EVALUATION OF THE EFFECTIVENESS OF NATURAL ALTERNATIVE COPPER PRODUCTS AND LOW RATE COPPER FORMULATIONS AGAINST GRAPE DOWNY MILDEW IN ORGANIC VITICULTURE

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***Abstract*:**

The control of pathogenic fungi, especially downy mildew, represents the main problem in organic viticulture as only few fungicides, above all copper salts, can be used. As the copper causes problems of environmental impact, the Regulation EC n. 473/2002 fixed a ceiling on the use of copper compounds. Two years field trials were carried out in organic vineyeards to test the effectiveness, against *Plasmopara viticola* (Berk. e*t* Curt.) Berl. e*t* De Toni, of alternative copper products and low rate copper formulations, able to take place or to reduce copper quantities used. Amoung the alternative substances, in the first year of activity we examinated phito-stimulant and cuprics, while in the second year we examinated natural extracts, both vegetables and animals, and natural compound associates to the copper. The achieved results have underlined that, using the low rate copper formulations examinated, the total copper quantities were always less than 6 Kg copper per hectare, in accordance with the provisions of Regulation EC. The alternative products investigated have not guaranteed, instead, an adequate protection with high pressure od downy mildew. The trials confirm that the copper is indispensable for plant protection in organic farming, as it is not possible to replace it. We can only reduce the copper quantities used, at this point of time, but further studies are necessary to find appropriate alternative solutions able to control pathogenic agents in organic farming.

Key words:

Organic farming, copper salt, *Plasmopara viticola*, grapevine

INTRODUCTION

Copper is widely used in organic farming where it represents one of the few usable fungicides and the only effective against downy mildew. Since the cupric products cause problems of environmental impact, the European Community has considered opportune to reduce their utilization and, with Regulation EC n. 473/2002, fixed a ceiling on use of metal copper in organic farming. It is therefore necessary to reduce the quantities of copper resulting from the treatments. Field trials have been carried out to test the effectiveness, against *Plasmopara viticola* (Berk. *et* Curt.) Berl. e*t* De Toni, and the collateral effects of

the cupric formulations characterised by low metallic content and alternative products in accordance with organic farming's objectives.

MATERIALS AND METHODS

The trials were conducted, in two years of activity, in an organic vineyard near Rome (Pavona). Data related to the trials planning are reported in table 1. We have considered 1 untreated control thesis, in order to follow the course of infection, and 1 standard farm reference thesis (standard), where the treatments, with copper compounds, were carried out according to the usual farm procedures. The characteristics of fungicides tested in the first year of activity (2004) are reported in table 2. The characteristics of the fungicides tested in the second year of activity (2006) are reported in table 3. The trials were carried out according to the Guidelines EPPO/OEPP PP 1/31 (3). In the theses Rame azzurro F2, King- Mastercop, Coprantol Ultramicron and Bentotamnio + copper the treatments started reaching 80% of the incubation period of the primary infection and verifying the foreseen conditions of the three ten rule. The theses Agribioprop, Solithe, Brotomax, Chitoplant and Croplife have been treated, instead, on the basis of the indications given by the label and the distributor firms. The assessments were carried out on leaves and bunches; the percentage of deseased organs (diffusion) was determined. The infection percentage index (I.% I.) was calculated according to the Townsend-Heuberger formula while the efficacy index according to Abbott's formula. The data obtained, after arc sin transformation, was evaluated by the Duncan test.

RESULTS AND DISCUSSION

In the first year of activity, with high pressure of downy mildew, the thesis treated with King and Mastercop showed the best results (table 4); good results showed the theses treated with Rame Azzurro F 2 and the Standard farm reference too. The quantities effectively used of metal copper are reported in figure 1. In the second year of trial, characterized by a low infection of *P. viticola*, the formulation Brotomax, associated to the copper hydroxide, showed the best downy mildew control (table 5). Satisfactory results have been obtained in the theses Coprantol Ultramicron and Croplife too. In the second year of activity only the leaves have showed the symptoms of the infection while the bunches are not resulted infected by the pathogenic fungus. In the figure 1 is reported the contribution of metal copper concerning the second year of trial.

