Journal of Applied and Natural Science 8 (2): 555- 558 (2016)

JANS

Evaluation of three way cross hybrids and single cross hybrids in sunflower *Helianthus annuus*

Vikas V. Kulkarni*

AICRP on sunflower, Main Agricultural Research Station, University of Agricultural Sciences, Raichur - 584104 INDIA
E-mail: vik_gene@rediffmail.com

Received: August 26, 2015; Revised received: December 29, 2015; Accepted: April 5, 2016

Abstract: Thirty-two sunflower, *Helianthus annuus* three way cross hybrids along with five popular single cross hybrids evaluated for yield and component traits during Kharif-2013. Out of 32 three way cross sunflower hybrids tested, none were significantly superior over single cross best check. However, two three way cross hybrids (CMS-207A X IB-104)X DOR-R3 (2066 kg/ha) and (CMS-148A X IB-101)XDOR-R3 (20132 kg/ha) recorded on-par seed yield compared to commercial single cross hybrid check RSFH-130. The three-way-cross hybrids were early for 50% flowering compared to single cross hybrids and were on-par for other quantitative characters *viz*., plant height, head diameter, volume weight and 100 seed weight. Looking into the advantage of reduced seed production cost and *on par* yield performance, identified two three-way cross hybrids needs to be tested over years and for different locations to find their suitability for commercial cultivation.

Keywords: Sunflower, Single cross hybrid, Seed production cost, Three way cross hybrid, yield performance

INTRODUCTION

The cultivation of sunflower (*Helianthus annuus* L.) at commercial scale as an oilseed crop is worldwide. The largest traditional producer is Russia and other sunflower producing countries include Argentina, the European Union, USA, China, India, Turkey and South Africa. In world, sunflower being cultivated over an area of 20 million hectares and production around 30 million tones. In India, sunflower is being grown over an area of 0.69 million hectares with a production of 0.54 million tones with the productivity of 791kg per ha. The major sunflower producing states in India are Karnataka (0.29 mt), Andhra Pradesh (0.88 mt) and Maharashtra (0.38 mt) and in recent years, its cultivation is taken up in non-traditional states like Punjab, Haryana, Uttar Pradesh, Gujarat, Orissa, Bihar and West Bengal (Anonymous, 2015).

The hybrids under commercial cultivation in India are dominated by single cross hybrids, where uniformity is a distinct advantage. However, knowingly or unknowingly three-way cross sunflower hybrids are also grown by farmers. So both single and three-way-cross hybrids are commercially grown by Indian farmers. Single cross hybrids have advantage over three-way-cross hybrids for their greater uniformity with respect to agronomic characters like plant height, head diameter, maturity, disease resistance and oil content. However, the advantage associated with three-way-cross hybrids is the economy of seed production owing to almost double the seed yields in seed production plots of three-way-cross hybrids compared to single cross hybrids (Jayalaxmi and Narendra, 2004). Therefore, the study was attempted to compare the performance of three-way-cross hybrids in relation to the commercially grown single cross hybrids at Main Agricultural Research Station, Raichur to identify promising three-way-cross hybrids in sunflower.

MATERIALS AND METHODS

The study comprised of 32 three-way-cross hybrids derived from five CMS Lines (CMS-850A, CMS-821A, CMS-852A, CMS-207 A and CMS-148A) and five commercial single cross hybrids. These 32 three-way-cross hybrids along 5 single cross hybrids were evaluated in randomized complete block design with two replications during Kharif-2013 at MARS, Raichur. Each entry was grown in 3 x 3 mt plot with spacing of 60cm between rows and 30 cm between plants. Standard agronomic practices as per the recommendations in package of practices for sunflower were followed (Reddy *et al.,* 2007).

