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The course of growth and yielding of white and green cauliflower cultivated in two terms for autumn production

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ABSTRACT

The three-year long experiment (2002 – 2004) was aimed at finding the dependence between the pattern of weather conditions and the vegetative growth and cropping course of the white and green cauliflower cultivars planted for autumn harvesting. For white cauliflower, the late cultivar Planita F_1 and early one Farras F_1 cultivar were used, for the green caulifower Trevi F_1 and Panther F_1 cultivars were used, respectively. Plants of late cultivars were planted in the second half of June, which is the usual time for autumn cultivars, whereas the early ones in the first half of July, the time used following the harvesting of certain forecrops. During vegetation, measurements were taken of the plants' height and diameter as well as the number of formed leaves. The times of initial curd formation as well as consecutive harvests were also registered. Weather conditions

included daily measurements of maximal, minimal and average air temperature, as well as totals of atmospheric rainfalls. Intensive vegetative growth (height and diameter of plants, as well as the number of formed leaves) was proved for both cauliflower types in full summer (end of July, August) until first curd harvesting. Planting in the second half of June and the first half of July of the cultivars of white and green cauliflowers of different lengths of the vegetation period allowed for proper timing of the course of harvesting. Using the delayed planting time it became possible to move harvesting to the later time in autumn. The cultivars of green cauliflower used in the experiment turned out to harvest a bit later than the white cultivars. However, in all years of the experiment, for both planting times, full harvest of curds turned possible. The analysis of harvesting dynamics against the weather conditions in particular years, at certain periods showed the visible effect of temperature on accelerating or delaying the cropping of both cauliflower types.

INTRODUCTION

In cauliflower cultivation, many factors are decisive for plant growth dynamics, as well as the course of yielding and uniformity of curd harvesting. Discovering these factors is an interesting phenomenon, both in terms of scientific research and horticultural practice. Sometimes described as “timing”, it allows projecting and, to a certain degree, managing cauliflower cultivation so that excessive supply of this vegetable on the market does not occur, resulting from yield accumulation. The pattern of weather conditions during plant vegetation is of primary importance in this aspect (Liptay 1981, Booij 1987, Hadley and Pearson 1998). Thermal conditions, water supply and sunlight during vegetative growth, especially at the stages of curd formation, significantly shape the course of cauliflower yield. However, temperature is of primary importance here. A cauliflower is a plant typical for moderate climate and shows negative reaction to high temperatures. If these occur at the phase of curd formation, they delay generative growth, often decreasing yield quality. However, the occurrence of high temperatures directly prior to harvesting, accelerates curd growth, thus increasing yield accumulation. The most often used method of timing in field cultivation relies on successive planting at various times of the vegetative season. The choice of a proper cultivar, suitable for a given cultivation time, taking into account the length of the vegetation period, is of particular importance here (Wurr et al. 1990, Cebula and Kalisz 1997, Fernandez et al. 2003). In autumn harvest, late cauliflower cultivars, of thick foliage, forming curds of a large mass, are usually planted. However, in certain second crop cultivations, cultivars of shorter vegetation period but of good commercial quality, are also used.

The aim of this study was to search for dependencies between the climate and the vegetative growth, as well as the course of the yield of cauliflower cultivated at two different times for autumn harvest. The study involved the traditionally cultivated cauliflower of white curds and its less known type of a similar curd shape but slightly greenish coloring.

MATERIAL AND METHODS

The 3-year long experiment connected with the cultivation of white and green cauliflower was conducted between 2002 and 2004 at the research station of the Agricultural University in Kraków. For each type of cauliflower, two cultivars of a different vegetation time were used: for white cauliflower - late cultivar Planita F_1 and the early one Farras F_1, for green cauliflower respectively - Trevi F_1 and Panther F_1 cultivars. The transplants of late cultivars were planted in mid-June, the time typical for autumn cultivation (20.06.2002; 23.06.2003; 28.06.2004), and the early ones in the first half of July, the time used after the harvest of certain forecrops (05.07.2002; 07.07.2003; 14.07.2004). Cauliflower was planted from transplants prepared in multipots (96-chamber trays) filled with peat substrate, planted at the stage of 4-5 true leaves. The experiment was established in 4 replications, with 32 plants on a single plot. The transplants were spaced at 67.5 × 50 cm. From the very beginning of planting in the field, plants of cauliflower were, if necessary, regularly irrigated. During vegetation, measurements of plant height and diameter as well as the number of formed leaves were carried out three times. The dates of the start-up of curd formation, first harvest, full harvest (at least 50% of the harvested curds) and the harvest end were also recorded. At harvesting run systematically, usually twice a week, the number of harvested curds in commercial yield was determined. Cauliflower curds were harvested at the stage of the highest quality with due attention paid to the fact that the size, of the harvested curds enabled the placement of 6 pieces in a plastic box of a universal size which is a standard commercial container.

