Tropical Technology Journal
Volume 16, January – December 2013
ISSN: 1656-0264

AGRO-MORPHOLOGICAL CHARACTERIZATION OF MILLET *Panicum sp.* GROWN IN NORTHERN CEBU, PHILIPPINES

Borbon SMS[1], Pascual MLD[1], Pasaje GM[1], and Rica RLV[2]
[1]Cebu Technological University-Barili Campus
[2]Cebu Technological University-Main Campus

ABSTRACT

An agro-morphological study of millet locally known as "kabog" and grown in the Northern part of Cebu was undertaken to characterize, identify and relate to commercially known millets (foxtail, pearl, proso and finger millets). The observations were recorded on the morphological traits (leaf blade and leaf sheath colour, leaf angle pubescence, ligule and auricle colour and structures, node and inter node colour, panicle habit, stamen and stigma colour and amount, shape and colour of grains, lemma and palea pubescence, seed coat colour, type of root system, number) and agronomical traits (number of days of seedling emergence, number of days from emergence to panicle initiation, number of days from first panicle initiation to blooming, number of days from blooming to ripening, number of days from ripening to harvesting, number of leaves produce from planting to panicle initiation, panicle height, plant height, fresh weight above-ground biomass, fresh weight panicle, number of grain per panicle, dry weight of above-ground biomass, dry grain weight per panicle, weight of 1000 dry seeds, fresh root weight, dry root weight, root number per plant and diameter of the biggest root)."Kabog" has more or less similar common morphological and agronomic characteristics with proso millet based on the morphological and agronomic performance of the four (4) common cultivated millet species.

Keywords: "kabog" agronomical fruits, morphology, agronomic performance

INTRODUCTION

Cereals are important economically and ecologically. It feeds the world either directly via grains or indirectly as primary fodder of most livestock. Cereals are grains produced by plants belonging to the grass family. As claimed by Doust et al., (2004) cereal crops account for over 50 percent of human energy and protein needs. It occupies two-thirds of all cultivated land. Cereals are the earliest cultivated plants and for over 10 thousand years have been the staple food for many human societies.

One factor that contributes to the importance of cereals is that there are many species and varieties and these are grown in different parts of the world. Species and varietal differences are important in cereal crops because individual cultivars have particular seasonal and climatic adaptations.

Common cereals are rice, wheat, barley, oats, maize (corn), sorghum, rye, and millets. Wheat and barley are found in temperate climates. Maize grows best in hotter conditions and is an important cereal crop in many tropical areas. Rice is a crop of the wet tropics while sorghum and millets can survive in very hot, dry conditions. All of these plants have adaptations which

enable them to survive and grow well in particular environmental conditions. Some of these adaptations are morphological.

Botanist and plant taxonomist use morphological characters of plants which can be compared, measured and described to assess the differences or similarities in plant and use these characters for plant identification, classification and descriptions. Crop architecture is one of the most useful characteristics for distinguishing among species. It can also be of great influence on the crop performance especially in terms of productivity. In cereal grains, variation in morphology is important; even among far and closely related species of millets.

Millet is a general term for a wide range of small-seeded cereal crops or grain. They do not form a taxonomic group, but rather a functional or agronomic one. The essential similarities are that they are small-seeded grasses grown in difficult production environment. These crops are thought of to have been among the first cultivated crops, being one of the staple foods in central and eastern Asia, Europe and some parts of Africa during the very early ages (http;//en.wikipedia.org/wiki/Millet).

Millet is diverse. Pearl millet (*Pennisetum glaucum*) for example comes from tropical West Africa and finger millet (*Eleusine coracana*) from Uganda and neighboring areas. From Eastern Asia, there are varieties such as foxtail millet (*Setaria italica*), proso (*Panicum miliaceum)*, little millet (*Panicum sumatrense*), barnyard millet (*Eichinochloa crus-gali)* and kodo millet (*Paspalum scrobiculatum)*.

Millets can play an important role in the economy. Developing countries in Africa and Asia account 94 percent of its global production of 28 million tons. India, is the world's largest producer with about 40 percent of world production. On the other hand, Lin (2005) reported that China is the world's producer of foxtail millets (3.7 million tons). However, in the West, millets are grown for birdseeds, livestock feed, hay or as an emergency catch crops.

