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RESEARCH ARTICLE

A high yielding sunflower hybrid LSFH-171 with resistant to downy mildew and wide adaptability suitable for different agro climatic condition in India

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Abstract

In India most of the released public sector sunflower hybrids have a narrow genetic base and are vulnerable to the sunflower downy mildew (SDM) disease. Under the regime of the coordinated network project on sunflower in the country (CRP), Oilseeds Research Station (VNMKV), Latur, Maharashtra, center, developed the high-yielding and downy mildew-resistant sunflower hybrid LSFH-171 that was released during the year 2018 for commercial cultivation in India. The hybrid was developed by crossing CMS-17 A (Female parent) with downy mildew resistant restorer line RHA-1-1 (Male parent). On an average of 102 trials conducted for seven years (2009-2015) in India. This hybrid was found promising for seed yield (1831 kg/ha) with 8.3 and 17.4 % superiority over the national check hybrids KBSH-44 and DRSH-1 respectively. The oil yield of the LSFH-171 (608 kg/ha) revealed that it is 5.3 percent higher over check KBSH-44 and at par with DRSH-1. The hybrid screened under the downy mildew sick plot under the artificial epiphytotic condition showed resistant reaction (0%) to downy mildew disease as against susceptible reaction of check hybrid KBSH-44 (62.0 %) and DRSH-1 (73.2 %). Being high yield potential, LSFH-171 also showed tolerance to major pest and lodging resistance. Due to dense seed filling and high test weight (6.1 g) this new hybrid is a suitable choice for the farmers of India under rainfed and irrigated conditions.

Keywords: Sunflower hybrid, released, downy mildew resistance, seed, oil yield

Introduction

Among the oilseed crops sunflower (*Helianthus annuus* L.) is major oilseed crop of the world and in India it has been introduced in early 1960's. Since the introduction of the sunflower crop to India, the Downy Mildew (DM) disease has become devastating on the crop that has resulted in yield losses of up to 100% in the state of Maharashtra, targeting the few districts of the Marathwada (Chaudhari *et al.,* 2022). Therefore, in order to control the disease without the need for seed treatment or spraying, genetic resistance assumes importance. The public sector bread sunflower hybrids in the country rely on a narrow genetic base particularly for resistance to downy mildew disease.

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High yielding sunflower hybrids with inbuilt resistance to not only to this soil borne pathogen but also to the major pest, diseases and adaptability to the changing environments (Dudhe *et al.,* 2020) is a priority of modern breeding by utilizing the available germplasm and realization of their production potential. The limited numbers of public sector hybrids are phased out rapidly owing to their susceptibility to downy mildew disease and necessitating development of DM resistant hybrids. The sunflower is a crop of high risk due to losses caused by diseases (Dudhe *et al.,* 2025). Among the prominent approaches two approaches to overcoming this problem: a chemical approach and a genetic approach. The breeding approach improves genetic architecture. Also incorporation of genetic resistance is the most economical and convenient means for the management of fungal diseases. *Plasmopara halstedii* is the source of downy mildew, one of the economically significant diseases that can cause large losses in sunflower area and ultimately production. During 1986, Marathwada region (Maharashtra) in India this disease appeared on cultivar Morden with recording 36% of the disease (Shrishikar, 1995). The pathogen belongs to race-1, based on the systematic research conducted by Patil and Mayee (1990) to determine the race condition of the *Plasmopara halstedii* isolate from India. Sporadic occurrence of disease was also reported in the states Andhra Pradesh and Punjab. Whether the infection is primary (systemic) or secondary determines the degree of infection. Usually, the diseased plants have flat, small capitulates that may or may not yield seeds, short internodes that are chlorotic and pale yellow, and stunted growth. Therefore, the most efficient method of managing downy mildew in sunflowers is unquestionably the adoption of genetically resistant hybrids. Against this background, resistance has been successfully incorporated to develop downy mildew resistance in the sunflower hybrid LSFH-171. The new hybrid LSFH-171 was evaluated under the All India Coordinated Network Project on Sunflower (Acronym AICRP sunflower) to assess its yield and oil potential besides its resistance to different abiotic and biotic stresses. The article describes the potential of the released hybrid LSFH-171.

Materials and methods

The fertility restorer line RHA-1-1 which is confirmed resistant source to downy mildew disease in sick plot as well as in field condition and used as male parent to develop the hybrid. Whereas, the CMS 17A was used as the female parent. The obtained hybrids were tested in the National Screening Facility for downy mildew disease at the Oilseeds Research Station, Latur in replicated trials during 2009-2015. Also, the hybrid LSFH-171 was evaluated in AICRP (National level testing trials to release the new test hybrids in India) during 2009-2015 at 102 locations for seed yield; agronomical characters disease and pest reaction. The experiment was conducted in completely randomized block design (RCBD) with a spacing of 45 x 30cm with DRSH-1 and KBSH-44 as National checks to compare the performance of the new test hybrid (LSFH-171).