Weather conditions, including minimal, maximal and average daily temperature as well as the total of atmospheric rainfalls were collected at the meteorological station in Kraków-Balice, located in the close vicinity of the experimental field. The course of weather conditions (Fig. 1) in all years of the experiment was rather uniform, with relatively high temperatures during summer and low ones in autumn (here differentiation between consecutive years was significantly higher) and moderate rainfalls, which occurred mostly at the early stage of the plant growth.

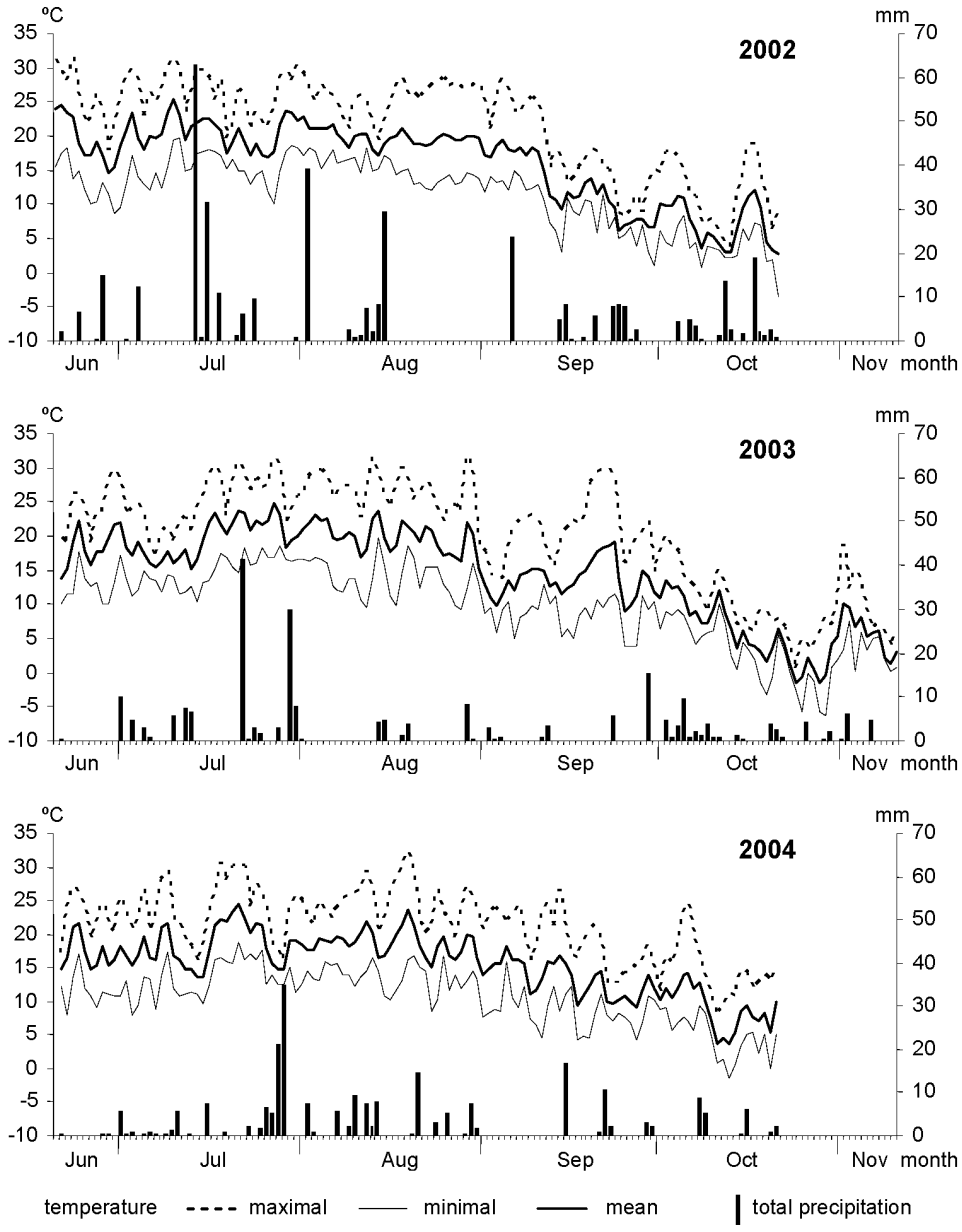

Figure 1. Pattern of weather conditions during cauliflower growth in the years 2002 – 2004

RESULTS AND DISCUSSION

The measurements of the plant height and diameter as well as the number of leaves in the period of intensive vegetative growth and curd formation (Fig. 2) suggest a dynamic growth of these parameters in the particular years of the experiment.

