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EFFECT OF DRIP IRRIGATION AND GENOTYPES ON THE PRODUCTION TRAITS OF SWEET CORN (*ZEA MAYS* SACCHARATA STURT)

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SUMMARY

Sweet corn is one of the essential food crops in Indonesia because of its many benefits, such as, being a source of carbohydrates, oil, flour, animal feed, and others. Corn demand increases yearly, needing a large land area to meet its requirements. However, planting maize during the dry season or low rainfall faces more challenges. Therefore, using drip irrigation is a solution to ensure corn growth and sustained optimal production. The presented study aimed to determine the effects of drip irrigation on the production of two varieties of sweet corn (*Zea mays* saccharata Sturt) and began from February to May 2021 at the Faculty of Agriculture, Universitas Teuku Umar, Meulaboh, West Aceh, Indonesia. The study used a randomized design (split-plot) each for two irrigation levels: without drip irrigation (T_0) and drip irrigation (T_1) in main plots on two sweet corn varieties, Bonanza and Paragon. The parameters observed were cob diameter with cornhusk (mm), cob diameter without cornhusk (mm), cob length with cornhusk (cm), cob length without cornhusk (cm), cob weight with cornhusk (g), and cob weight without cornhusk (g). Analysis of variance showed that the drip irrigation treatments had no significant effect on all the recorded parameters. However, the varieties had a highly relevant impact on the cob diameter and length and considerably influenced the cob weight. Then again, the sweet corn varieties showed nonsignificant differences for all other variables.

Keywords: Sweet corn (*Zea mays* saccharata Sturt), drip irrigation, production traits

Key findings: Drip irrigation is very effective and economical during the dry season, meeting the corn plants' water requirements for their growth and development. Sweet corn cultivation with drip irrigation revealed enhanced cob diameter, length, and weight, and the sweet corn cultivars also had a highly significant effect on such traits.

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INTRODUCTION

Sweet corn (*Zea mays* L.) is a widely planted crop by the farming community and a food crop highly demanded by the people of Indonesia. Corn is one of the most critical carbohydrate-producing food crops in the world, besides wheat and rice, providing carbohydrates and fiber that facilitate digestion (Nadeem *et al*., 2022). For sweet corn, the market demand continues to increase along with the emergence of supermarkets that require large quantities (Seprita and Surtinah, 2012).

The Food and Agriculture Organization (FAO) noted that corn production in Indonesia reached 22.5 million t in 2020. This number decreased by 0.38% compared with the previous year (22.58 million t). The Ministry of Agriculture recorded domestic production of corn with a moisture content of 25% at 23 million t in 2021. A projection states the amount will increase to as much as 23.1 million t throughout 2022. Next year, the Ministry of Agriculture estimates corn production will jump to 30 million t. Meanwhile, the number will increase again to 35.3 million t in 2024 (Ministry of Agriculture, 2022).

Growing corn on a large scale faces unpredictable weather conditions and water scarcity challenges. However, with drip irrigation, complete control of water delivery to root crops at the required time reduces climate-related risk, manages inputs, and secures profitability. Drip irrigation is a promising means to meet the water needs of plants, enhancing soil nutrient absorption and accelerating seedling adaptability with increased plant growth (Surata, 2007; Puttarach *et al*., 2016; Chozin *et al*., 2017). According to Kasiran (2006), drip irrigation can increase land productivity because crop production activities do not depend on the season, with crop plants grown throughout the year to enhance the planting index.

In addition to the harvested area, crop management including soil type, fertilizer inputs, irrigation, altitude, and other relevant environmental factors, impacts corn production. The most suitable soil for maize production is fine-textured and sandy loam soil (Sudjana *et al*., 1991; Wirosoedarmo *et al.*, 2011). However, the drainage in such soils is not good, lacking the soil ability to bind water (Kusuma *et al*., 2016). Overcoming these problems and efforts to increase productivity to support the corn agribusiness development program requires improved management and provision of sufficient water for the maize plant growth (Directorate General of Food Crops, 2005).

The rapid agricultural technology development enhanced irrigation water use and caused water to become more valuable in an efficient irrigation system (Rezky, 2018). Drip irrigation regulates water consumption according to plant needs with no wastage. It is a method of watering plants directly, in the root zone of plants and the soil surface, through continuous and slow drops (Hadiutomo, 2012). It is a water system placed either below or above the ground that delivers direct water accurately to the root zone based on the plant's current needs. It can apply to all topographies, field sizes, and soil types. Furthermore, it can maintain the optimal soil moisture level in all conditions that save water and improve yields.

