



Growth and yield performance of bird eye pepper in the forest ecological zone of Ghana

Nkansah G .O, Ofosu-Budu K. G and Ayarna A. W.

Forest and Horticultural Crops Research Centre-Kade, Institute of Agricultural Research, College of Agriculture and Consumer Sciences, University of Ghana, Legon, Accra, Ghana

Author for correspondence e-mail: gonkansah@ug.edu.gh/ gonkansah@yahoo.com

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ABSTRACT

Objective: To evaluate the growth and yield performance of Bird Eye pepper (*Capsicum frutescence*) in the forest ecological zone of Ghana.

Methodology and results: Field experiments were conducted at the teaching and research farm of the University of Ghana Forest and Horticultural Crops Research Centre, Kade during the rainy seasons of 2009 and 2010. The treatments were randomized in complete block design and replicated three times. The parameters assessed were: plant height, number of leaves/plant, number of branches/plant, stem girth, fruit number, fruit weight and yield as well as quantitative characters. Results showed that there were significant differences in growth parameters as well as in the yield and yield components of the four cultivars and in both seasons. Plant heights were highest in cultivar 7777 and local in both seasons. Cultivar 7777 had significantly higher number of branches, canopy girth, fruit number and weight compared to the other cultivars. In terms of fruit colour, cultivar 7777 had dark green colour, a characteristics required in the export industry. Based on the results, cultivar 7777 is recommended for release to farmers and stakeholders in the vegetable industry in Ghana due to its colour, yield and consumer preference on the export and local market.

Conclusion and application: The use of this cultivar will increase the foreign exchange earnings of Ghana and well-being of farmers not forgetting that it is going to be a good material for breeding purposes.

Key words: Bird Eye Pepper, evaluate, forest ecological zone, growth, quantitative characteristics, yield

INTRODUCTION

Bird Eye pepper (*Capsicum frutescence*) is one of the distinguished cultivar-groups of *Capsicum annuum*. The others are sweet pepper, chili and aromatic pepper (Grubben and Denton, 2004). Peppers are important in Ghana and are consumed in fresh, dried or processed forms. Non-pungent fruits called sweet pepper are eaten raw in salads but more commonly cooked, fried or processed together with other foods. The pungent types of which Bird Eye pepper belongs to are consumed in small quantities, considered a

condiment or spice for seasoning and stimulating appetite as well as used in local medicine especially for herbal practitioners who prepare ointments for rheumatism and joint pains (Grubben and Denton, 2004).

The Bird Eye pepper is a slow-growing short-term perennial or perennial sub-shrub. Flowers are in clusters of 2 or more, waxy greenish white, usually erect. Fruits elongate, usually upright, usually small and narrow, up to 5cm x 1cm, green to cream and yellow when immature, orange to red

when mature, fruit wall smooth and extremely pungent (Grubben and Denton, 2004).

In Ghana, pepper production is to a large extent limited to the long chilli some of which are exported. However, recent developments indicate that the Bird Eye pepper is gaining export importance because there is a niche market in Europe. According to the Vegetable Growers Associations of Ghana, the Bird Eye has a higher market value compared to the long chilli (Bonsu *et*

al, 2003). However, there are no known desirable cultivars in the country. It has therefore become very imperative to evaluate Bird Eye cultivars and recommend the best cultivar(s) to farmers and stakeholders in the vegetable industry. The aim of this study, therefore, was to evaluate the growth and yield performance of Bird Eye pepper in the forest ecological zone and recommend the best cultivar(s) for both the export and local markets as well as for future breeding purposes.

MATERIALS AND METHODS

Study site: Two field experiments were conducted at the Research Farm of the University of Ghana Forest and Horticultural Crops Research Centre (FOHCREC), Kade. FOHCREC-Kade is in the forest zone and is 114m above sea level on latitude 6°08'54"N and longitude 0°54'00"W. The dominant soil is Haplic Acrisol (FAO/UNESCO, 1990). The area which lies in the deciduous forest has an annual rainfall ranging between 1300-1800mm (Nkansah *et al.*, 2007; Ofosu-Budu, 2003). The area is subjected to marked wet and dry season with a bimodal rainfall pattern. The two rainfall peaks make two growing seasons possible. There is heavy rainfall in May-July, which is interrupted by a dry period of about two weeks in August; this is followed by another period of heavy rainfall from September to October. Dry season length is between 120 -130 days. Temperature ranges between 25-38°C.

