Forage Res., **38** (3) : pp. 151-155 (2012) **http://forageresearch.in**

SUITABILITY OF QUANTITATIVE TRAITS IN IDENTIFICATION OF OAT (*AVENA SATIVA* L.) CULTIVARS FOR RAINFED ENVIRONMENTS

YOGESH RUWALI* AND J. S. VERMA

Department of Genetics and Plant Breeding,
G. B. Pant University of Agriculture & Technology
Pantnagar-263145 (Uttarakhand), India
*(e-mail : ruwali.yogesh@gmail.com)
(Received: 8 December, 2012, Accepted: 20 July, 2013)

SUMMARY

The objective of this study was to check the efficiency of selection using quantitative traits in identification of oat cultivars suitable for rainfed environments in order to incorporate the high yielding genotypes in our oat breeding program. In our study plant biological yield decreased in rainfed plots compared to the timely irrigated plot. In general, it was found that yield of the oat plant (seed/ straw) can be an effective tool for preliminary selection of potent genotypes in stressed environments. The genotypes D. Sel.-1 and D. Sel.-5 with high susceptibility index values of 5.38 and 4.90 were identified as the most susceptible genotype. The genotype UPO 273 appeared better suited to rainfed conditions while, the genotype UPO 270 with susceptibility index value of 0.00 was recognized as the most stable genotype across the two different moisture level environments.

Key words : Suitability, quantitative traits, identification, rainfed environment, oat

Oat (*Avena sativa* L.) is one of the most important winter cereal forage crops of India and is used as green fodder, straw, hay or silage. Oat grain makes a good balanced concentrate in the rations for poultry, cattle, sheep and other animals. Green fodder contains about 10-12 % protein and 25-30% dry matter (Mishra and Verma, 1985). Looking into the fast growing dairy industry in our country, cultivation of oats as feed and fodder crop is catching up in a big way and has an enormous scope in Indian agriculture. However, its production per hectare is low as compared to other countries, due to various biotic and abiotic factors which ultimately affect the yield *per se*. It is the genetic makeup of a variety that is expressed by the favorable environment and produce different yields in different environments., thus abiotic factors are a key factor for a good crop harvest. Higher grain and straw yields are extremely important in highland of Uttarakhand due to its erratic and unpredictable environment. The upland area of Uttarakhand, India bears cold and moist climate during *rabi* season, with high winds and is almost rainfed. Thus biotic and abiotic factors both affect the yielding ability of crop plant; making the farming uneconomical. Oat Development Authority, Pantnagar has got the mandate to produce new high yielding and well adapted varieties that can be grown in the rainfed conditions of highland/ hills of Uttarakhand.

MATERIALS AND METHODS

The experimental field trial was laid out at Instructional Dairy Farm of G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India during **rabi**, 2010-11. The twenty oat genotypes (Table 5) were evaluated for their suitability to rainfed conditions in spilt plot arrangement by applying timely irrigation in alternate plots. The experiment on screening for suitability to rainfed cultivation conditions was conducted in Split plot design; where irrigation was the main factor and varieties as sub factor. The design had two levels of main factor (timely irrigation and no irrigation) with three replications and the above mentioned twenty genotypes were applied to the sub-plots randomly in each levels of the main factor.

Thus, each replication was divided in 2 large main plots, each with 20 small sub-plots. Total biological yield of oat is expected to increase under more plants per unit area, but too high seed rate may limit yield because of competition for light, nutrient and low tillering; at the same time low seed rate may result in poor yield as of sub optimal population. Hence an optimum 25-30 seedlings were allowed to grow in 1.5 m row length with an average distance of 5 cm between seedlings. Row to row distance was maintained at 20 cm and main plots were at 3 m separation distance from each other. Main factor was alternately applied in main plot while varieties were applied randomly to the sub plots within each main plot. The vegetative shoot characters studied for rainfed suitability analysis were plant height at 50% flowering (cm) and tiller diameter (cm); while the maturity character studied were number of productive tillers/ plant, days to maturity, biological yield per plant (gm), grain yield per plant (gm), and straw yield per plant (gm)

