Chapter 5

Preliminary Results Regarding the Use of Interspecific Hybridization of Sunflower with *Helianthus argophyllus* for Obtaining New Hybrids with Drought Tolerance, Adapted to Organic Farming

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Additional information is available at the end of the chapter

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Abstract

Taking into account the climatic changes expected in the future, significant shrinking of the current favourable ecological zones for sunflower is anticipated, and the transition period to that situation may be very short. The classical breeding process has a relatively long duration (7-9 years), so breeders are interested in taking advantage of some biotechnological methods (*embryo rescue*) for obtaining new sunflower lines with increasing tolerance to a certain stress factor.

Improving drought tolerance of sunflower cultivars is a priority for a breeding program of the National Agricultural Research and Development Fundulea (NARDI-Fundulea) because it provides stable productions under a changing climate condition already seen in the past twenty years.

In the period between 2008 and 2014 at NARDI-Fundulea, a research project was started to obtain new genotypes of sunflower with improved resistance to drought and heat through interspecific hybridization between *H. annuus* and H. *argophyllus* and that are suitable for application in organic culture. This research project received funding from the World Bank through a MAKIS project.

Keywords: Embryo rescue, interspecific hybridization, *H. argophyllus*, *H. annuus*, NARDI Fundulea, organic farming, drought

1. Introduction

In Romania, Vrânceanu (2000) [1] was able to obtain interspecific progenies *(H. annuus x H. argophyllus)* with drought resistance.

Interspecific hybridization is an additional technique to create new sources of genetic variability for the improvement of sunflower (Christov, 2013) [2]. With all the difficulties that may arise due to differences in the number of chromosomes (2x, 4x, 6x) and crossing incompatibility, interspecific hybridization is considered as an accessible way to incorporate wild germplasm into cultivated sunflower, especially to increase the resistance to abiotic stress factors (Iouraş and Voinescu, 1984) [3].

At the beginning of the project, 27 *H. annuus* parental lines were crossed with *H. argophyllus*, and two generations of interspecific hybrids/year were obtained in the greenhouse and house vegetation of NARDI-Fundulea in the first 2 years after the start of the project.

From each line hybrid obtained in 2008-2009 (Saucă et al., 2010) [4], six plants were selected, and their seeds underwent parallel backcross, self-pollination, and selection procedure.

As a result of this process, seven lines with significantly improved resistance to drought and heat (tested in field and laboratory) and that are suitable for organic farming system were selected in backcross 7. In 2015, these seven uniform lines with high production potential, oil content of over 43%, and resistance to broomrape and *Sclerotinia sclerotiorum* will be used to create commercial hybrids for ecological culture.

2. Background of organic farming

2.1. Definitions

The Ministry of Agriculture of Romania considered organic farming (similar to organic farming or biological agriculture), which differs fundamentally from conventional agriculture, as a "modern" process to cultivate plants, to fatten animals, and to produce food (www.mapam.ro) [5].

The Commission for Codex Alimentarius defines organic agriculture as "a production management system that promotes and maintains healthy development of agro-ecosystems, including biodiversity, biological cycles, and soil biological activity."

As science, organic farming deals with the systematic study of materials (living organisms and their environment) and functions (intra- and inter-relations material structures) of the agricultural systems, with design and management agro-ecosystems capable of providing for lengthy human needs for food, clothing, and housing, without reducing the potential environmental, economic, and social impact.

As occupation, organic farming is the activity that integrates theoretical knowledge about nature and agriculture in sustainable technological systems, based on the material, energy, and information resources of the agricultural systems (Toncea, 2000) [6].

To achieve this, organic farming relies on a number of objectives and principles, as well as on best practices designed to minimize human impact on the environment, while ensuring that the agricultural system operates as naturally as possible.

2.2. Principles underlying organic farming

Under the agreement in the integration of our country into the European Union, one of the measures imposed, inter alia, is the implementation of organic farming system. Apparently, this was something new, but some restrictions were easier to accept, for example, the interdiction for the use of chemical inputs that were not applied anyway on large surfaces in many agricultural areas due to economic considerations. However, a cause of concern is the lack of market demand for certified organic products and the low purchasing power of consumers. The price of an organic product is higher than its counterpart produced in the conventional system.

The normative acts operating in food production are particularly following the change in state of the art that occurred in agronomy. They do not refer solely on primary agricultural production sector, but also take into account the whole food chain, from primary production to final consumer. The agrifood complex is characterized by:

- Increasing the responsibility of those who practice this type of activity;
- Raising awareness and ability to reach market leadership.

Farms and organic agro companies are generally small- or medium-sized. Worldwide, most organic farms occupy small areas (0.5-30 ha), cultivate, and/or grow a small number of one, two, or three species of plants and animals and process one, two, or three different agricultural products.

Organic farming methods used in obtaining the unprocessed primary plant products, animals, and unprocessed animal products; animal and vegetable products processed for human consumption prepared from one or more ingredients of plant and/or animal origin; and compound feed and raw materials must meet the following conditions:

- Compliance with the principles of organic production;
- Non-use of fertilizers and soil improvers, substances used in animal nutrition, pesticides, food additives, growth promoters, cleaning and disinfecting products for livestock buildings, and products other than those permitted to be used in organic farming.

Developing of crop cultivation technologies targeted for alternative agriculture, especially for organic farming agriculture may improve the performance socio-economic indicators for these activities. This requires proper management of all the factors that contribute to high and stable yields per unit area, compliance with specific regulations and finally the recognition of finished products, in this case, an organic production certification.

2.3. Specific organic farming practices include

- Crop rotation as a prerequisite for the efficient use of farm resources;
- Very strict limits on chemical synthetic pesticides and chemical fertilizers, antibiotics for animals, food additives, and other substances used for additional processing of agricultural products;
- Not using of genetically modified organisms;
- Utilization of existing resources on site, such as using manure as fertilizer from animals and feed produced from the farm;
- Choice of species of plants and animals resistant to diseases and pests, adapted to local conditions;
- Livestock in freedom and open shelters and feeding them with organic feed;
- Using animal husbandry practices tailored to each race individually.

2.4. The objectives of organic farming

- Avoid all forms of pollution, both in products and in the environment;
- Maintain the natural fertility of soils, thereby ensuring food security in a sustainable planet;
- Allow farmers to have a decent life;
- To produce in sufficient quantities and at an appropriate quality level, thus ensuring the health of food consumers.

2.5. National and international legislations

The provisions on labeling of products from organic farming stipulated in Regulation (EC) no. 834/2007 on organic production and on labeling of organic products stated in Regulation (EC) no. 889/2008 that provide detailed rules for implementing Regulation (EC) no. 834/2007 are very precise and aim to offer consumers full confidence that products carrying the organic product label or the Community logo are obtained in accordance with the rules and principles contained in these regulations or, in the case of imports, are under the equivalent system with less demanding requirements.

To obtain and market labeled organic products and carrying specific organic production Community logo, producers must complete and strictly follow a rigorous process.

Thus, before you can obtain agricultural products that can be marketed as products of organic farming, the products must first undergo a conversion period of at least two years.

During the entire chain of production of an organic product, operators must constantly observe the rules established by Regulation (EEC) no. 834/2007.

In Romania, control and certification of organic products are currently provided by private inspection and certification bodies. They are approved by the Ministry of Agriculture and

Rural Development (MARD), based on the criteria of independence, impartiality, and competence as established in Order no. 688/2007 regarding the “Rules for organization of the inspection and certification system and approval of the certification and inspection bodies”.

MARD’s approval of control bodies requires a previous mandatory accreditation in accordance with European standard EN ISO 45011: 1998, which was issued by an agency authorized for this purpose. Following the inspections performed by regulatory bodies, certain products of operators complying with the rules of organic production may receive organic product certificate, and these products are permitted to be marked as “eco-labeled products".

Before the application of the label to an organic product, the following requirements must be fulfilled: the reference to organic production logo, name and code of the inspection and certification body that carried out the inspection and issued the organic product certification. The “ae" logo specific for national organic products, together with the Community logo, can be used for better views of consumer products from organic production.

The right to use the “ae" logo on product labels and packaging of organic products is given to producers, processors, and importers registered with MARD and holding a contract with a control body approved by MARD.

As part of the campaign to promote organic agriculture in the European Union (EU) at the initiative of the Directorate General for Agriculture and Rural Development of the European Commission, a website dedicated to this purpose was created: www.ec.europa.eu/agriculture/organic/home.ro.

The main objective of this site is to inform the general public about organic farming system as a starting point in the realization of promotional campaigns in different Member States.

Additionally, in order to promote the organic products, the European Commission provides support of up to 50% of information and promotion programs submitted by professional and inter-professional organisations, involving at least 20% of the actual cost of measures, and budget co-financing being provided by the State in accordance with Regulation (EC) no. 3/2008 on information and promotion actions for agricultural products on the internal market and in developing countries and Regulation (EC) no. 501/2008 that lays down detailed rules on implementing Regulation (EC) no. 3/2008 (information taken from the MARD website).

2.6. The national and international situations

If during the period 1950-1990 in Romania the objectives were to increase agricultural production to meet food requirements in view of the growing population, today the objectives are focused on finding new solutions that aim to respect the environment, create a system production that is economically viable, and maintenance and use of natural resources.

This new type of farming is called sustainable agriculture, and it involves a set of techniques and practices that should ensure a satisfactory production, ensuring food requirements are met and taking into account environmental protection.

After 1990, the gap recorded between quantitative indicators expressing the production potential and quality, caused by low endowment and equipment necessary to conduct the production process as well as related inputs, led to the development of technologies' extensive culture.

Another cause is the high fragmentation and dispersion of farms due to the implementation of the Land Law no. 18/1991. Currently, the farming land (14.8 million. Ha) is dispersed in about 40 million parcels. In 1972, the I.F.O.A.M. (International Federation of Organic Agriculture Movement) based in Germany was established. This federation groups more than 670 organizations and institutions from more than 100 countries worldwide.

The European Economic Community (EEC) recognized a majority vote of the European Parliament on 19 February 1986 on the existence of alternative agriculture based on resolutions adopted through Regulation 2092/91. A series of regulations were formulated, of which particularly important is Regulation EEC 1936/1995, which specified that from 1 January 2000, organic farming materials are the only ones to be used in sowing/planting.