Experimental layout: The first experiment was conducted during the rainy seasons (April – August) of 2009 and repeated in 2010. The site was ploughed twice and harrowed. The land area used for the experiment was 12m x 18.3m. The experiment was laid out into three blocks of 3m x 16.8m each with a space of 1.5m between the blocks. Each block contained four plots each measuring 3m x 4.2m with 0.5m spacing between plots in each block. Four Bird Eye pepper species, Salmon, BEK, 7777 and Local were used. The experiments were arranged in a randomized complete block design and replicated three times. Salmon was obtained from Green Seeds Co. Ltd, Vietnam and the rest from the University of Ghana Forest and

Horticultural Research Centre-Kade. Seeds were sown in seed trays and transplanted at the 5-6 leaf stage at a spacing of 60cm x 30 cm. Weeding was carried out whenever necessary. Standard management practices were employed for the duration of the growing seasons.

Data collection and analysis: The International Plant Genetic Resources Institute (IPGRI) descriptors for capsicum (1995) were used to evaluate the lines. The following traits were used plant height, number of branches, days to 50% flowering, fruit length, pericarp thickness, number of fruits per plant, average fruit weight, total fruit yield per plant, average fruit length and average fruit width, fruit shape, fruit colour, number of seeds per fruit and 100 seed weight (g). Twenty (20) plants per treatment/cultivar were tagged and used for data collection. Plant height was measured from the ground level to the raised leaf-tip with a meter rule. Total number of leaves and branches were counted per plant, and stem girth was measured using vernier calipers. Days to 50% anthesis was recorded as the number of days after transplanting to the time 50% of the plants in a treatment plot have their flowers opened. Number of fruits per plant was recorded as the number of fruits counted from harvested plants. Number of seeds in 10 fruits was determined as the number of seeds counted from 10 fruits. Fresh fruit yield was determined as the total marketable yield of green fruits harvested from sampled plants. Data were subjected to analysis of variance and means separated using Duncan's Multiple Range Test (DMR).

RESULTS

Results from Tables 2 and 3 indicate differences in growth parameters measured in the two seasons. Although there were marked variations in the data obtained for the two seasons but they followed a similar

pattern. Values obtained in 2010 were generally higher than those obtained in 2009. Significant difference ($p=0.05$) was observed in plant height, stem girth, number of branches/plant and canopy width of the four

cultivars evaluated. Plant height was highest in cultivars 7777 and the Local in both seasons. Among the cultivars, 7777 and the Local had significantly ($p=0.05$) higher value for plant height in both seasons. Stem girth of cultivars 7777 and Local differed significantly

among the others in both seasons. Highest values were obtained for cultivar 7777. In 2010, cultivar 7777 had significantly higher number of branches and canopy width compared to the other varieties.

Table 1: Rainfall data (mm) in 2009 and 2010 seasons

Month/Year	2009	2010
January	0	73.2
February	99	59.8
March	127	107.2
April	96.4	222.4
May	206.8	180
June	255.2	137
July	139.9	151.6
August	41.2	154.6
September	39.4	126.7
October	162.6	250
November	145	130.4
December	88.4	88.2
Total	1400.9	1681.1

Source: Meteorological Services Agency, Accra

Table 2: Growth parameters of Bird Eye Pepper in 2010 and 2009 seasons

Cultivar	Plant height (cm)	Stem girth (cm)	No. of branches Plant-1	Canopy width
2010 Season				
Salmon	40.4a	1.45a	58a	35.1a
BEK	42.8a	1.43a	63b	37.3a
7777	65.8b	1.68b	70c	88.2c
Local Bird Eye	68.3b	1.85b	65b	83.3b
2009 Season				
Salmon	33.7a	1.08a	48a	30.2a
BEK	32.1a	1.13a	53a	33.9a
7777	55.5b	1.35b	64c	75.6c
Local	60.7c	1.55b	55b	65.3b

Values followed by the same letter within a column are not significantly different ($P=0.05$)

Qualitative characteristics of Bird Peppers: Results from Table 3 show two shapes of calyx margin. These are Dentate and intermediate (Figure 1). Annular constriction at pedicel and calyx were either present or absent (Figure 2). Fruit shape at apex was pointed in all the pepper lines used (Figures 5 and 6) while fruit shape at pedicel attachment was either obtuse or acute (Figure 3). Fruit outline was found to be slightly

corrugated, corrugated and or intermediate. Neck at base of the fruit was either present or absent (Figure 4). It was observed that light green, green and dark green fruit colours were the three distinct unripe fruit colours whereas at the ripe stage all the fruits turned red with the exception of the Local which was observed to be orange.

