ANALYSIS OF THE EFFECT OF THE CLIMATE FACTORS ON THE ORANGE PRODUCTION IN YEMEN

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Abstract.

Yemen unquestionably produces many quantities of Oranges. There are about 985380 orange, which are affected by several factors. Climate is one of the important factors. This paper tends to focus on the effect of climate- causing an increase or a decrease- on the production of orange.

Spectrum analysis, used to analyze this problem on the production of orange in Yemen, and the extent of its effect on those working in the agricultural area in order to uncover, and solve the problems caused by climate.

This model concentrates also on temperature, rain, air relative humidity, wind and light. The spectrum analysis, which used the correlation between the production of orange and the temperature of many periods of time, is based specifically on the following relationship:

$$y_t = \tilde{y} + [\ \sum_{i=0}^{n} \alpha_i \cos W_i t + \sum_{i=0}^{n} \beta_i \sin W_i t\ ]$$

This relationship investigates if there is a correlation between the increase and decrease of temperature and the production of orange. The results show that the expected values of the production of orange in Yemen are not as required due to the effects of different factors like the climate. It is found that the climate directly affects the production of orange either by an increase or a decrease. To sum up, if the temperature decreases, then production of orange increases, and vice versa

1 Introduction:

The climatie factors influencing orange growth and production are discussed in this paper. Temperature, rain, humidity, wind and light are the most important climate factors, which determine the suitability of a specific site for the growing of orange.

The climate of Yemen varies mainly with altitude from a hot and dry desert climate in the low lying South East and West regions to a temperate in Southern, Central and Northern highlands. Based on climate, Yemen has traditionally been divided into five climatic zones, and these are: Coastal areas, Southern Uplands, Central Uplands, Northern Highlands and Eastern plateau (EL-Gouri, et al, 2006).

Mean annual temperature ranges from less than $11C^0$ in the highlands to above $31C^0$ in the coastal areas. In summer, temperature may rise up to $45C^0$ in low lands and above $45C^0$ in the desert of eastern region. In winter temperature may decrease below zero in the highlands, ranges from 30% in arid zones of the eastern region to above 80% in coastal areas, and generally it becomes less in winter during months of January to April (El-Gouri, et al., 2006 and Medhej, 2009).

Temperature is the first climate factor. Orange growing areas found to be of the highest maximum temperatures, which are the result of low humidity.

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The climate in Yemen in orange cultivation areas is characterized to be tropical dry and with two distinctive seasons; a hot season "April- September" 39.8C^{O} maximum, a cold season " October- March" 14.9C^{O} minimum (Medhej, 2009).

Secondly, there is a controversy about the effect of rain on pollination and fruit set. After pollination, rain is considered as a washing agent that takes away most of the applied pollen. Another negative effect of rain on fruit set also results from low temperatures that accompany or follow rain. A third factor is the reduction of the flower's receptivity when in contact with water (Zaid, et al, 2011).

Orange growers must assume that the rain will affect pollination/fruit set, and any pollination process must be repeated if preceded or followed by rain (4 to 6 hours). Rain is also responsible for increasing the relative air humidity, creating favorable conditions for cryptogrammic diseases that result in the rotting of inflorescences (Zaid, et al, 2011).

The areas of orange cultivation in Yemen are subject to rains in spring and autumn by an average not exceeding 76 mm., scarcely, rainfall may exceed 100 mm between once to 16 times annually (Falhoom, 2012).

Depending on air humidity at the locality of a orange plantation, the third climate factors where various advantages and/or disadvantages are found. In fact, the orange eco-system is mostly of an arid nature where air relative humidity has a large influence (Zaid, et al, 2011).

Air humidity also affects the orange quality during the maturation process. It causes little damage to the fruit in case they are neglected. At high humidity, fruits become soft and sticky, while at low humidity they become very dry. This phenomenon is strengthened when low humidity is coupled with hot and dry winds. The air relative humidity in Yemen is about 46% humid in minimum, the number of sunny hours is 9.5 per day. Sun radiation is not less than 450 calorie/cm^2 (Medhej, 2009).

