The African Journal of Plant Science and Biotechnology ©2012 Global Science Books

Screening Long Cayenne Pepper (*Capsicum frutescens* L.) Accessions Collected from Southwest Nigeria for Agronomic Performance

Oladayo O. Idowu-Agida[1] • Dotun J. Ogunniyan[2*] • Emmanuel O. Ajayi[1]

[1] National Horticultural Research Institute, P.M.B 5432, Idi-Ishin, Jericho, Ibadan, Nigeria
[2] Institute of Agricultural Research & Training, P.M.B. 5029, Moor Plantation, Ibadan, Nigeria

Corresponding author: * **dotunogunniyan@yahoo.com**

ABSTRACT

Germplasm collections and selection for agronomic traits are essential for genetic enhancement. *Capsicum* has great genetic diversity; greater than 200 landraces are grown in Nigeria, but there are no recommended cultivars. An experiment was conducted at the National Horticultural Research Institute of Nigeria, Ibadan to evaluate and select long cayenne pepper accessions, collected from 31 locations in Southwest Nigeria, for agronomic performance in rainy and dry seasons of 2008. Six-week-old seedlings of the pepper accessions were transplanted using 0.6 × 0.6 m spacing (28 plants/plot) into 3.6 × 2.4 m beds, separated by 1 m. Data were collected on eight middle plants on growth, flowering and fruit traits in both seasons. Data collected were subjected to analysis of variance; least significant difference was used to separate means, and least means square used to explain results of interactions. Different accessions were adapted to each season. Season had no effect on seedling vigour, plant height, number of seed/fruit and 1000-seed weight; but dryness hastened flowering and fruiting. Fruit yield/plant and number of seed/fruit were higher in the dry than rainy season. Accessions IA108-9, IA108-10, IA108-12, IA108-13, IA108-14, IA108-20 and IA108-28 performed best under rain-fed; accessions IA108-2, IA108-5, IA108-8, IA108-19, IA108-23 and IA108-31 did best in the dry season; and accessions IA108-3, IA108-4, IA108-7 and IA108-29 performed well in both seasons. Fruit yield/plant in 'IA108-28' (>100 g) was stable across seasons; the accession could be selected for further studies in Ibadan.

Keywords: Dry season, genetic diversity, hot pepper, seedling emergence index, pepper yield, rainy season
Abbreviations: DAS, days after sowing; **SW**, Southwest; **WAT**, weeks after transplanting

INTRODUCTION

Pepper (*Capsicum* spp.) is a popular vegetable valued around the world for the colour, flavour, spice and nutritional value it contributes to many meals (Berke *et al.* 2005). Hot pepper is an indispensable soup ingredient cherished as condiment in stews in Nigeria. It is among top 5% of the important vegetables consumed in the country (Denton and Makinde 1993). In Nigeria, *Capsicum* used to be a cash crop for exportation and for local consumptions in various local and international dishes. It also serves non-edible purposes. In the recent times, there had been decline in its production principally due to the cultivation of unimproved cultivars leading to average yield loss (FAO 2005).

There are more than 200 local varieties of pepper grown in Nigeria (Erinle 1989), but there are no recommended cultivars for specific season and location. Most of these local varieties are endangered because resource-poor farmer households depend on the regular, old unimproved varieties; planting from their own harvest or cheap seeds of uncertain quality and origin obtained from friends or local seed dealers. In the future, many landraces are likely to disappear (Grubben and Tahir 2004) as farmers now concentrate more on planting the most common seeds to disadvantages of yield and quality. Consequently, there is the need to collect and screen landraces for conservation.

Genetic variation among landraces of pepper in response to varying biotic and abiotic stresses provides the raw materials for its improvement. Pepper varieties display a wide range of plant and fruit traits, and production practices vary greatly from region to region (Berke *et al.* 2005; Burt 2008). The crop is grown in the dry season under irrigation or rain-fed in areas with rainfall between 600-2000 mm and temperature range of 18-30°C (Yayock *et al.* 1988; Erinle 1989; Grubben and Tahir 2004). *Capsicum* grows best in well-drained sandy or loamy soils with a pH of 5.5–6.8 and a high water retention capacity (Showemimo and Olarewaju 2007; Oluoch and Marandu 2008). Many studies had confirmed adequate water supply is required during the whole crop cycle of the crop. Attention on irrigation scheduling should be paid on the whole growing cycle (Khan *et al.* 2005; Ferrara *et al.* 2011).

Plant reproduction is an important and delicate phonological phase of plants. Yield of crop largely depends on the success of plant reproduction, which depends on many biotic and abiotic factors. Sunshine promotes anthesis in the crop. *Capsicum* tolerates up to 45% shade, though it may delay flowering (Grubben and Tahir 2004). Reproductive traits such as yield/plant, fruit/plant, fruit length, fruit weight and seeds/fruit are the most important quantitative characters for effective selection in *Capsicum* (Manju and Sreelathakumary 2002).