According to I.F.O.A.M. statistics (February 2001), the world agricultural area intended for organic production was estimated to be 15.8 million hectares, with the largest area in Australia (7.6 million hectares), Argentina (3 million hectares), and Italy (1 million hectares).

In all EU countries, there is a real desire for developing OA, which will hold over 10% of the cultivated area. Agricultural area in the "bio" or "organic" agricultural systems in some countries is as follows: Italy - over 1.1 million ha, United Kingdom - 600,000 ha, France - 400,000 ha, Spain - 380,000 ha, and Austria - 250.000 ha. In the USA and Japan, about 20% of food is through organic production system.

In Romania, organically cultivated agricultural areas have seen a spectacular growth in the period 2010-2013, so at the end of 2013, about 301,148 ha were recorded by MARD.

Regarding the European organic food market, Germany has the biggest market, with sales of approximately 2.5 billion euro, and in terms of average consumption per capita of ecological products, Denmark and Switzerland are leading.

The markets for organic products are both the countries that depend on exports of organic products (Italy) and the countries that depend on imports of organic products (UK). Extremes of demand and supply in each country adjust by themselves. According to the study, the current situation appears to be changing because, in the UK, it is estimated that domestic production will meet the demand, while in Italy, the demand will increase. Today, increasingly more organic products are imported from Eastern Europe.

European Commission experts estimate that the market for organic products last year reached a value of 23 billion euro in the European Union. The organic market in the European Union is virtually all primary and processed agricultural produce (bread, wine, meat, milk, oil, fish, etc.). According to the study, organic products are generally 25-30% more expensive than conventional products, but depending on the supply and demand, the price could reach 400% of the price of the conventional ones.

Many local experts consider that countries in the Eastern Europe would need 10-15 years to be able to develop and structure the internal market at the level of the Western EU states. An

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argument invoked to support this assertion is the example of Spain, where it required about 17 years after integration to structure the internal market at the level of the other member states. Meanwhile, Spain exports almost all northern European market organic products. Eastern European countries will need to focus on organic production of the scanty products in the EU, including vegetable protein and red fruit, because Western countries have begun to significantly reduce production in sectors requiring a large labor force.

In Romania, the ecological production sectors benefit from European funding of about 200 million euro, which is available through a dedicated position in the new National Rural Development Programme (RDP) 2014-2020.

In addition, payments for OA, which are made by APIA, will continue. The registered farmers in organic agriculture will receive grants of 500 euro/hectare/year for growing vegetables, 620 euro/hectare/year for horticulture, 530 euro/hectare/year for vineyards, and 365 euro/hectare/year under organic cultivation of medicinal plants.

The experts appreciate that prices of organic products could be 10-20% higher than those of conventional ones if there are many farms and slaughterhouses certified. Romania currently has only 2-3 farms of laying hen organic certificates and some organic dairy farms, but instead the Romanian exports of organic wheat are significantly high, meanwhile part of this commodity is imported back as processed ecological products at prices 2-3 times higher than the conventional ones.

According to the MARD, the value of the domestic market of organic products in 2008 was about 20 million euro, while exports were at 100 million euro, which was twice the amount in 2006. Under an adjustment of Common Agricultural Policy (CAP) in 2009, Romania proposed that organic farming be financially supported by this package. Since this adjustment, CAP has created a financial reserve that allows the Member States to develop certain programs to fully support a particular context, technically called Article 68.

The financial envelope allocated to Romania for 2010 only amounted to EUR 5 million. The increase in the organic market in Romania continues; with only 86 registered organic food processors in 2008; in 2010, the number became 3,155; and in 2012, it was 15,194.

Exports of organic products in 2008 amounted to 100 million euros, which was equivalent to about 130,000 tons of products, of which only 1% were processed products and 0.94% were honey products. The primary export destinations were the Netherlands, Germany, Denmark, Italy, and the UK. Imports of organic products were worth 10.8 million euro, which was almost double the amount for 2007, with fruit and legume preserves, coffee, and sweets being the most significant products.

The turnover in organic agriculture worldwide was 46 billion dollars in 2007, up by 10% compared to 2006, while in Europe the figure reached a level of 15.4 billion euro, 15% more than in 2006.

The productive potential of agriculture ecological system of the country can reach up to 15-20% of the total agricultural areas largely concentrated in hilly mountain where technology maintenance and use of pastures were based on traditional methods - organic (manure application, utilization of grazing and/or mowing, use of fodder and clover ameliorating soil fertility, use of vegetable-livestock mixed system), but are not neglected arable land in the North-East.

At global level, two opposite trends are rising as an increasing concern:

a. **Overproduction** and negative side effects of industrial type of farming that include decreasing of soil fertility due to erosion, acidification, salinization, and exhaustion of the reserve of organic matter; reducing of biological and genetic diversity; increased risk of air pollution exhaust and ammonia, shallow and deep waters and soils with nitrates, and heavy metal contamination of food with toxic substances, etc.;

b. **Production for subsistence** and its negative consequences - hunger and social inequity.

These imperatives can be resolved only by organic farming, an agricultural practice in some countries that is called organic or biological farming, which sprang from the secular experience of agriculture.

Organic farming is not a miracle or a wonder, but a creation of nature-loving farmers, who aim for harmony and dynamic interactions among soil, plants, animals, and humans, or, in other words between supply natural ecosystems and human needs of food, clothing, and housing.

2.7. Practical aspects of OA

- The agro-ecological systems have long life due to components, structural and functional stability, and ability to cope with any disruptive or disturbing factor.
- Organic production is done on farms, individual households, family associations, agribusiness companies, and rarely in large agricultural associations and companies or holding. Organic products are obtained also in the aquatic environment, forest, and other natural systems.
- Generally, many agricultural and agro-ecological farms are in small- or medium-sized category. At world level, the average surfaces for organic farms are within 0.5 and 3.0 ha range, and most of them cultivate only 1-3 different agricultural species.
- All organic farms and agro-industrial societies undergo a longer or shorter conversion period, which is equal to the time between the start of ecological management and getting the certificate by the ecological farm or company.
- Certification is provided by a national or international organization that is recognized by the International Accreditation Service International Federation of Organic Agriculture Movements (IFOAM) and empowered to assess and guarantee in writing that its production or processing system is in compliance with the standards of organic agriculture.
- The transition from conventional to organic farming is done step by step, in order to protect the economy from the shocks of decreases in productivity, and to allow producers to gain confidence in the ecological systems. Certification of these business units is made as soon

as a part of their work meets the environmental standards and provided that the two systems (conventional and organic) are clearly separated both in documentation and in production.

- With very few exceptions, organic farms are mixed, plant-animal type, on the one hand, to capitalize on higher crop and, on the other hand, to reuse as much of the nutrients extracted from the soil by plants grown. In this case, the structures of animal species and categories are determined by the potential of the farm and vegetable farming area, as well as the economic and financial resources (buildings and plant breeding, money) and the manpower (number of people, age, training) available in the farm.

Exceptions to this rule are organic vegetable farms and processing and marketing firms for semi-organic products. In such cases, the bulk of production is for direct human consumption (vegetables, fruits, canned vegetables and meats, cheeses, vegetables, and animal extracts); processing of the products is done with minimum consumption of energy, and this energy is, as far as possible renewable, sourced from animal manure (biogas), wind, and local fluid (residues and organic waste).

- The activities of farms and agro-industrial companies are carried out according to international and national rules. Any deviation from these standards results in losses, including the loss of farm and the ecological society.

- In organic farms and processing companies, all species and varieties of domesticated plants and animals are grown and processed, except those created by genetic engineering.

- Farms and processing companies of organic product are using mostly own financial economics and social resources. Land, goods, and services of the agro-ecological units are mainly privately owned, and the funds are secured, for the most part, from its own resources. In countries with developed organic farming, a significant share of financial resources is provided by the state through a diversified mechanism of subsidies (exemption from taxes, production inputs, and additional expenses to conventional agriculture). The workforce consists of organic agro-industrial unit farmers or owners and close relatives.

- Some farms and agro-industrial companies undertake labor from outside, also, but only for a determined period of time when the workload exceeds the skill and strength of the permanent employees.

Regarding the problems of agro-ecological systems, Köpke (2005) argued that compared with intensive farming system, ecological system is characterized by:

- Reduced availability of nutrients, especially nitrogen and phosphorus, with consequences on the level of yields (because of the limited growth) and especially on their quality;

- The danger of a high level of weed and pest infestations due to absence of chemical treatments. Claude Aubert, one of the pioneers of organic farming, supports with scientific arguments that for organic farming "the genotype is more important than the whole technology".

2.8. Reference of knowledge on the topic addressed

The Intergovernmental Panel on Climate Change (IPCC), which brings together experts from around the world, published on 6 April 2007 in Brussels a new report on the impact of global warming on people and the earth. This report is a readjustment of the report in 2001 and is recognized by 192 UN member states. The crucial passage of the new report indicates that "a drastic change in climate is expected if carbon concentrations in the atmosphere will reach 550 ppm (parts per million), which would cause a rise in temperature of about 3 degree Celsius. The main consequences of global warming are increasing ocean levels and extreme weather events (heat waves, droughts, floods, strong winds) that will bring major impacts like disappearance of animal and plant species, increasing human health risk, and inevitable demographic changes. Crop yields fluctuate from year to year, and this is being significantly influenced by climate variability and extreme weather events. Climate variability impacts all sectors of the economy, but agriculture remains the most vulnerable.

In Romania, from about 14.7 million ha of agricultural land, of which 9.4 million ha is arable land (64% of arable land), 7 million ha of agricultural surface (48%) soils are affected in different degrees by frequent droughts in most of the years and more than 6 million ha of agricultural land are affected by excess moisture in wet years. The extent and intensity of extreme weather events decrease annual agricultural production by at least 30-50%, and sustainable conservation of natural resources in agriculture is necessary to ensure scientific validity of all actions and measures to prevent and mitigate the consequences. Drought is a natural phenomenon caused by insufficient rainfall for meeting the crop requirements. The impact of drought is influenced by the severity of drought, physiological status of crop (including the development stage and cultivar adaptation) and soil properties.

The most severe effects are manifested especially on the rural population dependent on farming. Global climate changes as manifested by the increasing average temperature and change in rainfall regime have led, in recent decades, to an increase in drought-affected areas worldwide. In Romania, the areas most vulnerable to extreme drought are the south-eastern and Dobrogea, Baragan and southern areas of Oltenia, Muntenia, and Moldavia.

