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THE EFFECTIVENESS OF DIFFERENT TREATMENT METHODS ON CROP GROWTH RATE (CGR) AND SEED PRODUCTION RATE (SPR) OF TWO MAIZE (ZEA MAYS. L.) VARIETIES

Oyewusi K. I., Akeju. O., Akinola. M. O.
Department of Agricultural Technology, The Federal Polytechnic, Ado Ekiti, Ekiti State, Nigeria.
Corresponding author: kayoyewusi@gmail.com, +234 803 463 1189

Abstract
Maize productivity is often limited by various biotic and abiotic factors. This study evaluated the effectiveness of different treatment methods on crop growth rate and seed production rate of two maize varieties. Six treatments were applied to two maize varieties, including Control,(CLT), Bagging of Female Inflorescence,(BFI), Adjustment of Plant Density,(APD), Tassel Removal, (TR) Integrated Management Practices (IMP), and Hormone Application (HA). Sixty (60) Plastic pots of 7 liter capacity were be perforated at the bottom and filled with top soil. The experiment was a 2 x 6 factorial combination of two cultivars of maize namely Obatanpa (an indigenous variety) and Oba Super 6 (an improve variety) and six different treatment applications replicated five times to make a total of 60 pots arranged in a randomized complete block design (RCBD). Three seeds each of the tested maize varieties were sown per pot except in APD where only one seed was planted per pot. The results showed that Obatanpa and Oba Super responded differently to the treatments applied. The effectiveness of the treatments was observed in terms of crop growth rate and seed yield. Tarsel Removal, Integrated Management Practices and Hormonal Application treatments resulted in significantly higher Crop Growth Rates for both varieties than the other treatments. The shortest days to 50% tarselling and silking were observed in TA, IMP, and HA treatments, indicating faster reproductive growth. Seed yield were highest under TR, IMP and HA with highest seed yield recorded for Oba Super 6 (3.17t/ha) while lower seed yield were recorded for CLT, BFI and APD with the control having the lowest seed yield for Obantapa (2.16t/ha) Integrated Management Practices was the most effective treatment for the two tested varieties. This was closely followed by Tarsel removal and hormone application. The findings of this study can be used by farmers and researchers to optimize maize management practices and increase maize seed productivity.

Key words: Treatment Methods, Crop Growth Rate, Seed Production Rate, Maize Varieties

Introduction

Maize (Zea mays L.) is an important cereal crop that is grown extensively worldwide for food and feed. In maize seed production, the use of appropriate treatments can improve the quality and quantity of the seed produced. Maize is one of the most widely cultivated crops in the world, and its seed production is essential for feeding a growing population (FAOSTAT, 2019, Iheukwumere, & Muoneke, 2014). Several treatments are employed by farmers to enhance maize seed production, including Bagging of Female Inflorescence, Tarsel Removal, Adjusting Plant Density, and integrated Management Practices (Akhtar et al, 2013). Several studies have been conducted to investigate the effectiveness of different treatments on maize seed production. For instance, a study by Lamptey et al. (2014) found that adjusting planting density can significantly enhance maize seed yield. Similarly, a study by Mar et al. (2010), Cheng et al, (2020) found that the use of growth hormones can improve maize seed yield by up to 25%. Other studies have also found that bagging and tarsel removal can significantly enhance maize seed yield (Ejaz et al, 2017, Grzesiak et al., 2011). Previous studies have shown that foliar-potassium application increased maize seed yield by 10-20%, while hormonal applications such as GA3, IAA, and cytokinins also improved seed germination and vigor (Furlan et al, 2017, Akinwaleet al., 2019). Pest and disease management approaches, including the use of biocontrol agents and resistant cultivars, have also been found to be essential in reducing plant loss and improving yield (Van et al, 2016). Therefore, it is crucial to optimize the use of different treatment options to increase yields, quality of maize seeds, and profitability for farmers. The objectives of this study were to evaluate the effectiveness of different treatments on maize seed production, provide recommendations on improving crop growth rate and seed production rate in maize.

