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Improvement Strategy of High Yielding Sunflower (*Helianthusannuus L.*) Genotypes Adaptable for Rainfed Conditions in Blue Nile State, Sudan

Amin Al Sir Ahmed I.*[1], Mohamed Y. Mohamed[2] and Abubaker A. A.[1]

[1]*DamazinAgricultural Research Station, Sudan.*
[2]*Gezira Agricultural ResearchStation, Sudan.*

***Corresponding Author**: Amin A1Sir Ahmed I, Damazin Agricultural Research Station, Sudan.*

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ABSTRACT

A research work was conducted for seasons 2015, 2016 and 2017 (Three cycle of selection and selfing) at Damazin Agricultural Research Station Farm, Damazin, Sudan, located at longitude 34°22' E, latitude 11°47' N and altitude 470 m. The objective of research work is to provide new promising local sunflower genotypes (open pollinated varieties and hybrids) having high seed yield potential and adaptability for rainfed conditions in Blue Nile State area.The experimental materials consisted of two sunflower populations (DM-1 and DMHY) and two inbred lines (DM1-3 and DMHY-1). Unanalyzed field observations (primacy data) within each genotype just to assist in selection procedures were taken on days to 50% flowering, days to maturity, plant height (cm), head diameter (cm), seed set % and seed yield/plant (g). As a result of improvement strategy research, about 20 new promising genotypes (lines) possess high seed yield potential under rainfed conditions and are available for further breeding objectives.

Keywords: *Sunflower, Strategy, Open pollinated, Seed, constraint*

INTRODUCTION

Sunflower (*Helianthus annuus*L.) is an annual crop that is the source of one of the most important edible oil on a global scale. In season 2015/2016, sunflower area was 23.06 million hectares worldwide with a total production of 39.19 million metric tons, and an average productivity of 1.7 metric tons/ha ((USDA, 2016). The major sunflower producing countries are Ukraine, Russia, European Union, Argentina and China (USDA, 2016). Sunflower is a promising oilseed crop in Sudan. The seed of sunflower have high oil content (40-50%) and 30% digestible protein and can be used as a source of food for humans or as poultry feed (Younis. 2010).Sunflower cake can also be used as an animal feed. Sunflower is adaptable to a wide range of climatic conditions and is well suited for Sudanese conditions (Younis, 2010). It could be considered a suitable winter oil crop in irrigated conditions. Sunflower seed, which are a raw material for the oil industry, can increase the capacity of the local crushers, and the extra raw material can be exported to the Arab countries. Extensive commercial production of sunflower was initiated in Sudan in the late 1980's and the early 1990's with the introduction of hybrids such as Hysun-33 from Australia and PAN-7351 from South Africa (El Ahamdi, 2003; Noure*t al.*, 2005). The production was established mainly in rainfed areas of the country and, to a lesser extent in irrigated conditions. Two open-pollinated sunflower varieties, Rodio and Bolereo, were released under the names Damazin-1 and Damazin-2, respectively (Adam and Osman, 1989). In the last two decades sunflower failed to be expanded significantly in Sudan, which might be attributed mainly to some production constraints. Currently, sunflower breeding program at Damazin Research Station is going on, but due to the default of prenatal lines (A line, B line and R line) the program failed to generate local hybrids, so, sunflower breeding program started to emphasis to product local sunflower open pollinated varieties which is being the top in demand from sunflower

farmers in Blue Nile State. There are many production constraints are responsible of the fluctuation in area and productivity of sunflower crop in Blue Nile State. Time of seed availability and lack of local improved sunflower hybrids, unavailable of released open pollinated varieties seed (local or introduced) and high price of sunflower hybrids seed. These constrains are considered to be an important reasons faced sunflower growing in Blue Nile State. Sunflower breeding program in Damazin Research Station followed procedures of traditional breeding methods of cross pollinated crops. Damazin Research Station Farm, Damazin, Sudan, located at longitude 34°22' E, latitude 11°47' N and altitude 470 m. Soil is classified as typicchromusterts, fine, smectitic and isohyperthermic (Soil Survey staff, 1976). The objective of research work is to product and provide new promising local sunflower genotypes having high seed yield potential and adaptability for rainfed conditions in Blue Nile State area, open pollinated varieties (first phase) and hybrids varieties (second phase).

MATERIALS AND METHODS

Selfing Process (Season 2015)

DM-1 and DMHY sunflower populations were sown in July 2015 at Damazin Research Station Farm, selection was applied within each population separately. Selection was based on specific characters as days to flowering, days to maturity, plant height, head diameter, seed weight, seed size, seed color and seed yield/plant. The objective of selection is to provide different genetic materials for further breeding plans. During season 2015 about 45 individual plants were selected from DM-1 and DMHY populations. The selected plants were harvested separately (Cycle zero) and the seed were saved to be grown in the next season to produce F_1 seed(Cycle one). Selection and selfing will be continued.

