

Protective Effect of High Anthocyanins Content Plants in Cultured Tomatoes

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Abstract – Culture of tomatoes in ecological conditions is an excellent way, to analyze plant interactions. In these work we compare the resistance of cultured tomato plants in dependence of anthocyanins content, in front of, usual local tomato infections (*Sclerotinia sclerotiorum*, *Fusarium oxysporum*, *Botrytis cinerea*) and parasites (*Helicoverpa Armigera*). High anthocyanin content, not only protect the tomato plants it shelf, but also the surrounding cultures.

Keywords – Tomatoes, Culture, Protective Effect, Anthocyanins.

I. INTRODUCTION

Increase anthocyanins content of tomato fruits (blue tomato) is one of the recent goals in tomatoes culture. (1), (2). Many natural and GMO (genetically modified organisms) are now in the seed market (3). The aim to increase anthocyanin content in these tomatoes, have two reasons. First to obtain a full blue-purple colour, that doesn't exist in natural ones, second an increase on antioxidant molecules that improve healthy properties (4), (5). Author, have obtained previously a stable hybrid between the GMO from Norfolk Plant Sciences (Dark Indigo) and a natural tomato (AKA Indigo Blue Berries). It is a new, small cherry variety from Wild Boar Farms. The obtained hybrid has been cultured until second generation (F2) and then co-cultured with other classical tomato used for farming in Basque Country (Jack -F1, Robin-F1 and one heirloom Marmande variety from Navarra "Feo de Tudela").

All of them are cultured in a isolate plot in "ecological culture conditions" according with Christian Ulrichs et al (6) and using rules of Mark Schonbeck for Cropping Systems (7). The plants are placed in a matrix of 9x9 with a 70 cm separation between them. Previous to fruit collection, plants was examined, one by one, looking for fungal or parasitic infections. Not only, high anthocyanin plants remain unaffected also surroundings ones are influenced.

II. MATERIAL AND METHODS

A. High Anthocyanin Contends Plants

Stable hybrid between the GMO from Norfolk Plant Sciences (Dark Indigo) (8) and a natural tomato (AKA Indigo Blue Berries) (9) has been used as high anthocyanin plants. It is a new, small. The obtained hybrid has been cultured until second generation (F2) in order to obtain a high content stable and commercial plant (GMO have a fruity flavor and cherry size). (fig 1)



Fig. 1. Drack Indigo x AKA Indigo Blue Berries F1 hybrid (HAC)

B. Co-cultured Plants.

Tomatoes used habitually for farming in Basque Country, Jack -F1, Robin-F1 and one heirloom Marmande variety from Navarra (north of Spain) called "Feo de Tudela" has been used in co-culture as control plants.

C. Culture Area

One isolated culture area was prepared, for de experiment. One matrix of 9x9 plants separated by 75 cm free spaces, surrounded by one line of cultured high capsaicin contends plants (*Capsicum annuum*). Both cultures are sealed by one 1m upward stone wall. (fig2)

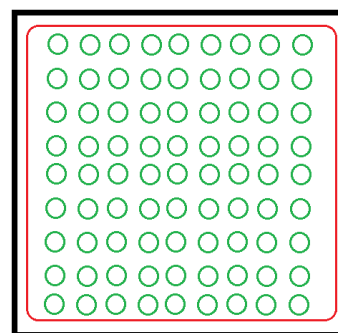


Fig. 2. Tomato plants distribution in a 9x9 matrix, red lines indicate *Capsicum* culture, black line stone walls

D. Culture Conditions.

Plants are planted in a randomized way by a technician none related with project. The final distribution of the matrix was as show in fig 3, were HAC (High Anthocyanin contends plant are indicated in blue.

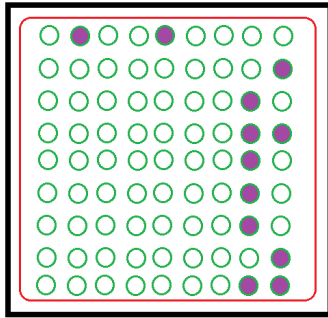


Fig. 3. HAC distribution inside culture area

The area is oriented in a south-west position with a slope of 10°. This is mandatory in tomato cultures in Basque Country (43°19'27.6"N 1°57'39.0"W) due to proximity of limit cultivation zone. The weather in Basque Country (north of Spain) is very wet, with media relative moisture of 75 % , 19,06 °C media temperature, 51,73 mm rain, and 10 days raining each month(10), during culture time (June, July, August). These limiting culture conditions, increase difficulty to obtain healthy tomato culture under ecological culture rules. Many parasitic and fungi diseases will appear inside cultures. Soil is clayey with calcium deficiency (11) and previous to culture starting the soil have been inoculated with commercial mycorrhiza's (Glomygel®), in order to maximize plant grow (12, 13).