MATERIALS AND METHODS

Site description

The experiment was conducted in the Teaching and Research Farm of the Department of Agricultural Technology of the Federal Polytechnic, Ado-Ekiti in June, 2022. The experiment was carried out to evaluate the effectiveness of different treatments methods on maize (Zea mays. L.) seed production. The study area experiences rainfall and sunshine with an annual rainfall of about 2000 mm-3000 mm and a temperature of between 250c to 300c. This encourages fast growth of crops and other vegetables which cannot tolerate frost condition.

Experimental design and treatments

Sixty (60) Plastic pots of 7 liter capacity were be perforated at the bottom and filled with top soil. The experiment was a 2 x 6 factorial combination of two cultivars of maize namely Obatanpa (an indigenous variety) and Oba Super 6 (an improve variety) and six different treatment applications replicated five times to make a total of 60 pots arranged in a randomized complete block design (RCBD). Three seeds each of the tested maize varieties were sown per pot for all treatments except for treatment that involved adjusting plant density where only two seeds were planted per pot. Three weeding regimes were carried out throughout the planting period for all the treatments to avoid bias. The treatments are itemized as follows;

Application of each of the treatments

Control (CTL)

This involved the normal farmers' practice of planting maize without any special intervention. No treatment was applied to this plot which served as the control.

Bagging of Female Inflorescence (BFI)

This method involved covering the female flowers with paper bags to prevent cross-pollination. The bags were put over the female flowers before the tassels appear, and removed after pollination. The procedure is straightforward, and it involved carefully tying the paper bag over the female flower at reproductive stage of growth (Lopez et al, 2016).

Adjusting Plant Density (APD)

This was achieved by reducing the number of plants per unit area. The recommended maize planting density is 80,000 plants per acre. (Patil et al, 2012). The process of adjusting plant density involved calculating the optimal number of plants per hectare based on the recommended planting density and adjusting the seed rate accordingly. In this research work, the plant density was reduced to 60,000 per acre after conversion. (Sangoi, 2019).

Tarsel Removal (TR)

Tarsel removal involved carefully selecting the tested maize plants and removing their tassels before pollen shedding to promote self-pollination. The process was be done by gently using a pair of scissors to snip off the tassel. The procedure was done early in the morning before pollination occurred (Tadessse and Dupas, 2007).

Integrated Management Practices (IMP)

Integrated management practices involved a combination of agronomic practices aimed at improving crop growth and yield. Such practices in this research work included fertilizer application. The fertilizer was applied at the rate of 40g/pot for the two tested varieties, while any diseased or infected plant was removed. Hand spraying of Cypermethrine insecticide was carried out to eliminate unwanted pest that defoliated the maize leaves in the study area. This was only done for this plot as IMP treatment. All treatments were however subjected to the natural rainfall condition (Midega et al 2017).

Hormone Application (HA)

The application of growth hormones to maize plants involved the use of cytokinins. The hormone was applied as a foliar spray at every two weeks for a period of 10 weeks to maximize efficacy for the tested varieties. The recommended hormone rate was at 50-150 ppm to improve seed vigor and germination (Salahuddin et al, 2015)

The germination percentage was calculated as follows

$$\text{Germination \%} = \frac{\text{Number of seed germinated x 100}}{\text{Number of seed tested}}$$

The numbers of seedling emergence were recorded on daily basis, starting from the third day after sowing until 14 days after sowing. Seedling was scored as emerged when the cotyledons break through the surface and the percentage seedling emergence was calculated by dividing the total number of seedlings that emerged by the number of seeds sown and multiplied by hundred.

