation to the control (Graph 4). Antracol WP-70 reduced the high surface tension of Wuxal Super, i. e., Antracol WP-70 retained its own surface tension. The high surface tension of the nutrient Wuxal Super, especially in tap water, was considerably reduced on

mixing with Actellic-50, even below the latter's value, which largely increased the wettability of their mixture. Similarly, in the mixture Confidor 200-SL + Wuxal Super, wettability was considerably improved as the surface tension of Wuxal Super was much reduced. It should be mentioned that the pH values of the mixtures which involved Wuxal Super were higher in tap water than in well water.

The results for surface tension (Graph 5) in individual components (Dithane M-70, Actellic-50, Confidor 200-SL, FIII) and their mixtures also showed perceptible reductions in the variants which involved the EC formulation. The suspension of Dithane M-70 and the mixture Dithane M-70 + FIII exhibited slight reductions in surface tension, of 10 to 15 mJ/m<sup>2</sup> in relation to the control. A similar phenomenon occurred in the triple mixture Dithane M-70 + Confidor 200-SL + FIII, but only in tap water. Among the binary mixtures, lowest surface tensions were shown in the mixture Actellic-50 + FIII in both kinds of water. Actellic-50 contributed to a lowered surface tension in the binary mixtures, or more precisely, it kept the tension values at its own level. Highest surface tension was exhibited by the mixture Dithane M-70 + FIII, regardless of kind of water. FIII caused a slight reduction in surface tension of Dithane M-70 in well water.

With the exception of the mixtures of Antracol WP-70 with FI, FII and FIII, only in tap water, stirring tended to reduce surface tension and increase wettability of all emulsions and solutions (Confidor 200-SL + Wuxal Super). Similar results were obtained when tank mixing cypermethrin (Sucip 20- EC) and chlorpyrifos (Pirinex 48-EC) with fungicides (Indić *et al.*, 1999; Klokočar Šmit *et al.*, 2000).

A study of Klokočar Šmit *et al.* (2001) on the effect of water quality on the physical properties of individual preparations and their mixtures showed a reduction of surface tension when active liquids were mixed with well water, as compared with suspensions and emulsions prepared with tap water. Exceptions were the suspension of Mankogal-80, whose surface tension was higher in well water than in tap water, and well water itself, which had a significantly higher surface tension than tap water.

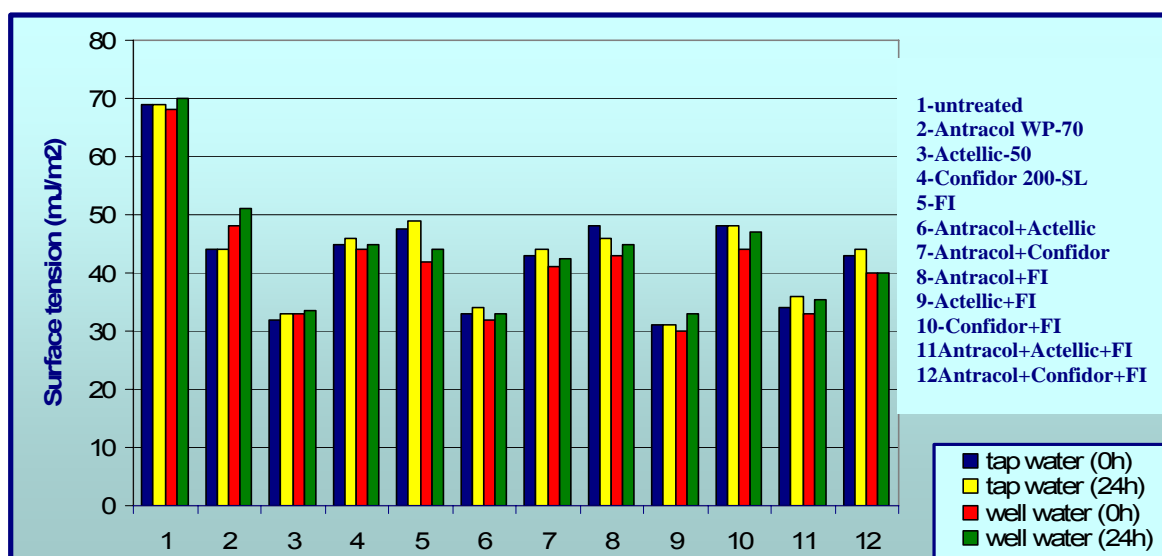


Fig. 1. Surface tension (mJ/m<sup>2</sup>) of Antracol WP-70 and insecticides in mixture with FI

