EVALUATION OF CASSAVA (Manihot esculenta Crantz) GENOTYPES UNDER DROUGHT-FIELD CONDITION

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Abstract

Cassava genotypes that experienced seven months of drought in the field had significant decrease in total plant biomass, shoot biomass, root biomass, root/shoot ratio, plant height, number of leaves, and total and adventitious roots, and total root yield. A decline in protein concentration of the roots was also noted. While the midday stomatal resistance and leaf water potential were found to increase during drought.

Results and Discussion

1.  Drought Effects on Biomass and Yield Production

Drought significantly reduced biomass production. The ratio of biomass of drought-treated plants to that of the control (rainfed) was used to quantify drought tolerance. The ratio was 0.32 on average and ranged from 0.14 to 0.47 among the 5 genotypes which varied markedly in their responses (Table 1). Genotypes with larger biomass under drought showed significantly higher values in that ratio (more tolerant to drought).

2.  Physiological Traits as Affected by Drought

When taken across genotypes, results showed that the highest transpiration rate occurred during the third month of growth when plants under both rainfed and drought-treated regimes reached their maximum vegetative stage (Fig. 5). High transpiration, even under declining soil water, is an adaptive mechanism of the plant in order to maintain adequate water level thereby avoiding leaf dehydration (Ike, 1982). On the other hand, the stomatal resistance increased during the later stages of growth (Fig. 6) when soil moisture was already scarce. Stomatal resistance was found to be an important adaptive mechanism in cassava during the time when soil water potential decreased (Ike and Cook, 1984). The midday leaf water potential was decreased during the later period of drought. Golden Yellow was able to maintain higher leaf water potential during drought period compared to the rest of the genotypes tested (Fig. 7).

3.  Morphological Traits as affected by drought

Irrespective of genotypes, development of leaves was inhibited during drought period. This suggest the sensitivity of cassava to water shortage. Plant height was also reduced by drought (Fig. 8). Golden Yellow was least affected in terms of leaf production and stem elongation, thus, producing the highest shoot biomass under drought condition. Reductions in the number and length of adventitious root were noticeable in drought-treated plants. Moreover, the storage roots of drought-treated plants were smaller and woody. There could be a shift of root function from storage of assimilates to mainly serving as channel of water and nutrients that would be delivered to the shoots in order to perform photosynthesis and respiration in the midst of water shortage.

Golden Yellow and Rayong 5 (Fig. 9) developed a unique root characteristic of extending their adventitious roots longer and farther compared to the rest of the genotypes. This adaptive trait was allowed these genotypes to absorb more water and nutrients in the soil which eventually resulted to higher biomass and yield production under drought condition.

Introduction

Cassava is known to be tolerant to drought (Cook, 1985). This could be the reason why the crop is commonly planted in areas that have been marginalized due to frequent occurrence of water shortage. However, the crop showed sensitivity to drought during the establishment period, i.e., from three months of growth from planting (Pardales et al., 2001). Drought stress during this period significantly reduced the growth and development of the plants. The drought stress, together with the harvesting of the roots, shoots and topsoil, which is a normal practice, is postulated that different genotypes show different reaction to drought and that the mechanism of drought tolerance varies from one genotype to another. Hence, a basic understanding on the drought response of different cassava genotypes is therefore important so that traits that give the crop the ability to withstand drought and thus stabilize its productivity be known.

Objectives

1. To screen cassava genotypes under drought-field condition.
2. To identify plant traits that relate resistance to drought in cassava under field condition.
3. To establish index of drought tolerance in cassava.

Methodology

1. Test Materials and Plant Establishment

Five cassava genotypes namely: PSC 19-1, PSC 11-1, VC-4, Golden Yellow and Rayong 5 were used in this study. Thirty stems cuttings (20 cm long) of each genotype were planted uniformly at one cuttings per hill in an interval of 100 cm between furrows and 70 cm between hills. The plants were established for about one month and a half under rainfed condition. Afterwards, half of the total number of the plants was subjected to drought under an acetate-covered rain shelter (Fig. 4). This condition was maintained for the rest of the experiment.

2. Data Collection

During the course of drought imposition the leaf water potential was measured using a pressure chamber (MPX 33T, Wescor, USA) at 8 A.M. from the midrib of open leaves of the plants with the use respectively of a dewpoint microvoltmeter (HE 33T, Wescor, USA) (Fig. 2) and a steady state porometer (LI-COR 1600, LI-COR, USA) (Fig. 3).

Eight and a half months after planting, all plants were harvested. Yield and other growth parameters were obtained.

3. Treatments and Experimental Design

The experiment was laid out in split plot arranged in a randomized complete block design with four replications. Water regimes (rainfed and drought-treated) served as mainplot while the genotype serves as subplots.

Table 1. Drought-treated/Rainfed Ratio on Different Plant Traits

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Total Yield</th>
<th>Harvest Index</th>
<th>Plant Height</th>
<th>No. of Leaves</th>
<th>Total No. of Adh. Roots</th>
<th>Total Length of Adh. Roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Golden Yellow</td>
<td>0.47</td>
<td>0.47</td>
<td>0.48</td>
<td>1.03</td>
<td>0.11</td>
<td>0.79</td>
</tr>
<tr>
<td>Rayong 5</td>
<td>0.60</td>
<td>0.42</td>
<td>0.46</td>
<td>0.68</td>
<td>0.09</td>
<td>0.59</td>
</tr>
<tr>
<td>PSC 19-1</td>
<td>0.32</td>
<td>0.37</td>
<td>0.27</td>
<td>0.36</td>
<td>0.08</td>
<td>0.28</td>
</tr>
<tr>
<td>PSC 11-1</td>
<td>0.18</td>
<td>0.18</td>
<td>0.16</td>
<td>0.61</td>
<td>0.08</td>
<td>0.52</td>
</tr>
<tr>
<td>VC-4</td>
<td>0.14</td>
<td>0.18</td>
<td>0.10</td>
<td>0.55</td>
<td>0.10</td>
<td>0.52</td>
</tr>
</tbody>
</table>

4.  Morphological Traits of Cassava under Rainfed and Drought-Treated Conditions

(a)  Total Yield

(b)  Harvest Index

(c)  Plant Height

(d)  No. of Leaves

(e)  Total No. of Adh. Roots

(f)  Total Length of Adh. Roots

References


