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Sina: The first released safflower variety for dry-lands of Iran.

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Abstract
Safflower (*Carthamus tinctorius* L.) is a multi-purpose oilseed crop and well adapted to Mediterranean climate. To find out a suitable safflower variety for rainfed conditions a safflower breeding program started at Sararood Dryland Agricultural Research Station in 1998. This program started with screening of germplasm collection then selected genotypes evaluated at seven locations i.e., Kermanshah, Gachsaran, Shirvan, Kurdestan, Ardabil, Ilam and Khoramabad, which are representative of different safflower growing areas under rain-fed conditions of Iran in the three growing seasons of 2001-02 to 2003-04.
Five promising genotypes along with Zarghan279 (check variety) were planted in on-farm trials in three sites at each of Kermanshah, Shirvan and Ilam locations, in two growing seasons of 2004-05 and 2005-06. Extensive trials in rainfed areas, in climatically different regions, show that this crop is suitable for low-rainfall lands, receiving winter and spring rainfall, and having a dry season during flowering, heading and maturation of the crop. PI-537598 always significantly out yielded Zarghan 279 (check variety) in fall planting over all locations and years. This promising line produced average seed yields of 2387, 1308, 1198, 1159, 650 and 590 Kg/ha during three years in fall planting under rain-fed condition in Ilam, Kermanshah, Ardabil, Khoramabad, Shirvan and Kordestan, respectively.

In general, PI-537598 produced about 45 per cent more seed yield compared to commercial check variety (Zarghan 279) in fall planting over different locations. It is suitable genotype to plant in warm and semi-cold dry-lands of Ian in rotation with wheat and chickpea. PI-537598 released as Sina variety in 2007.

Key words: Safflower – rainfed - released variety

Introduction

World safflower area been around one million hectares for the last couple of decades, average seed yield has been about 900 kg/ha. In 2005, there area of safflower production in the world was estimated to be about 814,000 ha (FAO, 2006). More than 20 countries grow safflower and Mexico and India produce over half, with 212,765 and 210,000 Million tones, respectively. Yield in Mexico is 1.8 t/ha and in USA little more than 2 t/ha. Asian yields average around 650 kg/ha. Iran's annual consumption of edible vegetable oil is about 850,000 tons. About 85 % of the need of edible oil is met through imports. There are now proactive efforts to create and develop area for important oilseed crops; in line with this government is now encouraging safflower cultivation for edible oil purpose. In the last few years safflower area has increased and was 15,000 ha in 2005-06. Ashri (1973) denoted that Middle East center of Knowles (1969) should be divided into three regions: Iran-Afghanistan, Near East and Turkey. Safflower is a suitable crop in rotation with wheat and chickpea for cold and semi-cold dry-lands of Iran (Pourdad and Beg 2003) and in rotation with barley (Yau 2005) in Mediterranean rain-fed condition.
Present safflower breeding program started with evaluation of 169 genotypes germplasm collection in Sararood Dryland Research Station (Kermanshah) in 1998, from which 15 genotypes were selected.

Materials and Methods

The 15 selected genotypes viz., CH-5, PI-250537, Syrian, CW-74, Dincer, LRV-55-245, PI-198290, Hartman, Gila, Kino-78, Yenice, PI-537636, PI-537636-s, LRV-51-51, PI-537598 along with Zarghan-279 (check variety) were planted at different locations i.e., Kermanshah,

Gachsaran, Shirvan, Kurdestan, Ardabil, Ilam, Khoramabad, which are representative of different safflower growing areas under rain-fed conditions of Iran in the three growing seasons of 2001-02 to 2003-04. At each environment the genotypes were planted in a randomized complete block design with three replications.
Sowing was done by hand. Each genotype was planted in 2 rows of 2m length, with 30 cm between adjacent rows. Plot size was $6m^2$ (4m length, 5rows, and 30 cm between adjacent rows). Plants were spaced 10 cm apart within rows. The area harvested was $3.6m^2$. Fertilizer application was 50 kg N ha^{-1} and 50 kg P2O5 ha^{-1} at planting.
Five or six promising genotypes along with Zarghan-279 (check variety) planted in on-farm trials at farmer fields of Kermanshah, Shirvan and Ilam three sites at each location in two growing seasons of 2004-05 and 2005-06. In farmer fields Plot size was bigger than on-station trials (6m length, 10 rows, and 30 cm between adjacent rows).
Seed yield (kg ha^{-1}) was obtained by converting the grain yields obtained from plots to hectare.

