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Morphological characterization and assessment of variability in selected oat, *Avena sativa* L germplasm accessions

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ABSTRACT

The present study was carried out to characterize 48 oat genotypes on the basis of morphological and qualitative characters. Lodging at mature stage was highly variable and five categories were established for this trait at harvesting time conforming the divergence among the genotypes studied. Upright at maturity stage was predominant (81.25%) among the genotypes followed by minor lodging (12.50%), intermediate (4.16%) and lodged type categories (2.16%). Regarding growth habit majority of the genotypes were found to possess erect nature (85.41%) followed by semi-prostrate (14.58%) and none of the genotypes possessed prostrate nature of growth habit. It is important to select favourable genotypes with convenient erect trait. All the genotypes were found to possess glabrous nature for hairiness of leaf sheath and equilateral nature of panicle. Most of the genotypes had yellow (89.58%) and 10.41 per cent had white colour lemma. None of the accessions had lemma hairiness. This descriptor is of great importance in differentiating the two different species. Thus these kinds of characters may be utilized to select the agronomically superior genotypes visually. The genotypes having an erect plant growth habit with glabrous leaf sheath, erect nature of panicles and spikelets with waxiness were to be selected for abiotic stress tolerance. From the frequency distribution of different qualitative characters the evolutionary significance of a particular class could be inferred.

Keywords: Descriptors; divergence; frequency distribution; morphological and qualitative characters; oat genotypes

INTRODUCTION

Oat, *Avena sativa* L is an important cereal grown in different regions of the world next to wheat, maize, rice, barley and sorghum. It is widely used for human food and livestock feed. Most cultivated varieties of oat belong to an allohexaploid species with 2n= 6x= 42 chromosomes originated from the aggregation of three ancestral diploid genomes AA, CC, DD (Rines et al 2006). The development of modern

farming practices, optimization of natural resources and the selection of superior genotypes with desirable agronomic traits have increased cereal yields in recent decades. Oat is considered to be a nutritious source of protein, carbohydrate, fibre, vitamins and minerals as well as of compounds with beneficial effects on health (Peterson et al 2005). Oats production has continuously decreased whereas the demand for oats as a human food has increased because of its dietary benefits of the whole grain and □-glucan content (Buerstmayr et al 2007). The increase in oat grain yield as a result of genetic improvement is up to 0.8 per cent per year depending on the site and the genotypes for the different evaluation periods (Holland 1997). The genetic gain in oat is lower than for other cereal species such as wheat and barley which can be attributed to the presence of undesirable traits in elite germplasm such as disease susceptibility (Stuthman 1995). A better understanding of the genetic control related to the phenotypic variation in morpho-physiological and qualitative-quantitative traits is seen as a fundamental step in breeding programmes. Assessment of the genetic variability can be achieved using morphological measurements and phenotypic characterization (Greene et al 2008). Several studies investigated the genetic control of important oat traits such as partial leaf rust resistance (Martinelli et al 2009), photoperiod sensitivity and flowering (Locatelli et al 2008), tolerance to aluminum toxicity (Oliveira et al 2005, Nava et al 2006), morphology of primary grain (Cabral et al 2001), plant height (Mariot et al 1999) and panicle type (Bertagnolli and Federizzi 1994). The objective of the present study was to characterize a set of oat accessions for different morphological traits and evaluating the variability available in the collection for proper utilization of the germplasm.

MATERIAL and METHODS

The experiment was conducted during Rabi 2013-2014 at Indian Agricultural Research Institute, Regional Station, Wellington. A total of 48 genotypes received from IARI, Regional Station, Wellington, Department of Forage Crops, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore and Indian Grassland and Fodder Research Institute, Jhansi were evaluated under field condition using randomized complete block design with three replications. Observations were recorded on five randomly chosen competitive plants of each genotype per replication for twenty morphological traits. The germplasms were characterized using descriptors for oats (Anon 1985). The traits studied were growth habit, plant height, stem thickness, node hairiness, angle of flag leaf to culm, rigidity of flag leaf, hairiness of leaf sheath (lower leaves), shape of panicle, erectness of panicle, erectness of spikelets, waxiness of the panicle, lemma colour, hairiness of lemma, kernel covering,

awnedness, awn type, position of awn insertion, lodging at mature stage, relation between maturity of grains and straw and grain shedding at maturity. Frequency distributions for all the morphological traits were computed for drawing necessary conclusions.

RESULTS and DISCUSSION

A total of 48 genotypes of oats were evaluated for twenty morphological descriptors/characters. The genotypes showed a wide range of variability for all the morphological traits studied. The frequency distribution for twenty morphological characters (discontinuous variables) is presented in Table 1 and its graphical representation is shown in Fig 1. Regarding plant growth habit majority of the genotypes were found to possess erect (85.41%) followed by semi-prostrate (14.58%) and none of the genotypes possessed prostrate nature of growth habit. It is important to select favourable genotypes with convenient erect trait. These selection tendencies have evolved through centuries of practical experience. Erect plants can be planted in dense pattern and have better air circulation among them reducing the chance of fungal disease spread etc. In terms of crop management it can also help in defining the area for each plant, easy harvesting and feasibility to calculate the volume of chemical spray. Based on the characterization of plant height most of the genotypes were predominantly found to possess medium plant height (47.91%) followed by tall (29.16%) and the lowest per cent was represented by short stature (22.91%).

