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SHORT COMMUNICATION

VARIABILITY FOR GRAIN YIELD AND RELATED TRAITS IN FINGER MILLET GERMPLASM ACCESSIONS FROM MALAWI

P. H. MNYENYEMBE and S. C. GUPTA[1,2]
Lunyangwa Research Station, P. O. Box 59, Mzuzu, Malawi
[1]SADC/ICRISAT SMIP, P. O. Box 776, Bulawayo, Zimbabwe
[2]ICRISAT, Sabon Bakin Zuwo Road, P.M.B. 3491, Kano, Nigeria

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ABSTRACT

Variations among 196 germplasm accessions of finger millet [*Eleusine coracana* (L.) Gaertn.] from Malawi were studied at Chitedze and Makoka Research Stations during the 1988/89 rainy season. The differences between germplasm accessions for number of days to flowering, plant height, finger length, finger width, number of fingers, number of productive tillers, panicle yield, grain yield, and finger blast incidence were significant at both locations. Six germplasm accessions with highest values and six accessions with lowest values of each trait are listed.

***Key Words*: *Eleusine coracana*, genetic variability, grain improvement**

RÉSUMÉ

Les variations entre 196 accessions de ressources génétiques d'eleusine [*Eleusine coracana* (L.) Gaertn.] en provenance du Malawi ont été étudiées dans les stations de recherche de Chitedze et de Makoka pendant la saison des pluies 1988/89. Les differences entre les accessions de ressources génétiques pour le nombre des jours à la floraison, la taille des plants, la longueur des doigts, le nombre des doigts, le nombre des talles productrices, le rendement en panicule, le rendement en grain, et l'incidence d'avortément des doigts étaient significatives dans les deux localités. Six accessions de ressources génétiques avec les plus grandes valeurs et six accessions avec les valeurs les plus basses pour chaque trait sont reportées.

***Mots Clés*: *Eleusine coracana*, génétiques variabilité, grain improvement**

INTRODUCTION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is an important traditional food crop in many parts of Africa and Asia. In Africa, it is extensively grown in Uganda, Tanzania, Ethiopia, Kenya, Rwanda, Burundi, Zimbabwe, Zambia and Malawi (FAO, 1990). In Malawi it is grown in several districts, but its cultivation is mainly concentrated in areas about 1000 m above mean sea level (masl). Most of these areas are in Chitipa, Mzimba, Rumphi, Kasungu and Nkhata-Bay (Lungu, 1974).

Finger millet is used for both food and brewing. Food prepared from finger millet malt is popular among expectant mothers and as a weaning food because it is high in calcium and sulphur amino acids (Malleshi and Desikachar, 1986). The grain stores well for a long period and for this reason

some farmers look upon finger millet as an insurance crop.

Improvement in any crop usually involves exploiting the genetic variability in specific traits. Simultaneous improvement of these traits depends on the nature and degree of association between traits. The finger millet germplasm accessions collected in Malawi (Appa Rao, 1979) were utilised, a) to study the variability in grain yield and eight other traits, and b) to identify germplasm accessions suitable for direct use in yield trials or breeding programmes.

MATERIALS AND METHODS

The trial consisted of 196 finger millet germplasm accessions collected in Malawi. The accessions were planted in a lattice design with two replications at Chitedze Research Station on 10 January 1989, and Makoka Research Station on 4 January 1989. Chitedze Research Station is located 18 km north-west of Lilongwe City (1100 masl, 13° 13'S and 33° 38'E). Makoka Research Station (1000 masl, 15° 32'S and 35° 13'E) is 20 km south-west of Zomba Town. The total rainfall during the cropping season was 1035 mm at Chitedze and 1291 mm at Makoka.

Each plot at Chitedze consisted of a single row of 5 m long and 40 cm wide. At Makoka, each plot had 2 rows which were 4 m long and 45 cm apart. Plant to plant spacing was maintained at about 10 cm by thinning when the seedlings were 20 to 25 days old. A basal dose of 25 kg N, 40 kg P_2O_5 and 30 kg K_2O per ha was applied at sowing using calcium ammonium nitrate, single superphosphate and muriate of potash. Additional 25 kg N per ha was top-dressed when the seedlings were 30 days old.

