INFLUENCE ON THE PATHOGEN AGENTS OF SOME ECOLOGIC TREATMENTS APPLIED DURING STORAGE TO THE APPLE FRUITS

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The research approaches the problem of pathological and non-pathological degradation that occurs during storage, in apple fruit, with the goal of finding ecological solutions to limit the losses that occur. The methods of prevention, which include post-harvest treatments with bioactive substances of natural origin, constitute a modern-day tendency, which is studied in all countries with an advanced horticulture.

From a phytopathological perspective, the major cause of the warehouse disease, including in apple fruit, is the technology applied on the tree plantation, but also the year-specific climatic conditions.

The treatemnts were effectuated by fine pulverization on the apple surface using a crude suspension of volatile oil from savory and swet basil, respectvely dispersed with a special pump of Sapanish manufacturing.

Suspensions containing about 60% volatile oils were freshly extracted from savory and sweet basil by the method of distillation through water vapors stimulation.

To highlight the pathogen microflora of the apple fruits we examined them carefully using a manual magnifying glass and wrote down the data necessary to calculate the frequency of the attack, the intensity of the attack as well as the level of damage or attack.

The statistic calculation pursued the underlining of differences between the intensity of attack of the pathogen agents encountered on the untreated fruits as against the variants treated demonstrating the level of effectiveness of each treatment variant.

The volatile oils had the best effects in reducing the intensity of attack – the percentage to which a fruit is attacked. The fruit losses due to the diseases in the storehouse may be reduced significantly by applying these treatments

Keywords *apple fruit, during storage, the pathogen agents, ecological treatments.*

The limitation of losses that occur in apple fruit during storage, due to the aforementioned reasons, was firstly possible due to the phyto-sanitary measures meant to prevent and fight the pathogens originating in the orchards, which can continue to act during storage, and secondly due to the post harvest treatments that were planned before the insertion into storage cells.

MATERIAL AND METHOD

The study focuses on the pursuing of the evolution for there years (2004-2005, 2005-2006 and 2006-2007) of the influence of some ecologic treatments over the pathogen agents during the storage of apple fruits from the breed Idared from the Fruit-growing Farm n.7 within the Station for Research and Development in Fruit-growing Iaşi.

Additionally, to the fruits under study, we applied 3 treatments with calcium chloride in concentration of 1%, before harvest, at intervals of one week.

The apple fruits from the experiment organized were harvested according to STAS, with peduncle, avoiding snatching, hitting or injuries. They were packed in box pallets that were transported to the frigorific storehouse Sârca – county Iaşi.

Here we organized four treatment variants as follows:

Variant 1: (witness) fruits where we did not intervene by post harvest treatments.

Variant 2: fruits treated with calcium chloride (the unchanged variant from the orchard).

Variant 3: fruits treated with calcium chloride + a treatment with a suspension of volatile oils obtained from savory.

Variant 4: fruits treated with calcium chloride + a treatment with a suspension of volatile oils obtained from sweet basil.

All variants were stored in the frigorific cell where we insured the temperature of 2^0C, relative humidity of 90-95%, and air circulation allowed a speed of at least 0,25 m/s, to a recirculation coefficient of 30 recirculations/hour.

RESULTS OBTAINED

In the first year of this study, 2004-2005, *(tab. 1)* we notice both significant increases of the frequency of attack of the pathogen agents and diminutions of this parameter.

Thus, variant 4 – fruits treated with calcium chloride + treatment with a suspension of volatile oils from sweet basil had a negative impact on the pathogen agent *Rhizophus stolonifer,* increasing three times its presence on the fruits under study.

In exchange, in other three cases, the variants treated eliminated the presence of the pathogen agents from fruits in a proportion of 100%. It is the treatment with calcium chloride against the pathogen agent *Rhizophus stolonifer* and the treatments with calcium chloride + a treatment with a suspension of volatile oils from savory and sweet basil against the pathogen agent *Sphaeropsis malorum.*

Table 1

Annual average differences of the frequency of attack of the pathogen agents

Year of study	2004-2005						
Variants studied/ Pathogen agents	V_1	V_2	Difference as comp. to V_1± (%)	V_3	Difference as comp. to V_1± (%)	V_4	Difference as comp. to V_1± (%)
Venturia inaequalis	42,66	24	**-43,75**	30	**-29,68**	24	**-43,75**
Podosphaera leucotricha	53,33	41,33	**-22,50**	69,33	**+30**	71,33	**+33,75**
Botrytis cinerea	65,33	44,66	**-31,63**	59,33	**-9,18**	60	**-8,15**
Alternaria tenuis	40,66	46,66	**+14,75**	36,66	**-9,83**	47,33	**+16,40**

