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RESEARCH ARTICLE :

DUS characterization of linseed (*Linum usitatissimum* L.) germplasm

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SUMMARY : The field experiment was carried out to study the DUS characterization of linseed (*Linum usitatissimum* L.) germplasm in the research plots of new area belongs to the Department of Seed Science and Technology, College of Agriculture Raichur during *Rabi* 2016-17. Linseed or flax 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) distinctness, uniformity and stability is very much applicable. Therefore, looking to these facts present study was based on DUS characterization of thirteen diverse line including exotic and indigenous accessions of linseed, The seed materials were collected from AICRP on linseed, PC Unit, Kanpur. The genotypes used for the study were 1) Jeevan, 2) Ruchi, 3) Pratapalsi 4) Parvati, 5) Meera, 6) Rashmi, 7) Shikha, 8) Nagarkot, 9) Gaurav, 10) Jrf-1, 11) Jrf-3, 12) Jrf-4, 13) Pcl-16-2. 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 69.23% 76.92%, 53.84%, 100% and69.23%, respectively. 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, Diversity, Germplasm, Fibre, DUS

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BACKGROUND AND OBJECTIVES

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, nonelasticity, 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 arise 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, uniformityand stability are assessed on the basis of characteristics. Describing the characteristics of a crop species basedon standard descriptors is effective for better utilization and conservation of germplasm (Diederichsen and Richards, 2003). Look to the above facts study wasundertaken for classification of thirteen diverse linseed morphological germplasm on linseed descriptor or DUS guidelines or DUS descriptor as per UPOV 2011.

RESOURCES AND METHODS

In the present investigation, the experimental material used in the research work obtained from AICRP on Linseed, comprised of 13 diverse lines selected including exotic and indigenous. The experiment was conducted in research plots of new area belongs to the Department of seed science and technology College of Agriculture Raichur during *Rabi* 2016-17 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. 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, thirteen 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.

OBSERVATIONS AND ANALYSIS

Characterization is the description of plant germplasm showed in (Table 1, 2 and 3). 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.

Plant characteristics :

Plant growth habit :

It is classified into 3 group erect, semierect and bushy here all the thirteen line or 100% were comes under bushy growth habbit (Table 1).

Plant height (cm) :

The height of plant fromthe base, to the tip of the main stem was recorded incentimeters, plant height divided into 3 classes namely, long (>70cm), medium (51-70cm), short (<51). Twolines or 15.38 % having long plant height, nine lines or 69.23 % were grouped in medium height andtwo lines or 15.38 % comes under short height (Table 1).

Flower characters :

Time of flowering :

For each genotype, numberof days taken from the day of sowing to the day on which 50% of the plants showed flowering was recorded asthe number of days taken for 50% flowering. Out of thirteen diverse germplasm ten lines or 76.92 % were showingmedium (50-60 days) and three lines or 23.07 % havinglate flowering (>60 days) (Table 1).

Flower shape :

It must be recorded before noon. Flower shape grouped in 4 groups namely, funnel, star, disk, tubular form, Out of thirteen diverse germplasm three or 23.07 % were showing star shape and ten lines or 76.92 % having disk flower shape (Table 1).

Flower size (mm) :

It is recorded in peak flowering, measured as the

Table 1 : Characterization of 13 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.	Bushy	13(100%)
Plant height	The height of plant from the base, to the tip of the main stem was recorded in centimeters.	Long (>70)	2(15.38%)
		Medium (51-70cm)	9(69.23%)
		Short (<51)	2(15.38%)
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.	Medium(50- 60days)	10(76.92%)
		Late (>60 days)	3(23.07%)
Flower shape	It must be recorded before noon.	Star	3(23.07%)
		Disk	10(76.92%)
Flower size	It is recorded in peak flowering.	Small (< 15 mm)	13(100%)
Petal aestivation	It is recorded as arrangement of petals.	Valvate	13(100%)
Petal venation colour	It is recorded in fully developed flower.	Blue	8(61.53%)
		Violet blue	1(7.6%)
		White	4(30.76%)
Stamen:filament colour	It is recorded after flower opening	Blue	2(15.38%)
		Colourless	11(84.61%)
Anther colour	immediately after flower opening	Blue	10(76.92%)
		Cream	3(23.07%)
Capsule size	It is recorded of fully developed capsule	Bold (>8.5 mm)	2(15.38%)
		Medium (7-8 mm)	7(53.84%)
		Small (<7 mm)	4(30.76%)
Capsule dehiscence	It is recorded at the maturity time	Non dehiscence	13(100%)
Seed colour	is recorded as visual observations	Brown	13(100%)
Seed size	Longitudinal dimension measured as the distance from the base to the tip of the seed.	Medium	13(100%)
Seed weight	Weight of 1000 well-developed grains collected from the bulk of plants selected was recorded and expressed in grams.	Medium (6-8 g)	9(69.23%)
		Low (< 6 g)	4(30.76%)

distance from petal to petalrecorded in millimeter. This character were categorized into 3 classes, *viz*., large (> 20 mm), Medium (15-20 mm), small (< 15 mm). here all the thirteen line or 100% were comes under medium flower size (Table 1).

Petal aestivation :

It is recorded as arrangement of petals. According to this, it is grouped into 3 classes *viz.*, semi twisted, twisted and valvatehere all the thirteen line or 100% were comes under valvate (Table 1).

Petal venation colour :

It is recorded in fully developed flower. It is grouped into 3 classes as, blue, violet and white, eight lines or 61.53 % included in blue colour, one lines or 7.6% were grouped into violet and four lines or 30.76 % showed white petal venation colour (Table 1).

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 and colourless. Out thirteen lines, two lines or 15.38 % showed blue colour, and eleven lines or 84.61 % were showed colourless filament colour (Table 1).