Farming households need genetic diversity to meet needs of consumption and marketing; to cope with the variation of soil and climatic conditions; and to keep options for the cultivars development open (Schippers 2002). Breeders also need information on crop genetic diversity to make crosses. Such information will guide plant breeders in defining their breeding goals as well as guide farmers in their choice of cultivars for commercial cultivation. The study, therefore, screened 31 accessions of long cayenne pepper collected from SW Nigeria for agronomic performance. The study provided data on early growth, flowering and fruit traits of the accessions and selected the accessions suitable for rainy and dry seasons.

Received: 2 February, 2012. Accepted: 17 March, 2012.

Original Research Paper

MATERIALS AND METHODS

Experimental site and materials

The experiment was carried out in rainy and dry seasons (**Table 1**); from April to December 2008 at the National Horticultural Research Institute of Nigeria (NIHORT), Ibadan which lies between latitude 7° 24′ N and longitude 3° 54′ E in a high humidity (80%) region. Physical and chemical properties of the soils are in **Table 2**. Seeds were extracted from fruits of long cayenne pepper collected from 31 locations representative of agro-ecologies of SW Nigeria (**Table 3**).

Seedling establishment and cultural practices

Seeds were sown 1.5 cm deep at 60 seeds per tray filled with fine nursery soil to raise seedlings for field evaluation on 25 April 2008 for the rain-fed and on 7 August 2008 for the dry season. Water was applied adequately daily for the first two weeks and every two days for the second two weeks (Khan *et al.* 2005).

Six-week-old seedlings were transplanted (Norman 1992) into beds measuring 3.6 × 2.4 m on 6 June 2008 for rain-fed and 18 September 2008 for dry season at spacing of 0.6 × 0.6 m representing 28 plants/plot (27,778 plants/ha). The beds were 1 m apart. The experiment was laid out in a randomized complete block design with three replications. Irrigation was applied in the dry season to field capacity twice a week because rain stopped by end of October. To meet the nutrient requirements of 130 kg/ha N, 80 kg/ha P and 110 kg/ha K (Grubben and Tahir 2004), fertilizer was compounded from N-P-K 20:10:10, single super-phosphate and K from muriate of potash. These fertilizers were applied at the rate of 5.85, 5.92 and 1.01 g/plant of the respective fertilizer at 3, 6, 9 and 12 WAT. The fertilizer was applied in four splits because the experimental field had been cultivated for more than 30 years. The soil drains easily as a result of long cultivation. Harvesting was done when the fruits were 100% red.

Data collection and statistical analysis

Observations were on plant and fruit traits (IPGRI *et al.* 1995). Data collected included emergence index and percentage, plant height measured from soil surface to the tip of the uppermost leaf on eight middle plants at 50% fruit ripening, days to 50% flowering and 50% fruiting, anthesis-fruit set interval, number of fruit/plant and 1000-seed weight. Emergence index (EI) was calculated according to Adetimirin (2008) as:

$$EI = \frac{\sum \text{(newly emerged seedlings on a day) (DAS)}}{\text{Seedlings emerged 15 DAS}}$$

Emergence percentage was taken as the number of seedling emerged at 15 DAS as a percentage of total seeds sown. Seedlings were scored for vigour using eight middle plants at 42 DAS on a scale of 1 to 9 based on transplant height, colour and size of leaves, where 1 = strong seedlings with large green leaves indicating very high vigour; and 9 = weak seedlings with small yellow leaves indicating very poor vigour (Adetimirin *et al.* 2006; Adetimirin 2007, 2008). Days to 50% flowering and days to 50% fruiting were, respectively, determined by days from transplanting to when 50% of the total plants/plot produced flowers and fruits. Anthesis-fruit set interval was difference between days to 50% fruiting and days to 50% flowering.

Data were subjected to analysis of variance using SAS (2004). When the accession × season interaction was significant it was used to explain results and Fisher's protected least significant difference (P = 0.05) was used to separate main effects means when the interaction was not significant.

RESULTS

Experimental field conditions

Weather conditions varied considerably between the two seasons (**Table 1**). Mean daily minimum and maximum air temperatures were, respectively, higher in dry season by 0.4 and 2.1°C. Number of rain-days and precipitation were 13 days and 20.7 cm higher in rainy season.

Table 1 Summary of weather conditions during the experiment.

Season	Temperature (°C)			No. of rainy days	Total precipitation (mm)
	Minimum	Maximum	Mean		
Rainy	21.2	30.6	25.9	57	1402.2
Dry	21.6	32.7	27.2	44	1195.4

Table 2 Physical and chemical properties of soils of the nursery and experimental field.

