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Influence of leaf fertilizer Kristalon on the yield and quality of sweet pepper seeds

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ABSTRACT

The aim of the present study was to establish the influence of "Kristalon" leaf fertilizer on the yield and sowing quality of pepper seeds. The experiments were carried out with typical Bulgarian pepper cultivars 'Kurtovska Kapia 1619' and 'Bulgarski Rotund'. "Kristalon" leaf fertilizer was applied in doses 1.5 g dm^{-3}, 3.0 g $dm^{-3}$and 6.0 g dm^{-3}. The pollen fertility, number of seeds per fruit, percentage of fully developed seeds, weight of 1000 seeds, seed yield, index of seed productivity, first count, germinability (final count), fresh matter of sprout, length of embryo root and hypocotile were investigated. Kristalon improved seed formation and seed productivity of pepper. The most appropriate concentration for 'Kurtovska Kapia 1619' was 3.0 g dm^{-3} while for 'Bulgarski Rotund' it was 6.0 g dm^{-3}, where seeds yield increased by 26.24% and 30.89%, respectively. The germinability was higher in comparison with seeds from non-treated plants.

INTRODUCTION

Applying leaf fertilizers is one of the basic ways for more efficient agricultural production. They are a mean for correcting a micronutrient deficiency and help more harmonized development of plants (Wittwer et al. 1963, Simonne and Hochmuth 2004). Following the application of some leaf fertilizers Askari et al. (1995) achieved the 21 day earlier flowering of pepper and increased number of fruits per plant and their sizes. Pereira and Mello (2002) established a higher fruit yield of sweet pepper with 27% in average after leaf treatment with six different combinations of schist retortage water, boric acid, chlorate calcium and quelate Ca. Improved growth and increased productivity of pepper as a result of leaf fertilization was also reported by Padem et al. (1999) and Toivonen (1999).

According to Mulyono (2003) the application of leaf fertilizers Kristalon and Multimikro in dosage 1.0 g dm^{-3} and 1.5 ml dm^{-3} respectively, influenced more intensive vegetative growth and increased the yield of pepper. Along with vegetative behaviors and fruit yield, leaf fertilizers also influence seed yield and quality. These conclusions were pointed out by Panayotov et al. (1996), Panayotov (2000), Panayotov and Dris (2000). They established that by means of Lactofol and Campofort leaf fertilizers the quantity and quality of pepper seed increased. Higher seed productivity in some agricultural crops was also observed by Selvaraju and Palanisamy (2001) after twice foliar treatment with 2.0% DAP.

The main goal of the present study was to establish the effect of different concentrations of Kristalon leaf fertilizers on the yield and sowing quality of pepper seeds.

MATERIAL AND METHODS

The trials were carried out in 2001 – 2003 in the experimental field of the Department of Horticulture at the Agricultural University – Plovdiv, Bulgaria. The plants of typical Bulgarian pepper cultivars ‘Kurtovska Kapia 1619’ and ‘Bulgarski Rotund’ were grown according to the traditional technology for middle early open field production for South Bulgaria. The transplants were produced in a plastic house sowed on 15 March and transplanted in the field in middle of May by the scheme 60 × 15 cm. The following quantity of mineral fertilizations: 180 kg ha^{-1} P_2O_5, 100 kg ha^{-1} K_2O and 210 kg ha^{-1} N were applied. The experiments were carried out in four replications by 5.5 m^2 each. Kristalon leaf fertilizer was applied as water solution at concentrations 1.5 g dm^{-3}; 3.0 g dm^{-3} and 6.0 g dm^{-3} at the stage of flowering, by a ten-day interval until the moment of fruit setting. Kristalon is a product of Hydro Agry company, Rotterdam and it contains N:P:K:Mg at 13:5:26:3 ratio and B, Fe, Mn, Cu, Mo, and Zn microelements. The plants were

sprayed to the very good wet and the quantity of solution was 800 l ha^{-1}. The control plants were sprayed with the same quantity of water. The adhesive was added to the solution. The pollen fertility was detrminated twenty days after the last treatment with the acetocarmin preparations. Seed yield was obtained at full physiological maturity. The number of seeds per fruit and the percentage of the fully developed seeds to all seeds in a fruit were investigated in an average sample of ten fruits at the time of seed extraction. The index of seed productivity (Y) was calculated as a ratio of seed quantity (kg ha^{-1}) to the fruit quantity (t ha^{-1}). The weight of 1000 seeds, first count, germinability (final count), (ISTA 2003), rate of germination by Piper (1952) and simultaneity of germination by Strona (1966) were analyzed. Fresh weight of sprouts of one seed, length of embryo roots and length of hypocotile on the twenty sprouts were measured at the moment of germinability determination (at the 14^{th} day). Statistical analiysis was executed by ANOVA.