In the Philippines, millet production has not been given much attention compared to other cereals as rice and corn. Only rice and corn have records in terms of accessions in international genebanks, national genebanks of global importance, and South-East Asian genebanks. No reports and records have been found on the history and the introduction of millet in the Philippines, even though few millet species are successfully grown in the Visayas region.

In Northern Cebu, there are some areas that grow millet for years. However, the kind of variety they are growing is not yet identified. Hence, its morphological and agronomical characterization is necessary. This study was carried out to characterize the millet locally known as "Kabog" grown in Northern Cebu.

MATERIALS AND METHODS

Cultivar and Locale of the Study

A pot experiment was conducted at Cebu Technological University-Barili Campus condition.

 ISSN: 1656-0264

The millet seeds used in this study were acquired from the millet growers in Northern part of Cebu. The seeds were sown based on the recommended and common millet planting time in the various places such as Barangay Agsuwao (Catmon, Cebu), Kalangahan (Tuburan, Cebu) and Nahus-an (Sogod, Cebu).

The germination percentage was determined firsts to ensure the viability of seeds and it was found out that the seeds possessed a quality germination percentage of 91 percent.

Pot Layout

The experimental plants were grown in a plastic polyethylene pots with uniform size (12 inches in diameter and 10 inches length) and shape. Each pot has uniform 5.1 kg garden and sandy soil mixture. The pots were placed on top of table with 1.5 m width, 2.0 m length and 1 m high. To have a comfortable space in data collection, pots were positioned in a single row with 10 pots per row. The distance per pot in a row was 15 inches while the distance between pots in a row was 24 inches. There were three (3) rows per table. Two tables were used in this experiment. Thirty pots were utilized to accommodate all the entries in one table. All in all 60 pots were utilized in this study.

Plant Establishment and Care and Maintenance

Cultural practices like thinning, watering, fertilizer application, pesticide application, etc., were equally applied and practiced to all the potted plants. Thinning was done 15 days after plant emergence following the specified plant densities, one plant per pot. Fertilizer application was done twice for all experimental plants at a rate 90-45-45 kg NPK. There was a split application of fertilizer. For first application of complete fertilizer was done before sowing and served as "footing". Urea was applied 30 DAS by side dressing method.

Harvesting

The experiment was not terminated simultaneously. The termination of the experimental plants depend on the various parameters collected. Also priming was employed to avoid loss of ripened grains from shattering. Termination was done when the panicle per plant had 90 percent of the grains turned brown. The brownish color of the panicle of millet is a significant indicator that the grain is matured. After the important data were collected, each experimental plant was uprooted carefully and cleaned from unnecessary particles.

Data Gathering

Data gathering started at emergence until termination stage of the experiment. Uniform techniques of data recording and collection were followed to all the experimental plants. The various morphological and agronomic characters were the following:

A. Morphological (qualitative) characters

1. Leaf - Leaf blade color, basal leaf sheath color, leaf blade pubescence, flag leaf angle, ligules and auricle shape.

2. Culm - Culm angle, nodes color, internodes color and pubescence.

3. Panicle - Panicle type and panicle shattering

4. Stigma – number and color

5. Stamen - Number and color

6. Grain – Shape, grain awning, lemma and palea pubescence, seed coat color and grain color

7. Root – Type of root system

B. Agronomic (quantitative) characters

1. Number of days of seedling emergence

2. At vegetative stage- this includes the days from emergence to panicle initiation, number of leaves produced of the main culm from planting to panicle initiation, number of tillers produced from planting to panicle initiation, average panicle height (cm) and final plant height (cm).
3. At reproductive – ripening stage

Shoot. This includes the number of days from the first panicle initiation to blooming, number of days from blooming to ripening, number of days from ripening to harvesting, fresh weight of above-ground biomass, fresh weight of panicles per plant (g), number of grains per panicle, dry weight of above ground biomass (g), dry weight of grains per panicle (g), dry weight of 1000 grains per plant (g) and number of seeds per 1 gram per plant.

Root. This includes the root fresh weight (g), root dry weight (g), number of roots per plant, average length of roots per plant (cm), diameter of the biggest root per plant (mm).

