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# Evaluation of peanut genotypes for foliar disease resistance and yield in Guyana and Florida

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**Abstract:** *Peanut is a globally important crop and in Guyana, South America, smallholder farmers rely on peanut as a primary source of income. Foliar diseases and local varietieslimit yields due to limited financial and logistic constraints to improved varieties and fungicides. The objective of this research was to evaluate peanut genotypes for foliar disease resistance and yield potential. Field evaluations comparing the local variety to introduced varieties were conducted in 2011 and 2012 in Aranaputa Valley Village in Guyana, and at two locations in Florida, USA in 2013. In 2012 and 2013 genotypes were evaluated under a reduced fungicide regime. In Guyana, low foliar disease pressure resulted in no effect of genotype or treatment on early and late leaf spot or peanut leaf rust incidence. Yields were not impacted by the addition of fungicide and 'York' was the only genotype to provide consistently greater yields compared to the local 'Guyana Jumbo' variety. In Florida, leaf spot pressure was much higher with no differences observed between location for genotype or fungicide. Fungicide reduced disease similarly for all genotypes with a 0.9 lower disease rating. A concomitant increase in yield of nearly 400 kg/ha was also observed with fungicide although yield was not increased similarly for all genotypes. Seed quality was affected by genotype only; fungicide had no impact. This study revealed that the local variety 'Guyana Jumbo' has comparable yields and disease resistance to improved UF breeding lines. However, smallholder farmers in Guyana might benefit from additional varieties, such as 'York' that have more desirable seed and quality characteristics for emerging value-added industries.*

**Key words:** Arachis hypogaea *L., leaf spot, leaf rust, Guyana*

## INTRODUCTION

Peanut (*Arachis hypogaea* L.) is an important food and oil crop (McWatters and Cherry 1982, Florikowski 1994) in many developing and developed countries where it is cultivated in tropical and subtropical climates (Hammons 1994). Peanut is also an important cash crop in less developed countries (Florikowski 1994), providing an important source of income for smallholder farmers. Guyana is a developing country in which peanuts are produced, and are important as a cash crop (Kemerait and LaGra 2007).

Two of the most ubiquitous peanut diseases distributed throughout the world wherever peanut is grown that impact production and ultimately yield are early leaf spot (*Cercospora arachidicola* Hori) and late leaf spot (*Cercosporidium personatum* [Berk. & Curt.] Deighton) (Commonwealth Mycological Institute 1966, Porter *et al.* 1982, Smith 1984, McDonald et al. 1985, Middleton *et al.* 1994). The severity of these diseases varies between locations depending on production practices, rainfall, and other variables, emphasizing the need for management on a local and regional basis

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(McDonald *et al.* 1985, Middleton *et al.* 1994). Another important disease of peanut, especially in tropical regions, is peanut leaf rust (*Puccinia arachidis* Speg.). While leaf spot diseases are more widespread globally, this disease can be much more devastating, and is considered one of the most damaging fungal diseases in global peanut production (Smith 1984, Middleton *et al.* 1994, Hammons 1977). Currently commercial management practices for leaf spot and leaf rust include multiple fungicide applications, although efforts to breed for resistance have been ongoing.

As part of USAID's Peanut Collaborative Research Support Program (CRSP), scientists at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) found genotypes with field resistance to leaf rust and/or resistance to leaf spot (Subrahmanyam *et al.* 1980). Resistance to leaf spot is obtained by reducing the severity of the infection (Gorbet *et al.* 1990, Pixley *et al.* 1990) and has been identified and incorporated into U.S. commercial breeding lines and released cultivars; such as 'Southern Runner' (Gorbet *et al.* 1987) and 'York' (Gorbet and Tillman 2011).