Table 3: Some morphological/qualitative characteristics of Bird Eye pepper fruits

Treatments	Calyx Margin Shape	Annular Constriction At Pedicel And Calyx	Fruit Shape At Apex	Fruit Shape At Pedicel Attachment	Fruit Outline	Neck At Base Of Fruit	Fruit shape	Fruit colour	
								Unripe	Ripe
BEK	Intermediate	Present	Pointed	Obtuse	Slightly corrugated	Absent	Elongated	Green	Red
SALMON	Dentate	Absent	Pointed	Acute	Corrugated	Present	Elongated	Light Green	Red
7777	Dentate	Present	Pointed	Obtuse	Intermediate	Present	Elongated	Dark Green	Red
Local	Intermediate	Present	Pointed	Acute	Corrugated	Present	Elongated	Light green-yellow	Orange



a. Entire b. Intermediate c. Dentate

Figure 1: Calyx margin



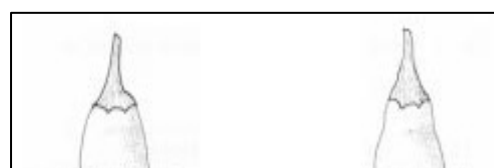
a. Absent b. Present

Figure 2: Calyx annular constriction



a. Acute b. Obtuse

Figure 3: Fruit shape at Pedicel attachment



a. Absent b. Present

Figure 4: Neck at base of fruit



Figure 5: Fruit shape (Elongated) of pepper



Figure 6: Fruits of Bird Eye: Left (7777), Middle (BEK) and Right (Salmon)

Yield and yield components: Differences in yield and yield components were observed among the varieties and in both seasons. In 2010 (Table 4) significant variations were observed among the cultivars in the number of days to 50% flowering. Local significantly ($p=0.05$) differed in terms of number of days to 50% flowering compared to the other cultivars and in both

seasons. Numerically, Salmon took the least number of days to 50% flowering (24) with cultivar 7777, BEK and Local taking 25, 26 and 30 days respectively (Table 4). In 2009 a similar pattern was observed with Salmon, 7777, BEK and Local taking 23, 24, 25 and 28 days respectively.

Table 4: Yield and yield components of Bird pepper in 2010 season

Treatments	Days to 50% flowering	Number of Fruits/Plant	Fruit Size (g)	Fruit weight/plant (g)	Fruit Yield (tons/ha)
2010 Season					
BEK	26a	180a	1.32b	324a	18.0ba
SALMON	24a	180a	1.46c	366b	20.3b
7777	25a	456c	1.74d	707c	39.3c
Local	30b	154a	1.02a	237	13.2a
2009					
BEK	25a	164b	1.28b	224b	12.4b
SALMON	23a	170b	1.46c	266b	14.8b
7777	23a	360c	1.52c	521c	28.9c
Local	30b	143a	1.00a	187a	10.4a

Values followed by the same letter within a column are not significantly different ($P=0.05$)

Number of fruits per plant varied significantly among the cultivars and in both seasons. In 2010 (Table 4) significant differences were observed among treatments. Highest values were obtained for cultivar 7777 (456) while the Local had the least (150). In 2009 a similar pattern was observed. Cultivar 7777 recorded the highest fruit number (360) per plant and the Local had the least (140). Fruit weight per plant and yield (t/ha) varied among the cultivars in both seasons. In 2010, cultivar 7777 had significantly higher fruit weight/plant and yield values of 707g and 39.3tons/ha respectively (Table 4) compared to the

others while the Local cultivar recorded the least fruit weight (237g) and yield (13.2t/ha). In 2009, cultivar 7777 had the highest fruit weight (521) and yield (28.9t/ha) while the local recorded the least values of 200g and 7.4t/ha respectively. Fruit length differed significantly ($p=0.05$) among the cultivars (Table 5). Cultivar 7777 recorded the highest fruit length (9.88cm) while BEK; Salmon had 4.83 and 4.81cm respectively. The Local had the least fruit length (3.2cm). Pedicel length, fruit girth and pericarp thickness followed a similar trend (Table 5).

Table 5: Fruit and pedicel length, fruit girth and pericarp thickness (pooled data for 2010 and 2009)

Treatments	Fruit length (cm)	Pedicel length (cm)	Fruit girth (cm)	Pericarp thickness (cm)
BEK	4.83b	2.87b	0.73b	0.15b
SALMON	4.81b	2.77b	0.71b	0.15b
7777	9.88c	3.35c	0.84c	0.18c
Local	3.2a	2.52a	0.68a	0.11a

Values followed by the same letter within a column are not significantly different ($P=0.05$)

Results from Table 6 indicate that the number of seeds per fruit was significantly higher in the Local compared

to the other cultivars. Dry seed weight per fruit was also significantly different among the cultivars. Cultivars

7777 and Local recorded higher dry seed weight than the other cultivars. Significant difference was observed in terms of 100 seed weight in grams among the

cultivars. Cultivar 7777 had the highest 100 seed weight than the others (Table 6).