One of the influential factors is wind; it is, however, a carrier of dust and sand that adhere to the orange fruits in their soft stage. In most orange growing areas the latter part of the pollination season is usually characterized by severe hot and dry winds, which dry out the stigmas of the female flowers. The falling down of an old orange may be caused by strong wind but only in the following cases:

- If the orange tree is very tall with a large crown and grows in shallow soil;
- If a large number of offshoots are removed form the trunk of a orange at one time, leaving the orange without basal support; and
- if rats have gnawed away the roots on one side of the orange tree (Zaid, et al, 2011).

The strength of winds in Yemen may cause falling of oranges and breaking of some orange bunch, and perhaps the fall of weak trees in some cases. It is preferred that anti wind repulsive from long trees to be cultivated in the areas which are liable to winds so as to preserve orange.

The growth of a orange is inhibited by light rays at the violet and yellow end of the spectrum, but enhanced by rays at the other end of the spectrum i.e. red light. These latter rays are most active in promoting photosynthesis. Clouds could reduce light intensity, but unfortunately, the sky is un-clouded in the orange growing countries during the ripening period (July to October in Northern Hemisphere and February to May in Southern Hemisphere) (Zaid, et al, 2011).

2 Spectrum Analysis:

The spectrum analysis is considered as a new mathematical method that studies the economic, social and natural problems. This method is used in the study of all phenomena that are affected by seasonal fluctuations, e.g. products connected with climate "Orange". This model can be shown in the graph consequent time series for at least ten years as below (Hajeer, 2011, Agilent, 2005, Abbas, 2001, AL-Hadrami, A.R. (1992, Barakat, 2004, Bolch, & Huang, 1974, Boxetal., 1994, and Candès, 1998)).

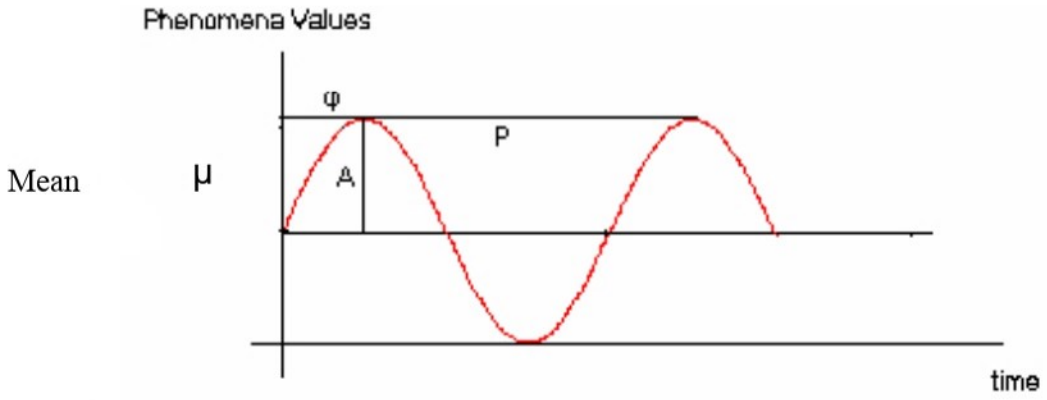

Figure 1: the spectrum analysis phenomena

Amplitude (A): is the distance that separates first high (peak) from the straight line, which is parallel to x-axis that means the mean.

The phase (φ): is the distance from the first high (peak) to y-axis.

The period (P): expresses the necessary number of time moments for one period.

μ = Mean.

Time series according to Fourier division:

Fourier theory for dividing time series is based on the following equation.