In Guyana, peanut production would greatly benefit from genotypes with improved yields and disease resistance. Most growers in these rural regions cannot access inputs such as fungicides, therefore varieties that have disease resistance would be beneficial. Peanut growers in Guyana are also interested in high yielding varieties with superior characteristics including pod size, flavor, and harvest maturity that are both acceptable and adapted to local production. Therefore,the objectives of this study were to evaluate peanut genotypes for disease resistance and yield for potential introduction into the peanut farming systems in Guyana. These efforts were a component of USAID Peanut CRSP projects (2001-2006; 2007-2012) in the region to improve peanut production for smallholder farmers in Guyana. This study was conducted in Region 9, Guyana during the last two years of the project (2011-12). Additional studies were conducted in two locations in Florida in 2013 to further assess disease resistance and yieldsof these genotypes.

## MATERIALS AND METHODS

Peanut genotypes were evaluated for resistance to leaf spot and leaf rust, and pod yield and quality as a function of a reduced fungicide regime or no fungicide. All evaluations included comparison to the locally grown Guyanese variety 'Guyana Jumbo'. Genotypes were selected based on yield and resistance to late leaf spot from the University of Florida peanut breeding program for potential application in developing countries. Genotypes are listed in Table 1 and included three commercial runner type cultivars - 'Southern Runner' (1984), 'C-99R' (1999) and 'York' (2006) 'C-99R' and 'York' also show good resistance to tomato spotted wilt virus (TSWV), and white mold/stem rot (S*cerotium rolfsii* Sacc.) (Gorbet and Tillman 2011). 'C-99R' was introduced to peanut farmers in Guyana through the Peanut CRSP, and is grown commercially in addition to the local variety, 'Guyana Jumbo'.

## GUYANA, 2011 AND 2012

Experiments were established in 2011 and 2012 at the Aranaputa Valley Village Community Farm, Region 9 (Rupununi District, Guyana), managed by the Society for Sustainable Operational Strategies (SSOS) - a local non-governmental organization (NGO). Land was prepared using four passes of a harrow and to incorporate limestone (1135 kg/ha) and fertilizer (15-15-15 NPK, 28kg/ha)applied prior to planting. One day after planting, a pre-emergent (Lazo Chlor, 45.1% active ingredient alachlor [ 2-chloro-2-6-diethyl-N (methoxymethyl) acetanilide]) was applied at a rate of 0.8 L/ha and a non-selective post-emergentherbicide (Glyphosate, 48% active ingredient N-(phosphonomethyl) glycine) at a rate of 0.4 L/ha were applied to manage seedling weeds and remaining vegetation from the tillage operations. Peanuts were planted on 7 May and 11 May in 2011 and 2012, respectively, and harvested approximately five months later, depending on genotype maturity. This production timeframe is typical of the region because it coincides with annual rainfall patterns. Irrigation was not used, and production relied completely on rainfall.

During the growing season, optimal production practices were applied utilizing guidelines developed by Kemerait and LaGra

(2007). This included application of insecticide (Karatax, 5% Iambda-Cyhalothrin as an emulsifiable concentrate (synthetic pyrethroid) at a rate of 150mL ai/ha at 45, 66, 87, and 108 DAP; boron (Disodium octaborate, 20.5% B) at a rate of 2.7kg/ha at 35 DAP; and one fertilizer (15-15-15 NPK, 28kg /ha) application during the growing season. Applications of insecticide and fungicide treatments were made using a hand pressurized backpack sprayer with a single 11004 flat fan nozzle. All foliar treatments were mixed with water and applied to the point of solution run-off. Applications were made during the early morning to avoid afternoon showers and all applications had a minimum of 5 hours drying time. Hand weeding occurred throughout the growing season to keep border areas (buffer zones, alleyways) clear of weeds. Plots consisted of two 5 m long rows with 76 cm row spacing and 7.6 cm seed spacing and separated by 1.5 m open buffer on each side and a 2 m wide alley front to back. In 2011, only genotype was evaluated as a main factor. In 2012, fungicide treatment regime was added resulting in a factorial design (two x nine) with fungicide x genotype and four replications in a completely randomized block design. Fungicide (ECHO900 WDG, 90% Chlorothalonil) at a rate of1.3 kg-ai/ha, (Sipcam Agro, Roswell, GA), treatment regime included four applications at 45, 66, 87, and 108 days after planting, or untreated. This regime reflects a reduced leaf spot management program, representative of what a smallholder farmer might utilize in Guyana.

