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Research Article

EVALUATION OF INTRODUCED MAIZE VARIETIES UNDER TROPICAL AGRO ECOSYSTEM ENVIRONMENT OF MOGADISHU, SOMALIA

Mohamed Mursal Ibrahim[1*], Abdullahi Sugal Hassan[2], Halim Kesici[3], Abdikadar Abdirahman Abdi[4], Mohamed Said[1]

[*1]*Erciyes University, Graduate School of Natural and Applied Sciences, Field Crops Department, Kayseri, Türkiye*
[2]*Zamzam University of Science and Technology Faculty of Agriculture, Mogadishu, Somalia*
[3]*Bilecik-Osmaneli District Directorate of Agriculture and Forestry, Osmaneli, Türkiye*
[4]*Zamzam University of Science and Technology Faculty of Agriculture, Mogadishu, Somalia*

Corresponding Author[*]
Email:alimursal013740@gmail.com

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ABSTRACT. Maize or corn (*Zea Mays* L) is one of the world's most significant crops for food security, cultivated for human consumption and animal feeding, and in recent years, is progressively playing an essential role as a source of biofuel. Maize is cultivated in a wide range of environmental conditions due to its more comprehensive range of adaptability**.** The main objectives of the study were to explore the Evaluation of Introduced Maize Varieties Under the Tropical Agro Ecosystem Environment of Somalia to evaluate maize varieties for yield and yield components of introduced maize varieties, as well as to find out the Suitable Variety of Maize for Southern Somalia of introduced maize. The experiment was conducted at The Agricultural Experimental and Research Center, Faculty of Agriculture of Zamzam University of Science and Technology, around the Garasbaaleey area. The experiment started at the beginning of (the Xagaa) season from August 2019 to December 2019. The experiment was laid out in a Randomized Complete Block (RCB) Design with Three replications. Each replication consists of 6 plots, which generally makes 18 in all replications. The experiment consisted of five introduced maize varieties and one variety of local maize (Somtex, Rx9292, Tuscant, Hioo, Antex, and Adasa16. Five were imported from Turkey. Another one is the local Somtex. In terms of morphological characteristics, 'ANTEX' demonstrated the best among the varieties, followed by 'SOMTEX,' 'ADASA16', and 'TUSCANT,' which displayed promptly; nevertheless, 'HIOO' and 'RX9292' recorded the lowest morphological parameters among the varieties. HIOO' and 'RX9292 was the variety with the lowest morphological parameters. Regarding Yield and yield components, 'ANTEX' was documented as having the best yield and yield components among the varieties. This was followed by 'RX9292' and, 'TUSCANT', 'HIOO,' displayed intermediate, while the varieties Local Variety 'SOMTEX'and 'ADASA16' were documented as having the lowest yield and yield component among the varieties.

Keywords*:* *maize, morphological characteristics, high yield variety.*

INTRODUCTION

Introduction Maize is the 3rd most important cereal crop after wheat and rice. Maize plays an important role in the agricultural economy of the country. The nutritional value of maize is very important. Its seeds contain 72% starch, 10% protein, 4.8% oil, 8.5% fiber, and many other by-products like glucose, fatty acid, and amino acid [1]. Maize, also known as Corn (*Zea mays* L.), is one of the world's most significant crops for food security, cultivated for human consumption and animal feeding, and in recent years, is progressively playing an essential role as a source of biofuel. Maize is cultivated in various environmental conditions due to its wider range adaptability [2]. In Sub-Saharan Africa (SSA), maize (*Zea mays* L.) is the most important staple crop among the five biggest crops, contributing more than 45% of total crop production value. Although maize is an essential crop in eastern Africa, there is still a deficit in production of the staple due to low soil fertility, frequent droughts, and insect pest damage [3].

Maize harvested at the dough stage of grain-filling, or green maize, may be roasted or boiled with or without the husk, while the immature cooked grains are consumed as a snack or partial meal. In addition, there is an increased preference for maize grains over products of other crops as raw materials for emerging and growing livestock feed and brewery industries. Several biotic and abiotic stresses impede attaining maximum maize yield potential [4]. Maize (*Zea mays* L.) has high economic value and is an essential crop in many Asian countries, including Indonesia. Maize is increasingly used as a staple food, feed for poultry, fish, and dairy cows, and raw materials for the food industries, including oil, flour, and snacks [5].