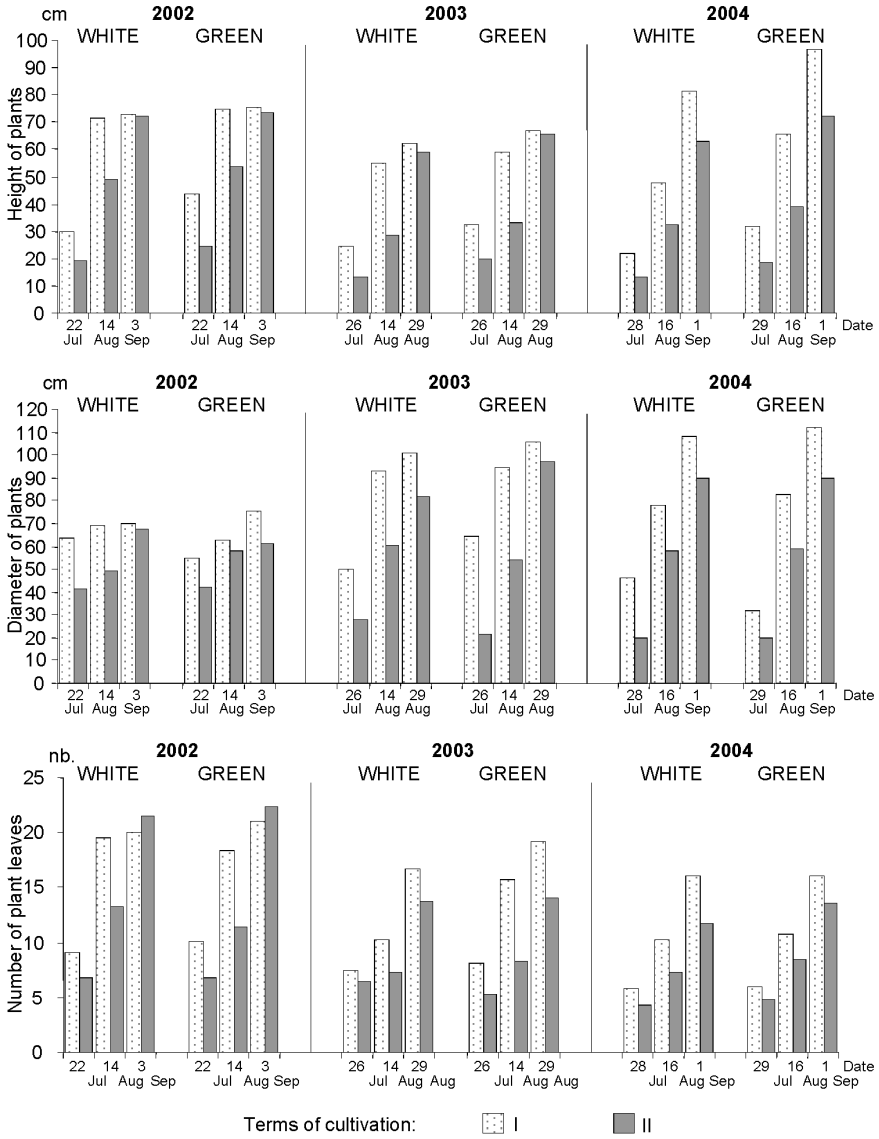

Figure 2. Height, diamater and number of leaves of white and green cauliflower in the years 2002 – 2004

In case of white cauliflower of Planita F_1 cultivar, the height of plants increased between the last decade of July and the beginning of the harvesting time by 147.0, 150.8 and 268.3% in consecutive years; the plant diameter by 9.8, 101.8 and 133.2%; and the number of leaves by 120.9, 127.0 and 177.6%. At the same time, Farras F_1 cultivar, planted at a later time, increased plant height by 277.1, 348.9 and 371.4%; the diameter by 63.8, 195.3 and 362.1%; and the number of leaves by 216.2, 112.3 and 174.4%.

In the analogical time, for green cauliflower of the Trevi F_1 cultivar, the plant height increased by 71.9, 106.1 and 203.4%; plant diameter by 37.6, 64.5 and 252.4%; and the number of leaves by 107.9, 137.0 and 166.7%. The Panther F_1 cultivar, planted at a later time, increased plant height by 197.6, 225.9 and 296.2%; the diameter by 46.0, 343.6 and 354.8%; and the number of leaves by 229.4, 166.0 and 183.3%.