Observations were recorded on five randomly selected plants of each entry of the replication on important attributes viz., days to 50% flowering, plant height (cm), head diameter (cm), volume weight (g), 100-seed weight (g), seed yield and oil content. Mean of five plant observations was used for the statistical analysis. However, net plot seed yield observation was used for yield analysis. All the quantitative observations recorded were subjected to Ananlysis of Variance

ISSN : 0974-9411 (Print), 2231-5209 (Online)

(ANOVA) due to different sources as per method outlined by Kempthorne (1957).

RESULTS AND DISCUSSION

The consumption and demand for vegetable oils has been increasing, which is both income and price elastic. The per capita consumption of vegetable oils in the country has increased from less than 3 kg / year at the time of independence to nearly 14 kg/year during2013-14 (Arvind Kumar, 2015). As per the projection of DAC-Rabo Bank, about per capita consumption of vegetable oils, which are likely to raise 15.33 and 15.88 kg/year by 2020 and 2030, respectively. Sunflower being second important oilseed crop after Groundnut and it is playing an important part to bridge the gap between local production and demand of vegetable oil.

Sunflower as an oilseed is a newly introduced crop in the country. This crop has gained importance due to its short duration of maturity, excellent quality oil, photo insensitivity, wide adaptability in different agro-climatic regions and drought tolerance. Sunflower is grown as inter crop with crops such as groundnut, pigeon pea, castor, soybean and urd bean. Since it is a photo-insensitive crop, it can be grown throughout the year. Availability of quality seeds of improved varieties and hybrids are grossly inadequate and are one of the important constraints to enhance oilseed production (Hegde, 2010). In last 10 year (2001 to 2010) there are about 17 varieties/hybrids have been developed and notified, having yield superiority over presenting the best cultivars with better resistance to insect pests and diseases for different agro climatic zones of the country. However, only a few varieties/hybrids are in a seed production chain mainly due to seed production of these high yielding hybrids is costly. Out of those in seed chain also, only a few specific cultivars are dominating the seed indent, as a result many new varieties suited for specific conditions are not finding their way to farmers' field. In sunflower, where hybrids are ruling with private sector involvement, making it far more expensive to reach to small and marginal farmers. Moreover, sunflower hybrids are to be produced every year owing to their hybrid nature and low seed viability which makes the sunflower hybrids costly for poor and marginal farmers to achieve area expansion. Hence, looking in to the importance and cost of sunflower hybrid seed production, the present study was undertaken to evaluate yield potential of three-way-cross hybrids as a source of low cost seed compared to single cross hybrids.

Days to 50% flowering: The three-way-cross hybrids and five commercial single cross hybrids showed non-significant variations for days to 50% flowering (Table. 1). Mean days required for 50% flowering ranged from 50 to 66. The cross (CMS-207A X IB-104)XR-8 and (CMS-148A X IB-101)XGM-39 were very early for 50% flowering (50 DFF), whereas the KBSH-44 & KBSH-53 took 66 days for 50% flowering. Mean values for days to 50% flowering of all the sunflower three-way crosses was 55 as compared to the 63 days of single cross commercial checks. Kalpande *et al*., (2002) reported sunflower three-way-cross hybrids showing significantly negative heterosis as compared to their corresponding single cross hybrids for days to 50% flowering.

Plant height: Analysis of variance showed highly significant difference (p=0.01) among 32 three-way-cross hybrids and 5 commercial single cross hybrids for plant height. Mean plant height ranged from 141 to 208. The highest plant height was observed in (852 A x IB-104) x R-10-Br with mean plant height of 208cm whereas the (CMS-850 A x IB-104) x GM-49 was dwarf with plant height of 141 cm. Overall mean of crosses was 171 cm. The mean plant height for three-way-cross hybrids was 170cm as compared to 175cm of single cross hybrids. Kalpande *et al*., (2002) reported 25 and 17 three-way-cross hybrids showing significant positive and negative heterosis, respectively as compared to their corresponding single cross hybrids for pant height in sunflower.

