Report

Evaluation of genetic resources of designated winter peas from the Vavilov Institute St. Petersburg for the traits frost tolerance, plant morphology, yield and raw protein quality

Figure 1: short internodes growth habit in the overwintering period

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Introduction

Selection depends on variation. The diversity in winter pea with high frost tolerance seems to be very small. Supported by BÖLN, Saatgutfonds and Seidlhof-Stiftung some genotypes were evaluated with good frost tolerance. However most of the genotypes were not adapted to long periods of bare frost without snow cover and alternating frost especially on sandy soil. The best adaptation was shown for genetic resources like the fodder pea type (tall, purple flowering and normal leaf). Progeny lines from crosses of these old fodder pea types with white flowering modern pea types with a higher frost tolerance especially for Darzau are going to be select. But to increase the diversity in white flowering winter pea lines with a variation in frost adaptation alleles is still needed.

The aim of the research is to increase the genotypic and phenotypic diversity for white flowering winter peas with an improved frost and disease tolerance. The best accessions shall be later parents for crossing.

Material and Methods

Twelve accessions of designated winter peas (Table 1) from VIR St. Petersburg were evaluated in yield tests and in the nursery at Darzau (lower Saxony – Germany). As references we took genotypes from USA, Hungary and own progeny lines (Table 2). Evaluated traits were: overwintering rate (percentage of plants after winter to plants for winter), lodging (percentage of stand height before harvest to stand height at flowering), yield, morphological characteristics, raw protein content (NIRS) and amino acids (NIRS). The sowing of the peas took place in mixture with triticale (cv. Benetto) as an additive mixture. The sowing density was 60 seeds/m² of pea and 130 seeds/m² of triticale.

Table 1: Genotypes from VIR St. Petersburg

Genotype	VIR identifier	type	testa colour	seed shape	cotyledon	hilum
UA	VIR-K-96	spring	clear Testa	round	green	white
BR.497-YU	VIR-4426	spring	clear Testa	round	yellow / green	white
BR.496-YU	VIR-K-4429	spring	white	round	yellow	black
Hybrid325-RU	VIR-K-4847	winter	white	round	green	white
Hybrid326/2-RU	VIR-5115	winter	white	round	yellow	white
Hybrid184/170-RU	VIR-K-5220	winter	white	round	yellow	black
VIK-RU	VIR-K-5220	winter	red brown	round	yellow	white
Ozimyi-RU	VIR-K-6089	spring	white	round	yellow	white
Winter21-MD	VIR-K-6513	winter	white	round	green	white
Winter27-MD	VIR-K-6514	winter	white	round	yellow	white
1528-AZ	VIR-K-6630	spring	white	round	yellow	white
Kaljot2-RU	VIR-K-7475	spring	white	round	yellow	white

Table 2: Reference genotypes

genotype	origin	type	testa colour	seed shape	cotyledon	hilum
A4	Darzau	winter	white	round	yellow	black
Afila	Hungary	winter	white	round	yellow	white
C3	Darzau	winter	white	round	yellow	white
D6	Darzau	winter	white	round	yellow	white
EFB33	Germany	winter	green brown	round	yellow	black
Karolina	Hungary	winter	white	round	yellow	white
TE	USA	winter	white	round	yellow	white
Nany	Hungary	winter	red brown	round	yellow	black
Nischkes	Germany	winter	green brown	round	yellow	black
O	USA	winter	white	round	green	white
Stamm60	USA	winter	white	round	yellow	white
Stamm61	USA	winter	white	round	yellow	white
ER	USA	winter	white	round	yellow	white

The location was situated at Köhlingen (GPS-coordinates: 53.2N; 10.8E). Altitude above sea level was 60 m. The long time average temperature was 8.9° C. The precipitation was 780 mm. The test was performed at a certified organic farm. The soil texture was loamy sand.

The Winter 2013/14 was very mild (Figure 2). Only a short frost period occurred with a thin snow cover. No winter pea disappeared completely.

