EVALUATION OF HOT PEPPER (*CAPSICUM* SPP) VARIETIES FOR SOME GROWTH AND YIELD PARAMETERS AT GARKAWA, NORTHERN GUINEA SAVANNA ZONE OF NIGERIA

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Abstract
The performance of elite pepper varieties for growth and yield parameters were evaluate at the Research Farm of College of Agriculture, Garkawa, in the northern guinea savanna zone of Nigeria. Six elite hot pepper varieties (Yolo – Wonde, Gadia – F_1, Semi-Grande-F_1, Grande- F_1, 1157 – F_1, and 1145 – F_1), obtained from the Agricultural Services and Training Centre (ASTC), Jos and a local variety (Shambe) made up the treatments, replicated three times in a Randomized Complete Block Design (RCBD). Parameters measured included plant height (cm), number of leaves/plant, days to first flowering, number of flowers/plant, number of fruits/plant and fresh fruit yield. The result of the study showed significant differences ($p<0.05$) in all the parameters assessed. Shambe distinguished itself from the six elite varieties in both growth and fruit yield. It recorded higher values for plant height (101.2cm), number of leaves/plant (324), number of fruits/plant (94) and fresh fruit yield (2.56 ton/ha) which differed significantly from the elite varieties. The earliest number of days to first flowering was observed in the six elite varieties (43-46 days), and values differed significantly from that of Shambe, which flowered late (57days). However, earliness or lateness to flowering did not translate to a corresponding increase in pepper fruit yield.
Key Words: Hot pepper, elite varieties, Capsicum spp, fruit yield

Introduction

Pepper (*Capsicum spp*) is a spice crop and one of the most important spices in terms of world trade. It is a pungent spice and a stimulant which has been cultivated due to its high value for centuries (Poulos, 1993). Pepper is known with the famous scientific name, *Capsicum* and it belongs to the genus of flowering plants. Pepper originated from America with their cultivation now grown all around the world because they are widely used as food and medicine (Mazourek *et al.,* 2009). Capsicum has two important species: *Capsicum annum* (sweet pepper) and *Capsicum frustescens* (Hot pepper). Pepper fruits vary in shape, colour, pungency and texture, with *C. annum* being the most widely cultivated (Russo and Biles, 2001).

Pepper is valued because of its nutritional and medicinal values (Tindall, 1986). Hot pepper is one of the major vegetable crops produced in Nigeria and because of its wide use in Nigerian diet, hot pepper is an important traditional crop mainly valued for its pungency and colour. The crop is also one of the important spices that serve as the source of income particularly for smallholder producers in many parts of rural Nigerian communities. Hot pepper has been cultivated in Nigeria for a long period of time Alicon (1984). Currently, it is produced in many parts of the country because, for most Nigerians, food is tasteless without pepper. That is, it is the main parts of the daily diet of most Nigerians. The fine powdered pungent product is an indispensable flavoring and coloring ingredient in the common traditional diet.

Burgeoning human population should be matched with corresponding food production. Hot pepper serves as one of the important sources of food and income to smallholder farmers and as exchange earning commodity (Beyene and David, 2007). In spite of its importance, hot pepper production system for green and dry pod has remained low. The decline in hot pepper production is also attributed to poor varieties, poor cultural practices, the prevalence of fungal (blights) and bacterial as well as viral diseases (Fekadu and Dandena, 2006). Pepper yield varies significantly from one region to the other and several factors such as topography, soil type, water quality, variety, cultural practices method, soil tillage and fertilizer application (Liu *et al*., 2008)

Even though hot pepper is a high valued commodity, which has the potential for improving the income and the livelihood of thousands of smallholder farmers in Nigeria and diversifying and increasing Nigeria's agricultural export exchange earnings, the crop is confronted with various production and processing related problems. There is therefore a strong need to help small producers to achieve sustainable production, in order to increase their income and secure their livelihood by providing adaptable and high yielding varieties. The present situation indicates that in Garkawa locality, Plateau state (Northern guinea savanna zone) there are limited *Capsicum* species and varieties including both improved and the local ones. As a result, varietal information for the improvement of the crop for high fruit yield in the existing agro-ecology is insufficient. Evaluation of selected varieties was therefore, inevitable to ease the existing problems of obtaining the desired varieties for which the output of this study would assist and sensitize hot pepper growers. Better adaptable and well performing variety (varieties) with improved cultural practices would boost production of quality yield of the crop in the study area. Therefore, this study was executed to investigate the performance of some elite varieties of hot pepper for growth and pod under the Garkawa condition in the northern guinea savanna agro-ecology.

