Scientific Bulletin. Series F. Biotechnologies, Vol. XXII, 2018
ISSN 2285-1364, CD-ROM ISSN 2285-5521, ISSN Online 2285-1372, ISSN-L 2285-1364

NEW GERMPLASM REALISED TO WINTER PEA WITH SUPERIOR AGRONOMIC TRAITS

Ancuța CRÎNGAȘU (BĂRBIERU)[1,2]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Biotechnologies, 59 Mărăști Blvd., 011464, Bucharest, Romania
[2]National Agricultural Research and Development Institute Fundulea, 1 Nicolae Titulescu Street, Călăraşi, Romania

Corresponding author email: cringasuancuta@yahoo.com

Abstract

The developments of the winter pea crop represent a major challenge to expand plant protein production in temperate areas. Breeding winter cultivars requires the combination of freezing tolerance as well as with high seed yield and quality.
In this paper we present data obtained from the F3, F4 and F5 lines of winter peas selected from the four hybrid populations (Specter/F95-927; F98-492/Windham; F95-927/CHECO; Specter/CHECO) and tested at NARDI Fundulea in the year 2017. At these lines were determined winter hardiness, earliness, yield and plant height in comparation with the three winter peas controls (Specter, Checo and Windham).
The results shown that several news F5 lines of winter peasrealized till 6.5 t / ha, exceeding the control varieties and had similar to or better earliness and winter hardiness than that of the parental forms.

Key words*: breeding, winter pea, winter hardiness.*

INTRODUCTION

Pea *(Pisum sativum* L.) is an important annual legume crop grown in temperate regions, can be considered an environmentally friendly crop providing furthermore a high quality source of proteins for animal feeding. By climate change, heat stress and drought are very determinal to the yield, especially for spring pea. Breeders are now developing winter pea varieties, more likely to avoid these stresses occurring at the end of the crop cycle, because they flower earlier. However, the high level of frost risk in winter could limit the extent of peas, even in a warming climate (Castel et al., 2017). One way to improve the yield of the pea crop is through the development of autumn-sown varieties, with a longer development cycle than spring peas, provided that plants are able to cope with low temperatures during fall and winter (Grimaud et al., 2013).
High levels of both tolerance and acclimation rate seem required to best benefit to the winter crops (Rammig et al., 2010). To this aim breeding for better frost tolerance isrequired. For these latter if frost level resistance is of primary importance, the rate of acclimation matters too. Frost stress level decreases systematically with lower rate of acclimation whatever the frost resistance level. The range of the acclimation rate effect is clearly frost resistance dependent. A relevant modelling at high spatial resolution of daily climate change and more robust mimics of theacclimation/de-acclimation processes for crop are needed to account for both warming patterns (abrupt fluctuations, variance, geography) and pea traits (frost resistance level, acclimation rate, date of sowing) (Pagter and Arora, 2013).
The frost stress intensity changes clearly drive the whole decreasing trend. While subtleincrease in the frost events support the „paradoxical" increase in freezing injury in a warming climate that has been widely documented for spring and for the perennials vegetation such as forestin mid and high latitudes (Ball et al., 2012).
The mechanisms of the spring frost increase is attributed to the hastening of bud burst that considerably increase the vulnerability to lessacclimation/deacclimation processes. In this case the exposure to the gradual appearance

ofextreme minimum temperature. By contrast,the winter frost damage is linked to the warmerlow temperature results the in delayed acclimation through slower accumulation of resistance (Wedendrop et al., 2008) anddecreases the frost resistance.
Crop vulnerability seems also to be increased bymid-winter more frequent deacclimation to moderate elevation in temperature (≃5°C or less) in warmer climate and by the longer exposure of the crop to the fluctuating winter temperatures (Castel et al., 2017).
The aim of this work was to appreciate the yield performance and other traits and mainly the winter hardiness of several winter pea lines in the climatic conditions from NARDI-Fundulea.

