Effect of Different CMS Sources on Oil Content and Quality of Sunflower Hybrids under Different Irrigation Regimes

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ABSTACT

A set of 40 hybrids were developed by crossing nine cms analogues from different cytoplasmic sources along with common maintainer with four perfect restorers from PET-1 source. The data was recorded on oil content and fatty acid composition under both the environments. The mean performances of different cytoplasmic sources were compared with the mean performance of cultivated cytoplasmic source to find out the effect of different sources on hybrid performance under both the environments. CMS analogues ARG-2A (32.64 and 31.93), ARG-3A (31.12 and 33.58) and ARG-6A (30.72 and 30.15) from H.argophyllus and PRUN-29A (33.29 and 31.51) from H. praecox ssp runyonii recorded significantly higher oil content than conventional CMS source (29.51 and 25.65) under both the environments respectively. Stearic acid content was significantly higher for all the sources except two (ARG-6A and DV-10A) under normal and cms-XA and PHIR-27A under stress environment. Oleic acid was not significantly affected by the cytoplasmic sources under both the environments but there were significant differences for linoleic acid under both the environments, all the sources had higher linoleic acid than PET-1 cultivated source, except PKU-2A under normal and E002-91A and ARG-2A under stress environment, which recorded lower level of linoleic acid. Present study indicates that oil content was affected by different cytoplasmic sources which may be attributed to either the effect of cytoplasm only or the nuclear cytoplasmic interactions.

Keywords: Sunflower CMS analogues, oil content and water stress

1. INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop widely adopted and accepted for its high quality edible oil. The objective of sunflower breeding is to develop the high yielding hybrids with high oil content and oil quality. (Dudhe *et al.,* 2009). Sunflower seed contains high percentage of poly-unsaturated fatty acids (60%) including oleic acid and linoleic acid at 16.0% and 72.5% respectively, which help in controlling cholesterol level in blood (Satyabrata *et al.,* 1988). Water shortage is becoming a major problem for sustainable agriculture in India mainly in Punjab. Sunflower is considered moderately resistant to drought and is often grown in hot, semi-arid climatic regions. Breeding for resistance to drought and high temperatures is an important objective in many sunflower programs. Sunflower has a great potential in bridging the gap between demand

and supply of edible oil to a significant extent in the years to come. Sunflower hybrids are object of breeding attention because of their agronomic and economic advantages over varieties. The central component of sunflower hybrid development is cytoplasmic male sterility (CMS). The choice of suitable parents is of paramount importance for a planned hybridization programme for the development of suitable hybrids having high oil content and good oil quality. Development of sterile CMS analogues in sunflower breeding programs for commercial hybrid development is one of the practical applications of CMS investigations. The alloplasmic lines (i. e. different cytoplasm in common nuclear genetic background) may contain certain factors affecting to water stress responsiveness. In order to achieve the desired goal of sunflower breeding for developing water use efficient genotypes one must have a thorough understanding of the interaction between alien cytoplasm and nuclear genes from commercially cultivated source i. e. *H. petiolaris* and the effect of this interaction on oil content and fatty acid composition. In this context the present work was undertaken to evaluate different *cms* sources and study the effect of various cytoplasmic male sterility sources on oil content and fatty acid composition to exploit them in hybrid development programme.

2. MATERIALS AND METHODS

The material comprised a set of 40 hybrids developed by crossing nine *cms* analogues from different cytoplasmic sources along with common maintainer with four perfect restorers from *PET-1* source. The material was shown during spring season 2011 and 2012 in randomized block design with three replications in a plot size of 4.5 m. × 0.6m to evaluate their performance for oil content and fatty acid composition under two environments (normal irrigation and water stress). In stress environment the irrigation was stopped after anthesis. The data was recorded on oil content and fatty acid composition *viz;* palmitic acid, stearic acid, oleic acid and linoleic acid under both the environments. Oil content was estimated using Nuclear Magnetic Resonance (NMR) and fatty acid were estimated using Gas Liquid Chromatography (GLC). The mean performances of different cytoplasmic sources were compared with the mean performance of cultivated cytoplasmic source to find out the effect of different sources on hybrid performance under both the environments.

