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PERFORMANCE OF WEST INDIAN HOT PEPPER CULTIVARS IN THE VIRGIN ISLANDS.

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ABSTRACT. Yield potential of selected hot pepper (*Capsicum chinense*) cultivars were evaluated in three field experiments conducted from November 1997 to September 1998 in the Virgin Islands. The first experiment was conducted at the Agricultural Experiment Station (AES) and two trials were established (on-farm) in grower's fields. Five cultivars were evaluated at AES and both on-farm trials. Plants were spaced 0.60 m between plants within rows at all locations and 1.0 m between rows (AES) and 1.5 m (on-farm). Results of the AES trial indicated significant differences among cultivars for the measured parameters. 'West Indian Hot' produced the highest number (897,000) and fresh weight (7642 kg) of fruits per hectare in the AES trial which were both significantly higher than 'Red Scotch Bonnet' and 'Scotch Bonnet'. Additionally, 'Early Scotch Bonnet' also produced significantly more fruits (685,000 fruits/ha) than 'Scotch Bonnet'. 'Early Scotch Bonnet' and 'Habanero' produced similar fruit yields. The higher yield from 'West Indian Hot' can be attributed to its longer duration of sustained production, reflecting a higher tolerance to viral infections, compared to the other cultivars. Results of the on-farm trials indicated that 'Yellow Scotch Bonnet' produced the highest number of fruits, but was not significantly different from 'Pink Scotch Bonnet'. Both cultivars produced fruit yields higher than 'Habanero'. 'Yellow Scotch Bonnet' was superior to the other cultivars in terms of fruit yield (16,973 kg/ha) significantly higher than the yield from all other cultivars. At the other farm location 'West Indies Red' was the most productive cultivar. The results of pungency analyses indicated that 'Chocolate Scotch Bonnet' produced the hottest peppers followed by Yellow and Pink Scotch Bonnets, and 'Habanero' from AES. 'West Indian Hot' was the mildest pepper. It appears that the Scotch Bonnet peppers are the most adapted and promising cultivars in the Virgin Islands. Additionally, 'West Indies Red' also has good potential for production in the Virgin Islands.

INTRODUCTION

Hot pepper, *Capsicum chinense* (Pickersgill, 1989; Cooper and Gordon, 1992), is a very popular cash crop among small-scale farmers in the U.S. Virgin Islands. Hot peppers are grown as a specialty crop, with an excellent market and commands a very good price of $4.40 - $6.60/kg on the local market. There is tremendous export potential for this crop because of the growth in ethnic populations in the U.S. and the general trend toward the inclusion of more herbs and spices in the American cuisine. A number of Caribbean countries are already exploiting this market opportunity. West Indian Hot peppers are considered to be elite among hot peppers and fetch premium prices in export markets (Cooper *et al.*, 1993). The West Indian hot pepper 'Scotch Bonnet' when

imported into the U.S. sells for an average of $0.25 per fruit (Marsh, 1988), or $33.00/kg (Marsh, 1991) in specialty shops. Farmers with small land holdings and limited resources can improve their income by growing hot peppers. The use of good germplasm, irrigation, fertilizers, and other inputs for intensive management of hot peppers can be easily justified based on the anticipated increased economic returns.

Hot peppers have many uses and their popularity is growing rapidly. Hot pepper is a major spice crop in the tropics and the crop is economically important for many farmers in the Virgin Islands and other Caribbean countries. West Indian hot peppers have also been identified as a specialty vegetable with a high production potential for Florida (Maynard, 1995a; 1995b). The tropical climate of the Virgin Islands is ideal for year-round production of hot peppers. The crop is well adapted to the Caribbean and can provide growers with a regular income for several months each year (Cooper *et al.*, 1993). Hot pepper production has the potential of providing farmers with increased revenues when compared to traditional vegetables.

The farmers are also less subject to the problems of marketing their produce. The hot pepper crop provides farmers with a flexibility in marketing, which is not available with most other traditional vegetables. This is because of the alternatives available for marketing the crop as fresh, ol peppers. Hot peppers can be easily processed into what is locally referred to as epper vinegar', hot sauce, dried whole fruits or pe per powder. In addition to their u for culinary purposes, hot peppers have also found iew markets for uses in medicinal cures, st control and pepp r sprays. These applica ons require peppers with very high pungency.

