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Evaluation of five tomato (*Lycopersicon esculentum*, Mill) cultivars for fruit, seed yield and quality in the forest zone of Ghana

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ABSTRACT

Five cultivars of tomato commonly grown by tomato farmers on commercial basisin the forest zone of Ghana namely: Cocoa, Akoma, Power, Petomech and Rendo were assessed for their fruit, seed yield and quality. Cocoa emerged the highest fruit yielder followed by Akoma and Power. Petomech fruits were observed to store longer, followed by Akoma and Rendo. Rendo recorded the highest seed yield. All the cultivars produced viable and vigorous seeds as indicated in a germination test. In terms of yield and quality of fruit and seed, Akoma, a local cultivar emerged the best.

Key words: fruit quality, seed quality, seed yield, tomato cultivar.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum*, Mill) is a fruit vegetable which belongs to the Solanaceae family. It is said to have originated from the Western Coastal Plains of South America extending from Ecuador to Chile. Domestication probably took place in Mexico where truly wild tomatoes are unknown but weed tomato are common in the Southern part of the country (Harlan, 1992). The first written account documenting the arrival of tomato in the old world appeared in 1554 by an Italian herbalist Pier Andrea Mattioli (Tigchelaar and Foley, 1991). It was introdcued into Ghana in the 16th or 17th Century by the Portuguese and it grows so well in most part of the country with many selected local cultivars flourishing as though it was indigenous to Ghana (Norman, 1992). In Ghana it is grown on both small scale in backyard gardens as well as large scale commercial production. Areas where the crop is grown commercially include Tono and Vea in the Upper East, parts of Northern Region, Akumadan, Agogo, Offinso and Tepa in the Ashanti Region, Wenchi and Tanoso in the Brong Ahafo Region. Other areas are Mangoase, Sese and Nsawam in the Eastern Region, Amansaman in the Greater Accra Region and Swedru and Mankessim in the Central Region (Norman, 1992).

Two main types are currently grown; the determinate or bushy type which has one time-limited flowering period, followed by a period of fruit development, and the indeterminate or 'vine' type which produces inflorescence or flowers continously throughout the plant's life. As a result, total yield of indeterminate cultivars is usually not affected by flower initiation. In addition to it's economic importance the tomato is an ideal research material for physiological, cellular, biochemical and molecular genetic investigations. The crop has a short life cycle and is amenable to various horticultural manipulations, including grafting or cutting. Various types of explants can be cultured *in vitro* and plant regeneration is feasible, allowing the development of transformation procedures (Hille et al., 1989).

The fruits are fleshy berries and hairy when young, but become smooth, juicy, and shinny when ripe. The seeds are flat and bedded in a jelly- like mass of tissues containing large qualities of phosphorous (Kochhar, 1986). The fruits not only contain about 94% water but also have moderate quantities of Vitamin C. According to Kochhar (1986), compared with oranges, tomatoes contain nearly 20 times as much Vitamin A, the same amount of Vitamin B1, slightly more Vitamin B2 and over 70% vitamin C. According to Siesmonsa and Piluek (1993), the seeds contain about 24% oil which is used as salad oil and also in the manufacture of margarine and soap. The residual mass or 'press cake'is used as a stock feed and fertilizer. Tomato is now a common ingredients of salads, valued for its colour, distinctive flavour and the pleasing acidic taste in fresh canned or preserved state. A large proportion is used in the preparation of tomato soups, pickles (green tomatoes), ketchup and sauces (Siesmonsa and Piluek, 1993).The tomato crop is propagated by seed. Seeds are first sown in the nursery and transplanted later in the field. Farmers need good quality seeds that would yield vigorous seedlings. The objective of this study was to identify tomato cultivars with acceptable qualities in fruit and seed yields for the benefit of peasant and commercial seed and fruit growers of the crop.

2. MATERIALS AND METHODS

Location of Site

The field experiment was conducted at the Department of Horticulture, Kwame Nkrumah University of Science and Technology, Kumasi in Ghana. The soils of the site fall within the forest ochrosols of the Nta soil series which has a dark grayish-brown sandy loam characteristics. It also falls within the forest zone of Ghana, which has a double maxima rainfall regime, comprising a major wet season followed by a short dry spell and a minor wet season.

