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The influence of the addition of Ekosorb to black soil and sandy soil on the content of water in soil, frost injury of flowers and on fruiting of strawberry

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ABSTRACT

A field experiment was carried out on black and sandy soil in order to estimate the influence of the addition of hydrogel Ekosorb on the content of water in soil, on frost damage of flowers and fruiting of strawberry. The results show that hydrogel used in a dose of 3 or 6 g dm^{-3} increased the amount of water accessible for plants in both types of soil, and yet the influence of the addition of Ekosorb was more visible in black soil than in sandy soil. The application of Ekosorb increased the number of flowers injured by spring ground frost in comparison to the control (soil without hydrogel). The higher was the Ekosorb dose, the more flowers were injured. The strawberry plants of 'Elsanta' were the most sensitive and of 'Senga Sengana' – the least sensitive to frost injuries. The highest yield of fruit, regardless of the type of soil, was obtained when hydrogel was applied in a dose of 3 g dm^{-3}.

INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch.) is a berry plant commonly planted in Poland. The average yield is quite low yet, and the cost of cultivation is rather high. One can believe that this is the result of strawberry cultivating without the possibility of cheap irrigation, which is of a vital importance. Great sensitivity of strawberry plants to periodical deficiency of water considerably decreases the quantity and quality of the yield. The deficiency of water is especially severe and affects negatively the yield, if it occurs during blooming period, as well as during the growth of anlages and fruiting (Mazur 1986, Hołubowicz and Rebandel 1997). One can assume that the application of hydrogels in the cultivation of strawberry may be a solution to that problem. Hydrogels have the capability for the reversible process of accumulating the rainfall water (Hetman and Martyn 1996), which is easily accessible for plants.

The aim of these studies was to estimate the influence of the addition of Ekosorb on water amount in black soil and sandy soil, frost damage of flowers as well as on fruiting of strawberry.

MATERIAL AND METHODS

An investigation was carried out under field conditions on a farm in Beszyce place near Sandomierz during the period of 1999 – 2001. Strawberry root cuttings of the ‘Senga Sengana’, ‘Dukat’, ‘Kent’, and ‘Elsanta’ cultivars were used as experimental material. They were planted in two soil types: black soil with clay skimmed layer and sandy soil. The experimental plots had the dimension of 1.0 x 2.0 m each. Plants were planted in the distance of 0.5 x 0.25 m. Hydrogel Ekosorb (ICSO “Blachownia”, Kędzierzyn-Koźle, Poland) was mixed up with soil to the depth of 0.2 m in the two following doses: 3 and 6 g per dm^3 of soil. The plots without the addition of hydrogel were the control. The experimental field on each soil consisted of twelve plots described above and 192 plants (16 plants x 3 Ekosorb doses x 4 cultivars). The content of water in the layer 0-40 cm of soil was evaluated by a drying-weight method on the base of samples obtained in the middle of each month from April to September. Observations concerned the determination of the percentage number of flowers injured by spring ground frost, as well as the yield of fruit. The frost injuries of flowers were determined in the year 2000 during flowering time, after three-day-long period of temperature fall to -4ºC. The yield was determined as a result of successive harvests of the ripe fruit in 2000 and 2001. The values obtained in the experiment were statistically analysed using the method of triple cross classification.

RESULTS AND DISCUSSION

The results obtained are presented in Table 1 as well as in Figs 1-3. The data summarized in Fig. 1 and 2 show that the humidity of both black and sandy soil to a large extent depended on the addition of progressive doses of Ekosorb.

