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RESEARCH PAPER

Biophysical basis of productivity in little millet (*Panicum miliare* L)

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Abstract : Plant regulation of water utilization and loss is important in determining the drought tolerance in crop plants. It was observed that high yielding genotypes had higher stomatal conductance at 60 days after sowing which could be because of higher stomatal frequency on abaxial surface which intern would have enhanced the canopy photosynthesis. The transpiration rate was higher in low yielding genotypes and low in high yielding genotypes. There was a minimum interveinal distance and high vein load frequency in high yielding genotypes.

Key Words : Biophysical parameters, Little millet genotypes, Yield

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INTRODUCTION

Little millet (*Panicum miliare* L.), commonly known as "Same" is an important minor millet belonging to the family Poaceae. It is rich in nutrients. It is suited to conditions of low and moderate rainfall areas ranging from 500 to 700 mm. It is widely cultivated as a cereal across India, Nepal and Western Burma. It is particularly important in the Eastern Ghats of India, where it forms important part of tribal agriculture (de Wet *et al.*, 1984). In India, the cultivation of little millet is mainly confined to Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, Orissa, Bihar, Madhya Pradesh and Uttar Pradesh. It is known that biophysical parameters may affect yield in many ways. It is better to identify those which have close positive relation with grain yield. With this background, the present study was taken up.

MATERIALS AND METHODS

A field experiment on little millet was conducted with 13 genotypes at university of Agricultural Sciences, Dharwad. The genotypes were classified in to high yielding (TNAU-63, OLM -20, TNAU-89, CO-2), medium yielding (OLM-203, TNAU-98, DLM-423, OLM -23) and low yielding (DLM -322,Varisukhdar,OLM-37PRC-3). Along with local check above little millet genotypes were sown in Randomized Block Design with three replications.

Measurement of photosynthetic rate (p), stomatal conductance and transpiration rate was made on third fully expanded leaf from the top at 60 DAS, using portable photosynthesis system (LICOR, Model, LI-6400). These measurements were made between 10.00 AM to 12.00 noon.

Stomatal frequency refers to the number of stomata per unit leaf area. It was measured by the leaf impression method. The quick fix solution was smeared thinly on the adaxial and abaxial surfaces of the third leaf from top. After drying, the thin film on the leaf surface was peeled off and mounted on a slide with cover slip and observed under microscope at 40x magnification. The number of stomata was counted on both adaxial and abaxial surfaces and expressed as number of stomata per mm^2 leaf area.

The interveinal distance and vein load frequency in leaf tissue were determined by following the method of Crookston and Moss (1974). The distance between the veins was expressed

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in microns (μ) and vein frequency was expressed as veins per mm^2 leaf area. The mean values for the characters subjected to statistical analysis were suggested by Panse (1967). Correlation analysis was carried out to study nature and degree of relationship between biophysical parameters with yield by following the method of Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Exchange of gases plays an important role in the metabolism of crop plants.The resistance to diffusion of CO_2 and water vapour between the leaf and atmosphere is a function of stomatal frequency and the degree of opening. A change in stomatal resistance has a greater effect on transpiration than on photosynthesis, because it constitutes a relatively larger proportion of the total resistance to water vapour diffusion than to CO_2 diffusion (Gaastra, 1959). Moreover, the stomata being one of the controlling factors in photosynthesis and transpiration, the stomatal frequency differences among cultivars could be related to differences in exchange of gases vapour water (Ciha and Burn, 1975).

It was observed in the present study that the high yielding genotypes, TNAU-89, TNA-63 and CO-2 had higher stomatal conductance at 60 DAS (Table 2) which could be because of higher stomatal frequency on abaxial surface which inturn would have enhanced the canopy photosynthesis. Hsiao (1973) reported that photosynthesis is largely dependent on stomatal regulation. However, these genotypes had comparatively lower stomatal frequency on adaxial surface (Table 1).

Correlation studies revealed a significant positive association between stomatal frequency on abaxial surface at 60 DAS and grain yield (r=0.79**). These results are in agreement with Pawar (1996) in sorghum. Shashidhar *et al*. (1982) and Bhoite (2000) also reported positive association between stomatal number and biological yield in foxtail millet.

Among the genotypes, transpiration rate was higher in low yielding genotypes and lower in high yielding genotypes which could be because of comparatively higher stomatal frequency on adaxial surface. Further, the correlation study revealed that there was no definite relation between stomatal frequency on adaxial surface, transpiration rate and grain yield (Table 2).