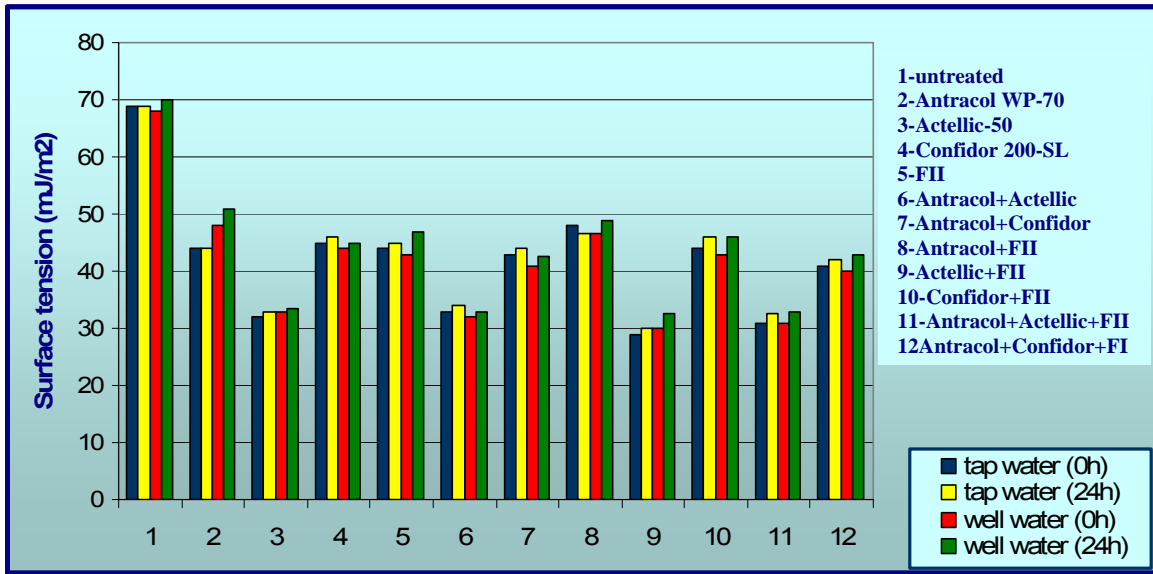


Fig. 2. Surface tension (mJ/m<sup>2</sup>) of Antracol WP-70 and insecticides in mixture with FII

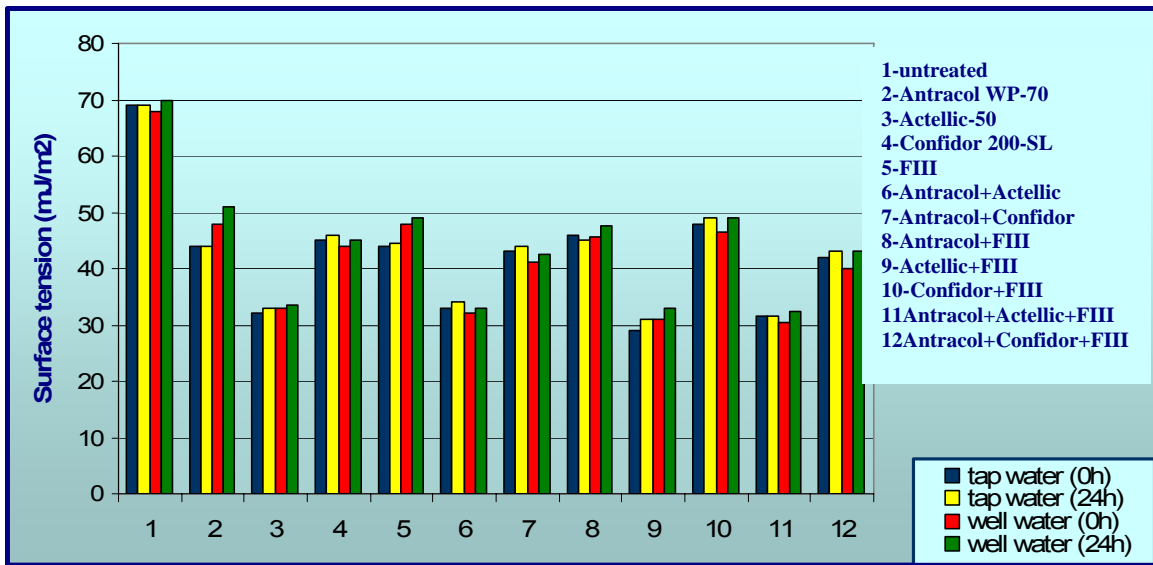


Fig. 3. Surface tension (mJ/m<sup>2</sup>) of Antracol WP-70 and insecticides in mixture with FIII