RESULTS AND DISCUSSION

Morphological (Qualitative) Traits of Millets

There are two responses of plants to the environment. These include genetic differentiation or change in genetic composition and the phenotypic plasticity of individual plants or changes in physiological, qualitative (morphological), and quantitative characteristics (Kuipper, 1990). The morphological characters and descriptions are presented in Table 1 and Table 2. Leaf characteristics including leaf blade color, basal leaf sheath color, leaf blade pubescence, and leaf sheath pubescence. The leaf blade coloration patterns from seedling to early reproductive stage

 ISSN: 1656-0264

varied from green to dark green color. Instead of green, the color of the basal leaf sheath was white with light fine vertical green lines. No tiny hair like appearance presents in the front and back side of the leaf blade. In fact the blades were all smooth, shiny and green. But the appearance of the leaf sheaths were opposite, the leaf sheaths have tiny white hair like appearance (pubescent) which is even prominent.

Table 1. Morphological Characteristics and Descriptions of Millet

Character/Trait	Description
Leaf	
Leaf blade color	Green- Dark green
Basal leaf sheath color	White with light green lines
Leaf blade pubescence	None
Leaf sheath pubescence	Pubescent
Leaf angle	Erect
Flag leaf angle	Intermediate
Ligule shape	Membranous (Fringed)
Ligule color	White (Ave. length = 3.58 mm)
Auricle color	White (Ave. length = 5.22 mm)
Culm	
Culm angle	Erect
Node color	Light green
Internodes color	Light green
Pubescence	Pubescent (Ave. Length: 4.38 mm)
Panicle	
Panicle type	Dropping
Panicle shattering	Low
Stigma	
Number	2
Color	Light pink
Stamen	
Number	3
Color	Orange
Grain	
Shape	Ovoid (Ave. size: 1.7 mm width, 2.43 mm length and 1.20 mm thick)
Grain awning	Absent
Lemma and palea pubescence	None
Seed coat color	Yellowish brown
Grain color	Light yellow
Hardness	Hard

On the adaxial surface of the leaf, where the blade joins the sheath, there was a small membranous flap of tissues, the ligules. The experimental plants had white membranous shape ligules with an average length of 3.58 mm. The plants also had projections in the same region as

 ISSN: 1656-0264

the ligule but at the margins of the leaf. The projections are known as the auricles. The same with the ligules, millet has white color auricle with average length of 5.22 mm.

Growth habit of the culm erect as well as its angle. The main body of the millet, including the culm of each tillers had white fine hairy appearance (pubescent). The average length of the hair like structure was 4.38 mm. The distal part of an otherwise hollow culm is solid. The hollow units between the partition of the culm represents the internodes and the transverse septa are the nodes. Millet node and internodes color were light green.

Opposite with the erect orientation of the culm, millet panicle has dropping panicle even at the early stage of reproduction. Panicles already exhibit dropping panicle position, when reaching maturity or even harvesting stage. It was observed that the panicle was also susceptible to shattering. In this experiment, panicle was not harvested simultaneously. Priming was done to avoid loss of ripening grains from shattering. Usually, the panicle of the main culm was harvested firsts, followed by the panicle of the first tiller, next the second tiller and so on.

The plant had open and lax panicles that usually join the spikelet stalks. The spikelet is ellipsoid. The main female part of the flower, the stigma, was light pink in color. There were two stigmas per floret. The stamen, the main male part of the flower had bright orange color. Three stamens per floret were observed. The shape of the spikelet observed was not similar with the shape of the seeds. The seed shape was ovoid and with an average size of 1.7 mm width, 2.43 mm length and 1.20 mm thick. No awn was observed per seed, also no white hairy structure in the lemma and palea. Lemma and palea sheds easily, even just by touching after harvest, but the grains were hard. Seed coat color was yellowish brown while the grain color was light yellow.

Root system was shallow with a fibrous type of root. Roots were observed on the first two nodes of the main culm, even to some lower nodes of the tillers.