RESULTS AND DISCUSSION

Pollen fertility (Table 1) as a result of the influence of Kristalon leaf fertilizer was observed as a cultivar response. In 'Kurtovska Kapia 1619' cultivar the change was very weak. The highest value was reported for concentration 6.0 g dm^{-3}. The effect in 'Bulgarski Rotund' was higher. In this cultivar the fertility was the highest in 3.0 g dm^{-3} and after that decreased.

The index of seed productivity, as one of the important characteristics in seed production, increased after the application of Kristalon. In each investigated dose it was higher than the control. For 'Kurtovska Kapia 1619' it reached up to 9.07 at 3.0 g dm^{-3}, while for non-treated plants it was 7.6. For 'Bulgarski Rotund' the highest index was 9.2 at 6.0 g dm^{-3} and for the control – 7.4.

Under the influence of Kristalon the number of seeds per fruit was higher, with the exception at concentration 1.5 g dm^{-3} for 'Bulgarski Rotund'. In 'Kurtovska Kapia 1619' cultivar it was the highest in variant 3.0 g dm^{-3}– 215.7 or exceeding the control by 17.9. For the other studied cultivar the highest number of seeds per fruit was obtained at the highest concentration – 246.4, i.e. by 35.4 above the control. At both mentioned concentrations the index of seed productivity was the highest and the correlation between them was positive – medium for 'Kurtovska Kapia 1619' – $r = 0.53$ and strong for 'Bulgarski Rotund' – $r = 0.81$.

The percentage of the fully developed seeds is an indicator which characterized the influence of the different factors. In this case Kristalon leaf fertilizer provoked a positive effect achieving higher values at all the concentrations. For 'Kurtovska Kapia 1619' cultivar, it varied from 90.2% in the control to 97.0% at the concentration 3.0 g dm^{-3}. In 'Bulgarski Rotund' with the

increase of the applied quantity of leaf fertlizers, the percentage of fully developed seed also increased reaching 99.2% at 6.0 g dm^{-3} or augmentation was by 4.9%. In the above-discussed variants, as it was pointed out for the number of seeds, the highest index of seed productivity was observed. The correlation between them in both cultivars was strongly positive: r = 0.85 and r = 0.95 for 'Kurtovska Kapia 1619' and 'Bulgarski Rotund', respectively. It indicated that those two characteristics were in a very strong association and to a great extent they determined the seed productivity of pepper plants.

The weight of 1000 seeds increased in most of the variants under the effect of Kristalon leaf fertilizer. An exception to this trend was observed for the highest concentration in 'Kurtovska Kapia 1619' and for the lowest one in 'Bulgarski Rotund', where there was a slight decrease. The values were the highest for the first cultivar at 3.0 g dm^{-3} – 6.07 g and for the other cultivar: at 6.0 g dm^{-3} – 7.48 g, while for both controls it was 5.70 g and 7.0 g, respectively.

Most of the differences between the variants were statistically significant at the highest level of authenticity.

The most important characteristic for the agricultural practice is the influence on plant productivity (Table 2). According to Chamel (1986) and El-Fouly and El-Sayed (1997) the application of the leaf fertilizers is most successful in the period of intensive growth and development of productive organs. Silvester and Morad (1996) and Pavlova and Bachvarov (1992) also achieved similar conclusions. They established that the economic effect and biological influence of the foliar feeding were significant when the treatments with leaf fertilizers carried out in the stages of strongest development of generative parts of the plants. The investigations of Alexander (1987) confirmed this affirmation. The application at the stage of flowering of Kristalon leaf fertilizer, during the three years of our study, also increased the seed yield in each dose, with an exception of the dose 6.0 g dm^{-3} for 'Kurtovska Kapia 1619' in 2003. The tendency concerning seed productivity during the whole investigation period was unidirectional. It can be summarized that the highest yield for the three years was obtained in 2003 and the lowest in 2002. Ziolek and Kulig (1998), Sharma et al. (1999) and Jasper et al. (2000) also pointed out a positive role of foliar fertilizers on the seed yield of some vegetable crops. On average for the three years the yield increase for 'Kurtovska Kapia 1619' was the biggest in variant 3.0 g dm^{-3} – by 26.24% above the control, followed by 1.5 g dm^{-3} – by 22.24% above. Mulyono (2003) however recommended Kristalon to be applied in pepper in dose from 1.0 g dm^{-3}. A small decrease – 3.05% was obtained for the highest concentration. In 'Bulgarski Rotund' the increase of the amount of Kristalon brought on the increase of yield from 9.47% at 1.5 g dm^{-3} to 30.89% in 6.0 g dm^{-3}. These results suggested some cultivar differences.