The present data show that in 2004 the growth of all examined features was significantly higher than in 2003 and even higher in relation to 2002. This might have been caused by the delay in planting time in consecutive years with a similar measurement times of particular plant parameters. Thus, in the second planting time, these values show even bigger polarization. Another decisive factor might have been higher average temperature, noted particularly at the end of June and July 2002 and partly in 2003, as it led to more intensive growth in the initial period. For this reason, absolute values taken at the first measurement were higher and they constituted the reference point for the last measurement time. In the conditions of higher temperature, vegetative growth of plants is more intense (Olesen and Grevsen 1997, Fellows et al. 1999). It should be remembered, though, that in the climatic conditions typical for Poland, these values are not too high, even in summer.

In 2002, the Planita F_1 cultivar of white cauliflower started curd formation 57 days following the planting time (20 June). Cropping started after 74 days and ended after 95 days. On the other hand, Farras F_1 cultivar, planted on 5 July, reached particular development stages after 52, 69 and 95 days, respectively. Green cauliflower from the first cultivation time needed respectively 63, 81 and 110 days, and, in case of the second planting time 56, 73 and 102 days (Fig. 3). In the following year, the Planita F_1 cultivar, planted on 23 June started curd formation after 52 days, first harvests started after 63 days to end only after 119 days. However, the Farras F_1 cultivar, planted on 7 July, reached particular stages of growth after 64, 84 and 108 days. In the case of green cauliflower from earlier planting time, respectively 53, 77 and as many as 140 days elapsed, whereas from later planting 75, 101 and 126 days. The influence of cold October, with freezing temperatures, was especially visible here. In case of green cauliflower of longer vegetation period, it led to the prolongation of harvest to the beginning of November.