Cultivars Collection

The cultivars were collected from ten farmers in Aumadan, a major growing areain the Forest zone of Ghana. At each collection point, fresh fruits were secured and later seeds were extracted using the fermentation method. The seeds were air dried for one week before sowing.

Nursery Practices

A seed bed was prepared by spit digging, sterilised by burning dry lawn mowings on it and left for a day to cool. The seeds were then sown by drilling and palm branches raised over it to protect it from direct splash of the rain. The seedlings were pricked a week later onto a prickout bed treated in a similar manner as the sowing bed. The seedlings were then protected from insect pests with mosquito nets to avoid the spread and transmission of diseases by pathogens.

Land Preparation and Experimental Design

The land was ploughed and harrowed twice. Decomposed poultry manure was spread on the field after the second ploughing and harrowed in. The field was layed out into four blocks and each block contained five plots. This was left for one week before the

seedlings were transplanted. Randomised Complete Block Design (RCBD) with four replications was used. Each block measured 1.8m wide by 56m long. The blocks were divided into five plots, each plot measuring 1.8 m by 7.2 m with 1 metre between plots and blocks. The experiment covered a total field area of 575.28 m^2. A spacing of 90cm between rows and 60cm within rows was adopted giving a population of 18,519 plants per hectare.

Field Operations

Seedlings were transplated onto the field four weeks after sowing. Cultural practices such as irrigation, weed control, pest control with pyrinex and fertilization were carried out. NPK (15-15-15) and sulphate of ammonia at 250kg/ha and 125kg/ha rates were respectively applied at two weekly intervals.

Data Collection in the Field

For each plot, the following data were taken from the central rows: flowering days, plant girth and height, number of flowers per truss, number of flowers per plant, number of fruits per truss, number and weight of fruits per plant, days to fruit set, number and weight of fruits per plot, number and weight of marketable fruits per plot, and fruit yield per hectare.

Data collected in the Laboratory

Diameter of fruit

The diameter of 10 fruits were measured and the mean per fruit determined using a veneer calipers.

Shelf life of riped fruits

Ten ripe fruits of uniform size per cultivar were selected, kept in anopen container and kept at room temperature.The fruits were observed daily and rotten fruits in each cultivar were removed and number of days recorded.

Total soluble solids (TSS)

Total soluble solids of fruits were determined by placing two drops of filtered juice of a fruit from each cultivar on the prism of a refractometer and the percent sugar content read from the equipment.

Number of locules per fruit

The mean number of locules per fruit of each cultivar was determined by making a transverse section of ten uniform fruits and counting the number of locules in each fruit.

Total titratable acid

Five grams of a sample for each cultivar was taken and ground with a blender and filtered. Fifteen (15mls) of the filterate was added to 100mls of hot water that was boiled for 2 minutes. The mixture was again boiled for one minute and cooled to room temperature. 0.5ml of phenolpthaline was added to the mixture and titrated against 0.1M of sadium hydroxide solution. When a sharp pink colour was observed the pipette reading was taken and, the percentage citric acids content of the fruit were calculated using the formula:

$$\frac{\text{Titre} \times \text{molarity} \times \text{molar mass} \times 100}{\text{Vol of pipette} \times \text{weight of tomato used} \times \text{volume topped to}}$$

Number and weight of seed per fruit

An average number of seeds per fruit was determined by extracting seeds from 10 fruits and counting the number of seeds per fruits. The number so obtained was weighed and the figures recorded.

Seed yield per hectare

The weight of seeds per fruit and the average number of fruits per plant was used to compute seed yiled/ha, by using the plant populatiuon.

