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THE EFFECT OF BULB PLANTING TIME AND TYPE OF MULCH ON THE YIELD OF *Allium aflatunense* B. Fedtsch.

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Abstract

The aim of the study was to determine the effect of bulb planting time and the type of mulch on the morphological traits of plants and on bulb yield of *Allium aflatunense* B. Fedtsch. 'Purple Sensation'. Bulbs of 12 cm diameter were used as the study material. The bulbs were planted in plots on three dates: September 15th, October 1st, and October 15th. The plantation was mulched after frost with two types of mulch: composted pine bark and wheat straw. Phenological phases of the plants were observed during the growing season. At the full flowering stage, several observations and measurements were taken: length of leaves, length of inflorescence peduncle, peduncle diameter, inflorescence diameter, and number of flowers per inflorescence. After harvest, total numerical and weight yield of bulbs were evaluated as well as number and weight of the largest bulbs (21–22 cm diameter). The study showed that in order to obtain *Allium aflatunense* of high ornamental value, which is determined by the number of flowers per inflorescence and the inflorescence peduncle diameter, bulbs need to be planted in the middle of September. Bulb planting in October leads to production of inflorescences of greater diameter. The optimum method of *Allium aflatunense* cultivation which ensures production of good total yield of bulbs, expressed in its weight, is bulb planting on September 15th and soil mulching with composted pine bark or straw. Mulching a plantation of *Allium aflatunense* planted on September 15th with bark has a positive effect on the number and weight of bulbs of 21–22 cm diameter.

Key words: *Allium aflatunense*, inflorescences, flowers, bulbs, cultivation method, mulching, pine bark, wheat straw

INTRODUCTION

Ornamental *Allium* is a large group of perennial plants of varying ornamental value (Krzymińska, 2003). It is a plant that is appropriate not only for planting in flower-beds but also for cut flowers cultivation. Some of them are used for forcing (De Hertogh and Zimmer, 1993). In the cultivation of bulbous plants, the proper planting time of bulbs is crucial to obtain good quality of flowers and high yield (Kizil et al., 2008; Mosleh Ud-Deen, 2008; Akpinar and Bulut, 2011).

Particular species of ornamental *Allium* differ in resistance to low temperatures. Those that are less resistant to unfavorable weather conditions can undergo mulching. Organic mulch which is placed in the autumn and then left for the entire cultivation period has been successfully used in the cultivation of ornamental plants for several years already. Thanks to the fact that mulch is left until the end of the growing season, the application of herbicides can be significantly limited. Rasmussen and Henriksen (1990) showed that plantation mulching can have a significant effect on tulip bulb yield. Mulch also protects plants from low temperatures. December is an especially critical month in the cultivation of tulips and other bulbous plants (Szlachetka and Drozd, 1990 a, b; Szlachetka et al. 1991). Mulch used as protection from frost (straw, pine needles, leaves, bark, agrotextile) helps maintain a balanced temperature of soil around the plant's root system and protects it from the effects of frequent soil frosting and defrosting.

The aim of the present study was to determine the effect of bulb planting time and the type of mulch on the morphological traits of plants and on bulb yield of *Allium aflatunense* 'Purple Sensation'.

MATERIALS AND METHODS

The study was conducted in the years 2005–2008, every year in the period between September 15th and the beginning of the third decade of June, that is, until bulb harvest.

Bulbs of *Allium aflatunense* B. Fedtsch 'Purple Sensation' of 12 cm diameter were used as the study material. The bulbs were planted in plots on three dates: September 15th October 1st, and October 15th. The plantation was mulched after frost with two types of mulch: composted pine bark and wheat straw. Control plots did not have any covering. 30 bulbs were planted in each 1 m^2 plot. Prior to planting, the bulbs were soaked for 20 minutes in 1% solution of Kaptan and 0.7% solution of Topsin. In the autumn, Azofoska was applied as fertilizer in the amount of 60 g × m^{-2}, whereas in the spring – Azofoska as top dressing (30 g × m^{-2}) and ammonium nitrate (20 g × m^{-2}). The phenological phases of the plants were observed during the growing season: emergence, beginning of flowering (25% of blooming plants in the plots), full flowering (75% of blooming plants in the plots), and end of flowering. The growing period was also determined. At the full flowering stage, several observations and measurements were taken: length of leaves, length of inflorescence peduncle, peduncle diameter, inflorescence diameter, and number of flowers per inflorescence. After harvest bulbs were dried, cleaned and calibrated. Total numerical and weight yield of bulbs were evaluated as well as number and weight of the largest bulbs (21–22 cm diameter).

