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Research Article

Influence of Inter and Intra Row Spacing for Growth and Yield of Maize

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Abstract

Effect of inter row and intra row spacing on growth, growth parameters, yield and yield related parameters of maize was studied at Melkasa Agricultural Research Center, Ethiopia during the rainy season in 2019 and 2020. The objective of this study was to evaluate impact of inter row and intra row spacing on growth and yields of maize variety Melkassa-II. The experiment was laid out in randomized complete block design with a split-plot treatment structure of 4 inter spacing levels as the main plot and 3 intra row spacing levels as sub plot factors. There was significant (P<0.05) main effect of inter row spacing, and interaction of inter row and intra row spacing on leaf leaf area index, cob weight, grain yield, 1000 seed weight and harvest index. There was also significance difference due to the main effects of inter row spacing on leaf leaf area index, cob weight, plant height, kernels per row, above ground biomass, grain yield, 1000 seed weight and harvest index. Higher grain yield and above ground dry biomass yield were due to intermediate and closer spacing. By considering other crop management factors it can be concluded that spacing combination of 65 cm * 20 cm can be recommended in attaining higher grain yield of Melkassa-II maize variety in similar environment.

Keywords

Plant Spacing, Maize Variety, Plant Population

1. Introduction

Maize (zea mays L.) belongs to the family poaceae (Gramineae) and the tribe Maydeae. It is an annual short-day, cross-pollinated crop. Maize plant have an erect stem which bear alternate leaves tassel at the top and auxiliary female inflorescence known as ear in the middle. Maize is known as a strategic food and feed crop that provides an enormous amount of protein and energy for humans and livestock. Even though much of the world maize production is used for animal feed, human consumption in many developed and developing countries is become steadily increasing [21]. It ranks 3rd next to wheat and rice [8]. Ethiopia is 4th largest maize producing country in Africa. It has been selected to achieve food self-sufficiency because of its high demand for food grains and high productivity in Ethiopia (Tolessa et al., 1993).

Crop management without proper spacing and arrangement of plants are too difficult. Ideal plant population vary with growth requirement of plant species and cultivars within plant species. Some crops readily compensate for low populations in some environments through vegetative development; others are more rigid. Optimum populations of annual crops may range from 50,000 to 80,000 plants per hectare with maize 300,000 to 400,000 plants per hectare

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with soya beans and 1.5 to 2 million plants per hectare with wheat. Well-spaced plants at 10% of an optimum population may yield 80% of those seeded at recommended rate. Plants at low populations explore their surroundings and more completely for light, water and nutrients. Reduced competition permits individual plants to grow larger and yield more than at higher plant densities. However, if the population density is below the genetic capacity of the individual to expand vegetatively yield per unit area is reduced. At low populations the crop canopy may not develop completely, and weed suppression is lessened.

Plants compete with each other for space and raw materials. As populations increase individual plant productivity declines, while area productivity increases. Individual plants of most species increase in height and decrease in stem diameter with further crowding until individual plants become barren, weaken, etiolated, and lodge and the crop is lost. Plants compete above and below ground level. Root-zone competition is not fully understood but growth is limited by close proximity of neighbors. Soil exploration and uptake of nutrients and water plant are limited. Accordingly optimum populations are smaller in dry areas than in more humid areas. As the canopy develops, lower leaves become increasingly shaded, light levels drop below the compensation point of photosynthesis. Spacing and arrangement of plants are important to good management. Equidistant arrangements normally produce maximum yield thereby permitting maximum interception of sunlight and forming a complete canopy more quickly than when planted closely in rows. There are however valid reasons for planting in rows with plants spaced closely, leaving inter row spaces unoccupied.

Maize is characterized by monoecious floral organization, low tillering cognition and synopsis ontogeny punctuation which leads maize production greatly affected by varying plant density than other members of the grass family. Proper adjustment of crop plant and optimum plan population is very crucial in crop production by enabling efficient utilization of resources. Efficient utilization of land, light, soil moisture and fertilizers are very needed for crop growth, development and yield (Ali et al., 1998: Majid et al., 1986). Maize crop photosynthetic efficiency, growth, development and yield are highly related to the impact of canopy architecture on the vertical distribution of light in the plants canopy. It is stated that optimum plant density plays a great role in increasing the capture of solar radiation of crop canopy. How ever, high plant population density decreases the efficiency of conversion of intercepted solar radiation because of mutual shading in the plants in the field (Zhang *et al.*, 2006).