Table 1. The influence of Ekosorb added to black soil and sandy soil on strawberry fruit yield in 2000 and 2001 (g plant^{-1})

Year	Soil type	Ekosorb dose (g dm^{-3})	Cultivar				Mean for soil
			'Senga Sengana'	'Dukat'	'Kent'	'Elsanta'	
2000	Black soil	0	274.1 b	331.7 bc	273.5 b	275.5 b	338.3 b
		3	563.1 e	377.0 bc	422.4 cd	430.1 d	
		6	266.6 b	278.1 b	280.0 b	278.8 b	
	Sandy soil	0	18.6 a	20.2 a	12.8 a	3.2 a	10.1 a
		3	27.6 a	13.7 a	7.1 a	2.1 a	
		6	5.7 a	4.2 a	5.8 a	0.0 a	
Mean for cultivars			192.6 b	170.8 ab	166.9 a	166.5 a	
2001	Black soil	0	524.0 f-j	600.9 h-k	482.7 d-i	406.5 c-f	547.1 b
		3	641.5 jk	804.1 l	729.1 kl	487.4 d-i	
		6	368.5 b-d	561.1 g-j	524.3 f-j	434.8 c-g	
	Sandy soil	0	236.6 a	213.2 a	196.2 a	215.1 a	230.9 a
		3	306.7 abc	266.0 ab	233.7 a	239.9 ab	
		6	225.7 a	240.1 ab	195.6 a	201.4 a	
Mean for cultivars			383.8 b	447.6 c	393.6 b	330.9 a	

Mean for Ekosorb dose	Year 2000	Year 2001
0	151.2 a	359.4 a
3	230.4 b	463.6 b
6	141.0 a	343.9 a

Means followed by the same letters do not differ significantly at p = 0.05

The higher the dose of hydrogel was added to the soil, the more water it contained. Black soil with 3 g dm^{-3} of Ekosorb added contained on average 4.2% more water and with the higher dose (6 g dm^{-3}) 7.2% more water than black soil with omission of the dose of hydrogel in 2000. Respective data for that soil in 2001 were 2.5% and 4.7%. The effect of increased accumulation of water in the presence of Ekosorb was lower in sandy soil. In that case Ekosorb added to the soil in increasing doses mentioned above resulted in increasing water accumulation respectively by 1.4% and 3.6% in 2000 and by 1.5% and 2.9% in 2001 (Fig. 1

and 2). These results were likely to occur as hydrogels can increase the retention of water due to their specified physicochemical structure and the possibility of reversible process of accumulating water. The effect was much more distinct in black soil, as it had better structure and different physicochemical properties than sandy soil.

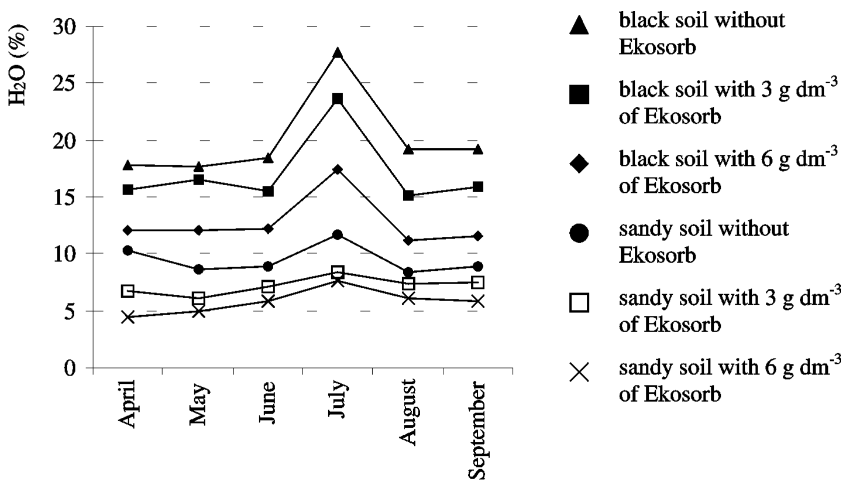

Figure 1. The influence of Ekosorb added to black soil and sandy soil on the percentage content of water in soil in layer 0-40 cm in 2000

