Comparison of selected Swiss chard (*Beta vulgaris* ssp. *cicla* L.) varieties

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ABSTRACT: Evaluation of 12 Swiss chard varieties (*Beta vulgaris* ssp. *cicla* L.) in field experiments was focused on the observation of morphological characteristics, yield and nutritional quality of leaves and stalks. The following mean parameters of all varieties were found: 86% field germination, plant weight 346 g, plant height 506 mm, stalk width 23 mm, 10 leaves per plant, and yield 35 t/ha. Mean content of vitamin C was 307 and 72 mg/kg of fresh matter (f.m.) in leaves and stalks, respectively. Potassium content was 4,198 and 4,848 mg, sodium amount was 2,101 and 966 mg, calcium content was 481 and 310 mg and finally magnesium content represented the levels of 361 and 113 mg/kg of f.m., always in leaves and stalks. Significant effects of plant height and plant leaf number on total plant weight were found. Plants with the mean weight of 400 g formed the widest stalks. In addition, a negative effect of higher yield on vitamin C and Ca stalk content was detected. An opposite effect was determined in Na and partially in Mg stalk content that simultaneously increased with higher yield levels. The variety Lucullus is still comparable with newer varieties such as Gator, Zürcher Gelber and Charlotte, which achieved good results among all tested varieties.

Keywords: Swiss chard; assortment; evaluation; yield; nutritional quality

Swiss chard (*Beta vulgaris* ssp. *cicla* L.) is one of the neglected vegetable species. Its production area is not commercially important, but this vegetable offers an interesting enlargement of the current vegetable assortment by using its stalks and leaves.

Swiss chard is a very nutritive demanding species. The content of mineral elements, total quality and yield are influenced by the amount, frequency and method of fertilisation (SANTAMARIA et al. 1999a). SHANNON et al. (2000) consider Swiss chard as a vegetable more tolerant to higher soil salinity. Regarding this fact, Swiss chard accumulates higher levels of sodium in its tissues compared with other leafy vegetables. Swiss chard is thus suitable for such soil conditions that limit the growing of many other sensitive vegetable species. On the other hand, extreme salinity causes a quality and yield decrease in Swiss chard, similarly like in many cultivated crops.

The effect of growing conditions on the growth and quality of Swiss chard is generally known. By exploitation of optimal locations we can achieve twofold yield and formation of good leaves and stalks (SMITH et al. 2001). The adequate yield is up to 50 t/ha (MALÝ et al. 1998), when the mean leaf weight is in the range of 200 to 350 g per plant (SMITH et al. 2001).

The nutritive value of Swiss chard is characterised by the higher level of sodium and oxalates (SANTAMARIA et al. 1999b). ROZYCKI et al. (1997) found a higher content of mineral compounds in non-hybrid and wild forms of Swiss chard in spite of modern varieties. High variability in the nutritive value according to the variety is also reported. The mean content of mineral substances in fresh stalks is 3,790 mg/kg of potassium, 510 mg of calcium, 81 mg of magnesium, 2,130 mg of sodium, and 460 mg of phosphorus (ANONYMOUS 2001). Ascorbic acid is very important among the vitamins in Swiss chard (300 mg/kg of f.m. in leaves) (ANONYMOUS 2001). GIL et al. (1998) reported content of vitamin C in the range of 400 to 500 mg/kg of f.m. depending on the tested variety.

The aim of the present work was to compare selected varieties of Swiss chard by their growth and yield parameters. The nutritive value of leaves and stalks was also analysed.

MATERIAL AND METHODS

Field trials with the Swiss chard assortment were performed in 1998 and 2000 at the Faculty of Horticulture in Lednice. Eleven varieties of stalk Swiss chard and one variety of leafy Swiss chard were included in the evaluation. Their origin is described in Table 1.

Sowing date was on the 15th April of each year. The content of nutrients in soil was tested according to Mehlich III with the following results in 1998 (mg/kg): 297 P, 358 K, 417 Mg and 5,030 Ca; in 2000 it was 271 P, 325 K, 359 Mg and 5,500 Ca. The soil reaction was pH 7.5 in both years.