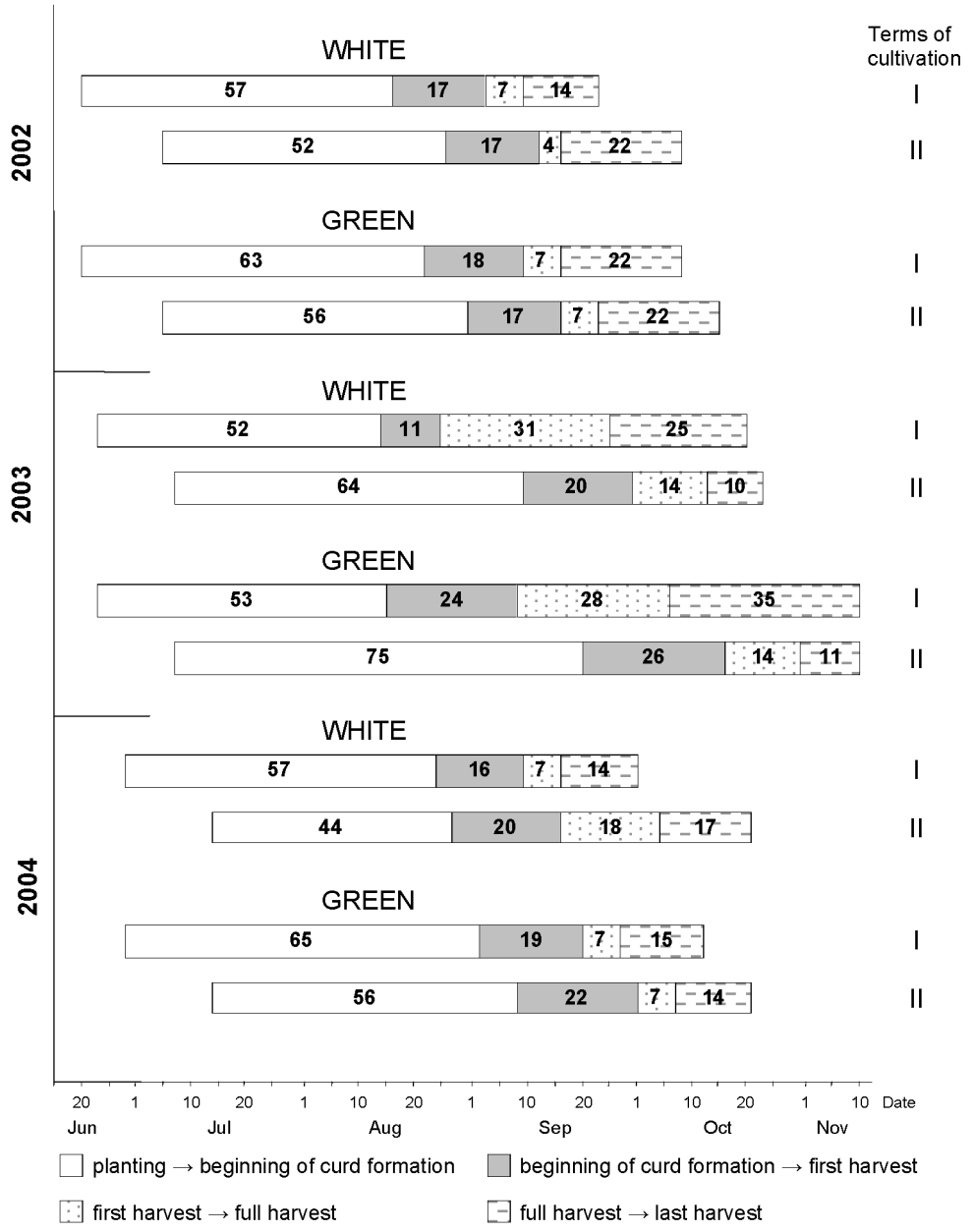

Figure 3. Growing stages of white and green cauliflower in two cultivation terms in the years 2002 – 2004

In 2004, similarly to 2002, a cumulated course of particular stages was observed. White cauliflower, planted on 28 June (1st planting time) reached the beginning of curd formation after 57 days, harvest start-up after 73 days and harvest completion after 94 days. Planted on 14 July as the second planting time, it started curd formation already after 44 days, with harvest beginning after 64 days and the end of cropping after 99 days. Green cauliflower needed respectively 65, 84 and 106 days since the planting date falling on 28 June and, respectively, 56, 78 and 99 from the date of planting falling on 14 July.

The use of two planting times with the cultivars of white and green cauliflower of different vegetation period allowed for time distribution of the yielding course, with a slight postponement of harvest for late autumn with planting in the first half of July. Green cauliflower cultivars screened in this experiment turned out to be a bit later than those of the white cauliflower. Despite this, in all years of the experiment, the amount of time they had was sufficient for vegetation necessary to obtain full cropping in both quantitative and qualitative terms, which has been described in other publications (Cebula and Kalisz 2005, Cebula et al. 2005).

The harvest of the curds of white cauliflower (Fig. 4) from the first cultivation time in 2002, started at the beginning of September and cumulated in the initial stage, with the obtainment of full harvesting on 9 September. In the second harvesting time, highest cropping was noted in mid-September (full harvest on 16 September). Following that, the harvesting continued until 8 October. A strong influence of high temperatures in the second half of the summer was evident in this case. They lasted until 10 September, causing high cropping of curds at the beginning of the harvesting time. Cold autumn followed then, favouring slow maturing. In 2003, however initial, small cropping from the first cultivation time was registered already at the end of August, harvest culmination occurred only at the end of September (full harvest on 25 September). Afterwards, few curds were cropped until 20 October. Cropping from the second cultivation time started only at the end of September, reaching culmination on 13 October and the end on 23 October. Harvest accumulation at the end of September, particularly evident in case of the first planting time, can easily be connected to the significant growth of temperature at that period (Fig. 1). In the last year of the experiment, temperatures during vegetation period were more uniform. Harvesting of the Planita F_1 cultivar started on 9 September, reaching culmination between 13 and 16 September and ended on 30 September. On the other hand, initial, slight cropping of the Farras F_1 cultivar was recorded on 16 September, full cropping on 4 October and final cropping on 21 October.

For both cultivars of green cauliflower, the period of vegetation was longer (Fig. 5) than in case of the white cultivars. However, the distribution of cropping in particular years was comparable, though moved in time by several or a dozen days.

