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THE EFFECT OF SOME AGROTECHNICAL FACTORS ON QUANTITY AND QUALITY OF GARLIC GROW FOR A BUNCH HARVEST

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Abstract

In the conducted experiment the effect of covers application (perforated foil, white polypropylene non-woven) and method of clove planting (in rows – one clove per point, two cloves per point and 3 cloves per point) of Polish garlic cultivar 'Jarus' was estimated. The cloves were planted in the first 10 days' of April, at planting density 20×6 cm.

Significantly higher yield of garlic was obtained when plants were grown under flat covers. Coincidentally, better productive effects were obtained when 3 cloves were planted per point. Moreover, it was proved that planting 2 and 3 cloves per point had a significant effect on higher plant weight, including leaves weight, in comparison with traditional planting method (planting 1 clove per point).

INTRODUCTION

Garlic is one of the oldest plant crops and one of the most nutritious and health benefits vegetables (Chun et al., 2005, Cieślik 2009). Garlic is also known as one of the plant crops with the multiple properties: antibacterial, antifungal, anti-atherosclerosis and strengthening the human immune system (Ismail et al., 2004). Usually, the usable parts of the garlic plants are the fresh underground bulbs consisting of individually wrapped cloves. In case of the cultivars which form flower stalks, the aerial bulblets and the flowers might be also consumed. Another usable parts of garlic are the young leaves which can enlarge the assortment of the fresh vegetables during the spring season. They contain large amounts of vitamins C, B_1, B_2, PP and mineral compounds (Rekowska and Skupień, 2009). Garlic is also a rich source of flavonoids known for their beneficial effects on human health (Mysiak and Tendaj, 2006). In many countries of South Europe it is popular to grow garlic for a bunch-harvest with green leaves. However, in Poland it is still a very little known method of cultivation of this vegetable. For this type of cultivation it is possible to use both types of garlic cultivars: winter ones (with the earliest yield) which are planted in autumn and spring cultivars planted in early spring. Positive effects of garlic cultivation for the early harvest with green leaves depend on choosing a proper crop area, cultivar, optimal date of clove planting and use of covers to provide favorable modification of microclimate conditions around the plants.

The aim of this conducted experiment was the estimation of the effect of using flat covers for soil and plant covering, and the method of clove planting on the quantity and quality of yield of garlic grown for the bunch-harvest.

MATERIAL AND METHODS

The field experiment was conducted in the years 2006-2007 at the Vegetable Experimental Station near Szczecin. The experiment was set in two-factorial, split-block design with four replications. The tested factors were: cover type (perforated film with 100 holes per $1m^2$, white polypropylene non-woven P-17) and the method of clove planting (one clove per point – the control, two and three cloves per point). The plot area for the harvest was 1.44 m^2 (1.2 × 1.2 m). Cucumber grown in manure was a forecrop followed by garlic plants. Mineral fertilization was quantified according to the results of the chemical analysis of the soil samples. Phosphorus and potassium fertilizers and half of the nitrogen dose were applied before clove planting. The second half of nitrogen dose was applied after the emergence of plants.

Garlic cloves of cultivar 'Jarus' were planted at the end of March, in 20×6 cm distance, at depth of 3 cm. According to the experiment methods, straight after the clove planting some of the experimental objects were covered. The covers were removed from the plants after about three weeks. Plots without covers were used as the control. Garlic was harvested twice: in the middle of June and 10 days later. After the harvest the quantity of yield of bulbs with green leaves, leaf length, number and weight of green leaves per one plant, diameter and weight of the bulbs were assessed. The chemical analysis were carried out in raw plant material (leaves and bulbs). The determinations included the content of dry matter (drying at 105°C to constant weight), L-ascorbic acid (using the Tillmans method) and total sugars (using the Luff-Schoorl method). The results of the study were subjected to an analysis of variance. The means were separated by the Tukey's test at p=0.05.