The number of days to flowering, plant height, finger length, finger width, number of fingers, number of productive tillers, and finger blast [*Pyricularia grisea* (Cooke) Sacc.] severity (degree of damage) were recorded in accordance with standard finger millet descriptors (e.g., IBPGR/ICRISAT, 1985). The number of days to flowering and finger blast incidence were recorded for each plot as a whole, and the remaining characters were recorded on three randomly chosen plants per plot. Finger blast severity was recorded on a scale of 1-9, where 1 = very low or no visible sign of susceptibility, 3 = low susceptibility, 5 = intermediate susceptibility, 7 = high susceptibility, and 9 = very high susceptibility. The number of fingers per panicle and number of productive tillers per plant were recorded. Mature panicles (all panicles in a plot) were harvested, sun dried, and weighed to record panicle yield, and then threshed to measure grain yield.

The mean values of each plot for each location were analysed separately, using the lattice design in MSTAT C statistical package developed by Michigan State University. Bartlett's test for homogeneity of variances was carried out before data from different locations were pooled. The adjusted accession means over replications were used for pooled analysis over locations. The pooled error mean squares were calculated by dividing the sum of effective error sum of squares over two locations by the total degrees of freedom associated with effective errors. In cases where lattice design was not efficient over randomised block design, effective error sum of squares and the associated degrees of freedom were replaced by the error sum of squares and the associated degrees of freedom of randomised block design. Since the pooled analysis was carried out using adjusted accession means over replications, the pooled error mean squares were divided by number of replications to obtain adjusted pooled error mean squares.

RESULTS

Differences among finger millet accessions were significant for all traits (number of days to flowering, plant height, finger length/width, number of fingers, number of productive tillers, panicle yield, grain yield, and finger blast severity) at both locations.

Lattice and randomised block designs were roughly equally efficient for the measurement of days to flowering and finger width. The efficiency advantage of lattice over randomised block design was less than 11% for the remaining traits, except for plant height at Chitedze (Table 1).

The error mean squares were homogeneous only for number of fingers and grain yield. The pooled analysis was carried out for all traits to estimate the interactions between accessions and locations. Based on pooled analysis, the

differences between finger millet accessions and between locations were significant for all the traits under study. The mean squares due to location x accession interactions were significant for number of days to flowering, finger blast severity, finger length, panicle yield and grain yield.

Means over accessions, and ranges between accessions for nine traits at individual locations and the means over locations are presented in Table 2. At both locations, similar trends of variation were observed for number of days to flowering, finger length, finger width, and number of fingers. Higher yields (grain and panicle) were obtained at Chitedze than at Makoka Research Station. Most of the accessions were taller and had more productive tillers at Chitedze than at Makoka Research Station. The adjusted values of finger blast severity varied from 0.86 to 7.21 at Chitedze, and 0.78 to 2.98 at Makoka.

Based on means over two locations, 12 accessions were identified for each trait, six accessions for high level and the other six accessions for low level. These accessions are listed in Table 3.

DISCUSSION

The finger millet germplasm accessions included in this study represent different geographical areas of Malawi. The differences among these accessions were significant for grain yield and its component traits. As large variation exists for many useful traits, a systematic selection for grain yield and other traits will be useful for developing cultivars of different maturity periods with such desirable traits as high grain yields, resistance to blast, and medium plant height.

Gupta and Mushonga (1992) reported significant differences among germplasm accessions from Zimbabwe for grain yield, finger length, finger width and number of fingers per head at both locations, while differences in panicle yield and productive tillers per plant were significant only at one location. Number of days to flowering and plant height were recorded only at one location, where the differences among accessions were significant. In the present study, for all these traits, significant differences among accessions were observed at both locations. In addition, significant differences among accessions were observed for finger blast severity, which was not studied by Gupta and Mushonga (1992).