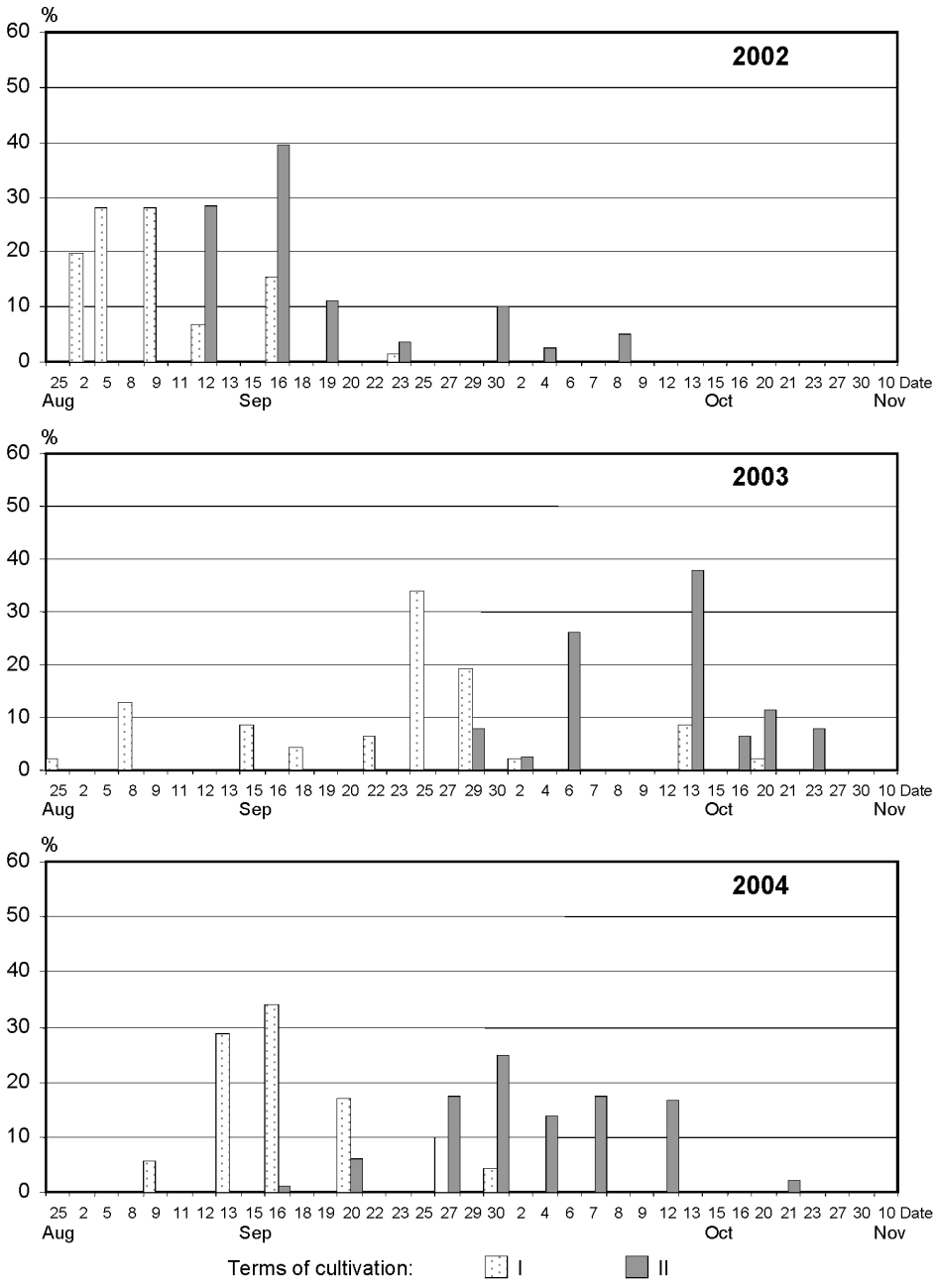

Figure 4. Pattern of white cauliflower cropping in the years 2002 – 2004

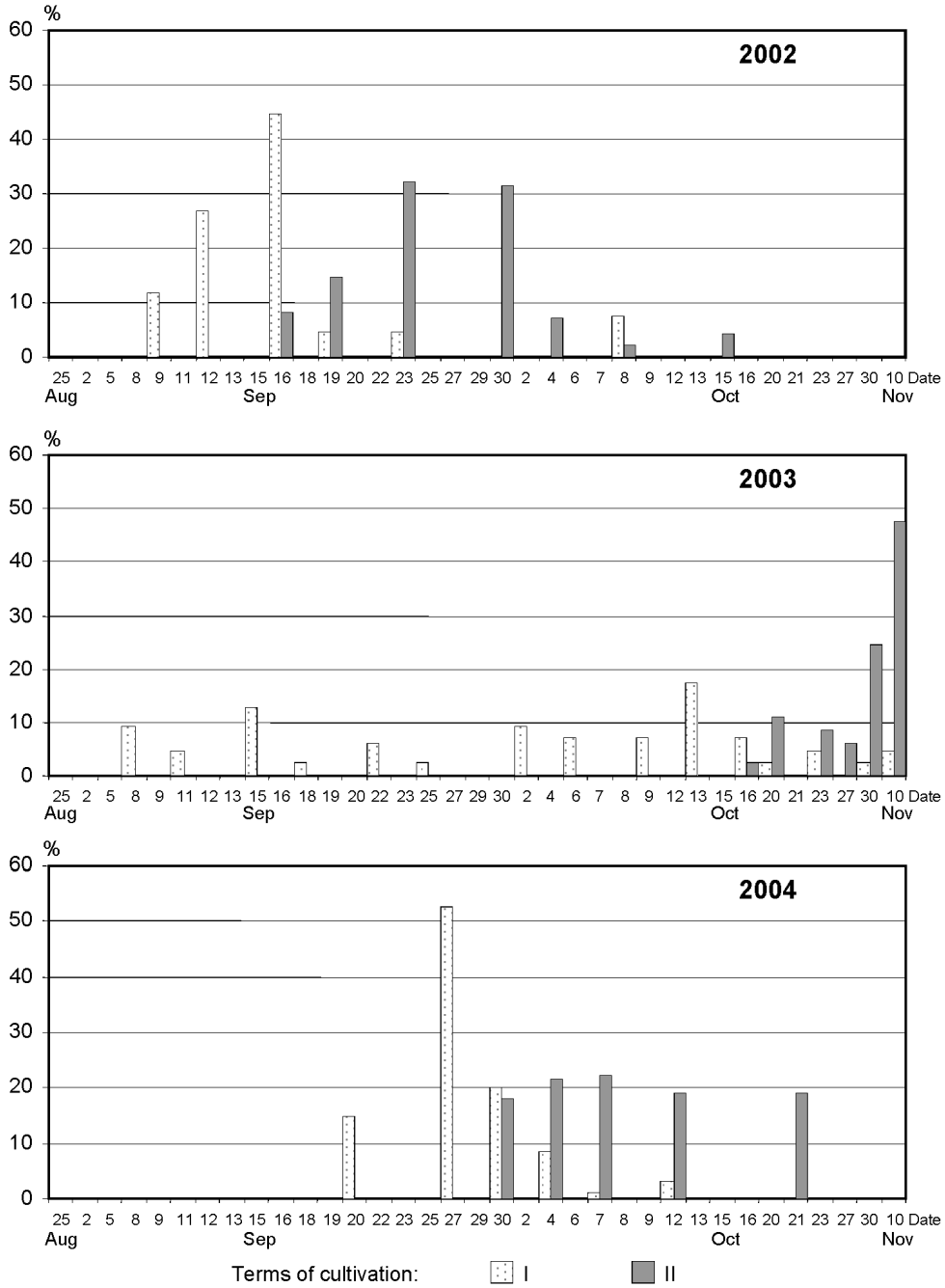

Figure 5. Pattern of green cauliflower cropping in the years 2002 – 2004

The only exception here was the Panther F_1 cultivar in 2003, in case of which harvesting started on 16 October and was completed in its main part only at the end of October and the beginning of November. In the same year, the Trevi F_1 cultivar gave first curds on 8 September and harvesting, of a very even character, continued until 10 November. In the remaining years, similarly as in case of the white cauliflower, cropping period was much more condensed. In the first year of the experiment, cauliflower planted on 20 June started cropping on 9 September, reaching full harvest on 16 September and cropping end on 8 October, whereas the cauliflower planted on 5 July on 16 September, 23 September and 15 October, respectively. In the last year of the experiment, cauliflower from the first planting time entered the cropping period on 20 September, achieving record cropping on 27 September (52.5%) and ending the cropping period on 12 October, whereas in case of the cauliflower planted on 14 July the respective dates were: 30 September, 7 October and 21 October.

The above presented analysis of cropping dynamics of both types of cauliflower against the weather conditions in particular years shows that in certain periods temperature had either accelerating or slowing effect on the course of harvesting. Once again, the temperature was proved to be the most important climatic factor decisive for cauliflower curds maturing, which was also found by other authors (Nowbuth and Pearson 