MATERIALS AND METHODS

In 2017, 31 lines of peas F3 generations from four hybrid combination (Specter/F95-927; F98-492/Windham; F95-927/CHECO; Specter/CHECO) were tested in two comparative trials with 25 entries in three replications, on the each plot of 6 m^2 harvested area.
In parallel, 34 lines of peas F4 generations belonging to the same hybrid combinations were tested in two preliminary comparative trials with 25 entries in three replications, with the same size of the plot like in the F3 trials.
Of the same four hybrid combination but in F5 generation were tested 67 lines of peas in four preliminary micro-trials, each of them with 25 variants, one rep besides the parents of these lines: Specter, Windham, Checo, F95-927 and F98-492, on the each plot of 6m^2 harvested area.
The 2017 winter was mild enough, with a short period with negative temperatures of -23°C (the begining of January), but with a 20 cm snow loyer, which has protected the crop. There are no damages registered due to frost. The early spring was normal, fact that led to restart the vegetation under optimum conditions.
The level of resistance to winter hardiness was estimated in the field, early in the spring, in a scale 1 to 9, where score 1 is very resistance and 9 very susceptible. Plant height was measure in cm, total length of plant from the ground till the top to the end of flowering time. The earliness was appreciated like number of days from 1st January till the end of flowering time and yield as kg/ha.
The statistic analyses of data have been evaluated by correlations and linear regressions between study traits.

RESULTS AND DISCUSSIONS

Yield performances of the lines F3, F4 and F5 generation, tested in advance trials and respectively in preliminary trials in 2017, (Figure 1 and Figure 2) shows that the coefficients of correlation between generation are significant high (r=0.86 ***, F4/F3 and r=0.72*** F5/F3) that means a high enough heredity of this trait and possibility, in the breeding program, is not difficult, to select the new lines with improve yield performances.

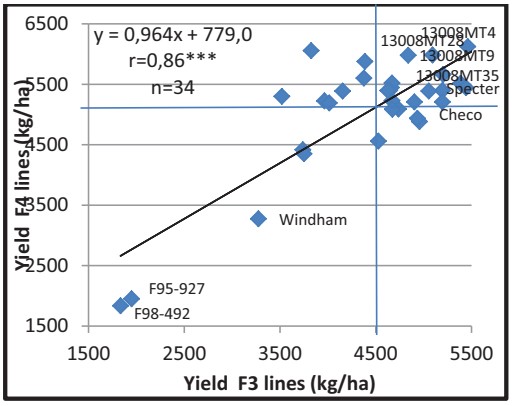

Figure 1. Correlation between yield of F3 and F4 lines selected from the four hybrid combinations of winter peas

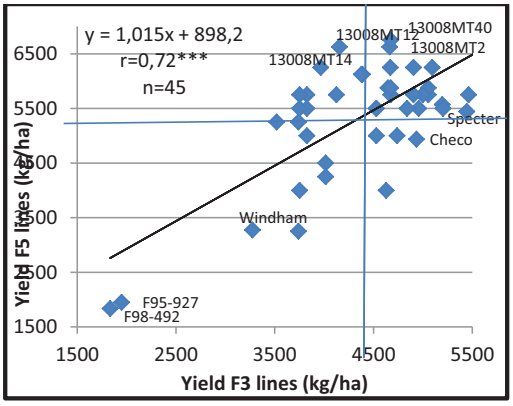

Figure 2. Correlation between yield of F3 and F5 lines selected from the four hybrid combinations of winter peas

Having in view that winter hardiness in winter peas is a very important trait, there was necessary to know in what way this trait could be recombined with other important agronomical characteristics, like earliness to flowering, plant height, grain yield as well as the relationship among other traits as plant height/earliness or yield/earliness.

In the Table1 are presented such correlations using the data collected from 31 F3 lines and 34 F4 lines in 2017.

The correlation between winter hardiness and yield either in F3 and F4 lines (Table1) was very distinct significantly negative (r=-0.61 and r=-0.77), what means that in winter peas is absolutely necessary to cultivate genotypes with good level of winter hardiness, to realize high and stable yields.

