ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. V SECTIO EEE 1997

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Yield of Winter Garlic with Relation to Planting Date and Kind of Propagation Material

Plonowanie czosnku ozimego w zależności od terminu sadzenia i rodzaju materiału mnożeniowego

Proper planting date is a significant factor affecting the growth and yield of garlic. Under the climatic conditions of Poland, winter garlic is planted from mid October to the beginning of November, depending on the region. Most authors (Kozłowska 1965, 1966, Orłowski and Kołota 1984, Ball 1988, Karba 1988) maintain that winter garlic planted in the autumn gives higher yields than spring garlic planted in the spring. A suitably early planting date is also very important. Orłowski and Rekowska (1993), in an experiment conducted in the Szczecin region, obtained significantly the highest yield of garlic when planting cloves at their earliest date (September 20). Cultivation of garlic planted at that date proved also to be the most profitable, which was very important in view of the constantly growing costs of production. The results of experiments conducted abroad (Rahim et al. 1984, Singh et al. 1984, Shin et al. 1988, Park and Lee 1989) fully support the conclusions of the Polish authors. Due to the low number of publications, both in Poland and abroad, the author has undertaken a study aimed at the determination of the effect of the date of planting of garlic plants of the local ecotype R under the climatic conditions of Lublin.

MATERIALS AND METHODS

The field experiment, conducted in the years 1992-1995, was set up according to the method of random blocks, in five replications. Cloves (300 g/100 pcs) and bulbils (100 g/100 pcs) of garlic were hand planted on five dates, at a spacing of 10 by 10 cm and at a depth of 5-6 cm. Plot surface area was 2.6 m2 (width was 1.0 m). The planting dates chosen for the experiment were July 28, August 28, September 28, October 28, and November 28.

At the beginning of vegetation the author made an assessment of plant emergence with relation to the number of cloves and bulbils planted at each of the five planting dates. At full vegetation of the plants, 5 rows of plants from the middle of the plot were chosen at random for every planting date and type of propagation material (cloves and bulbils), for every replication. The plants from the random selected rows were used for biometric measurements (plant height and number of leaves). The plants were also assessed after the harvest, for the weight of plants, bulbs and inflorescence, and for the number of cloves and bulbs. After the harvest, which was made in the second half of July, the author made an assessment, for each planting date of cloves as well as bulbils, of the total yield of bulbs and inflorescence, based on all the plants harvested from the plot. The results of the experiment were processed statistically. For non-orthogonal data the method of variance analysis of triple classification models was applied.

The distribution of temperature and precipitation in the analyzed periods of root system formation of hibernation of garlic was differentiated (Table 1).

Tab. 1. Mean monthly temperature (°C) and monthly sum of precipitation (mm) in the years 1993-1995 versus the multi-year average values (1951-1990)

Month	1992		1993		1994		1951-1990	
	temp.	prec.	temp.	prec.	temp.	prec.	temp.	prec.
July	18.9	43.2	16.3	73.8	20.9	17.3	17.4	77.7
August	21.3	8.1	16.5	27.0	18.0	95.3	17.3	73.7
September	12.0	114.0	11.8	36.3	14.4	58.5	12.7	46.4
October	5.6	101.0	8.4	25.0	6.2	79.1	7.8	39.5
November	3.1	51.3	-3.5	11.5	2.8	28.1	2.4	39.9
December	-1.4	29.2	1.1	30.2	-0.4	42.5	-1.1	34.5

RESULTS

During the period of plant vegetation, in the successive planting dates, a considerable decrease was observed in the rate of plant emergence. The percentage ratio of the number of plants emerged with relation to the number of cloves and bulbils planted is presented in Fig. 1.