1998, Wurr et al. 2000). However, in this experiment, rainfalls might have been less significant due to systematic watering of the plantation although the considerable cropping prolongation in 2003 might have been related to exceptionally low rainfalls in August and September.

CONCLUSIONS

1. In planting for autumn harvest, intensive vegetative growth of the white and green cauliflower cultivars (plant height and diameter, as well as the number of leaves) in full summer (end of July, August) until first curd harvesting was proved.
2. Planting in the second half of June and the first part of July of the cultivars of white (Planita F_1 and Farras F_1) and green (Trevi F_1 and Panther F_1) cauliflower, of different vegetation periods allowed for the timing of the harvesting period to the later date with the use of the delayed time of cultivation.
3. The cultivars of green cauliflower used in the experiment turned out to harvest slightly later than the white cultivars. However, in all years of the experiment, full cropping of curds was possible for both cultivars.
4. The analysis of the cropping dynamics against weather conditions in particular years proved, in certain periods, significant effect of temperature on accelerating or delaying the cropping of both types of cauliflower.

AKNOWLEDGEMENTS

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REFERENCES

BOOIJ R., 1987. Environmental factors in curd initiation and curd growth of cauliflower in the field. Neth. J. Agri. Sci. 35: 435-445.

CEBULA S., KALISZ A., 1997. Value of different cauliflower cultivars for autumn production in a submontane region as depending upon the planting time. I. Yields and pattern of cropping. Folia Hort. 9/2: 3-12.

