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Meteorological conditions of the blooming of nanking cherry (*Prunus tomentosa* Thunb.) and their impact on the yield

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ABSTRACT

The study was carried out in the years 1997 – 2005 to investigate phenophases of nanking cherry shrubs and its yielding under climatic conditions of the Warmia region (Olsztyn). The plants were obtained in Olsztyn from the seeds of nanking cherry shrubs originating from the eastern part of Belarus (Gorki). One-year old seedlings were planted at 3 × 2 m apart in grey-brown podsolic soil. Investigations were carried out on 40 shrubs from the second year after planting. The data on the beginning of vegetative season, the blooming period and the harvest time were recorded every year. The yield per bush was also recorded. More important climatic factors of the blooming season were analyzed as well, i.e.: mean daily air temperature, the sum of minimal temperatures from the beginning of the vegetative season till the end of the blooming, ground frosts, precipitation and its effect on yielding over a period of 9 years.

Phenophases were found to be diversified depending on experimental year. The greatest diversity was observed for terms at the start of the vegetative season. The difference between the extreme terms reached up to 6 weeks. On average, the blooming period occurred in April. The statistical analysis indicated that the yield of nanking cherry was significantly affected by mean temperatures of the blooming period, minimal temperatures, ground frosts, and precipitation.

INTRODUCTION

Nanking cherry (*Prunus tomentosa* Thunb.) belongs to a group of almost completely unknown fruit-bearing plants which are rare in Poland. It is a shrub that grows up to 1.5-2 m in height, blooms nicely with pink flowers usually at the beginning of May and produces round fruits of a diameter slightly exceeding 1 cm with red flesh, slightly tart but quite tasty. Fruits ripen in July (Bieniek et al. 2005).

Investigations carried out on nanking cherry cultivated under the conditions of Olsztyn city (Kawecki and Tomaszewska 2002, Kawecki et al. 2002) indicated that both the vegetative development and fruit bearing are determined, to a great extent, by meteorological conditions occurring in the blooming period. A study by Sękowski (1993) demonstrates that this species is resistant to frost and can be cultivated even on dry sands as it has low soil requirements.

The study was aimed at determining the effect of meteorological conditions of the blooming period on the yielding of nanking cherry shrubs.

MATERIAL AND METHODS

Investigations were carried out on shrubs of nanking cherry from generative reproduction. Seeds which were used for the production of seedlings were obtained from maternal shrubs originating from the Agricultural Academy in Gorki (eastern Belarus). Seedlings were planted at 3 × 2 m apart in grey-brown podsolic sandy soil (4^{th} quality class) in the Experimental Garden, University of Warmia and Mazury in Olsztyn.

Prior to planting, the soil was fertilized with manure at a dose of 40 t ha^{-1} and with mineral fertilizers at the following doses: 100 kg ha^{-1} P_2O_5 and 100 kg ha^{-1} K_2O, following the standard recommendations for berry shrubs. Spring fertilization with nitrogen at a dose of 30 kg N ha^{-1} and protection recommended in the cherry protection framework programme were applied each year. Soil in inter-rows was kept in bare fallow with the use of weeding hoes.

Investigations were carried out on 40 consecutive shrubs taken from the central part of a row. The results covered the first 9 years of yielding.

Meteorological data were provided by the Meteorological Station in Tomaszkowo, located 2 km west of the study object, belonging to the Chair of Meteorology and Climatology, University of Warmia and Mazury in Olsztyn.

In the analysis of the effect of meteorological conditions of the blooming season on the yield, consideration was given to the following variables:

Y – fruit yield in kg shrub^{-1}

x_1 – mean temperature of the blooming period

x_2 – the sum of minimal temperatures of the blooming period

x_3 – the sum of minimal temperatures from the beginning of the vegetative season to the end of the blooming time

x_4 – ground frosts (5 cm). Ground frosts were taken into consideration in the mathematical calculations since at the blooming time the height of cherry shrubs reached 1.8 m.

x_5 – precipitation in the blooming period in mm.

A correlation between the explained variable (yield) and the meteorological factors affecting its level was computed with the use of an analysis of regression at a significance level of $p = 0.05$ (Oktaba 1974).