Disease ratings for leaf spot were taken from the onset of visual disease symptoms every two weeks until harvest, including a final disease rating prior to harvest using the Florida 1-10 scale (Chiteka et al. 1988).There was no attempt to discern between early and late leaf spot when rating. Leaf rust ratings were taken prior to harvest using theInternational Crops Research Institute for the Semi-Arid Tropics (ICRISAT) 1-9 scale (Singh and Oswalt 1992).

At harvest, the center 3.5 m section of both rows in each plot were hand dug and pods removed immediately to avoid yield loss to animals. Peanuts were sun dried on tarpaulins until reaching 10% moisture content. Total dry pod weight for each plot was measured and from this a 100 pod sub-sample was taken. Pods were shelled to quantify hull and seed weight, and maturity was determined visually - dark brown inside hull color indicated maturity, white immaturity (Sanders *et al.* 1982).

**FLORIDA, 2013**

The project in Guyana was completed in 2012, but the low disease pressure warranted further evaluation so the study was repeated in 2013 at the University of Florida facilities at the North Florida Research and Education Center (NFREC) in Marianna, FL and at the Plant Sciences Research and Education Unit (PSREU) in Citra, FL. Experimental design and treatments at each location were the same as utilized in Guyana in 2012.

University of Florida Extension guidelines for commercial peanut production (Wright et al. 2013) were followed including conventional tillage with deep moldboard plowing and level harrowing with two field cultivations to a depth of 20cm. Fertilizer (6-15-21 with minor elements, including Boron), was added at this time. Pre-plant [Strongarm (31.6g ai/ha) (84% ai diclosulam) & Sonalan (2.8L ai/ha) (35.4% ai ethalfluralin)] and post-emergent [Dual Magnum (0.56 kg ai/ha) (82.4% ai S-metolachlor) at 14 DAP and Cadre (0.1kg ai/ha with surfactant) (23.6% ai Ammonium salt of imazapic) at 45 DAP] herbicide applications were made to control weeds as was an in-furrow insecticide [Thimet insecticide (5.6 kg ai/ha) (20% ai phorate)] application at planting to control thrips (*Frankliniella spp*.). At 80 days after planting (DAP) an insecticide [Asana (0.4 kg ai/ha) insecticide (8.4% ai esfenvalerate)] application was made to control foliage feeding insects at the Marianna location. Gypsum was applied at the rate of 1,100 kg/ha at 60 DAP to provide adequate calcium for pod development. Plots were planted 15 June and harvested 28 October and 8 May and 14 October for the Marianna and PSREU locations, respectively. Final leaf spot ratings were taken prior to harvest using the Florida 1-10 scale (Chiteka *et al.* 1988) as described in previous sections. Once again, there was no attempt to discern between early and late leaf spot when rating. Peanut leaf rust ratings were not taken due to the absence of the disease.

Standard grading equipment was used to obtain peanut quality characteristics of a 200 g subsample from each plot. Pod samples were graded using farmer stock grading equipment in compliance with federal-state inspection service methodology (USDA-AMS 2008). Pod grades presented include pod maturity (20 pod subsample), percent Virginia pods, percent seeds, percent hulls, percent extra-large kernels (ELK), and percent total sound mature kernels (TSMK) which included sound mature kernels and sound split kernels.

## STATISTICAL ANALYSIS

The data analysis was generated using SAS software, version 9.3 of the SAS System (SAS Institute©, Cary, NC). Analysis of variance (ANOVA) was used to test for treatment effects and interactions. Means were separated using Fisher's Protected LSD test at the $P<0.05$ level. Genotypes were evaluated over three years at three locations and in two countries. Studies will be discussed separately by country; data were combined (when possible) for analysis across years in Guyana (2011 and 2012) and locations in Florida (Marianna and PSREU, 2013).

## RESULTS

### Guyana

There were no statistical differences between years for leaf spot, so ratings were combined for the non-treated treatments (Table 2). Leaf spot severity and leaf rust was not different among the genotypes tested, and there was little to no impact of fungicide treatment on leaf spot or rust incidence. In both the non-treated and fungicide treated plots, leaf spot ratings were moderate to low, ranging from 2 (very few spotted leaves in the canopy) to 4 (some leaf spotting and < 10% defoliation). Low incidences of peanut rust were also observed for all genotypes, averaging 2.4 in the non-treated and 2.1 in the fungicide treated plots (Table 2).