Also relationship between plant height and earliness should be positively strong enough in some case, what mains that it quite easily to be recombine such characteristics.

The correlation, between plant height and winter hardiness, was negative not significantly (r=-0.33 and r=-0.11), that suggests possibility to select the genotypes which recombine both traits.

The relationship between yield and earliness, in F3 and F4 peas lines was not significantly, (0.13 and 0.04), what mains, in some cases, that later types can realize high yield than earlier types.

Also, the relationship between winter hardiness and earliness, in the all cases, was not significant, that mains it is possible to select the winter pea form which recombine the both traits.

Table 1. Correlation coefficients among different traits in F3 and F4 lines selected from the four hybrid combinations of winter peas

The generation these genotypes	Correlation between different characters	The correlation coefficient
31 F3 lines tested in comparative trails in 2017	Winter hardiness/yield	**-0,61*****
	Winter hardiness/earliness	-0,32ns
	Winter hardiness/plant height	-0,33ns
	Plant height/earliness	0.18ns
	Yield/earliness	0.13ns
34 F4 lines tested in preliminary comparative trails in 2017	Winter hardiness/yield	**-0.77*****
	Winter hardiness/earliness	-0.32ns
	Winter hardiness/plant height	-0.11ns
	Plant height/earliness	**0.40***
	Yield/earliness	0.04ns

The correlation between yield and winter hardiness of F5 lines (Figure 3) shown a very strong enough negatively relationship (r=-0.48***). However, the distribution of the lines along regression line, demonstrated the possibility to select the new lines with the same level of winter hardiness like winter parents but with high level of yield than those.

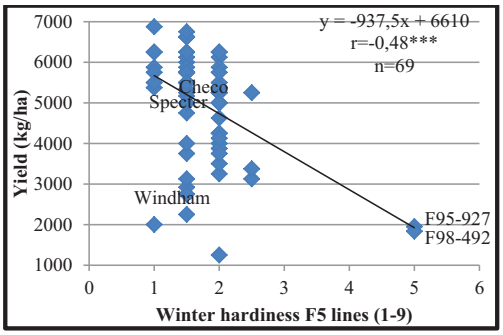

Figure 3. Correlation between winter hardiness and yield of F5 lines winter peas

Also, data from the Figure 4 indicated that is possible to select the perspective lines, with good yield potential but in the same time to recombine an acceptable earliness for Romanian climate conditions.

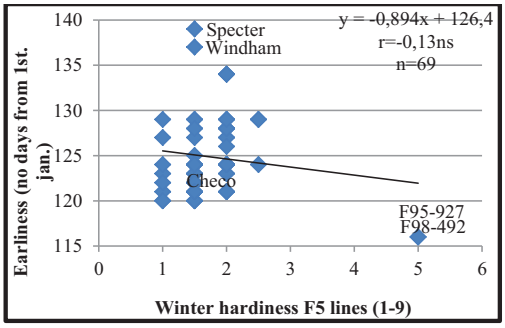

Figure 4. Correlation between winter hardiness and earliness of F5 lines winter peas

The data obtained till now form the study of relationship between winter hardiness and plant height, indicated the possibility of recombination of both traits -plant height and winter hardiness (Figure 5), suggesting that, in function of the end use the production, for forage need to be a tall variety with high biomass production or mid tall variety for grain type.

The date obtained between correlation between plant height and earliness to the F5 lines, shown a separation of the material în two

category, earlier lines with 50-100 cm plant height and later lines with 150-200 cm plant height (Figure 6).