Maize genotypes have variable morphological and physiological characteristics. Thus, it is needed to grow it under optimum plant population to get better yield. Yield of modern maize hybrids shows a curvilinear response to plant density which becomes maximum at optimum plant population. High plant density exceeding beyond a certain limit of plant population density leads to increase in plant infertility and plant to plant unevenness by elongating the duration between pollen shedding and silking resulting in more unproductive plants which resulted low final yield. Planting patterns as well as plant population densities have significant impact on growth, development and yield of maize [26].

Further improvements in tolerance to more planting densities and potential yield per plant under low stress conditions is best strategy to increase yielding ability of grains. Plant density exerts great effects growth of maize due to its competitive habit both on the early and lateral development stages (Singh and Chaundhry, 2008). The optimum plant density of modern hybrid is higher than that of oldest hybrid and plant number per area rely on various factors such as soil moisture availability, soil fertility, hybrid maturity group and plant spacing. Farmers should know the optimum plant density of the cultivars they grow. In crop production including maize it is very essential to develop enhanced crop management strategies by identifying the agronomic optimal plant density to maximize grain yield. This needs careful management of inter plant competition. Even though maize has multiple purposes and high yielding potential, the national average yield (3.67 $t{\cdot}ha^{-1}$) is low [6] as compared to developed countries' average yield which is about 6.2 $t{\cdot}ha^{-1}$ [4]. The low productivity of maize is attributed to many factors such as poor agronomic practices like inappropriate seed rate, row and plant spacing, poor soil fertility, drought, insects, diseases and weeds, farmers' limited access to fertilizers, and low access to seeds of improved maize varieties [24]. Among agronomic practices plant density is one of the factors that affect yield by influencing yield components such as the number of ears, the number of kernels per ear, and kernel mass [2]. Moreover, grain yield of maize is more affected by variations in plant population than other members of the grass family because of its low tillering ability [22]. Therefore, plant density and arrangement of plants in a unit area greatly determine resource utilization such as light, nutrients, and water; it affects the rate and extent of vegetative growth and development of crops particularly that of leaf area index, plant height, root length and density, yield and yield components, development of important diseases and pests, and the seed cost [13]. Because of this discrepancy, the establishment of required plant density is essential to get maximum yield since high plant density will deplete soil moisture and nutrients before the crop's maturity, whereas low plant density will leave nutrients unutilized [5]. So, it is important to determine the optimum plant density for maize variety depending on environmental factors (soil fertility, moisture supply) and agronomic management practices to get maximum yield [12]. Previous studies commented that the information on forming suitable plant density for each maize cultivar is one of the key factors for planning maize density to get maximum yield. Therefore the objective of this study was to determine the effect of inter and intra row spacing on growth, yield and yield components of Melkassa-II maize variety.

2. Materials and Medhods

Description of Study Area

The study was conducted at Melkassa Agricultural Research Center (MARC) which is located at about 117 km in East of Addis Ababa. Melkassa is located at 8°24 N and 39°21 E with 1550 m elevation. It is categorized under arid to semi-arid agro ecological zones. Its soil type is Andosols of volcanic origin with pH ranging from 7 to 8.2. Its minimum and maximum temperature is 14c° and 28.4c° http://www.eiar.gov.et/marc).

2.1. Experimental Design and Treatments

Treatments were developed by combining four inter spacing with three intra spacing (Table 1). Split plot design was used. Inter spacings were randomly assigned to the main plots and intra spacings were randomly assigned to sub plots. The randomized complete block design with a split-plot treatment structure of four inter spacing levels as the main plot and three intra spacings as subplot factors was used. The treatments were replicated three times.

The four inter spacing were allotted to main plots and four different intra spacing were allotted to sub-plots. Different plant populations were maintained by varying row to row distance and plant to plant distance in all plots. All cultural practices like fertilizer application, pest control and other operations were uniformly carried out whenever needed.

