Plant Archives Vol. 16 No. 1, 2016 pp. 297-302 *ISSN 0972-5210*

DUS CHARACTERIZATION OF LINSEED (*LINUM USITATISSIMUM* L.) GERMPLASM

Namrata Dhirhi*, Rajshree Shukla, Nandan Mehta, P. K. Singh[1] and S. D. Dubey[1]

Department of Genetics and Plant Breeding, I.G.K.V., Raipur - 492 012 (Chhattisgarh), India.
[1]PC Unit, I.C.A.R., AICRP on Linseed, Kanpur (Uttar Pradesh), India.

Abstract

Linseed or flax (*Linum usitatissimum*) is a multipurpose crop grown in many environments for food, feed, fibre and industry. The availability of diverse germplasm of characterization data and evaluation data is of greatest importance to realize the potential of flax in agriculture. In linseed, large number of germplasm are available with greater similarity for their plant structure as well as for blue flower so at this real use of DUS is very much applicable. Therefore, looking to these facts present study was based on DUS characterization of 150 diverse line including exotic and indigenous accessions of linseed, which were taken from AICRP on Linseed, Department of Genetics and Plant Breeding IGKV, Raipur (C.G.), India during *Rabi* 2014-15. Observations were recorded as per DUS, UPOV 2011. The morphological traits were evaluated as per Distinctiveness, Uniformity and Stability (DUS) guidelines. Yield contributing characters like plant height, time of flowering, capsule size, seed size and 1000 seed weight showed variation and most of the lines come under medium category as 79%, 43%, 52%, 77%, 43% respectively. The molecular descriptors developed here will be useful for genetic mapping and selection of breeding lines. The results showed the range of characters which can be exploited in breeding lines appropriate for smallholder and commercial farmers in, producing a sustainable, secure, high-value crop meeting agricultural, economic and cultural needs.

Key words : Linseed, flax, diversity, germplasm, fibre, DUS.

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". On the basis of diversity of plant types, linseed has two centers of origin *i.e.*, South West Asia, particularly in India (Vavilov, 1935 and Richharia, 1962). Linseed or flax (*Linum usitatissimum*) is an important crop for seed oil, stem fibre and to a lesser extent, flour. Linseed oil is used for paints, inks, varnish and other wood treatments, soap, linoleum, putty and pharmaceuticals. The fibre from flax is a widely used and valuable raw material for textiles, thread/rope and packaging materials, the straw and short fibre for pulp to produce special papers: for cigarettes, currency notes and artwork; and the wooden part serves as biomass energy or litter in cattle farming (Rowland, 1998). The strength, non-elasticity, repeated flexibility and its recyclable nature, with a low density was very attractive for use as a rope and thread, interest in its use. *Linum usitatissimum*, the only cultivated species from the genus Linum has been cultivated for oil from the start of agriculture 8,000 years ago and slightly later for fibre (Zohary and Hopf, 2000). Allaby *et al*. (2005) suggest that the cultivated species arose from a single domestication event from *L. bienne*, and the first domestication characters involved selection for annual habit, non-shattering of capsules and more efficient self-fertilization (Fu, 2011). Seeds of different species and varieties within plant species have specific characters, which are suitable for distinguishing of varieties differences. This fact has important place for DUS testing and variety identification and verification (Keefe, 1999). The requirement of distinctness, uniformity and stability are assessed on the basis of characteristics. Describing the characteristics of a crop species based on standard descriptors is effective for better utilization and conservation of germplasm (Diederichsen and Richards, 2003). Look to the above facts study was undertaken for classification of 150 diverse linseed morphological germplasm based on Linseed descriptors

***Author for correspondence:** E-mail: namrata123igkv@gmail.com

or DUS guidelines or DUS descriptor as per UPOV 2011.

