

An attempt at determining the areas in north-eastern Poland with meteorological conditions favouring or hindering fruit production

Jan Grabowski¹, Zdzisław Kawecki², Anna Bieniek²

¹Department of Meteorology
²Department of Horticulture
University of Warmia and Mazury in Olsztyn
Prawocheńskiego 21, 10-757 Olsztyn, Poland
e-mail: kat.ogr.@uwm.edu.pl

Key words: meteorological elements, effect on fruit crops, macroregions, vegetation period

ABSTRACT

In the present study the influence of selected meteorological factors on the yield of apples, pears, plums and cherries was examined. The average yields of fruits and the course of meteorological factors were analysed in 6 macroregions of north-eastern Poland during the period from 1979 to 1998. The following factors were evaluated: air temperature, precipitation, relative humidity, actual insolation and the number of days with frost, in April and May in the years when the maximum yield was $\geq 10 \text{ t ha}^{-1}$ and the minimum yield was 5 t ha^{-1} . An analysis of the results showed that the yield of fruits in this region of Poland depends mainly on the

meteorological conditions in April and May. Of the analysed macroregions of north-eastern Poland, the eastern part of the North Podlasie Lowland, Gdańsk Coastland and North Mazovia Lowland proved to be the most favourable to horticultural production.

INTRODUCTION

Fruit is one of the most important nutrients in the human diet. It is eaten raw and cooked. Its nutritional and health value is high. Among other substances, they contain considerable amounts of carbohydrates, organic acids, proteins, vitamins, mineral salts, cellulose, pectins, tannins, aromatic substances and enzymes (Kawecki and Kryńska 1994).

Apples, along with strawberries, cherries, sweet cherries, plums, blackcurrant and redcurrant are the main raw material for the fruit and vegetable processing industry. The fruit processing output is growing quickly. The annual average increase in the amount of food products in the last 20 years has amounted to 9.8%. Such a dynamic increase was possible thanks to the high dynamics of the production of fruit juices and beverages (Kubiak 1999).

The largest amounts of fruits are produced in China, India and the USA. Poland's share in global production does not reach 1%. The north-eastern region is characterised by a low productivity of fruit as compared to other regions of the country because of the frequent occurrence of meteorological factors influencing the production (Anonymus 1987, Grabowski 1998, Grabowski and Zielenkiewicz 1999). In this part of the country, the weather, and consequently the conditions of growth and development of plants during the vegetation period are highly differentiated (Grabowski 1998, Kondracki 2000).

The goal of this work was to determine the areas where meteorological factors favour or hinder fruit production. This may help to intensify orchard production and minimise the amount of money outlaid for the production in this region of Poland.

MATERIAL AND METHODS

The experimental part of this work was based on data from GUS (Main Statistical Office) which concern the yield obtained from fruit trees (apple, pear, plum, cherry, sweet cherry) in $t\ ha^{-1}$, obtained in the north-eastern Poland during the period from 1979 to 1998 (Anonymus 1977 – 1998, Main Statistical Office 1999). The fruit yields taken for calculations were average yields from the former provinces of Białystok, Elbląg, Łomża, Olsztyn, Ostrołęka and Suwałki (according

to the provincial boundaries up to the end of 1998). The areas of the former provinces corresponded to the geographical zones (macroregions) taken into account in the physical and geographical division in the decimal system put forward by Kondracki (2000). The analysis of the effect of meteorological elements was based on the data for the years 1979 – 1998, published in the Monthly Meteorological Reviews (*Miesięczny Przegląd Agrometeorologiczny 1979 – 1998*). This includes:

- the sum of average temperature in April,
- the sum of average temperature in May,
- total precipitation in April,
- total precipitation in May,
- number of days with precipitation in April,
- number of days with precipitation in May,
- number of days with frost in April,
- number of days with frost in May,
- average temperature in the period between April and September,
- total precipitation in the period between April and September,
- total number of insolation during the period between April and September,
- relative humidity of the air in the period between April and September.

