Effect of Different Soilwater Availability on Growth and Yield of Three Varieties of Corn (*Zea mays* L.)

Rusmana(✉), Eltis Panca Ningsih, and Savira Rafa Na'imah Cahyaningtyas

Agroecotechnology Departement of Agriculture Faculty, University of Sultan Ageng Tirtayasa, Serang, Banten, Indonesia
rusmana@untirta.ac.id

Abstract. This research was conducted at the screen house of the Banten Agricultural Research and Technology Center (BPTP) and the Agroclimatology Laboratory of the Faculty of Agriculture, University of Sultan Ageng Tirtayasa from November 2020 to March 2021. This study used a factorial Randomized Block Design (RBD). The first factor is several varieties with 3 levels, namely NASA 29, Lamuru, and Bisi 2. The second factor is soil water availability with 4 levels, namely 100% Field Capacity (FC), 80% FC, 60% FC, and 40% FC. The use of different corn varieties showed differences in the parameters of dry grain weight and weight of 100 grains. Soil water availability affected the length of the cobs, the dry weight of the cobs without husks, and the weight of dry seeds. There is an interaction between varieties and soil water availability for the parameters of leaf area, plant dry weight, and corncob diameter.

Keywords: Corn · Drought Stress · Varieties

1 Introduction

Limited water availability is one of the main factors restricting crop production [1, 2] and it is predicted to become an increasing problem under future climate conditions [3, 4]. Consequently, there is an urgent need to breed more drought-tolerant crops to meet future demands of the growing world population, for which efficient screening strategies are necessary.

Drought resulted in decreased corn production. Drought tolerant varieties are needed so that corn production can survive and even increase. Average temperatures and water availability are predicted to become an increasing problem under future climate conditions [5], which will also influence soil organic matter [6]. Thus, developing maize varieties with improved water and nutrient use efficiency is a primary breeding target [7]. In maize, it is shown that a considerably high percentage of the total variation in grain yield under drought conditions could be predicted by vegetative phenotypic data generated in water-limited controlled environments [8, 9].

Several varieties of corn were studied for their agronomic responses related to drought tolerance. This study aims to determine the agronomic responses of some corn varieties to drought conditions.

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Table 1. The average leaf area of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)			
	100	80	60	40
	……. (cm^2) ……..			
Nasa 29	5880,00a B	5764,5a A	2511,25b C	1675,00c A
Lamuru	5267,00a C	3207,75b C	5308,75a A	1307,00c A
Bisi 2	8009,00a A	4641,50b B	3178,00c B	1096,500d A

Note: The numbers followed by the same lowercase letter in the same row and the numbers followed by the same capital letter in the same column show no difference based on the 5% DMRT test

2 Research Methods

The research was conducted from Nopember 2020 to February 2021 in screen house of the Banten Agricultural Research and Technology Center and the Agroclimatology Laboratory of Agriculture Faculty, University of Sultan Ageng Tirtayasa, Banten.

A factorial experiment was carried out in a randomized block design with 3 replications. The first factor is several varieties with 3 levels, namely NASA 29, Lamuru, and Bisi 2. The second factor is soil water availability with 4 levels, namely 100% Field Capacity (FC), 80% FC, 60% FC, and 40% FC. Drought stress treatment was carried out by the gravimetric method by giving water every day by weighing the pot to determine the amount of water given. The variables observed: leaf area, plant dry weight, corncob diameter, corncob dry weight without husks, dry grain weight, and weight 100 grains. Data were analyzed using SPSS version 20 for analysis of variance and comparison test between treatments with the DMRT (Duncan Multiple Range Test).

3 Results And Discussion

3.1 Leaf Area

In general, all tested varieties (Nasa 29, Lamuru, and Bisi 2) experienced a decrease in leaf area with a decrease in soil moisture content as presented in Table 1.

The leaf area of the Bisi 2 variety decreased with decreasing water availability, while the other two varieties (Nasa 2 and Lamuru) did not. Drought stress during vegetative stages results in reduced stem and leaf cell expansion (shorter plants with less leaf area). Growth during this period determines the size that the plant achieves and the size of the individual leaves. A strong water stress during the vegetative growth stage could seriously inhibit the growth and leaf area of maize plants. The reduction in dry matter from short-term water stress at the beginning of the intensive vegetative growth stage

Table 2. The average plant dry weight of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)			
	100	80	60	40
	…….…….. (g) ……			
Nasa 29	6,82a B	5,21b B	5,66b B	6,28a A
Lamuru	6,76a B	6,83a B	6,47a A	4,13b C
Bisi 2	8,04a A	7,08b A	5,36dc B	4,87c B

Note: The numbers followed by the same lowercase letter in the same row and the numbers followed by the same capital letter in the same column show no difference based on the 5% DMRT test

was mainly caused by the reduction in plant height and leaf size and delay in leaf tip emergence [10].

3.2 Plant Dry Weight

The plant dry weight of the Lamuru variety did not decrease due to a decrease in soil water content to 60% of field capacity, a decrease occurred in soil water content of 40% of field capacity as presented in Table 2.

