PERFORMANCE OF WHITE MAIZE ON EARTHING UP UNDER VARYING LEVELS OF FERTILIZER APPLICATION

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CERTIFICATE

*This is to certify that the research work entitled, "**PERFORMANCE OF EARTHING UP ON WHITE MAIZE UNDER VARYING LEVELS OF FERTILIZER APPLICATION**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment for the requirements for the degree of **MASTER OF SCIENCE IN AGRONOMY**, embodies the results of a piece of bona-fide research work was successfully carried out by **MOST. MANIRA KHATUN** bearing Registration No.* **19-10351** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

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DADICATED TO

MY BELOVED

PARENTS &

HUSBAND

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PERFORMANCE OF EARTHING UP ON WHITE MAIZE UNDER VARYING LEVELS OF FERTILIZER APPLICATION

ABSTRACT

A field experiment was conducted at Sher-e Bangla Agricultural University in Agronomy farm during kharif season, March-June 2021, in order to find out the effect of different levels of earthing up and fertilizer application on the performance of white maize variety. Three levels of earthing up viz., E_0= no earthing up, E_1 = earthing up at 25 days after sowing, E_2 = earthing up at 25 days after sowing + earthing up at 50 DAS and four levels of fertilizer application viz., F_1 = 50% of recommended dose, F_2 = 75% of recommended dose, F_3 =100% of recommended dose and F_4 =125% of recommended dose were need in this study. The experiment was conducted in split-plot design with three replications. In case of earthing up, the highest plant height (202.92, 223.50 and 215.71 cm), base circumference plant^{-1} (5.77, 6.92 and 7.67 cm), leaf area index (1.80, 2.52, and 3.54), dry weight plant^{-1} (42.58, 90.50 and 129.07 g), cob length plant^{-1} (19.35 cm), cob circumference plant^{-1} (13.39 cm), grain weight cob^{-1} (95.38 g), cob weight plant^{-1} (113.78 g), number of grains cob^{-1} (375.06), highest 1000 grains weight (156.23 g), grain yield (8.07 t ha^{-1}), stover yield (10.09 t ha^{-1}), biological yield (18.16 t ha^{-1}), harvest index (44.38 %) was observed in the E_2 treatment respectively. In case of fertilizer application, experimental result revealed that the highest plant height (207.00, 228.56 and 215.78), base circumference plant^{-1} (5.66, 7.17 and 7.56 cm), leaf area index (1.89, 2.52 and 3.76), dry matter weight plant^{-1} (43.24, 91.50 and 127.74 g), cob length plant^{-1} (19.65 cm), cob circumference plant^{-1} (14.17 cm), grain weight cob^{-1} (105.83 g), cob weight plant^{-1} (126.08 g), number of grains cob^{-1}(396.67), weight of 1000 grain weight (160.98 g), grain yield (8.49 t ha^{-1}), stover yield (10.33 t ha^{-1}), biological yield (18.82 t ha^{-1}) and harvest index in this experiment (45.09 %) was observed in F_4 (125%) treatment at 40, 80 DAS and at harvest, respectively . In case of combined effect, the highest data was observed from plant height (210.00, 236.67 and 219.83 cm), leaf area index (1.33, 1.78, and 2.33), dry weight plant^{-1} (45.69, 98.83, and 138.52 g) and maximum grain yield (8.98 t ha^{-1}) and yield attributes in E_2F_4 treatment at 40, 80 DAS and at harvest, respectively and suitable for grain production as compared to other treatment combination. But the yield of E_1F_4 and E_2F_4 did not significantly differ. The treatment E_0F_1 had the lowest grain yield (5.33 t ha^{-1}) along with showing lower values in plant parameters in different growth stages.

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro-Ecological Zone
BBS	Bangladesh Bureau of Statistics
Agric.	Agriculture
Agron.	Agronomy
Biol.	Biology
Biotechnol.	Biotechnology
Bot.	Botany
cm	Centimeter
CV %	Percent Coefficient of Variation
DAS	Days After Sowing
et al.,	And others
Eds.	Editors
Entomol.	Entomology
Environ.	Environment
etc.	Etcetera
FAO	Food and Agricultural Organization
g	Gram (s)
i.e.,	id est (L), that is
Int.	International
J.	Journal
LSD	Least Significant Difference
M.S.	Master of Science
P	Phosphorus
K	Potassium
N	Nitrogen
No.	Number
Res.	Research
Sci.	Science
SRDI	Soil Resource Development Institute
Technol.	Technology
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Maize (*Zea Mays*), also referred to as corn, is grown globally and is one of the most important cereal grains in the world. It is the basis for food security in most countries especially in Africa as it is one of the staple foods. It can be processed into a variety of food such as flour, popcorns, cereals (cornflakes), and industrial products, such as starch, sweeteners, oil, beverages, glue, industrial alcohol, and ethanol (Ranum *et al*., 2014).