The following treatments were studied:

A. Inter spacing

85cm

75cm

65cm

55cm

B. Intra spacing

20cm

25cm

30cm

Table 1. *Combination of treatments.*

Plant density ha^{-1}	Number	Inter row * Intra row	spacing area of 1 Plant
1	55cm *20cm	0.11	90,909.09
2	55cm *25cm	0.1375	72,727.27
3	55cm *30cm	0.165	60,606.06
4	65cm*20cm	0.130	76923.00
5	65cm*25cm	0.1625	61,538.46
6	65cm*30cm	0.1950	51,282.0
7	75cm*20cm	0.150	66666.66
8	75cm*25cm	0.1875	53333.33
9	75cm*30cm	0.2250	44444.44
10	85cm*20cm	0.170	58823.53
11	85cm*25cm	0.2125	47058.80
12	85cm*30cm	0.2550	39215.68

2.2. Field Management

Prior to sowing, the field was well prepared by ploughing with tractor and then smoothed with a disc-plough to prepare a fine seedbed at the experimental site. Fertilizer was spot applied to individual plants using the micro-dosing method rather than broadcast, where a Coke bottle cap will be calibrated to deliver approximately x gm per plant. In this way, higher densities will receive higher fertilizer rates on a unit area basis but equal rates on a per plant basis, thus avoiding the confounding effect of competition for resources (at least fertilizer, but not moisture). All other cultural practices will be given based on available recommendation.

Data Collection and Measurements

Cobs: Number of cobs was recorded from the count of five randomly selected plants per plot at harvest.

Kernels per row: It was counted from cobs of five randomly taken plants at harvest.

Number Kernels per row: It was recorded from selected five plants.

Thousand seed weight: It was counted using electronic seed counter from a bulk of threshed seed and weighed using sensitive balance from a plot at harvest by adjusting at 12.5% moisture.

Grain yield: The seed from net plot area was cleaned, weighed and converted in to yield in Kg for both maize and common bean.

Biomass Yield: At physiological maturity stage the above ground biomass of ten plants selected randomly from the destructive rows was measured after drying the harvested produce till a constant weight for obtaining the total above ground dry biomass, then the dry biomass per plant obtained was multiplied with total number of plants in net plot area and converted in to Kg/ha.

Harvest Index: It was calculated as a ratio of grain yield to above ground biomass per multiplied by 100 at harvest from the restive treatments.

Statistical Analysis

Data collected from this experiment was analyzed using statistic 10.0 (Analytical software, Tallahassee FL). Data was tested for normality by normal probability plot and analysis of variance (ANOVA) was done using General Linear Model (GLM) procedure to test for statistical difference among treatments. Mean separation was carried out using LSD test at $P<0.05$ if significant treatment differences existed.

Result and Discussion

Plant height

Plant height was significantly(P<0.05) affected by main effects of inter row spacing. However, it was not significantly affected by neither by the main effect of intra row nor the interaction effects of inter row and intra row spacing (Table 2). The taller plant height (224.6cm) was obtained from the narrower spacing of 55cm and the shorter plant height (207.0cm) was obtained from the wider inter row spacing of 85cm. AS plant spacing decreased from 85cm to 55cm we observed consistent increment of plant height from 207cm to 224.6cm (Table 2). This increment of plant height at narrower inter row spacing might be due to low solar interception by crop canopy for high plant density. This result is inline with the finding of [18] that sorghum plant height was significantly affected by inter row spacing and narrower inter row spacing of 55cm was gave significantly the taller plant height than the wider inter row spacing of 75cm inter row spacing. Similarly, it was stated that sorghum plant height was increased with increment in sorghum plant density [11].

Table 2. *Effects of inter row and, inter row x intra row spacing effects on maize growth- and growth-related parameters.*

Inter row	**PH (cm)**	**LAI**	**Kernels per row**	**CW (t ha-1)**
55cm	224.6A	5.7A	33.9B	9.8778A
65cm	215.9B	4.95B	36.8A	9.9000A
75cm	211.5C	3.75C	35.6AB	8.7222B
85cm	207.0C	3.69C	34.7AB	6.6111C
LSD	9.45	0.1659	0.74	0.2703
CV (%)	9.34	11.03	9.29	9.24
Inter*intra row	PH (cm)	LAI	Kernels per row	CW (t ha-1)
85cm*20cm	217.7	3.9CD	34	5.533D
85cm*25cm	210.0	3.8CD	35	9.400AB
85cm*30cm	205.3	3.3D	35	9.467AB
75cm*20cm	211.3	4.0CD	36	10.000A
75cm*25cm	204.3	3.9CD	36	9.400AB
75cm*30cm	205.6	3.3D	35	9.100AB
65cm*20cm	220.0	5.4AB	38	10.267A
65cm*25cm	225.7	5.4AB	35	10.033A
65cm*30cm	220.5	4.1CD	38	10.167A
55cm *20cm	228.0	6.4A	34	6.633CD
55cm *25cm	224.7	5.9AB	33	7.667BC
55cm *30cm	224.3	4.8BC	35	7.667BC
Inter row	**PH (cm)**	**LAI**	**Kernels per row**	**CW (t ha-1)**
LSD	-	0.3	-	0.4375
CV (%)	4.99	8.27	6.3	6.10