The analysis of variance for each character was carried out in the randomized complete block design as suggested by Fisher (1946) for irrigated plots and rainfed plots separately,. The emphasis was to estimate the effect of irrigation on growth of crop, differential response of varieties and subsequent identification of varieties suitable for cultivation in rainfed environments, for which two factor analysis was done. To identify the tolerant and non-tolerant genotypes the data from the rainfed and irrigated plot was used to calculate drought/ rainfed susceptibility index (DSI) following Fischer and Maurer (1978). The DSI was used to assign the genotype in increasing trend for their suitability to rainfed cultivation conditions.

The formula used for DSI calculation was:

$$DSI=(1-Yd/Yp)/D$$

Where,
Yd=Grain yield of the genotype under moisture stress
Yp=Grain yield of the genotype under non-stress
D=1- (Mean yield of all genotypes under stress/Mean yield of all genotypes under non-stress).

TABLE 1
ANOVA table for timely irrigated plot in oat

Characters	Mean sum of squares				
	Replication	Treatments	Error	CV (%)	Grand mean
Plant ht. (50% heading) (cm)	0.137	30.37**	7.97	2.40	117.6
Tiller diameter (cm)	0.000014	0.0073**	0.0015	7.11	0.55
No. of tillers/plant	2.31	0.86**	0.37	14.52	4.30
Days to maturity	74.41	141.03**	19.76	2.68	165.8
Biological yield/ plant (gm)	834.87	165.33*	68.95	15.05	55.17
Grain yield/plant (gm)	34.60	15.51**	4.08	20.19	10.06
Straw yield/ plant (gm)	539.80	139.64**	52.87	16.12	45.09
Harvest index (%)	0.19	34.99**	8.47	15.69	18.54

*,**Significant at 5% and 1% probability levels, respectively.

Table 2
ANOVA table for non-irrigated plot in oat

Characters	Mean sum of squares				
	Replication	Treatments	Error	CV (%)	Grand mean
Plant ht. (50% heading) (cm)	3.30	122.54**	23.37	4.00	120.81
Tiller diameter (cm)	0.00074	0.0094**	0.0014	7.05	0.54
No. of tillers/plant	0.19	1.71**	0.41	14.90	4.18
Days to maturity	0.48	273.68**	9.79	1.94	160.66
Biological yield/ plant (gm)	784.13	255.37**	45.65	13.25	50.99
Grain yield/plant(gm)	3.744	18.17**	3.86	18.83	10.44
Straw yield/ plant (gm)	671.07	205.93**	34.87	14.57	40.51
Harvest index (%)	40.37	56.85**	9.87	15.07	20.84

*,**Significant at 5% and 1 % probability levels, respectively.

RESULTS AND DISCUSSION

The genotypes D. sel.-1 and D. sel.-5 with high susceptibility index values of 5.38 and 4.90 were identified as the most susceptible genotype while, UPO 273, EC 605838 and D. Sel. 6 (Fig. 4.3.1) were found to be suitable for rainfed cultivation conditions. The genotype UPO 270 with susceptibility index value of 0.00 was recognized as the most stable genotype asross the two different moisture level environments. Ehlers (1989) from his experimental findings stated that as compared with other crops, water use efficiency of oat appeared to be lower. Thus, in the present study days to maturity and fodder yield maximization of oat were of main consideration under different irrigation levels for identifying suitable genotypes.