The water requirement for each corn cultivar is varied. According to the Directorate General of Food Crops (2005), corn plants need sufficient water, especially when entering early growth, flowering, and seed-filling stages, with lack of water adversely affecting production. However, corn generally requires two liters of water per plant daily during hot and windy conditions. Hence, the presented study aimed to determine the effects of drip irrigation on the production of two varieties of sweet corn (*Zea mays* saccharata Sturt).

MATERIAL AND METHODS

Experimental site and plant material

This research happened from February to May 2021 in the experimental garden of the Faculty of Agriculture, Universitas Teuku Umar, Meulaboh, West Aceh, Indonesia. The materials used in this study were the two sweet corn varieties, i.e., Bonanza and Paragon. The fertilizers used were the manures Nitrophoska NPK and urea. The post-emergence herbicide Roundup and insecticide Tivoli 45SP applications controlled weeds and insect pests, respectively. The tools used in this study included a hoe, watering can, raffia rope, meter, saw, scissors, knife, machete, pamphlet board, caliper, scales, calculator, water pump, emitter, ball valve, pressure gauge, fertigation filter, elbow connector, T-elbow, PVC pipe, inner and outer shock drats, end plug, drip hose, drip hose connector, hole punch, seal tape, pipe glue, water tank, water timer, and stationery.

Research design

The study design was a randomized complete block design with a split-plot arrangement comprising two drip irrigation treatments (T0 - without drip irrigation and T1 - with drip irrigation) kept in main plots and two sweet corn varieties (Bonanza and Paragon) placed in sub-plots, with three replications. The number of samples per research unit was 14, totaling 84 samples.

Land Preparation

Using a total land area that measured 20 m x 10 m, the plot size was 18 m x 1.5 m and first cleared of weeds and plant debris. Performing tillage twice, the first treatment sprayed weeds with a roundup herbicide, hoeing roughly, then left the soil for two-three days to reduce the toxins. The second process was soil smoothing and leveling to make the ground more friable. Applying fertilizer using organic manure was given one week before planting at a dose of 50 kg per bed, spreading evenly over the plot (Sunaldi *et al*., 2020).

Drip irrigation methodology

Carrying out the drip irrigation followed the methodology of Prabowo *et al*. (2004) as listed below:

a. Firstly, measuring the total length of the beds with PVC pipes was necessary to know the number of needed drip hoses. Then, installing PVC pipes in each bed ensued, depending on their needs. The PVC pipes' length was slightly longer than the length of the beds.

b. Preparing a central hose had a two-inch diameter, depending on the requirement. Connecting a PVC pipe with a drip hose using connectors, namely the inner and outer shock drats, adjusting the size of the shock drat with the drip hose diameter. Generally, the drip hose diameter corresponds with the PVC pipes. The shock drat installation on the main pipe had the hole in the main tube slightly smaller than the shock drat diameter for a firm connection and no leaks.

c. The prepared paralon pipes measured two inches with a length of 10 cm. These pipes were a liaison between the drip hose and the shock drat and attached to the central hose. After finishing, with each end of the drip hose tied, turning on the pump determined whether the drip hose functions correctly or not.

d. The drip irrigation should use clean water. The use of cloudy/dirty water will clog the holes in the drip and can shorten the life of the drip hose.

Adjusting the distance of the emitter and lateral holes to the planting distance of corn ensures one corn seed gets one emitter hole. The determined operational time of drip irrigation was according to the required water of the plant divided by the emitter drip rate. The source of used water comes from groundwater that is sucked in by a deep well pump, with the only needed pump being a booster pump to drain water into the land.

Seed planting and follow-up fertilization

In the soil, a specified tool made the 3 cm deep holes, with each hole filled with one corn seed, then covered again with dirt having a spacing of 70 cm x 40 cm. After planting the seeds, watering followed according to each treatment. Applying follow-up fertilization using NPK and urea fertilizers continued. The NPK Nitophoska and urea fertilizer doses were 300 kg ha^{-1} and 150 kg ha^{-1}, respectively. One-third of fertilizer application was at 15 days after planting (DAP), while two-thirds were at 30 DAP (Pusparini *et al*., 2018).