Materials and Methods

In the present investigation, the experimental material used in the research work obtained from AICRP on Linseed, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. (India) comprised of 150 diverse lines selected including exotic and indigenous. The experiment was conducted at the Research cum Instructional Farm, College of Agriculture, IGKV, Raipur, Chhattisgarh (21^0 16" N and 81^0 36" E at an altitude of 289.6 meter above mean sea level), during *Rabi* 2014-15 to generate the phenotypic data under managed field conditions. The experimental material was planted in augmented design. Observations was recorded as per DUS UPOV 2011, in which three random plants from each lines were taken for recording of data. Quantitative and qualitative characters were examined using measurements from a single plant or its part or from groups of plants or their parts, visual assessments from single plant or its part or from groups of plants or their parts, depend on the element used to characterize the accession and analysis carried out as per DUS, UPOV 2011. To assess distinctness(D), uniformity(U) and stability(S), the characteristics and their states as given for the characteristics were used at optimum plant growth stage.

Results and Discussion

Characterization is the description of plant germplasm. It determines the expression of highly heritable characters ranging from morphological or agronomical features. Characterization of germplasm is essential to provide information on the traits of accessions assuring the maximum utilization of the germplasm collection to the final users. Characterization is also increasingly done using complementary characterization methods to capture the full information. The role of germplasm in the improvement of cultivated plants has been well recognized however, the use of germplasm collections, particularly in the developing countries, is still limited despite this wide recognition. Until a collection has been properly evaluated and its attributes become known to breeders, it has little practical use, germplasm evaluation, in the broad sense and in the context of genetic resources, is the description of the material in a collection. It covers the whole range of activities starting from the receipt of the new samples by the curator and growing these for seed increase, characterization and preliminary evaluation, and also for further or detailed evaluation and documentation. In view of the wide range of genetic variability in germplasm collections of cultivated plants ranging from wild and weedy types to high yielding varieties, all necessary care should be taken before making any strategy for their evaluation and characterization. Also, the breeding aims change rapidly. For effective evaluation of germplasm, a close organizational and personal contact between curator and breeder is necessary in the context of breeding objectives and evaluation programme.

In present study, 150 diverse line including exotic and indigenous accessions of linseed, which was taken from AICRP on Linseed. Each accession were regularly observed throughout the season at different growth stages, off types are roughed out. Qualitative characters were examined using measurements from a single plant or its part, or from groups of plants or their parts, visual assessments from single plant or its part, or from groups of plants or their parts depend on the element used to characterize the accession. All morphological descriptors showed remarkable differences in their distribution and amount of variations within them.

1. Plant characteristics

1.1 Plant growth habit : It is classified into 2 groups *viz*. erect and semi erect. Fifty three lines or 35% grouped under erect whereas, rest of ninty seven lines or 65% showed semi erect growth habit (table 1).

1.2 Plant height (cm) : The height of plant from the base, to the tip of the main stem was recorded in centimeters, plant height divided into 3 classes namely, long (>70cm), medium (51-70cm), short (<51). Seventeen lines or 12% having long plant height, one hundred nineteen or 79% were grouped in medium height and fourteen lines or 9% comes under short height (table 1).

2. Flower characters

2.1 Time of flowering : For each genotype, number of days taken from the day of sowing to the day on which 50% of the plants showed flowering was recorded as the number of days taken for 50% flowering. Out of one fifty diverse germplasm only thirty line or 20% having early (<50 days), sixty four lines or 43% were showing medium (50-60 days) and fifty six lines or 37% having late flowering (>60 days) (table 1).

2.2 Size of corolla : It is recorded in beginning of flowering. It is grouped in 3 categories *viz*. Large, medium, small. Measurement done of a numbers of individual plants or parts of plants. Sixty one lines or 41% showed large corolla, eighty four or 56% were showed medium corolla and only five line or 3% were observed under small corolla (table 1).

2.3 Flower shape : It must be recorded before noon.

Flower shape grouped in 4 groups namely, funnel, star, disk, tubular form, all the one fifty line or 100% were comes under funnel shape (table 1).

2.4 Flower size (mm) : It is recorded in peak flowering, measured as the distance from petal to petal recorded in millimeter. This character were categorized into 3 classes, *viz*. large (> 20 mm), Medium (15-20 mm), small (< 15 mm). Out of one fifty line, fourty nine line or 33% having large flower size, ninty two or 61% were showed medium and only nine line or 6% line comes under small flower size (table 1).