The term "desertification" refers to reduction or destruction of the biological potential of land that can lead to problems similar conditions in desert areas. Desertification includes the interaction of large-scale global climate dynamics, reflecting the general circulation of the atmosphere and ocean and climate physics of the earth's surface. It can be a result of the interaction of natural recurrence of droughty years with practice of irrational exploitation of the land, deforestation, and intensive grazing. Climatic data from the past century show a gradual warming of the atmosphere and a significant reduction in rainfall as limiting factors for crop growth and productivity and utilization of water resources. These changes can have significant impacts on growth and development of crops during the growing season, depending on the intensity of the disruptive factor, the manner and duration of action, and plant species vulnerability to extreme weather events during production.

Globally, according to studies, a significant warming in the coming decades is expected as a result of increased CO_2 concentration in the atmosphere and significant changes in precipita-

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tion. The IPCC report (2001) estimated an increase in global average temperature from 1.4°C to 5.8°C by 2100, depending on the emission scenario, which is 2-10 times more pronounced compared to the current condition. The amount of rainfall will record a rise/fall trend of between 5% and 20% globally, with significant differences occurring especially at the regional level. It will also intensify the occurrence of extreme weather conditions (winter and summer extreme temperatures, droughts, floods, tornadoes, hurricanes, etc.) with major consequences on the entire planetary ecosystem.

In Romania, projections of global scenarios for the period 1991-2099 as compared to the period 1961-1990 revealed an increase in the average air temperature of about 2°C during winter and 3.5°C to 4.3°C during summer (3.5°C and 4.3°C in the north and south, respectively). With regard to precipitation the expected changes are insignificant during summer and winter will be recorded water deficits. The northwest country regions are expected to become slightly wetter meanwhile the southwest and central regions will become drier.

In the twentieth century, global warming shows an annual average temperature rise of 0.3°C in almost the entire country, with the increase in temperature being more pronounced in the southern and eastern areas. Significant warming was experienced during winter and summer seasons (with Bucharest-Filaret being the most pronounced, 1.9°C), and significant cooling was found during fall in the western regions of the country.

Regarding the distribution of precipitation within year, there was a downward trend in the annual quantities especially in the central regions, and during the winter season, a decreased precipitation was observed in most regions, being more pronounced in the south and west.

Effects of global warming further include the following changes in the occurrence of meteorological phenomena in hot or cold season of the year: increased frequency of tropical days, decrease in the frequency of winter days, increasing average maximum temperature during winter and summer (up to 2.0°C in the south and southeast), significantly decreased thickness of snow in the Northeast and West, and increased annual production of winter atmospheric phenomena (frost, ice, frost).

Today, global climate change is associated with increased pollution, deforestation or changes in the landscape that caused an amplification on the process of aridization. As a result, some high-risk areas for drought tend to be affected by aridity and even by desertification (disappearance of vegetation cover and soil degradation). In our country, the high-risk territories for drought, with a tendency to be affected by aridity and desertification, include large areas of Dobrogea and southern Romanian Plain. These areas may be classified as areas most vulnerable to excessive and prolonged drought.

In the next decades, the implications of global warming in the industrial economy, water supplies, agriculture, and biodiversity will be very obvious. Globally, therefore, it has the effect of warming and increased frequency and intensity of extreme events, especially droughts and floods. The causes that lead to these phenomena are evident about both climate and human interventions or wasteful use of land and water resources, inappropriate agricultural practices, deforestation, overgrazing, and air and soil pollution.

During extreme droughts, the current agricultural practices recommended are: fixing assortment of varieties and hybrids at the beginning of each crop year and the use of appropriate technology depending on soil water reserves from sowing; cultivating a greater number of varieties/genotypes with different growing season for better use of the climate conditions, especially moisture regime. Significant yield losses can be prevented through observance of recommended sowing period, irrigation or application of a minimum tillage system, utilization of varieties adapted phenologically to the new climatic conditions (in order to avoid the occurrence of critical phases as pollination and grain filling during the maximal stress periods) and better adapted physiologically to stress.

In the long term, the necessary measures for the prevention and mitigation of climate change include reforestation programs, reducing pollution, restoring and upgrading anti-erosion work, and expansion of the development and improvement of sandy soils, etc. At the same time, educating people and raising awareness on environmental protection are major requirements in developing adaptation strategies to climate change.

Solutions and recommendations for the development of actions and procedures to prevent and minimize the effects of climate variability in agriculture must include the already well-known whole complex of measures (agro-technical, cultural, irrigation, etc.) and carrying out swift action and intervention to limit the consequences and spatial extension of the affected area.

However, addressing issues related to climate change impacts requires specialized scientific data and analysis, risk management in agriculture mainly involving actions concerning the management and conservation of environmental resources, and making the right decisions in the right perspective.

In 1996, the National Commission on Climate Change/CNSC (HG 1275-1296) was established, and in July 2005, Romania's National Strategy on Climate Change (GD 645/2005) was approved. Also, with Law no. 111/1998, Romania joined the United Nations Convention to Combat Desertification (CCD); the Convention adopted in Paris on 17 June 1994 the declaration that 17 June be recognized as the Desertification and Drought Day worldwide. (SMART financial - www. SMARTfinancial.ro.[7])

3. Improving sunflower to biotic and abiotic stress factors

NARDI-Fundulea has obtained an invaluable genetic basis with over 50 years of research experience. NARDI-Fundulea is the basic institution in Romania that provides the necessary seeds and parental lines of traditional culture system.

The requirements for sourcing germplasm to improve sunflower hybrids are becoming bigger and more important. The greater diversity is conserved, the more chances to meet the present and the future. Loss of genetic diversity or genetic erosion may occur as a result of many interrelated causes, such as socio-economic and agricultural, natural disasters such as epidemics, long periods of drought and floods, and even human contribution.

The collection, evaluation, and preservation of wild species of sunflower were done carefully and were the basic objectives of the scientific cooperation of the FAO Network Research Sunflower Sun. From its foundation in 1975 until today and in Vrânceanu's (2000) study [1], the main objective of improving the sunflower hybrid is said to be further improving productivity by increasing seed production and seed oil content. After seed production and oil content, the major objective of improvement is: genetic resistance to disease *(Sclerotinia sclerotiorum, Phomopsis helianthi),* parasite *Orobanche sp*, drought, and heat; with less attractively for birds were obtained.

3.1. Material and methods

The genetic materials used were seven inbred lines of sunflower obtained at the NARDI-Fundulea and wild *H. argophyllus* known as resistant to drought.

Two locations were chosen for organic testing: Stupina (Constanta), known as pole drought in Romania, and Fundulea (Calarasi county).

The breeding methods used were: interspecific hybridization (first year of experimentation), embryoculture to save interspecific *embryo rescue* backcross, self-pollination, and selection. Two generations/year worked in the field and in the greenhouse, as illustrated below.

As we have a lot of data from all the years of experimentation, we will present only the results obtained in 2014, which was an extremely dry year in terms of ecological culture of the Stupina. Some of the results were published in international journals, while others are in print.

Regarding drought tolerance, we deduced the parameters of productivity (weight/head, TKW, and oil content), which will be presented for each new genotype obtained.

Each "slash" code (for example 1/1/1...n) inside graphs represents a descendent from an initial interspecific hybrid that further was subject of the general breeding scheme (individual selection, self-pollination, back cross and new selection scheme). The labels Stupina1-Stupina3 and Fundulea1-Fundulea3 represent the number of repetitions per location.

3.2. Results

From Figure 1, we can see great differences among some genotypes, even if they have the same lineage. In the same cross-breeding, it has been observed that every head is a distinct genetic entity. Therefore, the seed obtained from each phenotypically different head was seeded (three times/head) into one isolate plant/row.

Both lines (1/1/1 and 1/1/2) showed instability of seeds and head weights, both at Fundulea and at Stupina. For TKV, 1/1/1 in terms of Fundulea, showed some stability; the differences between the three plants are insignificant. For Stupina, although TKW values are reduced by approximately 50%, stable new lines show the three plants. In Figure 1, the same applies. Great unevenness and instability on seed production/head were observed. The fact that while seed production was low, except for plant Fundulea 1 (1/2/1), TKW recorded values were between 29 grams and 49 grams.