Year of study	**2004-2005**						
Variants studied/ Pathogen agents	V_1	V_2	Difference as comp. to V_1± (%)	V_3	Difference as comp. to V_1± (%)	V_4	Difference as comp. to V_1± (%)
Sphaeropsis malorum	37,33	10	**-73,21**	0	**-100**	0	**-100**
Penicillium expansum	10,66	21,33	**+100**	8	**-24,95**	4,66	**-56,28**
Rhizophus stolonifer	2,66	0	**-100**	12	**+351,1**	10,66	**+300,7**
Glomerela cingulata	18	5,33	**-70,38**	4,66	**-74,11**	8,66	**-51,88**
Year of study	**2005-2006**						
Venturia inaequalis	65,6	78,4	**+19,51**	78,4	**+19,51**	79,2	**+20,73**
Podosphaera leucotricha	95,2	96,8	**+1,68**	92,8	**-2,52**	99,2	**+4,20**
Botrytis cinerea	60,8	70,4	**+15,7**	62	**+1,9**	67,2	**+10,52**
Alternaria tenuis	48,4	43,2	**-10,74**	37,6	**-22,31**	45,6	**-5,78**
Gloeosporium fructigenum	21	16	**-23,8**	2	**-90,47**	4,5	**-78,57**
Penicillium expansum	17	4	**-76,47**	2,5	**-85,29**	2	**-88,23**
Rhizophus stolonifer	2	0	**-100**	0	**-100**	2	**0**
Year of study	**2006-2007**						
Venturia inaequalis	100	94,5	**-5,5**	93	**-7**	95	**-5**
Podosphaera leucotricha	100	99,5	**-0,5**	99,5	**-0,5**	100	**0**
Botrytis cinerea	48,75	36	**-26,15**	31,5	**-35,38**	26,75	**-45,12**
Alternaria tenuis	60	51	**-15**	44,5	**-25,83**	50,75	**-15,41**
Rhizophus stolonifer	10,75	5,25	**-51,16**	2,25	**-79,06**	8	**-25,58**
Gloeosporium fructigenum	13,66	9,66	**-29,28**	10,33	**-24,37**	11,66	**-14,64**
Penicillium expansum	20,66	5,66	**-72,6**	8,66	**-58,08**	1,95	**-90,56**

Table 2

Annual average differences of the intensity of attack of the pathogen agents

Year of study	**2004-2005**						
Variants studied/ Pathogen agents	V_1	V_2	Difference as comp. to V_1± (%)	V_3	Difference as comp. to V_1± (%)	V_4	Difference as comp. to V_1± (%)
Venturia inaequalis	4,93	4,05	**-17,84**	4,55	**-7,7**	3,2	**-35,09**
Podosphaera leucotricha	7,13	3,8	**-46,7**	4,26	**-40,25**	2,69	**-62,27**
Botrytis cinerea	6,26	4,05	**-35,3**	4,67	**-25,39**	3,97	**-36,58**
Alternaria tenuis	3,44	3,03	**-11,91**	3,28	**-4,65**	2,42	**--29,65**
Sphaeropsis malorum	5,82	1,89	**-67,52**	0	**-100**	0	**-100**
Penicillium expansum	4,28	2,37	**-44,62**	2,02	**-52,8**	1,42	**-66,82**
Rhizophus stolonifer	1	0	**-100**	3,16	**+216**	1,89	**+89**
Glomerela cingulata	4,36	1,82	**-58,25**	1,74	**-60,09**	2,31	**-47,01**
Year of study	**2005-2006**						
Venturia inaequalis	7,87	4,93	**-37,35**	7,02	**-10,8**	6,57	**-16,51**
Podosphaera leucotricha	8,85	7,09	**-19,88**	7,67	**-13,3**	8,26	**-6,66**
Botrytis cinerea	4,64	2,62	**-43,53**	2,56	**-44,82**	3,16	**-31,89**
Alternaria tenuis	5,48	3,14	**-42,7**	3,49	**-36,31**	3,52	**-35,76**
Gloeosporium fructigenum	3,19	2,14	**-32,91**	1,19	**-62,69**	1,75	**-45,14**
Penicillium expansum	2,73	2,52	**-7,69**	1,41	**-48,35**	0,6	**-78,02**
Rhizophus stolonifer	1,16	1,05	**-9,48**	1,6	**+37,9**	0,72	**-37,93**
Year of study	**2006-2007**						
Venturia inaequalis	4,34	9,11	**+109,9**	7,64	**+76,03**	5,37	**+23,73**
Podosphaera leucotricha	8,12	9,07	**+11,69**	7,68	**-5,41**	8,95	**+10,2**
Botrytis cinerea	4,29	3,68	**-14,21**	3,65	**-14,68**	3,24	**-24,47**
Alternaria tenuis	6,13	3,69	**-39,80**	3,38	**-38**	3,42	**-44,2**
Rhizophus stolonifer	1,6	0	**-100**	0	**-100**	0,8	**-95**
Gloeosporium fructigenum	3,95	1,64	**-58,48**	0,3	**-92,4**	1,53	**-61,26**
Penicillium expansum	5,02	3,7	**-26,29**	3,1	**-38,24**	0,8	**-84,06**