2.5 Colour of corolla : It scored in fully opened flower by visual observation. it is classified into 6 groups as blue, tinge blue, Lilac, white, light violet blue, red violet. One fourty line or 93% were included into blue colour, three line or 2% having tinge blue, five line or 4% were showed white colour and only two line or 1% were comes under light violet blue (table 1).

2.6 Petal aestivation : It is recorded as arrangement of petals. According to this, it is grouped into 3 classes *viz*. semi twisted, twisted and valvate. Out of one fifty lines, twenty two lines or 15% having semi twisted aestivation, seventy three lines or 48% were grouped in twisted and Fifty five lines or 37% were comes under valvate aestivation (table 1).

2.7 Petal venation colour : It is recorded in fully developed flower. It is grouped into 3 classes as, blue, violet, white, light violet. one thirty four lines or 89% included in blue colour, ten lines or 7% were grouped into violet blue and only six lines or 4% showed white petal venation colour (table 1).

2.8 Stamen : Filament colour : It is recorded after flower opening. On the basis of filament colour, it is grouped into 3 categories *viz*. blue, violet, white. Out of one fifty lines, ten lines or 7% showed blue colour, eighty six lines or 57% were included under violet and fifty four lines or 36% were showed white filament colour (table 1).

2.9 Anther colour : Anther colour showed a continuous range of colour variation as, blue, violet, cream, grey. One line or 0% having blue colour anther, one line or 1% showed violet, ten lines or 7% were cream colour and the highest one thirty eight lines or 92% comes under grey colour anther (table 1).

3. Seed characteristics

3.1 Capsule size (mm) : It is recorded of fully developed capsule in millimeter. It is classified in 3 groups *viz*. bold (>8.5 mm), medium (7- 8 mm), small (<7 mm). Fourteen lines or 9% were recorded bold capsule, seventy eight lines or 52% grouped in medium and fifty eight lines or 39% showed small capsule size (table 1).

3.2 Capsule dehiscence : It is recorded at the maturity time. It is grouped into 2 classes as, Dehiscent, Semi Dehiscent and Non Dehiscent. Out of one fifty lines, twelve lines or 8% were grouped under semi dehiscence and the highest one thirty lines or 92% having non dehiscence nature (table 1).

3.3 Capsule : Shape of tip : It is recorded as the presence or absence of pointed and blunt tip. All the one fifty lines or 100% were found to have pointed tip (table 1)

3.4 Seed colour : It is recorded as visual observations. It is grouped in 4 categories *viz*. fawn, brown, dark brown, light brown and yellow. Sixty two lines or 41% having brown colour, twenty nine or 19% showed dark brown, fourty two or 29% grouped under light brown and seventeen lines or 11% showed yellow colour seed (table 1).

3.5 Seed size (mm) : Longitudinal dimension measured as the distance from the base to the tip of the seed. On the basis of size it is categorized into 3 classes as, bold (>5 mm), medium (4-5 mm), small (<4 mm). Four lines or 2% grouped into bold seeded, one hundred fifteen or 77% having medium seeded and thirty one lines or 21% comes under small seeded (table 1).

3.6 100 seed weight : Weight of 1000 well-developed grains collected from the bulk of plants selected was recorded and expressed in grams. According to weight, it is grouped in 3 classes *viz*. high (>8 g), medium (6-8 g), low (< 6 g). Sixty three lines or 42% were showed high seed weight. Sixty five or 43% having medium seed weight and twenty two line or 15% grouped into low seed weight (table 1).