1-Conrer frequencies:

$$W_i = \frac{2\pi_i}{N} \; when i = 0,1,2,3,\ldots\ldots\ldots\ldots\ldots,n$$

When (n) refers to a half 2n=N this indicates that the number of the time series components does not exceed half of the observations.

$$W_0 = \frac{2\pi_o}{N} = 0$$

$$.W_1 = \frac{2\pi_1}{N}$$

$$W_n = \frac{2\pi_n}{N} = \pi$$

The least waved.

$$C_i t = \sum_{i=1}^{\infty} \alpha_i \cos W_i t + \sum_{i=0}^{\infty} \beta_i \sin W_i t \text{ ----------(1)}$$

Where (W_0)=sinW_0t and cos W_0t =1 and the first term of each group is simplified to the following:

$$\alpha_0 .1 = \alpha_1$$

$$\beta_0 .0 = 0$$

And the first term of the second sum as (β_0) stands for the mean and the equation (1) becomes:

$$C_i t = \sum_{i=0}^{n} \alpha_i \cos W_i t + \sum_{i=0}^{n} \beta_i \sin W_i t \text{ ----------(2)}$$

The variances:

The variances will be computed as follows:

1- the total variance is estimated by the following equation:

$$\varsigma^2_{ty} = \frac{\sum_{i=1}^{N} (y_t - \bar{y})^2}{N-1}$$

2-The exponent variance is estimated as follows:

$$\delta^2_{tyy_i} = \frac{\sum_{i=1}^{N} (y_t - \tilde{y})^2}{N-1} \; when i = 1,2,3,\ldots\ldots,n$$

3-The non-exponent variance is applied:

$$\delta^2_{y_i} = \frac{\sum_{i=1}^{N} (\tilde{y}_i - \bar{y})^2}{N-1} \; when i = 1,2,3,\ldots\ldots,n$$

In conclusion, the basic equations in spectrum analysis are as follows:

$$y_t = \tilde{y} + [\sum_{i=1}^{n} \alpha_i \cos(w_i t) + \sum_{i=1}^{n} \beta_i \sin(w_i t)]$$

$$w_i = \frac{2\pi_i}{N}$$

$$A_i = \sqrt{\alpha_i^2 + \beta_i^2}$$

$$\alpha_i = \frac{1}{N} \sum_{i=0}^{N} (y_i - \tilde{y}) \cos w_i t$$

$$\beta_i = \frac{1}{N}\sum_{i=0}^{N}(y_i - \tilde{y})\sin w_i t$$

$$\theta_i = \tan^{-1}\frac{\beta_i}{\alpha_i}$$

$$\varphi_i = \frac{\theta_i}{w_i}$$

3 Results and Discussion:

Based on the results as shown in table (1), It seemed that there was no much influence of time factor on the production of orange. In this study, although time factor does seem to be positively correlated (r = 0.58) with production of orange, it can still generalize from these data that time factor could not be using as strong cause of the sequence changes of production of orange. This result indicated that other factors should be considered on the variation of production of orange. Climate parameters maybe considered as the main factors that affected on the variation of production of orange. To prove this consideration and to find out the best exponent variance, the following equation was used.

$$C_i t = \sum_{i=0}^{n}\alpha_i \cos W_i t + \sum_{i=0}^{n}\beta_i \sin W_i t$$

Table 1. Production of orange in Yemen (according to the recording of the Central Statistical Organization).

Year	Production (ton)	Year	Production (ton)	Year	Production (ton)
1997	14464	2003	21906	2009	27205
1998	14040	2004	22114	2010	27894
1999	31702	2005	22536	2011	29517
2000	33962	2006	21595	2012	30837
2001	25898	2007	24188	2013	32590
2002	21697	2008	25158	2014	33564

Source: Central Statistical Organization, 1998-2015.

The exponent variance was calculated after adding the components one by one, in order to get the best variance to interpret the phenomenon of orange production. The value of the first component was found to be 0.482. This result was not accepted to interpret the phenomenon. The values of 2nd, 3rd, 4th, 5th, 6th, 7th and the 8th components were "0.660, 0.691, 0.698, 0.726, 0.729, 0.731, 0.731" respectively. These results were not strong to interpret the positive correlation between time and climate factors. While the "9th" component recorded the best exponent variance "0.751". This is acceptable because it was the last component. In short, the production of orange in Yemen is affected by climate factors.