Agronomic (Quantitative) Traits of Millet

Plants exhibit natural variation in their form and structure. While all organisms vary from individual to individual, plants exhibit an additional type of variation aside from change in morphology. Economically important quantitative traits include agronomic characteristics. In this study the plant agronomic performance from planting until harvest was given important consideration. It was noted that the average total number of days from sowing until harvesting was only 88 days (Table 2 and 3). The development stage of cereals was determined by the number of leaves produced. Starting from sowing to seedling emergence (average of 4 days), days from germination to panicle initiation (average of 42 days), number of days from the first panicle initiation to blooming (average of 6 days), number of days from blooming to ripening (average of 31 days) and number of days from ripening to harvesting (average of 5 days).

From planting to panicle initiation, each experimental plant produced an average of eight (8) fully develop leaves at the same time the plants had an average of 10 tillers. In rice vegetative growth, there is a close relationship between the appearance of each tiller and the emergence of the leaves of the main culm (Escalada, 1983). It was reported that each of the respective leaves,

 ISSN: 1656-0264

both on the main culm and the tillers develop in parallel with the development of the leaves of the main culm. In addition, the number of headed tillers is an important yield component in cereal grain production. The system for quantifying cereal leaf and tiller development permits more definitively because each leaf and tiller on the plant is given a unique designation.

The panicle and inflorescence of cereals also has very important role in cereal yield. Productive tillers should also have healthier panicle. In this study, the average panicle height per tiller per plants was 43.35 cm. The average final plant height was 120.5 cm as shown in Table 2.

Table 2. Shoot Agronomic Performance at Vegetative Stage

Agronomic Characters	Performance Average
Days from emergence to panicle initiation (days)	**42**
Number of leaves produced of the main culm from planting to panicle initiation	**8**
Number of tillers produced at panicle initiation	**10**
Average panicle height (cm)	**43.35**
Final plant height (cm)	**120.5**

The shoot agronomic performance gathered at reproduction stage to maturity are shown in Table 3. The fresh panicles per plant had an average weight of 7.2 gram, more than one half of the average weight of all the shoots or above ground biomass which had only 12.77 gram. This means that the crop had an advantage in terms of the consumptive or economic yield (the grains per panicle). The experimental crop produced an average of 888 grains per panicle. The fresh weight of the above-ground biomass or shoot is 12.77 grams per plant was higher compared to the result of the fresh weight of the under-ground or root which is 9.12 grams (Table 4). But after drying (sun-drying) the root average dry weight only reduced into almost half. After drying, the average root dry weight per plant was 3.94 grams. Although there are differences in roots of different sizes from one (1) species, and also even roots of similar size belonging to different species, the millet or “Kabog” root system showed same behaviour as most grass roots. The root system is shallow and fibrous, which had an average number of 94 roots per plant, which had an average root length of 38.3 cm and the diameter of the biggest root per plant was 2 mm (Table 4).

Table 3. Shoot Agronomic Performance at Reproductive to Maturity.

Agronomic Characters	Performance Average
Number of days from the first panicle initiation to blooming (days)	**6.0**
Number of days from blooming to ripening (days)	**31.0**
Fresh weight of above-ground biomass (g)	**12.77**

 ISSN: 1656-0264

Fresh weight of panicles per plant (g)	**7.2**
Number of grains per panicle	**818**
Dry weight of above ground biomass (g)	**4.14**
Dry weight of grains per panicle (g)	**2.3**
Dry weight of 1000 grains per plant (g)	**2.9**
Number of dried seeds per 1 gram per plant	**346**
Number of days from ripening to harvesting (days)	**5.0**

Table 4. Root Agronomic Performance at Harvest

Root Performance	**Average**
Root fresh weight (g)	**9.12**
Root dry weight (g)	**3.94**
Number of roots per plant	**94.0**
Average length of roots per plant (cm)	**38.3**
Diameter of the biggest root per plant (mm)	**2.0**

Millet Relatedness to widely known and Cultivated Millet Species

Based on the available foxtail millet morphology and agronomic characteristics presented only the culm habit, hairy leaf sheath, stigma and stamen number, seed shape and color had similarities with the data obtained in the experimental plants morphological characters. Aside from annual grass, no exact similarities were observed between the foxtail and “kabog” agronomic traits presented. Although in terms of the days of maturity slight difference was observed. Foxtail has an average 82 days of maturity while “kabog” has 88 days.