Discussion

A range of descriptors was elaborate for 150 diverse linseed accessions maintained at and these have uses for both the characterization of germplasm and its evaluation for use by farmers and breeders. Diversity in the germplasm was essential to meet different purposes of the crop such as increased yield (Joshi and Dhawan, 1986), wider adaptation, desirable quality, pest and disease resistance (Begum *et al*., 2007). Information on the extent and nature of interrelationship among characters help in formulating efficient scheme of multiple trait selection. Besides this, knowledge of the naturally occurring diversity in a population helps identifying diverse groups of genotypes (Tedesse *et al*., 2009). These findings are significant for understanding linseed domestication and also are useful in classifying intra specific diversity of cultivated of linseed, establishing a core subset of the

Table 1 : Characterization of 150 diverse linseed germplasm based on Distinctness(D),Uniformity(U) and Stability(S) as per DUS, UPOV 2011.

Trait	Descriptor state	Class or scale	Distribution by classes of descriptor (%)
Plant growth habit	Recorded considering both the angle of the basal branching and the crop canopy.	Erect	53 (35%)
		Semi erect	97 (65%)
Plant height	The height of plant from the base, to the tip of the main stem was recorded in centimeters.	Long (>70)	17 (12%)
		Medium (51-70cm)	119 (79%)
		Short (<51)	14 (9%)
Time of flowering	Number of days taken from the day of sowing to the day on which 50 % of the plants showed flowering was recorded.	Early (<50 days)	30 (20%)
		Medium(50-60days)	64 (43%)
		Late (>60 days)	56 (37%)
Size of corolla	It is recorded in beginning of flowering.	Large	61 (41%)
		Medium	84 (56%)
		Small	5 (3%)
Flower shape	It must be recorded before noon.	Funnel	150 (100%)
Flower size	It is recorded in peak flowering.	Large (> 20 mm)	49 (33%)
		Medium (15-20 mm)	92 (61%)
		Small (< 15 mm)	9 (6%)
Colour of corolla	It scored in fully opened flower by visual observation	Blue	140 (93%)
		Tinge blue	3 (2%)
		White	5 (4%)
		Light violet blue	2 (1%)
Petal aestivation	It is recorded as arrangement of petals.	Semi twisted	22 (15%)
		Twisted	73 (48%)
		Valvate	55 (37%)
Petal venation colour	It is recorded in fully developed flower.	Blue	134 (89%)
		Violet blue	10 (7%)
		White	6 (4%)
Stamen:filament colour	It is recorded after flower opening	Blue	10 (7%)
		Violet	86 (57%)
		White	54 (36%)
Anther colour	immediately after flower opening	Blue	1 (0%)
		Violet	1 (1%)
		Cream	10 (7%)
		Grey	138 (92%)
Capsule size	It is recorded of fully developed capsule	Bold (>8.5 mm)	14 (9%)
		Medium (7-8 mm)	78 (52%)
		Small (<7 mm)	58 (39%)

Table 1 continued....

Table 1 continued...

Trait	Descriptor state	Class or scale	Distribution by classes of descriptor (%)
Capsule dehiscence	It is recorded at the maturity time	Semi dehiscence	12 (8%)
		Non dehiscence	138 (92%)
Capsule: shape of tip	It is recorded as the presence or absence of tip.	Pointed	150 (100%)
Seed colour	It is recorded as visual observations	Brown	62 (41%)
		Dark brown	29 (19%)
		Light brown	42 (29%)
		Yellow	17 (11%)
Seed size	Longitudinal dimension measured as the distance from the base to the tip of the seed.	Bold (>5 mm)	4 (2%)
		Medium (4-5 mm)	115 (77%)
		Small (< 4 mm)	31 (21%)
Seed weight	Weight of 1000 well-developed grains collected from the bulk of plants selected was recorded and expressed in grams.	High (>8 g)	63 (42%)
		Medium (6-8 g)	65 (43%)
		Low (< 6 g)	22 (15%)

linseed collection and exploring new sources of genes for linseed improvement (Fu, 2005). Adugna *et al*. (2006), Savita (2006), Fulkar *et al*. (2007), Sinha and Wagh (2013) reported wide range of genetic diversity in linseed.