Table 1 *- Trials Planning (I and II year of activity)*

Years	2004 - 2006
Location	Pavona
Farm	Due Antichi Casali
Grapevine	Malvasia di Candia
Rootstock	*Vitis berlandieri x Vitis riparia* Kober 5BB
Year of planting	1966
Form of growing	Tendone
Spacing	2,50 X 2,50
Sperimental scheme	randomized blocks
Theses compared	8
N° of repetitions	4
N° plants/plot	12
Sprinkling machine	Electrostatic atomizer Martignani KWH
Quantity of water used for the treatments l/ha	300 -1000 l/ha
Year of convertion into organic	1989
Control body	Suolo e Salute

Table 2 *- Products characteristics (I year of activity)*

Theses	**Products**	**Active substance**	**Commercial formulation**	**Concentration of a.s. (% o g/l)**	**Dose of c.f. (ml o g/hl)**	**Dose of a.s. (g/hl)**	**Dates of treatments**	**Number of treatments**
Standard	Zetaram 20 L	Copper from tetracopper chloride hydroxide	Suspesion concentrate	300	320-400	96-120	15/5; 25/5; 3/6	3
	Cuprobenton DC blu	Copper from tetracopper chloride hydroxide & copper from copper hydrated sulfate	Wettable powder	15	600	90	16/6; 23/6; 6/7; 19/7; 29/7; 9/8	6
Rame Azzurro F2	Rame azzurro F2	Copper from copper hydroxide	Suspesion concentrate	350	230-270	80,5-94,5	15/5; 25/5; 3/6; 16/6; 23/6; 6/7; 19/7; 29/7; 9/8	9
* King Mastercop	King	Copper from tribasic copper sulfate	Suspesion concentrate	360	200-250	72-90	15/5; 25/5; 3/6; 16/6	4
	Mastercop	Copper from pentahydrate sulfate	Suspesion concentrate	60	150	9	23/6; 6/7; 19/7; 29/7; 6/8	5
Solithe	Solithe = S	Calcium and Magnesium + olygoelements of sea origin	Powder					
	S + Soliplante Start	Phytostimulant (Plant macerate & seaweed)	Liquid				5/4	1
	S + Soliplante Croissance	Phytostimulant (Plant macerate & seaweed)	Liquid				28/4; 25/5; 8/6; 16/6	4
	S + Coprantol ultramicron	Copper from copper hydroxide	Water dispersible granules	35	150	52,5	21/4; 3/5	2
	S + King	Copper from tribasic copper sulfate	Suspesion concentrate	360	200	72	23/6; 6/7; 19/7; 29/7; 9/8	5
Agribioprop	Agribioprop	fluid mixture of microelements - copper (0,5%) & iron (2%)	Liquid	0,5	250	1,25	29/3; 5/4; 15/5; 19/5; 26/5; 3/6; 10/6; 16/6; 23/6; 30/6; 6/7; 15/7; 29/7; 9/8	14

** According to the indications given by the distributor firm, King formulation was used up to the fruit-setting, while Mastercop formulation was used in the following phenologial growt stages*

