ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
Vol. XI SECTIO EEE 2002

Mendel University of Agriculture and Forestry Brno, Faculty of Horticulture Lednice, Czech Republic

ROBERT POKLUDA, JAROSLAV KUBEN

Evaluation of Selected Faba Bean Varieties (*Vicia faba* var. *major* Harz.)

Ocena wybranych odmian bobu (*Vicia faba* var. *major* Harz.)

INTRODUCTION

Faba bean (*Vicia faba* var. *major* Harz.) is one of the oldest cultivated crops. Its use as vegetable species is currently neglected. In European Union countries faba bean is grown in small areas only, despite the possible exploitation of immature and mature seeds and pods (Malý et al., 1998). Faba bean varieties differ with their growing type: indeterminate varieties, which flower during the whole season, topless types, and finally semi-determinate ones suitable for field commercial cultures.

Loss and Siddique (1997) report seed yield of 4 t · ha^{-1} at 90-day culture, while Linsalata et al. (1990) mention 8 t · ha^{-1} and pod yield more than 28 t · ha^{-1}. Malý et al. (1998) report pod yield 30-35 t · ha^{-1}. The accurate sowing date regarding the specific variety needs and additional irrigation are necessary for the optimum faba bean yield.

The nutritive value of immature seeds is (mg · kg^{-1} of f.m.): 2500 K, 220 Ca, 380 Mg, 500 Na and 330 vitamin C. In case of dry seeds it is (mg · kg^{-1} of dry matter): 10620 K, 1030 Ca, 1920 Mg, 130 Na and 14 of vitamin C (Anonym, 2001).

The purpose of this work was to evaluate the growing, morphological, and yield parameters of faba bean as well as to determinate the nutritive value of faba bean seeds and pods.

MATERIAL AND METHODS

Experiments were conducted at the Faculty of Horticulture in Lednice in 1998 and 2000. There were 12 varieties of faba bean of different origin included in tests (Table 1). All varieties belonged to the semi-determinate growing type. Field experiments were established in randomised blocks design with 3 repetitions. The area of one experimental plot was 10 m^2 and 90 plants were included into morphological evaluation. Seeds were sown in distance of 0.5 by 0.2 m on 14th April 1998 and on 11th April 2000. Pods were harvested by hand on 7th July, 1998 and 10th July, 2000. Plants were cultivated according to current recommendations and they were additionally irrigated.

The soil nutrient status was determined by Mehlich in 1998 (mg · kg^{-1}): 297 P, 358 K, 417 Mg and 5030 Ca, and in year 2000: 271 P, 325 K, 359 Mg and 5500 Ca. Soil pH was 7.5 and 7.7 in 1998 and 2000, respectively. The mean air temperature during the season 1998 and 2000 was 17°C and 17.5°C and the total temperature sums were for these years 2069 and 2133°C, respectively.

The following traits of the studied faba bean varieties were measured: total plant height, position of the lowest fruitful pod, branching at basal node, pod length, total pod number per plant, total pod weight per plant, number of seeds per pod, seed weight, immature seed yield, and pod yield. The content of minerals (K, Ca, Mg and Na) in immature seeds and pods was analysed by the method of capillary isotachophoresis (Pokluda, 1998) and the content of vitamin C in pods by Tillman´s titration by dichlorphenol indophenol.

For the statistical evaluation of the effect of variety and year, variance analysis and Scheffe test at 95% level of probability were used. Relationships among the observed parameters were expressed by the Pearson correlation coefficient at 95% level of probability (Unistat 4.3, USA).

RESULTS

Information about selected varieties and their obtained characteristics is shown in table 1.

The mean plant height was 710 mm (standard deviation – s.d. 120). The highest plants were found at variety Dreadnought; the lowest were at Rato RZ with interval of 480 to 880 mm. There were detected statistically based differences among varieties, but no effect of the year was confirmed. The position of the lowest fruitful pod above soil level was 232 mm (s.d. 95) on average. The range of 95 mm (Rato RZ) and 397 mm (Early Dragon) was found. This parameter was significantly dependent on variety.

The mean number of shoots growing out of basal node was 2.8 pieces (s.d. 0.2). Significant variation was calculated among varieties, when the lowest number was shown by variety Bunyard´s Exhibition (2.4 pieces) and the highest one by varieties Green Windsor and Scorpio (3.1 pieces).