In finger millet, Kempanna and Thirumalachar (1968), Goud and Lakshmi (1977), and Abraham *et al.* (1989) found significant variation for grain yield and number of productive tillers per plant. Joshi and Mehra (1989) reported significant variation for days to heading, plant height, finger length, number of fingers, and grain yield but observed non-significant differences for number of effective tillers.

There were non-significant location x accession interactions for plant height, finger width, number of fingers, and number of productive tillers. This suggests that selection for these traits can be made based on the mean over locations, although error mean squares were heterogeneous for all these traits except number of fingers.

Based on mean performance over two locations, 12 accessions were selected for each trait i.e.,

TABLE 1. Relative effeciency of lattice design compared to randomised block design with 196 accessions. Trial replicated twice at two locations in Malawi for nine traits in finger millet

Trait	Chitedze	Makoka
Number of days to flowering	100	100
Plant height (cm)	136	110
Finger length (cm)	104	100
Finger width (mm)	100	100
Number of fingers	102	100
Number of productive tillers	102	107
Panicle yield (t ha^{-1})	100	108
Grain yield (t ha^{-1})	100	103
Finger blast (1-9)	102	110

TABLE 2. Means ± S.E., and ranges between accessions for nine morphological traits in finger millet germplasm at Chitedze, Makoka and pooled over locations during 1988/89 rainy season

	Chitedze		Makoka		Pooled	
Trait	Mean ± S.E.	Range	Mean ±S.E.	Range	Mean ±S.E.	Range
Number of days to flowering	83.15 ± 3.782	73.00 - 98.00	79.66 ± 2.677	68.00 - 93.00	81.40 ± 2.317	70.75 - 93.25
Plant height (cm)	98.96 ± 6.512	75.58 - 126.65	88.39 ± 8.259	53.79 - 129.21	93.68 ± 5.259	66.10 - 118.16
Finger length (cm)	6.64 ± 0.797	3.42 - 15.53	7.75 ± 1.172	4.40 - 13.50	7.19 ± 0.718	4.43 - 13.94
Finger width (mm)	9.87 ± 0.738	7.00 - 15.00	9.59 ± 0.976	7.00 - 13.50	9.73 ± 0.612	7.00 - 13.75
Number of fingers	7.17 ± 0.922	4.32 - 11.74	8.16 ± 1.042	5.00 - 11.00	7.67 ± 0.699	5.30 - 10.87
Number of productive tillers	11.80 ± 3.090	4.21 - 24.54	9.41 ± 1.592	5.20 - 17.33	10.61 ± 1.738	5.60 - 17.45
Panicle yield (t ha^{-1})	5.98 ± 1.159	0.94 - 9.69	3.76 ± 0.664	0.09 - 6.17	4.87 ± 0.680	0.85 - 7.16
Grain yield (t ha^{-1})	3.51 ± 0.578	0.44 - 5.62	2.27 ± 0.486	0.00 - 4.01	2.89 ± 0.380	0.40 - 4.42
Finger blast (1-9)	3.07 ± 0.905	0.86 - 7.21	1.24 ± 0.312	0.78 - 2.98	2.16 ± 0.478	0.95 - 4.71

TABLE 3. Finger millet germplasm accessions selected for low and high levels of nine traits

