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Full Length Research Paper

Assessment of quantitative traits of USTPx plantain (*Musa* sp.) hybrids for crossability studies

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Abstract

Assessment of quantitative traits is the preliminary aspect in conventional breeding to choose crossable species and consequent production of ideotypes. USTPx plantain (*Musa sp*.) hybrid population of 70 plants consisting of USTPx/01/01, USTPx/01/02, USTPx/01/03, USTPx/01/05, USTPx/01/06, USTPx/01/07 and landraces such as KM5 were selected for this study in which each specie was replicated ten times. All hybrids used were synthesized in the Department of Crop/Soil Science, Rivers State University, Port-Harcourt. They were subjected to physical *in-situ* and laboratory assessment. Data collected were arranged in Complete Randomization Design. Some baseline agronomic quantitative data were taken from all the species such as plant height, bunch weight etc. USTPx/01/05 was the tallest (2.2m) genotype and USTPx/01/01 was the shortest (1.0m) at anthesis. The bunch weight was highest (14.3kg) in USTPx/01/02 followed by (4.9kg) KM5, respectively and the other species do not possess edible fingers. An assessment of black sigatoka response of the species revealed that USTPx/01/01 is resistant while the other 6 were either less resistant or susceptible. KM5 and USTPx/01/02 should be used as potential male and female parent in any genetic plant breeding of *Musa* species due to inherently better quantitative traits such as high bunch weight (yield) and polleniferous capability andUSTPx/01/01 should also be used due to its polleniferous ability and apparent resistance to Sigatoka complex which can be introgressed into the cultivated (cultivar) species of *Musa* in order to avert yield losses as result of the disease.

Keywords: Qualitative, quantitative, traits, assessment, crossability.

INTRODUCTION

Musa is a genus that includes perennial stooling herbs. The true stem remains short until flowering. Leaves are large, blades are oblong, petioles are long and expanded below into long, sheathing and stem-encircling leaf-bases forming a pseudo stem. Inflorescence can be found as pendulous, half-pendulous, or erect. Bracts are plane or sulcate, convolute or more or less imbricate in the bud, usually deciduous (Silva, 2000). Flowers are placed in a single row or in two rows to each bract. Those of the lower bracts are female or hermaphrodite, and those of the upper bracts are male, some-times (i.e. in the cultivated or semi-domesticated forms) all functionally sterile. Perianth is (according to the usual interpretation) of two parts: a compound tepal (calyx) essentially tubular, but split to the base on the adaxial side, 5-toothed at the apex, or perhaps better described as 3-lobed at the apex with 2 accessory teeth between the main lobes; and a free tepal (petal or corolla) inserted within the compound tepal and opposite to it (i.e. in the adaxial position). A flower consists of five stamens while the ovary is inferior and trilocular. Fruit is a fleshy berry, with numerous seeds (except in the parthenocarpic forms). Seeds

are irregularly globose, lenticular, or cylindrical, with a perisperm chamber above the endosperm (Cheesman, 1947; Silva, 2000).

Musa species grow in a wide range of environments and have varied human uses, ranging from edible bananas and plantains of the tropics to cold-hardy fiber and ornamental plants. Plantain and Banana are native to tropical lowlands, usually found up to 30º latitude North and South (Morton, 1989). It is adapted to hot, wet tropical lowland. However, in Southern and Eastern Africa, banana cultivation may extend to 1500m above sea level. The ideal mean temperature is around 28 ºC while best temperature range is between 25 ºC and 30 ºC. An annual rainfall range of well distributed rain of between 2000 and 2500 mm is ideal for successful growth and development. Banana fruits are sensitive to temperatures. At temperatures below 16 ºC the growth of the plant stops. Temperatures above 38ºC are equally bad to the plant physiology resulting in stoppage of growth (Nakasone and Paull, 1999). Frost kills plants above ground, although the corm usually survives. Deep, well-drained loamy soils are best, but bananas can tolerate a wide variety of soil conditions (Changadeya, 2009).