Determination of soil physical and chemical properties

Soil samples were randomly taken at 0-30cm depth using soil auger before land preparation and analyzed for physical and chemical properties in the labouratory in the Agronomy Department of the Federal University of Technology, Akure, Ondo State using Standard procedure as described by Black (1965)

Determination of Crop Growth Rate

This is done by measuring the dry weight of the crop at different growth stages and determines the dry weight by drying the plant in an oven

Crop Growth Rate (CGR), was calculated throughout the entire crop duration. The CGR was calculated as CGR=T/DH

Where T=Total Biomass

DH is number of days to maturity.

Boez and Moore (2019)

Determination of leaf area index and seed production rate of maize

Measurement of leaf length and width for 5 leaves selected from the each of the six treatments of the two tested varieties were averaged to one value. Leaf area was calculated according to Li and Liu, (2019), as the ratio of the leaf area to the dry weight of the leaf tissue

LA=LAIxSLAxPlant density

Where

Plant density is the number of plant per unit area.

SLA = Specific leaf area

W = leaf width.

The values for each of the five plants selected from the two jute mallow varieties were averaged to get a single value for each plot. Then the average value for each plot in each replication for both varieties was calculated.

Maize stubbles were harvested at maturity, oven-dried and weighed to obtain dry matter yield. The grains were removed from the cobs and weighed to obtain yield of the grain, which was converted to hectare with the following calculation;

$$\text{Yield (ha)} = \frac{\text{Plot yield x 10000}}{\text{Plot area}}$$

Characteristics of Obatanpa maize varieties evaluated

i.Local or indigenous variety: Obatanpa

ii.High yield potential

iii. Good flavor and taste

iv.Used in local dishes and for making pap (a popular Nigerian breakfast food)

v..Obatanpa has a maturity period of 100-120 days and is adapted to a wide range of environmental conditions, including both upland and lowland areas (Iheukwumere, & Muoneke, 2014).

Characteristics of Oba Super 6 maize varieties evaluated

i. High yield potential

ii.Uniform plant height and ear placement

iii.Early maturity

iv.Good flavor and taste

v.Oba Super has a maturity period of 95-105 days and is adapted to both upland and lowland environments, with a high tolerance for drought with a neutral photoperiod (Akinwale et al., 2019)

Data collection and analysis

Parameters taken included Measurement of plant height (cm), Number of leaves, Total biomass (g) Stem girth (cm), Leaf Area (cm2), Days to 50% tarselling, Days to 50% silking, Days to maturity, Cob length (cm), Number of seeds per cob, Seed yield (t/ha). The germination percentage was also measured while the Crop Growth Rate (CGR) was calculated throughout the entire crop duration. The data obtained were subjected to analysis of variance and the differences between the treatments were estimated by the use of Duncan Multiple Range Test with the aid of Discovery Software (L.A.T., 2015). LSD, Standard Deviation and Standard Error were also employed to determine the level of accuracy and deviation from the Mean.

Result and Discussion

Table 1 showed the result of soil chemical properties before the experiment. The pH of the soil was 4.16 which is acidic. Organic matter contents analyzed was 1.35%. Nitrogen content was low 0.10 g/kg. The available P content in the soil was low 4.16 mg/kg, K was also low (0.14 cmol/kg), Na (0.22 cmol/kg), Ca (1.80cmol/kg) and Mg (0.70 cmol/kg). The result showed that the soil was sandy loam in texture with high proportion of sand (56.80%). This implies that basic cations such as Ca, K, Na and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Wapa and Oyetayo, 2014).