3. RESULTS AND DISCUSSION

The present investigation has been based on development of a set of nine alloplasmic cms lines having a common maintainer and four perfect restorers from PET-1 source. Beneficial cytoplasmic nuclear interactions have been reported in various crops (Jan, 1992). Only a few studies have reported the interactions between cytoplasms and nuclear genes in the expression of several qualitative and quantitative traits in sunflower. In sunflower, a unique cytoplasmic nuclear interaction caused reduction in chlorophyll, photosynthetic rate (Jan, 1990) and positive effects on oil content have been reported by Serieys (1992). To study the effect of different cytoplasmic sources the mean values of four crosses from each source were pooled and their grand mean values were calculated to study the effect of different cytoplasmic sources and compared them with the conventional petirolasis source (NC-41B) under both the environments.

A perusal of table 1 reveals that the mean sum of squares due to different sources were highly significant for oil content and fatty acid composition over both the years under both the environments. The pooled analysis over the years indicated highly significant mean squares due to different sources and years for oil content and fatty acid composition under normal environment except for stearic acid, oleic acid and linoleic acid for which years did not differ significantly under stress environment. Highly significant G x E (years) interactions for all the traits showed differential behaviour of sources over the years under both normal and water stress conditions.

3.1 Effect of different cytoplasmic sources on oil content and quality of hybrids under different irrigation regimes

The mean performances of different cytoplasmic sources were compared with the mean performance of cultivated cytoplasmic source to find out the effect of different sources on hybrid performance under both the environments.

In general the oil content of all the sources was in the lower range. However, it was significantly better than control NC-41B in both the environments. CMS analogues ARG-2A (32.64 and 31.93), ARG-3A (31.12 and 33.58) and ARG-6A (30.72 and 30.15) from *H. argophyllus* and PRUN-29A (33.29 and 31.51) from *H. praecox ssp runyonii* recorded significantly higher oil content than conventional CMS source (29.51 and 25.65) under both the environments respectively. Stearic acid content was significantly higher for all the sources except two (ARG-6A and DV-10A) under normal and cms-XA and PHIR-27A under stress environment. Oleic acid was not significantly affected by the cytoplasmic sources under both the environments but there were significant differences for linoleic acid under both the environments, all the sources had higher linoleic acid than PET-1 cultivated source, except PKU-2A under normal and E002-91A and ARG-2A under stress environment, which recorded lower level of linoleic acid. Present study indicates the influence of different cytoplasmic sources on oil content, which may be attributed to either the effect of cytoplasm only or the nuclear cytoplasmic interactions. Most important finding of this study is that CMS analogue ARG-3A recorded high oil percent under water stress environment as compared to normal environment which is very important character of this analogue. In conventional *petirolasis* cytoplasm system water stress is associated with low oil content in different genotypes as compared to normally irrigated environment.

This source was also observed to be associated with higher value of oilec acid under moisture stress condition. The CMS analogue DV-10A (*H. debilis spp. vestitus*) was least affected with respect to oil content and linoleic acid content and recorded oil content of 30.7 per cent and 30.9 per cent under normal and stress conditions, respectively.