Plantain and Banana are vegetatively propagated and sterile crops and are not usually grown from seed. All over the world plantain and banana have a rather narrow genetic base resulting in high vulnerability to diseases. Therefore, in commercial production of plantain and banana, large amounts of pesticides are used to reduce this high susceptibility to diseases. However more sustainable solutions could be found by breeding, while for some diseases such as the infamous panama disease, breeding is the only viable solution (Hernandez and Witter 1996).

A disturbing scenario could be observed recently in East African banana cultivation. Although banana was a hardy crop with a long plantation life and stable yields year round, with the arrival of the Black Sigatoka fungus, banana production in eastern Africa has fallen by over 40%. It is the most important disease of plantain (Ploetz, 1999). This is critical in countries where plantain and banana happens to be the main source of year-round food security. Even though the situation has started to improve as new disease resistant varieties have been developed, these new varieties taste differently from the traditional ones, which have made local farmers reluctant in accepting them (INIBAP, 2006).

Plantain and Banana cultivars are susceptible to a number of diseases. The majority of these diseases are caused by fungi, bacteria and viruses. The most threatening fungal diseases are Panama disease (Fusarium wilt), root rot, damping-off, and heart rot. Also there are a number of bacterial diseases found in banana such as Moko disease, wilt, fingertip rot, etc. Some viruses such as bunchy top of bananas, cucumber mosaic of banana and Abaca mosaic of banana may also cause severe damages to banana cultivations (Stover, 1972).

Plantains and bananas (*Musa* sp.) are perennials which grow to produce generations of ratoon crops. They represent the world's second largest fruit crop with an annual production of 129,906,098 metric tons. They rank as the fourth most important global food commodity after rice, wheat and maize in terms of gross value of production. They originated from South East Asia. Plantain and Banana are reliable sources of energy and fibre; they store carbohydrate reserves in the form of starch and sugar respectively. Bananas provide a starchy staple across some of the poorest parts of the world in Africa (with consumption up to 400 kg per person per year) and Asia, while dessert bananas are a major cash crop in many countries (FAO Stat, 2007).

Cultivated bananas and plantains are giant herbaceous plants within the genus Musa. Bananas (including plantains) grown today worldwide are cultivars derived from the interspecific hybridization of *Musa acuminate* and *Musa balbisiana*. There are over a thousand Musa cultivars embracing a wide genetic diversity, which reveal their multiple origins through hybridization from these two ancestral diploid species (Heslop Harrison and Schwarzacher, 2007). Inter and intra-specific hybridizations have led to parthenocarpic diploid and triploid cultivars. However, the difficulty in generating hybrids and the sterility of many cultivars showing parthenocarpy makes *Musa* cross-breeding challenging. The main objective for the genetic improvement of banana is to breed sterile triploid hybrids through the recombination of fertile cultivars and species that meet farmers‟ needs and consumers‟ demand (Ortiz and Vuylsteke, 1996). Although sterility and parthenocarpy are important factors that contribute to the desirability of banana fruits, sterility has impeded progress in breeding programs. Through natural somatic (vegetative) mutation, hybridization and selection over many thousands of years, considerable genetic variability have arisen within the cultivated bananas, giving rise to more than 1000 varieties worldwide. *Musa* breeding started about one century ago in Trinidad, aiming to develop pest and disease resistant cultivars for the export trade. Even so, all banana export cultivars grown today are still selections from somatic mutants of the group Cavendish and have a very narrow genetic base (Perrier *et al*., 2011). As noted by Dirk R. Vuylsteke "a broad-based, improved *Musa* germ plasm with pest/disease resistance will be a major component to achieve sustainable production of this vegetatively propagated, perennial crop." Such germ plasm can be produced through conventional cross-breeding, enhanced by the utilization of innovative

innovative methods for the introduction of additional genetic variation. Also, the increased use of molecular markers will accelerate the process of recurrent selection of improved *Musa* germ plasm and, hence, facilitate the development of new hybrids. The prospects of banana and plantain breeding are unlimited and increased effort would initiate a new phase of *Musa* evolution" (Ortiz, 2001). This research is an attempt to identify the quantitative traits of some indigenous plantain hybrids.