Aside from plant habit, leaf sheath appearance, ligule appearance, inflorescence stigma and stamen number, no other morphological similarities were observed between pearl millet and “kabog”. Even the available pearl millet agronomic trait, a difference was observed when being compared to “kabog” agronomic traits.

A promising result was observed between the morphological traits of proso millet. Majority of the available data presented fit to the results of “kabog” morphological characteristics. In terms of the agronomic traits, the proso and kabog had more or less similar average plant height, with 135 cm and 120.5 cm; respectively. Slight difference was observed in terms of the number of days to maturity. Proso has a maximum 75 days while “kabog” has an average of 88 days. However, there was an observable difference in terms of the tiller number and weight of the 1000 dry seeds.

On the other hand, no similarities was observed between finger millet and “kabog” in terms of spike number, seed colour, seed shape, grain colour, plant height and tiller number. Based on this, it was noted that the two (2) are of the same type. Although, they have the same culm and tiller characteristics but the two (2) traits are common to majority of cereals. The two (2)

 ISSN: 1656-0264

species have more or less average weight of 1000 dry seeds.

As observed, the agronomic traits are varied. Majority of the agronomic traits of the four (4) known millets did not coincide with the gathered agronomic traits of "kabog". Agronomic or quantitative traits of any species either plants, animals or even human is greatly influenced by the environment.

Qualitative traits (example the morphology) are not easily influenced or affected by environmental factors or changes. Thus, based on the qualitative traits of the four (4) known millet species, it was observed that "kabog" has more or less similar common morphological characteristics to proso millets. Maybe "kabog" is one of the accessions or type of proso millets. According to PROTA (2006), proso millets have two (2) major types, the wild and the cultivated. The true wild type is native to Central China and considered to be the ancestors of the cultivated types.

CONCLUSIONS

Based on the results of this study, the following conclusions were drawn:

1. "Kabog" has promising morphological characteristics. It has dark green pubescent leaf blade, white with light green lines leaf sheath, pubescent leaf angle with intermediate color, white membranous ligule, white auricle, erect pubescent culm, light green node and inter node colour, drooping and low shattering panicle, two (2) light pink stigmas, three (3) orange stamens, light yellow awnless ovoid and hard grain, pubescent lemma and palea, yellowish brown seed coat and fibrous shallow root system.

2. "Kabog" agronomic characteristics are: 88 days maturity, four (4) days seedling emergence, require 42 days from emergence to panicle initiation, require six (6) days from first panicle initiation to blooming, require 31 days from blooming to ripening, require five (5) days from ripening to harvesting, produce eight (8) leaves from planting to panicle initiation, produce 10 tillers at panicle initiation, 43.35 cm panicle height,120.5 cm. plant height, 12.77g above ground biomass fresh weight, 7.2g panicle fresh weight per plant, 818 number of grains per panicle, 4.14g dry weight of above-ground biomass, 2.3g dry weight of grains per panicle and 2.9g weight of 1000 dry seeds per plant, 9.12g fresh root weight, 3.94g dry root weight, 94 roots per plant, 38.3 cm average root length per plant and two (2) mm diameter of the biggest root per plant.

3. "Kabog" has more or less similar morphological characteristic with proso millet.

RECOMMENDATIONS

Based on the results of the study, the following recommendations were extended:

1. It is highly recommended that similar study should be conducted but under various Cebu field conditions.

 ISSN: 1656-0264

2. Collection and preservation of foxtail, pearl, proso and finger millets seeds and their accessions, should have actual comparison with “kabog” agronomical and morphological performance under Cebu condition.

3. To identify “kabog” at microscopic level, it is recommended to conduct research on “kabog” morpho-anatomical characterization.

LITERATURE CITED

Alcasid, C.E., A.M. Dela Rosa and A.L. Carpena. 2008. Morpho-Agronomic Diversity Analysis of 20 Lines of Thermo-Sensitive Genetic Male Sterile Rice. Based on the undergraduate thesis of the senior author; a contribution from the Crop Science Cluster, College of Agriculture, University of the Philippines Los Banos, College, Laguna Philippines. Philippine Journal of Crop Science. August 2008, 33(2):51-58

Damanai, A.B., E. Porceddu, and M.T. Jackson. 1983. A Rapid of Evaluation of Variation in Germplasm Collections of Cereals Using Polyacrylamide gel electrophoresis. Euphytica, 32:877-883.