Parameter	Nursery	Experimental field	
		0-15 cm	15-30 cm
Acidity (cmol kg$^{-1)}$	0.2	0.1	0.3
pH (1:1) H_2O	5.5	5.4	4.6
pH (1:1) KCl	4.8	4.6	3.5
ECEC (cmol kg$^{-1)}$	22.9	20.8	24.6
Total N (g kg^{-1})	1.2	1.1	0.8
Available P (mg kg^{-1})	6.3	26.4	10.9
K (cmol kg^{-1})	1.6	1.5	1.7
Ca (cmol kg^{-1})	14.0	12.6	15.2
Mg (cmol kg^{-1})	6.2	5.8	6.4
Na (cmol kg^{-1})	0.9	0.9	1.0
Zn (cmol kg^{-1})	82.4	72.8	70.6
Cu (cmol kg^{-1})	10.7	12.3	11.2
Mn (cmol kg^{-1})	138.7	129.3	175.3
Fe (cmol kg^{-1})	95.0	92.4	106.7
Sand (g kg^{-1})	872.0	812.0	722.0
Silt (g kg^{-1})	94.0	94.0	84.0
Clay (g kg^{-1})	34.0	94.0	194.0
Organic C (%)	11.7	10.3	7.6
Texture	Humus top soil	Sandy-loam	

Variations in agronomic traits

Accessions, season and accession × season affected emergence percentage (**Table 4**), fruit yield traits (**Table 5**) and anthesis-fruit set index (**Table 6**) of the accessions. Emergence percentage was higher in rainy season except in accessions IA108-3 and IA108-16. Number of fruit/plant was higher in dry season in all the accessions except in IA108-28, which was not significantly affected. Fruit yield/plant was higher in dry season except in 'IA108-14' and 'IA108-28'; yield/plant was not affected by accession × season in accessions IA108-12, IA108-13 and IA108-14. Anthesis-fruit set interval was lower in dry season in all accessions.

Season, not accession or accession × season, affected emergence index (**Table 4**); days to 50% flowering and days to 50% fruiting (**Table 6**). Irrigated cultivation enhanced emergence index in the accessions except IA108-1, IA108-16, IA108-21 and IA108-25; but did not affect accessions IA108-9, IA108-24 and IA108-27. All the accessions produced flowers and fruits earlier in the dry season.

Variations in seedling vigour, plant height and number of seeds/fruit were because of effect of accessions only. The 1000-seed weight was not significantly different among the accessions (**Table 7**). Seedling vigour was rated between 5.5 and 3.7. 'IA108-20 and 'IA108-27' had among the highest; 'IA108-15' lowest; the other accessions had values distributed within the highest and lowest. 'IA108-19' and 'IA108-9' were, respectively, among the tallest and shortest; other accessions also had values between the extremes. All the accessions were similar, but 'IA108-8' was significantly higher than the other accessions in number of seeds/fruit.

DISCUSSION

Weather elements varied considerably in the two seasons. The agro-ecology in which the crop was grown is characterized by bimodal rainfall pattern with rainfall reaching the peak in July-August. The rainy season crops benefited from the higher amount and more widely distributed rainfall, but

Table 3 Description of the locations in SW Nigeria where the accessions of long cayenne pepper were collected in 2008.

Accession	Collection site	Location		Agroecology
		Longitude (N)	Latitude (E)	
IA108-1	Sango	7°22'	3°58'	Southern Guinea Savanna
IA108-2	Sasa	7°22'	3°58'	Southern Guinea Savanna
IA108-3	Oja-oba	7°40'	3°50'	Southern Guinea Savanna
IA108-4	Bodija	7°22'	3°58'	Southern Guinea Savanna
IA108-5	Ogbomoso	7°46'	3°56'	Southern Guinea Savanna
IA108-6	Odo-oba	7°40'	3°50'	Southern Guinea Savanna
IA108-7	Saki	8°68'	4°79'	Southern Guinea Savanna
IA108-8	Ikire	7°36'	4°19'	Southern Rainforest
IA108-9	Ile-Ife	7°47'	4°57'	Southern Rainforest
IA108-10	Osogbo	7°77'	4°55'	Southern Rainforest
IA108-11	Ikirun	7°92'	4°67'	Southern Rainforest
IA108-12	Ado-Ekiti	7°48'	5°41'	Northern Rainforest
IA108-13	Ikole	7°60'	5°54'	Southern Guinea Savanna
IA108-14	Aramoko	7°43'	5°38'	Northern Rainforest
IA108-15	Ifaki	7°71'	5°90'	Northern Rainforest
IA108-16	Otta	7°95'	4°78'	Southern Rainforest
IA108-17	Abeokuta	7°15'	3°35'	Southern Rainforest
IA108-18	Sagamu	6°85'	3°65'	Southern Rainforest
IA108-19	Ago-iwoye	6°82'	3°92'	Southern Rainforest
IA108-20	Offa	8°13'	4°42'	Southern Guinea Savanna
IA108-21	Ilorin	8°05'	4°55'	Southern Guinea Savanna
IA108-22	Igbaja	8°36'	4°41'	Southern Guinea Savanna
IA108-23	Omu-aran	8°45'	4°40'	Southern Guinea Savanna
IA108-24	Ikorodu	6°62'	3°05'	Southern Rainforest
IA108-25	Ipaja	6°20'	3°30'	Southern Rainforest
IA108-26	Osodi	6°05'	3°35'	Southern Rainforest
IA108-27	Agege	6°32'	3°41'	Southern Rainforest
IA108-28	Akure	7°15'	5°05'	Northern Rainforest
IA108-29	Ore	7°32'	5°40'	Southern Rainforest
IA108-30	Ikare	7°52'	5°76'	Northern Rainforest
IA108-31	Ifon	7°42'	5°55'	Southern Rainforest

