IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
Volume 9 | Issue 1 | January, 2014 | 7-12

RESEARCH ARTICLE

Usefulness of morphological characters for varietal identification in oats (*Avena sativa* L.)

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SUMMARY

Eleven varieties of oats were studied to know the various morphological characters responsible for identification. The study revealed that seed morphological character like seed colour, seedling character like colour of coleoptile region and plant characters like, growth habit, stem hairiness of uppermost node, flag leaf attitude, orientation of branches in panicle, attitude of branches in panicle and presence of awns were found as the important morphological characters for identification. Other seedlings characters like, anthocyanin pigmentation on coleoptiles, first leaf, sheath of first leaf and plants characters like lower leaf hairiness of sheath were of secondary importance for identification of varieties. Some of the characters were recorded in quantitatively and the cluster was formed from the recorded quantitative data, based on similarity in the characters the varieties were grouped into two main clusters, the variety UPO94 alone formed the one main cluster and the remaining ten varieties formed the another main cluster.

Key Words : Oats, Morphological characters, Identification

How to cite this article : Sumathi, S. and Balamurugan, P. (2014). Usefulness of morphological characters for varietal identification in oats (*Avena sativa* L.). *Internat. J. Plant Sci.*, **9** (1): 7-12.

Article chronicle : Received : 04.06.2013; **Revised :** 16.09.2013; **Accepted :** 02.10.2013

Oats is an important cereal cum forage crop, it has rich medicinal value and being used as food by the diabetic patients, given that the grains are filled with cholesterol fighting soluble fibre (Singh *et al.*, 2003). At present large number of varieties are available for commercial cultivation based on local preferences and agro-climatic conditions. Among the varieties identification and estimation of genetic distances are of importance both in plant variety protection and in breeding programmes. Every new plant variety to be registered has to pass through species-specific tests defined by the guidelines of the International Union for the Protection of New Varieties of Plants (UPOV, 1991).

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The seed production programmes have to be strictly controlled to ensure good quality seed. So, descriptors of cultivars of crop species are required for verifying varietal/ cultivar identity, determining varietal purity, establishing the distinctiveness of new variety from existing varieties and documentation of genetic resources (Begum and Kumar, 2011). Under the variety protection Act in India, the need to verify the identity of variety and establish its distinctness has become very critical for variety registration (Mehla and Satishkumar, 2008). Individually the morphological characters have limited applications but when used in conjunction with each other they have considerable importance in detecting the varietal purity of crop stand. The characters used for to test the distinctness, uniformity and stability (DUS) are primarily morphological characters being scored in field and seed laboratory tests. Morphological characters, both quantitative and qualitative, have long been used to identify species, genera, to evaluate systematic relationships, and to discriminate between varieties. Characterization of varieties based on morphological characters are carried out with the specific markers in the field during different crop growth

phases *viz.*, seed, seedling, vegetative, reproductive and maturation phases. But it is expensive and time consuming process and the purity of seed will be known only after the seed developed into plant. Moreover, the morphological characters are influenced by environmental conditions and they were not quite enough to expose the genetic diversity between the morphological overlap varieties and morphologically identical accessions. In spite of many short comings, use of morphological markers is an age old method, universally approved method for genetic purity testing of seed lot. Use of morphological descriptors in sequential fashion is useful and convenient to distinguish different varieties. Keeping this in view the present investigation was carried out to differentiate eleven oats varieties based on morphological markers.

