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# ATTEMPT TO ESTIMTE SUNSHINE CONDITIONS IN THREE CHOSEN AREAS OF OLSZTYN VOIVODESHIP

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A b s t r a c t. In this paper an attempt was undertaken to estimate sunshine value for the period of 1971-1990 for three chosen localities of Olsztyn voivodeship, as well as its effect on potato yields. The highest sum of sunshine hours during the investigated 20-year period was found in Tomaszkowo (1348 h), the lowest sum was in Łężany (797 h). Coefficient of variation ranged from 11.34 in Tomaszkowo to 11.66 in Łężany. For potato yielding, the most favourable sunshine influence has been proved to be from 1100 to 1200 h.

K e y w o r d s: sunshine duration, global radiation, Mazury Lake District, potato yield

## INTRODUCTION

Sunshine duration is one of the elements of the general characteristics of climate conditions of the Mazury Lake District. Growth and development of plants and crops depend partly on the sunshine rate.

Meteorological stations in the Mazury Lake District as well as in the entire area of Poland, which measure sunshine ratio, are distributed randomly.

Meteorological stations of the University of Agriculture and Technology in Olsztyn (Bałcyny 53°40' N; 19°50' E, Łężany 53°56' N; 21°18' E, Pozorty 53°47' N, 20°32' E) do not cary out the sunshine observations. Therefore there was a need to interpolate these values from the observed data from the Institute of Meteorology and Water Management (IMGW) stations.

In this paper an attempt was undertaken to estimate the sunshine duration value for the period of 1971-1990 for the stations listed above. These data are approximate.

## METHODS

Data for Bałcyny, Łężany and Tomaszkowo were obtained by interpolating data from the nearest three meteorological stations, which carry out the sunshine duration measurements: Toruń, Prabuty and Kętrzyn [1,5].

While working on the material an attempt was made to investigate the influence of sunshine duration on the crop yield of potatoes at the Agricultural Experimental Station (RZD) Bałcyny as well as to find the radiation value.

Lacking suitable measuring equipment, global radiation was calculated indirectly, using Black's formula [2]:

$$Q = Q_A\,(a+b\,n/N)$$

where $Q$ is the searched value of global radiation in kWh during the vegetation period, $Q_A$ is the value of sun radiation, which would reach the ground surface with no atmosphere during the vegetation period, $n$ - the real number of sunshine hours, $N$ - maximum number of sunshine hours, $a$ and $b$ - regression coefficients assummed according to Paszyński [4] for the geographical northern latitude.

## RESULTS

On the basis of the IMGW observations from the meteorological stations, nearest to the investigated sites, the value of sunshine duration for Bałcyny, Tomaszkowo, Łężany for 1971-1990 vegetation periods was found through interpolation. The real sunshine values in hours are listed in Table 1.

Analysing the sunshine distribution given by Wiszniewski [7] for north-eastern Poland during the investigated period with maximum sunshine duration value of 1200 h, it can be stated that the values for the stations mentioned above are almost equal. The highest sum of sunshine hours during the vegetation period was observed in Bałcyny (23236 h), a little lower in Tomaszkowo (23021 h), and significantly lower - in Łężany (22716 h). A similar distribution appeared during most of the investigated period except for the years: 1971, 1972, 1977, 1984, 1985, and 1989, when the highest sunshine ratio was found in Tomaszkowo and Łężany. The lowest values among the three considered stations were found in the years 1973 and 1974 as well as in 1986 and 1990 in Bałcyny.

During the analysis an attempt was made to investigate the influence of sunshine duration on potato yields in RZD Bałcyny, for which the actual research material for 1972-1990 was available.

Analysing the sunshine duration value and potato crops, a significant correlation was found. This correlation is expressed through the 3rd degree polynomial (curvilinear correlation coefficient R=0.7173), (Fig. 1).

The figure shows a significant influence of sunshine duration on the potato crop between 912-1156 h. These values are matched by the specific radiation amount given to the plants at 660 to 770 kWh/m$^2$. At greater sunshine

**Table 1.** Real sunshine (in h) during the vegetation periods in years 1971-1990 in the chosen localities of the Mazury Lake District

| Year | Locality | | |
|---|---|---|---|
| | Balcyny | Tomaszkowo | Łężany |
| 1971 | 1305 | 1321 | 1318 |
| 1972 | 1077 | 1088 | 1080 |
| 1973 | 1336 | 1348 | 1355 |
| 1974 | 1190 | 1205 | 1224 |
| 1975 | 1329 | 1281 | 1189 |
| 1976 | 1306 | 1257 | 1188 |
| 1977 | 1098 | 1118 | 1124 |
| 1978 | 1099 | 1086 | 1094 |
| 1979 | 1183 | 1155 | 1164 |
| 1980 | 912 | 832 | 797 |
| 1981 | 1050 | 994 | 1022 |
| 1982 | 1288 | 1271 | 1216 |
| 1983 | 1179 | 1152 | 1112 |
| 1984 | 975 | 1004 | 989 |
| 1985 | 988 | 1009 | 983 |
| 1986 | 1037 | 1212 | 1222 |
| 1987 | 969 | 981 | 982 |
| 1988 | 1202 | 1175 | 1140 |
| 1989 | 1281 | 1285 | 1266 |
| 1990 | 1241 | 1247 | 1251 |
| Sum | 23045 | 23021 | 22716 |
| Mean | 1152.25 | 1151.05 | 1135.80 |
| C.V. | 11.41 | 11.34 | 11.66 |