Establishment and growth of the crop depend on growth of plant by 50% heading. In the present investigation all the characters observed *viz.*, plant height at 50% heading, tiller diameter, number of tillers/plant, days to maturity, biological yield/ plant, grain yield/plant, straw yield/ plant and harvest index (%) were significantly affected by irrigation levels (Table 1) which might be due to genetic and micro-environmental variability among the test genotypes. Therefore, suitable growing conditions available for the plant throughout the growing season are essential for boosting growth parameters which in turn enhance the biological matter production. Significant differences for plant height, grain yield and straw yield due to varieties in rainfed and supplemental irrigation conditions has been observed by **Zaheri and Bahraminejad (2012)**

The growth parameters are important for higher dry matter accumulation and yield which depends on the climatic and local environment available to various genotypes. Varieties did not influence majority of growth parameters taken in the present study (Table 3). In agreement to it statistically non-significant variability in cultivars of sweet sorghum in terms of growth parameters was reported by Kumar *et al.* (2008).

The data on oat biological yield (Table 1 and 2) revealed that in general, plant yield decreased in rainfed plots compared to the timely irrigated plot. Yadava (1989) in an attempt to correlate this reduction in yield with other characters screened twelve varieties of oat (*Avena sativa* L.) for relative drought tolerance based on the magnitude of chlorophyll stability index (CSI) and found a close agreement amongst the trends of CSI and proline accumulation, and per cent reduction in yield in rainfed over irrigated conditions.

In the present investigation total biological yield was found significantly higher in irrigated plots. It may be noted that total biological yield is the product which depends on all growth parameters *viz.* plant height, number of tillers, number of leaves, leaf weight, stem weight, stem diameter etc. The plant with more number of leaves have more leaf surface area as well as more exposure to solar radiation which might have enhanced photosynthate production thereby increased dry matter production (Ehlers 1989, Rizza *et al.* 2004).

The coefficient of variation for grain yield was

Table 3
ANOVA table for spilt plot experiment in oat

Characters	Mean squares Source of Variation				
	Irrigation	treatment	Irri. xTre.	Error	CV
Plant ht. (50% heading)	212.13**	64.54	8.00	22.30	3.92
Tiller diameter	0.0087**	0.0013	0.0079**	0.0014	6.99
No. of tillers/plant	1.35**	0.20	1.22**	0.39	14.89
Days to maturity	393.25**	218.83**	51.52**	15.37	2.40
Biological yield/ plant	234.12**	288.93*	199.00**	55.84	14.07
Grain yield/plant	18.85**	32.85**	13.39**	4.07	19.74
Straw yield/ plant	204.26**	146.83	166.73**	42.84	15.29
Harvest index (%)	56.46**	2.04	43.65**	9.53	15.67

*,**Significant at 5% and 1% probability levels, respectively.

Table 4
Drought/ rainfed susceptibility index (DSI) for oat genotypes

Genotype	Yr*	Yn**	DSI= (1- Yr/ Yn)/D
D. Sel.-1	45.00	76.00	5.38
D. Sel.-5	35.00	55.67	4.90
D. Sel.-6	62.67	53.93	-2.14
Wright	55.80	52.00	-0.96
HFO- 114	57.67	54.00	-0.90
OL- 125	65.00	60.07	-1.08
UPO- 265	57.67	54.00	-0.90
UPO- 270	62.67	62.67	0.00
UPO- 271	39.67	55.67	3.79
UPO- 273	56.00	46.00	-2.87
UPO- 275	50.67	60.00	2.05
KENT	40.00	51.67	2.98
UPO- 212	43.00	41.67	-0.42
No.- 1	50.00	62.00	2.55
OS- 6	39.00	45.00	1.76
EC- 605833	59.67	54.67	-1.21
EC- 605836	43.67	54.67	2.65
EC- 605838	60.00	50.13	-2.60
UPO- 260	44.00	52.67	2.17
EC- 246199	52.67	61.00	1.80

*Yr=Grain yield of the genotype under moisture stress,
**Yn=Grain yield of the genotype under non-stress,
***D=1- (Mean yield of all genotypes under stress / Mean yield of all genotypes under non-stress).

found highest among all other observations; and the range of grain yield for different genotypes (Table 1 and 2) suggests the differential response of genotypes thereby revealing the difference in genetic background for the concerned character. The genetic vigour of varietal seeds with suitable environment leads to better growth and seed yield, Zaheri and Bahraminejad (2012) found significant positive correlation between grain yields under rainfed and irrigated conditions with mean productivity and geometric mean productivity. Grain yield in combination with other characters has been used as an indicative character for tolerance to water stress conditions; Akcura and Ceri (2011) in their rainfed trials grouped the genotypes in drought tolerant category based on various drought tolerance indices including the rainfed grain yield and irrigated grain yield.