MATERIAL AND METHODS

The genetically pure eleven oats varieties *viz.*, Sabzar, Kent, HFO114, OS6, UPO212, OS7, HJ8, UPO94, OL9, JHO822 and OL88 obtained from G.B. Pant University of Agriculture and Technology, Uttarakhand were used as source material for this study. The experiment was carried out at the Department of Seed Science and Technology, Tamil Nadu Agricultural University. Observations on morphometric characters were recorded on five plants / replication for each variety. Each character was categorized with the help of the descriptors provided by National Test Guidelines and UPOV (International Union for the Protection of New Varieties of Plants, 1989) for the conduct of DUS (Distinctness, uniformity and stability) tests. Some of the additional characters were also included based on subjective measurements. Totally 29 characters were recorded. In seeds, seed colour (based on Royal Horticultural Society colour chart) and 1000 seed weight were observed. In the case of seedlings, anthocyanin pigmentation of coleoptiles, colour of coleoptile region, anthocyanin pigmentation on first leaf, sheath of first leaf were observed, and in plants, growth habit, lower leaf hairiness of sheath, stem hairiness of uppermost node, height of foliage on 30,45, 60 days after sowing and at maturity stage, number of tillers/plant, number of nodes/plant at 50% flowering, middle internode length at 50% flowering and stem thickness at one third height of plant at maturity. In panicle, time of panicle emergence (50% plants with a panicle), flag leaf length and attitude, orientation of branches, attitude of branches, panicle length, days to maturity, number of panicle/ plant, number of spikelets/ panicle, glumes length, awnness and awn length. For grouping the varieties based on similarity in the characters cluster was formed using Jaccard's similarity co-efficient matrix and to generate a dendrogram NTSYS with unpaired group mathematical average (UPGMA) was used.

RESULTS AND DISCUSSION

In the present study, eleven oats varieties were explored into 29 different morphological characters. In seed characters colour and weight of the seeds were useful traits for identification. The variety OS7 could be easily discriminated from other varieties due to greyed orange colour and all other varieties showed greyed yellow colour (Table 1).The maximum weight of 32g/1000 seeds were recorded in HFO114 and the minimum weight of 14.4g was recorded in OL88 (Table 2a). The reports by Jawaharlal (1994) in cotton, Bonetti *et al.* (1995) in field bean, Nagapadma *et al*. (1996) in maize, Calderin *et al.* (2002) in *Vigna radiata* and *Vigna unguiculata*, Thinh (2006) in sunflower and Patra *et al.* (2010) in rice obviously revealed the use of seed characters for identification of varieties.

In seedling, the anthocyanin pigment in first leaf and sheath of first leaf was absent in all the varieties. Colour of coleoptile region was the key character to differentiate the varieties like Sabzar, OS7 and JHO822. They were differentiated by green colour coleoptile from other varieties (white) (Table 1). The usefulness of seedling characters in identification/ grouping of varieties were reported by Halim and Saxena (1995) in pearlmillet, Ezhilkumar (1999) in cotton, Selvaraju and Sivasubramanium (2001) and Thangavel (2003) in sorghum, Yadav (2004) in rape seed and mustard.

In plant, out of 11 varieties OS7, JHO822, OL88 expressed the erect type of plant growth habit Kent, OS6, HJ8, UPO94, OL9 have semi erect type of growth habit, while rest of the varieties Sabzar, HFO114, UPO212 expressed the intermediate type of plant growth habit. Stem hairiness of upper most node was present in Sabzar, UPO212, OS7, OL88 and it was absent in remaining varieties. Two types of flag leaf attitude was recorded, one is slightly curved (Sabzar, Kent, HFO114, UPO212, OS7, UPO94, JHO822, OL88) and another one was recurved (OS6, HJ8, OL9). Unilateral type of panicle orientation of branches was exhibited by Sabzar, HFO114, HJ8, JHO822, while rest of the varieties expressed the sub unilateral type of orientation. The awns were present in all varieties except HJ8 (Table 1, Plate 1). Some of the other plant characters were also recorded in quantitatively and are expressed in Table 2a, 2b.

From the quantitative data the cluster (dendrogram) was formed using NTSYS software and the varieties were grouped based on similarity. Totally two main clusters were formed, Sabzar, Kent, HFO114, OS6, UPO212, OS7, HJ8, OL9, JHO822 and OL88 were formed the main cluster I and the variety UPO94 alone formed another main cluster (II). From the main cluster I three sub clusters were formed, Sabzar, Kent, HFO114, OS6 formed the sub cluster one, UPO212, OS7, HJ8, JHO822 and OL 88 formed second sub cluster, OL9 alone formed the third sub cluster. The dendrogram shows that among the 11 varieties UPO212 and OS7 has most similarity in many characters (Fig. 1). Successful reports on plant characters for varietal identification was reported in crops like *Vicia faba* (Bond and Crofton, 2001), pearl millet