Sweet corn [*Zea mays* L.) var. saccharata] is a cultivated plant for human consumption, and it is a raw or processed material of the food industry throughout the world. Corn features a high-quality phyto-nutrition profile comprising dietary fiber, vitamins, antioxidants, and a reasonable proportion of minerals [6].

Like many other crops cultivated in the tropics, Maize is influenced by the environmental changes (temperature, rainfall, etc.) associated with different sowing dates, and the wider the deviation from the optimum sowing date, the greater the yield loss. A considerable yield decline due to sowing too early or too late has been reported in maize [7].

Maize was first brought to the Mediterranean region from Mexico by Spanish explorers. Maize was introduced to Ottoman agriculture via Egypt and Syria more than four centuries ago. Maize is one of the most important crops in Turkish agriculture, after wheat and barley. It is extensively cultivated in the Black Sea region (37%), followed by the Mediterranean (29%) and Marmara (16%) regions [8]. Maize (*Zea mays* L.) is a staple food for an estimated 50% of the people in sub-Saharan Africa. s. During the last three decades, several improved maize varieties bred by the International Institute of Tropical Agriculture (IITA) and the International Maize and Wheat Improvement Center (CIMMYT) have been introduced and popularized in Benin [9]. Recurrent selection, introgression of exotic improved materials into locally adapted maize materials followed by recurrent selection and introduction of improved materials from international and national research organizations, and selection under local conditions were used to improve maize grain yield and harvest index [10]. It is grown under rain-fed conditions entirely dependent on rainfall and moisture conservation techniques. More often, it is negatively affected by drought at very critical stages of growth, thus reducing yield negatively.

The average yield of maize had been low due to the area where it was grown and frequent spells of drought, frost, heat, and hailstorms. Maize is an essential source of carbohydrates, proteins, vitamins, and minerals compared favorably with other starchy crops such as rice and potatoes [11]. Although maize can tolerate high temperatures up to 35 °C, yields usually decrease if the high temperature coincides with pollen shedding. Maize responds differently to changes in temperature at different stages of growth. During germination, the optimal temperature appears to be around 18 °C. Depending on the variety, a minimal range of 480–880 mm of well-distributed rainfall is adequate for maize. s. Maize is susceptible to moisture stress during flowering when a short stress spell can reduce the crop yield by up to 30–35%. Therefore, the soil cannot support meaningful maize yields without proper fertilization—yields less than 1 t ha-1 can be obtained without adding fertilizer [12].

Maize (*Zeta mays* L.) grows over 140 million hectares, producing six million tons annually. In Ethiopia, it is growing on over 2 million hectares and ranked first among cereal in total production and productivity. The total output is estimated to be about 60 million quintals [13].

Somalia is one of the poorest countries on the planet. The East African nation has been plagued by civil unrest and harsh environmental conditions, which have led to a perennial state of food insecurity. One of the principal cereal crops in the country is maize (*Zea mays* L.). Still, Somali maize production has been highly volatile, with total production levels in 2014 nearly identical to those observed in 1980. Domestic agricultural production must increase dramatically to combat food insecurity and reduce the country's reliance on imported foodstuffs [14].

The Shebelle Riverine is Somalia's most crucial maize-producing region. Though data regarding specific maize production practices in the region are scanty, most maize in the Shebelle riverine is traditionally open-pollinated and grown under furrow irrigation with little to no external fertilizers or mechanical implements [15]. Based on area and production, maize is the world's 3rd most important cereal crop after wheat and rice. Maize is an important cereal crop for many farmers in small-scale farms in Somalia. Maize productivity in Somalia is limited in irrigated areas and is very low if compared to other countries [16].

Maize is the most important cereal crop in the world, after wheat and rice. It has excellent yield potential and attains the leading position among cereals based on production and productivity, which is why it is called the "queen of cereals." Maize is nitro-positive and needs ample nitrogen to attain a high yield. Nitrogen deficiency is a key factor in limiting maize yield. The low yield of maize can be attributed to many constraints, but NPK fertilizer application is one of the major factors [17]. Most Africans depend on maize as their stable food to feed both rural and urban dwellers. Maize cultivation in the tropics is seriously threatened by low nitrogen in the soil, which causes low production in yield [18, 19, 20].