MATERIALS AND METHODS

The field aspect was carried out at the River State University, Teaching and Research Farm while the laboratory aspect was done in the Microbiology laboratory, Department of Microbiology, Rivers State University, Port-Harcourt. Rivers State has a landmass of 19420 sq.km.

The rainfall pattern is essentially bimodal with peaks in June and September, while in April and August there are periods of lower precipitation (Ukpong, 1992). The long rainy season is between April and October. The dry season lasts from November to March with occasional interruption by sporadic down pours. Annual rainfall is average of 2000mm to 4500mm (Anderson, 1967).

The mean monthly temperature ranges between 28^0C and 33^0C, while the annual monthly minimum is between 20^0C and 23^0C. The highest temperatures are experienced during the months of December through March and coincide with the overhead passage of sun (Enwezor, *et al*., 1990).

The project site is located between latitude 04.51^0N and longitude 07.01^0E with an elevation of 1.8m above sea level (FAO, 1984).

The site has been used for breeding of *Musa* species for several years. The site was acquired by the University for various agricultural operations which has a well drain soil with secondary vegetation that is made up of weeds, annuals and perennial grasses. It is completely a secondary vegetation consisting of broadleaf weeds such as *Chromolena odorata, Calosopogum mucunoides, Centrosema pubuscens, Sidaacuta* (Broom weed), wild shrubs and some grasses in abundance particularly *Pennisetum purpureum* (Elephant grass).

The soil of the site is typically sandy loam and formed over sedimentary rocks (Ojanuga *et al*, 1981). It belongs to the class ferralitic soil in the C.C.T.A classification system or ultisol in the United States, soil taxonomy (U.S.D.A, 1975). The soil is friable, slightly hard with very few root concentrations with a gradual smooth land topography which is well drained. The site is poor in nutrients due to the continuous cropping all year round, and low in exchangeable cations (<6) and percent N (0.01) but fairly high in available phosphorus (>20ppm) with a moderate amount of organic matter (1.8%) Hullugale *et al* (1990). The area is strongly acidic with a pH range of 4.6-5.1.

Soil samples were collected randomly from different points within the farm at two different depths; 0-15cm and 16-30cm using a soil auger to form a composite soil. Samples were prepared in the laboratory by air-drying and relevant parameters were determined.

Parameters were determined by physical analysis (Ohiri and Ano, 1988) as follows, soil pH by glass electrode pH meter, (Peech, 1965), exchangeable calcium and magnesium by the versenate titration method (Feech, 1965) while that of exchangeable potassium and sodium was by flame photometry (Strout, 1962). Available soil phosphorus was determined by the molybdenum blue color method (Chapman and Pratt, 1961) while that of organic carbon was determined by Walkey-black oxidation method (Walkey and Black, 1934). The kjeldahi apparatus was adopted in analyzing the total nitrogen, nitrate nitrogen as well as ammonium nitrogen (Stock, 1983). Particle size analysis was determined by the hydrometer method (Black, 1965) after which the textural triangle (U.S.D.A, 1950) was used in classifying soils based on the percentage constituent of individual particles (sand, silt and clay).

ANOVA method was used to analyse the quantitative parameters as recommended by Steele and Torrie and means were tested using Tukey means method of grouping at 5% level of probability (Minitab, 2010).

In regression, bunch weight has been used as an index of fruit yield, since this index has been preferred by others over the number of bunches cut and fruit weight per unit area because bunch weight is not affected by plant losses to the extent as the other criteria of yield (Gordon and Frank, 1983).

The experiment consists of a total of seven (7) USTPX plantain clones planted out individually in rows for phenotype evaluation. The experimental materials were made up of seven (7) different *Musa* species which serve as the treatments and each treatment is replicated ten times. The treatments were arranged in a Complete Randomization Design (CRD).