Harvesting

Carrying out corn harvesting transpired when the crop was 75 DAP, where the corn plants were still young (in the maturation phase of milk). The morphological characteristics noted were the yellowing of leaves.

Research parameters recorded

The parameters used in this study included cob diameter with and without cornhusks (mm), cob length with and without cornhusks (cm), and cob weight with and without cornhusks (g). Measuring cob diameter started after harvesting maize plants with and without husks. Cob length measurement at harvest used a measuring tape from the base to the tip of the cob with and without husks. Corn cobs' weight calculation employed a scale in grams at the time of harvest with and without husks.

RESULTS AND DISCUSSION

Drip irrigation effects on varieties traits

According to the results, the biggest cobs with the maximum average diameter emerged in the T1 treatment (drip irrigation), although statistically, it was not significantly different from T0 (without drip irrigation) (Table 1). Presumably, it is because watering with drip irrigation treatment makes the corn plant received more balanced amount of water, eventually causing better water absorption in the corn crop. According to Amuddin and Sumarsono (2015), implementing drip irrigation systems can increase land and plant productivity, ensuring planting in the land throughout the year, increasing the planting index, and cultivating activities not depending on the rainy season.

For cob diameter without cornhusk, the hugest cobs occurred in the treatment T1 (drip irrigation) but were not significantly different from T0 (without drip irrigation) (Table 1). Suspectedly, if fulfilling the available and suitable watering time is proper for corn plants, then better corn cob formation can surface. These findings were in analogy to the opinion of Kasryono *et al.* (2007), who reported that corn plants that get water according to their need and time have better production.

The highest average cob length showed in the treatment T1 (drip irrigation); however, it was at par with T0 (without drip irrigation) (Table 2). Results revealed that water adequacy during fruit formation provides a regular pattern of increasing the cob length. According to Harjadi and Yahya (2008), plants need water in steady quantities to support their growth, and water distribution throughout the growth life of plants will always be ideal. The amount of capillary water determined groundwater availability, i.e., water between field capacity and permanent wilting.

The maximum average length of cobs without cornhusks also came from the treatment T1 (drip irrigation), yet with a similar measurement from T0 (without drip irrigation) (Table 2). Water availability with drip irrigation is more effective in playing a better role in plant growth than the treatments without drip irrigation, resulting in water shortages during the growth and fruit formation periods. These results agree with Subandi (2013) that corn plants lacking water will wilt for one to two days during the season, reducing the yield by 22%. Moreover, if plant wilting occurs for five to eight days, corn yield decrease can reach 50%.

Based on Table 3, the average heaviest cob weight appeared in T1 (drip irrigation), although not significantly different from T0 (without drip irrigation). It showed that the water provision with drip irrigation could increase the average cob weight compared with corn plants with insufficient, irregular watering. Rudich and Luchinsky (1986) and Rezky (2018) findings revealed that the higher the level of water supply, the greater the fruit weight. A better level and timely water supply can increase fruit production and improve quality.

The average highest cob weight without cornhusks was also in the treatment T1 (drip irrigation) (Table 3). Results also authenticated that the lack of water causes the inhibition of the photosynthesis process, which results in decreased fruit weight in corn plants.

Table 1. Average cob diameter with and without cornhusks based on the effects of drip irrigation.

Parameters	Irrigation regimes	
	T0 (No drip irrigation)	T1 (drip irrigation)
Cob diameter with cornhusks (mm)	46.25	49.89
Cob diameter without cornhusks (mm)	46.28	46.54

Table 2. Average cob length with and without cornhusks based on the effects of drip irrigation.

Parameters	Irrigation regimes	
	T0 (No drip irrigation)	T1 (drip irrigation)
Cob length with cornhusks (cm)	25.05	26.77
Cob length without cornhusks (cm)	16.10	18.04

Table 3. Average cob weight with and without cornhusks based on the effects of drip irrigation.

Parameters	Irrigation regimes	
	T0 (No drip irrigation)	T1 (drip irrigation)
Cob weight with cornhusks (g)	174.88	224.52
Cob weight without cornhusks (g)	109.76	146.43

Following the research of Gardner *et al.* (1991), water deficiency during the grain-filling period reduces yield due to the low rate of photosynthesis.