Peanut yields for the studies conducted in 2011 without fungicide averaged 4,000 kg/ha with no differences among genotypes. York provided the highest yields at nearly 4,700 kg/ha, although the local variety 'Guyana Jumbo' also produced over 4000 kg/ha. In 2012, genotypes yielded between 2,001 to 2,787 kg/ha and 1,727 to 2,650 without and with fungicides, respectively (Table 2). Yields in 2012 were much lower than 2011, likely due to extreme drought in the region (weather data unavailable). 'York' produced the highest yields in both non-treated and fungicide treatments, significantly higher than many genotypes, including the local 'Guyana Jumbo' variety.

Seed quality parameters evaluated were affected by genotype ($P<0.0001$) and there was no effect of fungicide nor an interaction between fungicide treatment and genotype ($P>0.05$). 'Guyana Jumbo' and '97x36-HO2-1-B2G-3-1-2-2' had a lower percentage of mature pods (82%) and corresponding

**Table 1**
**List of peanut (*Arachis hypogaea* L.) genotypes† evaluated in 2011, 2012, in Guyana and in 2013 in Florida.**

| *Name/Breeding Line* | *Source* | *Maturity* |
|---|---|---|
| 97x36-HO2-1-B2G-3-1-2-2 | University of Florida | Unknown |
| 98x116-5-1-1-1-2-1 | University of Florida | Unknown |
| 99x33-1-B26-B-1-1 | University of Florida | Unknown |
| 99x33-1-B2G-2-2-2 | University of Florida | Unknown |
| BOL19-b5 | University of Florida | Unknown |
| C-99R | University of Florida | 140 days |
| York | University of Florida | 145 days |
| Southern Runner | University of Florida | 145 days |
| Guyana Jumbo | Guyana | 155+ days* |

†Seeds for this study were obtained from the University of Florida peanut breeding program courtesy of Dr. Barry Tillman.

*approximate based on field work and local grower observations

**Table 2**
**The effect of fungicide† on peanut (*Arachis hypogaea* L.) leaf spot (*Cercospora arachidicola*; *Cercosporidium personatum*), peanut leaf rust (*Puccinia arachidis*) incidence, and peanut yield for genotypes evaluated in Region 9, Guyana in 2011 and 2012. Data combined across years for non-treated leaf spot and rust ratings**

| | *Leaf Spot‡* | | *Leaf Rust§* | | *Yield* | | | |
|---|---|---|---|---|---|---|---|---|
| *Genotype/Breeding Line* | *NF* | *F* | *NF* | *F* | *NF-2011* | *NF-2012* | *F-2012* | *Avg. Yield¶* |
| 97x36-HO2-1-B2G-3-1-2-2 | 3.59 ns | 2.63 ns | 2.13 ns | 1.94 ns | 4,288 ns# | 2,501 ab | 2,060 ab | 2,948 ab |
| 98x116-5-1-1-1-2-1 | 4.31 | 3.38 | 2.59 | 1.25 | 3,954 | 2,322 ab | 2,370 ab | 2,878 ab |
| 99x33-1-B26-B-1-1 | 3.44 | 3.69 | 2.84 | 2.31 | 4,419 | 2,096 b | 2,010 ab | 2,690 ab |
| 99x33-1-B2G-2-2-2 | 3.81 | 3.25 | 2.78 | 3.13 | 3,990 | 2,013 b | 1,953 b | 2,650 ab |
| BOL19-b5 | 4.36 | 2.60 | 2.86 | 2.10 | 4,097 | 2,418 ab | 2,251 ab | 2,908 ab |
| C-99R | 3.13 | 3.13 | 2.31 | 1.38 | – – | 2,144 b | 1,995 ab | 2,069 b |
| Southern Runner | 3.94 | 3.67 | 1.64 | 2.30 | 3,680 | 2,311 ab | 1,945 b | 2,675 ab |
| York | 3.78 | 3.25 | 2.63 | 2.38 | 4,692 | 2,787 a | 2,650 a | 3,374 a |
| Guyana Jumbo | 3.38 | 2.75 | 1.63 | 1.63 | 3,966 | 2,001 b | 1,727 b | 2,715 ab |