Table 1 : Morphological characters of oats varieties

Sr. No.	Varieties	Seed	Seedling				Plant						
		Seed colour	Anthocyanin pigmentation on coleoptile	Colour of coleoptile region	Anthocyanin pigmentation on first leaf	Anthocyanin pigmentation on sheath of first leaf	Plant growth habit	Lower leaf hairiness on sheath	Stem hairiness of uppermost node	Flag leaf: attitude	Panicle: Orientation of branches	Panicle: Attitude of branches	Awnness
1.	Sabzar	Greyed yellow	Absent	Green	Absent	Absent	Intermediate	Absent	Present	Slightly curved	Unilateral	Semi erect	Present
2.	Kent	Greyed yellow	Absent	White	Absent	Absent	Semi erect	Absent	Absent	Slightly curved	Sub unilateral	Erect	Present
3.	HFO114	Greyed yellow	Absent	White	Absent	Absent	Inter mediate	Absent	Absent	Slightly curved	Unilateral	Semi erect	Present
4.	OS5	Greyed yellow	Absent	White	Absent	Absent	Semi erect	Absent	Absent	Re curved	Sub unilateral	Semi erect	Present
5.	UPO212	Greyed yellow	Absent	White	Absent	Absent	Intermediate	Absent	Present	Slightly curved	Sub unilateral	Erect	Present
6.	OS7	Greyed orange	Absent	Green	Absent	Absent	Erect	Absent	Present	Slightly curved	Equilateral	Semi erect	Present
7.	HJ8	Greyed yellow	Absent	White	Absent	Absent	Semi erect	Absent	Absent	Re curved	Unilateral	Semi erect	Absent
8.	UPO94	Greyed yellow	Absent	White	Absent	Absent	Semi erect	Absent	Absent	Slightly curved	Sub unilateral	Semi erect	Present
9.	OL9	Greyed yellow	Absent	White	Absent	Absent	Semi erect	Absent	Absent	Re curved	Sub unilateral	Erect	Present
10.	JH0822	Greyed yellow	Absent	Green	Absent	Absent	Erect	Absent	Absent	Slightly curved	Unilateral	Semi erect	Present
11.	OL88	Greyed yellow	Absent	White	Absent	Absent	Erect	Absent	Present	Slightly curved	Sub unilateral	Semi erect	Present

Table 2a : Morphological characters of oats varieties (Quantitative)

Sr. No.	Varieties	1000 seed weight (g)	Natural height on (cm)				Number of tillers/ plant (numbers)	Number of nodes at 50% flowering (numbers)	Middle internode length at 50% flowering (cm)	Stem thickness at one third height of plant at maturity (cm)
			30 DAS	45 DAS	60 DAS	At maturity				
1.	Sabzar	30.8	43.2	57.0	66.8	101.5	3.4	7.0	6.1	1.0
2.	Kent	25.8	38.2	50.4	62.4	92.1	3.4	7.0	5.4	0.5
3.	HFO114	32.0	35.6	48.0	61.0	86.4	4.4	6.4	5.1	0.9
4.	OS6	25.2	50.2	63.0	67.6	95.8	3.4	7.0	9.9	1.1
5.	UPO212	26.4	46.4	59.6	66.6	99.3	3.0	6.2	7.0	0.6
6.	OS7	24.0	40.6	53.4	62.0	92.8	2.6	6.2	6.0	1.0
7.	HJ8	22.8	45.4	58.2	71.2	109.3	2.2	5.8	7.1	1.0
8.	UPO94	27.8	30.2	42.2	53.6	85.6	3.2	6.0	5.0	1.2
9.	OL9	18.4	45.4	56.0	73.0	117.0	2.6	7.8	8.3	1.0
10.	JHO822	22.0	43.8	55.4	64.6	104.6	3.0	6.8	8.1	1.1
11.	OL88	14.4	43.0	55.0	66.4	98.2	2.6	7.6	3.6	1.2