Material and Methods

Description of the Study Area: The experiment was conducted at the Research Farm of the College of Agriculture, Garkawa, Mikang local government area of Plateau State. Garkawa is located in the northern guinea savanna agro – ecological zone, Latitude 10^0 11N and longitude 8^0 21E. The annual rainfall of the area ranges between 800-1500 mm. The soil of the experimental site is a well drained sandy loam (Table 1). The experiment was conducted between April and September in the 2013 cropping season.

Experimental Materials: Six elite hot pepper varieties were obtained from the Agricultural Services and Training Centre (ASTC) Jos, Plateau State. A local variety (local check) was also obtained from the Garkawa farming community. This gives a total of seven varieties used for the experiment. The varieties used were *Yolo – Wonde*, *Gadia – F_1*, *Semi-Grande- F_1*, *Grande- F_1*, 1157 – F_1, 1145 – F_1 and *Shambe* (Table 2). The seven pepper varieties were planted in the nursery in April. Seedlings were first raised in the nursery and plastic buckets were used for this purpose. The plastic buckets were perforated for good drainage and the soil used in the nursery was a well cured loamy soil mixed with matured cow dung. After planting, dry grass was used to cover the surface of the nursery for one week. Then, the seedlings were kept under a raised shade to protect the seedling from strong sun shine and heavy rainfall until the plants were ready for transplanting. Watering of the seedlings was done at an interval of 3 days with a fine watering can and fungicide (Mancozeb) was applied at the rate of 3.6 kg/ha.

Experimental Design: The seedlings were transplanted to the field when the seedlings were 5 weeks old in the nursery. The seven varieties of pepper made up the treatments, replicated three times in a Randomized Complete Block Design (RCBD). The Seedlings were spaced 30 cm between plants and 70 cm between rows. Weed control was done manually using hoe and NPK (15-15 -15) fertilizer was applied at the rate of 250kg/ha. Other pertinent agronomic and horticultural practices applicable to hot pepper were also followed in the field.

Data Collection and Analysis: The parameters measured included plant height, number of leaves per plant, days to first flowering, days to first fruiting, number of fruits per plant and fresh fruit weight. GenStat Discovery, Edition 4 was used in analyzing the data for the analysis of variance (ANOVA) and Least Significant Difference (LSD) was used to separate significantly different treatment means.

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Results and Discussion

Result of the soil at the experimental site showed 38.7% sand, 13.2% silt and 9.0% clay. The soil can be classified as sandy loam using the USDA textural triangle. The percentage composition of sand, silt and clay confirms the presence of organic matter, particularly with the value of silt which makes the soil good enough for crop production. The soil pH ranged between 5.5 and 6.1; though acidic, it is the preferred soil range for good growth and optimum yield of pepper (Akinbile and Yusoff, 2011). Salako *et al*. (2007) reported that that soil pH of 5.0 to 6.0 was best for the production of chilli pepper. Organic matter had an average value of 2.05% while the nutrient constituents of nitrogen, phosphorus, potassium, calcium and magnesium were 0.36, 0.29, 0.23, 1.16 and 1.00, respectively. These nutrients were in sufficient quantities for optimum production of pepper under standard environmental conditions (Akinbile and Yusoff, 2011).

The mean plant height of the pepper varieties evaluated differed significantly with the tallest being the local variety *Shambe* (101.2cm) and the shortest being variety *1157-F_1* (Table 3). There was a steady but gradual increase in plant heights in all the treatments. It was evident that the local variety (*Shambe*) clearly distinguished itself from the other six elite varieties (*Yolo Wonder, Gadia-F_1, Semi-Grande- F_1, Grande-F_1, 1157-F_1 and 1145-F_1*).The local variety reached the one meter mark (100cm) at 12WAT, about 17.5cm higher than the closest, which was *Gadia- F1* (65.8cm).

Varietal differences in nutrient absorption, especially nitrogen and phosphorus which have enhancing effect on vegetative growth by increasing cell division and elongation has been advanced as the main reason for variation in plant height by El-Tohamy *et al.* (2006). Gonzalez *et al.* (2001) reported that organic and inorganic fertilizers supplied most of the essential nutrients at growth stage resulting in increase of growth variables including plant height.

Mean number of leaves was not significantly ($p<0.05$) different at the early stage (2WAT) of the crop growth, but differed significantly between 4WAT to 12WAT for the pepper varieties evaluated in this study (Table 4). The highest mean number of leaves was recorded by the local variety (*Shambe*) producing leaves that ranged from 12-324, which differed significantly ($p<0.05$) from the elite varieties (*Yolo Wonder, Gadia-F_1, Semi-Grande- F_1, Grande-F_1, 1157-F_1 and 1145-F_1*). There were however, no significant differences among the six elite varieties of pepper in leave production.