There are a wide range of hot pepper types grown by Virgin Islands' farmers. However, many of these are indigenous Caribbean types which have not been properly characterized. The most common groups of the West Indian hot peppers are the Scotch Bonnets (famous for their hot, typical flavor), and both the red and yellow West Indian lantern types. Other types grown by farmers are the Puerto Rican hot peppers and the bird peppers. New and improved cultivars have been developed by U.S. seed companies and are now available in some seed stores. Examples of these are chocolate, pink, red, and yellow 'Scotch Bonnets'; 'Red Dominica', 'Peto Orange', 'St. Lucia Island Rainbow', White, and Yellow Habanero.

The most important characteristics for which hot peppers are grown are pungency and color. West Indian hot peppers are particularly famous for their high pungency. As with other types of hot peppers, the pungency level of the West Indian hot peppers is influenced by genetics and environment. Growers on St. Croix observed that application of high nitrogen fertilizer and high irrigation water increased yield but reduced the pungency and quality of hot peppers. According to Collins and Bosland (1994) the pungency level in chile is the result of two factors: the plant's genetic makeup and its interaction with the environment. The genetic control of pungency is not fully understood. Even without having complete knowledge of the genetics of ungency, it is possible for plant breeders to produce a chile plant with certain relative pungency. For example, a chile like 'NuMex Joe E. Parker' was genetically selected to produce "medium" pungency fruits. However, environmental factors such as temperature and water influence pungency. A mild chile cultivar, bred for low levels of pungency and exposed to any type of stress in the field, will become more pungent. Alternately, a

relatively hot chile cultivar given optimal environmental conditions will become only moderately pungent.

Plant density recommendations for hot peppers have varied in the Caribbean from country to country, ranging from 20,000 to 69,000 plants/ha (Anon. 1988). Within row spacing has been reported to affect the yield of 'Scotch Bonnet' peppers by Marsh and Rhoden (1990). They reported higher yields at lower planting densities. Conversely, Cooper *et al.*, (1993), reported that closer spacing of plants increased yields without any significant effect on fruit size, provided that the plants were adequately fertilized. Yields were increased from 16,800 kg/ha at a planting density of 9880 plants/ha to 29,120 kg/ha at 25,935 plants/ha.

It was reported by Cooper *et al.*, (1993) that, West Indian hot peppers do not appear to be particularly demanding regarding soil type or fertility. They stated that the crop does well on highly calcareous soil. An OECS report (Anon. 1988) also noted that, even though there had been no specific selection of soil types for hot pepper cultivation in the OECS, light loamy soils rich in lime promoted the best growth. This information is very relevant to production in the Virgin Islands, particularly St. Croix, where the calcareous (high pH) soils are normally found.

McDonald and Muller (1992) described some of the hot pepper diseases found in the Caribbean. They included diseases with viral, fungal, and bacterial causal agents. Thomas (1982) reported that the hot pepper mosaic disease was prevalent in the Caribbean. The seed borne Pepper Mosaic Virus was thought to be the most important disease of hot peppers (Anon. 1988). Cooper *et al.*, (1993) stated that viruses were the cause of the most important disease problems experienced in hot pepper production. These viral diseases were believed to be spread by seed, insects and mechanically. In Antigua, Cooper and Gordon (1992), reported that they have been successful in the production of West Indian hot pepper seed. The seeds have been made available throughout the East Caribbean States. The seeds are reported to be of high quality and treated for the important viral diseases. This is significant because traditionally, farmers have supplied their own seeds from their previous crops. Seeds of the West Indies Red and Yellow used in one of our trials were obtained from this source.