The following model was adopted to present that correlation:

$Y = ß_0 + ß_1 + x_1 ..... ß_n + x_n + e$

where:

Y – explained variable

$ß_1$ – coefficient of multiple regression

x_1 – explanatory variable

e – random error.

RESULTS AND DISCUSSION

Over the 9-year cultivation period of nanking cherry, no differences were observed in terms of commencing the vegetative season between individual shrubs, whereas diversity was reported between particular years (Table 1). The earliest bud swelling was observed in the years 1997 and 1998, respectively on 20th February and 26th February, and the latest was in the years 2001 and 2005, respectively on 17th April and 15th April. The maximum span between the dates exceeded 6 weeks.

Under the climatic conditions of the province of Warmia and Mazury, the beginning of the vegetative season of plants is subject to considerable changes over the years. As reported by Kawecki (1998) and Grabowski et al. (2005), in the case of berry plants, between some years differences in the beginning of the vegetative season are likely to exceed 2 months. According to Hołubowicz et al. (1993), under the conditions of the city of Poznań, shifts in the phenophases of one cherry variety may reach over 3 weeks.

Table 1. Phenophases of nanking cherry shrubs

Experimental year	Beginning of vegetative season	Full blooming season	End of blooming season	Fruit harvest
1997	20.02	25.04	05.05	11.07
1998	26.02	31.03	08.04	01.07
1999	02.04	27.04	06.05	12.07
2000	12.04	25.04	04.05	23.06
2001	17.04	27.04	08.05	12.07
2002	22.03	12.04	21.04	02.07
2003	10.03	24.04	30.04	28.06
2004	19.03	08.04	20.04	03.07
2005	15.04	30.04	12.05	25.07

Most cherry species bloom early in April or at the beginning of May (Sękowski 1993). According to Mika (1994), nanking cherry blooms in March or April. In the reported study, the full blooming time occurred between 31st March and 30th April, depending on the year. As postulated by Petrowa (1987), in the European part of Russia the blooming season of nanking cherry falls in May. Radiuk and Radiuk (1997) observed that under the conditions of the city of Mińsk, the blooming season spans 2 weeks – being the most intensive in mid-May. Hołubowicz et al. (1993) demonstrated that in the Wielkopolska region the length of the blooming time of cultural varieties of cherries ranges from 10 to 13 days, although a single flower blooms for no longer than 4-7 days.

Fruits were harvested at the end of June or in July. The earliest harvests were made in 2003, on 28th June, whereas the latest ones in 2005, on 25th July. In the first days of July, the fruits were picked in the years: 1998, 2002, and 2004. In those years, the vegetative season was characterized by high temperatures, particularly in June. It affected quickened ripening of the fruits. Under the conditions of Belarus, the harvest of fruits usually occurs in the second half of July (Radiuk and Radiuk 1997). This is an indicative of the thermal continentalism of the climate increasing from west to east (Kożuchowski and Wibig 1988).

Table 2 presents the results of the yielding and meteorological conditions of the blooming period of nanking cherry shrubs. They indicated that low air temperatures of the spring season recorded in the years 1997, 1998, 2003, expressed in the sum of minimal temperatures from the beginning of vegetation to the end of the blooming, as well as ground frosts, decreased yields of nanking cherry to the greatest extent.

Table 2. Meteorological conditions of the blooming period and yielding of nanking cherry in the years 1997 – 2005 in Tomaszkowo n. Olsztyn

Year Specification	1997	1998	1999	2000	2001	2002	2003	2004	2005
Mean yield of a shrub, kg	0.053	0.625	0.094	0.100	1.237	1.131	0.236	0.828	0.168
Mean temp.of blooming season, ^{o}C	10.1	6.6	7.8	15.3	13.5	10.0	9.9	7.3	11.6
Sum of min. temp. in blooming season, ^{o}C	55.4	23.7	38.5	78.0	96.1	39.4	28.8	75.6	52.1
Sum of temp. from the beginning of vegetation to the end of the blooming, ^{o}C	-25.3	-51.4	140.1	168.0	134.3	39.4	-10.1	75.6	93.0
Frosts in blooming season (5 cm), days	3	1	7	3	1	0	3	6	3
Precipitation in blooming season, mm	1.2	14.3	1.4	0	0.5	8.6	14.9	27.4	16.4