Trait	Level	SDFM Accession numbers
Number of days to flowering	Early: 70.8 - 72.2 Late: 90.0 - 93.2	1151, 1145, 1149, 1126, 1185, and 1146 1273, 1295, 1287, 1194, 1263, and 1169
Plant height	Short: 66 - 76 cm Tall: 113 - 118 cm	1187, 1149, 1125, 1148, 1235, and 1243 1271, 1284, 1262, 1258, 1173, and 1208
Finger length	Short: 4.43 - 4.57 cm Long : 12.39 - 13.94 cm	1129, 1248, 1276, 1234, 1235, and 1244 1134, 1120, 1311, 1137, 1301, and 1310
Finger width	Narrow: 7.0 - 7.8 mm Wide: 12.5 - 13.8 mm	1124, 1136, 1126, 1144, 1259, and 1248 1164, 1287, 1166, 1273, 1177, and 1278
Number of fingers	Low: 5.3 - 5.8 High : 9.6 - 10.9	1205, 1179, 1131, 1149, 1305, and 1166 1252, 1133, 1267, 1266, 1211, and 1214
Number of productive tillers	Low: 5.6 - 6.3 High: 16.1 - 17.4	1275, 1270, 1303, 1207, 1278, and 1153 1131, 1152, 1190, 1151, 1123, and 1124
Panicle yield	Low : 0.85 - 2.23 t ha^{-1} High: 6.59 - 7.16 t ha^{-1}	1124, 1125, 1126, 1178, 1151, and 1182 1288, 1142, 1159, 1209, 1175, and 1165
Grain yield	Low: 0.40 - 1.27 t ha^{-1} High: 4.09 - 4.42 t ha^{-1}	1124, 1125, 1126, 1178, 1144, and 1128 1172, 1213, 1173, 1165, 1256, and 1142
Finger blast	Less susceptible: 0.95 - 1.07 More susceptible: 3.69 - 4.71	1271, 1292, 1276, 1223, 1242, and 1284 1184, 1126, 1171, 1136, 1185, and 1135

those with the six highest, and the six lowest values (Table 3). Six finger millet accessions were selected for early flowering and six for late flowering. Similarly, accessions were selected for short and tall plant height, short and long fingers, narrow and wide fingers, low and high number of fingers per panicle, number of productive tillers, panicle yield, and grain yield. Finger millet accessions that were relatively less susceptible to finger blast were identified. The selected accessions had similar performances (for the trait for which they were selected) at individual locations. The seed of these lines are maintained at the SADC Regional Gene Bank, Lusaka, Zambia, and Genetic Resources Division, ICRISAT, Patancheru, India.

The lattice design showed no considerable advantage over the randomised block design for most of the traits, perhaps because of the small plot size (2 to 3.6 m^2) used in this study.

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REFERENCES

Abraham, M. J., Gupta, A. S. and Sarma, B. K. 1989. Genetic variability and character association of yield and its components in finger millet (*Eleusine coracana*) in an acidic soil of Meghalaya. *Indian Journal of Agricultural Sciences* 59:579-581.

Appa Rao, S. 1979. Germplasm collection mission to Malawi. Genetic Resources Unit Bulletin 2. ICRISAT, Patancheru, Andhra Pradesh 502 324, India: 1-25.

FAO (Food and Agriculture Organization of the United Nations). 1990. Structure and characteristics of the world millet economy. CCP:GR 90/4, July 1990, FAO, Rome.

Goud, J. V. and Lakshmi, P. V. 1977. Morphological and genetical variabilities for quantitative characters in ragi (*Eleusine coracana* Gaertn.). *Mysore Journal of Agricultural Sciences* 11: 438-443.

Gupta, S. C. and Mushonga, J. N. 1992. Variability, heritability, and correlations among morphological traits in finger millet [*Eleusine coracana* (L.) Gaertn.]. *Zimbabwe Journal of Agricultural Research* 30:59-66.

IBPGR/ICRISAT. 1985. Descriptors for Finger Millet. IBPGR Secretariat, FAO, Rome, Italy: 1-20.

Joshi, H. C. and Mehra, H. S. 1989. Investigations on variation, heritability, and genetic advances in ragi germplasm from Uttar Pradesh hills. In: *Proceedings of a National Seminar on Finger Millet Genetics and Breeding in India*, UAS, Bangalore, India. Seetharam, A. and Gowda, B.T.S (Eds.), pp. 73-75.

Kempanna, C. and Thirumalachar, D. K. 1968. Studies on the genotypic variation in ragi (*Eleusine coracana*). *Mysore Journal of Agricultural Sciences* 2:29-34.

Lungu, N. F. 1974. Country Report: Cereals Research in Malawi. In: *Proceedings of the Fifth Eastern African Cereals Research Conference*, Malawi, pp. 296-303.

Malleshi, N. G. and Desikachar, H. S. R. 1986. Studies on comparative malting characteristics of some tropical cereals and millets. *Journal of the Institute of Brewing* 92:174.