Seven (7) plantain hybrid clones growing *in-situ* at the Teaching and Research Farm of the River State University, Port Harcourt developed by the department of Crop/Soil Science were used. The *Musa* clones are: USTPX/01/01, USTPX/01/02, USTPX/01/03, USTPX/01/05, USTPX/01/06, USTPX/01/07, and Yangambi (KM5).These planting materials were growing *in-situ* in which suckers were collected to supply stands devoid of plants. Before

planting suckers were trimmed to 30-40cm high and planting was in March at a spacing of 3m x 2m. Holing was of the standard dimension 30cm x 30cm x 30cm (Swennen, 1990).

Immediately after the growth of the supplied stands, 5kg of poultry manure was applied to each stand of plantain which apparently boasts the vegetative growth and yield of the plants.

Weeds were controlled by regular monthly manual slashing throughout the growing period. At the beginning of dry season in November, the plants were heavily mulched with dry grasses such as *Pennisetum purpureum, Andropogon gyanus, Centrosema pubescens* etc.

At maturity of the plant, i.e. +90 days after shooting, Pollen samples were collected from the genotypes between 7:30 and 10:30 am and were immediately taken to the laboratory and were placed on a light microscope to observe the polleniferous nature of all the different species.

Plant height (m) at harvest was ascertained by using a long graduated meter rule. Number of leaves at harvest was ascertained by counting the number of standing leaves during harvest.

Leaf area at harvest (m^2) was ascertained by measuring the length and width of the 3rdleaf during harvest using a measuring tape.

Pseudo-stem Girth (m^3) was ascertained by measuring the girth using a measuring tape.

Length of Anther (m) was ascertained by measuring the anthers excised randomly at different stages on the glomerule or hand with a 30cm rule.

Style Length (m) was ascertained by excising the style carefully from the anther and measured with a 30cm rule.

Number of hands at harvest was ascertained by manually counting of the hands on each bunch harvested.

Number of fingers at harvest per bunch was ascertained by manually counting the fingers on each bunch harvested.

Circumference of mid-finger at harvest(cm) was done by measuring the mid-finger using a measuring tape.

Bunch Weight (kg) was ascertained by weighing each harvested bunch using a Weighing Scale.

Number of seeds per Bunch was ascertained by manually counting the seeds retrieved from each bunch during squashing.

Scoring of Black Sigatoka was assessed prior to anthesis by scoring the youngest leaf spotted (YLS) before flowering (Vakili, 1968), after which leaf production ceases.

RESULT AND DISCUSSION

Physico-chemical Soil Nutrient Characterisation

Soil analysis on the physicochemical properties of the site prior to anthesis of the plants (2017) indicates that the soil is low in hydrogen ion concentration (soil pH), organic matter content, total N and exchangeable cations which are shown in the Table 1. Based on the environmental requirement of plantain and banana, organic material such as poultry dropping of 10tons/ha was weighed using a weighing balance and incorporated to each stand of Plantain to increase the nutrient status of the soil which eventually improved the vegetative growth performance of the plants. As a result, a positive influence was recorded at harvest particularly USTPx/01/02 and KM5 that produce edible fingers. However, poultry dropping, which is a soil amendment material, did not influence the textural class of the soil as being either sandy loam at a depth of 0-15cm or clay at 16-30cm depth respectively.

Table 1: Physico-chemical Characterization of Experimental Plot

Sample Code	N (Mg/kg)	pH	Particle Size %			Texture	Av. P (Mgkg)	OC %	OM %	Cmol kg^{-1}			
			Sand	Silt	Clay					Na	K	Mg	Ca
01	0.02	5.60	82	12.6	5.4	Sandy	56.14	1.09	1.88	0.35	0.15	0.60	1.60
02	0.45	5.70	80	14.6	5.4	Sandy	59.64	1.17	2.02	0.22	0.12	1.00	1.20
03	0.01	5.80	82	14.6	3.4	Sandy	63.15	1.05	1.82	0.26	0.13	0.60	0.80
04	0.06	5.80	78	14.6	7.4	Loamy Sand	63.15	1.13	1.95	0.15	0.15	0.60	1.00

