Table 1. Important characters of the control and mutant of sunflower

Variety/ Mutant	Height (cm)	No. of leaves	Stem diameter (cm)	Head diameter (cm)	100-Seed weight (g)	Yield per plant (g)
Morden	89	26	2.1	18.8	6.21	43.73
Erectophylly leaf mutant	185	33	3.2	30.0	10.74	120.75

*(Contributed by **ELANGOVAN, M.**, Central Plantation Crops Research Institute, Kasaragod, Kerala, India)*

THE VARIATION OF NITROGEN AND PHOSPHORUS CONTENTS IN M4-GENERATION SEEDS OF AN IRRADIATED LOCAL SORGHUM VARIETY ORIGINATING FROM NORTHERN GHANA

Natural genetic variability in sorghum (*Sorghum bicolor* (L.) Moench) is very large, however, a number of attempts have been made to broaden its genetic base by induced mutations. Most authors [2; 3; 4; 5] refer to visible characters in plant and grain. Occasionally, effects on grain quality, e.g. high lysine/high protein, are reported [1].

Sorghum in northern Ghana, commonly called “guinea corn”, is a widely cultivated cereal crop and can be found in three local races among which the *caudatum* race is represented by 'Naga White', an improved local variety originating from the Upper East Region of Ghana. It is characterized by short straw, earliness, good grain yield, a semi-loose head, and white grains, but with a relatively poor grain quality. The objective in several breeding programmes was the improvement of its grain quality, and an induced mutations programme was started at Nyankpala Agricultural Experiment Station (NAES) in 1988. About 10,000 seeds of Naga White were treated with 200Gy from a ^{60}Co gamma-rays source. The M_1-generation was planted at NAES and multiplied up to M_4 in 1991, subject to selection for agronomic value. Protein contents (N x 5.7) varied from 9 to 10% for grains of parental geneotype and from 8 to 12% in M_2 grains harvested in 1990. In 1992, the agronomically best 112 seed samples of M_4 lines were analyzed for N and P contents, 1000-grain weight (GW) and protein contents. Protein contents ranged from 7.0 to 13.6%, phosphorus from 0.15 to 0.45%, and thousand grain weight varied from 11.8 to 19.0 g. The coefficient of the phenotypic correlation between N and P was + 0.337, and several lines with both high N and P contents could be identified. The coefficients of correlation between grain size and both N and P contents were slightly negative but not statistically significant. The coefficient of variation for the P content was twice as high as that for the N content. This might indicate a considerable microvariability in soil phosphorus due to its low content and availability (highly weathered oxisol, low organic matter, low pH). However, in spite of these difficulties, some of the lines tested showed the ability to accumulate normal to high phosphorus contents in their grains.

REFERENCES

[1] Hanna, W. W., 1982. Mutation breeding of pearl millet and sorghum. MBNL. **1**: 1-13.

[2] Singh, S. P. and P. N. Drolsom, 1973. Induced recessive mutations affecting leaf angle in *Sorghum bicolor*. Journal of Heredity. **64**: 65-68.

[3] Singh, S. P. and P. N. Drolsom, 1974. Induced early-maturing mutation in sorghum. Crop Sci. **14**: 377-380.

[4] Sree Ramulu, K., 1970. Mutagenicity of radiations and chemical mutagens in *Sorghum*. Theor.Appl.Genet. **40**: 257-260.
[5] Sree Ramulu, K., 1975. Mutation breeding in *Sorghum* (A review). Z.Pflanzenzüchtg. **74**: 1-17.

*(Contributed by **FROELICH, W., S.S.J. BUAH, M.S. ABDULAI** and **A.L. NYAMEKYE**, Nyankpala Agricultural Experiment Station, N.A.E.S. P.O. Box 483, Tamale, Ghana)*

SEARCH FOR C_4 DEVELOPMENTAL MUTANTS IN *Panicum maximum* Jacq.

Mutant plants are useful tools for studying developmental processes in defined genetic backgrounds by comparing them with their respective wild type forms. In this sense, developmental mutants or mutations involved in the establishment of certain leaf or flower specific traits are of special interest. In particular, the evolution of C_4 photosynthesis from C_3 precursors was accompanied by severe developmental changes in leaf morphology and anatomy. Our search of such mutants was followed by the idea to approach the evolution of the C_4 syndrome from a mutagenic point of view. Variants affecting normal development of the C_4 leaf anatomy may, in fact, represent possible regressive steps in C_4 photosynthesis [1].

Seeds of the C_4 grass *Panicum maximum* Jacq. were mutagenized using ethylmethanesulfonate (EMS) and putative variants were isolated in the M_2 generation by visual inspection. Main selection characteristics were whole plant, leaf morphology and pigmentation, and growth characteristics. The choice of a polyploid species for mutagenesis experiments was based on the need of detecting rare mutants, which are possibly lethal when using a diploid plant species. These variants could be of regulatory nature, affecting both morphology and physiology of C_4 photosynthesis early in leaf development. In total, nearly 100 variants were isolated and grown to maturity. Main isolated variants, which conforms to the prediction mentioned above, were as following: large interveinal space-1 and –3 (*lis1, lis3*), abnormal bundle sheath (*abs*), midribless (*mbl*) and variegated leaf -1 (*var1*). The variant *lis1* was a short plant with leaves smaller than the wild type, and had a leaf lamina with a crinkly surface. Photosynthetically, *lis1* indicates a clear regression from the C_4 to the C_3 photosynthesis type, which was correlated in the leaf lamina with an increase in the distance between small veins. The variant *lis3* was not similar phenotypically to *lis1*, but it also had very small leaves and reached a total plant height of maximal 0.6 meter. In leaf sections, it was characterized by an almost lack of the small veins surrounded by four bundle sheath cells. The leaf lamina of the variant *abs* showed several alterations, including doublets of veins, veins without bundle sheath, additional bundle sheath cells outside the veins or large bundle sheath cells participating in two bundle sheaths. Also the distribution of phloem and xylem cells within the bundles were quite altered in the variant compared to the wildtype. The leaves were greener, with a higher than normal chlorophyll content and with longitudinal veins not perfectly straight but following a wavy path on the leaf lamina.

Compared with wild type plants the phenotype of the *mbl* mutant was less erect and had pending leaves because of the absence of the main midrib. In wild type leaves the midrib was represented by an enlargement of the mesophyll parenchyma which included parenchymatous and sclerenchymatous cells. This structure was absent in mutant leaves, only small irregular files of parenchymatous cells were present at the base of the leaf lamina. The florets of this mutant had no carpel but one or two additional stamen.

The variant *var1* had a variegated phenotype with stripes of yellow-green and white tissues alternating the leaf laminae. In yellow-green sectors the chloroplasts were absent only in bundle sheath cells, which supports the hypothesis of different ways of development of bundle sheath and mesophyll cell chloroplasts. The adjacent mesophyll cells were less pigmented than