Development of high yielding and uniform tomato fruits using pure line selection.

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Development of high yielding and uniform Tomato fruits using pure line selection

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ABSTRACT

Tomato is one of the Ghana’s most important vegetable crop both in terms of production and consumption. Demand for the crop year-round owes to the versatility of its usage in both fresh and processed food preparations. The supply of tomato on the market is however, irregular because of the seasonality of production. Varieties grown in Ghana are mostly hybrid. Farmers sometimes select and re-select from segregating populations till they arrive at a relatively stable cultivar. Farmers in the transitional agro-ecological zone of Ghana have through the above process, identified a material they named “petofake” (an opened pollinated tomato) with very good attributes. Despite the good attributes exhibited, it still segregates probably because of poor handling and or it is not stabilized properly. Using pure line selection, 3, 080 seedlings were planted in 2011 for observation and selections. Based on their fruit shape, size, colour, surface and yield, 101 plants were selected. These were again planted in 2012 and of the 101 planted seedlings, eventually created 12 individual lines. In 2013, the 12 lines were further evaluated at the research station. Planting involved growing each progeny into single rows of about 12 plants in Randomized Complete Block Design (RCBD) with three replications. The results showed significant differences (P<0.005) were observed in the number of days to 100% flowering with no variad differences in the number of days to first flowering and 50% flowering. The treatments however, showed significant differences (P<0.005) in plant height with P082 and P000 given the tallest and shortest heights respectively. Treatment P082 produced the highest number of marketable fruits and was notably different from treatments P000, P077, P035, P068 and P085 respectively. The highest average fruit weight was obtained on P011. This was however, not varied from the other treatments except P020 and P035. Likewise, P082 gave the highest total marketable weight yet not significantly different (P<0.005) from all other treatments except P000, P002 and P068. This study has revealed that P000 which was used as a ‘control’, showed rather poor output compared to those of all other treatments in terms of number of marketable fruits, average fruit weight and total marketable fruit weight. Treatments P082, P005, P011 and P057 were however, showed better results as regards to plant height, number of marketable fruits, average fruit weight and total marketable fruit weights

Key words: Selection, marketable, Tomato, production, progeny, pure line.

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INTRODUCTION

Tomato is one of the Ghana’s most important vegetable crops both in terms of hectare and volume of production. The demand for this crop year-round owes to the versatility of its usage in both fresh and processed food preparations (Wolf 1999; Osei et al., 2014). Consumption of tomato in Ghana is increasing however, production has been lagging behind. This leads to a significant short fall which always has to be imported from Burkina Faso. IFRRI
(2009) reported that there are over 90,000 farmers are involved in tomato production, 5000 traders and more than 300,000 individuals in the retail and wholesale sector (IFRRI, 2009) in Ghana. An estimated 25 people are involved in getting one tomato from plot to plate, including day labourers working in the fields; haulage truckers; the men who load and unload the tomato crates onto and off the trucks; porters and restaurant and chop bar owners who are important consumers of tomato (IFPRI, 2009). Consumers typically use the tomato paste and fresh tomatoes throughout the year. Restaurants and chop bars are important consumers of tomato paste, consuming 49% of local market share (Monney et al., 2009). Despite the importance of tomato production in Ghana, it appears to have stalled or even declined. In addition, supply of tomato is irregular because of the seasonality of production. Production is done in Upper East Region of Ghana during the months of October and November using furrow irrigation. The rest of the country produces tomatoes during the major rainy season (April-July). Accordingly, these creates a glut during the months of August to November yet a limited supply in January-March and shortage of supply between April and July. Statistics showed that the price of this commodity greatly fluctuates as a result of this instability of supply (IFRRI, 2009; Wolf, 1999). Asuming-Brempong and Asuming Boakye, 2008 reported that yields of tomato in Ghana remains as low as 7.5-10 tons/ha, which is far below than those of the potential yield of tomato elsewhere under similar climatic condition. Moreover, identifying and growing the right variety for a particular season is also considered to be as an impasse to reach the target production. Farmers in the transitional agro-ecological zone have identified a tomato cultivar commonly called “petofake” (a locally opened pollinated tomato) with very good attributes. Despite the good attributes exhibited by this cultivar, it has been found to be segregating thereby giving non-uniform fruits. Thus, using pure line selection, may lead to selecting at least two main cultivars that could result in releasing two good varieties And that may provide the sustainable supply of purified seeds and uniform fruits.