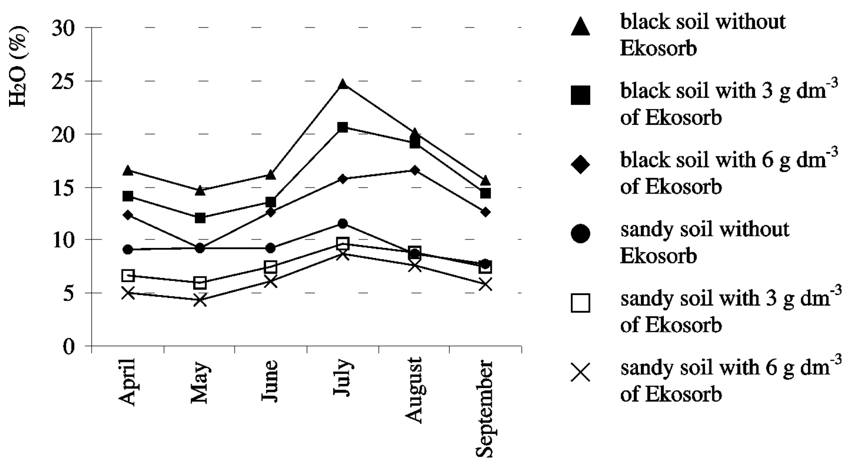

Figure 2. The influence of Ekosorb added to black soil and sandy soil on the percentage content of water in soil in layer 0-40 cm in 2001

An average percentage of flowers injured by spring ground frost estimated in 2000 was lower on black soil (16.9%), than on sandy soil (78.4%). The addition of Ekosorb caused the increase in the number of frost damaged flowers. The dose of 3 g dm^{-3} contributed to the increase in the percentage of injured flowers by 3.0% and the dose of 6 g dm^{-3} by 7.8% in relation to the control. Respectively, the data for sandy soil were 0.0% and 8.0%. It seems to be likely to acknowledge the higher number of frozen flowers on soil mixed up with hydrogel as a result of more even humidity of both black and sandy soil during the period of plant vegetation in these conditions. This is a confirmation of the studies of Hetman and Martyn (1996) in which it was presented that the level of humidity increased with the higher doses of hydrogel added to a medium. The number of almost five times as many injured flowers of plants in sandy soil was probably related with the localization of this part of experiment in the hollow of the ground where the frost marginal lake could be formed. It was also the reason of a very low yielding of strawberry plants there. On both black and sandy soil the flowers of 'Elsanta' occurred to be the most sensitive to frost injuries. The most resistant were flowers of 'Senga Sengana' (Fig. 3).