Head diameter: The thirty seven sunflower hybrids tested showed significant differences (p=0.05) for head diameter. Mean head diameter ranged from 11.6 to 19cm. Head diameter is one of the important yield contributing characters having positive association with seed yield in sunflower. Maximum (19 cm) head diameter was observed in (CMS 850 A x AK-190) x R-393, whereas (CMS-850 A x IB-104) x GM-49 recorded lowest head diameter of 11.6 cm. The average head diameter (16 cm) of three-way-cross hybrids showed non-significant difference as compared with single cross hybrids (17cm). However, Jayalaxmi and Narendra (2004) reported non-significant variation for head diameter between three-way -cross and single cross hybrids of sunflower.

Volume weight: Analysis of variance (ANOVA) for volume weight exhibited significant difference among 32 three-way cross and five single cross sunflower hybrids tested. Mean volume weight ranged from 27.4 to 36 g. The highest volume weight (36g) was recorded for (CMS 821 A x AK-190) x R-393, whereas the hybrid (CMS 821 A x AK-190) x R-10-Br showed lowest volume weight (27.4 g). Overall mean of 37 sunflower hybrids was 32.3g (Table 2). The mean volume weight of both three-way-cross and single cross hybrids was similar (32g).

100 seed- weight: ANOVA revealed non-significant differences for 100 seed weight among sunflower hybrids studied involving 32 three-way cross hybrids and five single cross hybrids. Mean values for 100 seed weight ranged from 2.4 to 4.5. The mean 100 seed weight of commercial single cross hybrids was 4g as compared to the 3g for three-way-cross hybrids. Contrary to our report, Jayalaxmi and Narendra (2004) have reported highly significant differences (p=0.01) for 100 seed weight among three-way-cross hybrids in sunflower.

Seed yield: The ANOVA regarding seed yield revealed significant variations (p=0.05) among 32 three-way cross hybrids and five single cross hybrids studied. Seed yield ranged from 794 to 2201 kg/ha. The maximum seed yield of 2201 kg/ha was observed in single cross hybrid RSFH-130 while the lowest seed

Table 1. Analysis of variance for seven quantitative characters in sunflower.

Source of variation	Df	Mean Sum of Squares						
		Yield	Days to 50% flow-ering	Plant Height	Head Dia	Volume weight	100 seed weight	Oil %
Replication	1	31799.4	0.01351	696.338	2.07784	1.46162	2.664	78.6005
Treatments	36	284613*	30.735	505.477**	7.24791*	8.76468*	0.58216	24.4928*
Error	36	6516.16	0.09685	161.588	1.62062	2.18079	0.00585	0.0832

Table 2. Performance of three way cross hybrids in sunflower.