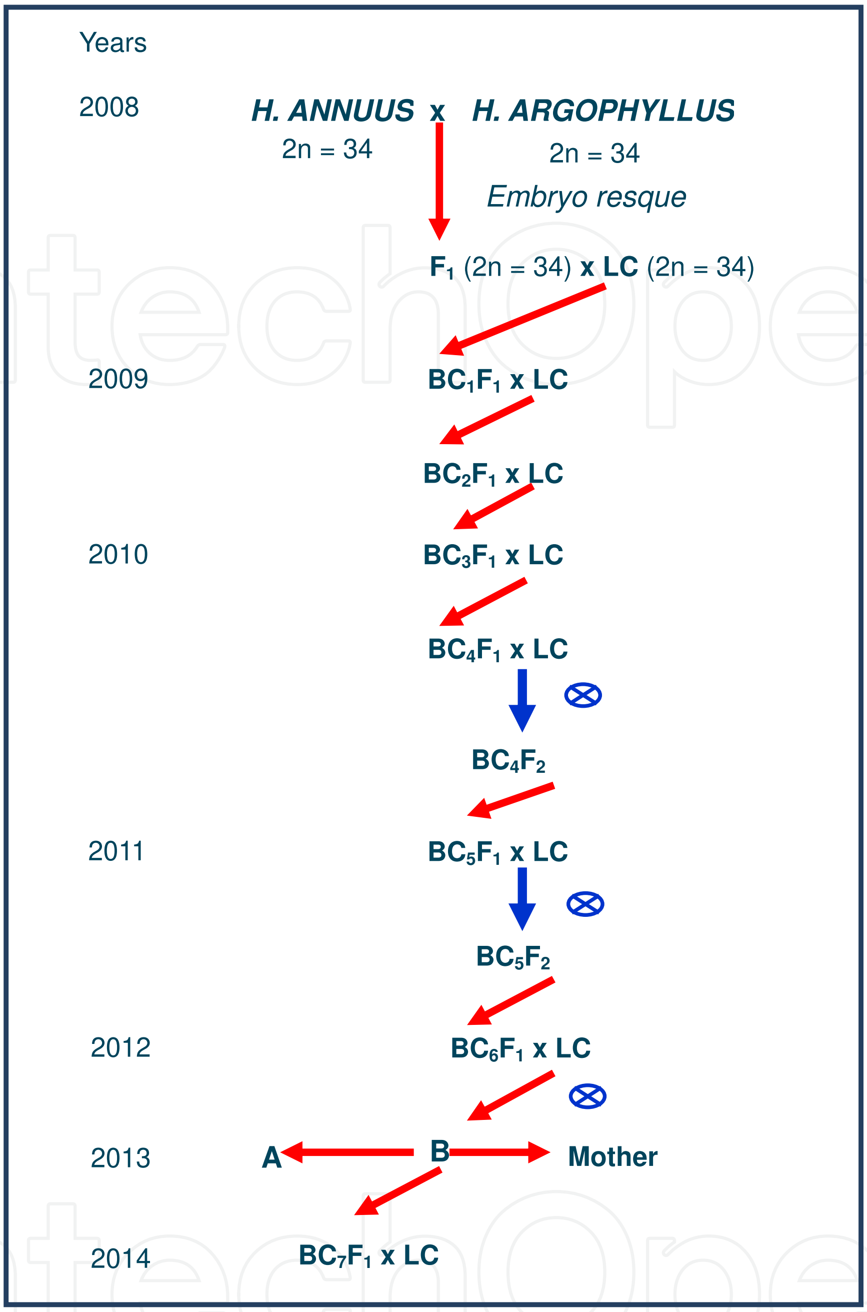

Figure 1. Sunflower breeding scheme

From Figure 4, one can see that the plant "Fundulea 3 (1/3/1)" progenies with a head weight of 70 grams at Fundulea and 38 grams at Stupina. The TKW for this genotype was the highest in both locations (49 grams).

Due to the very low values for both characters, in both locations, the genotypes 1/4/1 and 1/4/2 were not considered for the process of breeding for commercial hybrids (Figure 5).

In the extremely droughty conditions from Stupina, even the TKW and head weights were lower than in Fundulea they displayed a better uniformity.

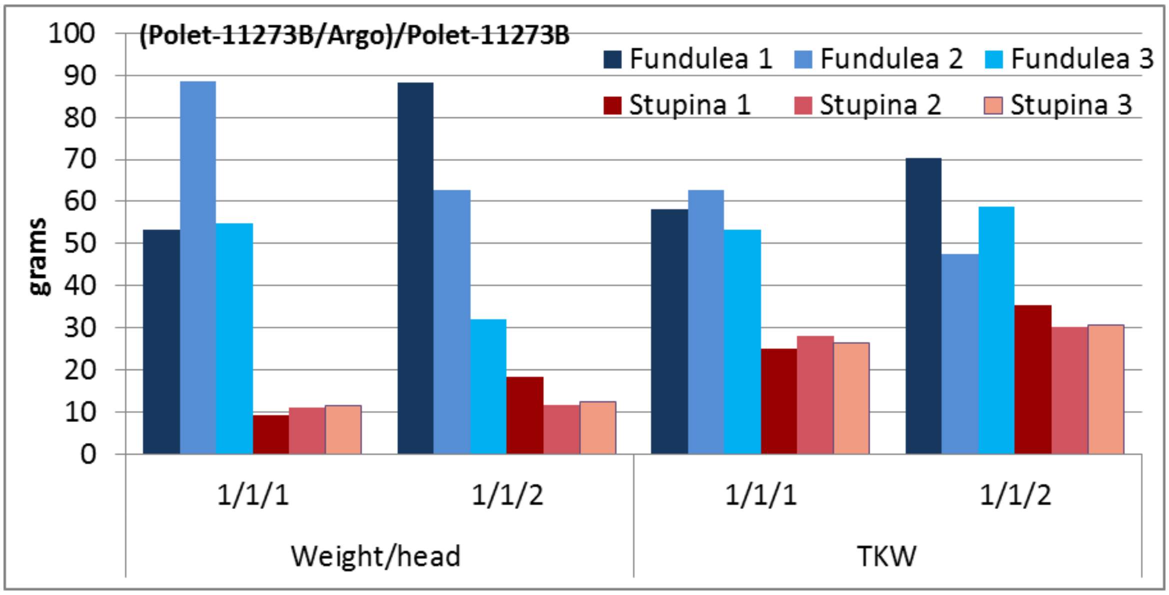

Figure 2. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 1/1/1 and 1/1/2 lines resulted from interspecific hybridisation Polet-11273B x *Helianthus argophyllus*

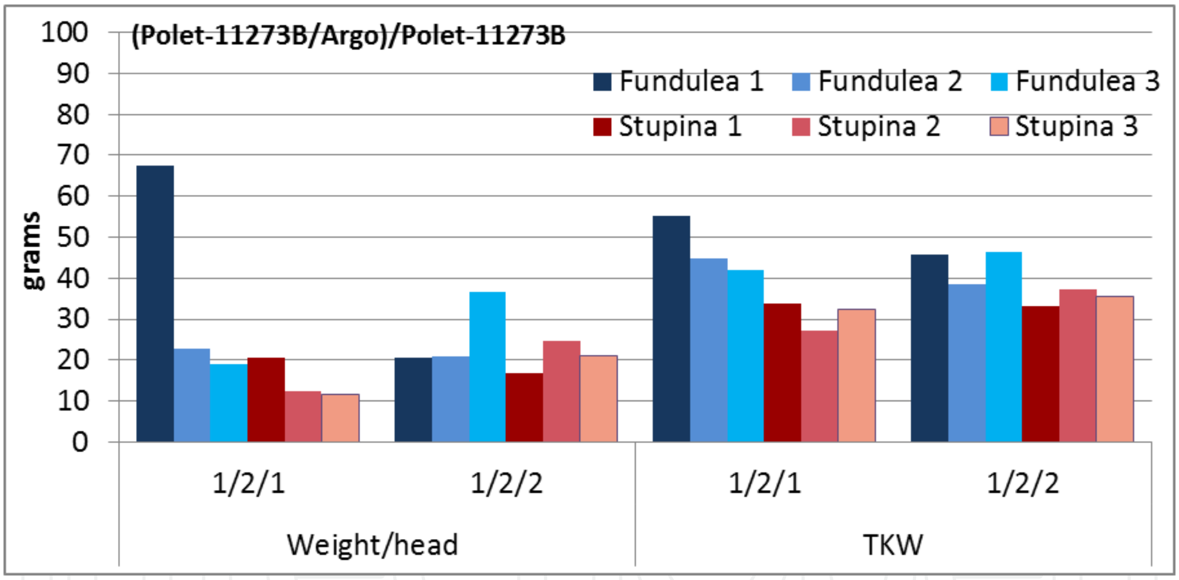

Figure 3. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 1/2/1 and 1/2/2 lines resulted from interspecific hybridisation Polet-11273B x *Helianthus argophyllus*

Due to the fact that the oil percentage is higher under heat and drought stress conditions, it is not surprising that all the genotypes obtained from hybridization of Polet-11273B x *Helianthus argophyllus* (Figure 6) have an oil content (estimated by NMR) greater than 40% at Stupina, significantly exceeding the oil content (determined with the same method) of the seeds obtained at Fundulea (29-33%)

From the hybridisation of line O-7493B with *Argophyllus*, 3 descendants with yield and oil content stability were selected: 3/1/1 (Figure 6); 3/2/1/ (Figure 7); and 3/4/2 (Figure 8). The seed

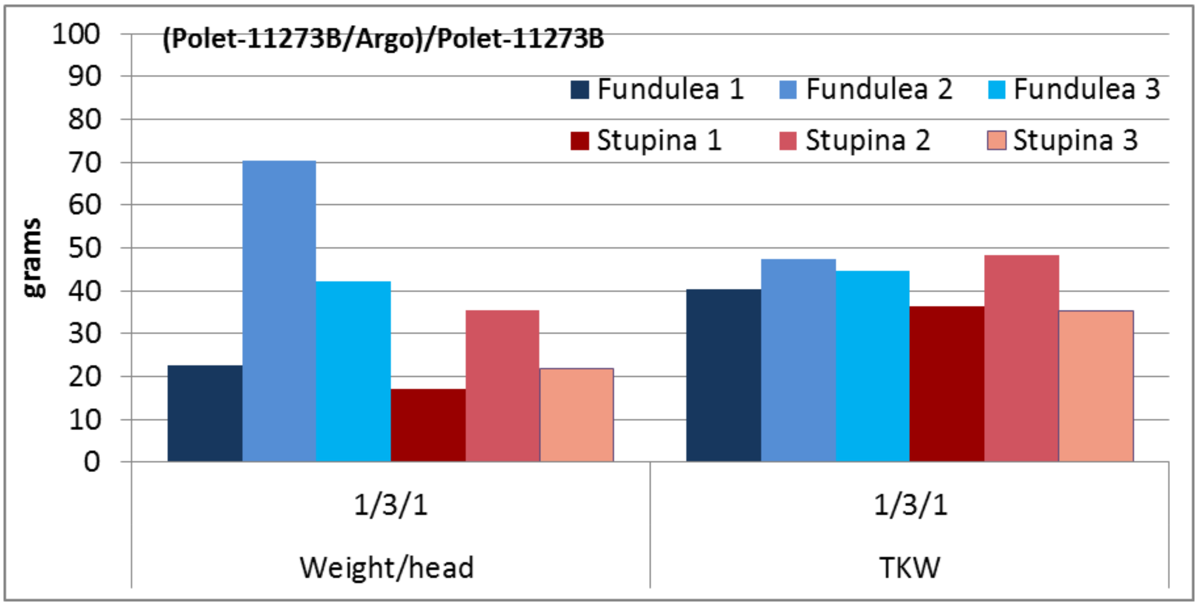

Figure 4. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 1/3/1 and 1/3/2 lines resulted from interspecific hybridisation Polet-11273B x *Helianthus argophyllus*