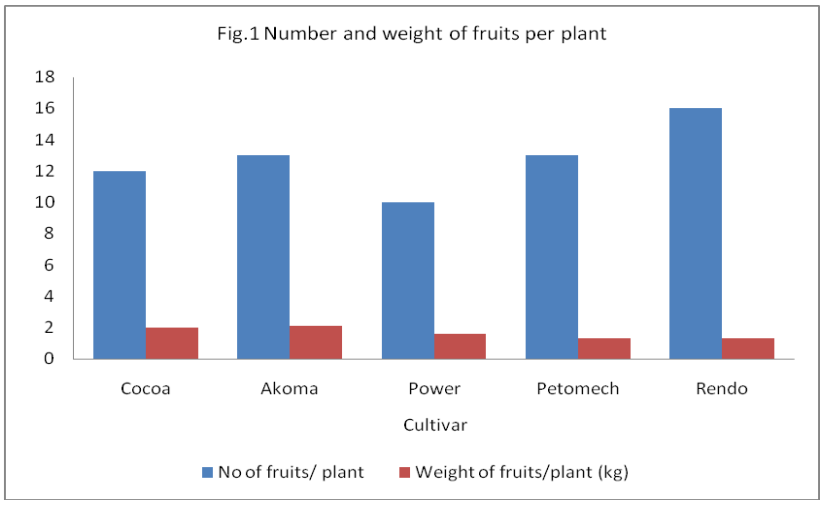
1000 seed weight

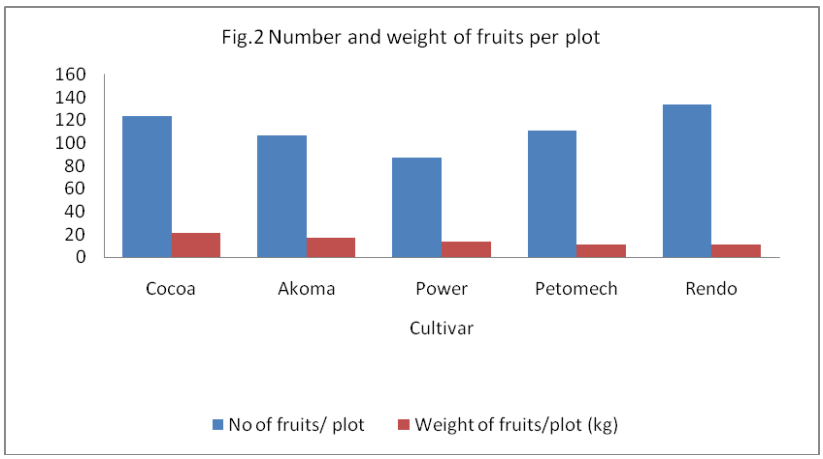
One hundred (100) seeds were counted, weighed, and was multiplied by 10 to obtain the 1000 seed weight for every cultivar.

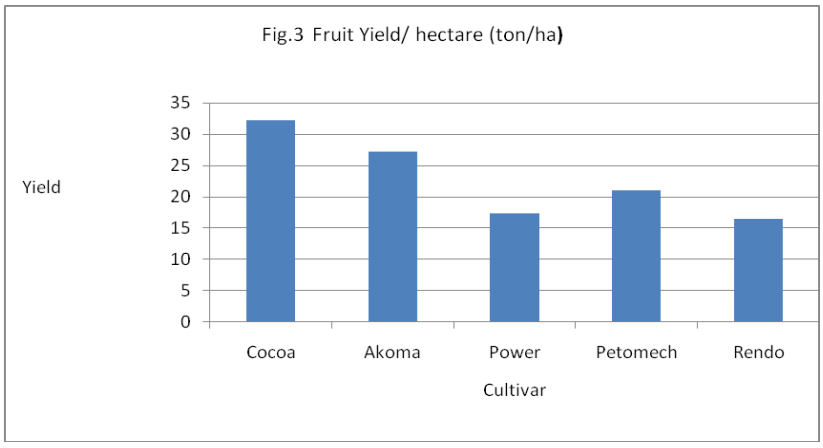
Germination percentage

Twenty–five (25) seeds of each cultivar were spread in pertri-dish lined with three pieces of filter papers soaked in distilled water. The petridishes were covered and set out in the laboratory at room temperature for 7 days. The seeds were separated into germinated and non germinated.The number of seeds germinated out of 25 was transformed into percentage as follows.

$$\frac{\text{No of seeds germinated}}{\text{Initial number seeds sown (25)}} \times 100$$







Seed health studies

The pathological status of the seeds were recorded by observing the seeds under stereo microscope. The fungal infection percentage, severity of infection as well as identity of the fungi were all recorded

3. RESULTS AND DISCUSSION

Fruit yield and related traits

Significant ***(p<0.05)*** differences were observed for plant height at flowering. Akoma and Cocoa, which are indeterminate types recorded 55.5 cm and 44.7 cm respectively for their plant height. Power, a determinate type recorded the shortest in height of 35.9 cm. Petomech and Rendo were 39.4 and 40.7 cm respectively. Similarly, significant differences in number and weight of fruits per plant among the cultivars were recorded. Akoma and Power recorded 13 and 10 fruits per plant and weighing 2.1 kg and 2.0 kg as the heaviest fruits bearing cultivars, with Rendo and Petomech recording 16 and 13 per plant respectively, weighing 1.3 kg. per plant, with Cocoa recording 12 fruits per plant weighing 1.6 kg (Figure 1).