S. N.	Hybrid	Yield (kg/ha)	Days to 50% flowering	Plant height(cm)	Head Dia (cm)	Volume weight (g)	100 seed weight (g)	Oil %
1	(CMS-850 A x R-103 NB) x R-393	1468	55	159	13.8	31.4	3.5	36.7
2	(CMS-850 A x R-103 NB) x GM-39	1199	54	155	15.8	32.6	2.4	36.3
3	(CMS-850 A x R-103 NB) x GM-49	1525	54	153	13.9	30.4	2.9	39.5
4	(CMS-850 A x R-103 NB) x R3- Br	1071	55	161	14.5	29.8	3.4	37.4
5	(CMS-850 A x IB-104) x 83-Br	1186	57	161	16.6	31.7	3.5	33.7
6	(CMS-850 A x IB-104) x GM-49	1185	55	141	11.6	34.2	2.9	29.0
7	(CMS-850 A x IB-104) x GM-39	1030	54	144	13.1	34.3	3.3	33.9
8	(CMS 850 A x IB-104) x R-393	1525	52	154	16.8	34.8	3.5	32.6
9	(CMS 850 A x AK-190) x R-393	1302	54	186	19.0	29.4	4.0	38.3
10	(CMS 850 A x AK-190) x R-630	1273	55	165	11.9	34.8	3.9	36.2
11	(CMS 850 A x AK-190) x GM-39	1216	55	165	14.7	30.1	2.9	33.1
12	(CMS 821 A x R3 Br) x R-8	1398	57	175	15.5	32.7	3.1	33.8
13	(CMS 821 A x R3 Br) x R3-Br	1205	58	186	16.7	35.9	3.3	30.4
14	(CMS 821 A x R3 Br) x R-5	1717*	61	200	17.2	34.4	4.0	34.4
15	(CMS 821 A x AK-190) x GM-59	1231	57	162	14.9	34.5	3.2	27.8
16	(CMS 821 A x AK-190) x R-393	1464	54	182	17.1	36.0	3.6	29.2
17	(CMS 821 A x AK-190)x FMS-821 B	1139	58	201	17.2	32.9	3.9	30.6
18	(CMS 821 A x AK-190) x DOR-R-3	997	58	193	15.1	31.0	3.8	30.7
19	(CMS 821 A x AK-190) x R-10-Br	794	53	171	13.8	27.4	2.6	34.3
20	(CMS 821 A x AK-190) x GM-39	1105	57	186	18.0	31.7	2.6	29.5
21	(CMS 852 A x IB-104) x R-10-Br	1699*	58	208	18.9	34.3	3.9	33.7
22	(CMS 852 A x IB-104) xR-393	1131	55	166	15.3	29.4	3.1	33.6
23	(CMS 852 A x IB-104) xDOR-R-3	867	52	154	13.1	30.4	3.7	28.9
24	(CMS 852 A x IB-104) xGM-59	1517	52	168	15.3	35.9	3.0	29.9
25	(CMS-207A X IB-104)X GM-39	1083	53	159	16.3	31.1	4.2	28.9
26	(CMS-207A X IB-104)X DOR-R3	2066*	51	177	16.5	34.0	4.0	30.9
27	(CMS-207A X IB-104)XR-8	1711*	50	166	14.6	29.5	4.1	33.8
28	(CMS-207A X IB-104)XGM-49	1821*	54	184	14.7	31.9	4.0	33.8
29	(CMS-148A X IB-101)XDOR-R3	2132*	53	173	17.4	33.8	4.1	35.2
30	(CMS-148A X IB-101)XGM-39	1254	50	181	17.5	31.2	3.6	33.7
31	(CMS-148A X IB-102)XDOR-R3	1333	53	153	16.1	32.0	3.8	28.9
32	(CMS-148A X IB-102)XGM-39	1994*	58	173	18.2	31.5	3.9	29.9
33	RSFH-130	2201	63	183	17.8	32.9	4.5	39.9
34	KBSH-44	1985*	66	174	19.1	32.8	4.0	39.3
35	KBSH-53	1792*	66	189	17.7	33.1	4.3	39.8
36	SB-207	1887*	58	168	15.0	30.6	4.4	35.5
37	GK-202	1941*	63	163	16.5	33.1	4.1	36.3
	Mean	1444	56	171	15.8	32.3	3.6	33.5
	Mean of Single cross hybrids	1961	63	175	17	32	4	38
	Mean of TWC hybrids	1220	55	170	16	32	3	33
	C.V.	15.589	0.558	7.431	8.0324	4.5662	1.4767	0.272
	S.E.	57.0796	0.22	8.989	0.9002	1.0442	0.813	0.065
	C.D. 5%	163.714	0.631	25.78	2.5818	2.995	2.439	0.185

yield was recorded by (CMS 821 A x AK-190) x R-10-Br (794 kg/ha). Overall mean seed yield was 1444 kg/ ha, while the single cross check hybrids recorded mean seed yield of 2201 kg/ha. However, the mean seed yield of commercial single cross hybrids (2201 kg/ha) was significantly superior (p=0.05) over the mean seed yield of three-way-cross hybrids (1220 kg/ha). Similar findings were reported by Jayalaxmi and Narendra (2004) where yield levels of two single cross hybrids were significantly superior over 36 three-way cross hybrids involving CMS-234A, CMS-850A, CMS-852A, CMS-302A and CMS-207A based three-way

cross hybrids in sunflower. Agarwal *et al.* (2000) also reported similar results for grain yield, while studying phenotypic stability for different quantitative traits in maize hybrids.