Table 1. Pollen fertility and characteristics of seed productivity of pepper after application of Kristalon leaf fertilizer (average 2001 – 2003)

Variants	'Kurtovska Kapia 1619'					'Bulgarski Rotund'				
	Pollen fertility (%)	Y*	Seed number per fruit	Fully developed seed (%)	Weight of 1000 seeds (g)	Pollen fertility (%)	Y*	Seed number per fruit	Fully developed seed (%)	Weight of 1000 seeds (g)
Control	90.0	7.6	197.8	90.2	5.70	89.6	7.4	211.0	94.3	7.00
Kristalon 1.5 g dm^{-3}	90.3	8.31	198.0	92.8	5.74	91.5	8.05	200.7	94.8	6.97
Kristalon 3.0 g dm^{-3}	90.8	9.07	215.7	97.0	6.07	95.4	8.15	219.4	95.9	7.20
Kristalon 6.0 g dm^{-3}	91.3	7.88	212.5	94.4	5.69	90.6	9.02	246.4	99.2	7.48
p = 0.05	0.8	0.61	12.36	3.8	0.7	0.9	0.67	7.42	3.7	0.93
LSD p = 0.1	1.4	1.49	18.31	5.9	1.01	1.5	1.07	10.65	5.4	1.53
p = 0.01	2.2	2.17	27.47	7.4	1.52	2.3	1.79	15.78	8.1	2.02
r** with Y			0.57	0.85				0.81	0.95	

*Y – index of seed productivity
**r – single correlation coefficient

Table 2. Seed yield after the application of Kristalon (kg ha^{-1})

Variants	'Kurtovska Kapia 1619'				'Bulgarski Rotund'			
	2001	2002	2003	Average	2001	2002	2003	Average
Control	231.5	131.1	245.6	202.7	156.4	130.3	213.5	166.7
Kristalon 1.5 g dm^{-3}	234.0	151.1	358.3	247.8	160.6	165.9	221.1	182.5
Kristalon 3.0 g dm^{-3}	275.0	154.4	338.4	255.9	156.4	168.5	241.5	188.8
Kristalon 6.0 g dm^{-3}	233.0	153.5	203.7	196.7	206.6	199.6	248.5	218.2
p = 0.05	13.8	18.3	10.0	76.4	14.3	19.9	13.3	22.5
LSD p = 0.1	20.0	26.5	14.6	110.7	20.7	28.9	19.3	32.6
p = 0.01	30.1	39.8	21.9	166.0	31.1	43.3	29.1	49.0
r with Y				0.88				0.99
r with concentrations				-0.21				0.99

Papadopoulos et al. (1999) in experiments with bell pepper also established the genotype response to application of foliar dressing and pointed out that important parameters affecting the effect are the rate and the timing of the application. The highest yield coincided with the sharpest increase of the index of seed productivity, the number of seeds per fruit and the percentage of fully developed seed, which reflected on the formation of seed productivity. Most of the differences between the variants were statistically significant. The correlations of the yield and index of seed productivity were strongly positive: r = 0.90 for 'Kurtovska Kapia 1619' and r = 0.99 for 'Bulgarski Rotund', which indicated its strong dependence on this characteristic. However, cultivar responses were observed in the correlation with the amount of the applied leaf fertilizer: strongly positive r = 0.99 for the latter cultivar, while for the former cultivar it was slightly negative – r = -0.21. It could be due to the lower yield obtained at the highest concentration for 'Kurtovska Kapia 1619'.

The sowing qualities of the seed are shown in Table 3. The number of germinated seeds in the first count increased only at 1.5 g dm^{-3} and 3.0 g dm^{-3} for 'Kurtovska Kapia 1619'. In each of the other variants it was lower than the control and the highest decrease was observed at 1.5 g dm^{-3} for 'Bulgarski Rotund' – by 13.3%. Nevertheless, germinability increased under the treatment with Kristalon, with an exception of 1.5 g dm^{-3} for 'Bulgarski Rotund'. In both cultivars the highest values were established at concentration 3.0 g dm^{-3}– 86.6% for 'Kurtovska Kapia 1619' and 82.4% for 'Bulgarski Rotund', while for the controls they were 77.1% and 81.3%, respectively. The cultivar response was established in respect of the rate of germination. In 'Kurtovska Kapia 1619' it improved and was the highest for concentration 1.5 g dm^{-3}. In 'Bulgarski Rotund', however, it decreased in each investigated variant. Stronger positive effect on the simultaneity of germination was observed for 'Kurtovska Kapia 1619', where the highest simultaneity was shown by the seeds from the plants treated with 3.0 g dm^{-3} Kristalon. In Bulgarski Rotund this characteristic was improved only at the mentioned concentration.