The evaluated mean pod number per plant was 7.5 pieces (s.d. 1.9) within the range of 4.8 pieces (Masterpiece Green Longpod) and 11.4 pieces (Scorpio). Compared to the other observed parameters a significant effect of variety and no year effect were detected. The average pod length of 124 mm (s.d. 25) was found. The shortest pods were in variety Early Dragon (75 mm) and the longest

Tab. 1. Mean characteristics of selected faba bean varieties

Variety	Company	Plant height (mm)	Position of the lowest fruitful pod above soil (mm)	Number of branches from basal node (piece)	Pod number per plant (piece)	Pod length (mm)	Pod weight (mm)	Seed number per pod (piece)	Weight of 100 seeds (g)
Rato RZ	Rijk-Zwaan (NL)	480	95	3,0	7,3	161	284	3,1	167
Hedosa RZ	Rijk-Zwaan (NL)	545	119	3,0	11,0	150	334	3,0	125
Medium Green Dragon	Tokita (JAP)	667	375	3,0	7,7	92	110	3,2	213
Bunyard´s Exhibition	King´s (UK)	860	248	2,4	5,7	145	151	3,4	112
White Windsor	King´s (UK)	841	283	2,5	8,2	120	153	3,8	141
Green Windsor	King´s (UK)	758	169	3,1	6,9	132	220	3,9	136
Early Dragon	Tokita (JAP)	800	397	2,7	7,0	75	122	3,6	119
The Sutton	King´s (UK)	643	134	3,0	6,3	118	172	3,7	137
Dreadnought	King´s (UK)	880	319	2,7	6,9	121	155	3,2	141
Masterpiece Green Longpod	King´s (UK)	741	174	2,8	4,8	140	161	3,9	120
Scorpio	Holland-select (NL)	668	257	3,1	11,4	94	159	3,7	135
Aquadulce	King´s (UK)	640	211	2,8	6,8	145	214	4,3	139
Mean		710	232	3	8	124	186	4	140
Year effect		ns	ns	ns	ns	ns	ns	ns	ns
Variety effect		*	**	*	**	**	**	*	*

Legend: ns – not significant, * – significant difference at p = 0.05, ** – significant difference at p = 0.01