Anther colour :

Anther colour showed a continuous range of colour

Table 2 : Grouping of genotypes based on qualitative characteristics

Genotypes	Flower shape	Flower colour	Petal aestivation	Venation colour	Stigma colour	Style colour	Anther colour	Filament colour	Capsule dehiscence
Gaurav	Disk	Blue	Valvate	Blue	Colourless	Blue	Blue	Blue	Non dehiscence
Pcl-16-2	Disk	Blue	Valvate	Blue	Colourless	Colourless	Blue	Colourless	Non dehiscence
Meera	Star	Blue	Valvate	Blue	Colourless	Blue	Blue	Colourless	Non dehiscence
JRF-4	Disk	White	Valvate	White	Blue	Blue	Cream	Colourless	Non dehiscence
Jeevan	Star	Blue	Valvate	Blue	Colourless	Colourless	Blue	Colourless	Non dehiscence
Parvati	Disk	Blue	Valvate	White	Colourless	Blue	Cream	Colourless	Non dehiscence
Ruchi	Disk	Violet	Valvate	Violet	Colourless	Colourless	Blue	Colourless	Non dehiscence
Nagarkot	Disk	Blue	Valvate	Blue	Colourless	Colourless	Blue	Colourless	Non dehiscence
Rashmi	Star	Blue	Valvate	Blue	Blue	Blue	Blue	Colourless	Non dehiscence
JRF-3	Disk	White	Valvate	White	Colourless	Colourless	Cream	Colourless	Non dehiscence
Shikha	Disk	Blue	Valvate	Blue	Colourless	Blue	Blue	Blue	Non dehiscence
JRF-1	Disk	White	Valvate	White	Colourless	Colourless	Blue	Colourless	Non dehiscence
Pratapalsi	Disk	Blue	Valvate	Blue	Colourless	Colourless	Blue	Colourless	Non dehiscence

Table 3 : Grouping of genotypes based on quantitative characteristics

Genotypes	Days to 50 % flowering	Flower size (diameter in mm)	Plant height (cm)	No. of capsules per plant	No. of seeds per capsule	Capsule size (diameter in mm)	Seed yield (g/plant)	Seed yield (q/ha)	Fibre yield (q/ha)
Gaurav	57.64	12.18	65.25	58.64	8.87	7.43	2.75	6.68	8.95
Pcl-16-2	57.56	11.50	42.25	84.94	7.27	8.20	2.79	6.85	7.58
Meera	57.20	12.48	69.75	84.75	8.45	7.28	2.92	7.03	9.40
JRF-4	57.31	12.33	88.75	67.79	7.94	8.23	3.34	9.02	11.88
Jeevan	59.65	12.25	63.00	76.52	7.41	6.25	2.93	7.82	9.77
Parvati	51.64	10.85	61.00	62.89	7.25	7.18	2.97	7.21	9.59
Ruchi	60.95	13.23	58.25	69.23	8.16	6.25	2.95	7.04	7.99
Nagarkot	54.27	14.03	41.50	73.79	8.27	7.28	3.05	7.08	10.53
Rashmi	61.33	12.65	54.00	51.69	9.47	6.53	2.96	7.06	8.64
JRF-3	60.34	14.40	53.50	61.94	9.43	7.20	2.93	7.28	9.14
Shikha	57.65	12.33	56.25	58.05	9.12	6.63	3.02	7.43	10.54
JRF-1	58.31	13.23	77.00	76.82	8.70	7.30	3.01	8.30	10.52
Pratapalsi	59.58	12.65	54.75	56.74	8.15	7.38	3.02	7.25	10.54
Mean	57.95	12.62	60.40	67.98	8.34	7.16	2.97	7.39	9.62
S.E.±	0.08	0.07	1.3	0.73	0.021	0.11	0.004	0.12	0.04
C.D. (P=0.05)	0.34	0.29	5.16	2.83	0.08	0.43	0.013	0.34	0.14

variation as, blue, violet, cream, grey. ten line or 76.92% having blue colour anther, three line or 23.07 % showed cream colour anther (Table 1).

Seed characteristics :

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). Two lines or 15.38 % were recorded bold capsule, seven lines or 53.84 % grouped in medium and four lines or 30.76 % showed small capsule size (Table 1).

Capsule dehiscence :

It is recorded at the maturity time. It is grouped into 3 classes as, Dehiscent,Semi Dehiscent and Non Dehiscent. All the thirteen lines or 100% were showing non dehiscent (Table 1).

Seed colour :

It is recorded as visual observations. It is grouped in 4 categories *viz*., fawn, brown, dark brown, light brown and yellow. All the thirteen lines or 100% were showing brown colour seed (Table 1).

Seed size (mm) :

Longitudinal dimension measured as the distance from the base to the tip of theseed. On the basis of size it is categorized into 3 classes as, bold (>5 mm), medium (4-5 mm), small (<4 mm).all Thirteen lines or 100% having medium seeded (Table 1).

100 seed weight :

Weight of 1000 welldeveloped grains collected from the bulk of plants selectedwas recorded and expressed in grams. According to weight, it is grouped in 2 classes *viz*., medium (6-8 g), low (< 6 g). nine lines 69.23% having medium seed weight and four lines or 30.76 % grouped into low seed weight (Table 1).

A range of descriptors was elaborate for thirteen 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 (Taedesse *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 linseed collection and exploring new sources of genes for linseed improvement (Fu, 2005). Adugna *et al*. (2006); Savita (2006); Fulkar *et al*. (2007) and 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 69.23% lines comes under medium plant height, 76.92% lines showed medium flowering duration, 53.84% lines grouped under medium capsule size, 100% seed size classified under medium size and 69.23% 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.

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