Comparing the drought resistance of two different varieties of Sorghum

Sorghum is a crop used for many things in tropical regions, for example the grain provides flour to make bread and porridge and also the stalks and leaves are used for livestock feed, construction and fuel. To find out why some varieties are more drought resistant than others we will analyse and conclude a research made by ICRISAT in India.

There are four aspects of plant growth that might be related to drought tolerance. They are:

- Development of root mass
- Development of shoot mass
- Changes to leaves
- Grain yield

Development of root mass

These are the results gained from ICRISAT.

	Root mass in soil core / g	
Time after sowing (days)	Drought susceptible variety	Drought resistant variety
40	0.84	063
89	1.06	1.10
179	4.48	9.39

If you look at the graph on the next page you can see that during the period of drought, both developed a similar in quantities. As soon as water would become available the drought resistant variety started to develop its root mass more rapidly. This is an advantage because water could be collected in a wider area as long as there's growth of a large root system. Under the growing conditions, which normally prevail for sorghum seeds are sown at the end of the wet monsoon. The initial growth of a larger root system gives the drought resistant variety survival advantages later in the growing season when conditions become a lot drier.

Evaluation

This experiment was only analysed under 3 circumstances. It resulted to an unreliable graph. You can see that I did not choose to use my graph with a curve because it was much too unreliable. Methods of improvement could be taking readings more often in regular intervals.

Development of shoot mass

This was done by measuring the dry mass of four plants (randomly selected) at intervals throughout the growing season. From these measurements the shoot mass in an area of 1 m^2 from each plot was estimated. The results are shown below.

	Shoot mass in 1 m^2 area of plot / g	
Time after sowing (days)	Drought susceptible variety	Drought resistant variety
39	350	89
88	1713	961
179	2852	2294

The graph for these results is shown on the next page.

Looking at the graphs, the development of shoot mass does not appear to depend on water availability for either variety. The drought resistant variety seem to make less shoot growth than the other variety. Possibly because root growth of the resistant variety takes place to a greater extend.

Evaluation

This experiment may have some sources of error because the shoot mass from each plot was *estimated*. Also, again we did not have enough data to draw a curve for this graph.

Changes to leaves and drought tolerance (leaf firing)

One way of a sorghum plant to respond to drought is leaf firing. It is when tips of the leaves dry out and die, turning yellow. The rest of the plant will still look the same and it continuous to function normally.

Examining fully emerged leaves on a number of plants each week did the experiment. Estimates were made within each plot of the average fraction of leaf firing which had occurred.

These are the results put up in a table:

	Shoot mass in 1 m^2 area of plot / g	
Time after sowing (days)	Drought susceptible variety	Drought resistant variety
39	6	0
46	10	0
54	22	0
60	22	0
67	24	4
75	50	22
82	60	32

The graph of these results is shown on the next page.

You can see on the graph that drought resistant variety shows less firing and its onset occurred about 40 days after. This proves that the drought resistant variety is better adapted to dry conditions and suffers less water loss from the leaves. “When leaf firing occurs parts of the leaf dies”. This could be an advantage for the plant under water stress. Transpiration is stopped in parts of the leaf where it has become dead. Therefore water loss is reduced. When a cell is dead it cannot photosynthesise therefore less occurs in a leaf suffering from firing. Because photosynthesis is reduced, productivity is lower and grain yield is reduced.

Evaluation

This experiment unlike the others, have enough results to draw a curve for. For this experiment there are also sources of error. They have been marked with red.

Changes to leaves and drought tolerance (leaf rolling)

Here we used estimates of the degree of leaf rolling from 10 plants from each plot per week in terms of leaf rolling index. Leaf rolling index is calculated as:

$$\frac{\text{Diameter of the rolled leaf}}{\text{the normal leaf width}}$$

A flat leaf has therefore an index of 1.0
These are the average readings of leaf rolling:

	Shoot mass in 1 m^2 area of plot / g	
Time after sowing (days)	Drought susceptible variety	Drought resistant variety
27	0.96	0.88
34	0.90	0.80
43	0.52	0.34
56	0.52	0.20
64	0.60	0.26
75	0.60	0.26

Drought susceptible variety and drought resistant variable responded differently to water availability. The drought resistant variety shows more leaf rolling and its onset occurs earlier than for the other variety. When the leaf is rolled, surface area of the leaf is decreased. When this happens, transpiration rate was reduced and less water can be evaporated. Then photosynthesis get reduced because of not enough surface area is exposed to sunlight. These two effects on the leaves makes sure heat is reduced and the temperature is less down. As the monsoon rain starts leaves are unable to unroll which are important because productivity can quickly reach a high level as photosynthesis and transpiration can start taking place again.

Evaluation
Looking at the graph you can see that there are points well away from the curve which can have been sources of error. On the graph it looks like the leaf unroll as after about 70 days the rolling index slightly goes up. But as we know it doesn't we can conclude that they are sources of error.

Conclusions and Evaluations

The bar graph here below shows how much yield grain was produced in average per m2 from each variety. The drought resistant variety produced more yield grain than the drought susceptible variety when grown under same conditions. There are many reasons for this.

Looking at the first experiment we saw that the drought resistant variety develops a more extensive root system for collecting water, which prevents water stress when conditions are dry and allows the plant to respond quickly (in terms of photosynthesising and nutrient supply) when water becomes available.

Also looking at the second experiment (development of root mass) less productivity goes into shoot growth in the drought resistant variety.

We proved in the 3rd experiment that leaves stay healthier with less firing in the drought resistant variety; therefore a greater area is available for photosynthesis as well as use of leaf rolling allows drought resistant variety to combat water stress quickly in dry conditions.

If this experiment would have been done again, I think the main improvements that should have been done is: Take more readings more often and Using more precise apparatus when inspecting leaf rolling and leaf firing. I can't say that this have been a fair test neither. There could have been many factors affecting the drought resistance that haven't been counted. Time is one of the factors… During the time of inspection of one plant to another, many things can have happened. Also, estimating and picking out from random can be a trouble too. To prevent taking randomly, they could have decided to pick plants, which are not noticeably destroyed or diseased. Taking more reading when taking averages can also improve the results.