One of the main indexes, which described very well the seed vigor and quality is the growth of sprouts (Copeland and Mc Donald 1995). The fresh matter of sprouts of one seed (Table 4) of 'Bulgarski Rotund' was lower after the application of Kristalon, while in 'Kurtovska Kapia 1619' an improvement was registered at 1.5 g dm^{-3} and at 3.0 g dm^{-3} – by 34.6 mg and 32.7 mg, respectively, versus 30.7 mg for the control. In this cultivar the increase of the leaf fertilizer doses contributed to the development of longer embryo roots, while in 'Bulgarski Rotund' they increased only at the highest concentration. The similar trend was observed for the length of hypocotile – increased for 'Kurtovska Kapia 1619' – the greatest for 1.5 g $dm^{-3}$and decreased at each dose for 'Bulgarski Rotund'.

Table 3. Pepper seed viability after the application of Kristalon leaf fertilizer (average 2001 – 2003)

Variants	'Kurtovska Kapia1619'				'Bulgarski Rotund'			
	First count (%)	Germinability (%)	Rate of germination (days)	Simultaneity of germination (%)	First count (%)	Germinability (%)	Rate of germination (days)	Simultaneity of germination (%)
Control	34.2	77.1	7.2	7.5	53.7	81.3	5.6	10.7
Kristalon 1.5 g dm^{-3}	51.3	83.6	6.2	11.7	40.4	80.5	7.23	10.6
Kristalon 3.0 g dm^{-3}	52.4	86.6	6.6	12.6	45.1	82.4	6.71	11.2
Kristalon 6.0 g dm^{-3}	32.7	83.6	6.7	12.2	52.0	82.1	6.46	10.6
p = 0.05	15.8	5.2	0.5	2.5	11.3	4.01	0.9	1.8
LSD p = 0.1	23.6	8.4	0.8	3.7	16.1	5.8	1.4	2.6
p = 0.01	34.0	12.1	1.4	5.5	25.7	8.7	2.1	4.0

Table 4. Morphological feature of pepper seeds sprouts after the application of Kristalon leaf fertilizer (average 2001 – 2003)

Variants	'Kurtovska Kapia 1619'			'Bulgarski Rotund'		
	Fresh weight (mg)	Length of embryo root (cm)	Length of hypocotyls (cm)	Fresh weight (mg)	Length of embryo root (cm)	Length of hypocotyls (cm)
Control	30.7	3.81	3.23	43.3	4.02	3.43
Kristalon 1.5 g dm^{-3}	34.6	3.93	3.39	37.7	3.83	3.13
Kristalon 3.0 g dm^{-3}	32.7	4.18	3.31	38.0	3.93	3.07
Kristalon 6.0 g dm^{-3}	27.9	4.07	3.32	40.2	4.32	3.27
p = 0.05	2.5	0.60	0.94	2.8	0.54	0.64
LSD p = 0.1	3.7	1.01	1.37	4.9	0.82	0.93
p = 0.01	5.6	1.53	2.05	7.9	1.35	1.4

CONCLUSIONS:

1. Kristalon leaf fertlizer provoked a strong influence on the seed productivity and sowing quality of pepper.
2. The index of seed productivity increased significantly as well as the number of seeds and the percentage of the fully developed seeds. The weight of 1000 seeds was higher after the application of leaf fertilizer. The pollen fertility changed weakly under the effect of Kristalon.
3. The seed yield was higher as a result of Kristalon application. The best appropriate concentration for 'Kurtovska Kapia 1619' could be recommended to be 3.0 g dm^{-3} and for 'Bulgarski Rotund' 6.0 g dm^{-3} – causing the increase of 26.24% and 30.89%, respectively.
4. The number of the germinated seeds in the first count decreased, while the germinability slightly increased, more significantly for 'Kurtovska Kapia 1619'. The rate and simultaneity of germination, fresh matter of sprouts, length of embryo root and hypocotile improved stronger in cultuvar 'Kurtovska Kapia 1619'.

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