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The Influence of Organic Fertilizers Concerning the Growth and Development of *Brassica oleracea* var. *acephala* Plants

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Abstract. Kale (*Brassica oleracea* L. var. *acephala* D.C.) is one of the vegetables that contains high levels of lutein and β-carotene, which possess important human health properties (Lefsrud, 2007), but it is a little cultivated vegetable specie and the conducted research on the crop technology of this species is quite poor. The aim of this work was to study the influence of organic multi-phase fertilization on the development of kale plants. The experiment was organised in the didactic fields of the University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania. It was a bi-factorial experiment, in which factor A - the cultivar- had two variants: Winterbor F1and Redbor F1, and factor B - the type of fertiliser has 3 variants: unfertilised, cattle dung and poultry manure. Very significant differences were observed in plants fertilized with poultry manure. The results obtained are: 52.3 cm height at the Redbor F1 hybrid, than 21.5 was the highest average number of leaf per plant at Winterbor F1 hybrid, 26.79 cm and 14.72 cm were the highest average for leaf length and respectively leaf width at the Redbor F1 hybrid. In conclusion the fertilization with poultry manure assured better development of kale plants, in terms of plant height, leaf size, and number of leaves per plant.

Keywords: kale, multi-phase fertilization, organic fertiliser

INTRODUCTION

Kale *(Brassica oleracea* var. *acephala* L.) is the one of the oldest forms of the cabbage family, originating in the eastern Mediterranean (Balkaya *et al.*, 2010).

Kale is very rich in important nutrients that are highly beneficial to human health, because it is an excellent source of dietary carotenoids (Holden *et al.*, 1999, Kurilich *et al.*, 1999 and 21, quoted by Lefsrud *et al.*, 2007). According to the USDA, kale has the highest concentration of lutein and β-carotene of any vegetable (USDA, 2002, quoted by Lefsrud *et al.*, 2007). Dietary intake of foods rich in lutein and β-carotene is associated with reduced risk of lung cancer and chronic eye diseases, such as cataracts and age-related macular (Le Marchand *et al.*, 1993, Ames *et al.*, 1995 and Landrum and Bone, 2001, quoted by Lefsrud *et al.*, 2007).

The high nutritive and dietetic value of kale derives from its rich chemical composition (Rosa and Heaney, 1996, quoted by Lisiewska, 2008). It is particularly rich in vitamins, minerals, dietary fibre and antioxidative compounds (Gębczyński and Korus, in press and Kurilich *et al.*, 1999, quoted by Lisiewska, 2008)

More than that, it has been widely used for decorative purposes, such as in landscaping. Kale is among the loveliest greens, with leaves that are incredibly varied (Creasy, 2010). Considered among the best of all the wonderful cool-season plants, flowering kale and cabbage produce foliage in brilliant, colorful shades of lavender, green, purple, pink and white. They last from October or November through April, bringing the winter garden alive. (Norman, 2003) Kale is used as bedding plants for color and landscape contrast. They can be planted in between other plants for a change in the landscape. Cold nights in October

and November will actually intensify the typical blue-green outer leaves and brightly colored inner rosette typical of ornamental kale (Carter, 2005).

Thus, new data on different influences crop technology has on the development of kale plants are considered very useful, given the growing tendency to practice the so-called "edible landscaping".

In the specialised literature is stated that is recommended to apply 1-2 multi-phase fertilization sessions during the growing season (Indrea, 2009), but stop fertilizing after the plants reach full size, or they won't color properly (Carter, 2005), at the same time Sima, (2009), states that additional fertilization is not recommended because the resulting excess nitrogen causes lush growth in plant at the expense of the resistance to frost of their tissues. On the other hand, with regard to the application of organic fertilizer on cabbage crops, Mitrea (2009), after conducting some specific research, concluded that in the variants using poultry manure there occur differences in plant height and number of leaves per plant. Amongst the variants fertilized with semi-fermented cattle manure, only the version with 2 kg manure /m^2 gave significantly distinct results.

This paper aims at analysing the effect of organic fertilisers on the development of kale plants, cultivars Winterbor F1 and Redbor F1.

MATERIALS AND METHODS

The experiment was organised in the didactic fields of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania. It was a bi-factorial, in which factor A - the cultivar - had two variants: Winterbor F1 and Redbor F1, and factor B the type of fertiliser has 3 varinats: unfertilised (control), cattle dung and poultry manure.

Thus there were obtained six variants, showed in Tab. 1, each present in three replication. For each variant biometric measurements were made. These measurements consisted in measuring plant height, number of leaves per plant, the length and width of leaf blade.