were adversely affected by lower sunshine, high incidence of pests and diseases. The last rainfall was on 25 October (45 days after transplanting) justifying the irrigation to field capacity carried out twice a week from 7 to 16 WAT in the dry season. Season has been reported to significantly affect the crop because of the variability in climatic conditions and their interaction with the accession (Dixit *et al.* 1997).

For starting any improvement work, information about the genetic variability in the population is a vital. Presence of high variability in this crop offers much scope for its improvement (Manju and Sreelathakumary 2002). There was considerable genetic variability among the accessions for seedling, fruit and yield traits within and between seasons. This indicates the possibility of the genetic improvement of long cayenne pepper of SW Nigeria to enhance productivity. The non-significant effect of season on emergence index in accessions IA108-9, IA108-24 and IA108-27 expresses their insensitivity to the fluctuation in storage conditions. Emergence percentage of 28 (representing 90.3%) of the 31 accessions screened was lower in dry season owing to loss in viability of the seeds in storage. The seeds were stored for 13 weeks before sown in the dry season. The loss in seed viability in such a short period implies most farmers in SW Nigeria sow seeds of low viability, because they plant from their previous harvests. Loss in viability due to storage could pose great challenge to yield of the crop. Difference in the extent of the loss in viability showed by various accessions was evident by the significant accession × season interaction. Interaction of moisture, temperature, physiological state and genetic potential of the seed affect longevity of seeds. The seeds undergo aging depending on the extent of the fluctuation of the weather elements and their interaction with the accessions. The seeds collected and evaluated in this study were dried under same condition to similar moisture content and stored at the same temperature; differences in emergence percentage within and between seasons could be attributed to genetic differences of the accessions and to their interaction with the storage conditions.

Similar expression for transplant height, colour and size of leaves which were used to determine seedling vigour; and the non-significant difference among most of the accessions in flowering and fruiting patterns within both seasons indicated limited genetic variability for these traits in the long cayenne pepper of Southwest Nigeria. This is a limitation to the development of long cayenne pepper varieties of different maturity cycles. The onset of anthesis is important in many species of crops because it determines their maturity and yield. Anthesis commences in pepper between 35 and 42 days after planting and peaks in seven days (Khah and Passam 1992). Cloud cover and wet weather of the rainy season could delay flowering and cause flower abortion and rot resulting in lower fruit yield. Abscission of flower buds, flowers, and fruits is an important yield-limiting factor in pepper (Khan *et al.* 2005; Marcellis *et al.* 2005; Ferrara 2011).

Different accessions performed best in fruit yield/plant in different seasons; suggesting that some accessions were better adapted to dry season and some to the rainy season. Mean fruit yield/plant and number of seed/fruit were higher in the dry than rainy season. Most of the accessions, with the exception of accessions IA108-12, IA108-14, IA108-20 and IA108-28 had higher fruit yield in dry season compared with the rainy season and this could be attributed to the higher temperature and drier conditions of the dry season which facilitated better flower and fruit retention (Yayock *et al.* 1988; Erinle 1989; Grubben and Tahir 2004). Accessions IA108-3, IA108-4, IA108-8, IA108-29 and IA108-31 had fairly good yield in the rainy season despite the generally high flower abortion, viral infections, stem lodging and high fruit rot. Accessions IA108-9, IA108-10, IA108-12, IA108-13, IA108-14, IA108-20 and IA108-28 had fruit yield/plant above the mean value of 61.1 g in the rainy season; accessions IA108-2, IA108-5, IA108-8, IA108-19, IA108-23 and IA108-31 above the mean value of 110.9 g in the dry season; and accessions IA108-3, IA108-4, IA108-7 and IA108-29 above respective mean for both seasons. 'IA108-28' had high yield with mean value above 100 g

Table 4 Interaction of accession × season on seedling emergence of long cayenne pepper accessions collected from SW Nigeria.