Oil Content: ANOVA for oil content exhibited significant difference among the 37 hybrids studied. Mean oil content ranged from 27.8% to 39.9%. The highest oil content was observed for commercial single cross hybrid RSFH-130, while the lowest (27.8%) was recorded by (CMS 821 A x AK-190) x GM-59. Overall mean oil content was 33.5%, whereas the mean oil content for single cross hybrids (38%) significantly superior (p=0.05) over three-way-cross hybrid mean oil content (33%).

The present investigation involving 32 three-way-cross hybrids and five commercial single cross hybrids were evaluated for yield and yield component traits in sunflower. The three-way-cross hybrids were early for 50% flowering compared to single cross hybrids and were on-par for other quantitative characters *viz*., plant height, head diameter, volume weight and 100 seed weight. While the three-way-cross hybrids were significantly lower for seed yield and oil content compared to single cross hybrids. However the (CMS-207A X IB-104)X DOR-R3 and (CMS-148A X IB-101)XDOR-R3 recorded on-par seed yield compared to commercial single cross hybrid checks. The cost involved for production of three-way-cross hybrids is much lower compared to single cross hybrids in sunflower. Hence these two three-way-cross hybrids (CMS-207A X IB-104)X DOR-R3 and (CMS-148A X IB-101)XDOR-R3 needs to tested over years and over locations, to identify their suitability for wide adaptability with less seed cost.

Conclusion

The sunflower hybrids showed significant differences for all tarits studied except days to 50% flowering and 100 seed weight. Among three-way cross hybrids seven hybrids ((CMS 821 A x R3 Br) x R-5; (CMS 852 A x IB-104) x R-10-Br; (CMS-207A X IB-104)X DOR-R3; (CMS-207A X IB-104)XR-8; (CMS-207A X IB-104)XGM-49; (CMS-148A X IB-101)XDOR-R3; (CMS-148A X IB-102)XGM-39) were most promising for seed yield. Whereas, the three-way cross hybrids (CMS-207A X IB-104)X DOR-R3 (2066kg/ha), (CMS-148A X IB-101)XDOR-R3 (2132kg/ha) and (CMS-148A X IB-102)XGM-39 (1994kg/ha) were significantly superior for seed yield as compared to mean of single cross hybrids (1961 kg/ha). These promising hybrids need to tested over different agro-climatic locations on large scale for adaption to commercial cultivation.

REFERENCES

Agarwal, P., Verma, S.S., Mishra, S.N. (2000). Phenotypic stability for different quantitative traits in maize hybrids. *Indian Journal of Agriculture Research*, 34: 107-111.

Anonymous, (2015). Annual Report of Sunflower. *Indian Institute of Oilseed Research, Hyderbad*. 14-15.

Arvind Kumar, (2015). Stakeholders access to oilseed technologies towards self sufficiency. *Publication by Indian Society of Oilseeds Research,* 11.

Hegde, D.M. and Venkattakumar, R. (2010). An overview of edible oil industry in India and future strategies. *Agricultural Year Book*, 121-125.

Kalpande, V.V., Lande, S.S., Weginwar, D.G. and Dudhe, M.Y. (2004). Heterotic studies in single and three way cross hybrids in Sunflower (*Helianthus annuus* L.). P.K.V. Research Journal, 28:73-74.

Kempthorne, O. (1957). An Introduction of Genetics Statistics. *The Iowa University Press*,pp.18-23.

Jayalaxmi V. and Narendra B. (2004). Evaluation of three way cross hybrids in Sunflower. *Agriculture Science Digest,* 24:286-288.

Reddy. B.N., Sudhakara Babu S.N., Harvir Singh, A.R.G. Ranganatha, A.R.G., Basappa, H. and Chander Rao, S. (2007). Sunflower: Package of practices for increasing production. *Published by The Project Director, Director of oilseeds Research, Hyderabad*.