The interveinal distance plays a major role in the translocation of photosynthates towards the economically important plant parts. In the present study, the minimum interveinal distance was noticed in high yielding genotype TNAU-89 followed by TNAU-63 and CO-2. While, the low yielding genotypes, PRC-3 and local check noticed comparatively maximum intervinal distance at 60 DAS (Table 1. Correlation study indicated significant positive relationship

Table 1: Variation in little millet genotypes for stomatal number, interveinal distance and vein load frequency at 60 DAS

Genotypes	Stomatal number mm^{-2} leaf area		Interveinal distance (μ)	Vein load Frequency (mm^{-2} LA)	Grain yield (q/ha)
	Adaxial surface	Abaxial surface			
High yielding					
TNAU-63	157.0	240.1	94.3	34.0	27.05
OLM-20	152.9	218.8	97.0	31.0	25.41
TNAU-89	159.0	251.9	90.5	33.7	24.13
CO-2	158.0	236.0	95.3	30.0	23.70
Mean	156.7	236.7	94.3	32.2	25.07
Medium yielding					
OLM-203	151.0	180.5	96.2	30.1	20.20
TNAU-98	169.0	186.0	99.5	30.5	19.60
DLM-423	167.0	195.1	97.0	29.9	18.70
OLM-23	158.0	177.9	98.4	30.0	19.05
Mean	161.3	184.9	97.7	30.1	19.38
Low yielding					
DLM-322	174.0	181.7	101.2	30.1	16.13
VARISUKHADAR	176.0	180.3	107.3	29.7	15.79
OLM-37	159.0	190.0	110.0	28.7	15.14
PRC-3	151.2	170.5	109.8	29.0	14.24
Mean	165.0	180.6	107.0	29.3	15.32
Check					
Local	146.9	200.1	110.7	28.0	13.63
S.E.±	1.72	3.56	1.08	0.74	0.55
C.D. (5%)	4.94	10.23	3.12	2.11	1.59

with grain yield (r=-0.87**) thereby indicating the importance of assimilates. These are in conformity with the results of Pawar (1996). Crookston and Moss (1974) were of the opinion that less interveinal distance in C4 grasses help them in achieving faster translocation of carbohydrates.

Vein load frequency refers to the number of viens per unit leaf area and has a direct bearing on assimilate translocation and productivity. The present study revealed that the high yielding genotypes, TNAU-63, TNAU-89 and OLM-20 had significantly higher number of viens per mm^2 leaf area (>30.0); whereas, the low yielding genotypes OLM-37 and Local check recorded lower values (<30). The vein load frequency showed significant positive correlation with grain yield (r=0.83**). These results are in accordance with the findings of Udapudi (1996) and Bhoite (2000) (Table 1) .

Photosynthesis is the basis of dry matter production and hence economic yield. The present investigations revealed that the photosynthetic rate was at its peak at 60 DAS and decreased thereafter towards maturity due to senescence. The high yielding genotypes, TNAU-89, TNAU-63 and CO-$_2$ had the higher photosynthetic rate at all the stages; whereas, the low yielding genotypes, PRC-3 and Local check recorded lower photosynthetic rate. Further, the correlation studies also indicated significant positive relationship

Table 2 : Variation in little millet genotypes for photosynthetic rate (Ps), stomatal conductance (SC, μ mol m^{-2} s^{-1}) and transpiration rate (m mol H_2O transpired m^{-2} s^{-1})

Genotypes	Ps rate (μ mole CO_2 m^{-2} s^{-1})		Stomatal conductance at 60 DAS	Transpiration rate at 60 DAS	Grain yield (q/ha)
	60 DAS*	80 DAS			
High yielding					
TNAU-63	30.2	20.2	0.410	2.33	27.05
OLM-20	23.0	16.1	0.215	1.67	25.41
TNAU-89	32.6	21.5	0.450	1.99	24.13
CO-$_2$	26.5	15.9	0.395	1.85	23.70
Mean	28.0	18.4	0.367	1.96	25.07
Medium yielding					
OLM-203	18.6	14.6	0.186	2.52	20.20
TNAU-98	15.3	11.5	0.259	1.70	19.60
DLM-423	16.1	12.0	0.299	1.98	18.70
OLM-23	14.9	12.2	0.246	2.00	19.05
Mean	16.2	12.6	0.248	2.10	19.38
Low yielding					
DLM-322	13.7	10.3	0.190	2.70	20.20
VARISUKHADAR	12.5	9.5	0.200	3.00	19.60
OLM-37	14.0	8.9	0.220	2.90	18.70
PRC-3	11.9	9.0	0.197	3.10	19.05
Mean	13.0	9.4	0.202	2.90	19.38
Check					
Local	10.1	8.6	0.300	2.40	13.63
S.E.±	2.51	2.13	0.070	0.14	0.55
C.D. (5%)	7.21	6.14	0.201	0.41	1.59

Table 3: Correlation co-efficient values for grain yield v/s. different biophysical parameters

