RESEARCH ARTICLE

SCREENING OF POWDERY MILDEW TOLERANCE IN LINSEED (*LINUM USITATISIMUM* L.)

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Abstract: A set of one hundred fifty linseed germplasm accessions were evaluated for powdery mildew tolerance which was taken from AICRP on Linseed, Department of Genetics and Plant Breeding IGKV, Raipur (C.G.) during *Rabi* 2014-15 *and* 2015-16. In India and Chhattisgarh it has been observed that major limiting factors for higher production is powdery mildew. Particularly in Chhattisgarh the yield losses due to powdery mildew may be more than 60% when the disease is severe. Powdery mildew is the major cause in the linseed production during *utera* cultivation, It lows yield about 40%. The assessment of the disease per plant was obtained by observing the intensity of lesions present on the leaves. Keeping in this view, disease screening studies were made to understand the development of powdery mildew diseases. So, we need a high yielding linseed variety for late sown conditions with resistance to powdery mildew. With this objective, field screening of linseed genotypes for resistance to powdery mildew was initiated. Powdery mildew score ranged from 0 (free) to 5 (highly susceptible), 21 genotypes found highly resistant, 44 genotypes showed resistant, 47 genotypes comes under moderately resistant, 20 genotypes shows susceptible and only 8 genotypes showed highly susceptible. Despite being high susceptible, some test entries produced good yield and showed tolerance to powdery mildew disease. Highly resistant genotype could be utilized as donar parent for powdery mildew resistance breeding programme.

Keywords: ALA, Germplasm, Linseed, Powdery mildew, SDG

INTRODUCTION

Linseed (*Linum usitatissimum* L.) 2n = 30, is an important oilseed crop that belongs to the genus *Linum* of the family Linaceae. It is also called flax or flaxseed. The name *Linum* originated from *lin* or "thread" and the species name *usitatissimum* is a Latin word meaning "most useful". It has been grown from ancient times for fiber (flax) and for its seed which is rich in oil. On the basis of diversity of plant types, linseed has two centers of origin *i.e.*, South West Asia, particularly in India (Vavilov, 1935; Richharia, 1962) and the Mediterranean region of Europe.

Around the globe linseed crop occupies an area of 22.70 lakh ha yielding out 22.39 lakh tones having an average productivity of 986 kg/ha. In India, it is grown in an area of 29210 ha with production and productivity being 141200 tones and 484 kg/ ha respectively. India ranks second in area after Canada which is almost equivalent to China which so far occupied the second slot in world area by the crop. Our national production slides to third place after Canada and China. India contributes about 14.89% and 6.56% to world area and production respectively. In India, the crop is mainly cultivated in the states like Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Maharashtra, Bihar, Odisha, Jharkhand, Karnataka and Assam accounting for more than 97 per cent of the total area. Chhattisgarh is one of the important linseed growing states of India, which account 26200 hectares area and 1100 tonnes production with productivity of 424 kg/ha (Annual Report, Linseed 2014-15).

Industrial oil and mostly, 80 percent of oil is used for paints, varnishes, a wide range of coating oils, linoleum, pad and printing inks, oil cloth, patent leather, enamels, stickers, tarpaulins leather and soap industries. Linseed contains about 33 to 45% oil and 24% crude protein which is one of the oldest commercial oils used for various purposes. Recently it has gained a new interest in the emerging market of functional food due to its high content of fatty acids, alpha linolenic acid (ALA), an essential Omega3 fatty acid and lignan content or SDG (secoisolariciresinol diglucoside) which constitute about 57 % of total fatty acids in linseed (Morris, 2005). Almost every part of its plant is commercially utilized, either directly or after processing. New industrial uses of both the linseed oil and the fibres of oilseed flax also will increase the demand for this multi-use oilseed crop.

The crop is affected by some diseases like alternaria blight, powdery mildew, rust and wilt. powdery mildew, caused by the obligate biotrophic ascomycete *Oidium lini* Skoric, is a common, widespread, and easily recognized foliar disease of flax present in most growing areas worldwide (Gill, 1987, Beale, 1991, Saharan and Saharan, 1998, Aly *et al.*, 2012) is one of the major limiting factors of linseed. The disease appear on all the aerial parts of the plant, ultimately causes substantial losses in yield up to 60 % (Srivastava *et al.*, 1997, Reddy *et al.*, 2013a). Over the last two decades, the importance of this disease has increased probably due to the appearance and rapid distribution of new races capable of attacking the previously resistant cultivars (Aly *et al.*, 1994, Mohamed, 2012). In India and

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Chhattisgarh it has been observed that major limiting factors for higher production is powdery mildew. Particularly in Chhattisgarh the yield losses due to powdery mildew may be more than 60% when the disease is severe, particularly at the time of flower initiation.