FAOSTAT (2022) reported that, the global maize production area in 2018 was 194000 ha of land producing about 1.12 million tons of grains. The total area and yield have been on an increase since then with about 1.16 million tons harvested from an area of 201 000 ha in 2020. This indicates a 3.29% increase in the maize production area as well as a 3.36% increase in maize yield over the 3 years owing to the increase in demands for both feed and food (NAB 2022).

In Bangladesh, it covers about 3.5 lac hectares of land producing 23 lac metric tons grains. The current average yield of maize is 7300 kg ha^{-1} which much lower than that of some other developed countries. Maize is cultivated on an area of 196 m ha, producing, 1110 mt grains with 5.66 t ha^{-1} productivity across the world (FAOSTAT, 2018-19).

As per Statista (2021) and USDA (2022), the United States consumed the highest quantity of maize with over 305 million tons, followed by China with just over 287 million tons. The lowest amount of maize in the top 5 countries was consumed in Mexico with about 43 million tons. As food, maize is largely consumed in Africa in the form of delicacies made from flour such as porridge and bread, unlike in the US and EU where it is largely used as livestock feed (United States Department of Agriculture (USDA, 2022).

Maize is also one of the largest components of animal feed (Kopp, 2021). Maize is used for human consumption in diverse forms (Poneleit, 2001) and is also used as a staple food in many countries of Latin America and Africa (Hotz and Gibson, 2001). The maize kernel is composed of approximately 72% starch, 10% protein, 5% oil, 2% sugar, and 1% ash with the remainder being water (Perry, 1988). It provides many of the B vitamins and essential minerals along with fiber. White maize is healthy because it contains vit-B1, B5 and C which helps in fighting disease and generating new cells. High in fiber content helps in lowering cholesterol levels in the body by reducing the levels of blood sugar in diabetics too & prevent weight loss.

Maize flour is used worldwide for tortillas, snacks, and breakfast cereals. Also, there are health-related reasons to advise the use of maize bread and related products, namely gluten intolerance (Ylimaki *et al*., 1989) and diabetes (Van der Merwe *et al*., 2001). This crop has much higher grain protein content than rice. But in Asia, it is used mainly used as animal feed (Khatibzadeh *et al*. 2016, Xu *et al*. 2017, Jiang, Liu *et al*. 2018, Dowswell 2019). Maize is also a primary constituent of materials for manufacturing many industrial products (Henchion *et al*. 2017) such as corn starch, maltodextrins, corn oil, corn syrup and products of fermentation used in the distillation industries (Durani *et al*. 2019). Besides this, maize is also recently used as biofuel (Serna- Saldivar, 2016).

There are three types of maize based on the endosperm color; yellow, white and red (FAO, 2002). Yellow is mostly used as feed, while the white is used as a preferred staple mainly in Southern and Eastern Africa, Central America, and Mexico and the choice is associated with the perception of social status (Ranum *et al*., 2014). Being a C_4 plant, maize is highly productive than any other cereals, less rigorous to produce and adapts to a wide range of agro-ecological zones (Babatunde *et al*., 2008).

Introduction of white maize in Bangladesh as human food can be a viable alternative for sustaining food security given the productivity of maize much higher than rice and wheat. In the recent years a number of production technologies has been developed both for hybrids and open pollinated ones such as varietal selection(Ullah et el., 2017a; Akhter *et al*., 2021;) fertilizer application (Raju, 2017; Ahmed *et al*., 2020; , planting configurations (Akbar *et al*., 2016; sowing time (Akhter *et al*., 2021; , seedling transplantation (Ullah *et al*., 2016; and methods of planting, irrigation (Ullah *et al*., 2021), water conservation (Ullah *et al*., 2018b; Ullah *et al*., 2018c), weed management (Mannan *et al*., 2019).