Tab. 1

Experimental variants

Variant symbol	Factor A – the cultivar	Factor B – organic fertilizer
V1	Winterbor F1	Unfertilized
V2	Winterbor F1	Cattle dung
V3	Winterbor F1	Poultry manure
V4	Redbor F1	Unfertilized
V5	Redbor F1	Cattle dung
V6	Redbor F1	Poultry manure

The biological material used consisted of the two kale cultivars mentioned above purchased in the UK. The fertilizer dose used was 0.5 kg/m^2, both for cattle dung and for poultry manure. The cattle manure was applied after being diluted with water in a ratio of 1:10 and left to soak for 2 days. The poultry manure was applied after being diluted with water in a ratio of 1:15 and left to soak for 7 days (Măniuțiu, 2008). Two multi-phase fertilizations were applied, by fertirrigation, at an interval of two weeks, the first fertilization being made one month after planting.

RESULTS AND DISCUSSIONS

The cultivars used in this experiment do not recorded significant differences in terms of their characteristics. They have a height between 45 and 61 cm and leaf rosette diameter is between 30 and 45 cm.

The leafs of both cultivar are fleshy, heavily embossed and scalloped edges. In terms of number of leaves per plant, Winterbor F1 hybrid has a richer foliage than Redbor F1 hybrid.

Another feature which differentiates the two hybrids is the color of the leaves, wich are green to bluish for Winterbor F1 and purple for Redbor F1. Both cultivars have a growing season of: 55 days if the seedlings are obtained from transplanters and 75 days for plants started from seeds (sours: www.missouribotanicalgarden.org).

Thus, Tab. 2 presents experimental data on the combined influence of organic fertilizers and the hybrids on kale plant height.

Tab. 2

The combined influence of the organic fertiliser and hybrid on the height of *Brassica oleracea* var. *acephala* plants

Experimental variants		Plant height		± d	Significance of difference
Fertilizer Type	Hybrid	cm	%	cm	
Unfertilized	Winterbor F1	38.5	82.74	- 8.03	ooo
Cattle dung	Winterbor F1	43.5	93.48	- 3.03	o
Poultry manure	Winterbor F1	44.0	94.56	- 2.53	o
Unfertilized	Redbor F1	49.1	105.52	2.57	*
Cattle dung	Redbor F1	51.8	111.32	5.27	***
Poultry manure	Redbor F1	52.3	112.40	5.77	***
Mean of the experiment Control		46.53	100.0	-	-

$LSD_{(p5\%)} - 2.34$ $LSD_{(p1\%)} - 3.40$ $LSD_{(p0.1\%)} - 5.11$

Analyzing the results in table 2 can be clearly seen the differences betwen variants. Thus, on the variants V1, V2, and V3 were obtained negative differences in comparison with the control, which is considered mean of the experiment. At the first variant the difference was 8.03 cm and was statistically assured as very significant negative and in terms of V2 and V3 variants, they have recorded significant differences.

In the second part of the table, it can be obseved that in the variants V4, V5 and V6 were obtained positive difference, very significant for variants where fertilizer was used (V5 and V6) and significant at unfertilized variant.

Next will be showed the unilateral influence of the two factors (hybrid and fertilizer).

Tab. 3

Experimental results concerning unilateral influence on plant height of hybrids of *Brassica oleracea* var. *Acephala*

Hybrid	Plant height		± d	Significance of difference
	cm	%	cm	
Winterbor F1	42.0	90.26	- 4.53	oo
Redbor F1	51.06	109.73	4.53	**
Mean of the experiment Control	46.53	100.0	-	-

$LSD_{(p\ 5\%)} - 2.45$ $LSD_{(p\ 1\%)} - 3.84$ $LSD_{(p\ 0.1\%)} - 5.24$

Tab. 3 presents the hybrid influence on kale plants heigh. In this table may be noted that two distinct hybrids showed significant differences compared with the control, with the diference that in the case of Winterbor F1 hybrid the difference was negative, the hybrid had a height smaller then the control by 4.53 cm, while Redbor F1 hybrid was taller then the control by 4.53 cm.

Then, in terms of unilateral influence of fertilization on plant height, the results obtained, presented in Tab. 4, show that for both variants fertilized with cattle dung and those fertilized with poultry manure, no significant differences were seen compared with the control, considered the mean of the experiment, only the unfertilized variant showed a significant negative difference.