E. Diseases Detection.

We considered a plant infected, if present usual tomato infections in north of Spain: (*Sclerotiniasclerotiorum*, *Fusarium oxysporum*, *Botrytis cinerea*)and/or parasites (*Helicoverpa Armigera*).Identification of diseases was by visual inspection, at first harvest time,according with the next examples.



Fig. 6. *Fusariumoxysporum*



Fig. 7. *Helicoverpa Armigera*

III. RESULTS

At harvest time none of the HAC tomato plants is identified as infected (fig 8).



Fig. 4. *Botrytis cinerea*



Fig. 5. *Sclerotiniasclerotiorum* (White fungi)

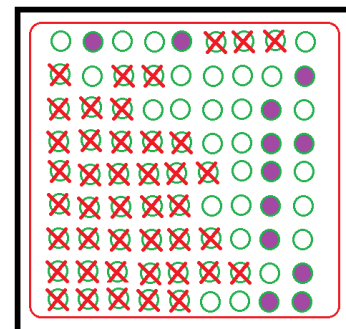


Fig. 8. Infected plant distribution at harvest time (Red Cross marks)

A 53% of tomato plants were infected vs a 47 % free of infections and a 100% of HAC remain uninfected.

If we consider frequency of infections as the relation of infected plants vs total plants in surrounding.

$F_i = \text{number of infected plants} / \text{total plants in surrounding}$

We may obtain the matrix of infection frequency

	1	2	3	4	5	6	7	8	9
1	(1/3)	(3/5)	(2/5)	(2/5)	(2/5)	(1/5)	(2/5)	(1/5)	(1/3)
2	(2/5)	(5/8)	(3/8)	(2/8)	(2/8)	(2/8)	(3/8)	(2/8)	(1/5)
3	(4/5)	(7/8)	(6/8)	(6/8)	(3/8)	(1/8)	(0/8)	(0/8)	(0/5)
4	(5/5)	(8/8)	(7/8)	(6/8)	(4/8)	(3/8)	(1/8)	(0/8)	(0/5)
5	(5/5)	(8/8)	(8/8)	(8/8)	(6/8)	(3/8)	(1/8)	(0/8)	(0/5)
6	(5/5)	(8/8)	(8/8)	(8/8)	(7/8)	(5/8)	(2/8)	(0/8)	(0/5)
7	(5/5)	(8/8)	(8/8)	(8/8)	(7/8)	(5/8)	(3/8)	(1/8)	(0/5)
8	(5/5)	(8/8)	(8/8)	(8/8)	(7/8)	(5/8)	(2/8)	(1/8)	(0/5)
9	(3/3)	(5/5)	(5/5)	(5/5)	(4/5)	(4/5)	(2/5)	(1/5)	(0/3)

Table 1. Frequency of infection matrix

Then we compare the infection around HAC plants and none HAC tomato plants were:

$\sum F_{iHAC} / N^{\circ} \text{ HAC plants} = \text{Infection frequency HAC plants}$

$\sum F_{iNoneHAC} / N^{\circ} \text{ none HAC plants} = \text{Infection frequency none HAC}$

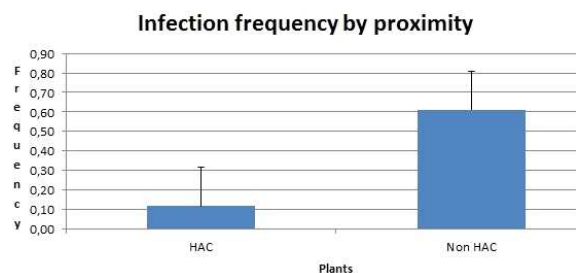


Fig. 9. Infection Frequency, in HAC and none HAC, plants. Mathematical signification was $p > 8 \times 10^{-6}$ using student T test of single frequency

IV. DISCUSSION

Use of mixed plant cultures to improve and optimize resistance to pest (14) is a culture strategy that is day by day more applied. Also overexpression of some metabolic genes is a well know way to enhanced bacterial resistance of the plant itself (15, 16). These may be an explanation of observed resistance of HAC plants to usual area infections. Other reason may be that a half of the genetic of the HAC plants used come from GMO that has been handled in tissue culture and probably selected for pathogen resistance (17). All these reason justifies resistance in HAC plants, but don't clarify why, surrounding plants also remain unaffected.

Use of commercial mycorrhiza's or rhizobacterium (18) is known increase parasitic fungi resistance, but these do not explain the differences between HAC and none HAC plants. The manipulation of resistance genes in some cases may also produce cross-resistance to other diseases (19), in this case the effect, is not limited to the plant body.

V. CONCLUSION

We show here an inter-plant signaling effect. Some of the changes related with the production of HAC in plant tomatoes, produce one environmental signal able to induce disease resistance. If the nature of this signals, is biochemical or due to previous establish mycelial networks (20), need more experimentation specifically designed.

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