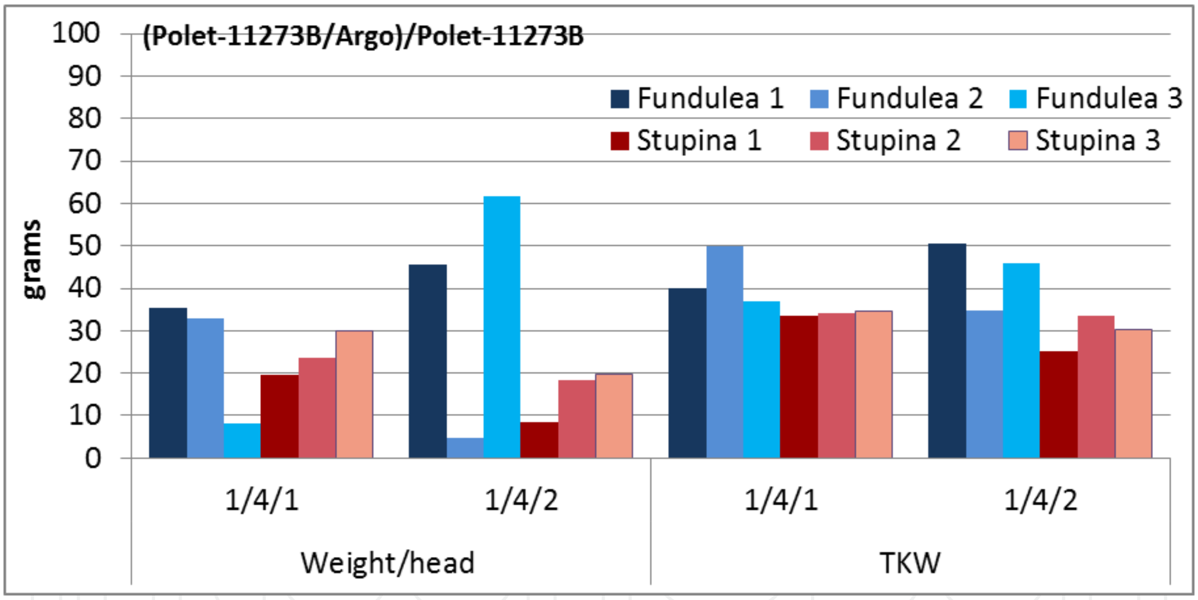

Figure 5. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 1/3/1 and 1/3/2 lines resulted from interspecific hybridisation Polet-11273B x *Helianthus argophyllus*

weight of heads of these descendants varied between 73 and 120 grams/head at Fundulea and between 25 grams and 60 grams at Stupina. The oil content varied between 32% and 40% at Fundulea and between 39% and 44% at Stupina (Figure 9).

After hybridizations, self-pollination, backcrossing, and selection of descendants of the hybrid Tard/85-19982B X *Helianthus argophyllus*, we obtained 11 new lines with a very large variability for the studied characters.

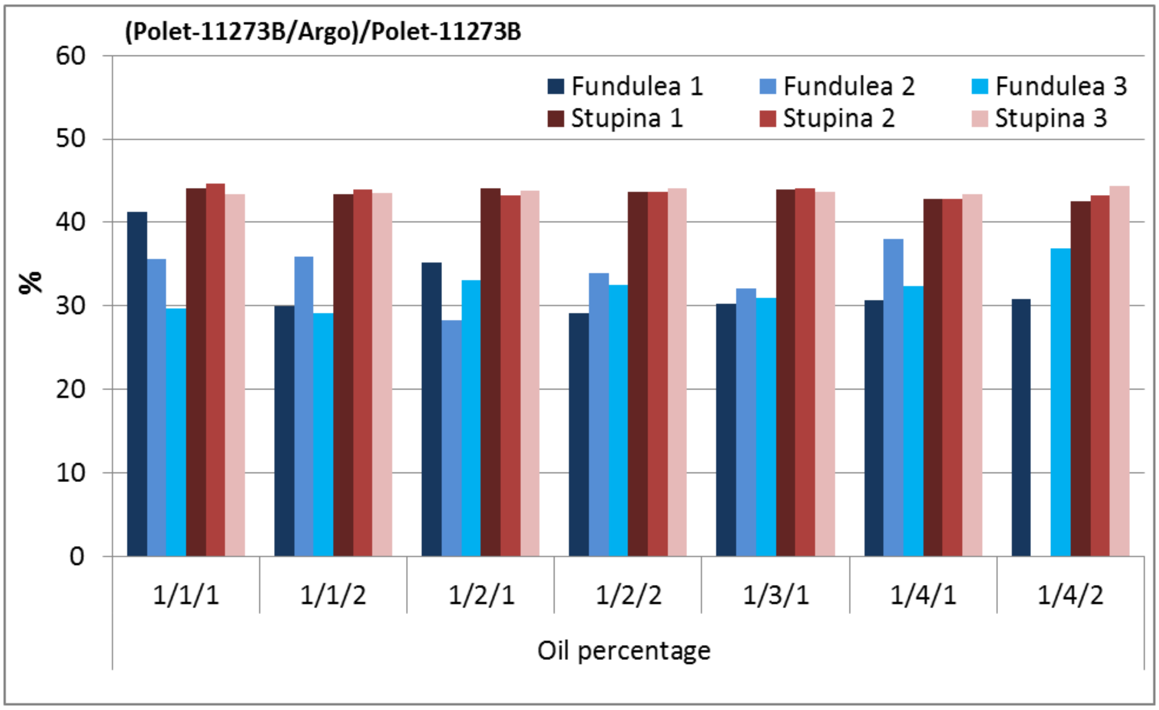

Figure 6. Oil content of the backcross 7th generation of sunflower lines obtained from interspecific hybridisation between Polet-11273B and *Helianthus argophyllus*

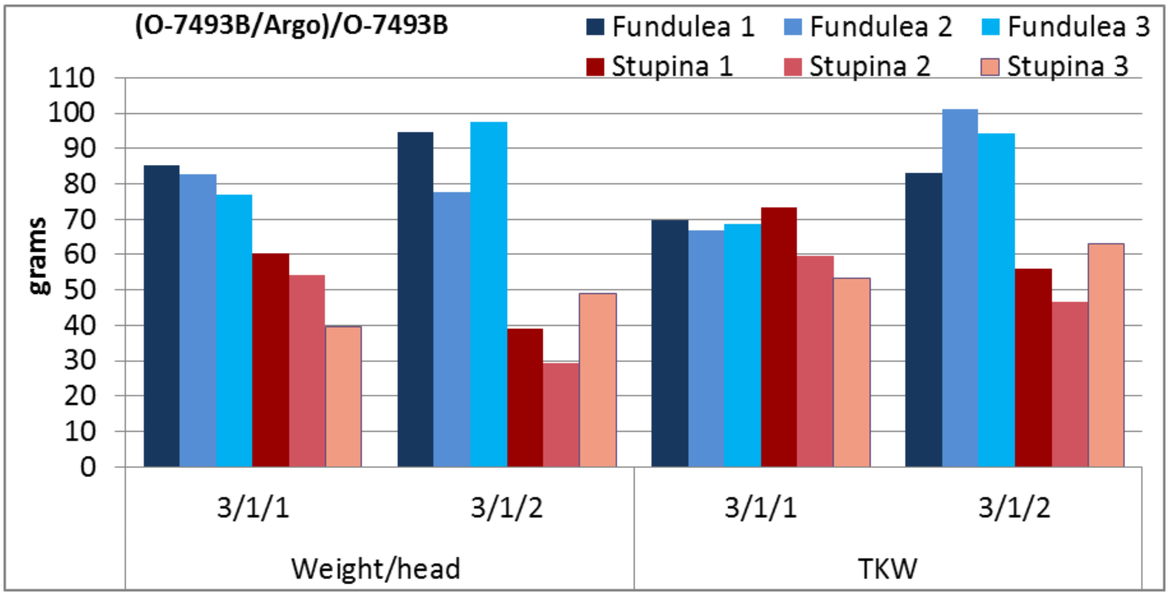

Figure 7. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 3/1/1 and 3/1/2 lines resulted from interspecific hybridisation between O-7493B and *Helianthus argophyllus*

Figure 11 shows that the weight of seeds/head in the case of line 11/1/1 was higher in the drought condition of Stupina. Therefore, the genotype "plant Stupina 2" achieved 72 g/head compared with "Fundulea 2" that produced only 40 g/head. Additionally, for the TKW character, this line proved to possess good adaptability to drought, reaching or exceeding the

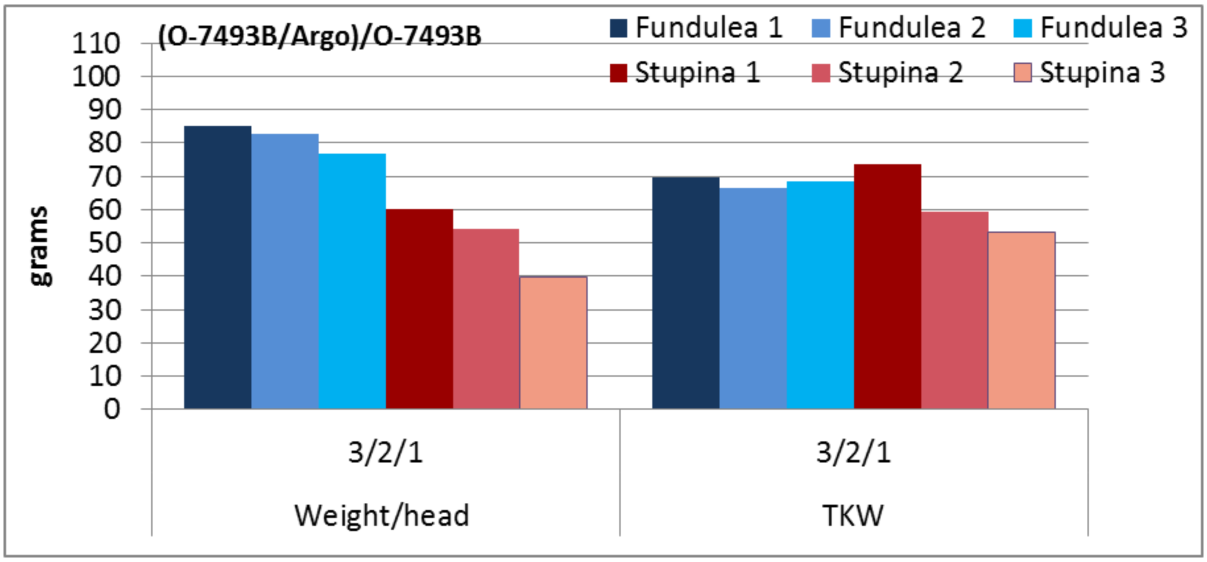

Figure 8. Average weight of head and TKW for the progenies of the progenies from backcross[th] generation of the 3/2/1 line resulted from interspecific hybridisation between O-7493B and *Helianthus argophyllus*