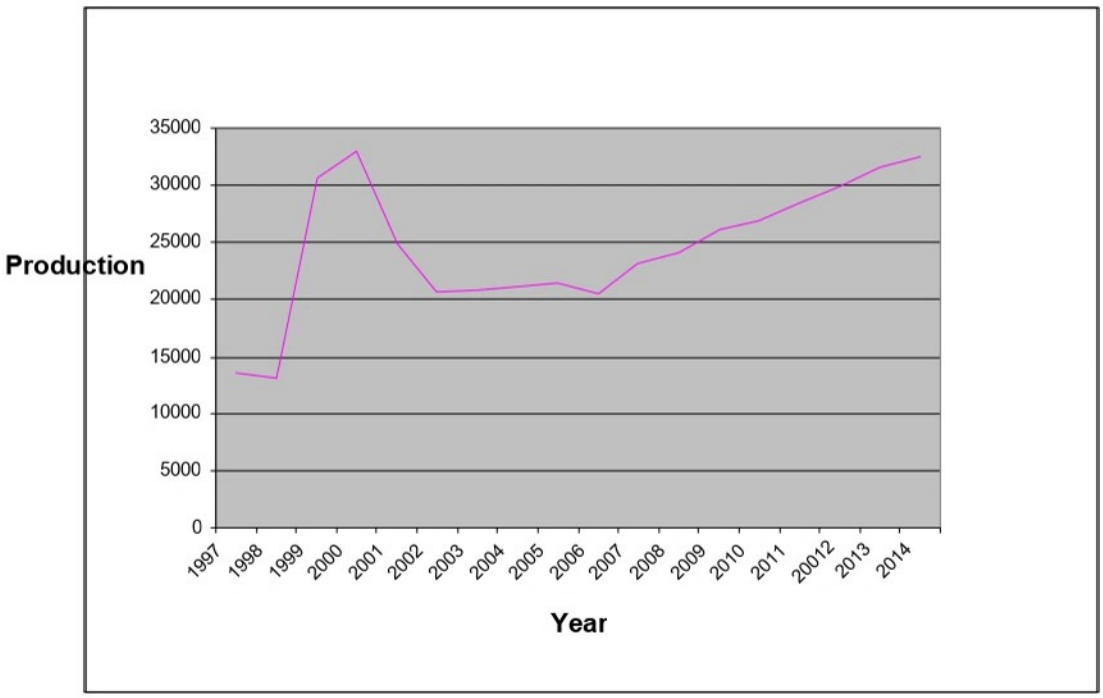

Figure 2. Production of orange in Yemen

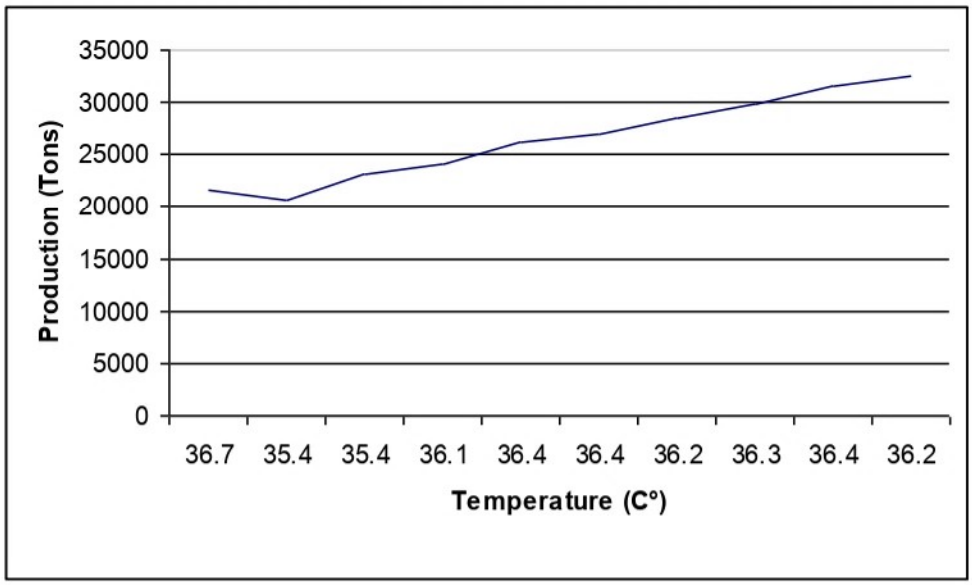

Figure 3. The effect of temperature on the production of orange in Yemen.

From figure (3), it is concluded that when temperature increases, the production of dates palm increases and vice versa.