Selfing Process (Season 2016)

In this season a new selfing was applied, about 11 introduced hybrids were self-pollinated (Table 1) to generate F_1 seed (Cycle one) which will be sown in the next season 2017 to generate F_2 seed (Cycle two). Selfing was done by used cotton tamp to covered florescence when flowering started. In addition to that, 45 selected plants from the previous season were sown separately in 45 plots. $20m^2$ was a plot area. Four to six plants from each plot (new genotype) were selected and self-pollinated by using cotton tamp to cover the florescence when flowering started (inbreeding) to produce F_1 seed (Cycle one).Selected plants of each genotype (plot) were harvested together to be grown in the next season to produce F_2 seed(Cycle two). Selection and selfing will be continued in the same time approximately five to seven generations to get uniform line or more with desirable traits use in other advance breeding procedures.

Table1. *Shows new self-pollinated hybrids.Season 2016:*

Number	Genotype name
1	H_1
2	H_2
3	H_3
4	H_4
5	H_5
6	H_6
7	H_7
8	H_8
9	H_9
10	H_{10}
11	H_{11}

Key: *H……Hybrid*

Crossing Process (Season 2015)

The common ways to generate new genetic variability through crossing are local genotype x introduced genotype and introduced genotype x introduced genotype to transfer one or more genes to another line or combine two genes or more that controlled desirable traits in a new promising line. All genetic materials (parental lines of crosses) were sown at Damazin Research Station Farm in July 2015. Emphases was given to cross between local inbred line DM1-3 (derived from OPV Damazin-1) and local inbred line DMHY-1 (derived for crossing between Damazin 1-3 x line 33, by Dr. M. Younis, ARC - Sudan) as male parents with four introduced lines as female parents to produce new local genotypes having high seed yield, oil content and Self fertility. Manual artificial emasculation was done using small pieces of cotton and normal water to remove completely

the florescence's stamens of the selected hybrid (female). Pollen grains were collected from inbred lines DM1-3 and DMHY-1 separately (males). The collected pollen grains were sponged on the emasculated florescence (female), the pollinated florescence was covered by cotton tamp. Emasculation and pollination were conducted from 5 to 10 days on the same plant during the season according to the florescence size (head diameter). Successfully eight crosses were made during this season. F_1 seed of each cross were raised separately to be grown in the next season 2016 to produce F_2 seed (Cycle one). Selection and selfing will be applied on each generation and continued from five to seven generations to result stable promising line (genotype) or more.

Crossing Process (Season 2016)

During the season 2016 a total of 22 new crosses were made between 2 local inbred lines (DM1-3 and DMHY-1) and 11 introduced hybrids, (Table 2). Manual artificial emasculation was done using small pieces of cotton and normal water to remove the florescence's stamens of the selected hybrid (female). Pollen grains were collected from inbred lines DM1-3 and DMHY-1 separately (male). The collected pollen grains were sponged on the emasculated florescence (female), the pollinated florescence covered by cotton tamp. Emasculation and pollination were conducted from 5 to 10 days on the same plant during the season according to the florescence size (head diameter). Seed of each cross were harvested separately to be grown in season 2017 (Cycle one). Selection and selfing will be continued from five to seven cycles to get promising genotype or more.

Table2. *Shows new sunflower crosses. Season2016.*

DM-3 × Hybrids set	DMHY× Hybrids set
DM-3× H_1	DMHY× H_1
DM-3 × H_2	DMHY× H_2
DM-3 × H_3	DMHY× H_3
DM-3 × H_4	DMHY× H_4
DM-3 × H_5	DMHY× H_5
DM-3 × H_6	DMHY× H_6
DM-3 × H_7	DMHY× H_7
DM-3 × H_8	DMHY× H_8
DM-3 × H_9	DMHY× H_9
DM-3 × H_{10}	DMHY× H_{10}
DM-3 × H_{11}	DMHY× H_{11}

***Key**:H……..Hybrid*

DM-3……..Population

DMHY……..Population

Result

Improvement strategy of high yielding sunflower genotypes at Damazin Agricultural Research Station is going on and conducted the third generations (Cycle Three) during the current season 2017. Uniformity on time to flowering, time to maturity, plant height, head diameter, seed set % and seed yield within each genotype appeared clearly. Due to this researchabout 20 new promising genotypes (lines) possess high seed yield potential under rain fed conditions in Blue Nile State are available for further breeding objectives. During the next season (2018), all new promising genotypes will be tested in a replicated trail against two controls Hy-33 and PAN-7153 to be evaluated for seed yield potential and oil content.

Conclusion

The research work aimed to provide promising local open pollinated sunflower varieties (OPV) to solve the absence of OPV seed in rainfed sector in Blue Nile State. Most of sunflower growers look for and demand seed of open pollinated varieties to be grown because of cheap price and reasonable seed yield/ha. Improvement strategy research resulted 20 new promising genotypes (lines) possess high seed yield potential. In addition to that, during the current season (2017) more than 25 new genotypes (lines) were included in sunflower improvement strategy (cycle one) and will be subjected to selfing and selection (cycle two) during the rainy season of 2018.

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