Number and weight of marketable fruits as well as fruit yield per plot all recorded significant differences among the cultivars. Rendo topped the list with 134 fruits per plot. Power recorded the least with 87.Cocoa ranked second with124 fruits, Petomech was third with 111 and Akoma recorded 107 fruits per plot. Cocoa recorded the highest of 20.9 kg in weight followed by Akoma (16.7) kg, Power (13.6) kg, Petomech and Rendo recording (11.3) kg and (10.6) kg respectively (Figure 2).

Consequently significant differences in fruit yield per hectare among the cultivars were recorded. Cocoa was the highest yielder with 32.2 tons/ha with Rendo yielding least with 16.4 tons/ha. Akoma ranked second, followed by Power and Petomech with 27.3 tons/ha, 21.0 and 17.4 tons/ha respectively (Figure 3).

The trend could be attributed to the morphological differences that existed in the cultivars as reported by Nsowah (1996). Cocoa and Akoma yielded highest with 32.2tons/ha and 27.3tons/ha respectively. These two cultivars are vine types and therefore by the

nature of their growth habits spread and have a higher light interception, resulting in higher photosynthate and consequently yield. It is therefore possible that the assimilate distribution was determined by competition between the sink (Ho and Hewitt, 1986).

Fruit quality

Fruit quality parameters of the cultivars showed no significant differences in total soluble solids and number of locules per fruit as shown in Table 1. Significant differences however, in shelf life, diameter of fruit and total titratable acid was recorded. Petomech which stored longer than the other cultivars had thicker skin and firmer in texture by touch and observation. Eyeson (1993) reported that small fruited types tend to be of higher sugar content and acid level with regard to total citric acidity, Rendo recorded the highest of 0.84% with Cocoa recording 0.49%. Altherton (1986) in his studies reported that there is tremendous variation among tomato genotype plants and titratable acidity. In a study of two hundred and fifty accessions, he reported that the percentage citric acid ranged from 0.40% to 0.90%. The result of the current work showed a similar range of 0.49% to 0.84% as was indicated in Table 1.

Table 1

Fruit Quality Parameter

Cultivar	Total soluble solids (TSS) % Sugar	Total titratable acid	Number of locules per fruit	Diameter of fruit (cm)	Shelf life of ripe fruits(days)
Cocoa	4.8	0.49	6.0	5.6	21.0
Akoma	5.5	0.65	6.0	5.6	26.0
Power	5.8	0.80	6.8	6.7	25.2
Petomech	5.8	0.78	6.0	5.0	29.0
Rendo	5.5	0.84	4.8	4.2	26.0
Mean	5.5	0.71	5.9	5.4	25.5
C.V. %	11.72	5.02	19.65	11.97	0.88
LSD (0.05%)	NS	0.06	NS	0.99	0.35

Table 2

Seed yield of the cultivars

Cultivar	Number of seeds per fruit	Weight of seeds per fruit (g)	Thousand seed weight (g)	Seed yield (kg/ha)
Cocoa	170.0	0.29	15.3	63.8
Akoma	114.0	0.24	18.0	54.9
Power	151.0	0.31	17.8	58.4
Petomech	141.3	0.26	15.5	60.8
Rendo	141.0	0.25	15.3	73.0
Mean	143.1	0.27	16.4	62.2
C.V. %	15.23	14.34	8.49	24.73
LSD (0.05%)	33.59	NS	2.14	16.74

Table 3

Seed health test

Cultivar	*Aspergillus flavus*	*Curvularia pallescens*	*Cladosporum*	*Fusarium solani*	% Infection
Cocoa	1	1	1	-	2.0
Akoma	-	10	1	4	6.5
Power	3	2	-	3	6.5

Petomech	1	3	-	1	3.0
Rendo	-	-	1	5	5.0
Total	5	16	3	13	

Seed yield

Rendo which was less fleshy with a greater number of fruits gave the highest seed yield of 73.0 kg. per hectare. Akoma which has a thick flesh with smaller size locules yielded the least number of seeds per hectare, 54.9 kg (Table 2).