Table 3

Annual average differences of the level of attack of the pathogen agents

Year of study	**2004-2005**						
Variants studied/ Pathogen agents	V_1	V_2	Difference as comp. to V_1± (%)	V_3	Difference as comp. to V_1± (%)	V_4	Difference as comp. to V_1± (%)
Venturia inaequalis	1,67	1,01	**-39,52**	0,92	**-44,91**	1,4	**-16,16**
Podosphaera leucotricha	4,26	3,24	**-23,94**	2,48	**-41,78**	2,03	**-52,34**
Botrytis cinerea	4,2	2,48	**-40,95**	3,1	**-26,19**	2,68	**-36,19**
Alternaria tenuis	1,48	1,69	**+14,18**	1,54	**+4,05**	1,15	**-22,29**
Sphaeropsis malorum	1,5	0,89	**-40,66**	0	**-100**	0	**-100**
Penicillium expansum	1,36	0,95	**-30,14**	0,95	**-30,14**	1,08	**-20,58**
Rhizophus stolonifer	0,9	0	**-10**	0,64	**-28,88**	0,52	**-42,22**
Glomerela cingulata	1,38	0,42	**-69,56**	0,08	**-94,20**	1,3	**-5,79**
Year of study	**2005-2006**						
Venturia inaequalis	7,29	3,93	**-46,09**	6,63	**-9,05**	5,86	**-19,61**
Podosphaera leucotricha	8,85	6,44	**-27,23**	7,5	**-15,25**	8,26	**-6,66**
Botrytis cinerea	2,94	1,60	**-45,57**	1,89	**-35,71**	1,96	**-33,33**
Alternaria tenuis	3,54	2,25	**-36,15**	2,36	**-33,70**	2,29	**-35,31**
Gloeosporium fructigenum	2,14	1,06	**-50,46**	0,86	**-59,81**	0,96	**-55,14**
Penicillium expansum	1,52	1,49	**-1,97**	0,97	**-36,18**	0,5	**-96,71**
Rhizophus stolonifer	0,63	0,46	**-26,98**	0,05	**-92,06**	0,3	**-52,38**
Year of study	**2006-2007**						
Venturia inaequalis	2,94	7,18	**+144,21**	7,02	**+138,77**	5,41	**+84,01**
Podosphaera leucotricha	7,81	8,9	**+13,95**	7,10	**-9,09**	8,89	**+13,82**
Botrytis cinerea	2,63	1,38	**-47,52**	2,84	**+7,98**	2,04	**-22,43**
Alternaria tenuis	2,53	1,68	**-33,59**	1,41	**-44,26**	1,61	**-36,36**
Rhizophus stolonifer	0,64	0	**-100**	0	**-100**	0,2	**-68,75**
Gloeosporium fructigenum	0,90	0,24	**-73,33**	0,02	**-97,77**	0,21	**-76,66**
Penicillium expansum	0,86	0,24	**-72,09**	0,28	**-67,44**	0,06	**-93,02**

The treatments applied *(tab. 2)* influenced negatively the intensity of the attack of the pathogen agents in the first year of study less the treatments with suspensions from volatile oils on *Rhizophus stolonifer*, which was influenced only by the treatment with calcium chloride. In the next year all the treatments managed to reduce significantly the intensity of attack of the pathogen agents in quite significant proportions (up to almost 80%), except for variant 3 on the pathogen agent *Rhizophus stolonifer*. In 2006-2007 the treatments applied did not have a positive effect any more for the pathogen agents *Venturia inaequalis* and *Podosphaera leucotricha*, on the contrary, they favored their action.