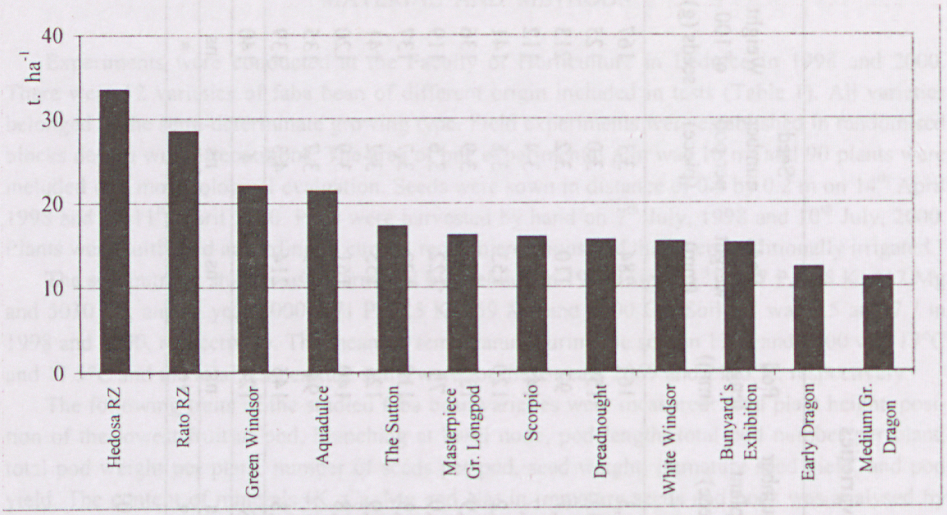

Fig. 1. Mean pod yield

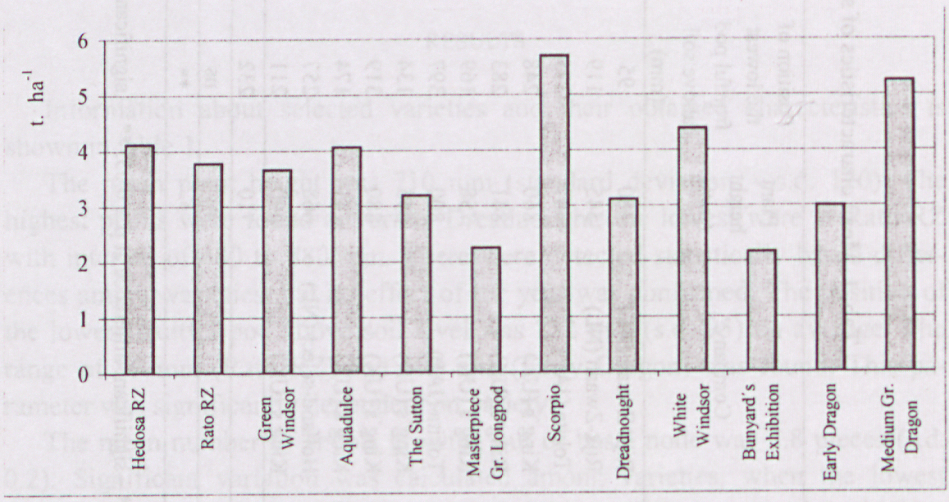

Fig. 2. Mean seed yield

in variety Rato RZ (161 mm). The pod length was highly influenced by the variety. The total pod weight per plant was 186 g (s.d. 63.3) on average. Very high differences among varieties were confirmed. Variety Medium Green Dragon brought pods with total weight of 110 g per plant, while the highest weight was achieved by Hedosa (334 g per plant).

Tab. 2. Mean content of selected minerals in immature faba bean seeds

Variety	K	Ca	Mg	Na
	(mg · kg^{-1} f.m.)			
Rato RZ	3660	159	151	133
Hedosa RZ	3492	161	180	174
Medium Green Dragon	4843	200	209	152
Bunyard's Exhibition	5351	132	257	225
White Windsor	5377	199	231	338
Green Windsor	4464	272	203	174
Early Dragon	6077	131	164	230
The Sutton	3371	156	137	288
Dreadnought	5573	192	280	214
Masterpiece Green Longpod	3113	200	165	233
Scorpio	5333	219	298	301
Aquadulce	4229	222	152	297
Mean	4574	187	202	230
Year effect	ns	ns	ns	**
Variety effect	**	*	*	**

Tab. 3. Mean content of selected nutrients in fresh faba bean pods

Variety	Vitamin C	K	Ca	Mg	Na
	(mg · kg^{-1} f.m.)				
Rato RZ	276	3753	154	212	106
Hedosa RZ	272	3902	192	243	87
Medium Green Dragon	152	3972	219	317	21
Bunyard's Exhibition	245	4221	219	153	47
White Windsor	288	3585	218	168	30
Green Windsor	302	4269	375	342	24
Early Dragon	192	5453	236	337	26
The Sutton	191	3469	207	177	38
Dreadnought	203	5168	306	249	25
Masterpiece Green Longpod	306	4451	227	198	26
Scorpio	295	5122	241	192	40
Aquadulce	288	4572	256	143	68
Mean	251	4328	238	228	45
Year effect	ns	ns	ns	ns	**
Variety effect	*	*	**	**	**

Legend: ns – not significant, * – significant difference at p = 0.05, ** – significant difference at p = 0.01

Tab. 4. Correlation effects of observed parameters

	Plant height	Position of the lowest fruitful pod above soil	Branchi mg from basal node	Pod number per plant	Pod length	Pod weight per plant	Seed number per pod	Weight of 100 seeds	Pod yield
Position of the lowest fruitful pod above soil	0,62	1							
Branching from basal node	**-0,70**	-0,39	1						
Pod number per plant	-0,38	-0,02	0,42	1					
Pod length	-0,35	**-0,80**	-0,06	-0,19	1				
Pod weight per plant	**-0,69**	**-0,79**	0,40	0,36	**0,72**	1			
Seed number per pod	0,23	-0,02	-0,08	-0,30	-0,06	-0,27	1		
Weight of 100 seeds	-0,35	0,21	0,39	0,10	-0,19	-0,12	-0,32	1	
Pod yield	**-0,69**	**-0,79**	0,40	0,36	**0,72**	**1,00**	-0,27	-0,12	1
Seed yield	-0,39	0,16	0,52	**0,78**	-0,34	0,06	-0,06	0,59	0,06

Data are Pearson correlation coefficients

The number of seeds per pod was relatively stable among varieties, 3.6 pieces (s.d. 0.4) on average. The lowest number was detected at Hedosa and the highest at Aquadulce with interval of 3 to 4.3 pieces per pod. The mean weight of 100 seeds was 141 g (s.d. 26), while the highest difference was found between Bunyard´s Exhibition (112 g) and Medium Green Dragon (213 g).