†Chlorothalonil fungicide (F) applied at 1.3 kg-ai/ha 45, 66, 87, and 108 days after planting. No fungicide (NF) plots were untreated. Fungicide was only a treatment in 2012. Genotype mean (GM) is the mean across fungicide treatments.

‡Leaf spot ratings taken at final harvest using the Florida 1-10 scale (Chiteka *et al.* 1988).

§Leaf rust ratings taken at final harvest using the ICRISAT 1-9 scale (Singh and Oswalt 1992).

¶Yield averaged over years and fungicide treatment (n=12).

#Means (n=8 for leaf spot and leaf rust; n=4 for yield) within a column followed by the same letter are not significantly different according to Fisher's protected LSD test ($P > 0.05$).

higher percentage of immature pods compared to the other genotypes (Table 3). 'York' also had fewer mature pods (85%), while all other genotypes yields were >90% mature at the time of harvest (Table 3). 'Guyana Jumbo' had the highest weight of 100 seed regardless of fungicide treatment, with each seed averaging about one gram (Table 3). Seed to pod ratio for all genotypes was >70% with 'Southern Runner' having the highest ratio of seed to pod with 79% (Table 3).

## Florida

There was no significant difference between location and the variables tested; therefore, data was combined across the PSREU and NFREC locations (Table 4). There was a significant effect of genotype and fungicide treatment for leaf spot ($P<0.05$), but no interaction between genotype and fungicide ($P>0.05$). At the Florida locations in 2013 there was much greater leaf spot disease pressure than in Guyana, ranging from 5.6-7.7 to 4.5-6.8 in non-treated and fungicide treated plots, respectively. Unlike Guyana, fungicide did prove to be effective in reducing disease incidence with an average reduction of 0.9 compared to the untreated plots (Table 4). There was also a wider range of leaf spot incidence across genotypes, with 'BOL19-b5' displaying nearly 1.0 less leaf spot compared to the other genotypes without fungicide and >2.0 less leaf spot compared to some genotypes with fungicide. Conversely 'York' displayed the highest level of leaf spot in both treatment regimes.

Yield showed a similar response with a significant effect of genotype and fungicide treatment ($P<0.05$), but no interaction between genotype and fungicide ($P>0.05$). Despite the high level of disease pressure, yields ranged from 3,528 to 4,982 kg/ha in the absence of fungicide treatment (Table 4). The highest yielding genotype was '98x116-5-1-1-1-2-1' at nearly 5,000 kg/ha. When fungicide was applied, 'York' once again showed the highest yields of over 5,300 kg/ha. There was a positive response to fungicide application in terms of increased yields, with almost 400 kg/ha greater yield.

Seed quality parameters evaluated in Florida were affected by genotype only ($P<0.0001$); there

**Table 3**
**The effect of genotype on maturity and seed quality parameters of nine peanut (*Arachis hypogaea* L.) genotypes evaluated in Region 9, Guyana in 2011 and 2012. Data combined across years and treatments for all parameters**

| | *Mature*‡ – – % – – | *Weight of 100 seeds*§ – – – g – – – | *Seed/Pod*¶ |
|---|---|---|---|
| Genotype/Breeding Line | | | |
| 97x36-HO2-1-B2G-3-1-2-2 | 82 c† | 88 c | 0.73 c |
| 98x116-5-1-1-1-2-1 | 95 a | 74 d | 0.73 c |
| 99x33-1-B26-B-1-1 | 91 b | 70 e | 0.76 ab |
| 99x33-1-B2G-2-2-2 | 90 b | 69 e | 0.76 bc |
| BOL19-b5 | 92 ab | 97 b | 0.76 ab |
| C-99R | 92 ab | 75 d | 0.74 bc |
| Southern Runner | 91 b | 66 f | 0.79 a |
| York | 85 c | 63 f | 0.72 c |
| Guyana Jumbo | 82 c | 102 a | 0.75 c |

† Numbers followed by the same letter within a column did not differ (*P*> 0.05).