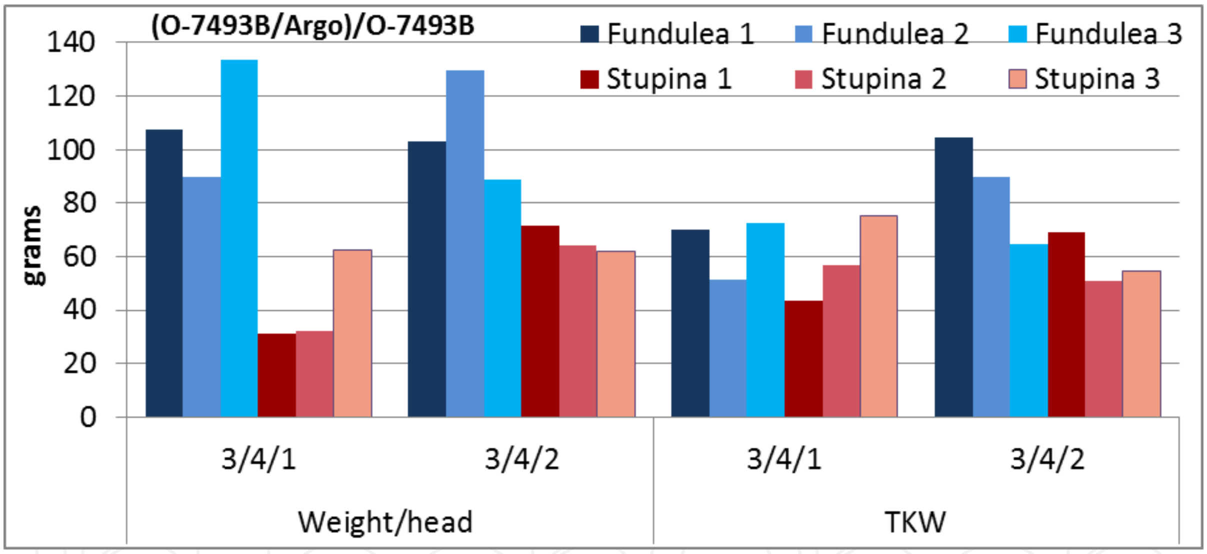

Figure 9. Average weight of head and TKW for the progenies of the progenies from backcross 7[th] generation of the 3/4/1 and 3/4/2 lines resulted from interspecific hybridisation between O-7493B and *Helianthus argophyllus*

values obtained at Fundulea, where the weather conditions were closer to normal. Another descendent of this interspecific hybridization is the line 11/2/1 (Figure 12) that achieved through the genotype "plant Stupina 2" a seed yield per head of 90 g and a TKW of 59 g being the only line out of all the combinations that have proven under drought conditions such a performance. It is necessary to mention that the line Tard/85-19982B is known to be like an intensive line with high yield under good irrigation and fertilization. In this case, it is obvious that the resistance and adaptability to drought were transmitted from the wild species, due to the fact that agro-ecological selection field from Stupina was not irrigated, and no fertilizer was applied.

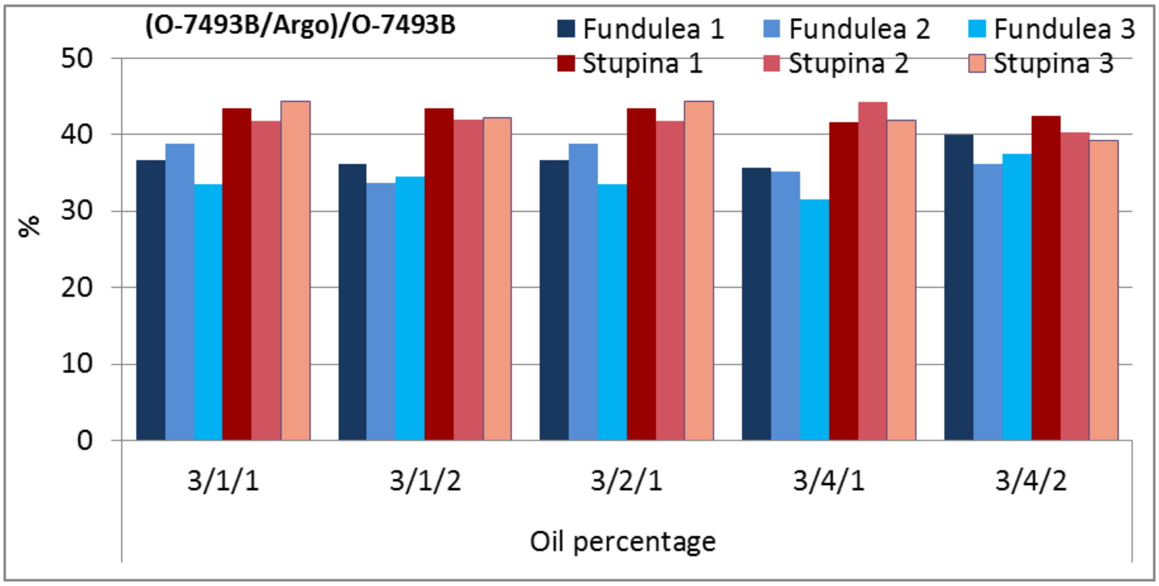

Figure 10. Oil content of the backcross 7th generation of sunflower lines obtained from interspecific hybridisation between O-7493B and *Helianthus argophyllus*

These two lines originating from this combination will be used to obtain commercial sunflower hybrids. For all other lines resulting from this combination, the breeding process will be continued through self-pollination and backcrossing, due to the fact that they represent a valuable biological material that can be further improved.

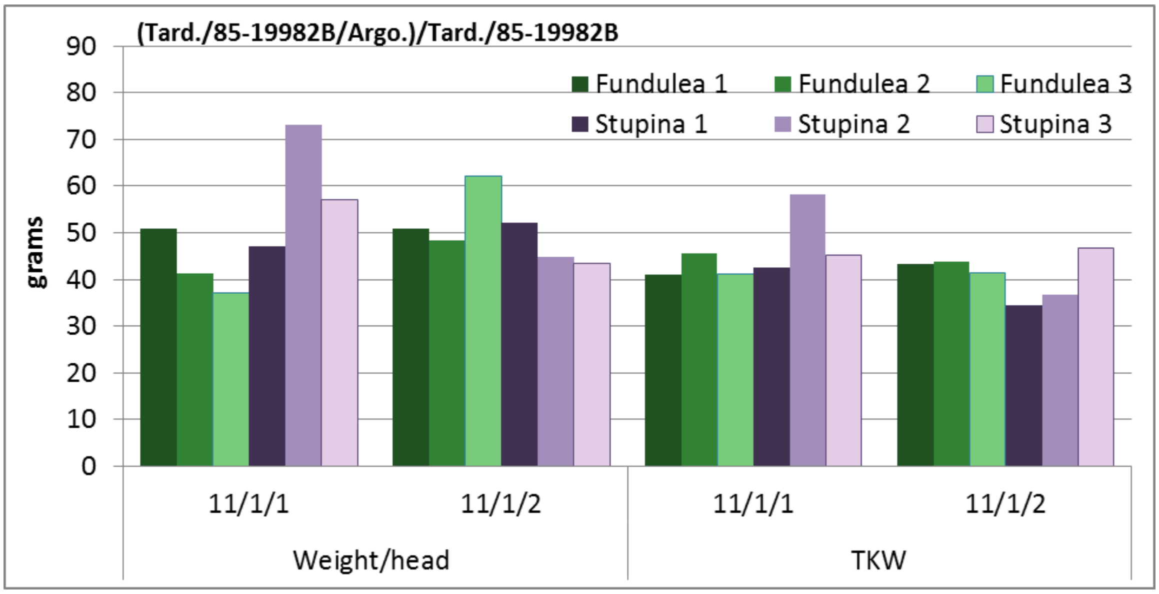

Figure 11. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/1/1 and 11/1/2 lines resulted from interspecific hybridisation between Tard./ 85-19982B and *Helianthus argophyllus*

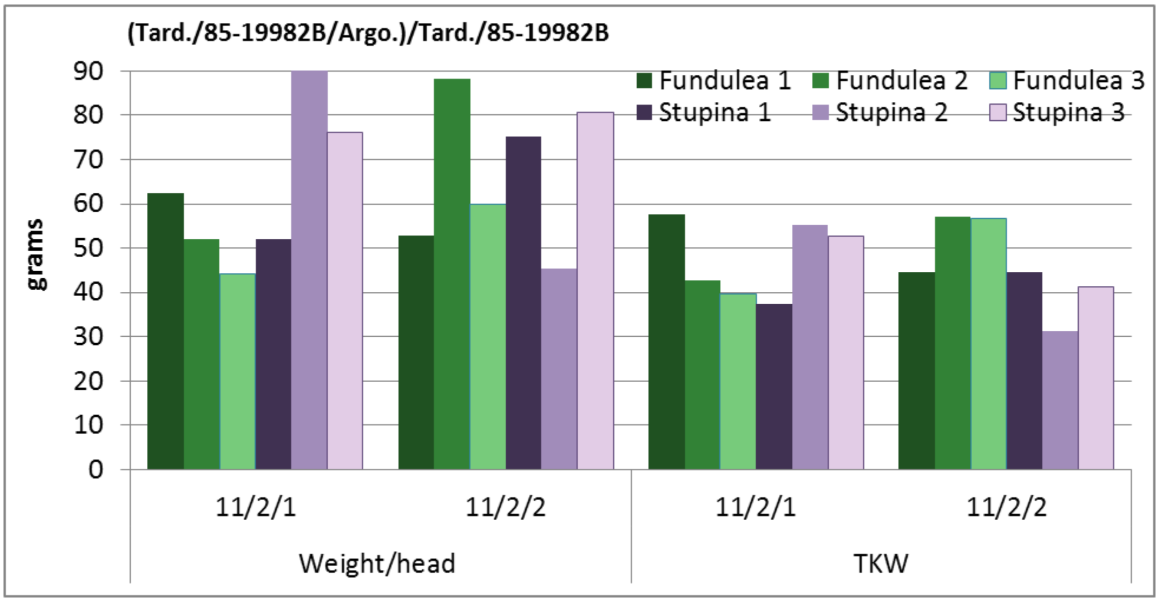

Figure 12. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/2/1 and 11/2/2 lines resulted from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