Maize is a tall statured crop having semi hard stem that stretches up to 2.5 meters. This tallness attribute exposes the plants to strong wind speeds that is a common prevalence in Bangladesh in the Kharif season. Maize lodging can occur at both the stalk and root.

Stalk lodging occurs when stalks are broken at or below the ear-bearing node, whereas root lodging refers to plants that lean at an angle greater than a certain threshold (typically 30 or 45°) from the vertical (Beck *et al*., 1988; Novacek *et al*., 2013).

This occurrence of strong wind frequently causes plants to lodge leading to a significant loses in yields like all other cereal crops (Novacek*et al*., 2013; Cook *et al*., 2019).

Different agronomic management has different degrees of impact on growth and yield of maize. Among those agronomic management practices earthing up is the most important one. Earthing up practices significantly influenced the growth attributes at different growth stages. A significant increase in grain and straw yield was reported due to earthing up by (Thakur *et al*., 2003).

Bangladesh facing problem of malnutrition due to its high population growth and low productivity of crops. At present, agricultural land is shrinking due to urbanization, industrialization and infrastructure development but the demand for food is increasing with growing population and rising income. The major constraints of low productivity are malnutrition, poor agronomic practices etc. Among the inter-tillage practices, earthing up is of great value as it helps in making efficient use of irrigation water, minimizing lodging of the crop and extensive development of root system (Chaudhry, 1983). In an experiment earthing-up in maize proved superior to maize crop grown without earthing-up operation (Prasad *et al*.,1988).

Fertilizer application affects plant growth and development greatly and such as affects yield through dry matter partitioning of the grain producing crops. The recommended dose of N, TSP, MOP, Gypsum, Zinc, Boric acid for the production of hybrid maize is 500,250,200,250,10,7 kg/ha respectively (BARI,2016). The activities of soil micro-organisms and enzymes and soil available nutrient contents can be increased by proper application of organic and inorganic fertilizers (Saha *et al*., 2008). He and Li (2004) recommended that the activities of soil interties and available nutrient content can be enhanced by combined utilization of organic and inorganic fertilizers.

Earthing up and fertilizer application may be critical in having greater yields in white maize. In view of the above the present study was conducted to find out the influence of fertilizer and earthing up on the yield performance of white maize with the following objectives:

1. To evaluate the effect of earthing up on white maize SAUWMOPT.

2. To optimize the fertilizer doses for the production of white maize SAUWMOPT.

3. To investigate the interaction effect of earthing up and fertilizer application on the performance of white maize SAUWMOPT.

CHAPTER II
REVIEW OF LITERATURE

Earthing up and fertilizer application are considered to be the most important factors in white maize cultivation. A number of research works have been done in different parts of the world to study the influence of earthing up and fertilizer application on the yield performance of white maize. Some of the important and informative works and research findings related to the earthing up and fertilizer application of white maize done at home and abroad have been reviewed under the following sub headings:

2.1 Effect of earthing up

Earthing up:

Earthing up of plants is one of the most important operations in maize cultivation. It means placing of soil near the base of the plant collected from the space between the rows. This operation helps to provide anchorage of the lower whorls of adventitious roots above the soil which then begin to function as absorbing roots. This operation also prevents the plants from lodging. The furrows made out of this operation could be used as drainage or irrigation channels, depending on the requirements. This operation can be performed with the help of spade at the time of application of the second dose of urea at 8-10 leaf stage of the crop.

Earthing up provides fine tilth with better aeration in root zone which ensures favorable conditions to root development. Moreover, it also provides anchorage of the lower whorls of adventitious roots above the soil level which then function as absorbing roots (Bhatnagar and Kumar, 2017). Earthing up covers the top-dressed fertilizer and improves both fertilizers use efficiency and yield.

Top-dressing of nitrogen in maize is done by broadcasting method manually which results in low fertilizer use efficiency. Urea applied by farmers on soil surface is subjected to various losses and causes poor nitrogen use efficiency (Jat *et al*., 2016) as applied N is lost due to volatilization (Jat *et al*., 2014). Placement of urea below the soil surface may prove an effective way to enhance nitrogen-use efficiency and thus may be helpful in reducing nitrogen dose (Jat *et al*., 2014). Thus, there is ample scope for improving growth and increasing productivity of maize crop by adopting different earthing up operations.