Varietal differences among the seven hot pepper types in days to first flowering (DFF), number of flowers/plant and number of fruits/plant are presented in Table 5. The earliest number of days to first flowering was observed in the elite variety *Semi-Grande-F_1* (43 days), which was followed by variety *1145-F_1* (44 days). This values were however, not significantly ($p=<0.05$) different from those of *Yolo Wonder* (45 days), *Gadia- F_1* (46 days), *Grande-F_1* (46 days) and *1157-F_1* (46 days).The longest days to attain first flowering of 57 day was recorded by the local variety, *Shambe*. Earliness to flowering may be due to inherent characters, different response of varieties to growing environments (e.g. temperature, rainfall, altitude, pests and diseases, etc.), acclimatization to the growing area and/or due to transplanting disturbance (Sam-Aggrey and Bereke-Tsehai, 2005). Though slight differences were observed in the mean number of flowers/plant, the differences were not significant and did not correspond with fruit yield (Table 5). Delelegn (2011) evaluated hot pepper varieties at Jimma and Kecheme region in Ethopia and reported that number of flowers/plant was not commensurate to the number of fruits/plant

The mean number of fruits/plant was highest for the local variety, *Shambe* (94), which differed significantly ($p<0.05$) from the other six elite varieties, whose mean values for number of fruits/plant ranged from 12-21 and were statistically the same (Table 5). According to Delelegn (2011), variation in number of fruits/plant is linked to response of varieties to growing environments, especially temperature as it affects number of branches/plant. The number of primary, secondary and tertiary branches has a linear relationship with the number of fruiting buds which are the locations for fruit production. The author also posits that variation in fruit development among varieties could be due to temperature stress during reproductive development than vegetative development. Sato (2005) reported that the reduction of fruit set under moderately elevated temperature stress was mostly due to a reduction in pollen release and viability in tomato plant (*Lycopersicum esculentum* Mill.). On the other hand, number of fruit can be affected by fruit abortion and predation have all been proposed as factors explaining low fruit set in plants. This also is in agreement with Schemske (1980) who stated that pollination can be the first factor limiting fruit production.

The mean fresh fruit yields of the seven varieties of pepper used in this study is presented in Figure 1. The local *Shambe* variety was distinct having mean fruit yield of 2.56ton/ha, which was similar to an earlier fruit yield of 2.64 ton/ha obtained by Delelegn (2011) when the author evaluated hot pepper varieties in two locations in Ethiopia. The fruit yield recorded in the local *Shambe* variety (2.56ton/ha) was significantly higher than those of *Yolo Wonder, Gadia-F_1, Semi-Grande- F_1, Grande-F_1, 1157-F_1 and 1145-F_1* having mean fruit yields of 0.44, 0.55, 0.49, 0.69, 0.60 and 0.38, respectively. Liu *et al*.

(2008) reported that pepper yield can vary significantly from one region to the other and several factors such as topographic, soil type, variety, cultural practices, tillage methods and fertilizer application are responsible.

On the other hand, the increase in total pod yield of the local *Shambe* variety could be due to the good values of plant height, as well as formation of more primary, secondary and tertiary branches that increase potential of pod bearing buds and also leaf area that maximizes photosynthetic capacity and assimilate partitioning to the pods. This result is further consolidated by the findings of Bosland and Votava (2000) who reported positive impact of vegetative growth on yield and yield components of hot pepper. The authors also pointed out that primary and secondary branches were locations of fruit buds and thus foundations of new fruit bud development in bell peppers.

Conclusion

Hot pepper is one of the major vegetable crops produced in Nigeria and serve as a source of income particularly for small holders or subsistence farmers. The yield of the crop is affected by cultural practices, variety and the growing environmental conditions. The result of the study showed significant differences ($p<0.05$) in plant height (cm), number of leaves/plant, days to first flowering, number of fruits/plant and fresh fruit yield. *Shambe* distinguished itself from the six elite varieties in both growth parameters and fruit yield. It recorded higher values for plant height (101.2cm), number of leaves/plant (324), number of fruits/plant (94) and fresh fruit yield (2.56ton/ha). However, earliness or lateness to flowering did not translated to a corresponding increase in pepper fruit yield. The overall result of the study indicated that the local variety was outstanding compared to the elite varieties Further evaluations of these lines in this ecological zone and beyond will be vital. Breeders need to strengthen the genetic base of these novel varieties for better and superior fruit yields for the specific benefits of the small scale producers and large scale producers in general.