Sr. No.	Parameters	Correlation values (r)
1.	Stomatal number (Adaxial)	-0.14
2.	Stomatal number (Abaxial)	0.79**
3.	Interveinal distance	- 0.87 **
4.	Vein load frequency	0.83**
5.	Photosynthetic rate (60 DAS)	0.92**
6.	Photosynthetic rate (80 DAS)	0.93**
7.	Stomatal conductance (60 DAS)	0.61*
8.	Transpiration rate (60 DAS)	- 0.67 *

*and ** Indicate significance of value at P=0.05 and 0.01, respectively

Table 4 : Genotypic differences in little millet for yield and yield components

Genotypes	Grain yield (Q ha^{-1})	Grain productivity $plant^{-1}$ day^{-1}	Panicle length (cm)	Harvest index (%)
High yielding				
TNAU-63	27.05	0.036	26.96	17.76
OLM-20	25.41	0.038	24.76	16.04
TNAU-89	24.13	0.032	27.13	15.55
CO_{-2}	23.70	0.031	30.00	15.11
Mean	25.07	0.034	26.46	16.12
Medium yielding				
OLM-203	20.20	0.024	18.89	13.69
TNAU-98	19.60	0.026	20.25	13.56
DLM-423	18.70	0.027	22.70	14.27
OLM-23	19.05	0.028	21.96	14.08
Mean	19.38	0.026	20.95	13.90
Low yielding				
DLM-322	16.13	0.021	17.87	11.44
VARISUKHADAR	15.79	0.018	18.31	11.92
OLM-37	15.14	0.022	19.70	12.09
PRC-3	14.24	0.019	19.86	11.11
Mean	15.32	0.020	18.93	11.64
Check				
Local	13.63	0.017	17.95	11.05
Grand mean	18.35	0.024	21.07	13.17
S.E.±	0.55	0.004	2.40	1.07
C.D. (5%)	1.59	0.012	6.91	3.09

between photosynthetic rate and grain yield (r = 0.92**). These results are in agreement with the findings of Udapudi (1996) in foxtail and Perumal (1980) finger millet (Table 2). Correlation studies also indicated a positively significant association of stomatal number on abaxial surface, vein load frequency, photosynthetic rate and stomatal conductance with grain yield (Table 3).

REFERENCES

Arnon, D. I. (1949). Copper enzymes in isolated chloroplasts: Poly phenol oxidase in *Beta vulgaris* (L.). *Plant Physiol.*, **24**:1-15.

Bhoite, A.G. (2000). Physiological indices for higher productivity in foxtail millet. Ph.D. Thesis, University of Agricultural Sciences, Dharwad, KARNATAKA (INDIA).

Ciha, A.J. and Brun, D.A. (1975). Stomatal size and frequency in soybean. *Crop Sci.*, **15** : 309-315.

Crookston, R.K. and Moss, D.N. (1974). Interveinal distance for carbohydrate transport in leaves of C_3 and C_4 grasses. *Crop Sci.*, **14** : 123-125.

De Wet, J.M.J., Prasadaroa, K.E. Brink, D.E. and Mengesha, M.H. (1984). Systematics and evolution of *Eleusine coracana*. *American J. Bot.*, **71** : 550-557.

Gaastra, P. (1959). Photosynthesis of crop plants as influenced by light, carbon dioxide, temperature and stomatal diffusion resistance. *Meded Landbouwhogesch, Wageningen*, **59** : 1-68

Hsiao, T.C. (1973). Plant responses to water stress. *Ann. Rev. Plant Physiol.*,**24** : 519-570.

Panse, P.V. and Sukhatme, V.G. (1967). *Statistical methods for agriculture workes.* ICAR, NEW DELHI, INDIA.

Pawar, S.M. (1996). Physiological indices for high yield and improving yield potential in *rabi* sorghum (*Sorghum bicolor* L.). Ph.D. Thesis, University of Agricultural Sciences, Dharwad, KARNATAKA (INDIA).

Perumal, K.R.(1980). Genotypic variability in photosynthetic efficiency and translocation and its relation to leaf characters, growth and productivity in finger millet (*Eleusine coracana* Gaertn.). Ph.D. Thesis, University of Agricultural Sciences, Bengaluru, KARNATAKA (INDIA).

Saradhambal, K.V., Singh, S.P., Prakash, S. and Naik, M.S. (1978). Effect of bacterial blight in the activities of nitrate reductase and peroxidase in rice plants. *Indian J.Biochem. & Biophysics* 15: 105-107.

Shashidhar, V.R.,Gurumurthy, B.R., Udaya Kumar, M. and Krishnasastry, K.S.(1982). Plant conductance and productivity in finger millet genotypes. *Paper presented at the National Symposium on finger millet genetics and breeding.* University of Agricultural Sciences, Bengaluru, KARNATAKA (INDIA).

Udapudi, S.S. (1996). Physiological basis of productivity in foxtail millet (*Setaria italica* L.) genotypes. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Dharwad, KARNATAKA (INDIA).

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