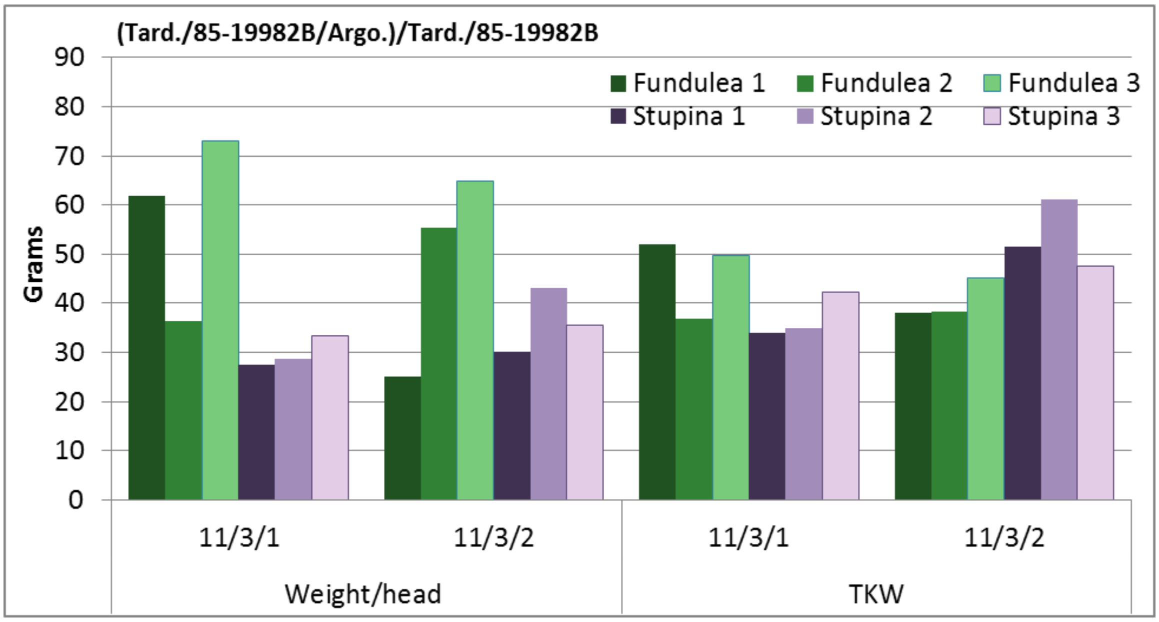

Figure 13. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/3/1 and 11/3/2 lines resulted from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

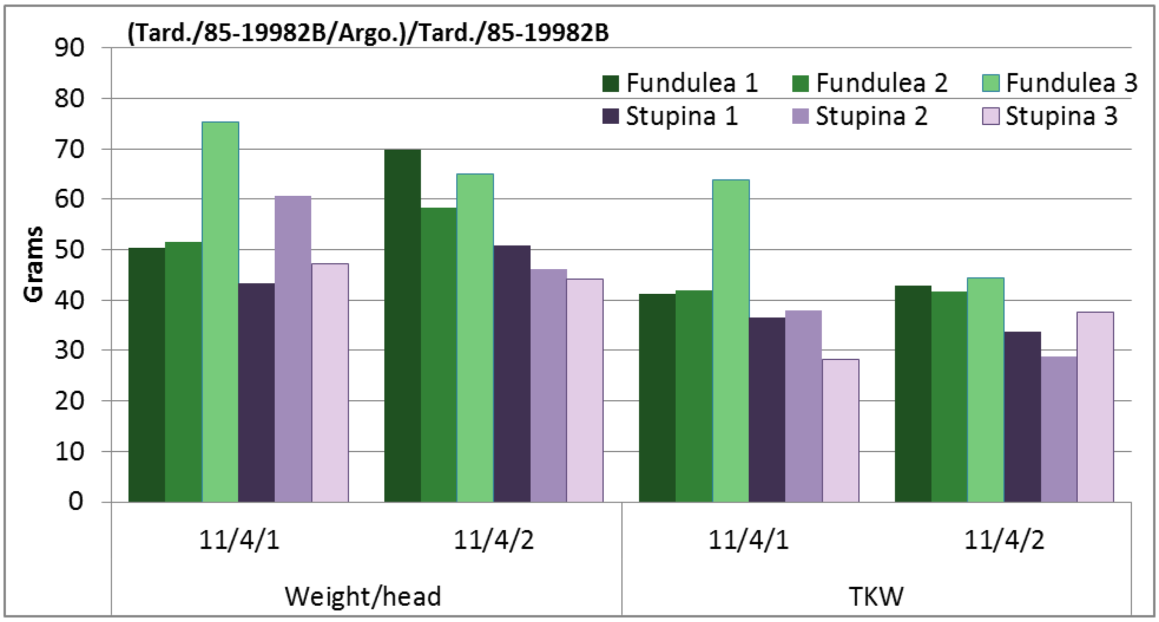

Figure 14. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/4/1 and 11/4/2 lines resulted from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

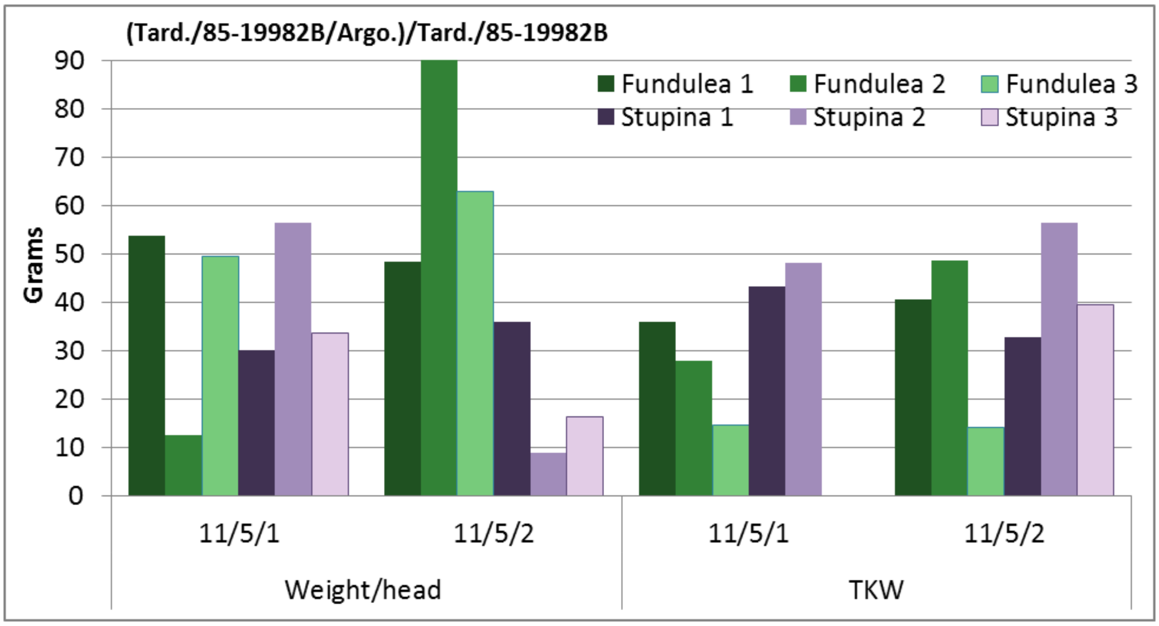

Figure 15. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/5/1 and 11/5/2 lines resulted from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

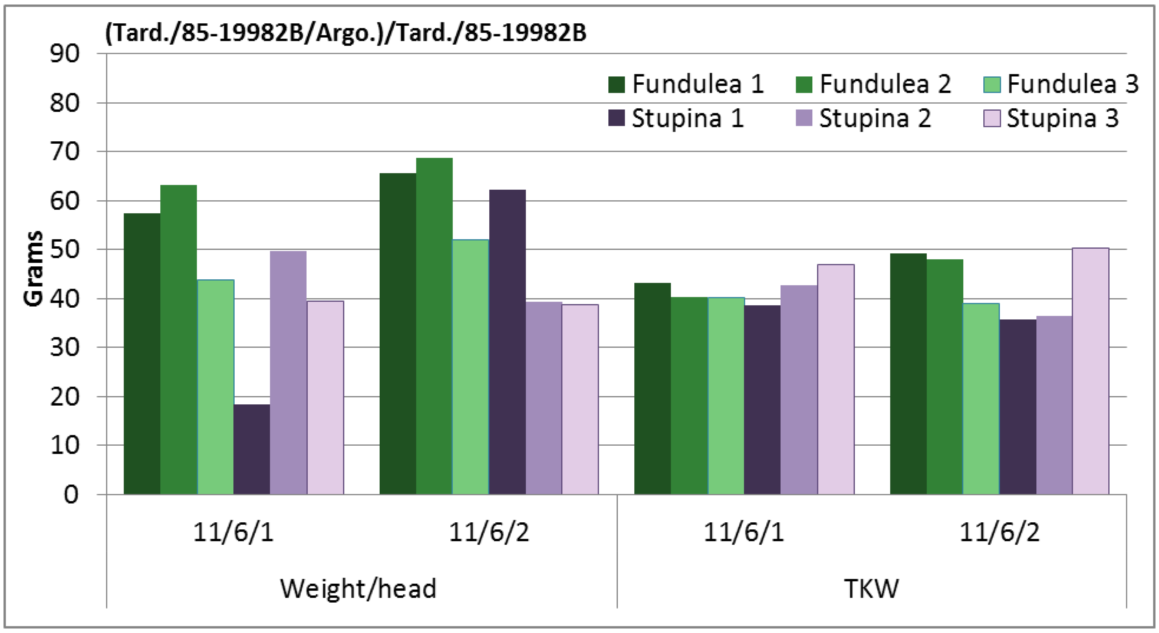

Figure 16. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 11/6/1 and 11/6/2 lines resulted from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