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Table 1: Some properties of soil samples from the study area

Parameter	Values
Organic matter (%)	2.05
pH	5.5-6.1
Nitrogen (mg Kg^{-1})	0.36
Phosphorus (mg Kg^{-1})	0.29
Potassium (mg Kg^{-1})	0.23
Calcium (mol Kg^{-1})	1.16
Magnesium (mol Kg^{-1})	1.00
Sand (%)	38.7
Silt (%)	13.0
Clay (%)	9.0

Table 2: Hot pepper varieties used for the experiment

Variety	Description	Source
Shambe	Local accession	Garkawa
Yolo – Wonder	Elite variety	ASTC, Jos
Gadia – F_1	Elite variety	ASTC, Jos
Semi-Grande F_1	Elite variety	ASTC, Jos
Grande- F_1	Elite variety	ASTC, Jos
1157 – F_1	Elite Variety	ASTC, Jos
1145 – F_1	Elite Variety	ASTC, Jos

ASTC – Agricultural services and training centre, Vom, Jos

Table 3: Mean plant height (cm) of pepper varieties at two weeks internal

VARIETY	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Shambe	9.4	29.5	38.2	45.1	72.7	101.2
Yolo Wonder	9.2	20.7	37.6	43.1	49.7	55.9
Gadia – F_1	8.9	22.6	39.7	47.3	52.8	65.8
Semi-Grande-F_1	8.2	19.9	31.6	40.2	50.5	57.6
Grande F_1	8.7	18.9	29.0	39.6	45.9	56.8
1157 - F_1	8.8	19.3	28.9	37.0	43.2	43.6
1145 - F_1	9.0	19.8	29.4	38.3	46.0	58.1
LSD(P<0.05)	2.0	3.3	4.6	5.2	6.0	20.5

Table 4: Mean number of leaves of pepper varieties at two weeks interval

VARIETY	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Shambe	12	85	139	219	257	324
Yolo Wonder	10	31	53	73	89	104
Gadia – F_1	8	25	51	74	92	115
Semi-Grande-F_1	9	20	35	78	97	135
Grande-F_1	9	25	43	79	95	109
1157 - F_1	8	28	36	87	101	119
1145 - F_1	9	22	39	57	86	115
LSD(P<0.05)	*NS	18.2	14.5	37.6	53.4	45.3

*NS= No Significance difference, WAT= Week after Transplanting

Table 5: Differences among 7 hot pepper varieties in days to first flowering (DFF), number of fruits/plant and number of fruits/plant

Variety	DFF	Number of flowers/plant	Number of fruits/plant
Shambe	57	105	94
Yolo Wonder	45	115	20
Gadia – F_1	46	99	13
Semi-Grande-F_1	43	112	19
Grande F_1	46	101	21
1157 - F_1	46	106	16
1145 - F_1	44	113	12
LSD(P<0.05)	3.5	NS	5.13

NS= No significant, DFF= Days to first flowering.

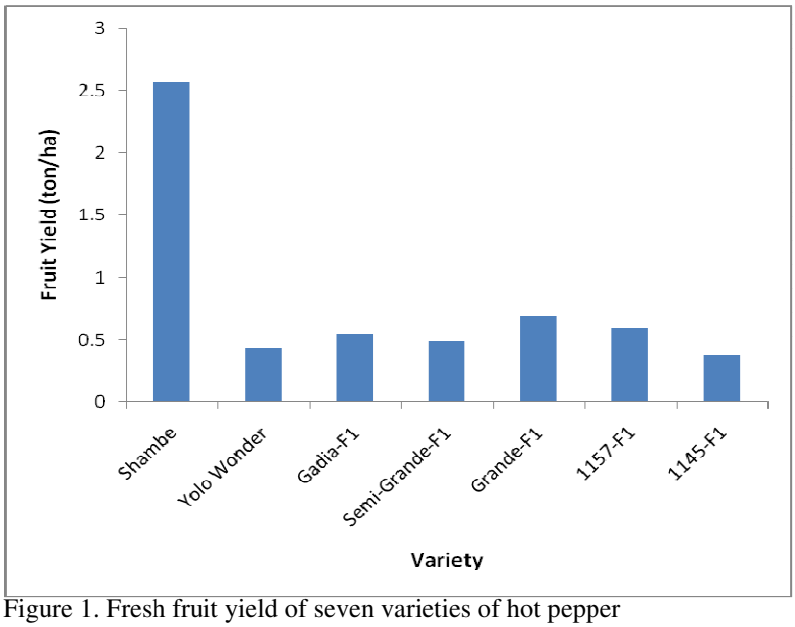

Figure 1. Fresh fruit yield of seven varieties of hot pepper