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Table 1. Mean parameters of selected cultivars of Swiss chard

Cutlivar	Company	Field germination (%)	Plant weight (g)	Plant height (mm)	Stalk width (mm)	Plant leaf number	Yield (t/ha)
Bright Lights F1	Johnny's (USA)	88	347	513	27.4	7.8	35
Červený	MoravoSeed (CZ)	97	161	446	15.0	10.0	16
Fordhook Giant	Johnny's (USA)	97	248	520	21.0	6.7	25
Gator	Semo (CZ)	85	519	537	23.2	15.8	52
Genfer Selma	Mauser Samen (D)	74	363	468	33.1	7.6	36
Charlotte	Mauser Samen (D)	96	443	425	23.3	10.4	44
Listový zelený	MoravoSeed (CZ)	44	502	538	21.7	14.8	40
Lucullus	Semo (CZ)	86	400	522	35.5	7.8	18
Lucullus	Semena Veleliby (CZ)	86	180	523	17.6	8.3	22
Rhubarb	Johnny's (USA)	83	223	457	13.6	8.6	23
Rhubarb Chard	Kings (UK)	95	233	481	15.9	10.8	42
Swiss Chard	Kings (UK)	93	422	579	28.8	7.8	46
Zürcher Gelber	Mauser Samen (D)	95	455	574	20.2	10.0	50

After direct sowing young seedlings were thinned to the distance of 0.5 by 0.2 m. Common cultural practices and supplemental irrigation were used. Thirty plants of each variety were evaluated and four replications were used in the trials and analytical works. The harvest was finished on the 20th and on 23rd July in both years.

The mean air temperature during the growing season in 1998 and 2000 was 17.0 and 17.5°C and total temperature sum was 2,069 and 2,133°C for these years.

The following parameters were evaluated: field germination, plant height and weight, stalk width, leaf number per plant, stalk colour and plant yield. Nutritive values separately for stalks and leaves were also determined: content of vitamin C (by dichlorphenol indophenol Tillman's titration method according to DAVÍDEK et al. 1977), and content of potassium, sodium, calcium, and magnesium by the methods of capillary isotachophoresis (POKLUDA 1998).

Analysis of variance (ANOVA) was performed for evaluation of variety and year effects at 95% of probability, accompanied by Tukey's test. The least significant difference (LSD) regression at 95% level was used to express mutual effects of observed parameters. The figures were completed by regression equation and logarithmic trends. All statistical processing was performed by Unistat, version 4.53 (Unistat, USA).

RESULTS

The varieties Červený, Charlotte, Rhubarb, and Rhubarb Chard have red stalks while Gator and Listový zelený green stalks and other varieties have white stalks. Only Bright Lights have stalks with different colours (white, yellow or orange). The results are shown in Table 1.

The highest field germination was determined in varieties Červený and Fordhook Giant (97%) while the mean value for all varieties was 86% and the lowest germination rate was found in Listový zelený. Gator variety achieved the highest plant weight (519 g) while the mean was 346 g and the lowest weight was observed in Červený variety. The highest plant height was found in Swiss Chard (579 mm), the mean level of all varieties was 506 mm and the smallest plants were produced by Charlotte. Lucullus had the best stalk width (36 mm) and the mean width of all varieties was 23 mm. On the other hand, Rhubarb resulted with the narrowest stalks. The maximum leaf number was observed in Gator (15.8 leaves) if compared with the mean number of

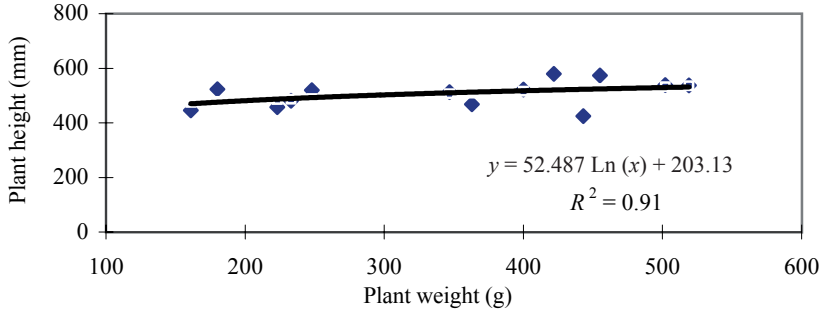

Fig. 1. Effect of plant weight on plant height

Table 2. Mean nutritive value of Swiss chard cultivars (mg/kg f.m.)