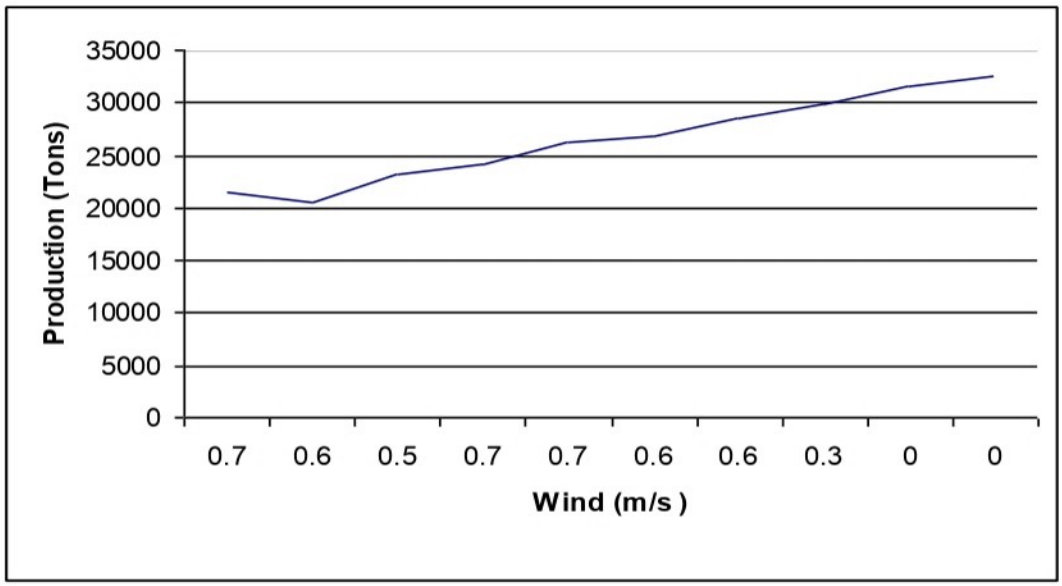

Figure 4.The effect of wind on the production of orange in Yemen

The above figure shows that strong winds cause falling of fruits and breaking of some bunches which lead to a decrease in the production of orange.