CEBULA S., KALISZ A., 1997. Value of different cauliflower cultivars for autumn production in a submontane region as depending upon the planting time. II. Quality of curds. Folia Hort. 9/2: 13-20.

CEBULA S., KALISZ A., 2005. Wybrane elementy wartości odżywczej kilku odmian kalafiora białego, zielonego i romanesco. W monografii „Zmienność genetyczna i jej wykorzystanie w hodowli roślin ogrodniczych". Wydawnictwo ISK: 49-53.

CEBULA S., KALISZ A., KUNICKI E., 2005. Wpływ terminu uprawy na plonowanie i jakość handlową róż kalafiora białego, zielonego i romanesco. Zesz. Nauk. AR (Wrocław), Rolnictwo LXXXVI, nr 515: 69-76.

FELLOWS J.R., WURR D.C.E., PHELPS K., READER R.J., 1999. Initiation of early summer cauliflowers in response to temperature. J. Hort. Sci. Biotech. 74(3): 328-336.

FERNANDEZ J.A., FRANCO J.A., BANON S., OCHOA J., 2003. Timing of cauliflower production in Southeast Spain. Acta Hort. 607: 103-106.

HADLEY P., PEARSON S., 1998. Effects of environmental factors on progress to crop maturity in selected brassica crops. Acta Hort. 459: 61-70.

LIPTAY A., 1981. Cauliflower curd initiation and timing of production in a high temperature growing season. Acta Hort. 122: 47-52.

NOWBUTH R.D., PEARSON S., 1998. The effect of temperature and shade on curd initiation in temperate and tropical cauliflower. Acta Hort. 459: 79-87.

OLESEN J.E., GREVSEN K., 1997. Effects of temperature and irradiance on vegetative growth of cauliflower (*Brassica oleracea* L. *botrytis*) and broccoli (*Brassica oleracea* L. *italica*). J. Exp. Bot. 48(313): 1591-1598.

WURR D.C.E., FELLOWS J.R., HIRON R.W.P., 1990. The influence of field environmental conditions on the growth and development of four cauliflower cultivars. J. Hort. Sci. 65(5): 565-572.

WURR D.C.E., FELLOWS J.R., KING G.J., 2000. Temperature influences on the plant development of different maturity types of cauliflower. Acta Hort. 539: 69-74.

PRZEBIEG WZROSTU ORAZ PLONOWANIA KALAFIORA BIAŁEGO I ZIELONEGO W DWÓCH TERMINACH UPRAWY NA ZBIÓR JESIENNY

Streszczenie: W trzyletnich badaniach (2002 – 2004) poszukiwano zależności pomiędzy kształtowaniem się warunków pogodowych a wzrostem wegetatywnym i przebiegiem plonowania kalafiora białego oraz zielonego w uprawie na zbiór jesienny. Dla kalafiora białego zastosowano późniejszą odmianę Planita F_1 oraz wcześniejszą Farras F_1, a dla zielonego odpowiednio Trevi F_1 i Panther F_1. Rośliny odmian późniejszych zostały posadzone w drugiej połowie czerwca, terminie typowym dla uprawy jesiennej, a wcześniejszych w pierwszej połowie lipca, w terminie stosowanym po zbiorze niektórych przedplonów. W czasie wegetacji dokonano pomiarów wysokości i średnicy roślin oraz liczby wykształconych liści. Rejestrowano również termin początku zawiązywania róż oraz pierwszych i kolejnych zbiorów. Dane klimatyczne obejmowały dobowe temperatury minimalne, maksymalne i średnie oraz sumy opadów atmosferycznych. Wykazano intensywny wzrost wegetatywny obu typów kalafiora (wysokość i średnica roślin oraz liczba liści) w pełni lata (koniec lipca, sierpień) aż do pierwszych zbiorów róż. Wysadzanie w drugiej połowie czerwca i pierwszej połowie lipca rozsady odmian kalafiora białego oraz zielonego, różniących się długością okresu wegetacji, pozwoliło rozłożyć w czasie przebieg plonowania, z przesunięciem zbiorów na późniejszy okres jesieni przy stosowaniu opóźnionego terminu uprawy. Użyte w badaniach odmiany kalafiora zielonego okazały się nieco późniejsze niż białego, jednakże we wszystkich latach w obu terminach uprawy dokonano pełnego zbioru róż. Analiza dynamiki plonowania na tle kształtowania się warunków pogodowych w poszczególnych latach wykazała w niektórych okresach widoczny wpływ temperatury, powodującej przyspieszanie lub opóźnianie zbiorów obu rodzajów kalafiora.

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