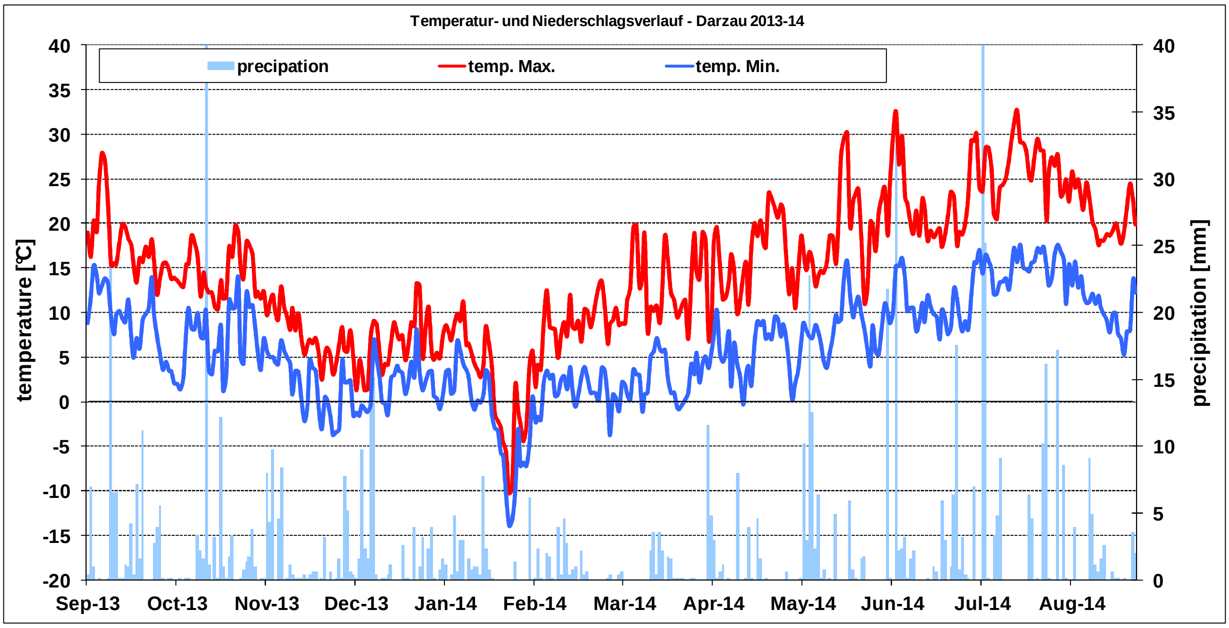

Figure 2: Temperature and precipitation at Darzau from Sept. 2013 until Aug. 2014.

The analysis of variance was conducted with linear mixed models by GenStat 15th. For significance the l.s.d. was calculated by formula critical t-value * s.e.d. for alpha = 5 %.

Outcomes and Discussion

The winter 2013/14 was too mild for measuring distinct frost tolerance. Only the peas which were not suited for sowing in autumn (after winter 0 to 39 %) differentiated from the pea genotypes which could be sown in autumn (after winter 89 to 100 %) (Table 3). Nevertheless due to the mild winter conditions we found differences for shooting during the over wintering period (Table 5). Depending on their photoperiodic sensitivity winter peas show differences in shooting, the higher the photoperiodic sensitivity the later shooting. Delayed shooting with a short growth habit and many basal branches (Figure 1) is related to a high frost tolerance. Peas which not showed the depressed growth stage (1528-AZ, Ozimyi-RU) were not adapted to sowing in autumn. Five white flowering and one purple flowering from the twelve genotypes of the VIR accessions were suited for sowing in autumn. New trait combinations were dwarf and white flowering genotypes with very short internodes and short plant height from 51 to 65 cm (Table 3). The yield of the dwarf peas (6 dt/ha) were not as high as for taller peas (15 to 18 dt/ha). The taller accessions reached nearly the yield of the references. But for lodging and yield the genotypes O, TE and ER performed better (Table 3).

Table 3: field emergence, overwintering, plant height, lodging index and pea yield of the genotypes