2.3. Leaf Area Index

Leaf area index (LAI) was significantly (P<0.05) affected inter row spacing and interaction of inter row and intra row spacing. The highest leaf area index of 5.7 was obtained from the narrowest inter row spacing of 55cm and the lowest leaf area index of 3.69 was obtained from the widest inter row spacing of 85cm. Generally, leaf area index was increased with increasing inter row spacing from 85cm to 55cm.

For combination of inter row spacing and intra row spacing the highest leaf area index of 6.4 was obtained from the narrowest combination of inter row and intra row spacing of 55cm and 20cm, while the lowest leaf area index of 3.3 was recorded from the widest inter row and intra row spacing combination of 85cm and 30cm and 85cm and 30cm (Table 2). This might be due to high number of plants per unit area under narrowest inter row plant spacing than widest inter row spacing. It is in line with the work of [1] who reported high leaf area index of maize 6.45 under narrower row spacing of 55cm than wider row spacing of 75cm. [23] also reported higher leaf area index of 4.6 at 40cm than lower leaf area index of 3.64 at 75cm inter row spacing. The highest value of leaf area index 6.19 was obtained from narrowest inter row spacing of 45cm and the lowest value of leaf area index 5.33 was obtained from the widest inter row spacing of 75cm (Yousaf *et al.*, 2007).

2.4. Kernels Per Row

Kernels per row was significantly (P<0.05) affected by inter row spacing but did not significantly affected by the combination effects of inter row and intra row spacing (Table 2). Higher number kernels of per row of 36.8 was recorded from inter row spacing of 65cm maize planted under the other treatments. Even though it was not significantly affected by the combination of inter row and intra row spacing high number of kernels per row was recorded from interaction of 65cm inter row and 30cm intra row spacing. We observed that kernels per row was decreased with increment in plant population density. This might be due to lower kernel formation ear under high plant population density. Lower supply of C and N to the ear causes immediate young kernel abortion after fertilization (Liu *et al.*, 2015). High plant density leads to intra specific competition and the crop faces more challenging and in constraint condition. This condition mainly starts at the end of stem elongation and grain development stage which is important in determining number of kernels per row.

2.5. Cob Weight

Cob weight was significantly (P<0.05) affected by the main effects of inter row and interaction effects of inter row and intra row spacing (Table 2). For inter row spacing the narrower spacing of 65cm gave the highest cob weight of 9.9 t ha^{-1} and the wider inter row spacing of 85cm produced the lowest weight of 6.6 t ha^{-1}. For interaction of inter row and intra row spacing the narrowest spacing of 65cm * 20cm gave highest weight of 10.267 t ha^{-1}. While the widest interaction spacing of 85cm inter row and 20cm intra row spacing gave the lowest weight of 5.533 t ha^{-1}. This could be due to high number of cobs from narrow spacing which leads to increased cob weight and final grain yield. This result is similar with a work of [3] reported that maize cob weight increased with increased plant population density.

2.6. Grain Yield

Maize grain yield was significantly(P<0.05) affected by inter row spacing and interaction of inter row and intra row spacing (Table 3). The highest grain yield of maize 5 t ha^{-1} was obtained from the narrowest inter row spacing of 65cm and the lowest grain yield were obtained from the widest inter row spacing of 75cm and 85cm inter row spacings. For combination effects of spacing grain yield was increased when the inter row spacing increased from 65cm to 75cm and then decreased after 75cm. The spacing combinations of 65cm * 20cm, 65cm * 30cm and 65cm *25cm gave the highest yield of 6.5 t ha^{-1}, 6.5 t ha^{-1} and 6.1 t ha^{-1} respectively. The wider spacing combinations of 85cm * 25cm, and 85cm * 30cm had gave the lowest grain yield of 4.12 t ha^{-1} and 4.23 t ha^{-1}, respectively. In general grain yield was increased with increment in plant population density. This could be due to the fact that high plant population ensured early canopy coverage and maximizes light interception leading to high crop growth rate and increase ear number resulting in increased grain yield of maize. Inline with this result [17, 27] explained that there was significant effect of between plant spacings and higher grain yield was obtained from narrower spacing against the lower grain yield from wider plant spacing.