In the first year *(tab. 3)* all the variants treated registered negative differences towards the witness variant, less the variants treated with calcium chloride and the one treated with suspension of volatile oil of savory on the pathogen agent *Alternaria tenuis*, where the increases are quite small. In the second year of study all treatments had a full success over the pathogen agents, the differences towards the witness sample being in some cases over 90%. In the third year, as well as for the intensity of the attack, the treatments did not have effect on *Venturia inaequalis* and *Podosphaera leucotricha*. In exchange, all treatments applied had effect on *Rhizophus stolonifer* two of them managing to eliminate completely this pathogen agent.

Table 4

Average of the annual differences for the frequency of attack of the pathogen agents between the variants treated and the witness

Pathogen agent	Average of annual differences		
	V_2 as comp. to V_1	V_3 as comp. to V_1	V4 as comp. to V_1
Venturia inaequalis	-9,91	-5,72	-9,34
Podosphaera leucotricha	-7,1	-2,63	+12,65
Botrytis cinerea	-14,02	-14,22	-14,25
Alternaria tenuis	-3,66	-19,32	-1,59
Sphaeropsis malorum	-73,21	-100	-100
Penicillium expansum	-16,35	-56,10	-78,35
Rhizophus stolonifer	-83,72	+57,34	+91,70
Glomerela cingulata	-70,38	-74,11	-51,88
Gloeosporium fructigenum	-26,54	-57,42	-31,96

To reduce the frequency of all pathogen agents in the storehouse (tab. 4), the best treatment seems to be the calcium chloride. In exchange, to eliminate some of them completely you need the volatile oils of savory and sweet basil.

Table 5

Average of the annual differences for the intensity of attack of the pathogen agents between the variants treated and the witness

Pathogen agent	Average of annual differences		
	V_2 as comp. to V_1	V_3 as comp. to V_1	V4 as comp. to V_1
Venturia inaequalis	+18,23	+19,17	-9,29
Podosphaera leucotricha	-18,29	-19,65	-19,57
Botrytis cinerea	-31,01	-28,29	-30,98
Alternaria tenuis	-31,47	-26,32	-36,53
Sphaeropsis malorum	-67,52	-100	-100
Penicillium expansum	-26,20	-46,46	-76,3
Rhizophus stolonifer	-69,82	+51,3	-14,64
Glomerela cingulata	-58,25	-60,09	-47,01
Gloeosporium fructigenum	-45,69	-77,54	-53,21

The volatile oil of sweet basil acts better as compared to the other treatments to reduce the intensity of attack for most of the pathogen agents.

Table 6

Average of the annual differences for the level of attack of the pathogen agents between the variants treated and the witness

Pathogen agent	Average of annual differences		
	V_2 as comp. to V_1	V_3 as comp. to V_1	V4 as comp. to V_1
Venturia inaequalis	+19,53	+28,27	+16,08
Podosphaera leucotricha	-12,40	-22,04	-15,06
Botrytis cinerea	-44,68	-17,97	-36,03
Alternaria tenuis	-18,52	-24,63	-31,32
Sphaeropsis malorum	-40,66	-100	-100
Penicillium expansum	-34,73	-44,58	-70,10
Rhizophus stolonifer	-45,66	-73,64	-54,45
Glomerela cingulata	-69,56	-94,20	-5,76
Gloeosporium fructigenum	-61,89	-78,79	-65,9

No treatment had effect to reduce the level of attack of the pathogen agent *Venturia inaequalis*. On the contrary, for all the others we managed to reduce to a large extent and even eliminate them from the lot under study.

CONCLUSIONS

The treatments applied had variable effects for each pathogen agent individually every year. In 2005-2006, though we registered increases of the frequency of attack of the pathogens to the variants treated, they influenced the other two parameters (intensity and level of attack). In 2006-2007 we managed to reduce the number of fruits attacked and diminish the frequency but we registered an increase in intensity and level of attack.

The treatment with calcium chloride proved to be the most efficacious to reduce the number of fruits attacked (frequency of attack); due to the increase of fruit firmness, the protecting tissues especially, the pathogen agents penetrate the fruit much harder. An important role was also played by the film of calcium chloride that formed on the fruit surface as well as the metabolism of the apple fruits easily modified due to the calcium effect.

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