Research Paper Agriculture

Study of Bioclimatic Relations on Olive Cultivation

Hairi Ismaili | Agricultural University of Tirana, Gene Bank Tirana Albania

ABSTRACT

In two olive varieties, Kaninjot and BTirana, in five geographic area were analysed, specifically: thermal Constant (CT), thermal Sum (St), Vegetative Constant (Cv), hydrothermal Constant (Cht), Edaphic Humidity, fat index, quality index, biometric index, maturity index etc. The data were modelled as per JMP software and DG modelling bioclim/domain. The results showed that suitability index (IS), has produced declining results following longitude (N), and by order: plot (1>2>3>4>5). Index IS, had a strong positive relation (r^2=0.98), with the longitude. Also through Ip, Ct, Cv and Cht, produced positive results and the correlation coefficient (r^2=0.88>0.82>0.79). The olive reacts positively up to longitude 390.38", until 42017', whereas further extension in terms of longitude presents a general declining performance, especially for the indices of maturity, quality and productivity

KEYWORDS Olive; Humidity; Bioclimatic; Olive growth; Territory

Introduction

The olive tree responds to climate elements especially temperature, light, wind, precipitation etc. Altogether they undergo physiological and morphological suitability and define yield [1]. Each element becomes important as of the area where it is studied, thus different authors have set different criteria in selecting the indices, in relation to the area under study [2]. The most important climate influences belong to vegetative growth, from blossom to fruit, dynamics of fruiting and fruit growth, and the process of fruit ripeness, oil contents etc., which in a lot of cases limit biological processes [3]. Considering the olive bio climate relations temperature is of great importance, as it is the first parameter that adjusts the geographical distribution of this species. This research uses several indices of the environment, defining the varietal performance at the longitude of cultivation, in order to serve the formulation of new olive groves.

Material and Method

Bio climate correlations of two cultivars were analysed at the longitude 39°38' in the South and 42°17' in the North, in five different areas during the period 2010-2012, for the index of suitability. Numerical indices of temperature and precipitation were gathered for a 30-year- period (1970-2010). Criteria were set for the selection of areal indices per each element. Thermal Constant (C^T) was analysed per each place, constituting the average temperature and number of days per period from blossom to ripeness ($C^T = T^m n$). Thermal Sum (S^T), was calculated via the formula; $S^T = S(t_m^{\circ} - z^b)$, above average and biological zero temperatures to identify the temperatures available at growth. Vegetative Constant (C^v), ($N^d/Z^{b)}$, for the active period of growth. Hydrothermal Constant (C^{ht}), was calculated:

$C^{ht}=\frac{\Sigma R}{\Sigma T_e}\times 0$ to analyse hydric ratios with the temperatures. Average monthly temperature and precipitation during May-October were calculated through the formula: ($P=\Sigma T_m^{\circ}.H_m$). Energetic Index (I^E), to display the heliothermal sum for the synthesis of 1 gram oil as of formula;

$I^e=\frac{E\cdot h}{P_{o\cdot}\cdot O}$, was calculated by the ratio of effective temperature with the oil grams per tree. Maturity Index (I^M) was analyzed on 20 December as of formula:

Other simultaneous analysis included: oil percentage in fruit, average fruit weight, D, d, D/d of the fruit, peroxides, acidity and soaps. Several indices were also calculated, such as: Edaphic Humidity, fat index, quality index, Morphological Index (M^I). The data were modelled as per JMP and DG software. Linear regression was used to analyse the common distribution of variables on the relation and the impact of environmental factors. The results of the statistical analysis enabled the use and processing of generalizing formulas for the scientific plausibility of such a method [4-7].

Results and Discussions.

Both olive varieties: Table 1, Kaninjot and B.Tirana, have a thermal Constant 24000, but they were under different climate conditions. Vegetative Constant CV, has minimal values in Koplik (197) and optimal values in Saranda (305). Maturity index as a function of thermal constant displayed the effects of bioclimatic relations per each space, for the oil and the elements responsible for quality (S>V>T>Sh>K). Energetic and hydric availability was different and has influenced differently on the physiological processes for the phase of the annual cycle of the olive tree: Formation of the floral cluster, corolla forms and predominates, corolla changes of color, We appreciate the stamens, beginning of the flowering, total flowering, dumbfounded fruit, hardening of the bone, environ, maturation of the fruit, Figure 1. Oil was reduced at 1% per each degree of longitude as follows: (S>V>T>Sh>K% oil). Southern oil is tastier, of better smell and colour, as it contains a higher percentage of fatty saturated acids, as opposed to the oil of the Northern areas as a result of ripeness differentiation. Low temperatures, strong winds during ripeness period have reduced the quality of oil in the Northern area. The number of peroxides goes beyond the optimal level as well as the percentage of acidity. (K>Sh>T>V>S. Acide%).