Table 1 Cont'd

05	**0.04**	**5.70**	**78**	**14.6**	**7.4**	**Loamy Sand**	**105.26**	**1.17**	**2.02**	**0.30**	**0.15**	**1.20**	**1.00**
06	0.05	5.70	78	14.6	7.4	Loamy Sand	59.64	1.13	1.95	0.21	0.15	1.40	0.80
07	0.05	5.60	78	14.6	7.4	Loamy Sand	108.77	1.21	2.04	0.30	0.15	1.00	0.80
08	0.06	5.70	80	14.6	5.4	Sandy	56.14	1.17	2.02	0.30	0.17	0.60	1.20

Quantitative traits of the different species (Cultivars)

Mean plant heights at harvest are shown in Table 2. USTPx/01/05 produced the tallest set of plants with a mean plant height of 2.22m which was declared significant from the rest six cultivars. This is followed by KM5 with a mean plant height of 2.03m though; there difference was declared significant using the Turkey method of mean separation. The mean height of KM5, USTPx/01/02 and USTPx/01/03 were not declared significant from one another. The least mean plant height of 1.01m was obtained in USTPx/01/01 and its mean height was not declared significant with that of the mean plant height of USTPx/01/07.

The leaf area at anthesis are shown in Table 2, USTPx/01/02 produced the highest leaf area with a mean of 1.3m^2 which was declared to have significant difference from any other cultivar. This is followed by USTPx/01/05 and it is also declared significant from any of the cultivars. The least leaf area was obtained from USTPx/01/07. USTPx/01/06 and KM5 were declared not significant from one another, though; significant from any other.

The mean number of leaves produced by the various cultivars is shown in Table 2. USTPx/01/05 produced the highest number of leaves at anthesis with a mean leaf number of 10.90 which was not declared significant from USTPx/01/02, though; significant from the rest cultivars. USTPx/01/01 was also not declared significant from USTPx/01/07 and KM5, though; they were declared to have significant difference from the rest cultivars. The least number of leaves at anthesis were obtained from USTPx/01/06.

The pseudo-stem girths of the various species are shown in Table 2. The highest pseudo-stem girth was obtained from USTPx/01/02 with a mean pseudo-stem girth of 0.4m followed by USTPx/01/05, though; the latter was declared significant from the former. The least pseudo-stem girth was obtained from USTPx/01/07 and all the cultivars were declared significant from one another.

The bunch weights of the various cultivars are shown in Table 2. The highest bunch weight was obtained from USTPx/01/02 which was declared significant from the rest of the cultivars with a mean bunch weight of 14.3kg and it is followed by KM5 respectively.

USTPx/01/07 and USTPx/01/05 were not declared significant from one another, though; significant from others. The minimum bunch weight was obtained from USTPx/01/01 with a mean of 0.4kg.

The circumferences of mid-fingers of the various cultivars are shown in Table 2. The highest circumference of mid-finger was obtained from USTPx/01/02 with a mean of 0.14m followed by KM5 and they were declared significant from one another. Among USTPx/01/05, USTPx/01/06, USTPx/01/07, USTPx/01/03 and USTPx/01/01 were not declared to be significant from one another. However, the minimum circumference of mid-finger was obtained from USTPx/01/01.

The numbers of hands per bunch of the various cultivars are shown in Table 2. The highest number of hands per bunch was obtained from USTPx/01/02 with a mean of 5.1 which is declared to have significant difference amongst the different cultivars. This is followed by USTPx/01/07, though; it was not declared significant from USTPx/01/05, USTPx/01/06 and KM5. USTPx/01/03 and USTPx/01/01 were also not declared significant from one another but they are declared significant from the other cultivars and produce the least number of hands per bunch.

The numbers of fingers per bunch of the various cultivars are shown in Table 2. The highest number of fingers per bunch was obtained from USTPx/01/02 and KM5 with a mean of 55.8 and 49.4 respectively which were not declared significant from one another. Amongst USTPx/01/03, USTPx/01/05, USTPx/01/07, and USTPx/01/06 were also not declared to be significant from one another, though; significant from the rest three cultivars. The minimum numbers of fingers per bunch were realized from USTPx/01/01 and it was declared significant from the other cultivars.