Table 2b : Morphological characters of oats varieties (Quantitative)

Sr. No.	Varieties	Time of panicle emergence (50% plants with a panicle) (days)	Flag leaf length (cm)	Panicle length (cm)	Days to maturity	Number of panicle plant	Number of spikelets/ panicle	Glumes: length (cm)	Awn length (cm)
1.	Sabzar	86	24.5	22.0	96	4.4	19.2	2.5	3.8
2.	Kent	88	17.0	20.1	98	4.4	15.2	3.3	4.5
3.	HFO114	89	24.3	17.2	109	5.4	11.8	2.8	2.9
4.	OS6	82	19.0	19.0	102	4.4	22.8	2.7	2.6
5.	UPO212	91	15.0	18.0	121	4.0	15.2	3.1	3.3
6.	OS7	92	18.5	17.0	122	3.6	15.4	2.5	3.0
7.	HJ8	96	13.0	17.5	126	3.2	20.8	2.7	-
8.	UPO94	95	8.0	19.0	125	4.2	13.8	2.1	3.4
9.	OL9	89	21.5	34.0	109	3.6	16.8	2.6	2.9
10.	JHO822	99	20.3	30.0	119	4.0	11.6	2.8	3.2
11.	OL88	101	29.0	23.0	121	3.6	13.6	2.2	2.0

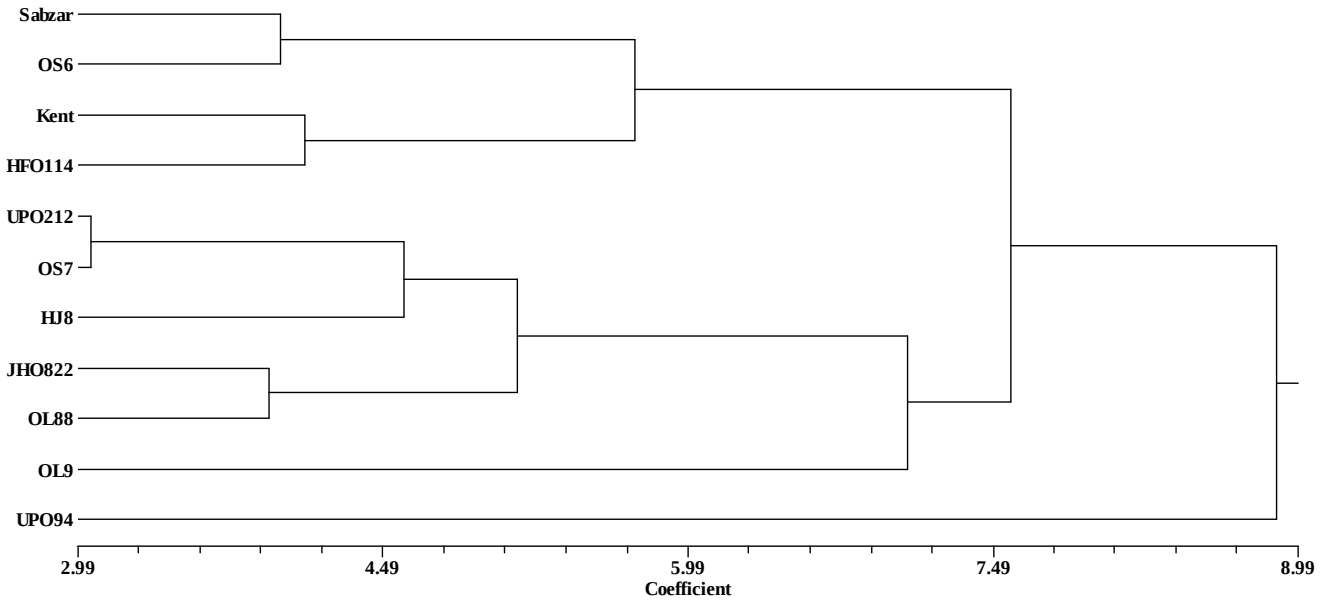
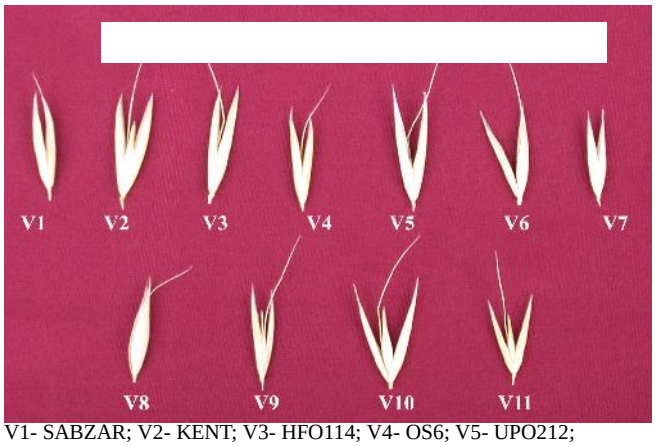