‡Pod maturity determined visually by the shell-out method and the color inside the hull from 100 pods (Sanders *et al.* 1982).

§Seed weight of 100 seeds.

¶ Seed weight/pod weight of 100 pod sub-sample.

**Table 4**
**The effect of fungicide† on peanut (*Arachis hypogaea* L.) leaf spot (*Cercospora arachidicola*; *Cercosporidium personatum*) and peanut yield for genotypes evaluated in Citra and Marianna,Florida in 2013. Data combined across locations for leaf spot ratings and peanut yields**

| | *Leaf spot*‡ | | *Yield (kg/ha)* | | |
|---|---|---|---|---|---|
| *Genotype/Breeding Line* | *NF* | *F*§ | *NF* | *F* | *Mean* |
| 97x36-HO2-1-B2G-3-1-2-2 | 6.4 ab† | 6.0 ab | 4,387 ab | 4,389 ab | 4,386 ab |
| 98x116-5-1-1-1-2-1 | 6.7 ab | 5.9 ab | 4,982 a | 4,997 ab | 4,989 a |
| 99x33-1-B26-B-1-1 | 6.8 ab | 6.1 ab | 3,829 ab | 4,247 ab | 4,038 b |
| 99x33-1-B2G-2-2-2 | 6.4 ab | 5.6 ab | 4,124 ab | 4,971 ab | 4,665 ab |
| BOL19-b5 | 5.6 b | 4.5 b | 4,417 ab | 4,060 b | 4,238 ab |
| C-99R | 7.6 a | 6.4 ab | 3,528 b | 4,397 ab | 3,962 b |
| Southern Runner | 6.8 ab | 6.5 ab | 3,748 ab | 4,331 ab | 4,039 b |
| York | 7.7 a | 6.8 a | 4,603 ab | 5,319 a | 4,961 a |
| Guyana Jumbo | 6.9 ab | 5.7 ab | 4,124 ab | 4,380 ab | 4,252 ab |
| Treatment Mean¶ | 6.8 a | 5.9 b | 4,194 a | 4,566 b | – |

†Fungicide (F) (90% Chlorothalonil) applied at a rate of 1.3 kg-ai/ha at 45, 66, 87, and 108 days after planting. No fungicide (NF) plots were untreated.

‡Leaf spot ratings taken using the Florida 1-10 scale (Chiteka et al. 1988).

§Numbers followed by the same letter within a column do not differ (*P* >0.05).

¶Means within the row (NF, F) followed by the same letter do not differ (*P* >0.05), in the case of yield, the p-value was 0.0536.

was no effect of fungicide nor an interaction between fungicide treatment and genotype but not by treatment (*P*>0.05)(Table 5). All genotypes displayed ≥95% maturity except 97x36-HO2-1-B2G-3-1-2-2 and 'Guyana Jumbo', similar to what was observed in Guyana. The access to commercial grading standards revealed 'Guyana Jumbo', 'York', and '97x36-HO2-1-B2G-3-1-2-2' had Virginia pod

**Table 5**
**The effect of genotype on standard grading of peanut (*Arachis hypogaea* L.) yields for genotypes evaluated in Citra and Marianna, Florida in 2013. Data combined across locations and treatments for all parameters**

| | *Pod Maturity*‡ | *Virginia Pods* | *Extra-large kernels*§ | *Total sound mature kernels*¶ |
|---|---|---|---|---|
| | | – – – – – %# – – – – – | | |
| Genotype/Breeding Line | | | | |
| 97x36-HO2-1-B2G-3-1-2-2 | 93 cd† | 58 b | 54 b | 76 bc |
| 98x116-5-1-1-1-2-1 | 96 abc | 12 e | 39 de | 76 bc |
| 99x33-1-B26-B-1-1 | 95 abc | 7 e | 30 f | 77 bc |
| 99x33-1-B2G-2-2-2 | 96 abc | 11 e | 37 e | 76 bc |
| BOL19-b5 | 98 ab | 19 d | 44 c | 74 d |
| C-99R | 94 abcd | 38 c | 43 cd | 79 a |
| Southern Runner | 94 bcd | 6 e | 28 f | 76 c |
| York | 98 a | 65 b | 52 b | 77 b |
| Guyana Jumbo | 90 d | 78 a | 64 a | 77 b |