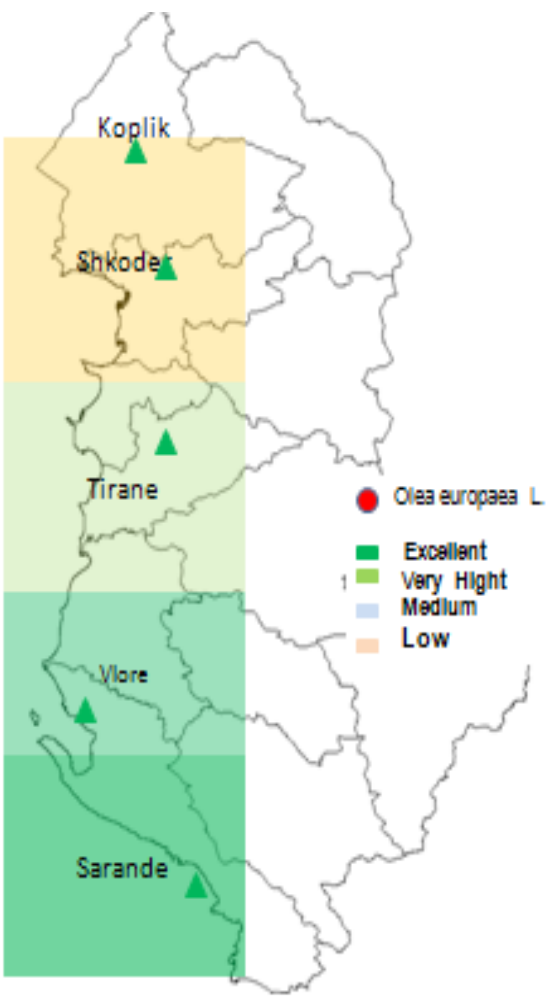
Table 1. The main bioclimatic indices in five geographical study area for two varieties of olive

Indice / Area	P	S^T	C^{ht}	C^v	C^T	O	I^e	I^M	M^I	C^B	H^{EN}	I^S
Koplik	1910	2046	9.3	197	3683	23.4	0.08	2.9	5	3	4	4
Sarande	1196	2832	4.2	305	4943	27.2	0.1	4	8	6	6	8
Shkoder	1844	2159	8.5	221	3814	24.2	0.08	3.1	5	4	4	5
Tirana	1219	2121	5.7	246	3958	25.4	0.08	3.2	6	4	5	5
Vlora	892	2427	3.6	294	4536	26.8	0.1	4	8	6	6	7

P-annual precipitation, ST-Thermal Sum, Cht-Hydrothermal Constant, Cv-Vegetative Constant, CT-Thermal Constant, O-oil, Ie-Energetic Index, IM-Maturity Index, MI-Morphological Index, HEN-Geographical Index, IS-Suitability index

Bioclimatic correlations: *In figure-1, Thermal constant* (C^T) displayed variation of increasing values of the cultivars at each biological phenophase, following longitude, (S>V>T>Sh>KC^T) which was statistically proved at the value of T^F. Average temperature is different and the impact of longitude in reducing temperature is 38%. Thermal Sum (S^t), in each analyzed area has different values available for growth, of the olive. Vegetative Constant (C^v), is a function of the thermal sum and was reduced following cultivation longitude. (C^v. from Saranda to Koplik) Hydrothermal Constant (C^{ht}), changed from 3.6-9.3, and the optimal focus of growth was 3-4,5. From Tirana to Koplik Cht, has higher value as the large effect of humidity. This climate is favorable for cycloconium infections that damage the leaves tree and indirectly reduce suitability index. During the phenophase formation of the floral cluster-maturation the olive needs 550-600 mm water, for the biochemical processes of fruiting, fruit growth and oil formation. It was observed that with the increase of temperatures, precipitation was reduced, thus creating the hydric crisis at the phenophase of endocarp sclerification. Fruit fallen from the trees have to preserve turgor and to survive. Pulp growth and oil formation started with the first autumn precipitation.