The effectiveness of different treatments methods on growth characters of two maize varieties is presented in Table 2. The result shows that the tested maize varieties responded significantly to the various treatments imposed. Significantly higher values were recorded for Oba Super maize variety under the integrated management practices (IMP) for plant height (200cm) and number of leaves, (16.0) over other treatments while total plant biomass was significantly better under the control for Obatanpa (384g).The highest mean value was recorded for IMP for Oba super (147.2) while the lowest was recorded for hormone application (HA) method for Obatanpa variety. The result shows that there was no significant difference for stem girth among the various treatments imposed on the two tested maize varieties. Leaf area development was significantly better under BFI for Oba Super 6 (221,8cm2) over other treatments while the lowest leaf area was recorded for Obatanpa under HA (164.7cm2)

The effectiveness of different treatments methods on Crop Growth Rate (CGR) and Seed Production Rate (SPR) of two maize varieties is presented in Table 3.The result shows that days to 50% tarselling and silking were significantly shorter under the IMP method for Oba Super 6, (58 days) and Tarsel Removal (TR) (59) days over all other treatments which took longer days to attain 50% tarselling. Conversely, it took longer days to attain 50% tarselling and silking for the control and Obantapa variety for most of the treatments imposed. There was no significant difference in the number of seed/cob for the control. Cob length was significantly higher for Oba Super 6 under the IMP (22.7cm) over Obatanpa (20.5cm) while a lower value was recorded for other treatments. There was no significance difference in the Crop Growth Rate (CGR) for the control, BFI, and ADP while higher values were recorded for CGR for TR, IMP and HA with Oba Super 6 having a higher CGR value over Obatanpa maize variety in the study area. Seed yield were highest under TR, IMP and HA with highest seed yield recorded for Oba Super 6 (3.17t/ha) while lower seed yield values were recorded for CLT, BFI and APD with the control having the lowest seed yield for Obantapa (2.16t/ha)

Oba Super had significantly higher seed production rate than Obatanpa since it recorded higher seed yield. For Oba Super, the highest seed yield was obtained under integrated IMP followed by TR and HA, while the lowest seed yield was obtained under control, BFI, and APD treatments. The effectiveness of the treatments was also observed in terms of the crop growth rate (CGR). TR, IMP and HA treatments resulted in significantly higher CGR for both varieties under TR, IMP, and HA treatments when compared to other treatment applications (Wortmann, et al, 2011). According to Salahuddin et al., (2015) and Shah, (2019), HA can lead to adverse effects on seed production by interfering with the natural physiological processes of the plant. Lopez et al., (2016) opined that BFI can hinder pollination and reduce seed production due to limited availability of pollen while Ejaz et al., (2017) and Makumbi et al, (2007) both stated that TR significantly reduces seed production due to the absence of silks which are required for pollination and fertilization. In this study, the shortest days to 50% tarselling and silking were observed in TR, IMP, and HA treatments, indicating faster reproductive growth. The results of this study are consistent with previous research on maize management practices. For instance, the use of IMP and HA has been reported to increase maize yield by controlling pest infestations and promoting growth and development (Akhtar et al, (2013). TR is another management practice that has been demonstrated to increase maize grain yield by redirecting nutrients towards grain production and reducing competition for assimilates and water. Furthermore, these practices have been shown to significantly affect maize growth and yield. According to Akhtar et al, (2013) and Dube et al, (2016), the practice of BFI has been used to protect maize fields from pests and diseases, and to improve seed quality. Bagging can also reduce cross-pollination and increase seed yield. However, some studies have shown that bagging can reduce the number of ears per plant and reduce the seed yield per plant. The effectiveness of bagging may also vary depending on the cultivar and environmental conditions. APD is a common practice in agriculture to manage crop development and maximize yields. The ideal plant density for maize varies depending on the cultivar, soil type, and weather conditions. Some studies have shown that increasing plant density can increase yields by improving light interception and reducing competition between plants. However, excessively high plant density can also reduce yields by increasing competition for resources and limiting root growth (Sangoi, 2019, Lamptey et al, 2014). Removing tassels from maize plants is a common practice to prevent unwanted cross-pollination. TR can improve the purity of seed stocks and prevent hybridization when growing different maize varieties together. However, the practice can also reduce seed yields by inhibiting pollination and reducing kernel formation. The effectiveness of TR can also depend on the timing of the practice and the availability of pollen from nearby plants. (Makumbi et al, 2007). According to Van Steenwyk et al, (2016), IMP is a holistic approach to crop protection that combines various pest control methods to minimize the use of chemical pesticides. IMP combines practices such as crop rotation, resistant varieties, biological control, and chemical control to manage pest populations. IMP has been shown to be effective in managing pests in maize crops while reducing the environmental impact of chemical pesticides. However, the implementation of IMP requires more time and effort than applying chemical pesticides alone, which may be a limiting factor for some farmers. Hormones such as auxins, cytokinins, and gibberellins have been used to stimulate growth and development in maize plants. Hormone application can improve seed and grain yields by promoting cell division, elongation, and differentiation in plants. However, the effectiveness of hormone application can depend on the timing, rate, and method of application, as well as the plant genotype and environmental conditions (Chen et al, 2020, Shah et al 2019)