MATERIALS AND METHODS

Tomato seeds were nursed at Kwadaso research station of the CSIR-Crops Research Institute during early 2nd week of October 2011 and transplanted to the field three weeks later. This was planted to a size of land of 0.2 ha (25.5m x 64.10m) at a spacing of 1m x 0.5m with plant population of 3080 using the augment of RCBD. Each plant was staked for observation and selections. Based on their fruit shape, size, colour, surface and yield, 101 plants were selected (Figure 1). These were later planted in 2012 leading to a selection of 12 individual lines (Figure 2). In 2013, the 12 lines were further evaluated at the research station (Table 1). Planting involved growing each progeny into single rows of about 12 plants in RCBD with three replications. The following inorganic fertilizers were used YaraMila (YARA) winner (150kg/ha), YaraLiva nitrabor (125kg/ha) and Krista K (50kg/ha). Fungicides and insecticides such as Victory, Triamagol, and Golan were applied at vegetative stage; (YARA) TopCop, Funguran, deltapaz, rim-on were applied at flowering stage; Shavit F, Dizconil, Karate were applied at fruiting stage. Plants were again staked individually to allow selection of fruits (Figure 3). Here, lines with defects

![Figure 1. Segregating fruits of tomato lines.](image-url)
were also rouged out. Data were taken on the fruit shape, fruit size, agronomic and yield characters. Others included diseases and pests incidence.

**RESULTS**

**Agronomic characters of tomato lines at Kwadaso**

Table 2 shows agronomic characters of twelve different tomato lines studied at Kwadaso. Significant differences were observed in the number of days to 100% flowering (P085 & P011, P077 & P011, P077 & P020, P085 & P020, P077 & P074) with no varied differences in the number of days to first flowering and 50% flowering. The treatments however, showed significant differences in plant height with P082 and P000 given the tallest and shortest heights respectively (Table 2).

**Yield components of tomato lines studied at Kwadaso**

Treatment P082 produced the highest number of marketable fruits and was notably different from treatments P000, P077, P035, P068 and P085. The least

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**Table 1. Progenies selected from second cultivation.**

<table>
<thead>
<tr>
<th>Accession number</th>
<th>Tomato lines from 101 progenies</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRI/P002/12</td>
<td>P002</td>
</tr>
<tr>
<td>CRI/P005/12</td>
<td>P005</td>
</tr>
<tr>
<td>CRI/P011/12</td>
<td>P011</td>
</tr>
<tr>
<td>CRI/P020/12</td>
<td>P020</td>
</tr>
<tr>
<td>CRI/P026/12</td>
<td>P026</td>
</tr>
<tr>
<td>CRI/P035/12</td>
<td>P035</td>
</tr>
<tr>
<td>CRI/P057/12</td>
<td>P057</td>
</tr>
<tr>
<td>CRI/P068/12</td>
<td>P068</td>
</tr>
<tr>
<td>CRI/P074/12</td>
<td>P074</td>
</tr>
<tr>
<td>CRI/P077/12</td>
<td>P077</td>
</tr>
<tr>
<td>CRI/P082/12</td>
<td>P082</td>
</tr>
<tr>
<td>CRI/P085/12</td>
<td>P085</td>
</tr>
</tbody>
</table>
The number of non-marketable fruits was also obtained from P000. Nonetheless, P057 gave the highest number of fruits recorded as non-marketable (Table 3). The highest average fruit weight was also obtained on P011. This was however, not different from the other treatments except P020 and P035. Likewise, P082 recorded the highest
total marketable weight but was however, not significantly different from all other treatments except P000, P002 and P068 (Table 3).

**Reaction of tomato lines to Tomato Fruit Borer (TFB)**

Figure 4 shows response of the tomato lines to tomato fruit borer (TFB). Treatment P002 and P020 yielded the highest (>4) and lowest (>2) number of fruits that were affected by tomato fruit borer respectively. About 42% of the tomato lines (P000, P002, P035, P057 and P082) had more than three (3) fruits affected with tomato fruit borer.

**Disease incidence of tomato lines**

The number of tomato plants infested under each treatment by disease is shown in Table 4. All treatments showed lower number of bacterial wilt and southern blight infections.

However, there were some variations in the treatments for Tomato yellow leaf curl virus (TYLCV) disease. Treatment P000 which gave the highest number of TYLCV infection was significantly different (P<0.005) from all other treatments.

Treatment P085 which also gave the least number of TYLCV infection was however not significant from the other treatments except P000.

Figure 5 shows the occurrence of early blight, late blight and *Fusarium* wilt infection on tomato lines. Obviously the disease incidence on the tomato lines were significantly minimum (P<0.005). *Fusarium* wilt incidence was negligible on all the treatments except P085.

However, P082 had the highest incidence of late blight on the other hand, P000 and P074 gave the lowest value.