† Values followed by the same letter in a column within the treatment do not differ ($P < 0.05$).
‡Pod maturity determined visually by the shell-out method and the color inside the hull from 20 pods (Sanders *et al.* 1982).
§Extra-large kernels are kernels that ride a 21.5/64" x 1" screen.
¶Total sound mature kernels include extra-large kernels, medium kernels (ride on a 18/64" slotted screen but falling through a 21.5/64" screen), and sound split kernels (undamaged split kernels).
#Expressed as a percentage of the total 200 g sub-sample collected.

and extra-large kernel weights that were >50% of the total weight. Despite the differences in maturity, all genotypes had total sound mature kernels (TSMK) ≥ 74% which is within the range of commercially acceptable quality.

## DISCUSSION

Farmers in developing countries face serious challenges in peanut production. Too often locally adapted/preferred varieties lack yield potential and resistance to diseases such as leaf spot and peanut rust. The use of peanut cultivars with high yield potential and resistance to one or both of these diseases has been shown to be useful in situations where fungicides cannot be applied in a timely manner or where available fungicides are not adequate (Branch and Culbreath 2013). Therefore, the aim of this study was to evaluate genotypes that could possibly fulfill this need in the peanut producing areas of the Rupununi region of Guyana.

Leaf spot resistance in Guyana was similar across the range of genotypes evaluated, including the local variety, 'Guyana Jumbo'. We were not able to include fungicide treatment in 2011, but levels were essentially the same as in 2012 and all ranged less than 4.5 (Table 2 – combined 2011-12 non-treated data). The application of fungicide in Guyana in 2012 was able to lower disease incidence by about 0.6 on the Florida 1-10 scale. However, this had virtually no impact on yield for most genotypes. The lower yields in 2012 were likely attributed to dry conditions during the later stages of production and it is possible that the dry weather also limited disease development (Singh and Oswalt 1992, Jensen and Boyle 1965). It is interesting to note that in 2011 yields were almost double for all genotypes, mostly likely due to adequate moisture and good growing conditions. This should have also translated into higher disease pressure, but this was not observed. This could have been related to several factors including lack of inoculum whereby low levels of inoculum were being produced, or due to reduced fungal infection by minimal leaf surface moisture, and/or reduced fungal transmission (Jensen and Boyle 1965). Rotation can also limit base inoculum levels (McDonald et al. 1985, Jensen and Boyle 1965). The other possibility is resistance inherent to the variety, which was the aim of this study (Parleviet 1979).

The same experiments conducted in Florida provided an interesting complement and contrast to the Guyana-based studies in the fact that yields were remarkably similar, despite drastic differences in cultural practices and disease pressure. In Florida we used commercial production practices including optimum seeding, fertility, and irrigation; thus only disease should have been the limitation to maximum yield for these varieties. Peanuts in Florida were subjected to much higher disease pressure due to the very wet season in 2013, translating into nearly twice the level of disease at the end of the season (Table 4). Fungicides were effective, but only reduced leaf spot by 0.9 on the Florida 0-10 scale due to the high disease pressure and the reduced fungicide program (Smith 1984, Kemerait et al. 2005). However, the yields of non-fungicide treated peanuts in Florida were similar to the non-treated peanut yields observed in Guyana in 2011. For example, York yielded 4,692 kg/ha in Guyana, 4,603 kg/ha in Florida; the local Guyana Jumbo yielded 3,966 kg/ha in Guyana, 4,124 kg/ha in Florida. This suggests that most of the varieties we evaluated could withstand disease pressure up to 6.0-6.5 and still maintain good yields. While dry conditions were the major contributing factor to low yields in Guyana in 2012, it suggests that fungicides would be effective in increasing yields if disease pressure was >6.0. Given the current production practices available in Guyana, it is likely other factors such as drought, poor fertility and weed pressure would limit yield of these varieties, not disease.