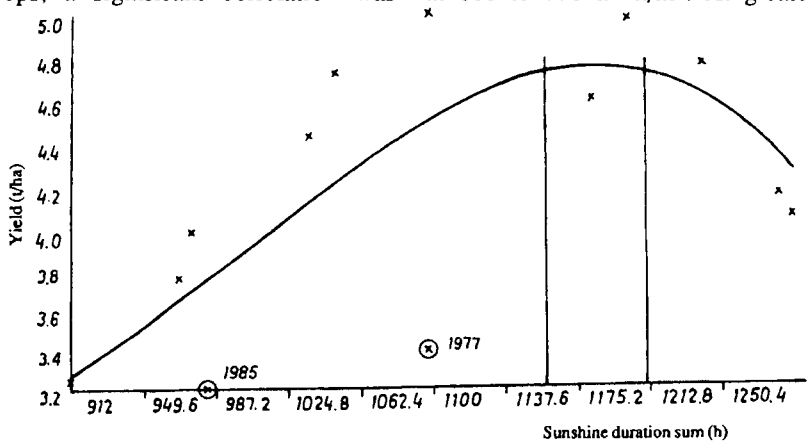


**Fig. 1.** Influence of sunshine duration (sums for vegetation period) on potato yielding in 1972-1990 in RZD Bałcyny.

values (more than 1200 h) this dependence is considerably lower [3].

In the study, the years 1972, 1973, 1974, 1975, 1976, 1983 were omitted. In the years between 1971-1976, the potato cultivar Noteć was cultivated, subsequently until 1990 - Tarpan cultivar. In 1983 the vegetation period for potato was shortened because of virus diseases (e.g., plant's height during flowering period was 47.7 cm, while the mean height during the investigated period was 76.5 cm). Despite that, if we assume the sunshine amount only for the observed period of potato vegetation, height of the crop will be on the presented curve. In 1977 and 1985 crops went far from the values on the curve (341 and 323 dt/ha, respectively).

In 1985 sunshine duration was relatively small, especially in June (approximately 140 h, 20-year mean was 212 h), i.e., during the period of intensive growth and development of potatoes. Moreover in June, rainfalls of 74.5 mm (58.7 mm in the 3rd decade of the month) were noticed. Cultivation conditions in 1977 were basically not far from the others. Only in the 3rd decade of August rain surpluses of 60.5 mm, according to plants' needs, were observed.

The 20-year mean sunshine coefficients of the studied meteorological stations were as follow: Bałcyny - 11.41; Tomaszkowo - 11.34; Łężany -11.66. Coefficients of variation were: 11.34, 11.41, and 11.66, respectively. The highest difference from the many-year mean was in 1980 in Bałcyny. Sunshine duration in that year in Bałcyny was lower from the mean value by 250 h, in Tomaszkowo - by 319 h, and in Łężany - 339 h lower than the 20-year mean.

## CONCLUSIONS

1. The values of sunshine duration observed during the vegetation period for Bałcyny, Tomaszkowo and Łężany (20-year mean) decrease according to the order.

2. The highest sum of sunshine hours during the investigated 20 years was found in Tomaszkowo (1348 h), the lowest sum was in Łężany (797 h). Coefficient of variation ranged from 11.34 in Tomaszkowo to 11.66 in Łężany.

3. The effect of sunshine duration on potato yielding has been proved to be the most favourable from 1100 to 1200 h.

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## PRÓBA OSZACOWANIA WARUNKÓW USŁONECZNIENIA OKOLIC TRZECH WYBRANYCH MIEJSCOWOŚCI WOJEWÓDZTWA OLSZTYŃSKIEGO

W pracy przedstawiono próbę oszacowania wartości usłonecznienia dla wybranych stacji meteorologicznych Akademii Rolniczo-Technicznej w Olsztynie za okres 1971-1990 oraz jego wpływ na wysokość plonów ziemniaka w RZD Bałcyny. Najwyższą sumę godzin usłonecznienia w badanym dwudziestoleciu zanotowano w Tomaszkowie (1348 h), najniższą w Łężanach (797 h). Współczynnik zmienności waha się od 11,34 w Tomaszkowie do 11,66 w Łężanach. Najkorzystniejszy wpływ usłonecznienia na plonowanie ziemniaka stwierdzono w przedziale 1100-1200 godzin.

S ł o w a k l u c z o w e: usłonecznienie, suma promieniowania, Pojezierze Mazurskie, plon ziemniaka.