Maize crop grown at 60 x 15cm spacing produced significantly higher grain yield (3.53 t ha-1 than that of 60 x 35cm (3.15 t ha-1) (Randhawa et al., 2007). [7] also reported that higher grain yield of maize (15.25 t ha-1) was obtained at narrower (55cm x 20cm) spacing than at wider (75cm x 30cm) spacing which is 11.43 t ha-1. [19] showed that higher grain yield of maize (8.370 t ha-1) was obtained with 12.50 x 70cm spacing while lower (6.646 t ha-1) at 17.50cm x 70cm spacing. Similarly, [9] reported that maize grain yield increased from 10.1 to 11.2 t ha-1 as plant density increased from 59,000 to 89,000 plant ha-1. According to Shrestha (2013), grain yield (5.11 t ha-1) obtained under plant density of 66666 plants/ha (60 × 25cm spacing) was significantly higher than that of 55555 plants/ha (60 ×30cm spacing) but that was at par with yield of 83333 plants/ha (60 ×20cm spacing). A similar trend in yield across planting density has been observed by [16] who reported that grain yield increased with increasing maize plant density.

2.7. Biomass Yield

Above ground biomass yield was significantly (P<0.05) affected only by inter row spacing but not significantly affected by interaction of inter row and intra row spacing (table 3). The narrowest inter row spacings of 55cm and 65cm had produced highest biomass of 14.039 t ha^{-1} and 13.911 t ha^{-1} respectively. While the widest spacing of 85 cm inter row spacing gave the lowest above ground dry biomass yield. This means increment in inter row spacing from 55cm to 85cm leads to decrease in above ground dry biomass. This could be due to higher plant population recorded at narrow inter row spacing and leading to greater dry matter production. This result is inline with the work of Yousuf *et al.*, (2007), that narrower inter row spacing produced higher total above ground dry biomass than that of 60cm and 75cm inter row spacing. Similarly, [18] stated that higher sorghum above ground dry biomass was produced at narrower inter row spacing. According to [10] the narrow row spacing or high plant population density had produced the highest biomass and the wide row spacing or low plant density had produced the lowest biomass. Similarly, [15] stated that biomass yields of maize were significantly higher in the narrow intra row spacing than in wider intra row spacing because of a greater number of taller plants per unit area and better interception of solar radiation by crop canopy.

Table 3. *Effects of inter row and, interaction of inter row * intra row spacing on maize yield and yield related parameters.*

Inter row	**GY (t ha-1)**	**BM (t ha-1)**	**HI**	**TSW (g)**
55cm	4.4667B	14.039A	31.8B	257.47B
65cm	5.0000A	13.911A	35.9AB	286.06AB
75cm	3.7500C	11.011B	34.1AB	301.28AB
85cm	3.8556C	10.628B	36.3A	320.18A
LSD	0.1489	0.5345	1.0286	16.716
CV (%)	10.46	12.9	8.97	10.45
Inter*intra row	GY (t ha^{-1})	BM (t ha^{-1})	HI	TSW (g)
85cm*20cm	4.9333DEF	11.633	42.4AB	265.40AB
85cm*25cm	4.1667F	11.100	37.5B	298.03AB
85cm*30cm	4.2667EF	13.633	31.3C	337.83A
75cm*20cm	5.0667CDEF	12.667	40.0AB	266.13AB
75cm*25cm	5.3000BCDE	13.100	40.5AB	276.37AB

Inter row	GY (t ha-1)	BM (t ha-1)	HI	TSW (g)
75cm*30cm	4.6333DEF	12.033	38.5B	273.67AB
65cm*20cm	6.5333A	15.100	43.3A	315.43AB
65cm*25cm	6.1000ABC	15.233	40.0AB	307.27AB
65cm*30cm	6.4000AB	14.833	43.1A	222.37B
55cm *20cm	5.7667ABCD	13.633	42.3AB	310.10AB
55cm *25cm	4.8333DEF	12.467	38.8B	327.60AB
55cm *30cm	4.9333DEF	13.633	36.2B	294.73AB
LSD	0.2798	-	2.4363	24.848
CV (%)	2.27	6.70	7.29	8.20