Accession ×	Season	Emergence index	Emergence percentage
IA108-1	Rainy	9.02	79.44
	Dry	8.01**	44.44**
IA108-2	Rainy	8.42	71.67
	Dry	12.25**	54.44**
IA108-3	Rainy	8.18	64.44
	Dry	9.91**	75.00**
IA108-4	Rainy	8.00	60.55
	Dry	8.93**	47.78**
IA108-5	Rainy	7.77	79.45
	Dry	8.37*	54.45**
IA108-6	Rainy	8.75	62.78
	Dry	9.48**	42.78**
IA108-7	Rainy	8.79	52.22
	Dry	9.10*	47.78**
IA108-8	Rainy	8.30	56.11
	Dry	9.49**	47.22**
IA108-9	Rainy	8.50	64.45
	Dry	8.63 ns	48.89**
IA108-10	Rainy	9.41	58.33
	Dry	10.08**	46.67**
IA108-11	Rainy	8.49	67.78
	Dry	9.34**	46.11**
IA108-12	Rainy	8.06	67.78
	Dry	9.34**	51.11**
IA108-13	Rainy	8.65	83.33
	Dry	9.48**	53.89**
IA108-14	Rainy	7.58	72.78
	Dry	9.37**	45.56**
IA108-15	Rainy	8.10	67.22
	Dry	8.46*	51.67**
IA108-16	Rainy	8.61	60.78
	Dry	8.08**	63.89**
IA108-17	Rainy	8.11	58.89
	Dry	8.54*	50.00**
IA108-18	Rainy	8.68	63.89
	Dry	9.04**	45.55**
IA108-19	Rainy	7.97	62.22
	Dry	8.90**	46.11**
IA108-20	Rainy	8.65	74.44
	Dry	9.56**	58.89**
IA108-21	Rainy	8.88	71.11
	Dry	8.45*	50.56**
IA108-22	Rainy	8.80	58.33
	Dry	9.46**	36.67**
IA108-23	Rainy	8.34	55.56
	Dry	8.71*	52.22**
IA108-24	Rainy	8.71	59.44
	Dry	8.63 ns	47.22**
IA108-25	Rainy	8.99	53.89
	Dry	8.30*	40.00**
IA108-26	Rainy	8.89	73.89
	Dry	9.20*	41.67**
IA108-27	Rainy	9.39	56.11
	Dry	9.61 ns	43.89**
IA108-28	Rainy	8.63	63.89
	Dry	9.52*	38.33**
IA108-29	Rainy	8.47	59.44
	Dry	9.18*	53.89**
IA108-30	Rainy	8.13	64.44
	Dry	9.55*	47.22**
IA108-31	Rainy	8.44	78.89
	Dry	8.98*	40.00**
ANOVA			
Source	**df**	**Mean square**	
Accession	30	1.24 ns	214.19**
Season	1	19.85**	12667.88**
Accession × Season	30	1.14 ns	164.71**
Error	122	0.98	99.61

Means across rows with ns, *, ** non-significant or significant at $P \leq 0.05$ or $P \leq 0.01$, respectively, Least Squares Means Analysis.

Table 5 Interaction of accession × season on number of fruit and yield/plant of long cayenne pepper accessions collected from SW Nigeria.

Accession ×	Season	No. of fruit/plant	Fruit yield/plant (g)
IA108-1	Rainy	4.1	25.95
	Dry	13.5*	70.68**
IA108-2	Rainy	7.7	60.56
	Dry	23.5*	136.09**
IA108-3	Rainy	8.5	67.96
	Dry	27.7**	170.55**
IA108-4	Rainy	11.8	74.98
	Dry	23.9**	178.13**
IA108-5	Rainy	8.5	46.63
	Dry	20.6**	118.65**
IA108-6	Rainy	7.4	51.51
	Dry	19.0**	100.93**
IA108-7	Rainy	13.1	66.04
	Dry	25.2**	144.32**
IA108-8	Rainy	8.4	57.95
	Dry	27.8**	159.28**
IA108-9	Rainy	11.5	65.23
	Dry	21.5**	104.79**
IA108-10	Rainy	12.3	76.36
	Dry	23.8**	92.36**
IA108-11	Rainy	7.2	46.94
	Dry	17.3**	82.27**
IA108-12	Rainy	10.0	84.62
	Dry	16.7**	77.69 ns
IA108-13	Rainy	10.1	79.10
	Dry	15.8**	80.63 ns
IA108-14	Rainy	13.5	90.95
	Dry	16.2*	86.28 ns
IA108-15	Rainy	7.7	54.24
	Dry	11.2*	74.98*
IA108-16	Rainy	8.7	47.69
	Dry	15.5**	90.98**
IA108-17	Rainy	9.3	57.68
	Dry	23.8**	110.72**
IA108-18	Rainy	5.6	34.90
	Dry	17.1**	98.18**
IA108-19	Rainy	10.2	40.24
	Dry	17.5**	116.52**
IA108-20	Rainy	10.3	84.74
	Dry	12.5*	60.78*
IA108-21	Rainy	8.3	58.26
	Dry	17.4*	78.54*
IA108-22	Rainy	6.6	43.59
	Dry	18.6**	93.50*
IA108-23	Rainy	8.9	44.99
	Dry	23.5**	143.27**
IA108-24	Rainy	9.2	59.34
	Dry	16.0**	87.99**
IA108-25	Rainy	8.0	51.65
	Dry	21.6*	97.75**
IA108-26	Rainy	8.5	59.12
	Dry	23.6**	100.38**
IA108-27	Rainy	10.4	57.70
	Dry	19.3**	105.78**
IA108-28	Rainy	18.0	118.67
	Dry	20.1 ns	104.60*
IA108-29	Rainy	12.8	75.21
	Dry	23.4**	157.27**
IA108-30	Rainy	9.0	56.99
	Dry	21.7**	108.07**
IA108-31	Rainy	8.5	45.66
	Dry	28.4**	184.12**
ANOVA:			
Source	**df**	**Mean square**	
Accession	30	47.5**	2130.49*
Season	1	5258.7**	112929.06**
Accession × Season	30	34.0**	2211.61*
Error	122	30.3	1219.34