Conclusion and recommendations

This study demonstrated the effectiveness of different treatment methods on the growth and seed yield of two maize varieties. The results showed that Obatanpa and Oba Super reacted differently to the treatments applied, indicating that the response of maize varieties to different management practices should be considered when developing management strategies. The study also established the effectiveness of Tarsel Removal, Integrated Management Practice and Hormone Application treatments in promoting maize growth and seed yield. The findings of this study can be used by farmers and researchers to optimize maize management practices and increase maize productivity.

Based on the results of this study, the following management practices are recommended for improving crop growth rate and seed production rate in maize: Integrated Management Practice should be adopted to control pests, reduce damage to plants, and promote growth and development. Tarsel Removal should be considered to improve maize grain yield by redirecting nutrients towards grain production and reducing competition for assimilates and water. Hormone Application treatments should be considered to promote plant growth and development and improve yield. Plant spacing and density should be optimized to ensure proper use of resources and enhance productivity. Varietal selection should be based on the response of maize varieties to specific management practices, to maximize crop productivity.

Table 1: Physical and chemical properties of the soil at experimental site

Properties	Value
pH (water) %	4.16
Total N (%)	0.10
Available P (mg/kg)	12.76
Ca^{2+} (Cmol/kg)	1.80
Mg^{2+} (Cmol/kg)	0.70
K^{+} (mg/kg)	0.14
Na^{2+} (Cmol/kg) 0.22	
Organic carbon (%)	0.78
Organic matter (%)	1.35
Particle size distribution	-
Sand	56.80
Silt	20.00
Clay	23.20
Total porosity (g/g) Water holding capacity (g/g) Texture	35.30 0.061 Sandy loam
Bulk density)g/cm^3)	1.32

Table 2: The potential effectiveness of different treatments methods on growth characters of two maize varieties

Treatment	Variety	Plant height (cm)	Number of Leaves	Total Plant Biomass (g)	Stem girth (cm)	Leaf Area Index (cm^2)	Mean
CLT	Obatanpa	167.0^{g}	12.9^{c}	384.4^{a}	3.17^{a}	215.0^{a}	156.2
	Oba Super 6	174.7^{f}	13.0^{b}	296.6^{b}	2.96^{a}	213.4^{a}	139.8
BFI	Obatanpa	180.0^{c}	12.6^{c}	300.9^{a}	3.01^{a}	216.6^{a}	138.4
	Oba Super 6	196.3^{b}	14.0^{b}	278.4b	2.84^{a}	221.8^{a}	141.3
APD	Obatanpa	178.0^{e}	12.0^{c}	310.0^{a}	3.00^{a}	197.2^{b}	140.0
	Oba Super 6	195.0^{b}	13.5^{b}	295.4^{b}	2.78^{a}	180.7^{b}	137.3
TR	Obatanpa	150.8^{i}	14.0^{b}	333.0^{a}	3.09^{a}	200.1^{a}	140.0
	Oba Super 6	167.6^{g}	15.9^{a}	301.1^{a}	2.89^{a}	193.9^{b}	136.0
IMP	Obatanpa	178.0^{e}	14.6^{b}	321.5^{a}	3.00^{a}	219.8^{a}	147.2
	Oba Super 6	200.5^{a}	16.0^{a}	256.0^{b}	2.78^{a}	198.4^{b}	135.0
HA	Obatanpa	159.7^{h}	13.7^{b}	278.7^{b}	3.21^{a}	164.7^{b}	114.0
	Oba Super 6	184.8^{d}	14.0^{b}	240.6^{b}	3.03^{a}	178.3^{b}	118.0
SD		18.27	1.17	44.12	0.13	19.11	
SE±		5.28	0.34	12.77	0.04	5.52	
LSD (95%)		11.6	0.75	28.1	0.09	12.14	