The purpose of this research was to evaluate the morphological attributes of five introduced maize varieties and one variety of local maize (Somtex, Rx9292, Tuscant, Hioo, Antex, and Adasa16.) to select a high-yield type of sunflowers suited to Somalia's environment and to identify their morphological traits. Five of them were imported from Turkey. Another one is the local Somtex.

MATERIALS AND METHODS

Experimental Site and Period

This experiment was conducted at the Agricultural Experimental and Research Center in the Faculty of Agriculture at Zamzam University of Science and Technology, located around the Garasbaaleey area. Garasbaaleey is geographically located in the West direction of Mogadishu-Somalia. According to the soil test conducted by SATG, the experimental site's soil is classified as sandy loam in texture and has a pH of 7.31. Additionally, it contains 66 mg/kg of total nitrogen, 0.50 mg/kg of phosphorus, 28 mg/kg of potassium, and 0.43 mg/kg of organic matter. The Benadir region, located along the coast of Somalia, is characterized by a hot and arid climate with high year-round temperatures averaging between 25°C to 35°C (77°F to 95°F). Coastal areas, including the capital city of Mogadishu, experience elevated humidity levels due to their proximity to the Indian Ocean. Seasonal winds, such as the southwest monsoons during the wet season, influence the local climate. Rainfall varies seasonally, with the long rains (Gu) typically occurring from April to June and the short rains (Deyr) from October to December are crucial for sustaining ecosystems and agriculture. Conversely, from July to September, the dry season brings minimal precipitation and potential drought conditions, impacting various regional sectors. The experiment started at the beginning of (the Xagaa) season from August 2019 to December 2019.

Research Design and Treatment

The experiment was laid out in a Randomized Complete Block (RCB) Design with Three replications. Each replication consists of 6 plots, which generally make 18 plots in all replications. Each plot consists of 5 rows with a row length of 6 m and width of 3 m, which brings a plot area of 18m2. Between the row and plant was 60cm×20cm. the experiment consisted of five introduced maize varieties and one variety of local maize (Somtex, Rx9292, Tuscant, Hioo, Antex, and Adasa16.), of which five were imported from Turkey. Another one is the local Somtex.

Experimental Procedure

The land measurement started on 20th Aug 2019 using tape. The length of the area was 39m, the width was 11m, and the total area was 429 m2. The land preparation was started on 24th Aug. The land measurement began on 20th Aug 2019, using hand hoes to remove shrubs and residue of the previous crop and then plowed using hand hoes, shovels, and rakes. The soil type in which maize grew was loam soil. The installation of the irrigation system was done on 1st Sep 2019, which was a drip irrigation system. Application of potassium nitrate (KNO3) was made on 2thSep 2019 as a basal application with the amount of 9kg, as well as the application of Di Ammonium Phosphate (DAP) 4.212kg with the amount of 234gr per plot and 9kg (KNO3) with the amount of 500gr per plot respectively as Side Dressing before sowing. Urea was applied on 16 October 2019 as Side Dressing with an amount of 3.528kg. Each plot consists of 196g of urea. The first irrigation was done on 2 September 2019 to mix KNO3 and DAP with the soil. The Sowing was done on 7thSep 2019 as direct sowing with manual method.

The germination sequence was different, where the Three varieties of maize began on 10th Sep 2019, and the other Three maize germinated on 11th Sep 2019. The first-hand hoeing was started on 17th Sep 2019, the second-hand hoeing was on 14th Oct. 2019, and the latest was on 19th Nov. 2019. There was one thinning process done during the cultivation of maize. The thinning process was done on 18th September 2019. The first insect that attacked the maize was a Caterpillar on 14th Sep 2019, which was controlled by using insecticides of collagen at the rate of 45ml respectively with a tank of 25L of water, and the method was a Foliar application. Stalk borer was the second insect attacked on the maize crop, which was controlled by using an insecticide known as BULDOCK with the rate of 1kg as a powder with foliar used by hand on 21st Sep 2019.