The experiment was set up in a randomized block design in three replications. One plot was one replication. The results were analyzed statistically by means of two-way analysis of variance, evaluating the significance of differences by means of Tukey's confidence intervals at the level of significance of =0.05 %.

RESULTS

Depending on the year of the study, the start of flowering of *Allium aflatunense* was in the period between May 7th and May 21st. The earliest flowering was noted in case of bulbs planted on the latest date, that is, October 15th. The type of mulch did not affect the start of flowering of *Allium aflatunense*. Full flowering was observed in the period between May 17th and May 28th. The average duration of flowering was between 15 and 20 days, counting from the beginning of flowering until its end. Plants from bulbs planted on October 1st, on average, flowered the longest.

Length of the growing period depended on the planting time. The longest growing period, which was on average 88 days, characterized bulbs planted on September 15th, while the shortest one, which lasted on average 85 days, was characteristic for plants from bulbs planted on October 15th.

The effect of bulb planting time and mulch on the morphological traits of plants was observed.

The longest leaves were produced by plants that grew from bulbs planted on October 1st and 15th (Table 1). Application of mulch in the cultivation of *Allium aflatunense* led to production of longer plant leaves. The longest ones were produced by plants that grew from bulbs planted on the earliest date – September 15th inn the plots mulched with straw (79.8 cm), the shortest ones in the control plots (76 cm). The largest diameter of inflorescence was obtained in the case of plants that grew from bulbs planted at the earliest date – September 15th (5.7 mm), compared to plants that grew from bulbs planted four weeks later (5.1 mm). The effect of correlation between bulb planting time and type of mulch applied on the diameter of *Allium aflatunense* inflorescence was not observed. It was proved that plants with larger inflorescences (10.8 cm) (Table 2) grew from bulbs planted on October 1st and 15th.

Bulb planting time and the correlation between planting time and type of mulch applied has a significant effect on the number of flowers per inflorescence. The most flowers per inflorescence were produced by plants obtained from bulbs planted at the earliest date – September 15th (323.2 pcs.), and similarly on October 1st (321.4 pcs.) (Table 2). The correlation of soil mulching and bulb planting time did not have a positive effect on the number of flowers per inflorescence.

The analysis of data concerning total numerical yield of bulbs shows that there was no positive effect of the correlation between planting time of *Allium aflatunense* B. Fedtsch and type of mulch (Table 3). In the total bulb yield obtained, expressed in pcs × m^{-2}, the only trend that was observed was an increase in the total number of bulbs along with later planting time. The total weight of daughter bulbs differed depending on bulb planting time. Mulching with bark or straw had a positive effect on the total weight of bulbs (Table 3). The total weight of adventitious bulbs was the highest in the case of the earliest planting time in the plots mulched with bark and straw (24694 g; 2408.7 g). The lowest total weight of bulbs was recorded in the control plots with the same planting time.

The analysis of numerical and weight yield of the largest bulbs, i.e. with a diameter of 21–22 cm, showed that early planting of bulbs and soil mulching led to production of higher yield of daughter bulbs with the greatest diameter (Table 4). The highest number and weight of bulbs – 4.1 pcs and 427 g, respectively, were obtained in the plots mulched with bark with the earliest planting time.

Table 1
The effect of bulb planting time and type of mulch on morphological traits *Allium aflatunense.* Means for 3 years

Planting time	Type of mulch	Morphological traits					
		Length of leaves (cm)	Mean for planting time	Length of peduncle (cm)	Mean for planting time	Diameter of peduncle (mm)	Mean for planting time
15. IX	Bark	60.9	59.7 A	78.5 ab	78.1	5.7	5.7 B
	Straw	60.5		78.4 ab		5.6	
	Control	57.7		77.3 ab		5.7	
1. X	Bark	60.2	60.5 B	78.3 ab	77.8	5.1	5.3 AB
	Straw	61.8		78.7 ab		5.5	
	Control	59.4		76.6 a		5.2	
15. X	Bark	62.1	60.9 B	77. ab	77.7	5.1	5.1 A
	Straw	62.1		79.8 b		5.1	
	Control	58.5		76.0 a		5.2	
Mean for mulch	Bark	61.1 B*		78.0		5.3	
	Straw	61.5 B		78.9		5.4	
	Control	58.5 A		77.7		5.4	

*Means followed by the same letter are not significantly different at =0.05.