Mean followed by the same superscript significantly different at 0.05% probability on the same row using Duncan's Multiple Test (DMRT).(CLT:Control), (BFI: Bagging of Female Inflorescence), (APD:Adjusting Plant Density), (TR: Tarsel Removal), (IMP: Integrated Management Practices), (HA:Hormone Application).

Table 3. The potential effectiveness of different treatments methods on Crop Growth Rate (CGR) and Seed Production Rate (SPR) of two maize varieties

Treatment	Variety	Days to 50% tarselling	Days to 50% Silking	Days to maturity	Cob length	Number of Seed/cob	CGR	Seed Yield (t/ha)
CLT	Obatanpa	75.0^{a}	88.0^{a}	125.0^{a}	16.7^{f}	236^{b}	2.5^{b}	2.16^{b}
	Oba Super 6	60.0^{e}	70.0^{d}	100.0^{d}	18.0^{e}	257^{b}	2.9^{b}	2.46^{b}
BFI	Obatanpa	70.0^{b}	80.0^{b}	105.0^{c}	17.9^{e}	269^{b}	2.9^{b}	2.38^{b}
	Oba Super 6	60.0^{e}	68.0^{d}	95.0^{d}	19.6^{d}	280^{b}	2.9^{b}	2.90^{b}
APD	Obatanpa	75.0^{a}	80.0^{b}	110.0^{b}	18.0^{e}	253^{b}	2.8^{b}	2.39^{b}
	Oba Super 6	65.0^{c}	73.0^{c}	98.0^{d}	19.8^{d}	289^{b}	2.8^{b}	2.32^{b}
TR	Obatanpa	68.0^{c}	75.0^{c}	103.0^{d}	19.4^{d}	278^{b}	2.9^{b}	2.78^{b}
	Oba Super 6	59.0^{d}	65.0^{e}	93.0^{e}	20.9^{c}	290^{b}	3.2^{a}	3.01^{a}
IMP	Obatanpa	63.0^{d}	75.0^{c}	100.0^{d}	21.3^{b}	307^{a}	3.1^{a}	3.12^{a}
	Oba Super 6	58.0^{e}	65.0^{e}	90.0^{e}	22.7^{a}	333^{a}	3.3^{a}	3.17^{a}
HA	Obatanpa	65.0^{c}	78.0^{b}	105.0^{c}	20.5^{c}	300^{a}	3.0^{a}	3.03^{a}
	Oba Super 6	60.0^{d}	65.0^{e}	94.0^{e}	20.9^{c}	310^{a}	3.1^{a}	3.00^{a}
SD		6.09	7.28	11.39	1.62	29.47	0.23	0.37
SE±		1.77	1.77	2.11	0.47	8.52	0.07	0.07
LSD (95%)		4.67	4.67	5.14	1.17	21.10	0.17	0.17

Mean followed by the same superscript significantly different at 0.05% probability on the same row using Duncan's Multiple Test (DMRT). (CLT: Control) – (BFI: Bagging of Female Inflorescence),(APD:Adjusting Plant Density), (TR: Tarsel Removal), (IMP: Integrated Management Practices), (HA:Hormone Application).

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