The style lengths of the different cultivars are shown in Table 2. The highest style length was obtained from USTPx/01/05 with a mean of 0.049 which was declared to have significant different analogically from the other cultivars except from USTPx/01/06. It is followed by USTPx/01/02 which did not have significant difference from KM5 while the least style length was obtained from USTPx/01/03; though, not declared significant from USTPx/01/07 and STPx/01/01.

Table 2: Quantitative Traits of *Musa* Species

Species Traits	USTPx/01/01	USTPx/01/02	USTPx/01/03	USTPx/01/05	USTPx/01/06	USTPx/01/07	KM5
Plant Height	1.0±0.3^{c}	2.0±0.4^{ab}	1.9±0.2^{ab}	2.2±0.5^{a}	1.6±0.2^{b}	1.0±0.3^{c}	2.0±0.5^{ab}
Leaf Area	0.7±0.3^{cd}	1.3±0.5^{a}	0.9±0.4^{abc}	1.1±0.4^{ab}	0.8±0.2^{bc}	0.3±0.2^{d}	0.8±0.2^{bc}
No. of Leaves	9.8±1.6^{ab}	10.9±1.7^{a}	9.1±1.5^{ab}	10.9±2.9^{a}	7.0±1.2^{b}	9.4±3.1^{ab}	9.4±2.5^{ab}
Pseudo-stem Girth	0.23±0.07^{de}	0.39±0.02^{a}	0.30±0.03^{bcd}	0.350.07^{ab}	0.25±0.02^{cde}	0.21±0.06^{e}	0.31±0.05^{bc}
Bunch Weight	0.4±0.1^{c}	14.3±7.8^{a}	0.5±0.2^{c}	0.6±0.5^{bc}	0.4±0.2^{c}	0.7±0.6^{bc}	4.9±3.2^{b}
Circumference of Mid Finger	0.05±0.01^{c}	0.14±0.02^{a}	0.05±0.01^{c}	0.06±0.01^{c}	0.06±0.01^{c}	0.06±0.01^{c}	0.10±0.02^{b}
No. of Hands per Bunch	3.7±0.7^{b}	5.1±0.6^{a}	3.7±0.7^{b}	4.0±1.1^{ab}	4.4±0.9^{ab}	5.0±1.4^{ab}	4.5±1.1^{ab}
No. of Fingers per Bunch	26.1±6.1^{b}	55.8±8.7^{a}	43.8±12.8^{ab}	42.0±16.9^{ab}	33.1±13.4^{ab}	34.6±21.6^{ab}	49.4±27.8^{a}
Anther Length	0.045±0.004^{c}	0.056±0.003^{b}	0.041±0.002^{d}	0.060±0.001^{a}	0.057±0.003^{ab}	0.042±0.002^{cd}	0.055±0.003^{b}
Style Length	0.033±0.002^{c}	0.039±0.001^{b}	0.029±0.002^{c}	0.049±0.002^{a}	0.047±0.005^{a}	0.031±0.002^{c}	0.043±0.003^{b}

*Means that do not share same letter are significantly different (Tukey method at 95% confidence level)

Polleniferous Nature of the Different Musa Species

All the different USTPx plantain (Musa sp.) hybrids were polleniferous except USTPx/01/07 shown in fig 1.It was discovered that USTPx/01/07 does not produce pollen grains, and it has adverse pistil morphological characteristics. Pistil morphological characteristics are related to female fertility of a cultivar. Style length, ovary length, number of ovules and the diameter of the stigma significantly affects the female fertility of a cultivar, and could exhibit a negative correlation. Cultivars with long styles have less chance of setting seeds after hand pollination. However, these cultivars do not produce pollen, but only bare stamens called staminoids. This infers male sterility. Due to the sterility of the crop, the development of new varieties through hybridization, mutation or transformation was not very successful in the 20th century (Heslop-Harrison and Schwarzacher, 2007).