Means across rows with ns, *, ** non-significant or significant at $P \leq 0.05$ or $P \leq 0.01$, respectively, Least Squares Means Analysis.

Table 6 Seasonal variation on flowering and fruiting of long cayenne pepper accessions collected from SW Nigeria.

Accession ×	Season	Days to 50% flowering	Days to 50% fruiting	Anthesis-fruit set interval
IA108-1	Rainy	127.3	148.0	20.7
	Dry	95.0^{**}	105.7^{**}	10.7^{**}
IA108-2	Rainy	127.0	146.7	19.7
	Dry	96.0^{**}	103.7^{**}	7.7^{**}
IA108-3	Rainy	127.7	147.7	20.0
	Dry	93.7^{**}	103.3^{**}	9.6^{**}
IA108-4	Rainy	127.7	147.0	19.3
	Dry	97.3^{**}	104.7^{**}	7.4^{**}
IA108-5	Rainy	128.0	147.0	19.0
	Dry	96.7^{**}	105.3^{**}	8.6^{**}
IA108-6	Rainy	126.3	144.7	18.4
	Dry	97.3^{*}	103.7^{**}	6.4^{**}
IA108-7	Rainy	127.7	145.0	17.3
	Dry	96.7^{*}	103.7^{**}	7.0^{**}
IA108-8	Rainy	128.3	148.0	19.7
	Dry	99.7^{**}	107.0^{**}	7.3^{**}
IA108-9	Rainy	127.0	146.7	19.7
	Dry	102.0^{**}	104.3^{**}	2.3^{**}
IA108-10	Rainy	127.0	145.0	18.0
	Dry	96.7^{**}	100.7^{**}	4.0^{**}
IA108-11	Rainy	127.0	145.0	18.0
	Dry	98.7^{**}	103.3^{**}	4.6^{**}
IA108-12	Rainy	127.0	146.0	19.0
	Dry	95.7^{**}	107.7^{**}	12.0^{**}
IA108-13	Rainy	128.3	148.0	19.7
	Dry	104.7^{**}	103.0^{**}	1.7^{**}
IA108-14	Rainy	127.0	145.3	18.3
	Dry	96.7^{**}	102.3^{**}	5.6^{**}
IA108-15	Rainy	127.0	145.3	18.3
	Dry	100.3^{**}	102.3^{**}	2.0^{**}
IA108-16	Rainy	127.0	145.0	18.0
	Dry	97.3^{**}	103.7^{**}	6.4^{**}
IA108-17	Rainy	126.3	144.0	17.7
	Dry	98.0^{**}	107.7^{**}	9.7^{**}
IA108-18	Rainy	127.7	146.3	18.6
	Dry	96.7^{**}	105.3^{**}	8.6^{**}
IA108-19	Rainy	128.3	149.0	20.7
	Dry	99.3^{**}	105.0^{**}	5.7^{**}
IA108-20	Rainy	127.0	145.0	18.0
	Dry	99.0^{**}	108.7^{**}	9.8^{**}
IA108-21	Rainy	127.7	146.3	18.6
	Dry	100.3^{**}	113.7^{**}	13.4^{**}
IA108-22	Rainy	127.0	145.0	18.0
	Dry	95.3^{**}	105.3^{**}	10.0^{**}
IA108-23	Rainy	129.0	147.0	18.0
	Dry	95.7^{**}	100.7^{**}	5.0^{**}
IA108-24	Rainy	127.0	147.0	20.0
	Dry	96.7^{**}	108.3^{**}	11.6^{**}
IA108-25	Rainy	128.3	147.7	19.4
	Dry	95.0^{**}	100.2^{**}	5.2^{**}
IA108-26	Rainy	127.0	145.0	18.0
	Dry	100.3^{**}	103.3^{**}	3.0^{**}
IA108-27	Rainy	127.0	145.3	18.3
	Dry	95.3^{**}	101.0^{**}	5.7^{**}
IA108-28	Rainy	127.0	145.0	18.0
	Dry	93.3^{**}	100.7^{**}	7.4^{**}
IA108-29	Rainy	127.0	145.0	18.0
	Dry	96.7^{**}	103.3^{**}	6.6^{**}
IA108-30	Rainy	127.7	148.0	20.3
	Dry	98.0^{**}	106.0^{**}	8.0^{**}
IA108-31	Rainy	127.7	148.7	21.0
	Dry	98.3^{**}	101.3^{**}	3.0^{**}

ANOVA:

Source	df	Mean square		
Accession	30	9.88^{ns}	27.94^{ns}	39.10^{**}
Season	1	41281.94^{**}	83375.51^{**}	4003.23^{**}
Accession × Season	30	8.30^{ns}	30.23^{ns}	907.81^{**}
Error	122	9.54	28.96	87.68

Means across rows with ns, *, ** non-significant or significant at $P \leq 0.05$ or $P \leq 0.01$, respectively, Least Squares Means Analysis.