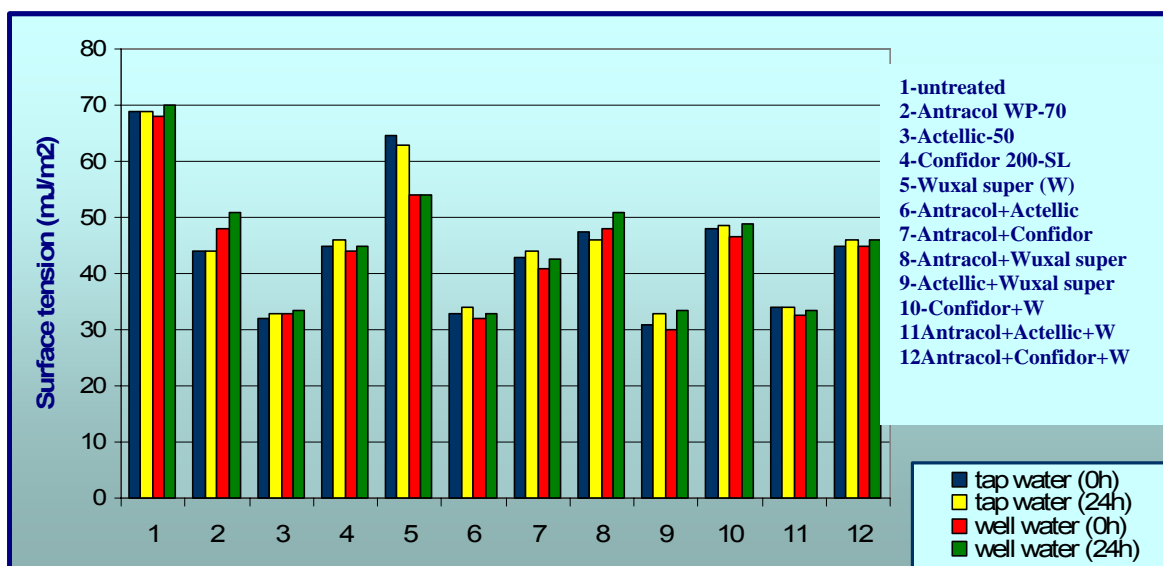


Fig. 4. Surface tension (mJ/m<sup>2</sup>) of Antracol WP-70 and insecticides in mixture with Wuxal Super

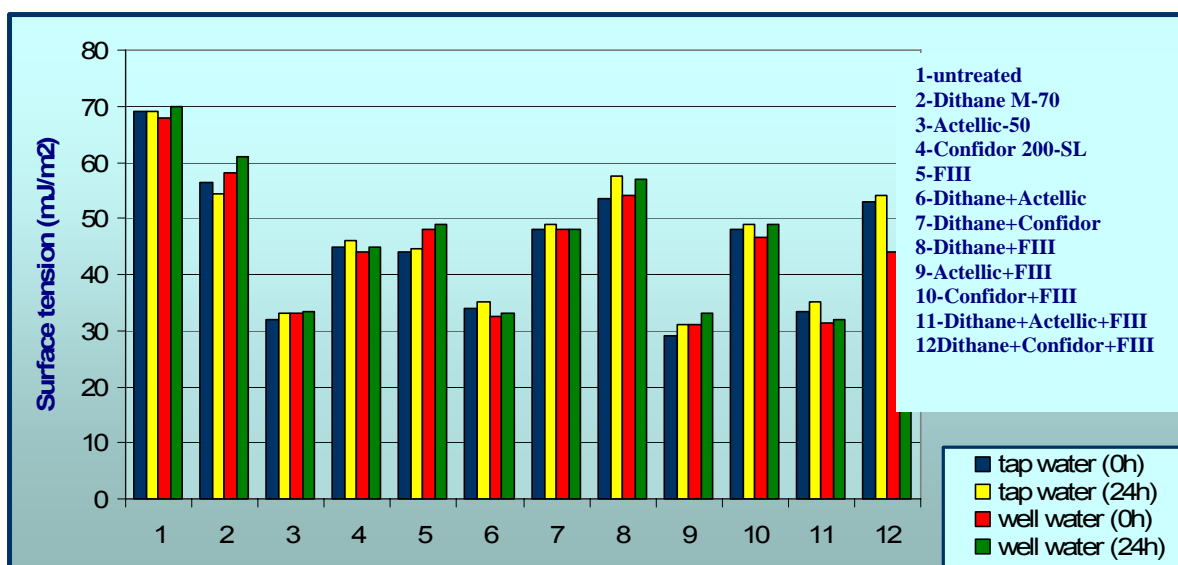


Fig. 5. Surface tension (mJ/m<sup>2</sup>) of Dithane M-70 and insecticides in mixture with FIII

#### 4 CONCLUSIONS

The surface tension of tap water was 69 mJ/m<sup>2</sup> both after mixing and after 24 hours. The surface tension of the well water was 68 mJ/m<sup>2</sup> after mixing and 70 mJ/m<sup>2</sup> after 24 hours. Considered on the whole for all components and mixtures, the surface tension was reduced in relation to pure water, ranging from 30.5 to 61 mJ/m<sup>2</sup>. In relation to the controls than included the tap and well waters, surface tension was notably reduced, regardless of water quality, in the mixtures that had Actellic-50 as a component. The reduction was about 40 mJ/m<sup>2</sup>, which is understandable considering the formulation of that preparation (EC). The reductions of surface tension in the other variants were around 20 mJ/m<sup>2</sup>, which again can

be attributed to the formulations of the preparations. Reduced wettability can be effectively corrected by adding certain surface-active agents.

Differences were observed in surface tension due to water quality. Increased tension in the well water was registered for Antracol WP-70, FIII and Dithane M-70. Increased tension in the tap water was registered for Wuxal Super and Dithane M-70 + Confidor + FIII. Negligible differences in surface tension were also observed between the measurements done directly after mixing and 20 hours later.

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