Results and discussion

The major objective of this study was to evaluate the yield, ancillary traits and downy mildew disease reaction of the hybrid LSFH-171 under National Coordinated trials on Sunflower during 2009-2015. Sunflower accessions were artificially screened against downy mildew disease using inoculation procedures such soil inoculation, seed inoculation, radical inoculation, and foliar spray approach (Patil *et al.,* 1993).

Under the National Screening Facility (diseased plot) developed for the *Plasmopara halstedii* till date 10000 accessions that include genetic stocks, inbreds, restorers, cultivated germplasm, varieties, national test entries and hybrids collected from national gene bank, ICAR-IIOR Hyderabad and from various AICRP centers in India were screened (Ghodke *et al.,* 2004; 2016). During 2009-2015 the hybrid was tested in AICRP project trials at 102 locations all over the country both in *kharif* and *rabi* seasons. The new hybrid LSFH-171 showed the overall superiority in seed yield of 18% and also over the check hybrids DRSH-1 (15.1) and KBSH-44 (16.3) (Table 1). The hybrid exhibited superiority over the standard (checks KBSH-44 and DRSH-1) in seed yield across the years and at all the locations. The seed yield of LSFH-171 (1838 kg/ha) was significantly higher over the check hybrids KBSH-44 (1696 kg/ha) and DRSH-1 (1564 kg/ha). The hybrid LSFH-171 surpassed in seed yield over the check hybrid KBSH-44 (8.15%) and DRSH-1 (17.71%) (Tables 2 and 3). The hybrid LSFH-171 has recorded the oil yield of 612 kg/ha against the check hybrids KBSH-44 (580 kg/ha) and DRSH-1 (613 kg/ha) (Table 4). Screening in downy mildew diseased plot revealed that the hybrid LSFH-171 was consistently resistant to downy mildew which it showed at par reaction to *Alternaria* and various other pests (Table 5). The six year testing of the hybrid showed 100% resistance (0 incidence) to downy mildew disease reaction under field and as well as sick plot conditions. Also the test hybrid showed 0 incidence of Necrosis where as in the check hybrid DRSH-1 and KBSH-44 the incidence is more than 60%. Data on other yield contributing and quality characters revealed that the hybrid LSFH-171 possess high test weight (6.1g) in comparison to the checks KBSH-44 (5.3 g) and DRSH-1 (5.7g) (Table 6).

Table 1: Overall performance of the test hybrid under the AICRP Co-ordinated *kharif* and *rabi* trials in India

Attributes	Year of testing	No. of trials	Proposed variety LSFH-171	DRSH-1 ©	KBSH-44 ©
Mean yield (q/ha)	First year (2009-10)	20	17.50	15.13	16.34
a) Zonal	Second year (2010-11)	31	17.66	13.82	16.90
b) Across zones (if, applicable)	Third year (2011-12)	15	23.38	20.11	20.54
	(2013-14)	11	17.53	16.14	19.92
	(2014-15)	13	14.32	13.90	13.43
	(2015-16)	12	17.68	15.81	15.66
	Mean (weighted)	**102**	**18.03**	**15.49**	**17.06**
Percentage increase or decrease over the checks and qualifying varieties	First year (2009-10)	20		+ 14.37	+ 7.09
	Second year (2010-11)	31		+ 27.78	+ 4.49
	Third year (2011-12)	15		+ 16.26	+ 13.82
	(2013-14)	11		+ 8.61	- 11.99
	(2014-15)	13		+ 3.02	+ 6.62
	(2015-16)	12		+ 11.82	+ 12.89
	Mean (weighted)	**102**			
Frequency in the top group (pooled for ¾ years)		**102**	**58**	**35**	**09**

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Table 2: Comparative performance of the LSFH-171 hybrid for seed yield and oil content

SN	Features	LSFH-171	DRSH-1(c)	KBSH-44 (c)
1	High seed yield (kg/ha)	1838	1564 **(17.71)**	1696 **(8.15)**
2	High oil yield (kg/ha)	612	613	580 **(5.69)**
3	Downy mildew disease (%)	0.00	73.27	62.07
4	High test weight (g)	6.1	5.7	5.3

(Figures in the parenthesis indicates % increase over check)

Table 3: Seed yield data for the AICRP co-ordinated trials tested in India

Year of testing	No of locations	Seed yield mean performance of		
		LSFH-171	DRSH-1 (c)	KBSH-44 (c)
2009 -2010	20	17.50	15.13	16.34
2010 -2011	31	17.66	13.82	16.90
2011 -2012	15	23.78	20.11	20.54
2012 -2013	02	24.10	20.93	22.61
2013 -2014	02	25.00	19.37	22.01
2014 -2015	19	15.90	14.83	14.84
2015 -2016	16	17.60	15.51	15.72
Mean (weighted)	**102**	**18.03**	**15.64 (17.71)**	**16.96 (8.15)**