Influence of sweet corn varieties

Based on the presented results, the average largest cob diameter occurred in the sweet corn variety Paragon, showing significant difference from the variety Bonanza (Table 4). The difference in cob diameter could refer to the genetic makeup of the genotypes. According to results from Wardani *et al.* (2009), fruit diameter positively correlated with productivity. It means that the higher the cob length and diameter of the fruit, the greater the productivity.

The average largest cob diameter without cornhusks came from the Paragon variety, although not significantly different from the other sweet corn variety, Bonanza (Table 4). Presumably, the genetic and environmental influences caused the non-husked diameter of the Paragon variety to be superior to the Bonanza variety. It is also linear with the diameter yield, with the corn husk of the Paragon variety being superior to the Bonanza variety. According to reports from Made (2010), the high-yielding hybrid varieties have almost the same yield component characters, the diameter of the cob, and with and without cornhusks. Hybrid corn has a very prominent role in increasing yield per unit area and its activity level in an environment because low yields can result from the unresponsiveness of crop plants to environmental conditions. Widiyawati (2016) stated nonsignificant differences appeared in the yield-related characteristics of the various varieties, even as influenced by genetic factors and environmental conditions.

Table 5 displays the highest average cob length in the sweet corn variety Paragon, which gave a significant difference from the other variety, Bonanza. Given the genetic makeup of the different genotypes could have variations in quantitative traits with diverse fruit sizes in selections under the existing environmental conditions. As stated by Mangoendidjojo (2008), if there is a difference in the plant population grown under the same environmental conditions, then the variations come from the individual genes of the populations. The different genotypes will also cause differences in the shape and nature of the fruits.

Table 4. Average cob diameter with and without cornhusks based on the effects of different sweet corn varieties.

Parameters	Cultivars		$LSD_{0.05}$
	Bonanza	Paragon	
Cob diameter with cornhusks (mm)	46.47a	49.67b	1.78
Cob diameter without cornhusks (mm)	45.27	47.55	-

Table 5. Average cob length with and without cornhusks based on the effects of different sweet corn varieties.

Parameters	Cultivars		$LSD_{0.05}$
	Bonanza	Paragon	
Cob length with cornhusks (cm)	24.90a	26.92b	0.60
Cob length without cornhusks (cm)	17.52	16.62	-

Table 6. Average cob weight with and without cornhusks based on the effects of different sweet corn varieties.

Parameters	Cultivars		$LSD_{0.05}$
	Bonanza	Paragon	
Cob weight with cornhusks (g)	183.21a	216.19b	19.94
Cob weight without cornhusks (g)	120.24	135.95	-

The maximum average cob length without cornhusks emerged in Bonanza but showed no significant difference from the other sweet corn variety, Paragon (Tale 5). It could be because the Bonanza variety genetically has a better fruit length, and presumably, the said corn variety adapts well to environmental conditions. The result follows the findings of Zahrah (2011), who stated that each selection could appear with different characteristics due to varied genetic attributes and their responses to environmental and production factors.

The average heaviest cobs resulted in the variety Paragon, giving a significant difference from the other sweet corn variety Bonanza (Table 6). It could be due to sweet corn varieties tend to have influences from genetic factors and environmental conditions. Djafar *et al.* (1990) explained that similar and different performances occur in selections resulting from genetic factors and their response to environmental conditions. These results align with the findings of Syafruddin *et al*. (2012), who stated that the cob weight with and without husks, cob diameter with and without husks, and the cob length with and without husks gained impacts from three different sweet corn varieties. Zainudin (2005) reported that the different sweet corn varieties influenced the cob length and diameter.

Based on Table 6, the densest cobs with enhanced weight without husks appeared in Paragon, although it showed no significant difference from the other sweet corn variety Bonanza. It could refer to the advantages of different characters, photosynthetic processes, leaf shape, and tolerance level to the environment. The fruit weight percentage determines and manages the maximum yield potential of a variety. According to Maintang *et al*. (2010), photosynthesis (carbohydrates) in the foliage determines the fruit weight, which is translocated and accumulated in the fruits. Leaves that are erect, thick, narrow, and dark green and do not fall off early are signs of maximum fruit setting, better nutrient intake, and tolerance to pests and diseases.

CONCLUSIONS

Results revealed that drip irrigation significantly influenced the observed parameters of the sweet maize variety. However, sweet corn varieties indicated higher significant effects on the cob diameter, length, and weight.

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