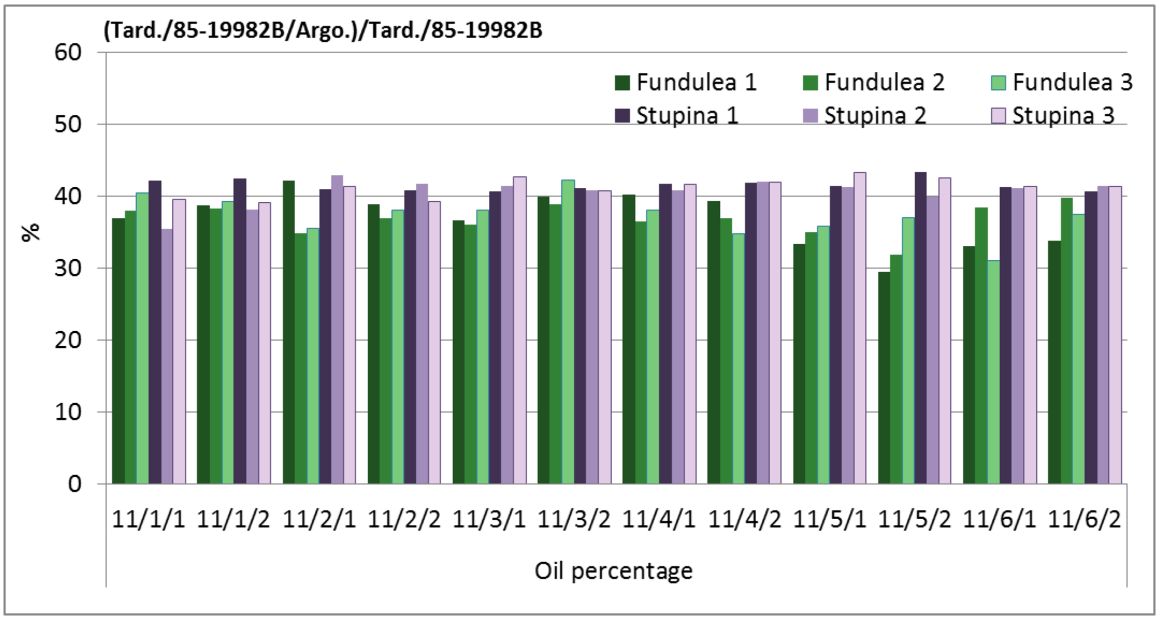

Figure 17. Oil content of the backcross 7th generation of sunflower lines obtained from interspecific hybridisation between Tard./85-19982B and *Helianthus argophyllus*

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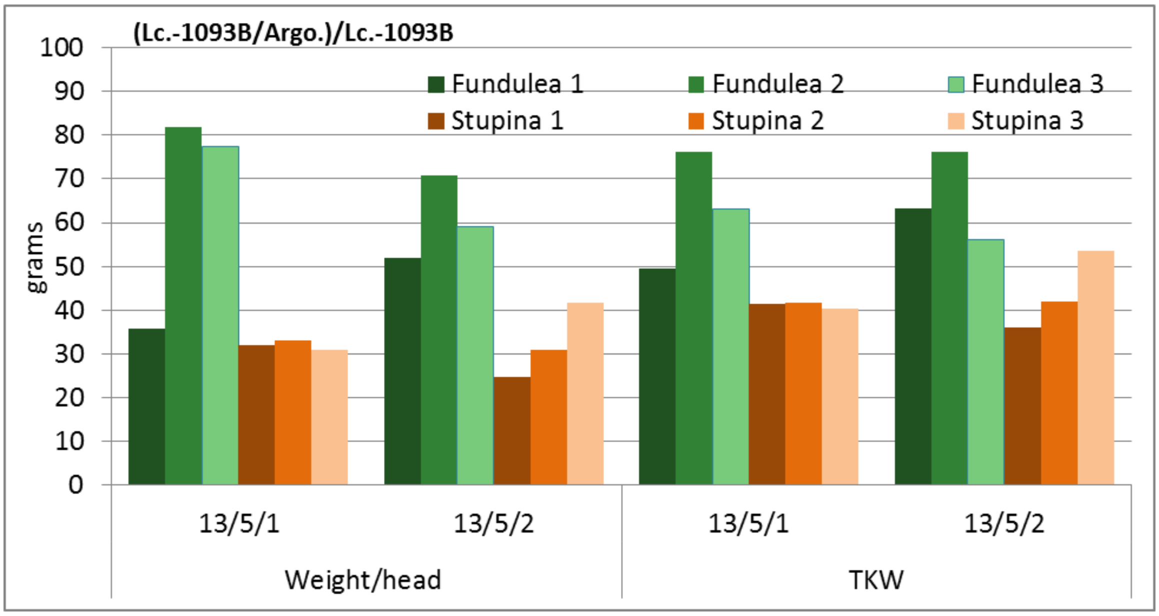

Figure 18. Average weight of head and TKW for the progenies of the progenies from backcross 7th generation of the 13/5/1 and 13/5/2 lines resulted from interspecific hybridisation between LC-1093 B and *Helianthus argophyllus*

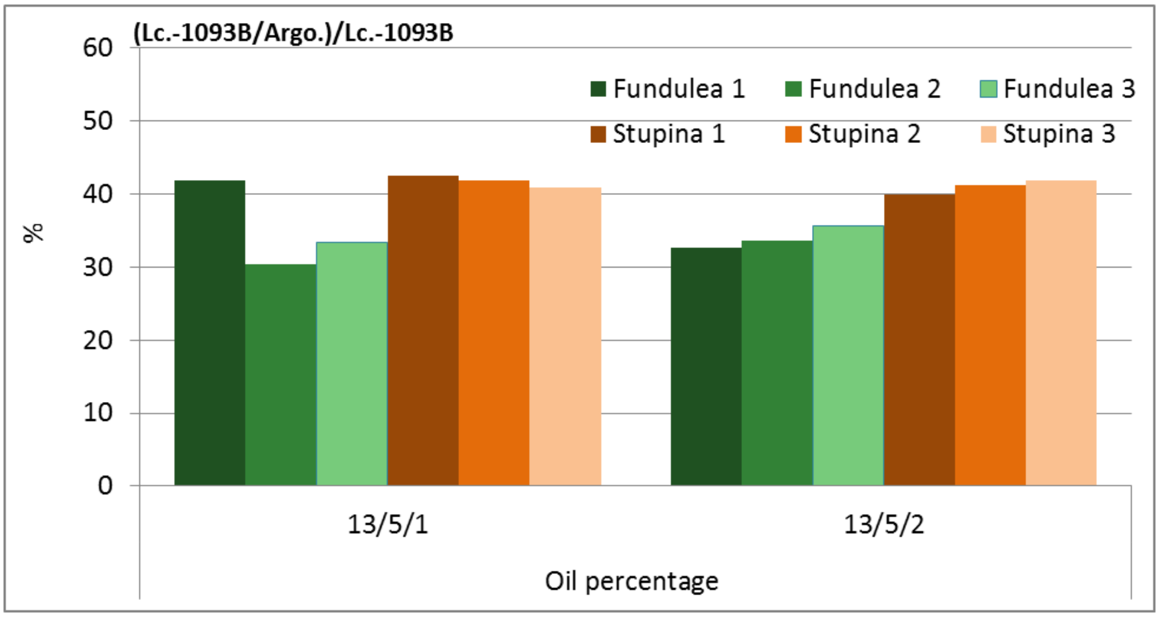

Figure 19. Oil content of the backcross 7th generation of sunflower lines obtained from interspecific hybridisation between LC-1093 B and *Helianthus argophyllus*

The inbred line 1093 B was considered by breeders as having a large ecological plasticity, and it is used in obtaining very valuable hybrids with resistance to plant diseases and *Orobanche*. In combination with *Argophyllus*, the results were spectacular. Even if the yield was very low under limited water conditions (Figure 17), the lines 13/5/1 and 13/5/2 proved a very good resistance to *Sclerotinia sclerotiorum* (at Fundulea) and bird atttack (at Stupina). It is necessary that at Stupina and under the agro-ecological management, there are enough tree windscreens were a lot of rooks and house sparrows are nesting and increasing very much their numbers. For the local farmers, these birds are source of damages not only for sunflowers but also for wheat and barley. This new line has the advantage that it is avoided by birds so even if the yield is low it is safe.

4. Conclusions

a. It is very important that together with the fulfillment of the main objective of the study (yield stability in water stress conditions in organic farming system), the results selection included achievements for biotic factors (resistance to *Sclerotinia* and *Orobanche*). Three genotypes with resistance to *Orobanche* in conditions of soil were identified, with a very high infestation with broomrape due to monoculture of sunflower for three years.

Under our experimental conditions, the genotypes with a longer vegetation period presented a better resistance to broomrape (Figures 20-21).

b. Some of the genotypes resulting from the interspecific hybridizations with *H. argophyllus* were not affect by the massive bird attacks from Stupina in 2014, when many farmers reported severe losses due to birds. This represents an important step in releasing sunflower hybrids with resistance or tolerance to this character (Figures 22-23).

c. In the conditions from Fundulea, in favorable year, a strong attack of *Sclerotinia sclerotiorum* was recorded, and this was a good opportunity to find among the tested combinations the reactions ranging from being tolerant to being sensible to this pathogen (Figures 24-25).

Figure 20. O-7493B X*Helianthus argophyllus* - genotype with sensitivity to *Orobanche cumana* and vegetation period of 115 days (Stupina location)

Figure 21. LC-1093 B X*Helianthuus argophyllus* - genotype resistant to *Orobanche Cumana* and vegetation period of 130 days (Stupina)

Figure 22. Tard/85 -19982B - genotype with seeds highly preferred by birds (Stupina)

Figure 23. Line 13/5/1 - genotype avoided by birds (Stupina)

Figure 24. Polet-11273B - obtained through hybridization backcross x androsterile line. Attack of *Sclerotinia sclerotiorum* on stem, Fundulea (2014).

http://dx.doi.org/10.5772/61486

Figure 25. LC 1093X - obtained through hybridization, with total resistance to *Sclerotinia sclerotiorum*, Fundulea (2014)

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