Selection of varieties normally favoured medium plant height since very tall plants would not be input responsive and prone to lodging whereas medium statured plants would be input responsive and tolerant to lodging. At the same time plants having medium height will offer enough fodder value also not as that of dwarf ones which might be input responsive and non-lodging bent would not provide sufficient quantity of fodder. For stem thickness character thin class predominated (54.16%) followed by intermediate (29.16%) and thick nature (16.66%). Most of the accessions had glabrous node (87.50%) whereas rest of the genotypes had slightly pubescent class (12.50). In case of angle of flag leaf to the culm the majority of the genotypes were distributed under acute category (60.41%) and 39.58 per cent under intermediate class. Rigidity of flag leaf of 41.91 per cent of the genotypes had slightly bent category, 35.41 per cent were under bent category and 16.66 per cent had stiff category. All the genotypes were found to possess glabrous nature for hairiness of leaf sheath and equilateral nature of panicle.

Dropping category was found in 47.91 per cent of the genotypes, 33.33 per cent possessed semi-erect and 18.75 per cent recorded erect class. For erectness of

Table 1. Frequency distribution of qualitative characters in oat genotypes

Character	Class	f	%
Growth habit	Erect	41	85.41
	Semi prostrate	7	14.58
	Prostrate	0	0.00
Plant height	Short	11	22.91
	Medium	23	47.91
	Tall	14	29.16
Stem thickness	Thin	26	54.16
	Intermediate	14	29.16
	Thick	8	16.66
Node hairiness	Glabrous	42	87.50
	Slightly pubescent	6	12.50
	Moderately pubescent	0	0.00
	Highly pubescent	0	0.00
Angle of flag leaf to culm	Acute	29	60.41
	Intermediate	19	39.58
	Obtuse	0	0.00
Rigidity of flag leaf	Bent	17	35.41
	Slightly bent	23	47.91
	Stiff	8	16.66
Hairiness of leaf sheath (lower leaves)	Glabrous	48	100.00
	Slightly pubescent	0	0.00
	Moderately pubescent	0	0.00
	Highly pubescent	0	0.00
Shape of panicle	Unilateral	0	0.00
	Equilateral	48	100.00
Erectness of panicle	Drooping	23	47.91
	Semi-erect	16	33.33
	Erect	9	18.75
Erectness of spikelets	Drooping	38	79.16
	Semi-erect	9	18.75
	Erect	1	2.08
Waxiness of the panicle	Absent	0	0.00
	Present	48	100.00
Lemma colour	White	5	10.41
	Yellow	43	89.58
	Grey	0	0.00

	Red	0	0.00
	Black	0	0.00
	Others (specify)	0	0.00
Hairiness of lemma	Glabrous	48	100.00
	Slightly pubescent	0	0.00
	Moderately pubescent	0	0.00
	Highly pubescent	0	0.00
Kernel covering	Grains naked	1	2.08
	Grains covered	47	97.91
Awnedness	No awns	8	16.66
	Weak awns	28	58.33
	Strong awns	12	25.00
Awn type	Straight	26	54.16
	Geniculate	14	29.16
	Others (specify)	0	0.00
Position of awn insertion	1/4 from base	0	0.00
	1/3 from base	6	12.50
	1/2 from base	36	75.00
	>1/2 from base	0	0.00
Lodging at mature stage	Upright (all plants)	39	81.25
	Minor lodging	6	12.50
	Intermediate	2	4.16
	Lodged	1	2.08
	Extremely lodged (all plants)	0	0.00
Relation between maturity of	Grain ripe before straw	39	81.25
grains and straw	Simultaneous	9	18.75
	Straw ripe before grain	0	0.00
Grain shedding at maturity	Low	33	68.75
	Intermediate	15	31.25
	High	0	0.00

spikelets character 79.16, 18.75 and 2.08 per cent of the genotypes were under drooping, semi-erect and erect category respectively. All the genotypes were having waxiness on their panicles. Majority of the genotypes had yellow (89.58%) and 10.41 per cent had white lemma colour. None of the accessions had lemma hairiness. This descriptor is of great importance in differentiating the two different species. Most of the genotypes possessed covered kernel (97.91%). Weak awns were predominated (58.33%) followed by strong awns (25.00%) and 16.66 per cent of the

accessions were not having any awns. Majority of the genotypes were having straight awns (54.16%) followed by geniculate type (29.16%). For position of awn insertion 75.00 per cent of the accessions had awn insertion half way from base whereas in 12.50 per cent it was located at one third from the base. Lodging at mature stage was highly variable and five categories were established for this trait at maturity stage conforming the divergence among the genotypes studied. Upright at maturity stage was predominant (81.25%) among the genotypes followed by minor lodging (12.50%), intermediate (4.16%) and lodged type category (2.16%). Based on the characterization of relation between maturity of grain and straw most of the genotypes were predominantly found to possess ripe grain before straw category (81.25%) and the lowest per cent was represented by simultaneous maturity category (18.75). Based on grain shedding at maturity 68.75 per cent of the accessions were grouped under low grain shedding category followed by intermediate type (31.25%). This descriptor can be used to characterize the cultivated species and wild relatives.

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