The mean daily temperatures of the air were characterized by great variation: in 2000 they appeared to be the highest (15.3ºC), whereas in 1998 they were the lowest at 6.6ºC. Despite the considerable extremes in the microbiological factors analyzed in the blooming period of nanking cherries, their effect on the blooming of the cherries is complex in character and typical of the area under study. Hence, the impact of these factors was evaluated with the use of multiple regression analysis (Oktaba 1974). Having performed all calculations, the following equation was obtained:

$Y = 0.87 - 0.19\ x_1 + 0.03x_2 - 0.08x_4 + 0.03x_5 \quad R^2 = 0.84;\ p = 0.05$

The ranges of significance of the regression equation in respect to significant explanatory variable are as follows:

$X_1 \in \langle 7.36;\ 13.10 \rangle$

$X_2 \in \langle 28.23;\ 75.79 \rangle$

$X_4 \in \langle 0.71;\ 5.29 \rangle$

$X_5 \in \langle 0.10;\ 18.90 \rangle$

The presented equation, depicting the effect of meteorological conditions of the blooming season of nanking cherry on the yield size indicates that the yield was significantly affected by: the mean temperature of the blooming season, the sum of

minimal temperatures in that period, ground frosts and precipitation. In contrast, a variable sum of minimal temperatures from the beginning of vegetation to the end of the blooming appeared to be insignificant. The coefficient of determination R^2 of the equation presented is very high and reaches 84%, which explains the dependency of cherry yield size on the meteorological conditions of the blooming season.

The yields of the nanking cherry obtained in the period analyzed were low in particular experimental years. The highest mean yield was obtained in the years 2001 and 2002 which were characterized by low precipitation and as little as one frosty day in the blooming season.

The studies of Grabowski and Zielenkiewicz (2000) indicate that good flight conditions for *Apidae* family insects is a highly important factor that affects yielding. The nanking cherry is an entomophilous shrub, hence, a relatively short period of pistil receptivity is likely to reduce pollination and fertilization which, in turn, affect yield.

CONCLUSIONS

1. Phenophases of nanking cherry shrubs were differentiated depending on the year. Over the 9-year experimental period, the greatest difference in the stage of vegetation commencement exceeded 6 weeks.
2. Under the conditions of the Warmia region, the full blooming period occurs in different decades of April, depending on the year. In 6 out of the 9 experimental years, the full blooming fell in the last decade of April.
3. Yields of the nanking cherry were significantly affected by: mean temperatures of the blooming season, minimal temperatures, ground frosts and precipitation in that period.
4. The greatest effect on yielding was ascribed to the lowest and mean temperature of the air in the blooming period.

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WARUNKI METEOROLOGICZNE OKRESU KWITNIENIA WIŚNI KOSMATEJ (*PRUNUS TOMENTOSA* THUNB.) I ICH WPŁYW NA PLON

Streszczenie: W latach 1997 – 2005 badano fenofazy krzewów wiśni kosmatej i jej plonowanie w warunkach klimatycznych Warmii (Olsztyn). Rośliny otrzymano w Olsztynie z nasion krzewów wiśni kosmatej pochodzącej ze wschodniej części Białorusi (Gorki). Jednoroczne siewki posadzono w rozstawie 3 × 2 m na glebie płowej. Badania przeprowadzono na 40 krzewach, począwszy od drugiego roku po posadzeniu. Każdego roku rejestrowano datę: rozpoczęcia wegetacji, okresu kwitnienia i zbioru owoców. Co roku oceniano także plonowanie poszczególnych krzewów. Przeanalizowano również ważniejsze elementy klimatyczne okresu kwitnienia: średnią dobową temperaturę powietrza, sumę temperatur minimalnych od początku wegetacji do końca kwitnienia, przymrozki przygruntowe, opady oraz ich wpływ na plonowanie w okresie 9 letniego okresu badań. W pracy stwierdzono, że fenofazy były zróżnicowane w poszczególnych latach. Największe różnice, dochodzące do 6 tygodni, stwierdzono w terminach rozpoczęcia okresu wegetacyjnego. Średnio okres kwitnienia przypadał na miesiąc kwiecień. Analiza statystyczna wykazała, iż na plonowanie wiśni kosmatej istotny wpływ miała temperatura okresu kwitnienia, przymrozki przygruntowe i opady.

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