Cultivar	Company	Vitamin C (leaves)	Vitamin C (stalks)	K (stalks)	Na (stalks)	Ca (stalks)	Mg (stalks)	K (leaves)	Na (leaves)	Ca (leaves)	Mg (leaves)
Bright Lights F1	Johnny's (USA)	340	99	5,648	875	314	48	3,306	2,046	510	549
Červený	MoravoSeed (CZ)	322	57	4,933	937	438	108	3,769	2,593	636	268
Fordhook Giant	Johnny's (USA)	318	66	3,794	949	273	104	3,800	1,778	514	221
Gator	Semo (CZ)	276	56	4,838	944	236	105	5,879	2,433	394	381
Genfer Selma	Mauser Samen (D)	238	94	3,791	659	273	114	6,277	2,242	420	170
Charlotte	Mauser Samen (D)	239	65	4,743	1,011	331	128	4,548	1,986	515	365
Listový zelený	MoravoSeed (CZ)	339	65	7,594	1,401	371	143	7,051	3,379	367	609
Lucullus	Semo (CZ)	324	93	4,522	793	313	116	3,448	1,810	634	440
Lucullus	Semena Veleliby (CZ)	284	69	3,689	824	366	122	3,604	1,977	523	468
Rhubarb	Johnny's (USA)	378	82	4,381	637	276	99	3,384	1,634	413	334
Rhubarb Chard	Kings (UK)	276	66	4,270	779	257	133	3,151	1,708	586	198
Swiss Chard	Kings (UK)	353	84	4,853	958	310	105	3,221	1,359	311	162
Zürcher Gelber	Mauser Samen (D)	311	43	5,970	1,790	273	141	3,142	2,366	428	531

9.7 leaves per plant. Fordhook Giant had the lowest leaf number. The highest yield was found in Gator (52 t/ha), the lowest production was shown by Červený (16 t/ha) and the mean yield amounted to 35 t/ha.

Evaluation of nutritional quality (Table 2) indicated a high content of minerals and vitamin C in leaves and stalks of Listový zelený. The variety Zürcher Gelber was rich in analysed mineral elements (5,970 mg/kg f.m. of K, 1,790 mg Na, and 141 mg Mg in stalks). The highest Ca content was determined in Červený (438 mg). The best vitamin C content in stalks was found in Bright Lights (99 mg/kg of f.m.).

Genfer Selma was the richest in potassium leaf content (6,277 mg/kg), in sodium and calcium it was Červený (2,593 and 636 mg), and finally in magnesium Bright Lights (549 mg). The highest vitamin C leaf content was detected in Rhubarb (378 mg/kg).

Lower levels of vitamin C in leaves were shown by Genfer Selma and Charlotte, in stalks it was in Zürcher Gelber.

DISCUSSION

Variety was confirmed as an important factor influencing all growth characteristics, yield and nutritional quality (ROZYCKI et al. 1997; GIL et al. 1998). Plant weight was positively correlated to the increasing plant height (Fig. 1). An interesting effect was detected between plant weight and stalk width (Fig. 2), where the highest weights were achieved by plants with stalks 30 or more millimetres in width. It can be assumed that smaller plants do not produce sufficiently wide stalks. The plants with weight above 420 g increase their leaf blade part by limiting stronger stalk formation.