However, a couple of factors come to mind when addressing this scenario. First, in Florida we were only dealing with leaf spot, and in fact all the genotypes were developed, screened and evaluated in Florida to select for leaf spot resistance. The results strongly suggest that even under high pressure, most, if not all genotypes can still yield well. It also suggests that there is little to no difference in the strains of leaf spot as a function of resistance despite all screening and selection under Florida leaf spot conditions, because we saw similar levels of resistance in Guyana.

The big question comes to the evaluation of leaf rust. While we measured rust infection in these studies, it was only tested as a function of genotype in Guyana due the lack of rust in Florida. In addition, the fungicide package we used (Chlorothanonil alone) has little to no activity on peanut rust, so the levels observed were likely inherent to the varieties themselves. This situation bears future studies, because leaf rust is potentially much more devastating to yields compared to leaf spot. However, even in good conditions (as observed in 2011), rust incidence was low. This could be due to a lack of inoculum or varietal resistance. Although this was not the focus of this study, it would be very interesting to continue screening of these varieties in Guyana, since most of these lines were developed in Florida where the target disease for resistance was leaf spot.

However, due to the varying environmental conditions at each location and each year, and the varying disease pressures, it is recommended that further field evaluations are conducted in Guyana and Florida to determine the effects of fungicide applications, including the inclusion of the more frequent, recommended rate of application, and yield potential of these genotypes under optimal (according to U.S. standards) fungicide regimes. For the Guyanese context, where fungicide is rarely applied at the recommended 14-day interval, the results from this study support the introduction of several genotypes that will yield well under Guyana's growing conditions.

Seed quality and other parameters associated with grade were fairly consistent across locations, although the lack of equipment prevented grade measurements in Guyana. 'Guyana Jumbo' showed the greatest number of extra-large kernels and had the highest seed weight of the genotypes evaluated. However, this variety also took the longest to mature, as indicated by the highest percentage of immature kernels and lowest pod maturity. Surprisingly, this genotype showed longer maturity compared to 'Southern Runner', which is considered to be a 155 day variety under Florida conditions. This maturity data suggests a 160+ day to reach full yield potential, which is substantiated by observations from growers in the region. While this might be considered desirable by some growers, under rainfed conditions this could result in severe yield loss due to the inability to 'carry the crop' for the entirety of its growth cycle.

Results from both locations suggest that the varieties produced locally in Guyana('Guyana Jumbo' and 'C-99R') yield well and have similar levels of disease resistance compared to introduced varieties developed in the U.S. Even under heavy disease pressure such as was observed in both Florida locations in 2013, the introduced genotypes performed well in the presence of high leaf spot pressure. In these studies, it seems that the most important factor in determining yield was adequate water and genotype and while yield differences in genotypes could be partially attributed to disease resistance or tolerance, likely overall yield potential among genotypes is the main factor for yield differences (Cantonwine et al. 2006).

## CONCLUSIONS

Yields of the introduced genotypes of peanut suggest that farmers in Guyana might achieve similar yields to the local variety, 'Guyana Jumbo' but obtain some of the traits that they desire (such as seed size and plant shape similar to 'C-99R'). One genotype that may have the best potential for adoption by smallholder farmers in the rural interior of Guyana as an alternative to'C-99R' is 'York'. Under high leaf spot ratings and adverse growing conditions (such as reduced rainfall in 2012), 'York' yielded well (Tables 2 and 4), as has been observed by Branch and Culbreath (2013). The seed qualities, such as seed/pod ratio, of 'York' were similar to 'C-99R' (Table 3), which is the variety the current peanut butter market in Guyana prefers. As an alternative to 'Guyana Jumbo', smallholder farmers in Guyana could use 'BOL19-b5', which has similar seed weight of 100 seeds, as well as seed to pod ratio (Table 3).Ultimately, market acceptability of these introduced lines will be the deciding factor for farmer acceptance, and merits further investigation in Guyana.

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