Table 7 Variation in seedling vigour, plant height, number of seed per fruit and 1000-seed weight of long cayenne pepper accessions collected from SW Nigeria.

Accession	Seedling vigour (1-9)	Plant height (cm)	No. of seed /fruit	1000-seed weight (g)
IA108-1	5.2^{ab}	38.90^{a-h}	80^{b}	3.28^{ns}
IA108-2	4.7^{abc}	41.49^{b-h}	65^{b}	3.28^{ns}
IA108-3	5.2^{ab}	46.07^{a-f}	113^{b}	3.23^{ns}
IA108-4	3.9^{bc}	36.63^{f-h}	77^{b}	3.30^{ns}
IA108-5	5.2^{ab}	49.50^{a-d}	82^{b}	3.28^{ns}
IA108-6	5.2^{ab}	38.13^{e-h}	78^{b}	3.30^{ns}
IA108-7	4.8^{abc}	35.80^{f-h}	81^{b}	3.25^{ns}
IA108-8	4.5^{abc}	43.10^{a-g}	184^{a}	3.25^{ns}
IA108-9	5.2^{ab}	32.25^{h}	71^{b}	3.18^{ns}
IA108-10	4.8^{abc}	34.87^{gh}	80^{b}	3.25^{ns}
IA108-11	5.2^{ab}	39.34^{e-g}	88^{b}	3.20^{ns}
IA108-12	4.5^{abc}	39.91^{d-h}	81^{b}	3.28^{ns}
IA108-13	4.3^{abc}	50.89^{ab}	72^{b}	3.30^{ns}
IA108-14	4.8^{abc}	43.87^{a-g}	88^{b}	3.18^{ns}
IA108-15	3.7^{c}	34.92^{gh}	83^{b}	3.28^{ns}
IA108-16	4.7^{abc}	43.10^{a-g}	88^{b}	3.27^{ns}
IA108-17	5.2^{ab}	42.27^{a-g}	70^{b}	3.18^{ns}
IA108-18	5.0^{abc}	45.48^{a-f}	71^{b}	3.25^{ns}
IA108-19	4.5^{abc}	51.33^{a}	72^{b}	3.20^{ns}
IA108-20	5.5^{a}	42.20^{a-g}	68^{b}	3.28^{ns}
IA108-21	4.7^{abc}	38.66^{e-h}	82^{b}	3.25^{ns}
IA108-22	4.8^{abc}	35.74^{gh}	81^{b}	3.25^{ns}
IA108-23	5.2^{abc}	50.60^{a-c}	78^{b}	3.20^{ns}
IA108-24	5.0^{abc}	42.29^{a-g}	74^{b}	3.27^{ns}
IA108-25	4.7^{abc}	47.56^{a-e}	82^{b}	3.23^{ns}
IA108-26	5.0^{abc}	39.90^{d-h}	85^{b}	3.25^{ns}
IA108-27	5.5^{a}	41.08^{c-h}	76^{b}	3.20^{ns}
IA108-28	4.0^{bc}	41.64^{a-h}	77^{b}	3.25^{ns}
IA108-29	4.3^{abc}	49.48^{a-d}	59^{b}	3.25^{ns}
IA108-30	4.8^{ab}	44.51^{a-g}	68^{b}	3.20^{ns}
IA108-31	4.5^{abc}	44.50^{a-g}	74^{b}	3.23^{ns}

Means with ns; same letter(s) down the columns are not significantly different ($P = 0.05$)

across the two seasons. This accession may be further investigated for its potential for cultivation in the two seasons in Ibadan. 'IA108-31' had low yield/plant in the rainy season but highest yield/plant, and one of the highest number of fruit/plant in dry season. IA108-1 had the lowest fruit yield/plant in rainy season; second lowest and significantly similar to the lowest accession in dry season. These results clearly show that IA108-1 is a poor fruit producer. Consequently, the different accessions that optimize fruit yield in each of the seasons could be selected for further evaluation, release and cultivation in the seasons in which they perform better.