Table 3 - *Products characteristics (II year of activity)*

Theses	Products	Active substance	Commercial formulation	Concentration of a.s. (% o g/l)	Dose of the c.f. (ml o g/hl)	Dose of a.s. (g/hl)	Dates of treatments	Number of treatments
Standard	Cuprobenton DC blu	Copper from tetracopper chloride hydroxide & copper from copper hydrated sulfate	Wettable powder	15	400	60	2/05, 12/05, 24/05, 6/06, 14/06, 23/06, 5/07, 10/07, 20/07, 10/08, 31/08	11
* King-Mastercop	King	Copper from tribasic copper sulfate	Suspesion concentrate	360	200 - 225	72 - 81	16/05, 30/05, 08/06/06	3
	Mastercop	Copper from pentahydrate sulfate	Liquid	60	150	9	16/06, 30/06, 10/07, 20/07, 31/07	5
Coprantol Ultramicron	Coprantol Ultramicron	Copper from copper hydroxide	Water dispersible granules	35	150 - 175	52,5 - 61,25	16/05, 30/05, 8/06, 16/06, 30/06, 10/07, 20/07, 31/07	8
Bentotamnio + Copper	Bentotamnio	Bentonite, *Lithothamnium*, rock powder	Powder		400 - 500		16/05, 30/05, 8/06, 16/06, 30/06, 10/07, 20/07, 31/07	8
	Snow crystal copper sulfate	Copper from copper sulfate	Soluble microcrystals	25	150 - 175	37,5 - 43,75	16/05, 30/05, 8/06, 16/06, 30/06, 10/07, 20/07, 31/07	
	Bed	Potassic soap & tensioactives	Soluble crystals		150		16/05, 30/05, 8/06, 16/06, 30/06, 10/07, 20/07, 31/07	
Brotomax + Copper	Cupravit idro WG	Copper from copper hydroxide	Water dispersible	25	400 - 500	100 - 125	08/05/06, 30/05, 31/07	4
	Brotomax	Copper (Cu) Zinc (Zn) Manganese (Mn) Total nitrogen (urea)	Liquid	22,69 0,5 0,75 8	2,75 - 3,2 - 4,3 - 2	62,4 - 72,6 - 97,6 - 45,4	08/05/06, 30/05/06, 31/07/06, 16/10/06	
Chitoplant	Chitoplant	Chitosan	Water soluble powder	100	250		28/04/06	1
	Biomacro	Total nitrogen (N) Phosphorus (P_2O_5) Potassium (K_2O) Organic carbon of biological origin	Fluid	6 6 5 30	500			
	Coprantol Ultramicron	Copper from copper hydroxide	Water dispersible granules	35	200 - 175	70 - 61,25	30/05/06, 8/06, 16/06, 30/06, 10/07, 20/07, 31/07	7
Croplife	Croplife	Citrofresh (orange extract) Ethyl alcohole Octanoid acid	Liquid		67,5		15/02, 30/03, 12/04, 31/05, 8/06, 12/09	6
	Invigorator	Total nitrogen (N) Phosphorus (P) Phosphorus as P_2O_5 Potassium (K) Potassium as K_2O Calcium (Ca) Magnesium (Mg) Sodium (Na) Sulphur (S) Boron (B) Iron (Fe) Manganese (MN) Copper (Cu++) Zinc (Zn) Molybdenum (Mo) Cobalt (Co)	Liquid	9,83 8,38 20,33 8,03 9,67 200 200 650 3500 150 850 370 350 140 10 5	7	1,568		
	Calcium carbonate	Calcium carbonate	Powder	100	62,5 - 125			

** According to the indications given by the distributor firm, King formulation was used up to the fruit-setting, while Mastercop formulation was used in the following phenologial growt stages*

Table 4 *- Trial results (I year of activity)*

THESES	I ASSESSMENT 18/06/04 (10 days following flowering)						II ASSESSMENT 11/08/04 (Varaison)						III ASSESSMENT 24/09/04 (Vintage)					
	LEAVES			BUNCHES			LEAVES			BUNCHES			LEAVES			BUNCHES		
	Dif. %	I.%I.	Eff.%	Dif. %	I.%I.	Eff.%	Dif. %	I.%I.	Eff.%	Dif. %	I.%I.	Eff.%	Dif. %	I.%I.	Eff.%	Dif. %	I.%I.	Eff.%
Untreated control	48,5 b	19.9 c	-	48.9 c	24,7 d	-	50,4 b	21,4 c	-	55,2bc	40,3 c	-	55,8 b	26,5 c	-	58,4 bc	41,5 bc	-
Standard	38,1 ab	14,6 ab	30,8	30,9 ab	13,9 ab	48,2	41,5 a	16,8 a	25,1	42,3 ab	28,7 ab	31,8	44,7 a	20,5 a	27,5	45,6 abc	32,9 abc	27,8
King-Mastercop	32,7 a	12,0 a	46,2	22,4 a	11,1 a	73,9	39,8 a	15,8 a	30,2	39,4 a	26,1 a	39,3	42,5 a	20,4 a	33,0	38,4 a	26,1 a	44,8
Rame Azzurro F2	36,5 ab	14,5 ab	35,7	31,6 ab	16,7 abc	50,0	42,3 ab	17,3 ab	23,0	43,2 ab	28,0 ab	29,6	44,3 a	21,8 ab	28,6	44,6 ab	30,5 ab	29,9
Solithe	47,2 b	18,0 bc	2,7	45,6bc	22,3 cd	9,7	49,9 b	21,1 c	0,4	61,0 c	41,7 c	-13,9	54,4 b	25,8 bc	3,3	59,6 c	43,3 c	-5,3
Agribioprop	45,4 b	17,2 bc	8,1	37,0 abc	17,8 bc	35,0	47,2 ab	19,6 bc	8,5	48,6 abc	34,0 b	16,1	52,6 b	26,2 c	7,7	51,9 abc	37,6 bc	12,1

Different letters indicate significant different values by Duncan test for P ≤ 0,05