The fall armyworm was the Third insect attack on the maize crop which was controlled by using an insecticide known as concord with the rate of 175ml with a tank of 100L of water, and the method was a Foliar application on 17th October 2019. Ear Worm was the last insect attacked on the maize crop, which was controlled by using an insecticide known as Russell with a rate of 250ml respectively with a tank of 250L of water, and the method was a Foliar application on 8th November 2019. Finally, the harvesting operation was done on 22nd December 2019 as a manual harvesting method, followed by postharvest practices, which include threshing and cleaning, which also was done as a manual method.

Data Collection Procedure

Data were recorded on Plant height, number of cobs, cob weight, cob length, free grain cob length, Number of grains per cob, thousand-grain weight, Grain yield, Straw yield, biological yield, and Harvest index. The plant height was measured from the ground level to the tip of the maize, excluding the tassel of each plant, and ten plants were selected randomly at maturity from each plot. The number of cobs per plant was recorded from ten randomly selected plants from each plot, and the average value was recorded. The cob weight was weighed by using Digital Electric Balance and recorded in grams. The cob length was measured from the base to the tip of the cob for ten randomly selected plants from each plot, and the average value was recorded. The free grain cob length was measured in the free grain space for ten randomly selected plants from each plot, and the average value was recorded. The number of grains per cob was counted as the number of grains per cob from ten randomly selected plants from each plot, and the average value was recorded. The thousand cleaned seeds were counted randomly from each sample, weighed using Digital Electric Balance, and recorded in grams. The grain yield was recorded from each plot after threshing and cleaning, and weighed by using Digital Electric Balance. Grain yield was recorded into Kg/Plot, and finally converted into t/ha. The straw yield was recorded from each plot and weighed using Digital Electric Blanca. The biological yield was recorded into Kg/plot and finally converted into t/h.

The biological yield was calculated by using the following formula: -

Biological yield = Grain yield + Straw yield.

Harvest Index was recorded in percentage by using the following formula: -

$$\mathbf{HI\ (\%)} = \frac{\text{Grain Yield}}{\text{Biological yield}} \times 100$$

After we finished collecting the data, we analyzed them data using **the MSTATC** Master of Statistics and used the Least Significant difference (**LSD**) Method.

RESULTS AND DISCUSSION

Table 1. *Morphological parameter*

Treatments	Plant Height (cm)	No. of Cobs/Plant	Cob Weight (gr)	Cob Length (cm)	Free Grain Cob Length (cm)
V1	2.46 A	1.00 A	166.40 B	16.10 C	1.94 BC
V2	2.34 A	1.00 A	226.67 A	20.20 A	1.60 C
V3	2.41 A	1.00 A	214.87AB	18.16 ABC	3.03 AB
V4	2.37 A	1.00 A	166.17 B	18.26 ABC	4.15 A
V5	2.49 A	1.00 A	238.70 A	19.00 AB	2.50 BC
V6	2.46 A	1.03 A	201.70 AB	17.03 BC	2.31 BC
Level of Significant	Ns	Ns	*	*	**
CV (%)	7.44	2.34	13.79	7.87	24.65

**= highly significant at 1% level, NS= non-significance, SE±= Standard Error of a Mean, CV= coefficient variation.

Plant Height

There were non-significant significant variations among the varieties (Table 1). The highest plant height (2.49 m) was observed from variety 5" ANTEX," followed insignificantly by types 1"SOMTEX" (2.46 m) and variety6 "ADASA" (2.46 m), and variety 3"TUSCANT" (2.41 m) showed intermediate. In comparison, the lowest plant height was recorded from varieties 4 "HIOO" (2.37m) and varieties 2"RX9292" (2.34). These results are further supported by [21], who reported That Maize plant height among the varieties differed. These findings agree with those of others, but it is highly significant among our varieties and their varieties [22]. Plant height significantly differed among maize cultivars in 2006 and 2007 (Table 2). Cultivar C-955 had the highest plant height (238.3 cm), while the lowest plant height (173.6) was recorded in cultivar DKC-6842 (Table 3). The plant height was close to those obtained previously by [23]. The average plant heights ranged between (268.6 cm) and (280.9 cm) for cultivars and between (269.0 cm) and (276.8 cm) for nitrogen fertilizer levels.