As expected, the dependence of plant weight on leaf number was confirmed because the highest leaf number (around 15 per plant) was produced by the heaviest plants (around 500 g). The data are shown in Fig. 3. On the other hand, no correlation effect was found between stalk width and leaf number, but such a relation can be supposed.

By evaluation of nutritive values, the negative influence of plant yield and vitamin C content in stalks was achieved. The highest vitamin C level was analysed in yields around 35 t/ha (Fig. 4). Similar information was reported by ROZYCKI et al. (1997).

The yield and potassium content did not correlate with each other, but the positive effect was found in the case of yield and stalk sodium content (SHANNON et al. 2000). This can be caused by increasing Na content and accumulation in vigorously growing and higher yielding varieties (Fig. 5).

The interesting effect of yield and calcium content was achieved. The higher yield levels (around 50 t/ha) were connected with decrease of calcium content in stalks by a half of the maximum level (Fig. 6).

CONCLUSION

Statistically significant differences in observed parameters were found as affected by the variety. Based on

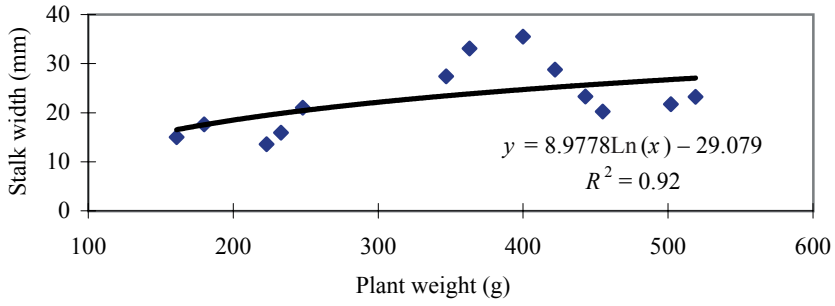

Fig. 2. Effect of plant weight on stalk width

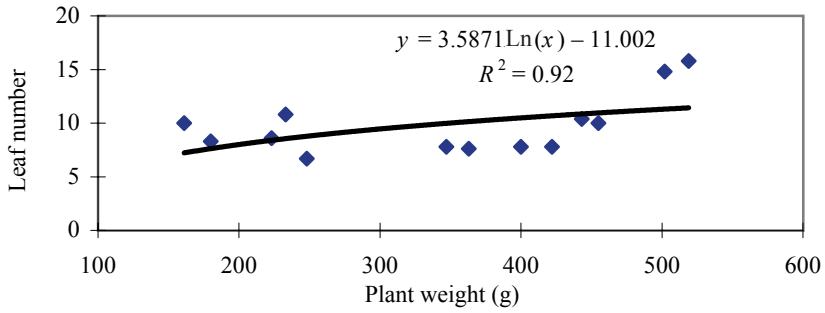

Fig. 3. Effect of plant weight on leaf number

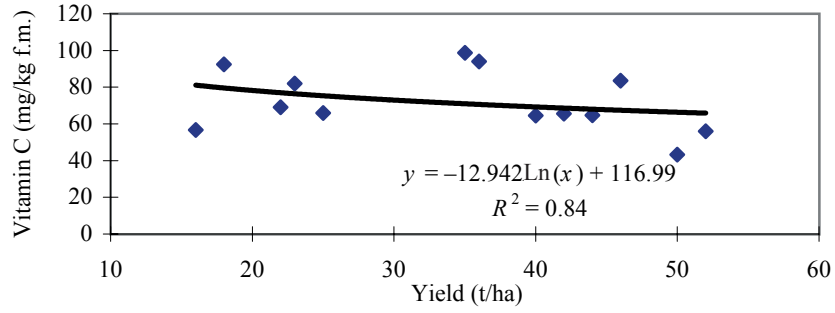

Fig. 4. Effect of yield on stalk vitamin C content

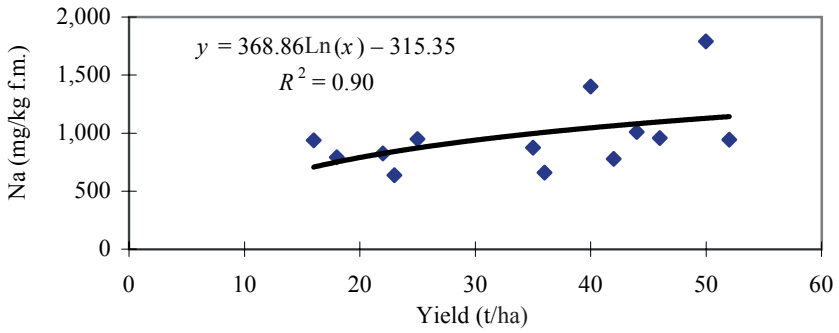

Fig. 5. Effect of yield on stalk Na content

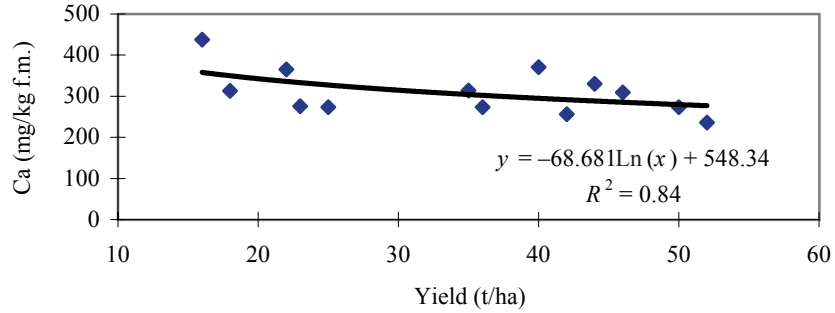

Fig. 6. Effect of yield on stalk Ca content

the achieved results, the importance of variety selection for assurance of optimum stalk quality can be confirmed.

Good stalk width was found in Lucullus, Genfer Selma, Swiss Chard and Bright Lights. Commercially important yield was obtained in the varieties Gator, Zürcher Gelber, Charlotte.