RESULTS AND DISCUSSION

In both years of the study, it was found that significantly higher marketable yield of garlic was obtained when plants were covered with the flat covers (Table 1), but only in the case of the earliest harvest. According to quantity of the yield collected at a later date there were no significant differences found between covering plants and growing them without covers. This corresponds with the investigation of Rekowska and Słodkowski (2005). The authors found that covering plants of corn salad with polypropylene non-woven had a positive effect on the yield quantity, in comparison with the control object, but only with regard to the earliest date of harvest. The positive effect of covering wintering onion and shallot with plastic covers for a short period of time was also observed by Tendaj and Gruszecki (2002), Orłowski et al. (2005), and Tendaj and Mysiak (2006). The authors confirmed that the use of perforated foil as flat covers had a significant effect on the increase of the yield of the onions in comparison with use of polypropylene non-woven and the control object (without covers). In opinion of Adamczewska-Sowińska and Kołota

(2001) perforated foil unlike polypropylene non-woven gives better productivity effects in the case of the leek cultivation for the early harvest. In the conducted experiment, there were no significant differences found in the yield quantity of the plants covered with perforated foil and the plants covered with polypropylene non-woven. For the harvest acceleration in garlic cultivation, except flat covers, Dyduch and Najda (2010) recommend the use of non-heated plastic tunnels. The authors proved that plants of wintering garlic grown in a high non-heated tunnel were ready for the harvest on average by 2-3 weeks earlier in comparison with the field cultivation. Moreover, the marketable yield of leaves of plants grown in the tunnel was higher by 34.4%.

In each year of the study, when the cloves were planted by three per point, there was a significantly higher yield of bulbs and leaves determined (Table 1). On average for two years of the study the yield increase was noted, by 86.4% (at first harvest date) and by 70% (at the second harvest date) in comparison with planting one clove per point. Similar research at this area was conducted by Jadczak et al. (2009). The authors proved that planting two plants of hot pepper per point had a significant effect on the increase of the yield in comparison with planting just one plant per point. However, in that case the fruit weight was significantly lower. Also, Żurawik and Jadczak (2008) carried out the experiment on effects of number (3, 4 and 5) of planted transplants of garlic chives on the quantity and quality of the yield. Significantly the highest marketable yield of leaves was obtained from planting 5 transplants per point (3.59 $t \cdot ha^{-1}$ from one-year old plants).

In the study the positive influence of covering garlic with flat covers on some quality characteristics of the yield obtained from the first date of harvest was also confirmed (Table 2). Plants covered with perforated foil, same as the ones covered with non-woven, were characterized by significantly longer leaves and higher unit mass of the plants including higher mass of leaves, in comparison with the control object – without covers. However, the method of clove planting had no effect on biometrical features of the plants. There was just one exception – diameter of bulbs collected at the second date of harvest. In that case significantly the highest diameter of garlic bulbs was assessed for the control object - one clove per point.

In the present study it was also proved that covering plants had a significant effect on the content of some chemical compounds in the edible parts of garlic (Table 3).

Significantly lower content of dry matter, total sugars and L-ascorbic acid was found in the leaves and the bulbs of plants covered with perforated foil and polypropylene non-woven comparing with the cultivation in the open field. Similar findings were obtained by Biesiada (2008). The author proved that flat covers used in the spring cultivation of kohlrabi had an effect on decrease of the mentioned above chemical compounds. Also, Siwek (2009) found that celery plants grown in a non-covered field (in comparison with cultivation in low plastic tunnel mulched with polyethylene foil) contained higher amounts of dry matter and soluble sugars. It was because of the effect of better light conditions of the cultivation in a non-covered field.

Table 1. Influence of flat covers and methods of clove planting on marketable yield of garlic cultivated for bunch harvest

Type of covers	Methods of clove planting	Yield (kg·100 m^{-2})					
		2006		2007		2006-2007	
		I date of harvest	II date of harvest	I date of harvest	II date of harvest	I date of harvest	II date of harvest
Perforated foil	3 cloves per point	244,1	272,5	197,4	225,9	220,8	249,2
	2 cloves per point	160,2	198,4	141,6	164,2	150,9	181,3
	1 clove per point (control)	137,4	164,6	110,9	136,4	124,2	150,5
	mean	180,6	211,8	150,0	175,5	165,3	193,7
Non-woven polypropylene fabric	3 cloves per point	253,1	280,1	202,9	226,6	228,0	253,4
	2 cloves per point	180,4	202,9	144,0	165,8	162,2	184,4
	1 clove per point (control)	124,9	159,9	113,6	136,5	119,3	148,2
	mean	186,1	214,3	153,5	176,3	169,8	195,3
Without covers (control)	3 cloves per point	219,1	277,1	180,6	218,8	199,9	248,0
	2 cloves per point	166,0	199,4	128,9	160,1	147,5	179,8
	1 clove per point (control)	112,3	165,4	98,7	120,6	105,6	143,0
	mean	165,8	214,0	136,1	166,5	151,0	190,3
$LSD_{\alpha=0,05}$ for							
type of covers (I)		5,11	n. s	1,38	n. s	4,61	n. s
methods of clove planting (II)		4,69	9,11	1,11	5,02	5,49	6,02
interaction I×II		7,91	11,03	2,34	6,93	7,78	9,09