The mean pod yield of all varieties was 18.6 t · ha^{-1}, while the best yield was shown by Hedosa (33.4 t · ha^{-1}) and variety Medium Green Dragon achieved 11 t · ha^{-1} only. The pod yield did not correlate with the seed yield. The highest seed yield was confirmed in Scorpio (5.7 t · ha^{-1}), while the lowest at Bunyard´s Exhibition and Masterpiece Green Longpod (2.2 t · ha^{-1}). The total mean seed yield was 3.7 t · ha^{-1} and results of all varieties are shown Fig. 1 and 2.

The nutritive value of faba bean is displayed in tables 2 and 3. Important differences of nutrient content in fresh seeds and pods affected by variety were found. The mean potassium content was 4574 mg · kg^{-1} of fresh matter (s.d. 952) with the highest level at Early Dragon (6077 mg) and the lowest content (3113 mg) in variety Masterpiece Green Longpod. The mean calcium content was 187 mg · kg^{-1} (s.d. 39) with the range between 131 mg (Early Dragon) and 272 mg (Green Windsor). The mean magnesium content was 202 mg · kg^{-1} (s.d. 52) and the lowest level was 137 mg (The Sutton), while the highest, 298 mg was shown by Scorpio. Finally, the mean content of sodium was 230 mg · kg^{-1} (s.d. 62). The lowest level was found in Rato RZ (133 mg), while the highest in White Windsor (338 mg).

The nutritive value of faba bean pods is shown table 3. The mean vitamin C content was 251 mg · kg^{-1} f.m. (s.d. 50). The range of its concentration was from 152 (Medium Green Dragon) to 306 mg · kg^{-1} (Masterpiece Green Longpod). The mean content of potassium was 4328 mg (s.d. 620), calcium 238 (s.d. 54), magnesium 228 (s.d. 68), and sodium 45 mg · kg^{-1} (s.d. 27). The highest potassium content was detected in Early Dragon, for calcium and magnesium in Green Windsor and for sodium in Rato RZ.

Evaluation of mutual correlations among the observed parameters of faba bean varieties is presented in table 4. The achieved correlation coefficients point to a higher effect of plant height, the position of the lowest fruitful pod and pod length as compared to the other parameters.

DISCUSSION

Costa et al. (1997) report the importance of variety selection according to the conditions of place and variety effect on the biomass and yield performance. This conclusion was also confirmed in our experiments. The pod and seed yields belong to the most important factors, which differed among varieties up to triple levels.

Similarly, Al Abdulsalam et al. (1996) mentioned the effect of variety on seed size and shape, and on the difference of their nutritive values and growth characteristics. While the seed number per pod was relatively comparable among varieties, the total number of pods per plant was variable and thus strongly affect the total yield of the tested varieties. Seed weight was similar to the literature data (Malý et al., 1998). Yield levels also correspond to the previously published works (Loss and Siddique, 1997).

As the result of correlation analysis, a negative effect of plant height and branching intensity was found. This shows that the lower the plants are, the higher number of shoots develops. The total pod weight per plant was also negatively influenced by the plant height. It can be expected that lower plants can also bring good yield levels (Costa et al., 1997).

The position of the lowest fruitful pod was dependent on variety and this factor determines suitability of each variety to the field commercial growth. When the pod was located higher above the soil level, the pod length was shorter. We can assume the varieties suitable for mechanized harvest have shorter pods, which can resist to the mechanical damage better. On the other hand, varieties with low position of fruitful pod have longer pods acceptable for hand harvest especially.

The commonly reported positive effect of pod length and their total weight per plant was also confirmed (Loss and Siddique, 1997).

A high effect of variety on nutritive quality is indisputable, however, many other factors can contribute to this property. Vitamin C content and levels of selected minerals are shown by the data from the literature (Anonym, 2001).