Focusing on the nutritional quality, the vitamin C stalk content was highest in Bright Lights, Genfer Selma and Lucullus. A high content of selected mineral elements was achieved in Listový zelený and Zürcher Gelber.

The results confirm good possibilities of production of quality Swiss chard in our conditions accompanied by sufficient yield levels and nutritional quality. Our current assortment can achieve comparable economic parameters if confronted with the tested foreign varieties.

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Porovnání vybraných odrůd mangoldu (*Beta vulgaris* ssp. *cicla* L.)

ABSTRAKT: V polních podmínkách bylo hodnoceno 12 odrůd mangoldu zahradního (*Beta vulgaris* ssp. *cicla* L.) na morfologické znaky, výnos a obsah vybraných minerálií a vitaminu C. Byly zjištěny následující průměrné hodnoty: polní vzcházivost 86 %, hmotnost rostliny 346 g, výška rostliny 506 mm, šířka řapíků 23 mm, 10 listů na rostlinu a výnos 35 t/ha. Z analýz nutričních hodnot vyplynul průměrný obsah vitaminu C 307 a 72 mg/kg č.h. v listech a řapících, dále draslíku 4 198 a 4 848 mg, sodíku 2 101 a 966 mg, vápníku 481 a 310 mg a hořčíku 361 a 113 mg/kg č.h. vždy v listech a v řapících. Byl nalezen významný vliv výšky rostliny a počtu listů na celkovou hmotnost rostliny. Nejširší řapíky byly zjištěny u rostlin o průměrné hmotnosti 400 g. Bylo také zjištěno negativní ovlivnění obsahu vitaminu C a vápníku v řapících vyšším výnosem a naopak se projevilo současné zvyšování výnosu a obsahu sodíku a částečně hořčíku v řapících mangoldu. Na základě srovnání a výsledků pokusů lze konstatovat, že v domácím sortimentu můžeme nalézt odrůdy plně porovnatelné s testovanými zahraničními položkami.

Klíčová slova: mangold; sortiment; hodnocení; výnos; nutriční hodnota

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