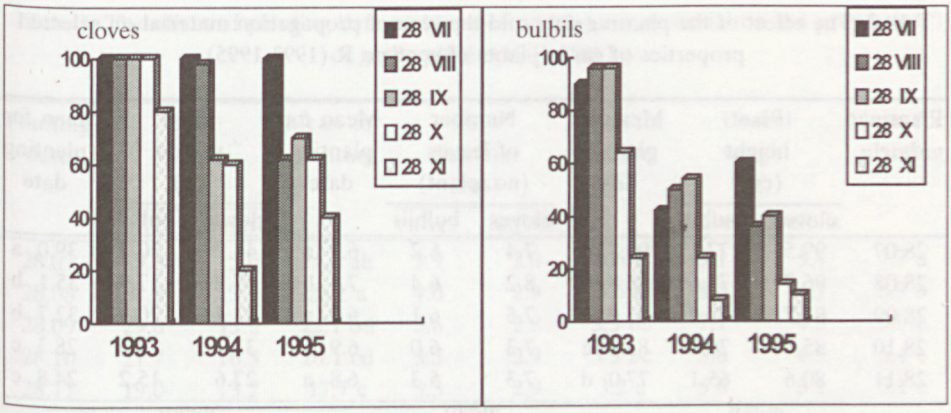

Fig. 1. Emergence of garlic plants propagated from cloves and bulbils for the particular planting dates (%)

Comparing plant emergence in particular years one can observe that the effect of the selected planting dates was significant. In 1993 the decrease in the emergence rate among the plants propagated from cloves occurred only at the last planting date, and among the plants propagated from bulbils at the penultimate planting date. In the following year the decrease occurred already at the third planting dates (cloves). Plants propagated from bulbils emerged at a considerably lower rate than in the preceding year, with the best emergence — over 50% — for the third planting date.

In 1995 the decrease in the rate of emergence occurred already for the second planting date, with a slight increase for the third date, for plants propagated both from cloves and from bulbils. The differences in the rate of emergence in particular years of the experiment are to be attributed to the effect of differentiated meteorological conditions, and especially to the different temperature distributions (Table 1).

It can be concluded, therefore, that the earlier dates of planting allow better development of the root systems of the cloves and bulbils, which facilitates their hibernation. On the basis of the results obtained, the author found significant differences between the mean values of all the properties studied, with relation to all the primary factors (propagation material and planting dates) and the corresponding interactions. The corresponding mean values and semi-intervals of confidence are presented in Tables 2-4.

In the experiment, on the average, significantly taller plants (91.5 cm) and plants of a larger number of leaves (7.5 per plant) were obtained from

Tab. 2. The effect of the planting date and the type of propagation material on selected properties of garlic plants of ecotype R (1993-1995)

Planting date	Plant height (cm)		Mean for planting date	Number of leaves (no./plant)		Mean for planting date	Plant weight (g)		Mean for planting date
	cloves	bulbils		cloves	bulbils		cloves	bulbils	
28.07	99.5	77.1	90.8 a	7.4	6.2	6.9 a	44.2	30.7	39.0 a
28.08	96.7	72.6	86.8 b	8.2	6.4	7.4 b	47.2	17.9	35.1 b
28.09	87.7	77.2	83.0 c	7.5	6.1	6.9 a	42.4	20.9	32.7 b
28.10	85.4	78.1	83.1 c	7.3	6.0	6.9 a	31.1	22.3	28.3 c
28.11	80.6	65.1	77.0 d	7.3	5.3	6.8 a	27.6	15.2	24.8 c
	mean			mean			mean		
	91.5	75.4		7.5	6.1		40.0	22.7	

$LSD_{0.05}$
type of propagation material
1.4 0.1 1.5
a,b,c... — homogeneous groups in the case of significant differences

cloves rather than from bulbils (75.4 cm and 6.1 leaves per plant, respectively) (Table 2). Moreover, significant differences were observed between the mean values obtained for all the planting dates, with the exception of the mean values for September 28 and October 28. This shows that it was the first two planting dates which had the significantly positive effect on the mean height of garlic plants of the R ecotype under study, while the effect of the planting dates on the mean number of leaves was only slight. Significantly the highest mean number of leaves (7.4 leaves per plant) characterized the plants obtained from the second planting date, while the mean values for the remaining planting dates did not differ significantly from one another.

The type of propagation material used had a very strong effect on the mean weight of plants. The weight of plants obtained from cloves (40.0 g) was, on the average, almost double as compared to plants obtained from bulbils (22.7 g). The effect of the planting date on that property was also significant, and plant weight decreased with later planting dates.