Table 5 *- Trial results (II year of activity)*

THESES	I ASSESSMENT 15/06/2006 (Berries growth)			II ASSESSMENT 08/08/2006 (Varaison)			III ASSESSMENT 26/09/06 (Vintage)		
	LEAVES			LEAVES			LEAVES		
	Dif. %	I.%I	Eff.%	Dif. %	I.%I	Eff.%	Dif. %	I.%I	Eff.%
Untreated control	0,50 a	0,06 a	-	0,80 a	0,10 a	-	1,80 c	0,40 c	-
Standard	0,00 a	0,00 a	100,0	0,00 a	0,00 a	100,0	0,50 ab	0,06 ab	71,4
King-Mastercop	0,30 a	0,03 a	50,0	0,50 a	0,06 a	33,3	0,80 abc	0,09 abc	57,1
Coprantol ultramicron	0,00 a	0,00 a	100,0	0,50 a	0,10 a	33,3	0,30 ab	0,06 ab	85,7
Bentotamnio + copper	0,30 a	0,03 a	50,0	0,80 a	0,09 a	0,0	1,00 bc	0,10 bc	42,9
Brotomax + copper	0,00 a	0,00 a	100,0	0,30 a	0,03 a	66,7	0,00 a	0,00 a	100,0
Chitoplant	0,30 a	0,03 a	50,0	0,50 a	0,06 a	33,3	0,80 abc	0,09 abc	57,1
Croplife	0,00 a	0,00 a	100,0	0,30 a	0,03 a	66,7	0,30 ab	0,03 ab	85,7

Different letters indicate significant different values by Duncan test for P ≤ 0,05

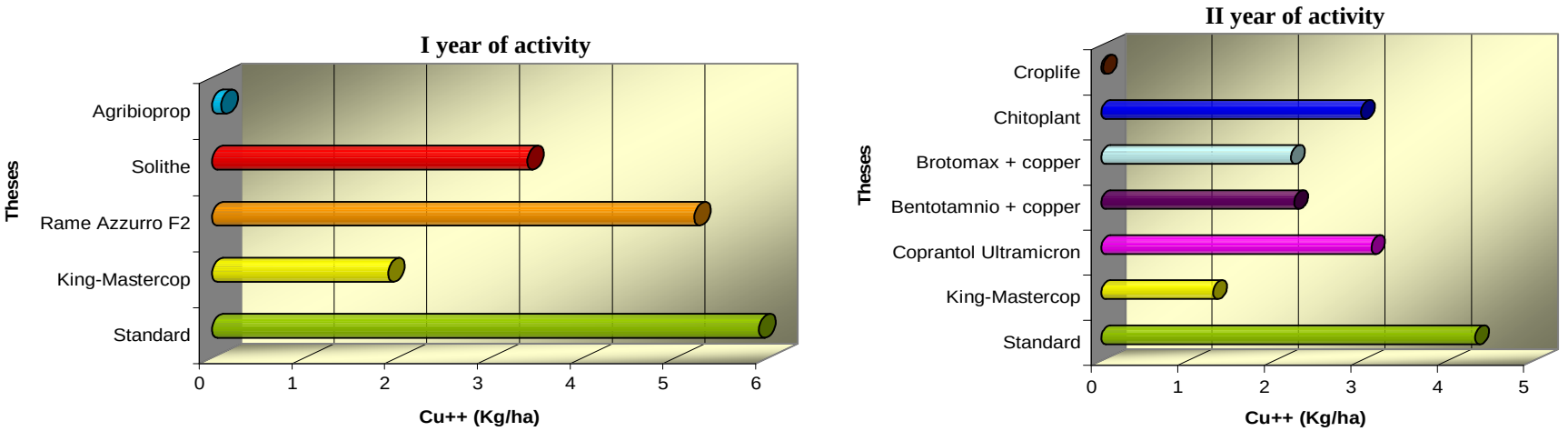

Figure 1 *- Quantity of metal copper (Kg/ha) distributed by the treatments during the I and II year of activity*

CONCLUSIONS

The results of the trials have showed that, when the infection of *P. viticola* was high, the alternative products have not garanteed a good downy mildew control. In fact, the phytostimulants associated with copper tested were not able to improve the copper salts effects or to substitute them, and the Agribioprop formulate showed a low anti-downy mildew capability, more accentueted on bunches. The cupric products characterised by the low metallic content: King - Mastercop and Rame azzurro F2 showed, instead, a good terapeutic efficacy and allowed to respect the limits established by the Regulation EC. In the second year of activity, characterized by a low infection of *P. viticola*, the copper formulations tested guaranteed a good effectiveness in the control of downy mildew with a low contribution of metal copper. Croplife formulate was the alternative product that offered encouraging results. In both years of trials any phytotoxic effects were found.

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