MATERIALS AND METHODS

Three field experiments conducted from November 1997 to September 1998 evaluated the yield potential of selected hot pepper cultivars in the U.S. Virgin Islands. One study was conducted at the University of the Virgin Islands, Agricultural Experiment Station (AES), on St. Croix. The soil at AES was a Fredensborg clay loam (coarse, loamy, carbonatic, isohyperthermic, typic calciustoll). The other two experiments were located on the farms of local growers, one in Estate Glynn (Glynn) and the other in Estate Carlton (Carlton). The soil at both on-farm locations was a Glynn gravelly loam (clayey, skeletal, mixed, superactive, isohyperthermic, typic, argiustoll). Seeds were obtained from a local grower, CARDI (Antigua), Pepper Gal and other seed sources in the U.S.

AES Trial

Five hot pepper cultivars ('Early Scotch Bonnet', 'Red Scotch Bonnet', 'Scotch Bonnet', 'Habanero' and 'West Indies Hot') were evaluated at AES. Hot pepper seeds were sown in Speedling trays (Speedling Mfg., FL) containing Pro Mix BX (Premier Brands, PA) in October 1997. Seedlings were transplanted on November 25, 1997. The experimental design was a randomized complete block design with three replications. Plots consisted of three rows 7.2 m long, with a spacing of 1.0 m and 0.6 m between rows and plants, respectively. A drip irrigation system was installed consisting of 1.27 cm poly-hose (Hardie Irrigation, CA) as the sub-mains and 15 mil Hardie New Tape (Hardie Irrigation, CA) with laser-drilled orifices 0.6 m apart as the laterals. Soil moisture levels were maintained at field capacity using tensiometers (Irrometer Co., CA). Plants were initially fertigated with 20-20-20 soluble fertilizer then later banded in three split-applications of 200 g/plot for each application in January, April, and June, using a granular formulation of 15-15-15. Data were collected on plant height, number and fresh weight of fruits. Pungency analyses were performed for selected cultivars using the HPLC method. Visual observations were made on the severity of viral infections on all cultivars.

On-Farm Trials

The on-farm trials each evaluated five cultivars. Seedling production, irrigation system installation, data collection, visual disease observations, and pungency analysis were performed similar to the AES trial. The plot layout for these trials was three rows 7.2 m long, with a spacing of 1.5 m and 0.6 m between rows and plants, respectively. The cultivars 'Red Scotch Bonnet', 'Pink Scotch Bonnet', 'Chocolate Scotch Bonnet', 'Yellow Scotch Bonnet', and 'Habanero' were evaluated at Glynn. Hot pepper seeds were sown during October 1997 and the seedlings transplanted on November 21, 1997. The irrigation and fertilization regimes were managed by the farmer using tensiometers and fertigating with soluble 20-20-20 fertilizer. The experimental design was a randomized complete block design with four replications.

The cultivars 'West Indies Red', 'West Indies Yellow', 'Santo Domingo Pueblo', 'Red Squash', and 'Habanero' were evaluated at Carlton. Hot pepper seeds were sown on February 2, 1998 and the seedlings transplanted on March 11, 1998. The irrigation of the plants was managed by the farmer using tensiometers. Granular 15-15-15 fertilizer was applied in two split-applications of 1533 g/plot for each application in April and May. The experimental design for this trial was a randomized complete block design with three replications.

RESULTS AND DISCUSSION

AES Germplasm Evaluation

There was a total of eight harvests during the period from March 25 to June 3, 1998. Significant differences were observed among cultivars for plant height, number of fruits, and fruit weight (Table 1). The 'Early Scotch Bonnet' plants were significantly

taller (104 cm) than all other cultivars, while the 'Habanero' plants were the shortest (54 cm). 'West Indian Hot' produced the highest number fruits (897,000 fruits/ha) and total fruits fresh weight (7642 kg/ha). Both parameters were significantly higher than 'Red Scotch Bonnet' and 'Scotch Bonnet' (Table 1). Additionally, 'Early Scotch Bonnet' (685,000 fruits/ha) produced significantly more fruits than 'Scotch Bonnet'. 'Early Scotch Bonnet' and 'Habanero' produced similar fruit yields (Table 1). The 'Scotch Bonnet' fruits with an average size of (9.5 g) were significantly larger than fruits from the 'Early Scotch Bonnet' (7.6 g) cultivar. The consistently higher yield at most harvest dates obtained from 'West Indian Hot', can be attributed to the higher tolerance to viral infections (suspected to be the pepper mosaic virus) exhibited by this cultivar Even though the 'West Indian Hot' plants were infected with the virus they did not decline as rapidly as did most plants of the other cultivars. In terms of productivity, 'West Indian Hot' has the greater potential for production in the Virgin Islands. 'Habanero' and 'Scotch Bonnet' were the most susceptible to virus. The Scotch Bonnet types were as productive as the 'Habanero', a common cultivar in the Caribbean and the U.S.