Result

Evaluation of germplasm collection in rain-fed conditions showed that PI-537598 had a good yield rank (15 out of 169 genotypes) and it's seed yield was 275 kg m^{-1} while Zarghan279 (check variety) rank was 90 and produced 160 kg m^{-1} seed yield. Seed yield trails of 15 promising genotypes along with check variety (Zarghan-279) at seven location during three years showed that PI-537598 had the best mean rank (2.79) and Zarghan-279 (check variety) had the worst mean rank (14.71) (Table 1). Mean seed yield of PI-537598 was superior at the most of the locations so that overall mean yield of this line was the highest (1110.9 kg/ha). Rank standard deviation of PI-537598 was the lowest (1.08) showed less variation in seed yield ranks, and good stability across locations.
Five superior genotypes selected from adaptation trials went to on-farm trials in four locations (Kermanshah, Ilam, Koramabad and Shirvan) and three different farmer fields in each location. Results showed that PI-537598 was superior genotypes at all locations. Mean of oil content was 30.1 per cent for PI-37598.

Discussion

Results of six year study on safflower genotypes revealed that PI-537598 had the best seed yield adaptability and stability in rain-fed conditions of warm and semi-cold areas of Iran. This line had always higher seed yield then Zarghan-279 (check variety) and was the superior genotypes on stations and on-farms trials. It is suitable genotype to plant in warm and semi-cold dry-lands of Ian in rotation with wheat and chickpea. PI-537598 released as Sina variety in 2007.

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Table 1. Rank, mean of rank, standard deviation of rank and mean yield of safflower genotypes in rain-fed condition of different locations during three years.

Genotype	Rank							Mean of Rank	Standard Deviation of Rank (SDR)	Mean Yield (kg/ha)
	Kermanshah	Kurdestan	Ardabil	Khoramabad	Ilam	Gachsaran	Shirvan			
PI-537636-s	5	6.5	8	10.25	7	9	8.75	7.79	1.76	941.4
Dincer	10.75	4.75	14.5	7.75	7.5	8	15.25	9.79	3.89	785.8
Zarghan279	9.25	16.75	16.75	13.5	13.5	16	17.25	14.71	2.86	635.2
CH-5	7	9.5	8	11.5	1.5	3	4.75	6.46	3.58	961.0
PI-537636	12.5	14.75	11.25	9	8	6.5	8	10.00	2.93	838.4
PI-537598	1	3.75	2.5	4.25	3	3	2	2.79	1.08	1110.9
Syrian	7.75	11.25	8.25	7.75	4.5	7.5	7.25	7.75	1.97	890.0
PI-250537	7.5	3	10	9.5	5.5	3.5	6	6.43	2.73	906.3
PI-198290	8	10.75	8.75	12.5	6	10	10.75	9.54	2.14	823.7
LRV-51-51	11.75	10.75	10.25	14.5	13.5	8.5	6.75	10.86	2.70	717.9
Gila	12.75	9.5	9.75	3	9	9	6.75	8.54	3.01	879.9
Kino-76	5.5	13	10.5	9.25	8	13	11.75	10.14	2.77	845.0
CW-74	11.25	7.5	10.75	10	12.5	9	8.75	9.96	1.69	811.4
Hartman	12	12.75	2.75	10.25	14	13.5	14.25	11.36	4.03	873.7
Yenice	7.5	12	10.75	14.5	12	10	10	10.96	2.18	795.6
LRV-55-295	16	6	9.25	11	10	7.5	4.25	9.14	3.82	824.6