CONCLUSION

1. The studied varieties achieved the mean plant height of 710 mm with different levels of the lowest fruitful pod within the range from 95 to 397 mm and differed in the number of pod per plant (4.8 to 11.4 pieces).

2. The number of seeds per pod was comparable (3.6 pieces in average), but the total pod yield varied from 11 to 33.4 $t \cdot ha^{-1}$ and the seed yield was from 2.2 to 5.7 $t \cdot ha^{-1}$.

3. The best pod yield was shown by varieties Hedosa, Rato, and Aqualdulce with the level above 20 $t \cdot ha^{-1}$ and the highest seed yield was shown by variety Scorpio (5.7 $t \cdot ha^{-1}$).

4. The mean vitamin C content in pods was 251 $mg \cdot kg^{-1}$ f.m. In case of minerals, it was 4328 K, 238 Ca, 228 Mg, and Na 45 $mg \cdot kg^{-1}$ f.m. The mean seed nutritional value was (in $mg \cdot kg^{-1}$ f.m.) 4574 K, 187 Ca, 202 Mg, and 230 Na.

5. The best nutritive value was shown by variety Scorpio.

SUMMARY

Selected assortment of faba bean (*Vicia faba* var. *major* Harz.) varieties was evaluated in the field experiments. The habitual characteristics, yield, and nutrient properties of pods and seeds of the faba bean were determined. The following mean results were obtained: plant height was 710 mm, the lowest position of fruitful pod was 232 mm, the number of lateral shoots growing out of the basal node was 2.8 pieces, pod number per plant was 7.5 pieces, pod length was 124 mm, total pod weight per plant was 186 g, and weight of 100 seeds was 141 g. The marketable mean pod yield was 18.6 t · ha^{-1} and mean seed yield was 3.7 t · ha^{-1}. The mean nutrient values of pods and immature seeds were (in mg · kg^{-1} of f.m.): 251 of vitamin C (pods only), 4328 and 4574 K, 238 and 187 Ca, 228 and 202 Mg, 45 and 230 Na. A good total mineral value was found in variety Early Dragon regarding its high potassium content and in Scorpio due to the generally high content of all minerals and vitamin C. A negative correlation of the pod length and the pod weight, as well as the position of the lowest pod node and total pod yield per plant were confirmed. Also, aninteresting negative effect of plant height to the shoot branching and to the total pod yield per plant was detected. The pod length was positively affected by the total pod weight.

ACKNOWLEDGEMENT

The financial support by the Czech Ministry of Education and Youth (project MSM 435100002) is gratefully acknowledged.

REFERENCES

Al Abdulsalam M. A., Al Tahir O. A., Burhan H. O., 1996. Variation in seed size of faba bean (*Vicia faba*) as influenced by cultivars, irrigation regimes and nitrogen. Ind. J. of Agron., 41 (2): 269-274

Anonym, 2001. USDA Nutrient Database for Standard References, Release 14 (July 2001). Department of Agriculture, Agricultural Research Service. http://www.nal.usda.gov/fnic

Costa W., Dennett M. D., Ratnaweera U., Nyalemegbe K., De Costa W., 1997. Effects of different water regimes on field-grown determinate and indeterminate faba bean (*Vicia faba* L.). I. Canopy growth and biomass production. Field Crops Research. 49 (2-3): 83-93

Linsalata D., Spada B., Bianco V., 1990. Climate and water regimes on broadbean for green consumption. Acta Hort. 278: 245-252

Loss S. P., Siddique K. H. M., 1997. Adaptation of faba bean (*Vicia faba* L.) to dryland Mediterranean-type environments. I. Seed yield and yield components. Field-Crops-Research. 52 (1-2): 17-28

Malý I., Bartoš J., Hlušek J., Kopec K., Petříková K., Rod J., Spitz P., 1998. Polní zelinářství (Field vegetable production). Agrospoj Prague, 196 pp. (in Czech)

Pokluda R., 1998. Exploitation of Capillary Isotachophoresis in Monitoring of Hydroponic Nutrient Solution in Tomato. Acta Horticulturae et Regiotecturae, Vol. 1, Sept., 1998, Supplement, The 1st Hortic. Conf. Nitra, Slovakia : 219-218.