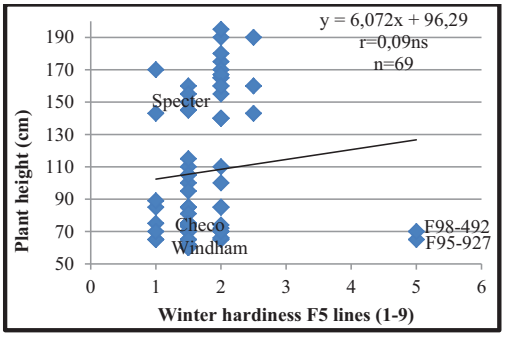

Figure 5. Correlation between winter hardiness and plant height of F5 winter peas lines

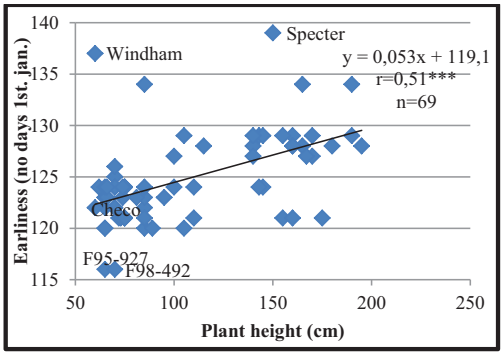

Figure 6. Correlation between plant height and earliness of F5 winter peas lines

The relationship between yield and earliness is negative (r= -0,23*), however ther are several which recombine the earliness with with high level of yield, that is important in the breeding winter peas program to select ssuch type of varieties (Figure 7).

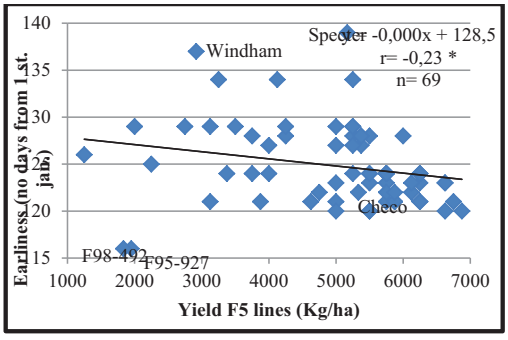

Figure 7. Correlation between yield and earliness of F5 lines winter peas

CONCLUSIONS

The data obtained in these studies, on the F3, F4 and F5 random lines from four hybrid combinations *(Specter/F95-927; F98492/Windham; F95-927/CHECO; Specter/CHECO)* shown existance the important lines of winter peas which posedhigh yield, good level of winter hardiness, plant height and earliness. In this study were remarked winter peas lines F5 with good level of winter hardiness, with high yield (6000-7000 kg/ha), earliness and with the plant height between 125-135 cm, this trait is very important for varieties of winter peas because can utilized both as pure crops and for cereal grain mixtures (high biomass).

REFERENCES

Ball M.C., Harris-Pascal D., Egerton J.J.G., Lenne T., 2012. The paradoxical increase in freezing injury in a warming climate: frost as a driver of change in cold limate vegetation. In: Storey KB, Tanino KK, 179-185.

Castel T., Lecomte C., Richard Y., Lejeune-Henaut I. and Larmure A., 2017. Frost stress evolution and winter pea ideotype in the context of climate warming at a regional scale. OCL, Vol. 24 (1):106-117.

Grimaud F., Renaut J., Dumont E., Sergeant K., Lucau-Danila A., Blervacq A.-S., Sellier H., Bahrman N., Lejeune-Hénaut I., Delbreil B., Goulas E. 2013. Exploring chloroplastic changes related to chilling and freezing tolerance during cold acclimation of pea (*Pisum sativum* L.). Journal of proteomisc, 80: 145-159.

Pagter M., Arora R., 2013. Winter survival and deacclimation of perennials under warming climate: physiological perspectives. Physiol Plant, 147: 75–87.

Rammig A., Jonsson A.M., Hickler T., Smith B., Barring L., Sykes M., 2010. Impacts of changing frost regimes on Swedish forests: incorporating cold hardiness in a regional ecosystem model. Ecol Model, 221: 303–313.

Weldendrop G., Hill M.J., Doran R., Ball M.C., 2008. Frost in a future climate: modelling interactive effects of warmer temperatures and rising atmospheric (CO2) on the incidence and severity of frost damange in a temperate evergreen (*Eucalyptus pauciflora*). Glob Change Biol, 14:294-308.