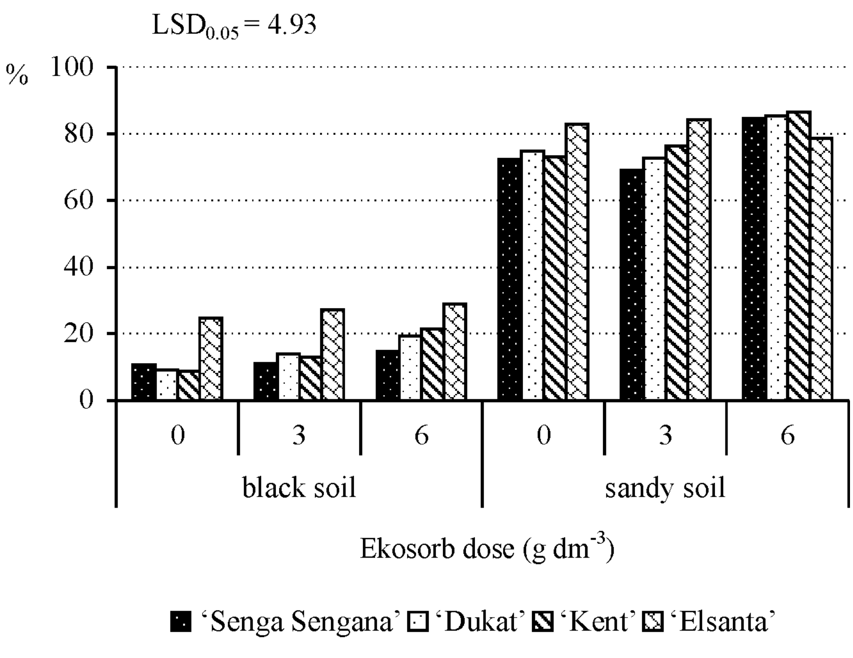

Figure 3. Percentage of strawberry flowers injured by spring ground frost in 2000 depending on Ekosorb dose added to black soil and sandy soil

The studies on the influence of the addition of Ekosorb to black soil and sandy soil and the correlation of the dose of hydrogel and the yield show that the results both in 2000 and 2001 were analogous. The highest yield was obtained from plants grown in soil with the addition of 3 g dm^{-3} of Ekosorb. Their fruit yield was over 52.0% higher in 2000 and almost 30.0% higher in the following year than the yield obtained from plants grown in soil without hydrogel. However, the application of Ekosorb in the dose of 6 g dm^{-3} decreased the yield insignificantly. In that case the yield was 7.0% lower in 2000 and 4.3% lower in 2001 than in the control (Table 1). Favourable influence of Ekosorb application to soil in a lower dose on the yield undoubtedly resulted from a better supply of water to strawberry plants. The studies of Mazur (1986), as well as Hołubowicz and Rebandel (1997) had proved that strawberry reacts very favourably to irrigation. It can be assumed that higher dose of Ekosorb added could compete with plants for water in the longer periods without rainfall and hence not so big negative influence of the dose of 6 g dm^{-3} on yielding of strawberry plants was observed both in black soil and sandy soil. The reason of such an effect is that only completely hydrated hydrogel can make up the source of water for plants. Not completely hydrated hydrogel absorbs water for itself and in that case competes with plants.

CONCLUSIONS

1. Ekosorb added in two doses of 3 and 6 g dm^{-3} formed considerably more favourable conditions for the accumulation of water in black soil and sandy soil and increased the percentage content of water in both soil types.
2. The presence of Ekosorb in soil increased the flower susceptibility to spring ground frost injuries. The most sensitive were the flowers of ‘Elsanta’ variety and the least those of ‘Senga Sengana’.
3. Ekosorb in a dose of 3 g dm^{-3} added both to black soil and to sandy soil resulted in a significant increase in fruit yield.

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WPŁYW DODATKU EKOSORBU DO CZARNEJ ZIEMI I GLEBY PIASZCZYSTEJ NA ZAWARTOŚĆ WODY W GLEBIE, MROZOWE USZKODZENIA KWIATÓW I PLONOWANIE TRUSKAWKI

Streszczenie: W doświadczeniu polowym badano wpływ dodatku hydrożelu Ekosorb do czarnej ziemi i gleby piaszczystej na zawartość w nich wody, liczbę kwiatów truskawki uszkodzonych przez przymrozki wiosenne oraz plonowanie truskawki. Uzyskane rezultaty wskazują, iż hydrożel zastosowany w dawce 3 lub 6 g dm^{-3} zwiększał zawartość wody dostępnej dla roślin w obydwu typach gleby. Wpływ dodatku hydrożelu na tę cechę był bardziej wyraźny w czarnej ziemi niż w glebie piaszczystej. Dodatek hydrożelu do obydwu typów gleb zwiększał podatność kwiatów na uszkodzenia mrozowe w porównaniu do obiektów kontrolnych (bez hydrożelu). Im wyższą dawkę hydrożelu zastosowano, tym więcej kwiatów uległo przemarznięciu. Najbardziej podatne na przemarzanie były kwiaty odmiany ‘Elsanta’, a najmniej odmiany ‘Senga Sengana’. Największy plon owoców uzyskano niezależnie od typu gleby, przy zastosowaniu hydrożelu w dawce 3 g dm^{-3}.

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