Doust, A.N., K.M. Vevos, M.D. Gadberry, M.G. Galand E.A. Kellogg. 2004. The Genetic Basis for Inflorescence Variation Between Fxtail and Green Millet (Poaceae). University of Missouri, Department of Biology, Saint Luis United Kingdom. The Genetics Society of America. DOI:10.1534/genetics.104.035543.

Escalada, G. R. 1983. Advanced Cereal Production Manual. Department of Agronomy and Soil Science. Visca Open University. Office of the Graduate School. Visayas State College of Agriculture. Baybay, Leyte.

Frederick, S. E., E. H. Newcomb, E. L. Vigil and W. P. Wergin. 1968. _____. Department of Botany, University of Wisconsin (http://www.springerlink.com/content/g78w131911x40767/)

Gottlieb, L.D. 1977. Eletrophoretic Evidnece and Plant Systematic. Ann. Missouri. Bot. Gard. , 64:161-180.

Grubben, G.J.H., and S. Partohardjono. 1996. PROSEA “Plant Genetic Resources of South East Asia 10: Cereals” Backhuys Publisher, Leiden

Hoey, B. K., K. R. Crowe, V. M. Jones and N. O. Polans. 1995. _____. Department of Biological Sciences and Plant Molecular Biology Center, Northern Illinois University. (http://www.springerlink.com/content/ut6x213952087754/)

Ishimaru, K., M. Yano, N. Aoki, K. Ono, T. Hirose, S. Y. Lin, L. Monna, T. Sasaki and R. Ohsugi. 2000. _____. National Institute of Agrobiological Resources and JPRice GenomeResearch Program, National Institute of Agrobiological Resources/ Institute of Society for Techno-Innovation of Agriculture, Forestry, and Fisheries Tsukuba, Ibaraki

 ISSN: 1656-0264

http://www.springerlink.com/content/9fmqbvnavn8nkb5f/

Kim, K. S. and J. B. Beard. 1988. _____. Crop Science Society of America. Department of Soil and Crop Sciences, Texas A&M University. (http://crop.scijournals.org/cgi/content/abstract/28/2/32)

Klepper, B., R. W. Rickman and C. M. Peterson. _____. Quantitative Characterization of Vegetative Development in Small Cereal Grains. http://agron.scijournals.org/cgi/content/abstract/74/5/789

Kuiper, P. J. C. 1990. Analysis of phenotypic responses of plants to changes in the environment in terms of stress and adaptation. Acta Bot. Neerl. 39 (30), 217 – 227.

Mannetje, L.T. and R.M. Jones. 1992. PROSEA "Plant Resources of South East Asia 4: Forages. Pudoc Scientific Paper. Wageningen. Pp 126-127, 185-188.

Peterson, D.M., D. M. Wesenberg, D. E. Burrup and C.A. Erickson. 2004. Small Grains and Potato Germplasm Research. Crop Sci 45:1249-1255 and http://crop.scijournals.org/cgi/content/full/45/4/1249

Ramirez, H. A., Hussain, W. Roca, and W. Bushuk. 1986. Isozyme Electrophoregrams of Sixteen Enzyme in Five Tissues of Cassava (*Manihot esculenta* Crantz) varieties. Euphytica 36: 39-48.

Reed, J.D. 1992. Sorghum and Millets as Forage Crops in the Semi-Arid Tropics. International Crop Research Institute for Semi-Arid Tropics.pp: 173-178.

Reddy, V.G., H.D. Upadhyaya and C.L. Gowda. 2007. Morphological Characterization of World's Proso Millet Germplasm Collection. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).ejournal.icrisat.org.| Volume 3 | Issue 1.

Riley, K.W., S.C. Gupta, A. Seetharam and J.N. Mushonga. 1994. Advances in Small Millets. International Science Publisher New York.

http://en.wikipedia.org/wiki/Millet

http://en.wikipedia.org/wiki/Plant_morphology

http://lubbock.tamu.edu/othercrops/doc/nmsumilletprod.htm

http://ukcrop.net/millet.html