Fig. 1 : Dendrogram of eleven oats varieties



V1- SABZAR; V2- KENT; V3- HFO114; V4- OS6; V5- UPO212; V6- OS7; V7- HJ8; V8- UPO94; V9- OL9; V10- JHO822; V11- OL88

Plate 1 : Awn characters

(Arunkumar *et al.*, 2004), Jute (Kumar *et al*., 2006), Lucerne (Dumbre *et al*., 2007), maize (Yadav and Singh, 2010) and Switchgrass (Cortese *et al.*, 2010)

Plant morphology has been in use since very long time (Dhananjaya *et al.*, 2012). Morphological descriptors can provide a unique identification of cultivated varieties (Molona - Cano and Elena-Rossello, 1978). These plant characters form the basis for the breeder's selection of promising plant material. The morphological traits are used mainly for identification of genotypes and varieties. These descriptors reflect not only the genetic constitution of the variety, but also the interaction of the genotypes with the environment (G x E) within which it is expressed (Lin and Bins, 1984). Genotype x Environment interaction effect has been found to cause aberrant means for traits, therefore, morphological data collected in field, which can provide only an initial screening of varietal identity or distinctness. Some of the morphological variations have been eliminated with consequence that most of the varieties outwardly appear similar due to their unknown genetic control. It is known that multiple genotypes can give phenotypes of similar outward appearance (Ravi, 2000), also the number of morphological traits is limited, most of them are multi genic, quantitative or continuous characters, and their expression is influenced by environmental conditions (Smykal *et al.*, 2008). From the above studies it is concluded that the identification of varieties based on plant characters gave better results than seed and seedling characters and inspite of many short comings, the morphological descriptors can be used effectively for initial identification and grouping of the oats varieties.

REFERENCES

Arunkumar, M. B., Sherry, R.J., Dadlani, Malavika, Varier , Anuradha and Sharma, S.P. (2004). Characterization of pearlmillet hybrids and parental lines using morphological characters. *Seed Res.*, **32**(1):15- 19.

Begum, T. and Kumar, D. (2011). Usefulness of morphological characteristics for DUS testing of jute (*Corchorus olitorius* L. and *C. capsularis* L.). *Spanish J. Agric. Res.*, **9**(2): 473-483.

Bond, D. A. and Crofton, G. R. A. (2001). *Vicina faba* mutants with narrow leaflets, with and without tendril- like structures. *Plant Varieties & Seeds,* **14**: 201- 205.

Bonetti, A., Miggiano, A., Dinelli, G. and Lovato, A. (1995). Identification of bean *(Phaseolus vulgaris* L.) cultivars grown in Italy by field and electrophoresis tests: a comparative study. *Seed Sci. & Tech.,* **23** (1) : 69-84.

Calderin, G.M.E., Mendez, I.E., Brizuela Garicia, E., Hernandez Zamora, O. and Alverz Tellez, O. (2002). Analytical key for the differentiation of varieties of *Vigna radiata* (L.) *R.* Wilczek and *V. unguiculata* Walp. cultivated in camaguey. *Seed Abs.*, **25** (3):96**.**

Cortese, L.M., Honig, J., Miller, C. and Bonos, S. A. (2010). Genetic diversity of twelve switchgrass populations using molecular and morphological markers. *Bioenerg. Res.*, DOI 10.1007/s12155-010-9078-2.