Tab. 4

Experimental results concerning the unilateral influence of fertilization on plant height *Brassica oleracea* var. *Acephala*

Hybrid	Plant height		± d	Significance of difference
	cm	%	cm	
Unfertilized	43.83	94.19	- 2.7	o
Cattle dung	47.64	102.38	1.11	-
Poultry manure	48.14	103.46	1.61	-
Mean of the experiment Control	46.53	100.0	-	-

$LSD_{(p\ 5\%)} - 2.38$ $LSD_{(p\ 1\%)} - 3.45$ $LSD_{(p\ 0.1\%)} - 5.07$

Another morphological character followed in the experiment was the number of leaves per plant.

Experimental results on the combined influence of hybrid and fertilizer, on the number of leaves per plant, presented in Tab. 5, shows that in the case of Winterbor F1 hybrid the highest values were obtained in the variant fertilized with poultry manure, were a very significant positive difference was recorded and in the variant fertilized with cattle dung the difference was only significantly positive, compared to the control, considered the mean of the experiment.

Tab. 5

Experimental results concerning the combined influence of fertilization and hybrid factors on the number of leaves per plant on *Brassica oleracea* var. *acephala*

Experimental variants		Number of leaves		± d	Significance of difference
Fertilizer Type	Hybrid	nr.	%	nr.	
Unfertilized	Winterbor	18.4	100.76	0.14	-
Cattle dung	Winterbor	20.3	111.17	2.04	*
Poultry manure	Winterbor	21.5	117.74	3.24	***
Unfertilized	Redbor F1	15.5	84.88	- 2.76	ooo
Cattle dung	Redbor F1	16.5	90.36	- 1.76	oo
Poultry manure	Redbor F1	17.4	95.29	- 0.86	-
Mean of the experiment Control		18.26	100.0	-	-

$LSD_{(p\ 5\%)} - 1.09$ $LSD_{(p\ 1\%)} - 1.59$ $LSD_{(p\ 0.1\%)} - 2.38$

In the case of the second hybrid Redbor F1 compared with the control, a very significant negative difference was recorded, then on the variant fertilized with cattle dung a significantly distinct negative difference can be obseved, and in the case of the variant fertilized with poultry manure the difference is insignificant compared to the control.

Tab. 6 presents the results on the unilateral influence of hybrid on the number of leaves per plant. Thus, can be observed that compared to the mean of the experiment, taken as control, Winterbor F1 hybrid has a distinctly significant positive difference and Redbor F1 hybrid shows a distinct significant negative difference.

Tab. 6

Experimental results concerning the unilateral influence of hybrid on the number of leaves per plant on *Brassica oleracea* var. *acephala*

Hybrid	Number of leaves		± d	Significance of difference
	nr.	%	nr.	
Winterbor F1	20.1	110.07	1.84	**
Redbor F1	16.3	98.26	- 1.96	oo
Mean of the experiment Control	18.26	100.0	-	-

$LSD_{(p\ 5\%)} - 1.15$ $LSD_{(p\ 1\%)} - 1.62$ $LSD_{(p\ 0.1\%)} - 2.40$

In the case of unilateral influence of fertilizer on number of leaves per plant (Tab. 7), there was a significant positive influence in comparison with the control, the mean of the experiment, in fertilizing with poultry manure and a significantly negative difference in the unfertilized variant.

Tab. 7

Experimental results on the unilateral influence of fertilization on number of leaves per plant on *Brassica oleracea* var. *acephala*

Fertilizer Type	Number of leaves		± d	Significance of difference
	nr.	%	nr.	
Unfertilized	16.9	92.55	- 1.36	o
Cattle dung	18.4	100.76	0.14	-
Poultry manure	19.5	101.31	1.24	*
Mean of the experiment Control	18.26	100.0	-	-

$LSD_{(p\ 5\%)} - 1.20$ $LSD_{(p\ 1\%)} - 1.70$ $LSD_{(p\ 0.1\%)} - 2.45$

Other morphological characters that have been pursued in this experiment, with the purpose of observing the plants growth under the influence of organic fertilizers were leaf length and width. Fig. 1 and 2 present the values obtained from biometric measurements.

Thus, we can see that in the case of Winterbor F1 hybrid values regarding leaf length, increased from 23.45 cm - the unfertilized variant, to 24.83 cm – in the variant fertilized with cattle dung and the highest value being 25.34 cm occurring in the variant fertilized with poultry manure.

Data varied in the same way for Redbor F1 hybrid, the lowest being the unfertilized variant (24.51) and the highest value was recorded in V6, Redbor F1 + poultry manure.

Regarding leaf width, values varied as those of leaf length. At both hybrids, the lowest values were obtained from unfertilized variants, and the highest values in variants fertilized with poultry manure.