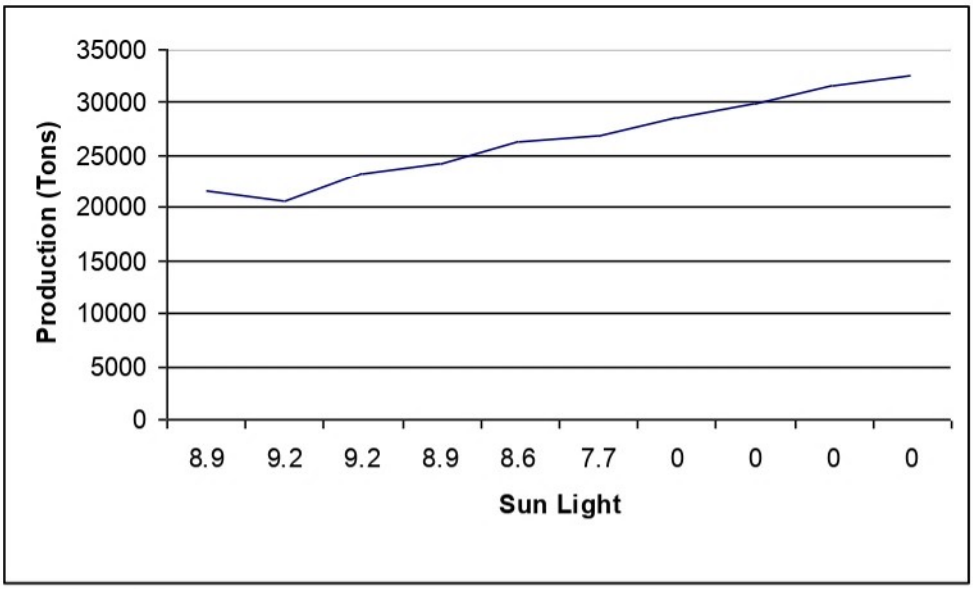

Figure 5. The effect of light on the production of orange in Yemen

Figure (5) shows that when sun light intensity is high, it causes damage in the fruits. And when it is cloudy, it leads also to the same damage. As a result, the production of orange decreases.

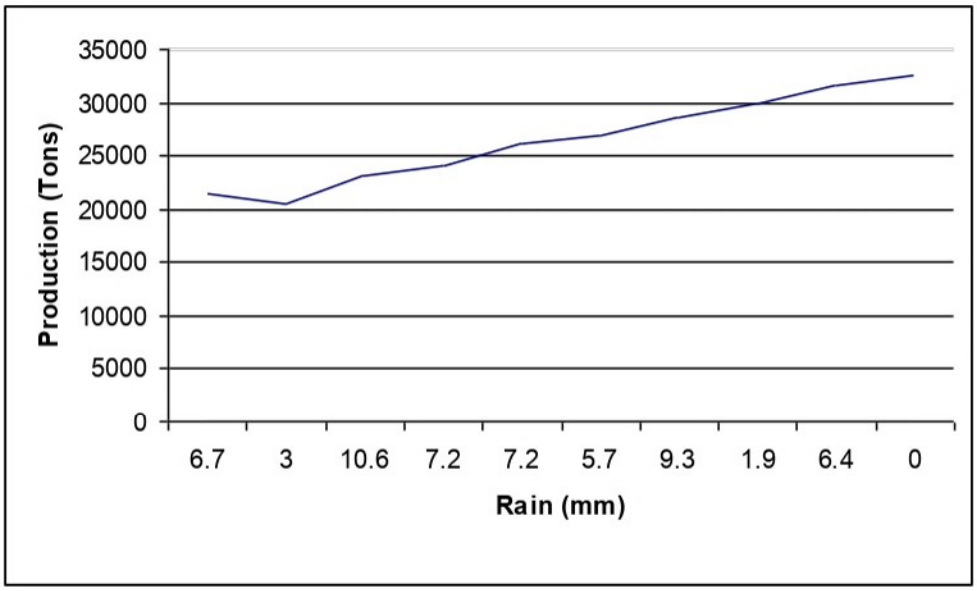

Figure 6.The effect of rain on the production of orange in Yemen

Figure (6) indicates that when the average rainfall (during pollination and Rutab) is high ,it causes wetness in the fruits .Consequently, the production of orange decreases.