The Number of Cobs Per Plant

The number of cobs per plant was significant among the varieties according to the number of cobs per plant presented in Table 1. Variety 1"SOMTEX" (1.00), followed insignificantly by variety 2“RX9292” (1.00), variety 3 “TUSCANT” (1.00), and variety 4 “HIOO” (1.00), and variety 5“ANTEX” (1.00) and finally variety 6 “ADASA 16” (1.03). Comparable results were reported by this research [24]. These results are further supported by [25] this research reports similar results.

Cob Weight

Significant variations among the varieties according to cob weight are presented in Table 1. The maximum cob weight among the varieties (238.70) was recorded from the variety5 “ANTEX,” followed significantly by variety2 “RX9292” (226.67) and variety3 “TUSCANT” (214.87) and variety 6 “ADASA 16” (201.70) and variety 1 “SOMTEX” (166.40). In contrast, the minimum cob weight (166.17) was verified from variety 4 “HIOO”. These results agree with [26]. Many studies have supported our research in grain yield but have found different results that may be attributable to different climatic factors. There is significant variation within these studies in cob weight as well as supported by [27].

Cob Length

There were significant variations among the varieties (Table 1). The longest cob length among the varieties (20.20 cm) was recorded from “RX9292”, followed significantly by variety 5“ANTEX” (19.00 cm) and variety 4 “HIOO” (18.26 cm), and variety 3 “TUSCANT” (18.16 cm) showed intermediate, while the shortest cob length by variety 6“ADASA 16” (17.03 cm) and was recorded from variety 1(16.10) “SOMTEX”. Among cultivars, cob length appeared significantly [28]. A similar result was obtained by [29].

Free Grain Cob Length

There were highly significant variations among the varieties (Table 1) according to free grain cob length. Variety 4 “HIOO” (4.15 cm), followed significantly by variety 3 “TUSCANT” (3.03cm), variety5 “ANTEX” (2.50) and variety 6“ADASA16” (2.31) showed intermediate, and while the shortest free grain cob length by variety 1“SOMTEX” (1.94cm) and was recorded from variety 2(1.60) “RX9292”. [30] There were highly significant variations among our studies.

Table2. *Yield Parameters*

Treatments	No. of grains/cob	1000GW (gr)	Grain Yield (t/ha)	Straw Yield (t/ha)	Biological Yield (t/ha)	Harvest Index (%)
V1	468.67 BCD	270.67 C	7.03 D	14.63 B	21.67 B	48.10 BC
V2	531.27 AB	513.33 A	9.82 B	18.87 A	28.68 A	53.64 BC
V3	527.97 ABC	316.67 B	9.82 B	11.38 B	21.15 B	86.99 A
V4	459.67 CD	316.33 B	8.27 C	19.72 A	27.98 A	42.20 C
V5	548.17 A	342.00 B	10.93 A	19.30 A	30.23 A	56.60 B
V6	437.17 D	349.67 B	6.67 D	14.97 B	21.63 B	44.63 BC
Level of significant	*	**	**	**	**	**
CV (%)	7.78	6.46	5.97	12.68	8.50	13.29

**= highly significant at 1% level, NS= non-significance, SE±= Standard Error of a Mean, CV= coefficient variation.

Number of Grains/Cob

There were significant variations among the varieties (Table 2); the maximum number of grains per cob among the varieties (548.17) was recorded from variety5 “ANTEX”, followed significantly by variety2 “RX9292” (531.27) and variety3 “TUSCANT” (527.97), and variety

1“SOMTEX”(468.67) and variety 4“HIOO”(459.67). In contrast, the minimum number of grains per cob (437.17) was verified from variety 6“ADASA 16”. A similar type of result was found by [31]. There was significant variation among). Our results are also confirmed by the findings [32].

