SUMMARY

Of the doctoral thesis entitled:

RESEARCH ON SELECTION OF SEVERAL MAIZE HYBRIDS DEVELOPED BY THE NARDI FUNDULEA FOR THE PRODUCTIVITY AND ADAPTABILITY TO DIFFERENT ENVIRONMENTS IN ROMAN

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Maize (Zea mays L.) is a very generous crop plant by its high randaments and the great variety of uses, in animal and human nutrition and as a raw material for industrial processing. It is cultivated worldwide on large areas, including in Romania.

The climatic factors in Romania show a great variability both during the maize growing season but also from one year to another, influencing maize crops during the entire growing period. Thus, the weather conditions unfavorable to corn crop affects the achievement of high and stable yields.

An important way to the increase the yield and its stability is the adaptation of hybrids to the variations in environmental conditions by the *good practices* in *natural resource* management and the reduction of damage caused by abiotic and biotic stress factors.

The main objectives of breeding programs are increasing the yield potential and yield stability.

The yield is a complex attribute, thus for its fulfillment the entire genetic system of the plant acts in relationship with the environmental conditions, during the entire growth period.

Yield stability is achieved by genetic dynamic equlibrium and tolerance to biotic factors (different diseases and caracteristcs pests) and abiotic factors (heat, drought, low temperatures).

In this PhD thesis, two sets of corn hybrids from two maturity groups (semi-early and semi-late hybrids) were analyzed, in field conditions with two levels of drought and also in laboratory conditions.

The maize germplasm tested and the methodology used led to the identification of variability, productivity, yield stability and finally the maize hybrids adaptability to various environments.

The aim of this PhD thesis was the selection of corn hybrids developed by NARDI Fundulea, for productivity and adaptability to various Romanian climatic conditions.

The researches for this PhD thesis were performed along 3 years, in 6 different pedoclimatic locations.

The objectives pursued in the research were the following:

- selection of corn hybrids for productivity and adaptability by multiannual and multilocational experimentation under different water stress conditions;

- selection of corn hybrids for tolerance to unfavorable temperatures (drought, heat, low temperatures during germination) under laboratory conditions;

- selection of corn hybrids for tolerance to biotic stress (to fusarium attack on cobs and corn borer larvae under artificial infections or infestations).

The research carried out in this thesis has an innovative feature through the multi-year and multi-locational testing of different maize genotypes, for their productivity and adaptability to the representative cultivation areas in Romania, completed with laboratory tests for tolerance to unfavorable temperatures and field testing for tolerance to principal and agresive diseases and pests under artificial infections or infestations

This thesis is organized in two parts and four chapters:

- The first part, Bibliographic study, contains the first chapter named "The current state of research on the maize hybrids selection for productivity and adaptability".

- The second part, “Personal research”, contains: “The purpose and objectives of the research”; Chapter II. entitled “ Experimental conditions” Material and research methods used for selection of some maize hybrids developed by NARDI Fundulea, in terms of productivity and adaptability to different climatic zones in Romania"; Chapter III entitled "Research results"; Chapter IV entitled "General conclusions and recommendations".

Chapter I: "The acctual state of research on the maize hybrids selection for productivity and adaptability" presents information on the economic significance of corn, trends regarding the harvest area of this crop and maize yield and also the results of international and national research concerning of the productivity and adaptability of maize hybrids. This first chapter was written after a specific bibliographic review, consisting of books and specialized scientific works, published in national and international journals.

Chapter II: "Experimental conditions, material and research methods used for the maize hybrids selection developed by NARDI Fundulea, regarding its productivity and adaptability to different climatic zones in Romania" presents the

natural setting of the field experinces, the weather conditions along the three years of experimentation period, the biological material used, the conduction method of the field experiments, and the research methods which were used for the hybrids selection.

The research was performed during the years 2020, 2021 and 2022, in six different pedoclimatic zones of the country: NARDI Fundulea, ARDS Brăila, ARDS Lovrin ARDS Șimnic, ARDS Valu lui Traian, and ARDS Livada.

Climatic conditions were described by years and locations, and climate diagrams were drawn up based on mean monthly temperatures and the total of monthly precipitation. Thus, the periods of drought that occurred during the corn growing season, their duration (horizontally) and their intensity (vertically) were reported.