The significant effect of the type of propagation material (cloves and bulbils) on the mean weight and diameter of bulbs and on the mean weight of the inflorescence was also demonstrated (Table 3). Plants obtained from cloves developed bulbs of greater weight (27.9 g) and diameter (3.7 cm) than those obtained from bulbils (14.4 g and 2.9 cm, respectively). The weight of inflorescence of plants propagated from cloves (7.5 g) was also signi-

Tab. 3. The effect of planting date and type of propagation material on the properties of garlic plants (1993-1995)

Planting date	Bulb weight (g)		Mean for planting	Bulb diameter (cm)		Mean for planting	Umbel weight (g)		Mean for planting
	cloves	bulbils		cloves	bulbils		cloves	bulbils	
28.07	29.8	15.0	24.0 ab	3.9	3.0	3.6 a	9.1	5.4	7.7 a
28.08	34.9	13.5	26.1 a	4.0	2.9	3.5 a	8.5	4.7	6.9 b
28.09	29.0	13.6	22.1 bd	3.6	2.8	3.3 bc	7.1	4.5	5.9 c
28.10	21.7	16.5	20.1 cd	3.5	2.9	3.3 bc	5.8	4.5	5.4 c
28.11	19.0	13.2	17.7 c	3.3	2.9	3.2 c	5.8	3.1	5.1 c
	mean			mean			mean		
	27.9	14.4		3.7	2.9		7.5	4.7	

$LSD_{0.05}$
type of propagation material
1.2 0.1 0.3
a,b,c...— homogeneous groups in the case of significant differences

ficantly higher than the mean weight of inflorescence of plants obtained from bulbils (4.7 g).

The planting date had a significant effect on the mean bulb weight. Significantly highest bulb weight (26.1 g) characterized plants obtained from the second planting date, and significantly lowest (17.7 g) — from the last planting date. Delayed planting dates for garlic had also a significant effect on the diameters of the bulbs produced. Plants from the later planting dates had bulbs of significantly smaller diameter (3.2 cm and 3.3 cm, respectively), as compared to those from the first two planting dates (3.6 cm and 3.5 cm, respectively).

The factors under study had also a significant effect on the mean number of cloves in a bulb and on the average number of bulbils in an inflorescence (Table 4). Plants propagated from cloves were characterized by a larger mean number of cloves (6.9 cloves per bulb) and of topsets (9.8 per plant) as compared to plants propagated from bulbils (5.1 and 7.6, respectively). Plants of significantly the highest mean number of cloves (6.6 cloves per bulb) were obtained when the garlic was planted on August 28 (second planting date). The differences between the mean values for plants from the first two planting dates were statistically insignificant. Delay in the planting date, however, had no negative effect on the mean number of topsets per plant.

Tab. 4. The effect of planting date and the type of propagation material on the properties of garlic plants crop (1993-1995)

Planting date	No. of cloves (per plant)		Mean for planting date	No. of topsets (per plant)		Mean for planting date
	cloves	bulbils		cloves	bulbils	
July 28	7.1	5.6	6.5 a	11.4	8.9	10.5 a
August 28	7.7	5.1	6.6 a	9.0	7.5	8.4 b
September 28	7.1	4.8	6.1 b	8.6	6.4	7.6 b
October 28	6.2	5.1	5.8 bc	9.9	8.0	9.3 a
November 28	5.9	3.9	5.5 c	9.9	6.7	9.2 a
	mean			mean		
	6.9	5.1		9.8	7.6	
$LSD_{0.05}$ type of propagation material	0.2			0.6		

a,b,c...— homogeneous groups in the case of significant differences

Tab. 5. The effect of planting date and the type of propagation material on the yield of garlic (1993-1995)

Planting date	Total yield of bulbs (t/ha)		Mean for planing date	Yield of inflorescence (t/ha)		Mean for planting date
	cloves	bulbils		cloves	bulbils	
July 28	29.0	15.0	24.1 ab	9.1	5.5	7.7 a
August 28	35.1	13.5	26.2 a	8.5	4.8	7.0 b
September 28	29.1	13.7	22.2 bc	7.1	4.5	5.9 c
October 28	21.8	16.5	20.1 cd	5.9	4.6	5.5 c
November 28	18.9	13.2	17.6 d	5.8	3.2	5.2 c
	mean			mean		
	28.0	14.4		7.6	4.8	
$LSD_{0.05}$ type of propagation material	1.2			0.3		

a,b,c... — homogeneous groups in the case of significant differences

Irrespective of the type of propagation material, the highest total yield of bulbs (26.2 t/ha) was obtained for plants planted on August 28. The differences between the mean total yield of bulbs for plants from the first and the second planting dates were statistically insignificant. The yield, however, was significantly higher (28.0 t/ha) for plants propagated from cloves than for those from bulbils (14.4 t/ha) (Table 5).