Dhananjaya, P., Channakeshava, B.C., Bhanuprakash, K., Murali, S. and Swamy, M. (2012). Characterization of vegetable soybean [*Glycine max* (L.) Merrill] genotypes based on morphometric traits. *Plant Archives,* **12** (2): 947-950.

Dumbre, A.D., Shaikh, R.S., Girase, V.S. and Pokharkar, M.B. (2007). Morphological and biochemical markers for varietal identification in lucerne. *Seed Res.*, **35**(1):43-47.

Ezhilkumar, S. (1999). Studies on varietal identification in hybrids, parents and varieties of cotton (*Gossypium* spp.). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Halim, S. and Saxena, O.P. (1995). Identification of pearlmillet hybrids and parents a comparative study of laboratory and field methods. *Seed Sci. & Technol.,* **23** (3) : 689- 696.

Jawaharlal, K. (1994). Studies on varietal identification in inbreds, hybrids and varieties of cotton (*Gossypium* spp) through physical, chemical and biochemical methods. M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Kumar,D., Mahata, P., Lakshman, S.S. and Mandi, S. (2006). Morphological characterization and *C. capsularis* L. varieties testing of jute (*Corchorus olitorius* L.) and their application for DUS. *Indian J. Genet.,* **66**(4): 319-323.

Lin, C.S. and Bins, M.R. (1984). The precision of cultivar trials within eastern cooperative tests. *Can. J. Plant Sci.,* **64** (3) : 587- 591.

Mehla, B.S. and Satishkumar (2008). Use of morphological traits as descriptors for identification of rice genotypes. *Agric. Sci. Digest,* **28** (2): 101- 104.

Molona-Cano, J.L. and Elena-Rossello, J.M.E. (1978). A further contribution to the classification of barley cultivars: use of numerical taxonomy and biochemical methods. *Seed Sci. & Technol.,* **6** (2) : 593- 615.

Nagapadma, K.B., Muralimohan Reddy, Ankaiah, R. and Sarad, P. (1996). Characterization of Twenty-three maize inbred lines through seed morphology, leaf stomatal studies and response of seedlings to added chemicals. *Seed Res*., **24**(1): 15-19.

Patra, N., Agarwal, R.C. amd Chawla, H.S. (2010). Assessment of distinctiveness, uniformity and stability of basmati rice (*Oryza sativa* L.) varieties based on morphological descriptors. *Indian J. Genet.,* **70** (1) : 48-57.

Ravi, M. (2000). Molecular marker based varietal profiling and monitoring in rice (*Oryza sativa* L.). M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Selvaraju, P. and Sivasubramaniam, K. (2001). Identification keys for sorghum varieties. *Madras agric. J.,* **87**(10/12): 660.

Singh,C., Singh, P. and Singh, R. (2003). *Modern techniques of raising field crops*, Second Ed., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, pp. 429-436.

Smykal, P., Horaeek, J., Dostalova, R. and Hybl, M. (2008). Variety discrimination in pea (*Pisum sativum* L.) by molecular, biochemical and morphological markers. *J. Appl. Genet.*, **49**(2): 155–166.

Thangavel, P. (2003). Characterization of sorghum *(Sorghum bicolor* L. Moench*)* cultivars by traditional and modern approaches. M.Sc.(Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Thinh, N.T. (2006). Techniques of seed enhancement and varietal documentation in sunflower (*Helianthus annus* L.). M.Sc. (Ag.) Thesis. Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

UPOV. (1991). International convention for the protection of new varieties of plants, Publication No. 221e, March 19, Geneva, Switzerland.

Yadav, S.K. (2004). Importance of rapeseed mustard and taramira seedling characters in cultivar characterization. *Plant Arch.*, **4**: 311-318.

Yadav, V.K. and Singh, I.S. (2010). Comparative evaluation of maize inbred lines (*Zea mays* L.) according to DUS testing using morphological, physiological and molecular markers. *Agric. Sci.,* **1** (3) : 131-142.