CLIMATIC CHARACTERIZATION OF THE MAIN INDUSTRIAL TOMATO PRODUCING AREAS OF SPAIN

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INTRODUCTION

In 2017, the tomato growing industry in Spain covered an area of 33,206 fully irrigated hectares, accounting for a total national production of more than 3.0 million tons. The main cultivation areas are located in the South of Spain: in Las Vegas Altas of the river Guadiana (49.4% of production), the wetlands of the Guadalquivir River (30.5%), Las Vegas Bajas of the Guadiana River (18,0%) and the Vegas of the Alagón River (1.4%).

Climatic characterization to determine the constraints and potential of these growing areas to better understandthe degree to which the climatic conditions satisfy the demands of the crop, is problematic due to the combination
of different factors that are involved. These studies will allow the characterization of growing areas by climatic profile, determine potential yields, and identify variability to enable more sustainable management.

MATERIALS & METHODS

From the maximum, minimum and average daily temperatures of 11 representative stations of the cultivation areas, the days with thermal climatic risks and days with optimum temperatures for each of the fortnights of the months of March, April, May have been determined. and June (vegetative growth period) and the months of June, July, August and September (fruiting period), during the years 2001-16. A total of 96 variables were calculated, of which 35 were finally selected after discarding those that presented a variance of zero or very low. With the selected variables, a principal components analysis (PCA) was carried out, to eliminate the possible redundancy between the variables studied. Second, to obtain a multicriterial climate grouping of the years of study, a hierarchical classification was carried out first and once the cluster number was defined, a non-hierarchical classification was made to group the years of the study period and finally the growing areas according to the types of climatic years obtained.

VEGET PERIOD
Frost days: Minimum daily temperatures below 0ºC
Days with temperature above 12ºC, considered as the minimum of vegetative growth (Criddley et al. 1994; Peet et al. 1997).
Optimal days of vegetative growth: Days with maximum temperatures above 12ºC and maximum maximum temperatures of 30ºC. (Criddley et al. 1994, De Koning, 1994, Sato et al. 2000).
Days with maximum maximum temperatures of 35ºC. (Criddley et al. 1994, Hazra et al. 2007).
Days with temperature differences between day and night between 9-10ºC (Benaccchio 1982).
Days with optimum average temperatures, between 21 y 24 ºC (Geisenber and Stewart, 1986, Adams et al. 2001, Hazra et al. 2007)

FRUCTIFICATION PERIOD
Frost days: Minimal daily minimum temperatures of 0ºC
Days with favorable nighttime temperatures superior to 15ºC (De Koning 1994, Sato et al. 2000)
Days with favorable daytime temperatures below 27ºC (De Koning 1994, Johjima 1995, Adams et al. 2001)
Days with maximum stressful temperatures for the correct development of the fruit, (T>32ºC). (Johima 1995, Levi et al. 1978).
Days with optimum average temperatures: between18 y 24ºC. (Peet et al. 1997, De Koning, 1994, Adams, 2001)

RESULTS & DISCUSSION

Table 1. Results of the main component analysis for the climatic indices derived from the year of the climate stations used in the analysis of the tree climatic groups in Extremadura.

	Etapa de crecimiento vegetativo				Etapa de fructificación				
Year group	PC2	PC4	PC6	PC9	PC1	PC3	PC5	PC7	PC8
1	0.445 a	0.067 a	-0.557 b	0.556 a	-0.135 a	-0.152 b	0.310 a	0.409 a	-0.088 a
2	0.008 a	0.172 a	0.302 a	-0.336 b	0.206 a	0.461 a	-0.462 b	-0.270 b	0.159 a
3	-0.750 b	-0.175 b	0.172 a	-0.074 b	-0.272 a	-0.962 c	0.670 a	0.016 ab	-0.291 a

Means in the same column followed by different letters indicate significant differences according to Tukey's test (P <0.05)

Typology of the years

Years of group 1: Greater number of favorable days at the end of the period of vegetative growth (15 / V-15 / VII). Fewer favorable days for fruiting in July and more favorable nights at the end of the vegetative period (15 / VIII-30 / IX),

Years of group 2: Greater number of favorable days during the period of vegetative growth (1 / V to 15 / VI). Greater number of favorable days in July and fewer favorable nights for fruiting of the end of the vegetative period (15 / VIII-30 / IX).

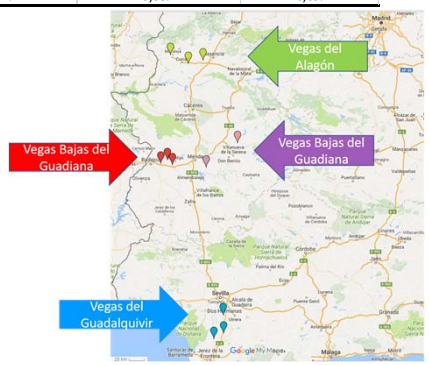
Years of group 3: Less number of favorable days than the previous ones in the vegetative period and in the fruiting conditions.

Table 2. Climate characterization of the main tomato producing areas of industry in Spain

Year gruops	Marismas del Guadalquivir	Vegas Bajas del Guadiana	Vegas Altas del Guadiana	Vegas del Alagón
1	46,53%	33,33%	28,13%	16,25%
2	14,12%	56,25%	62,50%	63,07%
3	39,35%	10,42%	9,38%	20,69%

In the marshes of the Guadalquivir the percentage of years 1 (46.5%) is higher than the rest of the zones, although also the number of most unfavorable years (group 3 years: 39.3%) is the highest. Both Las Vegas Altas, Los Bajas del Guadiana, and La Vega del Alagón, the percentage of dominant years is that of group 2.

The percentage of the best groups of years 1 and 2, is higher in Las Vegas del Guadiana, assuming practically 90% of the years, in the fertile plains of Alagón almost 80% and in the Marismas del Guadalquivir this percentage is 60%.



Grafic 1. Map of weather stations

CONCLUSIONS

In the four areas analyzed:

The limiting climatic factors of the crop (frost and high temperatures) have not been differentiating elements of the cultivation areas.

The favorable thermal conditions make it possible to identify and group both the years and the study areas.

Las Vegas del Guadiana presents, in general, the best climatic conditions in the studied years, although in the marshes of the Guadalquivir the best classified years predominate and at the same time the largest number of less favorable years are also produced.

It would be convenient to extend the years of study and other production areas, with an analysis of trends, in a context of global warming.

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