For each of the planting dates the total yield of bulbs was, on the average, twice as high for plants grown from cloves as compared to those grown from bulbils. A more notable decrease in the yield with delayed planting date was observed in the case of cloves as the propagation material.

DISCUSSION

The literature of the subject offers only scarce data on the effect of the planting date of cloves and bulbils on the growth and yield of winter garlic. The results presented herein support the results obtained by Tursunov (1971), Rahim et al. (1984), Singh et al. (1984), Park and Lee (1989), Singh and Phogat (1989) and Orłowski and Rekowska (1993). In the case of plants from the earliest planting dates, those authors found the best rate of emergence, the fastest growth, significantly higher yields and greater weight and diameter of bulbs, higher number of cloves and greater weight of a single clove, as compared to plants from later planting dates. Depending on the climatic conditions of their studies, the authors found the following times to be the best for planting winter garlic: Rahim et al. (1984) (the Indian Peninsula) — October 31; Singh et al. (1984) (India) — October 15; Singh and Phogat (1989) (India) — September 20; Shin et al. (1988) (Korea) — from September 20 to October 10; Park and Lee (1989) (Korea) — the beginning of September; Orłowski and Rekowska (1993) (Szczecin, Poland) — September 20. Under the conditions of South-East Poland, the best planting dates proved to be July 28 and August 28, which is illustrated by the results presented herein. In this study the mean total yield of bulbs for garlic planted at the first two planting dates was 25 t/ha, thus being 30-50% higher than the corresponding yield obtained by Rahim et al. (1984), Singh et al. (1984), and Singh and Phogat (1989). Differences of such magnitude were probably caused by the earlier time of planting — by about 1-2 months — as well as by the higher planting density of garlic in the experimental plots.

The results obtained from the study presented here are in opposition to

those obtained by Park and Lee (1989) who observed an increase in garlic plants height and in the number of leaves with delayed planting date. In this study, plants of significantly decreased height were obtained as the planting dates of cloves and bulbils were delayed. The largest number of leaves, however, was that characterizing the plants from the second, late-summer planting date.

The results presented here indicate the need for early dates to be used for garlic planting, depending on the local climatic conditions.

CONCLUSIONS

1. The author showed a significant effect of the planting date on the emergence, the biometric properties and the yield of winter garlic plants of the local ecotype R propagated from cloves and from bulbils. Irrespective of the type of propagation material used, delaying the planting date resulted in a decrease in the rate of emergence and in deterioration of the quality and quantity of the crop.

2. The most abundant and the best crop was obtained when garlic was planted on the earliest dates, i.e. July 28, August 28 and September 28. Garlic planting on such early dates ensured the optimum conditions for root system development, which facilitated their hibernation and affected their further growth and development.

3. Irrespective of the date of planting cloves and bulbils, in the case of garlic propagation from cloves healthier plants were obtained, with better morphological and quality features and providing higher yield.

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STRESZCZENIE

W trzyletnich (1993-1995) badaniach polowych oceniano wpływ pięciu jesiennych terminów sadzenia ząbków oraz cebulek powietrznych czosnku lokalnego ekotypu R. Czosnek sadzono od 28 sierpnia do 28 listopada. Oceniano wschody roślin w poszczególnych terminach sadzenia, prowadzono pomiary biometryczne w czasie wegetacji oraz po zbiorze roślin. Określono także plon ogólny główek i baldachów. Na podstawie uzyskanych wyników stwierdzono istotny wpływ terminu sadzenia ząbków i cebulek powietrznych czosnku lokalnego ekotypu R na wschody oraz badane cechy roślin. Niezależnie od rodzaju matriału mnożeniowego opóźnianie terminu sadzenia miało negatywny wpływ na wschody oraz badane cechy roślin czosnku.