Maturity Index, average fruit weight has proved changes ***lsd.1.11, alpha=0.05***, simultaneously ripeness index, thus as a result oil percentage and endocarp colour. Energetic index resulted 0.08-1. Edaphic Humidity, fat index, quality index, biometric index according catminate code resulted differently. Pursuant to the analysis of distribution and variable relations in ***figure 2***, climatic availabilities and limiting factors were provided. Information processed by statistical data, showed that the space - object of the study, in its complexity is characterized by thermal heterogeneous availability, in several cases appropriate for a wide range of varieties with retarded ripeness.



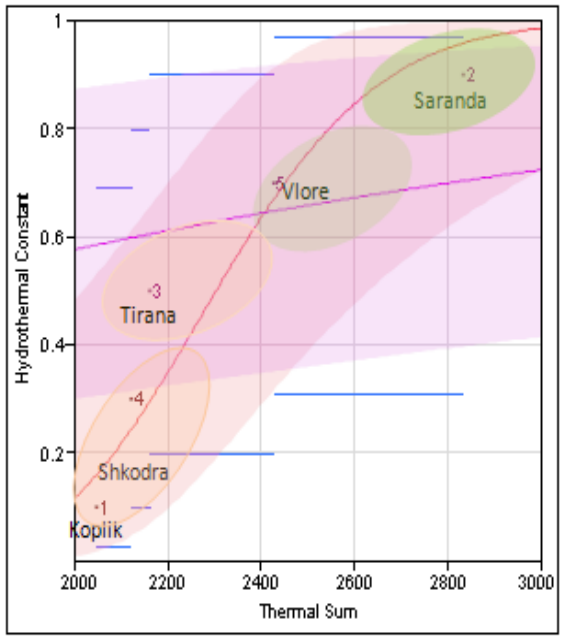


Figure 1. (left) The longitude of the olive cultivation in Albania.The presentation of five study area DG bioclim/ domain, expresses the suitability index olive "Kaninjot" and "BTirana" cv.

Figure 2. (right), the orthogonal regression and Statistics Estimates of Thermal Sum and Hydrothermal Constant probability for the Kaninjot and B. Tirana Cv.

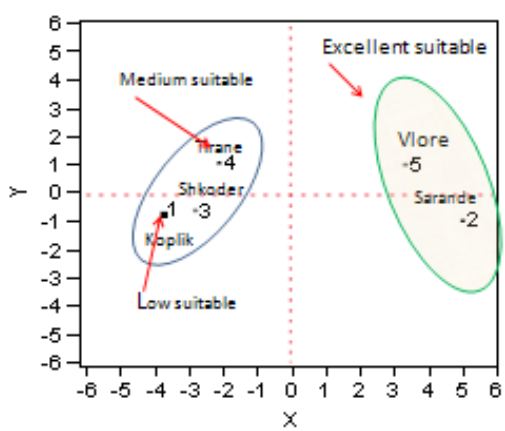


Figure 3. Analysis of the main coordinates for the five study area based on the bioclimatic indices and the catminate code. PC1 and PC2 contitue 97.4% of the total variation. The area were distributed in four representative spaces positive and negative of PC1 and PC2

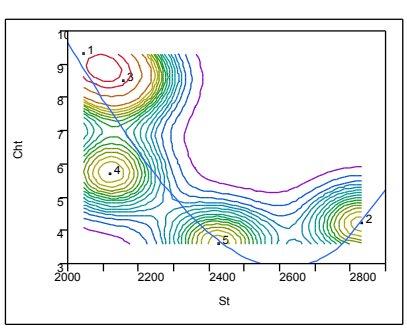


Figure 4. (right) Discriminant method for the Statistics Comparisons of Thermal Sum By Hydrothermal Constant and biological indicators.