Thousand Grain Weight(gr)

There were highly significant variations among the varieties according to the 1000-grain weight Presented in Table 2. The maximum 1000–grain weight among the varieties (513.33 gr) was recorded from the variety2 “RX9292”, followed highly significantly by variety 6 “ADASA 16” (349.67 gr), and variety5 “ANTEX” (342.00 gr), variety 3“TUSCANT” (316.67 gr) and variety 4“HIOO” (316.33 gr), whereas the minimum 1000–grain weight, (270.67 gr) was verified from variety 1“SOMTEX”. These results are in line with those of [33]. our research, there were variation findings by [34].

Grain Yield(t/ha)

There were highly significant variations among the varieties (Table 2). The maximum grain yield among the varieties (10.93 t/h) was recorded from variety 5 “ANTEX”, followed significantly by variety 2 “RX9292” (9.82t/h), and variety 3 “TUSCANT” (9.77 t/h), and variety 4“HIOO” displayed intermediate (8.27 t/h), while the minimum grain yield Variety 1 “SOMTEX”. (7.03 t/h) and (6.67 t/h) were documented from variety 6 “ADASA 16” The grain yield there was significant variation among our studies but supported by [35]. A similar type of result was found by [36].

Straw Yield (t/ha)

There were highly significant variations among the varieties (Table 2), the maximum straw yield among the varieties (19.72t/h) was recorded from variety 4, “HIOO”, followed significantly by variety 5, “ANTEX” (19.30t/h), and variety 2 “RX9292” (18.87 t/h), and variety 6 “ADASA” (14.97 t/h) and variety 1 “SOMTEX” (14.63 t/h) showed intermediate, while the minimum straw Yield (11.38 t/h) verified from variety 3 “TUSCANT”. There are similar results reported by this research [37].

Biological Yield (t/ha)

There were highly significant variations among the varieties (Table 2). The highest biological yield among the varieties (30.23t/h) was recorded from variety 5 “ANTEX”, followed significantly By variety 2 “RX9292” (28.68t/h), and variety 4 “HIOO” (27.98t/h), while the shortest biological yield by variety 1 “SOMTEX” (21.67 t/h) and variety 6 “ADASA16” (21.63 t/h), whereas the least biological yield among the varieties was recorded by variety 3“TUSCANT” (21.15 t/h). our research, there were variation findings [38]. Our results are also in line with [39], who obtained higher biological yields (18408 A), (17142 A), and (16961A).

Harvest Index (%)

There were highly significant variations among the varieties (Table 2). The maximum harvest index among the varieties (86.99%) was recorded from variety 3, “TUSCANT,” followed highly significantly by varieties 5, “ANTEX” (56.60%), and variety 2, “RX9292” (53.64%), while the lowest harvest index variety 1 “SOMTEX” (48.10%) and variety 6 “ADASA16” (44.63%), whereas the least harvest index variety 4(42.20%) “HIOO”. Similarly, [40] stated that there is significant variation in the harvest index due to different climatic factors.[41] who reported that no -significant variation was observed in the harvest index.

CONCLUSION

Maize is a staple food crop in Somalia and across the globe. Food production falls short of demand because of rising populations and associated increases in per-person consumption; imports fill the resulting gap. There is a reliance on imported maize seeds in Somalia. The food sector and the nation of Somalia benefit significantly from increased maize output. Maize seed production should be prioritized so that we may become food self-sufficient and lessen our reliance on foreign suppliers. As a result, farmers would benefit from a reduction in the cost of inputs if they could raise Maize more efficiently. Researchers found that “ANTEX” and “RX9292” were the most productive because of their ability to thrive in the harsh conditions of the Somalian countryside. Maize cultivation is an essential skill for farmers to acquire.

In terms of Plant Height Character, “ANTEX” exhibited the best Plant Height among the Varieties, followed by “SOMTEX,” and Varieties “ADASA16” and “TUSCANT” displayed immediately. In contrast, Varieties “HIOO” and “RX9292” recorded the lowest Plant Height among the varieties.

As well as in terms of Yield “ANTEX” (10.93 t/h) Variety was recorded as the best yield among the varieties, followed by “RX9292” (9.82t/h), and varieties “TUSCANT” (9.77t/h), “HIOO” (8.27 t/h), displayed intermediate, while the lowest yield among the varieties was documented by Local Variety “SOMTEX” (7.03 t/h) and (6.67 t/h) “ADASA 16”.

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