In the present investigation days to maturity decreased in rainfed plots than in the irrigated plots (Table 1 and 2). Singh and Singh (2011), also reported high phenotypic and genotypic coefficient of variation coupled with high heritability and genetic advance as (%) of mean for green fodder productivity, plant height, tillers/plant, dry matter yield and green fodder yield in oat. All the test genotypes have been marked as good, poor or average for suitability of genotypes of oat for rainfed

Table 5
Summary of suitability of quantitative characters in oat genotypes for rainfed cultivation conditions based on mean performance and DSI values

S. No.	Evaluated genotype	Plant ht. (50% heading)	Tiller diameter	No. of tillers/ plant	Days to maturity	Biological yield/plant	Grain yield/ plant	Straw yield/ plant	Harvest index (%)
1.	D. Sel.-1	P	G	P	G	P	P	A	P
2.	D. Sel.-5	A	P	P	G	P	P	P	G
3.	D. Sel.-6	A	G	A	P	G	P	G	P
4.	Wright	A	G	A	P	G	A	G	A
5.	HFO-114	A	G	A	P	G	A	G	P
6.	OL- 125	A	G	A	P	G	G	G	A
7.	UPO-265	P	A	A	P	G	A	G	P
8.	UPO-270	P	G	G	P	G	G	G	G
9.	UPO-271	P	A	G	P	P	A	P	G
10.	UPO-273	G	G	G	P	G	G	G	A
11.	UPO-275	G	A	G	G	A	A	A	G
12.	KENT	G	P	A	G	P	P	P	P
13.	UPO-212	G	P	G	G	P	A	P	G
14.	No.-1	G	P	A	G	A	A	A	A
15.	OS- 6	G	A	A	G	P	A	P	G
16.	EC-605833	G	G	A	A	G	G	G	A
17.	EC-605836	P	P	A	G	P	A	P	A
18.	EC-605838	P	A	A	A	G	A	G	P
19.	UPO-260	G	G	A	G	P	A	P	G
20.	EC-246199	A	A	A	G	A	A	A	A

A=Average, G=Good, P=Poor.