The biological material used in the experiments consisted of 34 maize hybrids, developed by NARDI Fundulea, belonging to the groups FAO 301-400 (17 semi-early hybrids) and FAO 401-500 (17 semi-late hybrids). The hybrids were developed by dialel hybridizations, in the second and third year of testing. The control hybrids used in the experiments to compare the results were : Oituz and Iezer hybrids, both developed by NARDI Fundulea. Data and observations were collected during the growth period of corn.

Under field conditions, the experiments were performed by the Randomized Complete Block Design method in 3 replications, in plots of 4 rows with a length of 4.8 m and 0.7 m distance between rows , the total area of the plot being of 13.44 m^2. To reduce competition between hybrids, the 2 central rows were harvested. The harvestable area of the plot was 6.72 m^2. The plant population in the 6 experimental locations was 65,000 plants/ha for semi-early hybrids and 60,000 plants/ha for semi-late hybrids.

The assessment for tolerance to water deficit stress and heat was achieved indirectly by studying the behavior of corn hybrids to droughtly and heat in the laboratory in the early phases of plant development, by using physiological methods of inducing drought and heat, using polyethylene glycol (PEG) solution.

The assessment for tolerance to cold temperatures was performed by the Coldtest 6ºC method followed by early sowing in the field at 4°C. Experimental field were sown in 2020, in two rows of lenght 5 m, in 3 replications, designed by the method of completely randomized blocks. The biological material used in the laboratory consisted of the experimental hybrids seeds. The analyzes were performed in three replication.

The hybrids behavior to the attack of the pathogen *Fusarium* spp. on cobs and the larvae of *Ostrinia nubilalis* was only experienced by NARDI Fundulea, The hybrids were sown in a row of 10 plants each, in three replications.

Chapter III: Research results: includes all the results achieved in field and laboratory experiments with the aim of selecting hybrids for productivity and

adaptability to different environments. The selection of hybrids on adaptability to different environments was carried out according to:

- the average yield (t/ha) obtained in the 6 locations during the 3 years of trial:
- the index of adaptability and yield stability, (DRIND) proposed by Mandache in 2013 (high value);
- the drought susceptibility index proposed by Fischer and Mauer in 1978 (subunit value);
- regression analyses of the production of each hybrid in the 18 environmental conditions by calculating the value of the regression constant -intercept "a" and the slope of the regression-slope "b", according to the proposal of Brukner and Frohberg in 1987 (b<1, a = positive values - hybrids well adapted to unfavorable environments b>1, a = small, negative values- hybrids well adapted to favorable/optimal environments);
- coefficients of variation (small values = stable hybrids);

During the 3 years of experimentation, in the 18 experimental conditions, the hybrids HSF 1191-14 (8.87 t/ha), HSF 4687-16 (8.84 t/ha), HSF 4075- 17 (8.68 t/ha) and HSF 7395-18 (8.64 t/ha) belonging of the group of semi-early hybrids, recorded higher yield than the mean experience (8.40 t/ha). According to DRIND index, the hybrids HSF 4687-16(13.74), HSF 1191-14 (13.47), HSF 4075-17(13.25) and HSF 3656-16 (13.17) were highlighted and by ISS the most drought tolerant hybrids are HSF 4687-16 (0.83), HSF 3656-16 (0.86) HSF 4075-17 (0.91) and HSF 1191-14 (0.92).

According to the yield regression analysis, the most adapted hybrids are HSF 4687-16, HSF 4075-17 and HSF 3656-16 while according to the coefficient of variation the most stable hybrids are HSF 4075-17 (2.93), HSF 4687-16 (3.84) and HSF 7395-18 (4.21).

The hybrids Felix (9.23 t/ha) and F423 (8.83 t/ha) from the group of semi-late hybrids, recorded higher yield than the mean yield experience (8.03 t/ha). According to DRIND, the hybrids Felix (12.63), F423 (11.85) and HSF 5373-17 (11.53) were highlighted, and according to ISS the most drought-tolerant hybrids are HSF 7413-18 (0.84), HSF 4101-17 (0.86), Felix (0.96) . According to the yield regression analysis, the most adapted hybrids are HSF 7151-18, HSF 4101-17 and Iezer and according to the coefficient of variation the most stable hybrids are HSF 7151-18, (0.36), Iezer (3.00) and HSF 1133-17 (3.65).

For the hybrids characterization and selection, it was necessary to use some physiological indices which are in relationships/or involved with the performances of hybrids realized in the field both for drought and for heat, which is difficult to quantify in the field.