Despite considerable increase in productivity and production a wide gap exists between potential yield and the yield realized at farmer's field which is largely because of a number of biotic stresses, to which linseed crop is exposed. The cost of chemicals farmer rarely practice such control measures and the usage of such fungicide will negatively affect environment and specially human health. Therefore the most effective way to control powdery mildew is the use of resistant varieties. Genetic resistance is a priority for flax breeders because fungicides can be hazardous, costly, and associated with environmental concerns. The genetics of resistance to powdery mildew in flax and reported a single dominant gene designated PM1 for resistance to powdery mildew (Rashid and Duguid, 2003).

Therefore, there is a need to develop varieties resistant to powdery mildew to stabilize the yield potentials of linseed varieties. Therefore, this research work helps in developing varieties resistant powdery mildew diseases to stabilize the yield potentials of linseed varieties. The manipulation of inherent potentials of plants in the form of resistant varieties is a cheap, viable and environment friendly alternative to reduce losses from biotic stress.

MATERIAL AND METHOD

The biological experimental materials comprised of one hundred fifty diverse lines selected based on morphological and unique traits from germplasm collection of exotic and indigenous accessions of linseed, which was taken from AICRP on Linseed, Department of Genetics and Plant Breeding IGKV, Raipur (C.G.). Experiment was conducted at the Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh (210 16‟ N and 810 36‟ E at an altitude of 289.6 meter above mean sea level), during *Rabi* 2014-15 and 2015-16. The climatic conditions of Raipur are subtropical. The region receives 1200-1400 mm rainfall annually out of which about 8 per cent is received during *Rabi* season. The rainfall pattern has great variation during rainy season from year to year. Monsoon generally breaks by the end of June and continues up to September.

Disease assessment

The disease reactions presented (Table 1) are based on two-year observations. The results are based on screening under natural field conditions. Germplasm were sown one month late during November. All entries were assessed visually based on percentage of leaf area affected using 0-5 scale (Anonymous, 1991) as detailed below:

Table 1. Scale (0-5) for rating of reaction to powdery mildew

S.N.	Score	Disease intensity (% area of leaves/plant infected)	Rating	
1	0	Free from disease	Highly resistant	HR
2	1	1 to 10	Resistant	R
3	2	11 to 25	Moderately resistant	MR
4	3	26 to 50	Moderately susceptible	MS
5	4	51 to 75	Susceptible	S
6	5	Above 75	Highly susceptible	HS

Screening method

One hundred fifty germplasm were screened against powdery mildew under natural epiphytotic conditions during *Rabi* 2014-15 and 2015-16 under the Research cum Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. All entries were assessed visually based on percentage of leaf area affected using 0-5 scale genotypes which were tagged with labels, Each plant was scored visually in the field and plants were rated (Table 1) in 0-5 scale, where, 0- highly resistance, 1- resistance, 2- moderately resistance, 3- moderately susceptible, 4- susceptible and 5-highly susceptible(AICRP 1991). The assessment of the disease per plant was obtained by observing the intensity of lesions present on the leaves. The plants with disease rating <2 were considered as resistant and above 2 as susceptible. All recommended package of practices was followed except spraying of plant protection chemical to allow maximum inoculation of powdery mildew diseases.

RESULT AND DISCUSSION

The plant breeder is the principal user of germplasm collections and therefore, it is pertinent to consider the kind of information that the breeder will want about each accession. Though, the potential of a germplasm sample is largely unknown at the time of its collection, it has been observed that a number of desirable characters are identified whenever a diverse group of germplasm samples are evaluated and screened. The breeder is only interested in a small fraction of the entire collection for its immediate objectives. Further, the crop is prone to the disease powdery mildew caused by *Oidium lini* Skoric due to late sowing. When powdery mildew appears in severe format an early stage of crop growth, yield

reduction is very high substantial losses in yield up to 60 % (Srivastava *et al.,* 1997, Reddy *et al.,* 2013 b). Infected plants produce poor quality seed and fibre. It is a common foliar disease of linseed, powdery mildew control strategies include usage of chemicals but due to the cost of chemicals farmer rarely practice such control measures and the usage of such fungicide will negatively affect environment and specially human health. Therefore the most effective way to control powdery mildew is the use of resistant varieties. Keeping in this view, disease screening studies were made to understand the development of powdery mildew diseases. So, we need a high yielding linseed variety for late sown conditions with resistance to powdery mildew. With this objective, field screening of linseed genotypes for resistance to powdery mildew was initiated.