Table 2
The effect of bulb planting time and type of mulch on morphological traits of *Allium aflatunense*. Means for 3 years

Planting time	Type of mulch	Morphological traits			
		Diameter of inflorescence (cm)	Mean for planting time	Number of flowers per inflorescence	Mean for planting time
15. IX	Bark	10.2	10.4 A*	312.8 abc	323.2 B
	Straw	10.4		328.1 bc	
	Control	10.5		328.7 bc	
1. X	Bark	10.8	10.8 B	328.7 bc	321.4 B
	Straw	10.7		295.4 a	
	Control	11.0		336.1 c	
15. X	Bark	10.7	10.8 B	301.8 ab	299.1 A
	Straw	10.6		299.9 ab	
	Control	11.1		293.9 a	
Mean for mulch	Bark	10.6		316.3	
	Straw	10.6		307.3	
	Control	10.9		320.1	

*Means followed by the same letter are not significantly different at =0.05.

Table 3
The effect of bulb planting time and type of mulch on total numerical (pcs.×m^{-2}) and weight (g. × m^{-2}) yield of *Allium aflatunense* daughter bulbs. Means for 3 years

Planting time	Type of mulch	Total yield of bulbs (pcs × m^{-2})	Mean for planting time	Total yield of bulbs in g × m^{-2}	Mean for planting time
15. IX	Bark	88.2	86.1	2469.4 g*	2312.8 C
	Straw	85.8		2408.7 f	
	Control	84.4		2060.4 a	
1. X	Bark	92.3	88.2	2217.5 c	2300.6 B
	Straw	85.9		2388.2 e	
	Control	86.4		2296.2 d	
15. X	Bark	87.1	90.6	2134.1 b	2216.6 A
	Straw	92.3		2284.4 d	
	Control	92.4		2231.2 c	
Mean for mulch	Bark	89.2		2273.8 B	
	Straw	88.0		2360.4 C	
	Control	87.8		2195.6 A	

*Means followed by the same letter are not significantly different at =0.05.

Table 4
The effect of bulb planting time and type of mulch
on the number and weight of *Allium aflatunense* daughter bulbs of 21–22 cm diameter. Means for 3 years

Planting time	Type of mulch	Number of bulbs (pcs×m^{-2})	Mean for planting time	Weight of bulb (g×m^{-2})	Mean for planting time
15. IX	Bark	4.1 f*	3.2 B	427.0 f	330.9 B
	Straw	2.2 bc		272.4 cd	
	Control	1.7 a		293.4 d	
1. X	Bark	2.7 cd	2.8 B	248.4 abc	304.2 B
	Straw	3.5 e		386.7 e	
	Control	1.9 ab		277.4 cd	
15. X	Bark	2.9 d	1.9 A	178.4 a	198.9 A
	Straw	2.8 d		212.1 ab	
	Control	2.0 ab		206.2 a	
Mean for mulch	Bark	2.7		284.6 B	
	Straw	2.7		290.4 B	
	Control	2.6		258.9 A	

*Means followed by the same letter are not significantly different at =0.05.

DISCUSSION

The increasing popularity of this little known, yet incredibly ornamental species of *Allium* creates a great demand for its bulbs. Bringing to perfection cultivation technology and reproduction of this group of plants is needed to meet the demands of the market.