The areas where fruit production is favoured or hindered have been determined on the basis of the average size of yield in the six analysed macroregions (former provinces), weighed means of meteorological factors during the analysed 20-year period and the number of years when the yield was the largest ($\geq 10 \text{ t ha}^{-1}$) and the lowest ($\leq 5 \text{ t ha}^{-1}$).

RESULTS AND DISCUSSION

In the six analysed macroregions (Fig. 1) the highest average yield for the 20-year period were recorded: in the eastern part of the North Podlasie Lowland (formerly province of Białystok) – 8.96 t ha^{-1} , North Mazovia Lowland (former province of Ostrołęka) – 9.26 t ha^{-1} , Gdańsk Coastland (formerly province of Elbląg) – 7.51 t ha^{-1} , Mazury Lake District (formerly province of Olsztyn) – 7.47 t ha^{-1} , western part of the North Podlasie Lowland (formerly province of Łomża) – 6.21 t ha^{-1} .

The fact that yields were constant, or even decreasing, in some macroregions, may be explained by the low and changeable outlay on fruit production (Kawecki and Kryńska 1994, Kawecki 1996, Kubiak 1999). It was caused by an increase of the prices of fruit production, and consequent decrease in its profitability. The situation will be aggravated by the simultaneous loss of markets which are attractive in terms of prices obtained (Kawecki 1997).

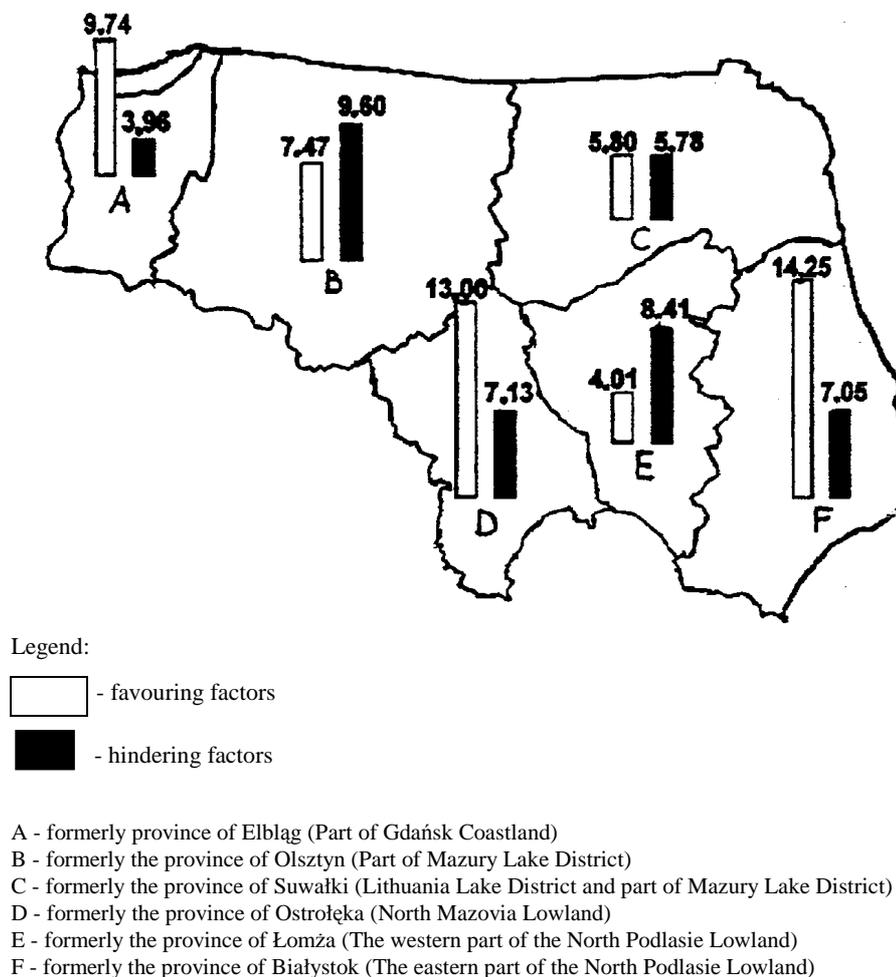


Figure 1. The weighed mean of the course of meteorological factors in fruit production in north-eastern Poland in 1979 – 1998

Table 1 contains the average values of the course of meteorological values which favour or hinder fruit production in north-eastern Poland. The years in which yields were at least equal to 10 t ha^{-1} were taken as favourable to horticultural production; while those in which the yield were equal or lower than 5 t ha^{-1} were taken as hindering horticultural production.