Genotype	emergence (pea/m²)		after winter (%)	plant height	lodging index	pea yield (dt/ha)
l.s.d. (5%)	16		4	4	0.1	4.7
BR.497-YU	43		11			0
BR.496-YU	48		8			0
Hybrid-325-RU	16	*	100	65	1.0	6
Hybrid326/2-RU	42		100	51	1.0	6
Hybrid184/170-RU	18	*	100	61	1.0	1
VIK-RU	52		100	123	0.4	18
Ozimyi-RU	46		49	110	0.8	5
Winter21-MD	51		89	122	0.4	18
Winter27-MD	47		96	109	0.7	15
1528-AZ	46		39	120	0.7	8
Kaljot2-RU	49		2			0
UA	18	*	2			0
A4	45		100	131	0.5	21
Afila	50		100	147	0.4	21
C3	57		100	131	0.5	25
D6	47		100	137	0.5	22
EFB33	50		100	124	0.4	21
Karolina	48		100	133	0.5	23
TE	58		100	82	1.0	19
Nany	57		100	127	0.4	24
Nischkes	55		100	106	0.5	23
O	28		100	107	0.8	19
Stamm60	47		100	134	0.5	23
Stamm61	53		100	115	0.3	24
ER	43		99	87	1.0	21
* less seeds						

For all genotypes was the crude protein content comparatively high (24 to 30 %DM). The white flowering, regular leaf genotypes from VIR reached 26 to 29 % CP (Table 4). There were no distinguished differences in the content of amino acids (Table 4).

Table 4: Content of crude protein and amino acids lysine, methionin and cystein (% of dry matter)

Genotype	CP (%DM)	LYS (%DM)	MET (%DM)	CYS (%DM)
l.s.d. (5%)	mixed samples of the 2 replicates			
BR.497-YU				
BR.496-YU				
Hybrid-325-RU	26	2.0	0.2	0.4
Hybrid326/2-RU	28	2.1	0.2	0.4
Hybrid184/170-RU	28	2.1	0.2	0.4
VIK-RU	26	2.0	0.2	0.4
Ozimyi-RU	25	1.9	0.2	0.4
Winter21-MD	26	2.0	0.2	0.4
Winter27-MD	29	2.2	0.2	0.4
1528-AZ				
Kaljot2-RU				
UA				
A4	24	1.8	0.2	0.4
Afila	28	2.0	0.2	0.4
C3	23	1.8	0.2	0.4
D6	24	1.9	0.2	0.4
EFB33	28	2.0	0.2	0.4
Karolina	27	2.0	0.2	0.4
TE	25	1.9	0.2	0.4
Nany				
Nischkes	30	2.2	0.3	0.4
O	26	2.0	0.2	0.4
Stamm60	26	2.0	0.2	0.4
Stamm61	28	2.1	0.3	0.4
ER	24	1.9	0.2	0.4

New trait combinations were found among the VIR genotypes with a high overwintering rate, like white flowering, normal leaf types and short plant height or genotypes with a high TKW and high protein contents (Table 5).

Table 5: Morphological traits: leaf type, flower colour, plant height, flowering, shooting und TKW.

Genotype	leaf type [1]	flower colour [2]	flowering start (days in May)	flowering end (days in June)	shooting [3] (19.03.2014)	TKW
BR.497-YU	r	w				
BR.496-YU	r	w				
Hybrid325-RU	r	w	9	6	5	165
Hybrid326/2-RU	r	w	3	4	6	175
Hybrid184/170-RU	r	w	2	4	6	192
VIK-RU	r	p	11	10	4	144
Ozimyi-RU	r	w	14	4	9	195
Winter21-MD	r	w	8	4	4	109
Winter27-MD	r	w	8	4	5	101
1528-AZ	r	w	1	1	9	193
Kaljot2-RU	r	w				
UA	r	w				
A4	s	w	19	10	4	152
Afila	s	w	5	3	7	196
C3	s	w	13	10	5	159
D6	s	w	15	10	3	134
EFB33	r	p	16	10	6	105
Karolina	r	w	4	6	7	191
TE	s	w	10	10	4	179
Nany	r	p	12	10	7	122
Nischkes	r	p	19	10	4	117
O	s	w	7	10	5	189
Stamm60	s	w	12	10	6	128
Stamm61	r	w	3	6	6	105
ER	s	w	10	10	6	179

[1] r = regluar leaf; s = semileafless; [2] p = purple, w = white; [3] Evaluation Shooting: 1 = extremely delayed shooting; 9 = strong shooting

Conclusion

We found new trait combinations among the VIR genotypes like white flowering dwarf types and high TKW. Due to the mild winter conditions in 2013/14 a higher frost tolerance for bare or alternating frost could not evaluated. On the assumption that morphologic different winter peas are also different for the genetic background of frost tolerance new crosses between the VIR accessions and the references could eventually accumulate different frost resistance alleles. So the progeny lines of these new crosses could be more adapted to frost.

Acknowledgment

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