On-Farm Germplasm Evaluation (Glynn and Carlton)

At the Glynn location there was a total of ten harvests during the period from April 3 to August 12, 1998. 'Chocolate Scotch Bonnet' and 'Red Scotch Bonnet' plants (124-125 cm) were taller than plants of the other cultivars. Pink and Yellow Scotch Bonnet plants (89 -92 cm) were the shortest (Table 2). Significant differences were also observed in the number and weight of fruits. 'Yellow Scotch Bonnet' plants produced the highest number of fruits (2,563,000 fruits /ha) significantly more than all of the other cultivars except 'Pink Scotch Bonnet'. The yield of fresh fruits (16,973 kg/ha) produced by 'Yellow Scotch Bonnet' was significantly superior to all of the other cultivars (Table 2). 'Red Scotch Bonnet' fruits with an average weight of (9.4 g) were significantly larger than fruits from all of the other cultivars. 'Yellow Scotch Bonnet' fruits were among the smallest fruits averaging only 6.6 g. The yield data for individual harvests showed that 'Chocolate Scotch Bonnet' had a production pattern that was different to the other Scotch Bonnet cultivars. The highest yields from 'Chocolate Scotch Bonnet' were obtained early in the harvesting season and tended to taper off as the season progressed. However, production from the other Scotch Bonnet cultivars peaked during the mid-harvesting season. The excellent performance of 'Yellow Scotch Bonnet' is very encouraging, because yellow hot peppers are always in the highest demand, of all the colors, in the local markets and cottage industries. All cultivars were affected by virus, but the disease was more severe in 'Red Scotch Bonnet'.

At the Carlton location there was a total of six harvests during the period from June 18 to September 3, 1998. 'Habanero' (77 cm) plants were significantly taller than all other plants except 'West Indies Yellow' (74 cm), while 'Red Squash' and 'Santo Domingo' plants were the shortest. This location experienced a number of problems which adversely affected the productivity of the plants. There was some flooding of field during the early stages of growth, mealy bugs and white flies were also a problem in addition to the virus. 'West Indies Red' produced 49,000 fruits/ha, significantly more than all other cultivars except 'Red Squash' which produced 33,000 fruits/ha (Table 3) The total fruit fresh yield of 450 kg/ha obtained from 'West Indies Red' was significantly

higher than from all of the other cultivars. 'Habanero' and 'West Indies Red' produced the largest fruits, weighing 9.5 and 9.2 g., respectively, significantly larger than fruits from all other cultivars. The fruits from 'Red Squash' with a weight of 5.7g were the smallest. The data for individual harvests (Fig. 3) shows that 'West Indies Red' produced the highest yields at almost all harvest dates and this was much more pronounced during the middle and latter part of the harvesting season. The performance of 'West Indies Yellow' was very poor producing only 6,000 fruits with a weight of 41kg/ha, ranking the lowest of all cultivars, statistically (Table 3). Most of the cultivars were affected by virus, but the 'West Indian Yellow' seemed to be the most susceptible resulting in the lowest yield (Table 3).

Pungency Analysis

The results of pungency analyses indicated that 'Chocolate Scotch Bonnet' produced the hottest peppers, expressed in Scolville units, of all the cultivars tested (Table 4). Yellow and Pink Scotch Bonnets had similar pungency levels and were the second hottest peppers. The AES 'Habanero' also ranked as hot as the Pink and Yellow Scotch Bonnets, and was observed to be much hotter than the 'Habanero' from the Glynn trial. It must however, be noted that the seeds for both trials were obtained from different sources and therefore may not be the same. The mildest pepper was the 'West Indian Hot'.