In the present investigation one hundred fifty accessions were screened for identification of resistance sources against natural infection by powdery mildew diseases under field conditions during late *Rabi* season 2014-15 and 2015-16. All recommended package of practices was followed except spraying of plant protection chemical to allow maximum inoculation of powdery mildew diseases.The natural disease incidence was quite severe during the season due to conditions favourable for the development of the disease. Disease intensity on each accessions was scored as per the scale of AICRP (1991), 0-5 scale. Accessions were screened for their reaction against powdery mildew diseases and depending upon their genetic makeup of each accessions responded differentially to powdery mildew diseases. Powdery mildew score ranged from 0 (free) to 5 (highly susceptible), 21 genotypes found highly resistant, 44 genotypes showed resistant, 47 genotypes comes under moderately resistant, 20 genotypes shows susceptible and only 8 genotypes showed highly susceptible. Despite being high susceptible, some test entries produced good yield and showed tolerance to powdery mildew disease. The germplasm lines (R-17,RLC-148,RLC-151,CGLC-1,Polf-5,Parvati, Jeevan, R-4229, R-4231, R-4238,R-4211, R-4214, R-4222,R-2620,ES-13239,EX-5-36, ys1805, YS1818, CGLC-12, ES-1445, R-4209) shows high yield and highly resistant to powdery mildew. Highly resistant genotype could be utilized as donar parent for powdery mildew resistance breeding programme. The list of genotypes and disease reaction present in Table 2.

The results are based on screening under natural field conditions. Environmental factors such as humidity, temperature or light can influence development of the diseases possibly explaining these differences in scores. So, the resistant genotypes need to be evaluated under artificial conditions to confirm the resistance before using them in breeding programme. The present work is agreement with Reddy *et al*.,(2013c), Dash *et al*.,(2016).

The success of breeding programme is primarily depend on genetic variation availability in the breeding material. Evaluation and understanding the extent of genetic variation existing in the germplasm is important and leads to effective utilization of the germplasm thus only a small portion of genetic variability has been exploited in genetic improvement of this crop. Inspite of several diverse linseed accessions having been collected, only a few have been chosen and repeatedly employed in cultivar development programme. The germplasm is the prime source for resistance to diseases and insect pest. Plant breeders need to explore the nature of disease resistance and identify additional resistance genes from new sources. Therefore, this research work helps in developing varieties resistant to powdery mildew to stabilize the yield potentials of linseed varieties.

Table 2. Screening of one hundred fifty germplasm for powdery mildew tolerance during 2015-16 at Raipur, C.G.

Score	Disease intensity (% area of leaves/plant infected)	Rating	Number of genotypes
0	Free from disease (HR)	21	R-17,RLC-148,RLC-151,CGLC-1,POLF-5,Parvati, Jeevan, R-4229, R-4231, R-4238,R-4211,R-4214, R-4222,R-2620,ES-13239,EX-5-36, YS1805, YS 1818, CGLC-12, ES-1445, R-4209,
1	1 to 10% (R)	44	Sagarlocal, Neela, Sakoor,Kartika,RLC-92, Meera, Kiran, Nagarkot, R-7, CGLC-3, CGLC-10, CGLC-11, CGLC-15, CGLC-16, CGLC-17, CGLC-20, R-4193, R-4194, R-4195, R-4196,YS1806,YS1807,YS1808,YS1809,YS1814,YS1816, YS1817, R-552, RLC-29, RLC-26, Sabour Yellow, R-4227, R-4230, R-4233, R-4235, R-4236, R-4237, R-4216, R-2609, R-2627, R-2632, EX-79-5-9, POLF-15
2	11 to 25% (MR)	47	IA-32, RLC-149, RLC-150, RLC-152, CGLC-6, CGLC-13, CGLC-18, CGLC-21, R-4192, RL-99-50, Ayogi-91, RLC-71, Padmini, Surabhi, OL-8-2-7, RL-10195, R-4226, R-4228, R-4232, R-4239, R-4240, EX-53-9, EX-304, FLAX-16, ES-1463, ES-153, CGLC-2, CGLC-19, POLF-19, JRF-3-1, Rashmi, R-4234, R-4204, R-4205, R-4206, R-4207, R-4210, R-4213, R-4215, R-4218, R-4220, R-2618, R-2622, R-2624, RLC-133, EX-339-6, ES-1476, DEEPIKA.
3	26 to 50%	20	CGLC-5, CGLC-9, R-4191, YS1810, YS1812, YS1813, YS1815, R-2605, R-2606, R-

	(MS)		2611, R-2617, R-2625, R-2631, ES-13230, EX-3-3, FRW-11, ES-1474, ES-1534, CGLC-4, R-2610.
4	51 to 75% (S)	10	CGLC-8, R-4221, R-2613, R-2629, FRW-6, YS1811, ES-13219, EX-3, EX-63, R-2623
5	Above 75% (HS)	8	T-397, Neelam, Chambal, Shekhar, R-2601, R-2630, CGLC-7, YS1819.

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