The synthetic drought tolerance/resistance index was calculated as the unweighted average of the normalized values of seven specific drought tolerance/resistance indices, namely: stem and root lengths, leaf area, stem and root dry matter, chlorophyll content and root volume.

The synthetic heat tolerance/resistance index was calculated/determined as the unweighted average of the normalized values of six specific heat tolerance/resistance indices, namely: stem and root lengths, leaf area, stem and root dry matter, and chlorophyll content.

These indices measure the hybrid behavior in the presence of stress and no stress conditions, the low values indicating high tolerance of the analyzed hybrid to drought, respectively heat,

In the semi-early hybrids, the low-value synthetic drought tolerance indices range from -1.892 (HSF 3425-16) to -1.114 (HSF 3656-16) and in the semi-late hybrids from -1.728 (Felix) and -1.109 (HSF 7417 -18).

In regards to synthetic low heat tolerance index, it ranges from -2.326 (HSF 4687-16) to -1.004 (HSF 1214-17) in semi-early hybrids and from -2.326 (Felix) to -0.923 (HSF 1108-17) for semi-late hybrids.

- The selection of corn hybrids studied for tolerance to low positive temperatures during germination was performed by the laboratory method, Coldtest 6ºC and by early sowing in the field conditions(4°C).

In the semi-early group, the hybrids HSF 3407-16, HSF 1128-14, HSF 3425-16, HSF 4687-16, HSF 1034-17 and HSF 1191-14 displayed the superior values of germination at 6°C, between 91- 96%.

In the semi-late group, the hybrids Felix, HSF 7413-18, HSF 7145-18, HSF 5373-17 and HSF 2837-17 displayed the highest values of germination ability at 6°C, between 92-97%.

- For the selecting maize hybrids to the *Fusarium* spp. attack tolerance was realized, based on the weighted average score of the cob attack. According to this, the hybrids were clasiffied into tolerance classes based on the rating scale (rate 1-2.9: very sensitive hybrids, rate 3-4.9: sensitive, rate 5-6.9: medium tolerant and rate 7-9: tolerant hybrids).

In the semi-early hybrids, level of the disease of the cob expressed by attack degree (weighted average of the attack degree) had values between 2.3 (HSF 1128-14) and 7.9 (HSF1033-17) in 2020, between 5, 3 (HSF 3407-16) and 7.3 (HSF 1033-17) in 2021 and between 6.7 (HSF 1214-17) and 8.9 (HSF 3877-17) in 2022.

In semi-late hybrids, the level of cobs attack , expressed by the weighted average of the attack rates, had values between 2.3 (HSF 5373-17) and 6.2 (Felix) in 2020, between 5.3 (HSF 7151- 18) and 7.2 (F423) in 2021 and between 6.0 (Iezer) and 8.8 (HSF 2837-17) in 2022.

- The selection of studied maize hybrids for tolerance to *Ostrinia nubilalis* attack was realized on the basis of the average tunnels length /plant, induced by larvae into maize stalk.

From the group of semi-early hybrids, experimented during 2020-2022, the following hybrids stood out: HSF 1191-14 (4.2, 5.8, 0.7 cm tunnels/plant) and HSF

1034-17 (3.4, 5 .5, 1.1 cm. tunnels/plant) that proved tolerant to the *O.nubilalis* larvae attack.

From the group of semi-late hybrids, tested during 2020-2022, the following hybrids stood out: HSF 5373-17 (4.6, 11.3, 0.5 cm tunnels /plant), Felix (7.6, 10.5, 1.1 cm tunnels /plant), F423(8.8, 6.6,1.2 cm tunnels /plant), and HSF4101-17(8.6, 11, 1.1 cm tunnels /plant) which proved tolerant/medium tolerant to the *O. nubilalis* larvae attack.

Chapter IV: General conclusions and recommendations, includes:

- conclusions on the characterization and selection of maize hybrids from the two maturity groups for adaptability/stability to different environments, using the average yields achieved on two stress levels (optimal conditions and water stress conditions);

- conclusions regards selection of maize hybrids for tolerances to unfavorable temperatures and to the attack of the pathogen *Fusarium* spp. and the pest *Ostrinia nubilalis* .

-recommendations for the breeding of maize germoplasm regards the productivity and adaptability to different environments and climatic factors which present a great variability.