2.8. Harvest Index

Harvest index was significantly (P < 0.05) affected by inter row and interaction of inter row and intra row spacing (Table 3). Inter row spacing at 85cm recorded the highest harvest index of 36.3%, whereas the narrowest inter row spacing of 55cm recorded the lowest harvest index of 31.8 in case of main effect of inter row spacing. For interaction effects of inter row and intra row spacing the narrowest combination spacing of 65cm inter row and 20cm intra row spacing had recorded the highest harvest index of 43.3%, while the widest spacing combination of 85cm inter row and 30cm intra row have recorded the lowest harvest index of 31.1%. It is observed that harvest index increased at all intra row spacing as inter row spacing increased from 55cm to 75cm inter row spacing. How ever increasing inter row spacing beyond 75cm for all intra row spacing could not increase harvest index in case of interaction effect. Thus, intermediate plant spacing had gave higher harvest index. This result is inline with findings of Yousaf *et al.*, (2007) showed that harvest index increased with increasing spacing and become declined with further increment of plant density. This implied that intermediate inter row spacing recorded higher harvest index than both lower and higher plant spacing.

Thousand seed weight

Thousand seed weight was significantly (P<0.05) affected by inter row spacing and, interaction of inter row and intra row spacing (Table 3). For inter row spacing the widest inter row spacing of 85 cm had recorded the highest thousand seed weight of 320.18g whereas, the narrowest inter row spacing of 55cm had recorded the lowest thousand weight of 257.47g. with respect to interaction of inter row and intra row spacing the highest thousand seed weight of 373.8g was recorded from combination of 85cm inter row and 30cm intra row spacing and the lowest thousand weight of 222.37g was recorded at 65cm inter row with 30cm intra row spacing. Plant spacing increment will lead to decrease in weight of thousand seed. This might be due to assimilates partitioning between numbers of kernels used in connection with decreased inter plant competition leads to increased plant capacity for utilizing the environmental inputs.

With respect to combination of inter and intra row spacing, the thousand seed weights increased with increase in inter and intra row spacing combination where the lowest thousand seed weight (222.37g) was recorded at 65cm and 30cm inter row and intra row spacing combination and the highest seed weight (373.8g) was recorded from the combination of 85cm inter row and 30cm intra row spacing.

With increased inter row and, combination of inter row and intra row spacing, thousand seed weight increased. This might be because of assimilates partitioning between higher numbers of kernels used in connection with the decreased inter plant competition that leads to increased plant capacity, for utilizing the environmental inputs in building great number of metabolites to be used in developing new tissues and increasing its yield components. In addition, wider spaced plants, that improved the supply of assimilates to be stored in the kernel hence, the weight of thousand kernel increased. This result is inline with the work of [5] reported that wider spacing produced higher thousand kernels weight than narrower plant spacing. Similarly, [9] reported that thousand kernels weight with increased plant population density.

3. Summary and Conclusion

Maize production is greatly affected by varying planting density than other members of the grass family because of its monoecious floral organization, its low tillering cognition to fill the gap among plants and the presence of synopsis ontogeny punctuation. Among agronomic practices, variety and plant spacing require special attention.

The results of the present study concluded that the highest leaf area index, harvest index and thousand seed weight was obtained at spacing combination of 85cm inter row spacing and 30cm intra row spacing. While the highest Kernels per row, cob weight, grain yield and biomass yield were obtained at a combination of 65cm inter row spacing and 20cm intra row spacing.

So, it could be concluded that sown maize, Melkassa-II at spacing combination of 65cm inter row and 20cm intra spacing maximized maize productivity under the environmental conditions of central rift valley of Ethiopia.

Abbreviations

BM	Biomass
CW	Cob Weight
GY	Grain Yield
HI	Harvest Index

LAI	Leaf Area Index
MARC	Melkassa Agricultural Research Center
PH	Plant Height
TSW	Thousand Seed Weight

Conflicts of Interest

The authors declare no conflicts of interest.

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