CONCLUSIONS

The results of these trials have provided us with promising cultivars which can be used for further crop management studies. At AES, cultivars 'West Indian Hot', 'Habanero', and 'Early Scotch Bonnet' were promising. The 'West Indian Hot' cultivar was the most productive in the AES trial and most tolerant to viral infections, but because of its mild pungency, it might not be ideal for use in the hot pepper sauce industry. However, improving or manipulating crop management practices may increase its pungency appreciably, since pungency can be influenced by factors related to cultural management. In on-farm trials, all of the Scotch Bonnets as well as 'West Indies Red' were identified as promising cultivars. Although the 'Chocolate Scotch Bonnet' is the hottest pepper, its color is a drawback. As a result of this, it may not be attractive to consumers who are more familiar with yellow and red hot peppers and also prefer their hot sauce to be these colors. The promising cultivars from all trials have been selected for further studies.

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Table 1. Plant height, total number of fruits and total fruit weight of hot peppers (*Capsicum chinense*). On-station Trial, UVI/AES, St. Croix, 1997-98. Data total of 8 harvests.

Cultivar	Plant Height (cm)	Number of Fruits per ha (000)	Fruit Fresh Wt. ($kg\ ha^{-1}$)	Fruit Size (g)
Early Scotch Bonnet	104 a	685 ab	5227 ab	7.6 b
Habanero	54 c	503 abc	4227 ab	8.4 ab
Red Scotch Bonnet	81 b	340 bc	2866 b	8.4 ab
Scotch Bonnet	76 b	232 c	2199 b	9.5 a
West Indian Hot	76 b	897 a	7642 a	8.5 ab

Mean separation in columns by Duncan's Multiple Range Test, P=0.05.

Table 2. Plant height, total number of fruits and total fruit weight of hot peppers (*Capsicum chinense*). On-farm Trial, Glynn, St. Croix, Virgin Islands. 1997-98. Data total of 10 harvests.

Cultivar	Plant Height (cm)	Number of Fruits per ha (000)	Fruit Fresh Wt. ($kg\ ha^{-1}$)	Fruit Size (g)
Chocolate Scotch Bonnet	125 a	1526 bc	10602 b	6.9 bc
Habanero	107 b	1001 c	7886 b	7.9 b
Pink Scotch Bonnet	89 c	1908 ab	11868 b	6.2 c
Red Scotch Bonnet	124 a	1118 c	10473 b	9.4 a
Yellow Scotch Bonnet	92 c	2563 a	16973 a	6.6 c

Mean separation in columns by Duncan's Multiple Range Test, P=0.05.

Table 3. Plant height, total number of fruits and fruit weight of hot peppers (*Capsicum chinense*). On-farm trial, Carlton, St. Croix, Virgin Islands, 1998. Data total of 6 harvests.

Cultivar	Plant Height (cm)	Number of Fruits per ha (000)	Fruit Fresh Weight ($kg\ ha^{-1}$)	Fruit Size (g)
Habanero	77 a	17 bc	162 b	9.5 a
Red Squash	44 c	33 ab	187 b	5.7 c
Santo Domingo	33 c	22 bc	170 b	7.7 b
West Indies Red	61 b	49 a	450 a	9.2 a
West Indies Yellow	74 ab	6 c	41 c	6.8 b

Mean separation in columns by Duncan's Multiple Range Test, P=0.05.

Table 4. Pungency analysis[z] for selected hot pepper (*Capsicum chinense*) cultivars grown in St. Croix, Virgin Islands, UVI/AES, 1998.

Cultivar	Moisture (%)	Scoville Heat Unit	
		Wet Basis	Dry Basis
Chocolate Scotch Bonnet	4.07	318,178	331,677
Habanero (Glynn)	5.60	165,271	175,075
Habanero (AES)	4.14	248,068	258,782
Pink Scotch Bonnet	4.51	249,302	261,077
Red Scotch Bonnet	4.32	162,619	169,961
West Indian Yellow	4.26	72,315	75,574
Yellow Scotch Bonnet	5.05	259,686	273,498

[z]Samples were analyzed by Strasberger & Siegel Lab, Hanover, Maryland.