Table 6: Number of seed per fruit, fresh and dry seed weight per fruit, and 100 dry seed weight (pooled data for 2010 and 2009).

Treatments	Number of seeds/ fruit	Seed weight/ fruit(g)		100 seed weight (g)
		Fresh	Dry	
BEK	60a	0.39a	0.10a	0.20a
SALMON	60a	0.35a	0.08a	0.17a
7777	62a	0.82b	0.20b	0.42c
Local	70b	0.81b	0.22b	0.38b

Values followed by the same letter within a column are not significantly different (P=0.05)

DISCUSSION

The results in these studies revealed that growth parameters in terms of plant height, stem girth, number of branches and canopy width were significantly and numerically higher in cultivar 7777 and the local cultivar compared to the other cultivars. But in terms of fruit number per plant, fruit weight and yield in tons per hectare, cultivar 7777 significantly differed from the other cultivars. The differences in plant height observed in this study can be attributed to the differences in growth rate of the Bird eye pepper species studied. The taller plants achieved their heights due to increase growth at their apical meristems. Rudall (1994) stated that increase in height is often accompanied by a corresponding increase in stem thickness which could minimize lodging and this was evident in these studies as cultivars that obtained the highest height also had the greatest stem girth. The lower total number of branches and small canopy width of BEK and Salmon peppers may be attributed to the fact that these plants had upright growth of their branches instead of the spreading nature as produced by the cultivar 7777 and the other cultivars. Large canopy width provides large leaf surfaces which enhance the interception of solar radiation with subsequent increase in the amount of photosynthetic activities which may correspondingly increase the plant's assimilatory ability. (Orak and Ilker, 2004). However, this can be said to be true of cultivar 7777 but not the Local cultivar as the yield of the latter was lower than the improved Bird Eye cultivars used in these studies. The differences in growth parameters observed in the two seasons can be attributed to differences in the amount of rainfall the plants received. The rainfall amounts during the growing seasons from April to August were 845.6mm and 739.1mm in 2010 and 2009 respectively (Table 1). The total annual

rainfall in 2010 (1681mm) was also higher than that of 2009 (1400.9mm) (Table 1). The differences in rainfall amount may have contributed to differences in the growth of the plants. Growth was higher in 2010 than in 2009. Climatic variables namely temperature and rainfall are important in determining the productivity of a crop (Square, 1990). In terms of the qualitative traits, the results also revealed that light green, green and dark green fruit colours were the three distinct unripe fruit colours at physiological maturity. The dark green fruit colour observed in cultivar 7777 at the unripe stage is a character very much desired in the export trade. This cultivar is ideal and will be released to farmers and exporters as well as used to develop materials to suit the export market.

Pepper fruits with thick fruit walls are tough. Fruits with thin walls are tender and readily get damaged in transport and storage. From the results, cultivar 7777 had fruits with thicker pericarp and this cultivar may therefore be capable of withstanding shock during transport and thus withstand normal handling and shipping. The results in these studies again revealed that cultivar 7777 recorded the highest fruit number, weight and yield (t/ha) compared to the other cultivars in both seasons. The high fruit yield may be due to the higher number of fruits and fruit weight as well as the bigger canopy size which is associated with more number of branches. Thus the more the number of branches, the more fruits the plant can develop. This indicates a positive impact of vegetative growth on yield and yield components of hot pepper. Bosland and Votava (2000) also reported that primary and secondary branches were locations of fruit buds and thus foundations of new fruit bud development in bell peppers. The findings indicate that large canopy size is

related to higher yield. Norman (1992) reported that yield is dependent on cultivar. Thus cultivar/Line 7777 with its high yield and dark green fruits compared to the other cultivars is a good material for the export market and breeding purposes. In this study, *Capsicum*

species with heavier seed weight could have more food reserves. The large food reserves could prolong seed viability, seed storage and as such enhance seed germination and vigorous seedlings growth.

CONCLUSION

These studies have shown that cultivar 7777 had higher growth and yield for the parameters considered compared to the other cultivars. Cultivar 7777 provides a good source of material for pepper growers, exporters and farmers in general. The dark green colour was also identified to be of preference which is the desired

character by pepper growers and exporters. Thus cultivar 7777 is the best Bird Eye pepper cultivar recommended for stakeholders in the vegetable industry in terms of its high yield and dark green colour characteristic. It is also a good material for breeding purposes.

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