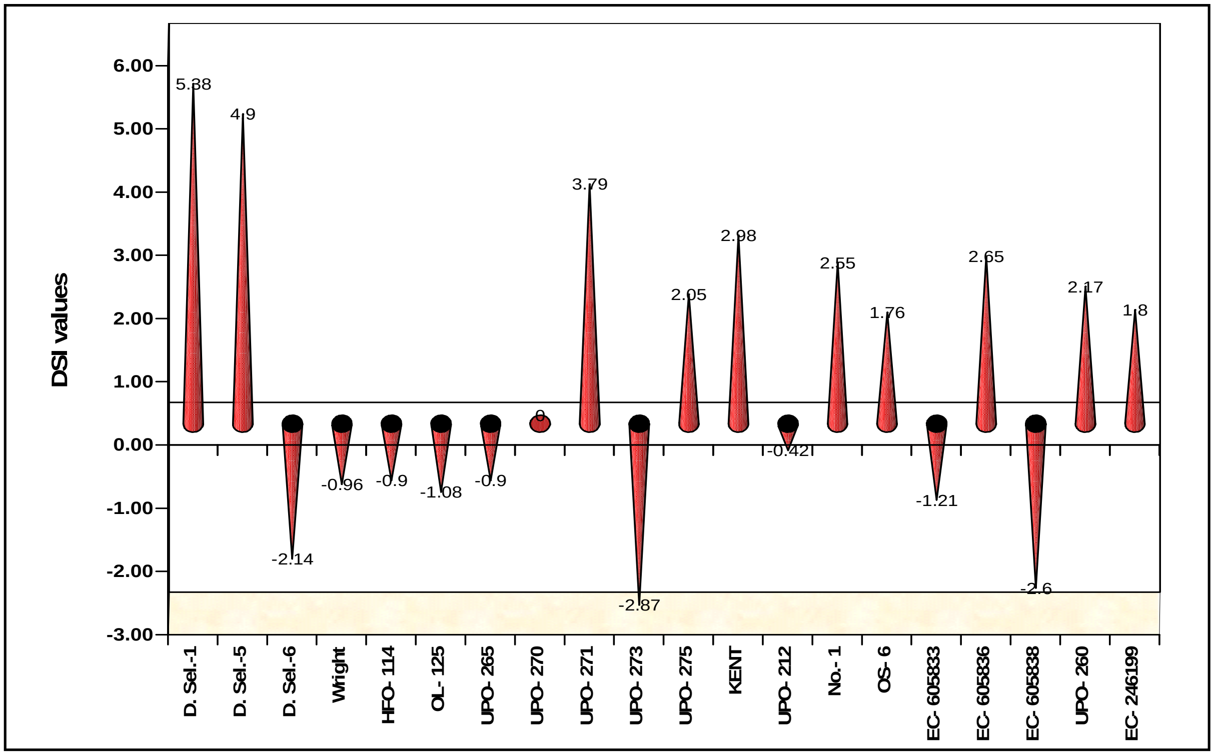

Fig. 1. Genotypes grown in rainfed environment with their respective stress susceptibility index values.

cultivation conditions based on the mean performance of the genotypes in rainfed plot and the susceptibility index values (table 5). The genotype UPO 273 appeared better suited to rainfed conditions with respect to the observed quantitative traits. Thus, the quantitative characters can well be used for preliminary identification of potential genotypes for rainfed cultivation. Because of the prevailing diversity among test genotypes, used in the present study, the certainty of the correct identification of a putative genotype may be high. Nevertheless, in cases with higher cultivar similarity it will be necessary to use some other, more sensitive techniques.

REFERENCES

Akcura, M. and S. Ceri, 2011: *Zemdirbyste Agriculture,* **98**(2): 157-166.

Ehlers, W. 1989: Transpirations Efficiency of Oat. *Agron. J.,* **81** (5): 810-817.

Fischer, R.A. and R. Maurer, 1978: Drought resistance in spring wheat cultivars: grain yield response, *Aust. J. Agric. Res.*, **29**: 897-907.

Fisher, R.A. 1946: Statistical methods for research workers. (10th edition). Olivar and Byod, Ed. In burg.

Kumar, S.R., P.K. Shrotria, and J.P. Deshmukh, 2008: *World J. Agric. Sci*., **4** (6): 787-789.

Mishra, S.N. and Verma, J.S. 1985: Oat Research at Pantnagar, India. *In*: World Crops: Production Utilization Description. Lawes and Thomas (*Eds)*, Martinus Nijhoff Publisher, Netherlands, pp. 260-264.

Rizza, F., F. W. Badeckb, L. Cattivellia, O. Lidestric, N. Di Fonzoc, and A. M. Stanca, 2004**:** *Crop Sci.*, **44**(6): 2127-2137.

Singh, S. B. and A. K. Singh, 2011: *Indian J. Plant Genetic Res.*, **24**(1): 56-61.

Yadava, R. B. R. and Bhat, R. K. 1989: *J. Agron. and Crop Sci.*, **163**(2): 138-140.

Zaheri, A. and Bahraminejad, S. 2012: *Annals Biol. Res.*, **3**(5): 2194-2201.