Findings revealed that there was pollen grain production in all the cultivars except from the USTPx/01/07 that did not produce pollen grain; though, their production and quantity differs from variety to variety and was influenced by the environment. Low pollen production in triploids compared to diploids and tetraploids has been attributed to meiotic abnormalities (Ramirez, 1990; Simmonds, 1966). However, this trait also may be under genetic control (Ortiz et al., 1995) and influenced by the environment (Ulburghs, 1994). The white substances found on the style and anther wall are the pollen grains shown in Figure 1.

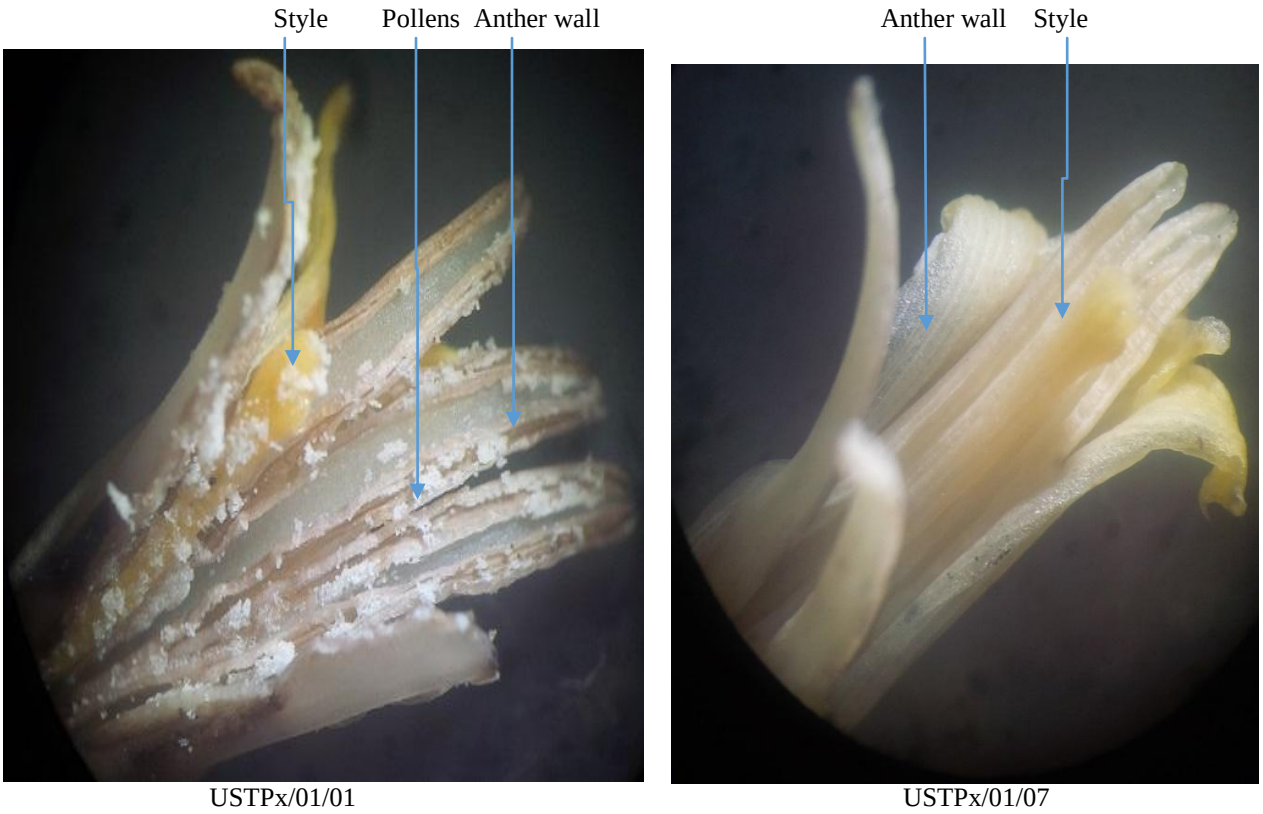

Figure 1: Microscopic view of anther of USTPx/0101 and USTPx/0107 showing the presence and absence of pollen grains at anthesis respectively.