Different spatial relations were identified for the relation between bioclimatic indices, which had different suitability index. PCA highlighted the degree of influence per each cultivation space, where 7 indices were important among 18 analyzed factors. PCA identified the variances of the principal components and the proportion of the total variance each factor accounts for, and three PC that account for 99.6% of the total variance are retained for further analysis. The percentages of total variation accounted for by each of the first three PCs are 91.8%, 5.6%, and 2.2%, respectively. PC_1 and PC_2 contitue 97.4% of the total variation. DG bioclim/domain processed the relation between biological and environmental indices and classified suitability spaces.

Figure 3, displays heterogeneous suitability pursuant to longitude to test maturity index quantity and quality of the oil considered as a marker of testing performance. Variance analysis has displayed the degree of interrelation genotype-environment. Phenotype features were the results of genotype interaction with the environment, which means the result of their function. Suitability index resulted differently and from this viewpoint the spaces were ranked as follows: (S>V>T>Sh>K. I^S) and with a value of (8>7>5>4 I^S). ***Prob > F 0.53, Prob>t 0.49***

The results showed that suitability index (I^S), has produced declining results following longitude (N), and by order: plot (1>2>3>4>5). Index I^S, had a strong positive relation (***r^2=0.98***), with the longitude. Also through I^P, C^t, C^v and C^{ht}, produced positive results and the correlation coefficient (***r^2=0.88>0.82>0.79). Analysis SG Discriminant method, displayed olive space in 4*** plots which have heterogeneous performance. P***olynomial Fit Degree =*** Cht = 32.213241 - 0.0118304*St + 1.4533e-5*(St-2317)^2 + 1.192e-8*(St-2317)^3. The plot 2 to 5 have the excellent suitability index, number 4 has suitability average, while in the north have the shown smaller performance, *figura-4*. The olive reacts positively up to longitude ***39^0.38", until $42^0$39', whereas further extension in terms of longitude presents a general declining performance, especially for the indices of maturity***, quality and productivity.

In ***figure 2 and 3,*** the five spaces were positioned on two plots at the coordination axis. One of them had ideal performance, and the second average suitability. Characterization of spaces ***figure-1*** helps and orientates for the creation of new olive groves, based on the specific environmental needs.

Areas in their complexity were characterized by thermal availabilities suitable for the use of a wide range of indices. Their analysis shows the variability of latitude, which characterizes the whole plant cycle specifically during the ripeness months, thus showing a critical factor to get qualitative yield. This scarcity might be filled in by the immersion of new varieties of a short ripeness cycle.

Conclusions

Oil is a product of metabolism strongly influenced by the relation genotype-environment. This relation has an important role on the fruit characteristics, dimensions, pulp/endocarp ratio, ripeness index, lipid content, oleic/linoleic ratio, in strong correlation with the environmental conditions.

In Albania optimal area of olive cultivation is at longitude $39^0$38' to $40^0$45'. In the space $40^0$45'-$41^0$38', suitability Index has the average value. In pursuit of the geographical longitude this index is reduced and the olive cultivation is done without economic value. In these conditions should be cultivated olive varieties with Thermal Sum (S^T), 1800-2200.

REFERENCES

1. Forbes H., Foxhall: L: The queen of all trees. Preliminary notes on the archaeology of the olive. Expedition, 1978, 21: 37-47. http://dx.doi:10.1086/356568 | 2. Mulas, A, Porceddu, A. (2006): "Genetic Structure of Wild and Cultivated Olives in the Central Mediterranean Basin," Annals of Botany, Vol. 98, No. 5, pp. 935-942. | 3. Gregoriou C. (1996) Assessment of variation of landraces of olive tree in Cyprus. Euphytica 87: 173-176 http://dx.doi.org/10.1007/BF00023745 | 4. Jolliffe I.T: (2002). Principal Component Analysis, Second edition, Springer Series in Statistics. UK,2002, (3): p.143-180. http://dx.DOI: 10.1002/0470013192. | 5. SAS: JMP Statistical Discovery. (2012) .SAS Institute Inc. (10): 1-76. | 6. Franzluebbers AJ. Introduction to special section – Supporting ecosystem services with conservation agricultural approaches. Renew Agr Food Syst. 2013;28:99–101. doi.org/http://dx.doi.org/10.1017/S1742170513000021 | 7. Younge A, Fowkes S. (2003). The Cape Action Plan for the Environment: Overview of an ecoregional planning process. Biol Conserv. 2003;112:15–28. http:// | doi.org/10.1016/S0006-3207(02)00393-2 |