In conclusion, there is substantial morphological variation within the linseed germplasm and reflecting both regional and altitude differences. Yield contributing characters like plant height, time of flowering, capsule size, seed size and seed weight showed variation themselves. The highest 79% lines comes under medium plant height, 43% lines showed medium flowering duration, 78% lines grouped under medium capsule size, 77% seed size classified under medium size and 43% lines comes under medium seed weight. Results from the present study indicate that several genes interact for development of different characters. Measurements of morphological variation will be helpful in the selection of distinguishable, uniform and stable traits, which will be very useful at the time of seed production, monitoring programme of linseed. In addition to that suitable parents for breeding programme may be used by making diallel among diverse parents. They provide good transgressive segregant for oil, linen, dual purpose integrated with value addition along with regional adaptation. In this way the crop diversity can be exploited for reaching the goals as well as linseed with regarding the area, production and productivity in future with respective challenges.

References

Adugna, W., M. T. Labuschagne and C. D. Viljoen (2006). The use of morphological and AFLP markers in diversity analysis of linseed. *Biodiversity and Conserv*., **15** : 3193-3205.

Allaby, R. G., G. W. Peterson, D. M. Andrew and Y. B. Fu (2005). Evidence of the domestication history of flax (*Linum usitatissimum* L.) from genetic diversity of the Sad2 locus. *Theor. Appl. Genet*., **112** : 58-65.

Begum, H., A. K. M. M. Alam, M. J. A. Chowdhury and M. I. Hossain (2007). Genetic divergence in linseed (*Linum usitatissimum* L.). *Int. J. Sustain. Crop. Prod*., **2(1)** : 04-06.

Diederichsen, A. and K. Richards (2003). Cultivated flax and the genus *Linum* L. : taxonomy and germplasm conservation. In: Muir AD, Westcott ND (eds) Flax: the genus Linum. CRC Press, London, pp 22–54.

Fu, Y. B. (2011). Genetic evidence for early flax domestication with capsular dehiscence. *Genet. Resour. Crop Evol*., **58** : 1119-1128.

Fu, Y. B. (2005). Geographic patterns of RAPD variation in cultivated flax. *Crop Sci*., **45** : 1084-1091.

Fulkar, P. L., P. B. Ghorpade, J. J. Maheshwari, S. R. Patil, M. N. Reddy and P. Chebrolu (2007). Evaluation of linseed germplasm for genetic divergence and choice of parents. *J. Soils and Crops*, **17(2)** : 333-338.

Joshi, A. B. and N. L. Dhawan (1986). Genetic improvement of yield with special reference to self-fertilizing crops. *Indian J. Genet*., **26** : 101-113.

Keefe, P. D. (1999). Measurement of linseed (*Linum usitatissimum* L.) seed characters for distinctness,

uniformity and stability testing using image analysis. *Plant Varieties and Seeds*, **12(2)** : 79–90.

Richharia, R. H. (1962). *Linseed*. The Indian Central Oilseeds Committee, Hyderabad, India: 155.

Rowland, G. G. (1998). *Growing flax : Production, management and diagnostic guide*. Flax Council of Canada and Saskatchewan Flax Development Commission.

Savita, S. G. (2006). *Diversity of linseed germplasm for yield and yield components*. M. Sc. (Agriculture) in Genetics and Plant Breeding. Dissertation. Department of Genetics and Plant Breeding, College of Agriculture, University of Agricultural Sciences, Dharwad.

Sinha, S. and P. Wagh (2013). Genetic studies and divergence analysis for yield, physiological traits and oil content in linseed. *Res. J. Agric. Sci*., **4(2)** : 168-175.

Tadesse, T., H. Singh and B. Weyessa (2009). Genetic Divergence in Linseed Germplasm. *J. Innov. Dev. Strategy*, **3(2)** : 13-20.

Vavilov, N. I. (1935). Studies on the origin of cultivated plants. *Bot. Pl. Breed*., **16** : 39-145.

Wang, Z., N. Hobson and L. Galindo (2012). The genome of flax (*Linum usitatissimum* L.) assembled de novo from short shotgun sequence reads. *Plant J*., **72** : 461-473.

Zohary, D. and M. Hopf (2000). Domestication of plants in the Old World : The origin and spread of cultivated plants in West Asia, Europe and the Nile Valley. Oxford University Press, Oxford.