Table 1. The average values of the factors favouring or hindering the fruit production in the north-eastern macroregions of Poland

Specification	The eastern part of the North Podlasie (formerly the province of Białyсток)		Gdańsk Coastland (formerly the province of Elbląg)		The western part of the North Podlasie Lowland (formerly the province of Łomża)		Mazury Lake District (formerly the province of Olsztyn)		North Mazovia Lowland (formerly the province of Ostrołęka)		Lithuania Lake District (formerly the province of Suwałki)	
	a	b	a	b	a	b	a	b	a	b	a	b
Average yield in (t ha ⁻¹)	11.8	4.6	11.8	3.9	10.1	3.7	11.2	4.2	13.1	3.7	11.4	4.4
Sum of average temperature in April (°C)	212.7	216.0	229.5	190.5	232.5	206.2	216.0	193.0	227.3	188.3	190.0	235.0
Sum of average temperature in May (°C)	419.2	366.0	424.2	375.1	439.5	393.3	416.6	384.4	442.3	393.7	378.2	421.6
Total precipitation in April (mm)	32.0	55.0	36.0	46.0	12.0	39.0	31.0	44.0	34.0	32.0	35.0	43.0
Total precipitation in May (mm)	68.0	57.0	43.0	7.0	37.0	47.0	43.0	39.0	49.0	57.0	68.0	40.0
Number of days with precipitation in April	15.0	15.0	6.0	7.0	6.0	10.0	7.0	8.0	8.0	7.0	8.0	11.0
Number of days with precipitation in May	11.0	11.0	8.0	6.0	5.0	8.0	8.0	7.0	9.0	8.0	9.0	8.0
Number of days with frost in April	5.0	15.0	6.0	11.0	9.0	14.0	7.0	14.0	6.0	12.0	5.0	10.0
Number of days with frost in May	1.0	9.0	2.0	7.0	0.0	7.0	1.0	7.0	1.0	9.0	2.0	6.0
Average temperature in the period between April and September (°C)	13.7	14.0	13.7	13.1	13.9	13.7	13.7	13.3	14.4	13.6	13.4	13.6
Total precipitation in the period between April and September	334.0	412.0	378.0	428.0	340.0	382.0	343.0	374.0	316.0	393.0	323.0	359.0
Total number of hours of actual sunning in the period between April and September (mm)	1185	1305	1186	1005	1099	1105	1129	1096	1231	1094	1307	1227
Relative humidity of the air in the period between April and September (%)	60.0	61.0	62.0	63.0	62.0	62.0	57.0	63.0	58.0	62.0	61.0	62.0
Number of years of extreme yields	9.0	1.0	6.0	2.0	2.0	5.0	5.0	6.0	9.0	4.0	3.0	3.0

a – high yields ≥ 10 t ha⁻¹ b – low yields ≤ 5 t ha⁻¹

The data contained in Table 1 suggest that high yields were favoured by high temperature in April and May, without an excessive amount of precipitation during the vegetation period or excessively high air humidity (which is related to the amount of precipitation and which significantly affects the development of pathogens and pests in orchards). Earlier research by the authors (Kawecki and Kryńska 1994, Grabowski 1998, Grabowski and Zielenkiewicz 1999) indicated that the yields were affected by weather conditions during the blooming period.

The ratio of the number of years with the highest yields to the number of years with the lowest yields was the greatest in the eastern part of the North Podlasie Lowland (9 : 1) and the North Mazovia Lowland (9 : 4). The data presented in Table 1 indicate that it was the lowest in the Mazury Lake District (5 : 6) and the Lithuania Lake District (3 : 3). The above relations can be explained by the unfavourable course of meteorological elements in the analysed macroregions in April and May. It particularly concerns the distribution and amount of precipitation and the number of days with frost.