Earthing up also improves the nutrient use efficiency by reducing the losses in the form of volatilization. Regular supply of nitrogen in adequate amount is necessary to enhance the productivity of maize (Singh *et al*., 2003).

Among the inter-tillage practices, earthing up is of great value as it helps in making efficient use of irrigation water, minimizing lodging of the crop and extensive development of root system (Chaudhry, 1983).

Lodging:

The critical wind speed of lodging, which is the synthesized result of wind, leaf area, ear weight, ear height and mechanical properties of main stem internode etc., is needed to evaluate the lodging resistance of plants under different varieties and cultivation practices such as fertilizer application and earthing-up (Ahmad *et al*., 1987; Nath *et al*., 2020; Nath *et al*., 2022).

It was reported that in mechanical grain harvesting, the maize ear loss increased by 0.15–0.59% for each 1% increase in the lodging rate. Additionally, it was found that the mechanical grain harvesting speed decreased exponentially with increasing lodging rate (Sue *et al*., 2020).

The accurate evaluation of the maize lodging resistance in the field can assist in the development of lodging-resistant varieties, the regulation of cultivation measures, and the selection of optimum planting environments (Xue *et al*., 2020).

Maize plants that have not reached full maturity and that exhibit high levels of turgor pressure will often exhibit snapping failures (i.e., the stalk will snap in half) during natural lodging events. This failure type is sometimes referred to as "green snap" (Cook *et al*., 2019).

Studies on stalk morphology have shown that maize plants with long basal internodes have a higher ear position and center of gravity than plants with shorter basal internodes, which increases the risk of lodging. In contrast, maize plants with short and thick basal internodes display greater stalk-lodging resistance (Kamran *et al*., 2018; Ma *et al*., 2014).

Previous studies on maize stalk lodging focused on aspects of plant morphology, stalk mechanical characteristics, stalk anatomical structure, carbohydrate accumulation and distribution, pests and diseases, planting density, water and fertilizer management, and plant growth regulators (Xue *et al*., 2017).

Moreover, as plant density increases, the length of the basal internode significantly increases and the diameter significantly decreases, the contents of cellulose, hemicellulose, and lignin, and the stalk mechanical strength decrease, and the risk of lodging increases (Xue *et al*., 2016).

Reasonable water and fertilizer management and the application of plant growth regulators can reduce the internode elongation rate, the ratio of length to diameter, the plant height, and the ear height, promote structural carbohydrate accumulation, and increase stalk mechanical strength and lodging resistance (Xu *et al*., 2017; Xu *et al*., 2018). Sekhon *et al*. reported that stalk bending strength is strongly associated with maize stalk lodging incidence across multiple environments (Sekhon *et al*., 2020). Stalk strength is significantly positively correlated with the contents of cellulose, hemicellulose, and lignin (Xue *et al*., 2016).

Stalk lodging causes greater grain losses than root lodging (Li *et al*., 2015). When stalk lodging occurs before maturity, stalk breakage halts grain filling in the entire plant due to the death of the plant above the breakage site, resulting in yield reduction or even the failure of the entire crop [Li *et al*., 2015; Zuber and Kang, 1978; Minami and Ujihara, 1991).

About 50 to 80% of the strength of a maize stalk comes from its outer structure, the rind (Zuber *et al*., 1980). Several studies have indicated that the rind penetration strength (RPS), crushing strength (CS), and bending strength (three-point bending flexural tests) are all significantly negatively correlated with the stalk lodging rate (Robertson *et al*., 2014).

Crop lodging can lead to the physical collapse of the plant canopy and can happen spontaneously due to mechanical instability of the plant structure, through external forces such as wind, or both. Maize lodging can occur at both the stalk and root. Stalk lodging occurs when stalks are broken at or below the ear-bearing node, whereas root lodging refers to plants that lean at an angle greater than a certain threshold (typically 30 or 45°) from the vertical (Beck *et al*., 1988; Novacek *et al*., 2013).

However, most of these studies were based on the resistance of the plant itself, and less consideration was given to the impact of the external environment on the plant, such as wind. Wind is the primary environmental factor responsible for crop stalk lodging. Stalk lodging occurs when plants are subjected to wind forces greater than the maximum force that the stalk can withstand before breaking. This may be prevented or reduced by putting soil at the base of the plants that supports giving strength to the base of the stem.