n.s. – non significant

Table 2. The effect of covering and methods of clove planting on some biometrical characteristics of garlic cv Jarus (mean for years 2006-2007)

Type of covers	Methods of clove planting	Lenght of fleat (cm)		Number of leaves		Diameter of bulb (cm)		Weight of plant ($g \cdot plant^{-1}$)		Weight of laves ($g \cdot plant^{-1}$)	
		I t.	II t.	I t.	II t.	I t.	II t.	I t.	II t.	I t.	II t.
Perforated foil	3 z	35,4	46,3	4,8	6,1	1,93	2,07	17,87	19,28	8,63	10,04
	2 z	35,9	44,8	5,1	5,9	1,95	2,26	17,94	21,56	8,70	10,11
	1 z	37,0	40,4	4,8	6,5	1,90	2,52	18,15	20,98	9,80	10,20
	mean	36,1	43,8	4,9	6,2	1,93	2,28	17,99	20,61	9,04	10,12
Non-woven polypropylene fabric	3 z	34,9	42,2	4,7	6,2	1,91	2,05	18,23	19,03	8,96	9,82
	2 z	33,8	44,2	5,1	6,1	1,94	2,06	18,69	19,92	9,76	10,13
	1 z	35,5	42,9	4,8	6,6	1,89	2,49	18,70	21,04	9,62	10,23
	mean	34,7	43,1	4,9	6,3	1,91	2,20	18,54	20,00	9,45	10,06
Without covers (control)	3 z	30,1	47,7	4,8	6,1	1,69	1,98	15,42	19,23	7,26	9,91
	2 z	30,2	44,8	4,7	6,0	1,73	2,00	15,65	18,92	7,48	9,39
	1 z	27,6	40,5	3,9	6,1	1,60	2,30	15,02	19,05	7,14	9,98
	mean	29,3	44,3	4,5	6,1	1,67	2,09	15,36	19,07	7,29	9,76
$LSD_{\alpha=0,05}$ for											
type of covers (I)		2,02	n. s	n. s	n. s	n. s	n. s	2,23	n. s	1,64	n. s
methods of clove planting (II)		n. s	n. s	n. s	n. s	n. s	0,30	n. s	n. s	n. s	n. s
interaction I×II		n. s	n. s	n. s	n. s	n. s	0,47	n. s	n. s	n. s	n. s

n.s. – non significant

Table 3. Chemical composition of garlic edible parts in dependence on cover type and methods of clove planting (mean for 2006-2007)

Type of covers	Dry matter (%)		L – ascorbic acid (mg·100 g^{-1} f. m)		Total sugars (% f. w)	
	leaves	bulb	leaves	bulb	leaves	bulb
Perforated foil	15,8	19,1	83,3	14,6	7,2	14,1
Non-woven polypropylene fabric	15,4	18,9	80,3	14,9	7,2	13,3
Without covers (control)	18,9	21,9	91,3	15,3	10,1	16,8
LSD $_{\alpha=0.05}$ for type of covers	1,89	0,89	2,98	0,62	0,39	0,21

CONCLUSIONS

1. Use of flat covers in the cultivation of garlic grown for an early bunch-harvest had a significant effect on the increase of quantity of the yield collected from the earliest date of harvest, in comparison with cultivation in a non-covered field.
2. There were no significant differences found in the quantity of the marketable yield according to the type of covers used in the experiment.
3. Method of planting three cloves per point had a significant influence on the increase of the yield of the whole plants by 86.4% (at the first harvest date) and by 70.0% (at the second harvest date) comparing to the planting one clove per point.
4. The plants grown in a non-covered field showed significantly higher content of dry matter, total sugars and L-ascorbic acid in the leaves, as well as in the bulbs.

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