Assessment of Black Sigatoka as a Quantitative Trait

The host responses to black sigatoka disease of the different cultivars are shown in Table 3. Findings revealed that USTPx/01/01 is highly resistant and USTPx/01/05 is susceptible while the other five cultivars are either susceptible or less susceptible. Host response to black sigatoka disease was assessed prior to anthesis by scoring the youngest leaf spotted (YLS) before flowering, after which leaf production ceases. This method involves recording the youngest leaf with the necrotic spots, counting down from the first unfurled leaf.Most of the cultivated *Musa*, especially plantains, are threatened by black sigatoka, a destructive fungal leaf spot disease caused by *Mycosphaerella fijiensis*. This disease causes yield losses of 30% to 50% (Stover, 1983). Of the seven (7) USTPx plantain hybrids, USTPx/01/01 is highly resistant to the black sigatoka disease and can be used a potential male parent for the introgression of the resistant gene while others are either susceptible or less susceptible. Host response to black sigatoka disease was assessed prior to anthesis by scoring the youngest leaf spotted (YLS) before flowering (Vakili, 1968) after which leaf production ceases.

This method involves recording the youngest leaf with the necrotic spots, counting down from the first unfurled leaf. This method used for scoring black sigatoka was also prescribed by Vuylsteke *et al.* (1993) where the youngest leaf spotted was counted and assessed based on the standard range.

Breeding for resistant varieties is the key to the successful control and prevention of the disease as fungicidal control is expensive and causes health and environment hazard. Breeding of improved cultivars with durable host plant resistance is generally considered the most appropriate control strategy (Vuylsteke *et al*., 1993b).The improvement of quantitative traits such as black Sigatoka in bananas will require accumulation of favourable alleles into the desired genotype. This implies that several cycles of hybridizations will have to be carried out to achieve the desired result. This is because quantitative traits are controlled by several genes though they are measurable and can be seen phenotypically. It is also important to estimate the genetic gain after each cycle through genetic analysis of the traits.

Table 3: Host Response to Black Sigatoka of different USTPx Plantain Hybrids

Species	Number of Standing Leaves (NSL)	Youngest Leaf Spotted (YLS)	Black Sigatoka Response Assessment (BSRA)	Code
USTPx/01/01	11	11	Highly Resistant	HR
USTPx/01/02	12	10	Less Susceptible	LS
USTPx/01/03	11	9	Less Susceptible	LS
USTPx/01/05	10	8	Susceptible	S
USTPx/01/06	10	9	Less Susceptible	LS
USTPx/01/07	10	9	Less Susceptible	LS
KM5	11	9	Less Susceptible	LS

YLS Scores: <8: Susceptible
8-10: Less susceptible
>10: Partially resistant
No necrosis: Highly resistant

CONCLUSION

Conventional plant breeding approach to *Musa* is time consuming; nevertheless, it is an essential part of the breeding process. The success of breeding plantain and banana should be measured by the extent to which new *Musa* cultivars are used profitably and sustainably by farmers. Access to bred germ plasm of plantain and banana such as the different USTPx plantain hybrids is therefore exceedingly vital, especially in a crop with a few active breeding programs but a great demand from farmers worldwide.

Findings on the quantitative traits indicate that USTPx/01/05 was the tallest (2.2m) genotype and USTPx/01/01 was the shortest (1.0m) at anthesis. The bunch weight was highest (14.3kg and 4.9kg) in USTPx/01/02 and KM5 respectively. Although bunch weight values were very low in the other species population, they could be improved directly through hybridization other species that possesses traits associated with high bunch weight. The assurance of producing hybrids with desirable qualities that will meet the demand of the teaming population through transgenesis of a desired gene (trait) in conventional breeding is made possible by selection of potentially fertile parents with better quantitative traits for the eventual introgression of such genes which were evident in species such as USTPx/01/01, USTPx/01/02 and KM5.

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