Seed health and viability

Curvularia pallescens was observed to be the most prevalent pathogen on or in the seeds, followed by *Fusarium solani, Aspergilus flavus* and lastly *Cladosporum spp*. Akoma and Power were worse affected followed by Cocoa and Rendo. Petomech had less pathogens recorded on the seeds (Table 3). The seed germination of the cultivars range between 73.5% and 87%. This could be attributed to the fact that red ripe fruits were selected from all the cultivars for the extraction. Baruah et al. (1966) working on seed quality in tomato reported that seeds with the best germination potential should be extracted from red ripe fruits. In a similar experiment on seed viability and seedling vigour, Doijoe (1988) reported that seed harvested from the ripe stage showed high germination capacity and seedling vigour. Das and Baruah (1997) comparing manual extraction from fruit pulp with fermentation found that the highest percentages were observed for seeds extracted using fermentation technique. The percentages were low because seeds were stored under ambient temperature for three months before testing for viability.

4. CONCLUSION

The results showed significant differences in fruit yield. Cocoa, Akoma and Power were identified as the top three yielding 32.2, 27.3 and 21.0 ton/ha respectively. Rendo was the lowest fruit yielder/ha but recorded the highest seed yield of 73kg/ha, followed by Cocoa which recorded 63.8kg/ha. On fruits shelf-life Petomech stored longer i.e. 29 days, followed by Rendo and Akoma for 26 days. Power stored for 25 days and Cocoa 21 days. For seed quality traits Petomech recorded the highest germination of 87% followed by Rendo 79.8%, Cocoa 77.3%, Akoma 76.3% and Power 73.5%. All the cultivars were equally vigorous. Cocoa was observed to have exhibited a higher health status than the rest as the health test indicated that it had less pathogens growing on it. Cocoa is therefore suggested to be the best cutlivar for high fruit yield in this experiment, followed by Akoma. The top three; Cocoa, Akoma and Petomech could be recommended for peasant farmers for commercial production in the forest zone of Ghana. Breeders can also capitalize on their favorable traits in improving other cultivars.

REFERENCE

1. Altherton, J.G and Rudich, J. *The Tomato Crop.Scientific Bases for Improvement*. Chapman and Hall Press, 1986, 136 – 144
2. Baruah, G.R. S., Paul, S.R., Das, G. Effect of Fruit maturity stages and drying methods on seed quality of tomato. *Annals of Agricultural Research. India,* 1966, *17(3) 331-332*
3. Das, G., and Baruah, G.R.S. The Influence of plant density on the Yield and quality of Tomato. *J. of Am hort. Sc.,* 1997, *107, 282-5*
4. Doijoe, S.D. Changes in seed Quality on deterioration in tomato *Progressive Horticulture*, 1988, 20 (3-4) 253 –256
5. Eyeson, K.K. Composition and quality of some processed tomato Concentrates. *Ghana Journal of Agric Science,* 1993, *Vol* 6(2) 133-136
6. Harlan, J.R. *Crops and Man* 2nd ed. American Society of Agronomy Crops Science society of America, Madison, W.I. 1992
7. Hille, J., Koornneef, M., Ramanni, M.S. and Zibel, P. *Tomato: A Crop species Amenable to improvement by cellular Methods*. Euphytia: 1989*,* 41.1-23
8. Ho, L.C. and Hewitt, J.D. Fruit Development. *The Tomato Crop.Scientific Bases for Improvement* In: Altherton, J. G.and Rudich, J. (eds) Chapman and Hall London, 1986, 201-239.
9. Kochhar, S.L. *Tropical Crops*. A Textbook of Economic Botany 2nd Ed., 1986, Pp 260-263. Macmillan Publishers Ltd.
10. Norman, J.C. *Tropical Vegetable Crops* Arthur H. Stockwell Ltd. II Fracombe U.K. 1992, 316-319
11. Nsowah, G.F. Preliminary studies of Tomato processing variety at Wenchi. *Ghana Journal of Agric,* 1966, 8, 10-13
12. Siesmonsa, S., Pileuk, K. Prosoa 8 Vegetables Pudeck Scientific Publishers, Wageningen, 1993, Pp199-204
13. Tigchelaar, E.C. and Foley, V.L. Horticultural Technology. A case Study. *Hort Technology*, 1991, 1. 1-16