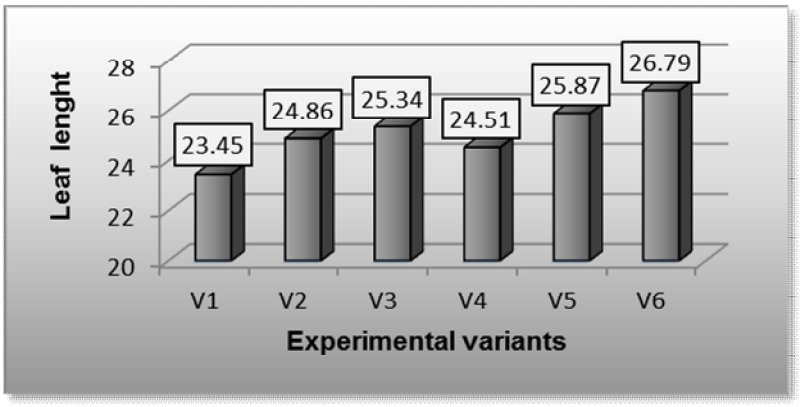

Fig. 1. The influence of organic fertilizer on leaf length (cm) on *Brassica oleracea* var. *acephala*

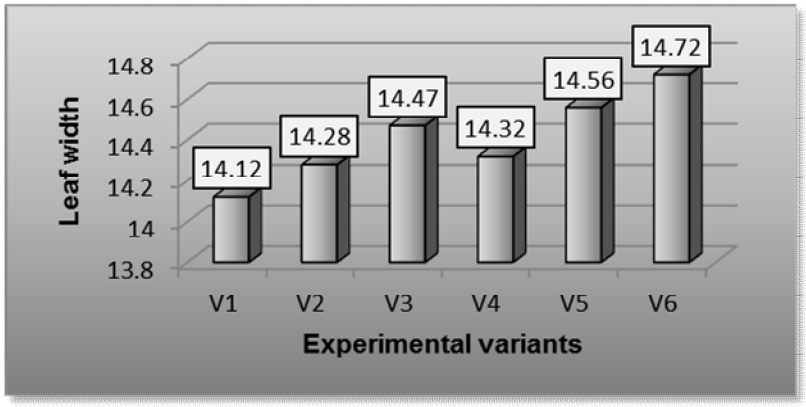

Fig. 2. The influence of organic fertilizer on leaf width (cm) on *Brassica oleracea* var. *acephala*

In Fig. 3 we can see the degree of correlation between leaf length and width. The correlation coefficient between these two characters is very significantly positive, with a value of 0.98.

It is clear that the increase in length of the leaf determines its width increased.

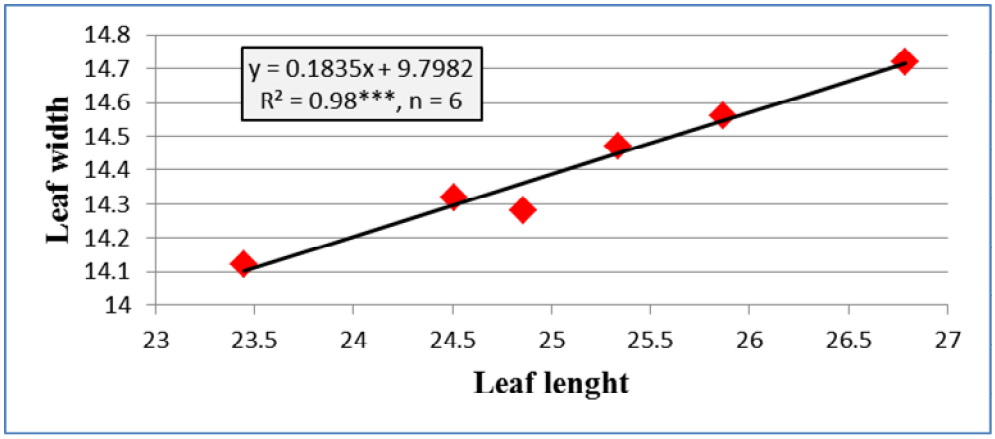

Fig. 3 The correlation between leaf length and width

CONCLUSIONS

Analyzing the results regarding the influence of organic fertilizers on plant development of *Brassica oleracea* var. acephala, we can draw the following conclusions:

The application of multi-phase fertilization with organic fertilizer on the kale crop, has been shown to have a positive influence on plants development;

Of the two types of organic fertilizers used, cattle dung and poultry manure, the latter showed the best results in terms of plant development of kale plants;

Given the positive influence of multi-phase fertilization with organic fertilizer on kale plants development and especially the number of leaves per plant, it is assumed that the fertilization can lead to increased production of leaves. Research will continue in order to obtain accurate data.

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