

Development of region-specific organic cultivars in faba bean
Entwicklung ökologischer Regionalsorten bei Ackerbohnen

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Abstract:

The agronomic performance of faba bean showing a range of genotypic structures (heterozygosity, heterogeneity) was analysed in four different organic locations and one conventional location in 2004. Heterogeneous and heterozygous genotypes were most often highest performing (grain yield). The project is continued.

Introduction:

Local, specific adaptation is given high priority by organic farming principles. Genotypes with contrasting genotypic structures and identical genetic background were compared as to their local adaptation to different organic sites. Among the inbred lines, one will be identified as agronomically best adapted per location. Its polycross progeny is heterogeneous; this is disadvantageous since this variability originates from the residual, inferior inbred lines. This disadvantage will be more or less counterbalanced by the realisation of heterosis in the polycross progeny. It is unclear which effect will turn the balance.

Material and methods:

Eighteen homozygous inbred lines were used *per se* and to produce five different genotypic structures with orthogonal genetic background: 18 polycross progenies, one blend of the inbred lines, one blend of the 18 polycross progenies and finally one blend of 58 F1-hybrids resulting from crosses among the 18 inbred lines. The experiment was laid out as lattice design with N = 49 entries, sown in March 2004 in five locations with two replicates. The five locations involved are Tröndel (north), Ramsthal and Willmering (south) and Reinshof and Deppoldshausen near Göttingen (center of Germany). Reinshof is a conventional site.

Results and discussion:

The ANOVA for grain yield, height and lodging showed that most of the variation was caused by locations and genotypes (table 1). Genotype x environment interaction was highly significant for grain yield and height.

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Table 1. F-values for the different sources of variation for grain yield (t/ha), height (cm) and lodging (1-9); ANOVA across genotypes and locations.

Sources of variation	Df	Yield	Df	Height	Df	Lodging
Genotypes (G)	48	6.07**	48	5.20**	48	1.60*
Locations (L)	4	425**	4	548**	3	416**
G x L	192	2.04**	192	3.88**	144	0.98

The polycross progenies contributed 8 of the $5 \times 3 = 15$ locally highest yielding genotypes (table 2), whereas the 18 inbred lines contributed only with 2. The blend of polycross progenies and the blend of inbred lines were never found among the three highest yielding entries. The single hybrid blend contributed even with 2. This makes clear that heterozygosity and heterogeneity promote high local adaptation.

Table 2. Identity and genotypic structure of the three “best” genotypes for yield over the five experimented locations.

Locations	Rank	Genotypes	Nature	Average yield (t/ha)	Genotype/PP blend(%)
1 Reinshof	1	Hybrid blend	HB	8.73	135.35
1 Reinshof	2	Herz freya/22-PC	PC	7.36	114.11
1 Reinshof	3	Styria_343-PC	PC	7.30	113.18
2 Tröndel	1	Hybrid blend	HB	8.08	146.91
2 Tröndel	2	Herz freya/22-PC	PC	7.20	130.91
2 Tröndel	3	Styria_343-PC	PC	6.95	126.36
3 Willmering	1	Espresso	C *	5.39	142.59
3 Willmering	2	Music/1-PC	PC	4.96	131.22
3 Willmering	3	Alfred/9-PC	PC	4.83	127.78
4 Deppoldsh.	1	Viktor/2-PC	PC	6.09	129.57
4 Deppoldsh.	2	Espresso	C *	6.01	127.87
4 Deppoldsh.	3	L1_MxCEx/19	IL	6.00	127.66
5 Ramsthal	1	Limbo	C *	3.46	233.78
5 Ramsthal	2	L1_MxCEx/19-PC	PC	3.38	228.38
5 Ramsthal	3	Scirocco06.91742	IL	3.10	209.46

(IL: inbred line; PC: polycross progenies; HB: hybrids blend; C: cultivar; *: check; PP blend: polycross progenies blend)

The phenotypic variance for local yield among the inbred lines varied from 0.27 to 0.79 with a mean estimate of $0.59 (t/ha)^2$. The general mean yield of the inbred lines was 3.72 t/ha. Assuming a normal distribution, the mean yield of the 5% best inbred lines at a typical organic location is expected as 5.15 t/ha. Correspondingly, the phenotypic variance for local yield among the polycross progenies varied from 0.20 to 0.63 with a mean estimate of $0.34 (t/ha)^2$. The general mean yield was 4.75 t/ha. The mean of the 5% best polycross progenies is expected as 5.84 t/ha ($5.84 > 5.15$). Future experiments will show whether the present expectation holds: at a given organic location, the best performing polycross progeny yields higher than any inbred line. This is mainly due to the partly heterozygous status of polycross progenies; noteworthy, they show the potential of further evolution and local adaptation.

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