Drought affected not only dry matter accumulation but also the partitioning of dry matter between leaves, the stem, and grains. Drought is known to affect morphology, photosynthesis, and dry matter accumulation as well as grain yield and the nutritional composition of maize [11].

3.3 Corncob Diameter

Lamuru and Bisi 2 varieties had larger cob diameters than Nasa 29 varieties at 60% and 40% field capacity water content. The Lamuru variety has the largest cob diameter at 40% soil water content of field capacity as presented in Table 3.

Progressive drought from the jointing and tasselling stages decreased both length and diameter of the cob significantly [12].

3.4 Dry Weight of Corncobs Without Husks

The three varieties tested (Nasa 29, Lamuru, and Bisi 2) experienced a decrease in dry weight of corncob without husks at 40% field capacity water content. The three varieties tested (Nasa 29, Lamuru, Bisi 2) showed no difference in dry weight of dry weight of corncob without husks as presented in Table 4.

Table 3. The average corncob diameter of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)			
	100	80	60	40
	…….…….. (cm) ……			
Nasa 29	3,30a B	2,76b B	2,96b B	1,73c C
Lamuru	2,96b C	3,00b A	3,40a A	3,56a A
Bisi 2	3,56a A	2,53d C	3,30b A	2,86c B

Note: The numbers followed by the same lowercase letter in the same row and the numbers followed by the same capital letter in the same column show no difference based on the 5% DMRT test

Table 4. The average dry weight of corncob without husks of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)				Averages
	100	80	60	40	
	…….. (g) ……				
Nasa 29	6,01	4,22	4,18	2,35	4,19
Lamuru	5,04	4,87	4,53	3,73	4,54
Bisi 2	6,47	4,21	5,62	4,29	5,15
Averages	5,84a	4,43b	4,78b	3,46c	

Note: The numbers followed by the same lowercase letter in the same row show no difference based on the 5% DMRT test

3.5 Dry Grain Weight

The dry grains weight of Lamuru and Bisi 2 was not different and both were higher than the Nasa 29 variety. The three varieties experienced a decrease in dry seed weight in line with the decrease in soil water content as presented in Table 5.

As reported, water stress leading to the reductionin grain yield was mostly due to a reduction in dry matter allocation to grains and not as much due to lower production of dry matter [13]. Grain yield was significantly reduced by progressive drought during either vegetative or reproductive stage, and the reduction in grain yield from reproductive progressive drought (41.6–46.6%) was greater than that from vegetative progressive drought (18.6–26.2%). The decrease in grain yield was largely caused by the decrease in kernels per ear [12].

Table 5. The average dry grain weight of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)				Averages
	100	80	60	40	
	…….…….. (g) ……				
Nasa 29	5,84	3,69	3,12	2,63	3,82b
Lamuru	5,96	5,55	4,84	3,52	4,97a
Bisi 2	5,63	4,98	5,01	3,81	4,86a
Averages	5,81a	4,74b	4,32c	3,32d	

Note: The numbers followed by the same lowercase letter in the same row show no difference based on the 5% DMRT test

Table 6. The average leaf area of three maize (*Zea mays* L.) varieties at different soilwater availability

Varieties	Soilwater availability (% FC)				Averages
	100	80	60	40	
	…….…….. (g) ……				
Nasa 29	4,19	3,81	4,20	3,70	3,97c
Lamuru	4,63	4,78	4,35	3,82	4,40b
Bisi 2	4,45	5,08	5,39	4,53	4,86a
Averages	4,42	4,56	4,65	4,02	

Note: The numbers followed by the same lowercase letter in the same row show no difference based on the 5% DMRT test

3.6 Weight 100 Grains

The three varieties showed different weights of 100 grains, in order from the highest, namely Bisi 2, followed by Lamuru and Nasa 29. Weight of 100 grains is not affected by a decrease in the content of soilwater availability. Bisi 2 variety has the highest weight of 100 grains of the three corn varieties tested as presented in Table 6.

the weight of 100 grains is related to the size of the seeds, a larger weight of 100 grains indicates that the size of the seeds is also large. According to research results [14] showed that the highest 100 seed weight was from KSC720 cultivar and other cultivar had significant differences together.

4 Conclusions

1. In general, the three maize varieties (Nasa 29, Lamuru, and Bisi 2) experienced a decrease in leaf area due to a decrease in soil moisture content.

2. The dry weight of the Lamuru variety decreased at 40% soil moisture content of field capacity.
3. The Lamuru variety has a larger cob diameter than the Nasa 29 and Bisi 2 varieties at a moisture content of 40% field capacity.
4. The three maize varieties (Nasa 29, Lamuru, and Bisi 2) experienced a decrease in cob weight without husks at 40% field capacity moisture content.
5. The dry grains weight of Lamuru and Bisi 2 were not different and both were higher than the Nasa 29 variety. However, the three maize varieties experienced a decrease in dry grains weight along with the decrease in soil moisture content.
6. The three varieties showed different weights of 100 grains, ordered from the highest, namely Bisi 2, followed by Lamuru, and Nasa 29.

5 Sugestions

Further research is needed to use the Lamuru variety to select corn plants that are drought tolerant.

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