A comparable (mutual) contribution of the course of meteorological factors in fruit production, expressed as a weighted mean, showed that the greatest mean values were recorded in the eastern part of the North Podlasie Lowland and the North Mazovia Lowland, lower ones – in the Mazury Lake District, and the highest – in the Lithuania Lake District, Gdańsk Coastland and the eastern part of the North Podlasie Lowland.

Taking into consideration the average yields of fruit in the analysed macroregions along with weighed means of the course of meteorological elements during the vegetation period and the number of years favouring and hindering the yield of fruit trees throughout the analysed 20-year period, the north-eastern part of Poland was divided in terms of utility for fruit production (Fig. 1). The diagram indicates that in some macroregions (the eastern part of the North Podlasie Lowland, the North Mazovia Lowland and the Gdańsk Coastland) the course of meteorological elements is such that they can be considered favourable to fruit production. However, the Mazury Lake District, the Lithuania Lake District and the western part of the North Podlasie Lowland are considered as unfavourable for fruit production.

CONCLUSIONS

On the basis of the conducted analysis of the available data concerning the yields of fruit and the meteorological factors during the vegetation period of the years 1979 – 1998, the following conclusions have been drawn:

1. Among the analysed macroregions of north-eastern Poland, the following are the most favourable to fruit production: the eastern part of the North Podlasie Lowland, the Gdańsk Coastland and the North Mazovia Lowland.
2. The size of yields depended mainly on the course of meteorological factors in April and May.
3. In the years of the highest yields, the share of favourable meteorological elements was the highest in the eastern part of the North Podlasie Lowland and in the North Mazovia Lowland.

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PRÓBY WYODRĘBNIENIA W POLSCE PÓŁNOCNO-WSCHODNIEJ
OBSZARÓW O WARUNKACH METEOROLOGICZNYCH SPRZYJAJĄCYCH
LUB OGRANICZAJĄCYCH PRODUKCJĘ SADOWNICZĄ

Streszczenie: W niniejszej pracy oceniono wpływ wybranych elementów meteorologicznych na plon jabłoni, grusz, śliw, wiśni i czereśni. W tym celu przeanalizowano średnie plony owoców i przebieg warunków meteorologicznych w latach 1979 – 1998 w 6 makroregionach Polski północno-wschodniej.

Analiza elementów meteorologicznych dotyczyła kształtowania się średnich temperatur powietrza, ilości i rozkładu opadów, wilgotności względnej powietrza, występowania przymrozków, usłonecznienia rzeczywistego w kwietniu i maju oraz przebiegu tych elementów w okresie wegetacyjnym. Obszary sprzyjające i ograniczające produkcję sadowniczą ustalono na podstawie wielkości średnich plonów owoców, liczby lat o najwyższych ($\geq 10 \text{ t ha}^{-1}$) i najniższych ($\leq 5 \text{ t ha}^{-1}$) plonach oraz średnich ważonych przebiegu elementów meteorologicznych w analizowanym 20-leciu z 6 makroregionów Polski północno-wschodniej. Na podstawie analizy wyników badań stwierdzono, że na wielkość plonów głównie wpływał przebieg elementów meteorologicznych miesiąca kwietnia i maja. Spośród analizowanych dawnych województw (1976 – 1999), które w zasadzie odpowiadają makroregionom Polski północno-wschodniej najbardziej przydatne do produkcji sadowniczej pod względem kształtowania się warunków meteorologicznych są: wschodnia część Niziny Północnopodlaskiej, Pobrzeże Gdańskie i Nizina Północnomazowiecka. Pozostałe makroregiony: zachodnia część Niziny Północnopodlaskiej, Pojezierze Mazurskie, Pojezierze Litewskie należy uznać jako niesprzyjające do produkcji sadowniczej.

Received October 3, 2003; accepted December 6, 2004