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**Table 4. Bacteria wilt, Southern Blight and TYLCV Disease incidence of tomato lines.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>BW</th>
<th>SB</th>
<th>TYLCV</th>
</tr>
</thead>
<tbody>
<tr>
<td>P000</td>
<td>0.5</td>
<td>0.5</td>
<td>2.5</td>
</tr>
<tr>
<td>P002</td>
<td>0.5</td>
<td>0.5</td>
<td>1.83</td>
</tr>
<tr>
<td>P005</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P011</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P020</td>
<td>0.5</td>
<td>0.5</td>
<td>1.83</td>
</tr>
<tr>
<td>P035</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P057</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P068</td>
<td>0.5</td>
<td>0.5</td>
<td>1.83</td>
</tr>
<tr>
<td>P074</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P077</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P082</td>
<td>0.5</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>P085</td>
<td>0.5</td>
<td>0.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Mean</td>
<td>0.5</td>
<td>0.5</td>
<td>1.66</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>*</td>
<td>*</td>
<td>0.49</td>
</tr>
<tr>
<td>CV (%)</td>
<td>0</td>
<td>0</td>
<td>17.7</td>
</tr>
</tbody>
</table>

BW = Bacteria wilt, SB = Southern Blight, TYLCV = Tomato Yellow Leaf Curl Virus.
Figure 5. Incidence of Early blight, Late blight and Fusarium wilt.

DISCUSSION

The present report contains a description of some achievements of the development of high yielding and uniform tomato using pure line selection in Ghana. The results have shown significant differences (P<0.005) in the days to 100% flowering with no varied disparity in the days to first flowering and 50% flowering may be due to differences in genetic and environmental conditions. This was anticipated since, different genotypes perform differently in same environment (Blay, 1999).

Variations in the climatic conditions during the experiment provided sufficient evidence for the disparity that existed in the flowering of the tomato lines. By and large, flowering appeared early in all the tomato lines studied at Kwadso. Sinnaduari (1992) reported that flowering in tomato usually starts after 50 to 65 days post-sowing. According to Norman (1992), tomato grows best at day temperature of 23.9 to 29.4°C and night temperature between 15.6 and 21.1°C. Extreme temperatures during flowering may cause tomato pollen abscission, bud drop, failure of anther to dehisce, and other flower abnormalities resulting in low fruits set (El – Ahmadi and Stevens, 1979). It is likely that the tomato lines had the right temperatures during flowering which led to early flowering. The tomato lines varied in plant heights. This was in agreement with Messiah (1992), who indicated tomato plant height may vary up to 2 m.

The significant response of the tomato lines to yield and quality characters may be due to the genetic makeup, status of water and oxygen during the growing period of these varieties. The oxygen deficiency may restrict root respiration and negatively affects water and nutrient uptake. This eventually reduces the yield and its quality. Raviv et al. (2004) reported that responses to low yield and quality may also be attributed to the poor rainfall, high day and night temperatures during the experimental period. Several workers (Blay, 1999; Norman, 1974; Sinnaduari and Doku 1976; Villareal, 1981) have shown that tomato yields amay be reduced in the dry season by 6 to 45% due to low moisture supply, depending on the varieties and growing conditions. The number of borer larvae were found to be low during cultivation. The incidence of fruit borer is caused by both fruiting stage of the crop and the time of planting. Temperature has grossly gives positive effect on borer larval numbers. Late sowing and planting is discouraged as ambient temperature gradually increases and has had adverse effects on tomato plant growth including fruit maturation. Impact of other climatic factors has definite effect throughout the cultivation time.

Chaudhuri (2000) has reported very high loss of tomato due to borer infestation. But in the present study the extent of loss is comparatively moderate. Present observations are supported by Sing (1984) who has also recorded that fruit borers lay eggs on buds and flowers of tomato and subsequently attack developing fruits. All these activities were obviously stemmed from climatic changes. From this, we are of this opinion that the incidence and abundance of tomato fruit borer, H. armigera (Hubner) is dependent on both the climatic change and as well as the growth stage of the tomato crop in Ghana.

The reason attributed to low disease prevalence may be due to the good agronomic practices and low pest pressure during the growing season for the experiment at
Kwadaso. These agronomic practices were in agreement with Joey, (2009) which declare that roguing of plants/fruits with initial symptoms may slow the spread of the diseases. The high incidence of early blight and TYLCV comparatively to other diseases on the tomato lines may also be attributed to high temperature and humidity that occur during the experimental period. This favoured white flies (Bemisia tabaci) which are the primary vector transmission of virus causing TYLCV against tomatoes.

CONCLUSION

The present studies have confirmed that P000, which was used as a ‘control’, performed poorly compared to those of other treatments in terms of number of marketable fruits, average fruit weight and total marketable fruit weight. Treatments P082, P005, P011 and P057 showed significant difference when it came to plant height, number of marketable fruits, average fruit weight and total marketable fruit weights. The disease incidences on the tomato lines were low. However, in the mix of low disease pressure, P000 (Control) had higher disease incidence which was significantly (P<0.005) different. Further work is warranted.

ACKNOWLEDGMENT

We are thankful to Afrique Link Limited, Farm and Factory at Wenchi in the Brong Ahafo region, Ghana for financial support.

REFERENCE

Joey W (2009). Home and Garden Information Center (HGIC) provides research-based information on landscaping, gardening, plant health, household pests, food safety & preservation, and nutrition, physical activity & health. 1-888-656-9988.