(Figures in parenthesis indicates % increase over check)

Table 4: Oil yield data for the AICRP co-ordinated trials tested in India

Year of testing	No of locations	Oil yield mean performance of		
		LSFH-171	DRSH-1 (c)	KBSH-44 (c)
2009 -2010	20	609	602	585
2010 -2011	31	581	520	569
2011 -2012	15	779	816	739
2012 -2013	02	853	854	746
2013 -2014	02	918	777	742
2014 -2015	19	531	580	491
2015 -2016	16	549	611	505
Mean (weighted)	**102**	**612**	**613**	**580**

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Table 5: Reaction of test hybrids to major diseases and pests in the AICRP trials

Disease / pests	Evaluation / years	Mean disease / pests (%)		
		LSFH-171	DRSH-1 (c)	KBSH-44 (c)
Downy mildew (%)	Artificial (2009 to 2015)	0.00	73.27	62.07
Necrosis (%)	Artificial (2009 to 2015)	0.00	73.27	62.07
	Natural (2009 to 2011)	11.71	9.96	15.49
	Artificial	53.50	53.06	57.36
Alternaria (%)	Natural (2009 to 2011)	6.60	7.8	8.9
	Artificial (2009 to 2015)	38.61	43.22	44.99
Defoliators / plant stem borer (%)	Natural (2009 to 2015)	5.01	3.52	5.42
Stem borer (%)	Natural (2009 to 2015)	21.98	20.52	23.62
Thrips / plant	Natural (2009 to 2015)	8.41	7.56	7.94
Leaf hoppers / plant	Natural (2009 to 2015)	69.00	7.51	6.00
Helicoverpa / plant	Natural (2009 to 2015)	0.98	0.93	1.37

Table 6: Data on ancillary yield and quality parameters under AICRP trials

Characters	Years	Mean		
		LSFH-171	DRSH-1 (c)	KBSH-44 (c)
Plant heights (cm)	2009 to 2015	173	191	186
Days to 50 % maturity	2009 to 2015	64	65	66
Days to maturity	2009 to 2015	90	92	93
Head diameter (cm)	2009 to 2015	15.7	15.7	15.9
100 seed weight (g)	2009 to 2015	6.1	5.7	5.3
Volume weight (100 ml)	2009 to 2015	40.3	41.2	39.7
Hull content (%)	2009 to 2015	35.5	31.4	37.7

Due to its superior nature for high seed yield potential coupled with downy mildew disease resistance and high test weight over the check hybrids KBSH-44 and DRSH-1, the hybrid LSFH-171 was identified at national level for general cultivation during *kharif* and *rabi* seasons. The description and characteristics of LSFH-171 hybrid and the parents are presented in table 7. The hybrid LSFH-171 showed typical characters like, dark green shining medium leaves with deep serration which could be utilized as a marker character to identify the test hybrid. The test hybrid is an early-medium maturing hybrid and requires 90 days for maturity. Being a hybrid with high yield potential, LSFH-171 also showed tolerance to major pests, resistance to downy mildew and resistant to lodging. The present findings of yield superiority coupled with resistance to major pests and diseases are in agreement with the observations for the sunflower variety Phule Bhaskar by Rajguru *et al.,* (2019) and the hybrid COH-3 by Manivannan *et al.,* (2021). The LSFH-171 hybrid is crucial for the long-term sustainability of sunflower in various agro-production systems in India because of its resistance to the downy mildew disease and high seed output potential in both the *kharif* and *rabi* seasons.

Table 7: Characteristics of the parents and released hybrid

Characters	**Female (CMS 17A)**	**Male (RHA-1-1)**	**Hybrid (LSFH-171)**
Plant height (cm)	140-150	170-180	175-180
Distinguishing morphological characters	Light green, shining medium leaves	Dark green medium leaves.	Dark green shining medium leaves
Serrations	Medium serration	Deep serration	Deep serration
Steam attributes	Thin stem	Strong stem	Strong and stout stem
Head attributes	Flat head	Flat head	Flat to convex head
Days to 50% flowering	52-55 days	60-63 days	57-58 days
Maturity (Range in number of days-seed to seed).	85 days	95 days	90 days
It there any problem of synchronization? If yes, methods to overcome it	--	6-8 days early sowing than female	--
Reaction to major pests	Tolerant to major pest	Tolerance to major pest	Tolerance to major pest
Reaction to major diseases	Susceptible to downy mildew disease	Resistant to downy mildew disease	Resistant to downy mildew disease
Agronomic features	Resistant to lodging	Susceptible to lodging	Resistant to lodging

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