CONCLUSIONS

Emergence percentage was higher in rainy season except in accessions IA108-3 and IA108-16. Season had no effect on seedling vigour, plant height, number of seed/fruit and 1000-seed weight; but dryness enhanced earliness in flowering and fruiting. Fruit yield/plant and number of seed/fruit were higher in the dry than rainy season. Different accessions are adapted to different seasons. Accessions IA108-9, IA108-10, IA108-12, IA108-13, IA108-14, IA108-20 and IA108-28 performed best under rain-fed; accessions IA108-2, IA108-5, IA108-19, IA108-23 and IA108-31 best in the dry season; and accessions IA108-3, IA108-4, IA108-7 and IA108-29 in both seasons. Fruit yield/plant in 'IA108-28' (>100 g) was stable across seasons and the accession could be selected for further studies.

REFERENCES

Adetimirin VO (2007) Relationship among three non-destructive seedling vigour traits in maize. *International Journal of Plant Breeding* **1 (2)**, 123-128

Adetimirin VO (2008) Stand establishment and early field vigour variation in a tropicalized *shrunken-2-maize* population. *Field Crops Research* **108 (2)**, 143-149

Adetimirin VO, Kim SK, Szczech M (2006) Factors associated with emergence of *shrunken-2-maize* in Korea. *Journal of Agricultural Science* **144**, 63-68

Berke T, Black LL, Talekar NS, Wang JF, Gniffke P, Green SK, Wang TC, Morris R (2005) Suggested cultural practices for Chili pepper, International Cooperators Guide, AVRDC World Vegetable Centre, 8 pp

Burt J (2008) Growing capsicums and chillies. *Farmnote. Department of Agriculture and Food.* No. 64/99. State of Western Australia. Available online: www.agric.wa.gov.au

Denton L, Makinde MJ (1993) Variation among landraces of pepper in Nigeria. *Capsicum and Eggplant Newsletter* **12**, 42-44

Dixit JP, Rao VSN, Ambawatia GR, Triathi SK (1997) Genotype × environment interaction in sesame growth in Central Narmada Valley in Madaya Pradsesh. *Crop Research* **13 (2)**, 423-427

Erinle ID (1989) Present status and prospect for increased production of tomato and pepper in Northern Nigeria. In Tomato and pepper production in the tropics. International Symposium on Integrated Management Practices 21-26 March, Asian Vegetable Research and Development Center, Taiwan, pp 536-548

FAO (2005) Food and Agricultural Organization. World crop statistics facts and trends. Available online: www.fao.org.

Ferrara A, Lovelli S, Di Tommaso T, Perniola M (2011) Flowering, growth and fruit setting in greenhouse bell pepper under water stress. *Journal of Agronomy* **10 (1)**, 12-19

Grubben GJH, Tahir IM (2004) *Capsicum* species. In: Grubben GJH, Denton OA (Eds) *Plant Resources of Tropical Africa. 2. Vegetables*, PROTA Foundation, Wageningen, Netherlands, Backhugs Publishers, Leiden, Netherlands, 668 pp, pp 154-163.

IPGRI, AVRDC, CATIE (1995) Descriptor for *Capsicum* spp. International Plant Genetic Resources Institute, Rome, Italy. The Asian Vegetable Resources and Development Center, Taipei, Taiwan and The Centro Agronómico Tropical de Investigacíon y Ensenanza, Turrialba, Costa Rica, pp 1-49

Khah EM, Passam HC (1992) Flowering, fruit set and development of fruit and seed of sweet pepper (*Capsicum annuum* L.) cultivated under conditions of high ambient temperature. *Journal of Horticultural Science* **67 (2)**, 251-258

Khan MH, Chattha TH, Saleem N (2005) Influence of different irrigation intervals on growth and yield of bell pepper (*Capsicum annuum* Grossum Group). *Research Journal of Agriculture and Biological Sciences* **1 (2)**, 125-128

Manju PR, Sreelathakumary I (2002) Genetic variability, heritability and genetic advance in hot chilli (*Capsicum chinense* Jacq.). *Journal of Tropical Agriculture* **40**, 4-6

Marcelis LFM, Heuvelink E, Baan Hofman-Eijer LR, Den Bakker J, Xue LB (2005) Flower and fruit abortion in sweet pepper in relation to source and sink strength. *Journal of Experimental Botany* **55 (406)**, 2261-2268

Norman JC (1992) Effect of age of transplanting of hot pepper (*Capsicum*). *Acta Horticulturae* **53**, 42-48

Oluoch MO, Marandu YF (2008) Field guide for vegetable evaluation research, AVRDC – World Vegetable Center, Arusha, Tanzania, pp 4-13

SAS (2004) SAS Institute user's guide: Statistics, version 9.0. SAS Institute Inc, Cary, North Carolina, USA, 1028 pp

Schippers RR (2002) African indigenous vegetables. An overview of the cultivated species 2002-Revised version on CD-ROM. Natural Resources International Ltd., Aylesford. UK

Showemimo FA, Olarewaju JD (2007) Drought tolerance indices in sweet pepper (*Capsicum annuum* L.). *International Journal of Plant Breeding and Genetics* **1**, 29-33

Yayock JY, Lombin G, Owonubi JJ (1988) *Crop Science and Production in Warm Climate*, Macmillan, London, 216 pp