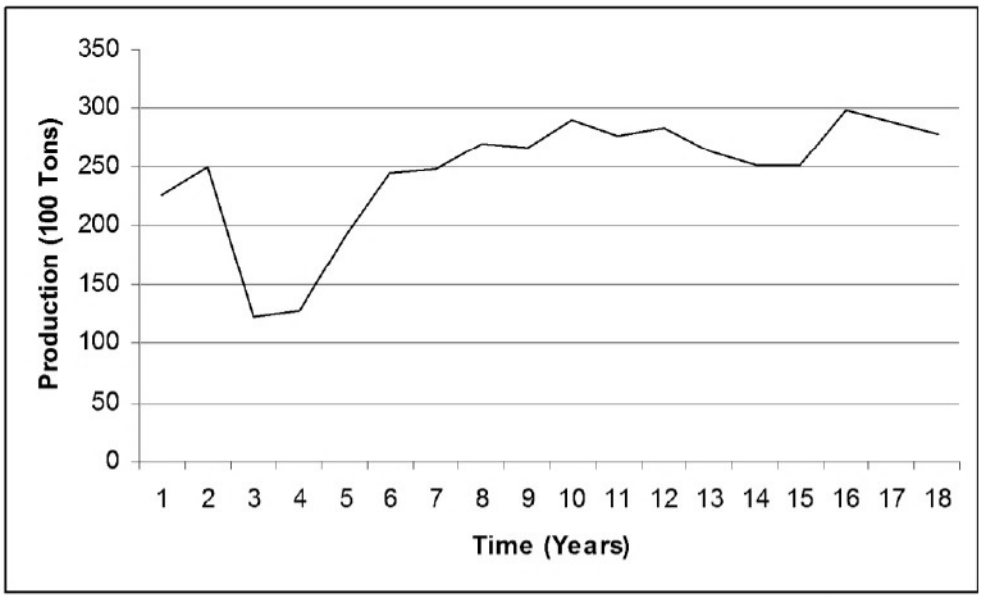

Figure 7. The production of orange in Yemen after the addition of the 9th component.

4 Conclusion

Based on the results in this study, it could be concluded that production of orange was affected by climate factors. In addition, the five important factors (temperature, rain, humidity, light and wind), which determine the suitability of a site for orange cultivation, could be used as predictors for the changes in production of orange. The effect of these factors on the growth and production of orange can be considered as a combination of all the factors and not by a discrete one.

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تحليل تأثير العوامل المناخية في انتاج البرتقال في اليمن

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الملخص

اليمن تنتج كميات من البرتقال من نحو 985380 شجرة برتقال، وهي تتأثر بمجموعة من العوامل، فالمناخ هو أحد أهم هذه العوامل. هذا البحث يحاول أن يركز على أثر العوامل المناخية المتسببة في زيادة أو انخفاض إنتاج البرتقال.

استخدم البحث طريقة التحليل الطيفي لتحليل هذه المشكلة المتعلقة بإنتاج البرتقال في اليمن، وامتداد تأثيرها في المساحات الزراعية، ومعالجة المشكلات التي تحدث بسبب المناخ.

هذه الطريقة تركز أيضًا على: الحرارة، والأمطار، والرطوبة، والرياح، والضوء.

والتحليل الطيفي يستخدم العلاقة بين إنتاج البرتقال والحرارة لفترات زمنية متعددة، تعتمد على العلاقة الآتية:

$$y_t = \tilde{y} + [\ \sum_{i=0}^{n} \alpha_i \cos W_i t + \sum_{i=0}^{n} \beta_i \sin W_i t\ ]$$

هذه العلاقة تستكشف ما إذا كان هناك علاقة بين الزيادة أو الانخفاض في الحرارة وإنتاج البرتقال. إنَّ نتائج هذه الدراسة تبين أنَّ القيم المتوقعة لإنتاج البرتقال في اليمن لا تعود فقط للعوامل المناخية، وإنَّما العوامل المناخية هي التي لها أثر أكبر في إنتاج البرتقال. فقد وجدت هذه الدراسة أنَّ العوامل المناخية لها تأثير مباشر في إنتاج البرتقال بالزيادة أو الانخفاض في الإنتاج. وخلاصة ذلك أنَّه كلما انخفضت درجة الحرارة فإنَّ إنتاج البرتقال يزداد، والعكس صحيح.

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