Table 1. Analysis of variance for oil content and quality traits with respect to different cms sources under under different irrigation regimes (Pooled over the years)

Source	d.	Oil content		Palmitic acid		Stearic acid		Oleic acid		Linoleic acid	
2011		**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Replicates	**2**	0.24	0.01	0.68	0.19	0.02	0.02	3.04	0.2	0.89	0.71
Treatments	**9**	6.89**	5.16**	1.00**	0.98**	0.55**	0.57**	26.94**	55.12**	21.93**	53.38**
Error	**1**	0.01	0	0.02	0.12	0.05	0.05	0.22	0.2	0.07	0.47
2012											
Replicates	**2**	0.01	0.08	0.05	0.03	0.02	0.58	0.22	0.84	0.59	0
Treatments	**9**	7.86**	38.54**	1.17**	1.78**	0.49**	1.02**	23.68**	50.91**	23.29**	52.07**
Error	**1**	0.05	0.03	0.02	0.05	0.07	0.05	0.1	0.09	0.12	0.18
Pooled											
Rep.(withinyears)	**4**	0.12	0.05	0.36	0.11	0.02	0.3	1.63	0.52	0.74	0.36
Years	**1**	60.70	15.50	1.88**	0.49*	0.81**	0.03	53.37	0.12	25.27	0.77
Treatments	**9**	9.48**	27.41**	1.81**	2.23**	0.79**	1.54**	47.32**	105.29**	41.68**	103.23**
Interactions	**9**	5.27**	16.29**	0.37**	0.53**	0.25**	0.05	3.30**	0.73**	3.53**	2.22**
Error	**3**	0.03	0.02	0.02	0.08	0.06	0.05	0.16	0.15	0.09	0.33

Table 2. Effect of different cytoplasmic sources on oil content and quality traits under different irrigation regimes (Pooled over the years)

S. No.	Sources	Oil content (%)		Palmitic acid		Stearic acid		Oleic acid		Linoleic acid	
		N	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
1	**CMS-XA**	32.75**	30.57**	4.99**	4.26*	2.91*	2.77	43.97	43.65	48.13*	49.32**
2	**CMS-E002-01A**	29.91	30.71**	5.29**	4.42**	3.32**	3.51**	40.15	49.39	51.24**	42.67
3	**CMS-PKU-2A**	31.15**	32.21**	5.77**	4.15*	3.23**	4.12**	45.78	42.73	45.22	49.00**
4	**CMS-ARG-2A**	32.64**	31.93**	5.54**	5.05**	3.19**	3.00*	42.70	49.00	48.57*	42.96
5	**CMS-ARG-3A**	31.12**	33.58**	4.97**	5.60**	3.83**	3.95**	38.71	43.97	52.49**	46.49*
6	**CMS-ARG-6A**	30.72*	30.15**	4.39	4.60**	2.69	3.24**	41.09	42.45	51.83**	49.72**

7	**CMS-DV-10A**	30.77*	30.98**	5.42**	3.97	2.74	3.15*	39.83	37.74	52.01**	55.15**
8	**CMS-PHIR-27A**	30.55*	29.14**	4.39	5.23**	2.91*	2.84	42.54	42.37	50.16**	49.56**
9	**CMS-PRUN-29A**	33.29**	31.51**	5.10**	4.97**	3.24**	2.93*	39.89	39.98	51.77**	52.12**
10	**NC-41B (Control)**	29.51	25.65	4.10	3.68	2.65	2.59	47.31	50.48	45.93	43.25
SE±		0.40	0.68	0.17	0.19	0.12	0.16	0.89	1.33	0.83	1.31
CD 5 (%)		**0.90**	**1.53**	**0.39**	**0.44**	**0.26**	**0.36**	**2.01**	**3.00**	**1.89**	**2.97**
CD 1 (%)		**1.48**	**2.51**	**0.64**	**0.71**	**0.43**	**0.59**	**3.29**	**4.91**	**3.09**	**4.87**

N=Normal & S=Stress

4. CONCLUSIONS

Present study indicates that oil content and oil quality were affected by the cytoplasmic sources which may be attributed to either the effect of cytoplasm only or the nuclear cytoplasmic interactions. However, it is an important finding that the effect of different cytoplasmic sources on the expression of oil content and linoleic acid was in desirable direction which can be exploited to develop better hybrids having high oil content and good oil quality.

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