Planting bulbs at the proper timing is extremely important. The optimum planting time guarantees higher bulb yield and plants of better quality. In the research on patchiness, Kizil et al. (2008) planted bulbs on four dates: September 1st and 15th as well as October 1st and 15th. The research showed that the best planting time leading to production of the highest numerical yield of *Fritillaria imperialis* L. bulbs was the first decade of September. However, that same research showed a trend towards an increase in numerical yield of *Allium aflatunense* bulbs with later bulb planting time (October), which is not in agreement with the results of the research by Kizil et al. (2008). The quoted authors claimed that the earlier planting time also affected morphological traits of plants. Bulbs planted at the beginning of September produced the highest plants with the thickest shoots and the greatest number of flowers per inflorescence. This finding has been confirmed by the results of this study where in the case of the earliest planting time, i.e. September 15th, a tendency was observed for production of the longest inflorescence peduncles and the largest peduncle diameter in *Allium aflatunense*. Similarly, the number of flowers per inflorescence was the highest in the case of plants that grew from bulbs planted at the earliest date.

In the present study, the highest weight yield of daughter bulbs was obtained at the earliest planting date. It confirms the results of the research by Hetman et al. (2007) where in the cultivation of *Allium moly* L. the highest weight yield of daughter bulbs was obtained with the earliest planting date (September 29th and October 9th).

The quality of plants and the size of yield can be improved through application of mulch to the plantation. Mulch improves soil moisture and protects the plant root system from frost. In the present experiment, the application of mulch, depending on bulb planting time, had a positive effect on the length of inflorescence peduncle and also on bulb yield. This confirms the results of studies by other authors. Bhuiya et al. (2003) who observed the effect of planting time and mulch on yield of edible garlic proved that earlier planting along with mulching with, e.g., straw increases bulb yield by over 27%. It also leads to increased height of plants and size of bulbs. Rekowska and Skupień (2007) obtained similar results through application of agrotextile. Yield of bulbs was greater by over 24% in comparison with plants that were not covered. A positive effect of application of agrotextile on tuber yield was observed in the cultivation of early potato (Hamouz et al. 2005). The present research confirms the results obtained by others. Application of pine mulch or wheat straw mulch has positive effect on bulb weight of total yield.

CONCLUSIONS

1. In order to obtain *Allium aflatunense* of high ornamental value, with a specific number of flowers per inflorescence and diameter of inflorescence peduncle, bulbs need to be planted in the middle of September. Bulb planting in October leads to production of inflorescence of greater diameter.
2. Optimum method of *Allium aflatunense* cultivation which ensures production of good total yield of

bulbs, expressed in its weight, is bulb planting on September 15th and soil mulching with composted pine bark or straw.

3. Mulching a plantation of *Allium aflatunense* planted on September 15th with bark has a positive effect on the number and weight of bulbs of 21–22 cm diameter.

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Wpływ terminu sadzenia cebul i rodzaju ściółki na plonowanie czosnku aflatuneńskiego (*Allium aflatunense* B. Fedtsch).

Streszczenie

Badano wpływ terminu sadzenia cebul oraz rodzaju ściółki na cechy morfologiczne roślin i plon cebul czosnku aflatuneńskiego ‘Purple Sensation’. W doświadczeniu wykorzystano cebule o obwodzie +12 cm. Cebule były sadzone na poletkach w trzech terminach: 15 września, 1 października i 15 października. Po przymrozkach plantację przykryto dwoma rodzajami ściółek: przekompostowaną korą sosnową i słomą pszenną. W czasie wegetacji obserwowano fazy fenologiczne. Podczas pełni kwitnienia wykonano następujące pomiary i obserwacje: długość liści, długość szypuły kwiatostanowej i jej średnica, średnica kwiatostanu oraz liczba kwiatów w kwiatostanie. Po zbiorze oceniono ogólny plon liczbowy i wagowy oraz liczbę i masę cebul największych (21–22 cm obwodu). Wykazano, że w celu uzyskania czosnku aflatuneńskiego o wysokich walorach dekoracyjnych, określonych liczbą kwiatów w kwiatostanie i średnicą szypuły kwiatostanowej, cebule należy sadzić w połowie września. Sadzenie cebul w październiku umożliwia uzyskanie kwiatostanów o większej średnicy. Optymalnym sposobem uprawy czosnku aflatuneńskiego zapewniającym otrzymanie dobrego plonu ogólnego cebul, wyrażonego jego masą, jest sadzenie cebul 15 IX i ściółkowanie gleby przekompostowaną korą sosnową lub słomą. Ściółkowanie korą plantacji czosnku aflatuneńskiego posadzonego 15 IX korzystnie wpływa na liczbę i masę cebul o obwodzie 21–22 cm.