2.1.1Review on growth parameter:

2.1.1.1 Plant height

Khan *et al*., (2012) was reported that the plant height of maize did not get significantly affected by different earthing up practices at 30 DAS. However, during the year 2017, at 60 DAS, the treatment manual earthing recorded significantly highest value of plant height (185.1 cm) as compared to no earthing treatment (159.8 cm). Similar trend was also followed at 60 DAS in 2019 and at 90 DAS and at harvest stage during both the years. This could be mainly attributed to the beneficial effect of earthing up and proper placement of top-dressed fertilizers on the growth of maize plants.

Nizami and Shafiq (1988) was conducted a field experiment. Plant height at harvest was affected significantly by different inter-tillage practices. The maximum plant height was recorded in treatment (inter-tillage twice with spade + earthing up). These treatments, however, did not differ significantly from one another but were superior to (no inter-tillage + no earthing up). The maximum plant height was due to better condition available for plant growth and development.

2.1.1.2 Leaf area index

Ahmad *et al*., (2000) was noticed that the different earthing up practices also produced a significant effect on leaf area per plant of maize. During the year 2017, at 30 DAS, the significantly highest value of leaf area per plant was obtained in the treatment earthing by machine (1218 cm^2) as compared to other treatments viz. manual earthing (1017 cm^2), and no earthing (901 cm^2). Whereas, in the year 2019 and in pooled analysis, earthing manually was found to be significantly superior as compared to no earthing.

2.1.1.3 Dry matter weight

In another experiment earthing-up in maize proved superior to maize crop grown without earthing-up operation (Prasad *et al*., 1988). The different earthing up methods has also significantly affected the shoot dry matter accumulation in maize. At 30 DAS, in 2017, the significantly highest shoot dry matter accumulation was recorded in earthing manually (10.8 g $plant^{-1}$), as compared to other treatments viz., no earthing treatment (8.6 g $plant^{-1}$). Similar trend in terms of shoot dry matter accumulation was also recorded at all other growth stages in both the years. This higher dry matter accumulation in shoot is mainly because of the beneficial effect of earthing up on growth and development of maize plants and proper placement of top-dressed fertilizers.

2.1.2 Review on Yield contributing characters

2.1.2.1 Number of cobs^{-1}plant

Prasad *et al*., (1988) conducted a field experiment. According to this experiment, Number of cobs per plant were significantly affected by the inter-tillage practices. Maximum number of cobs per plant was recorded in plots inter-cultured twice with spade + earthing up. The minimum number of cobs were found in case of control treatment.

2.1.2.2 Number of grains^{-1} cob

Rafiq (1989) conducted a field experiment. According to this experiment, number of grains per cob was also affected significantly by different tillage practices. The maximum number of grains cob was achieved from the plots with inter-tillage manually + earthing up. On the other hand, the crop grown without any inter-tillage produced the minimum number of grains per cob. The lesser number of grains per cob was attributed due to poor growth and development of the plants in control treatment as a result of more weeds infestation.

2.1.2.3 1000-grain weight

Prasad *et al*., (1988) was conducted a field experiment. The maximum 1000-grain weight was recorded in (inter-tillage twice with spade + earthing up) closely.

2.1.3 Review on Yield characters

2.1.3.1 Grain yield (t ha^{-1})

Ahmad *et. al*., (2000) was conducted a field experiment according to this experiment, the different earthing up practices also produced a significant effect on leaf area per plant of maize. During the year 2017, at 30 DAS, the significantly higher values of grain yield as compared to other treatments viz. no earthing (41.4 q ha^{-1}). Whereas, in the year 2019 and in pooled analysis, earthing manually was found to be significantly superior as compared to no earthing. Similar findings related to better performance of earthing up was also reported by Ahmad *et al*., (2000), Khan *et al*., (2012) and Bhatnagar and Kumar (2017).

According to Prasad *et al*., (1988) there was also a significant effect of different earthing up practices on grain yield of maize.

2.1.3.2 Harvest index (%)

Nizami and Shafiq (1988) was conducted a field experiment. The physiological efficiency of a maize plant to convert the total dry matter into economic yield is reflected by its harvest index (H.I.). Different inter-tillage practices significantly differed with respect to HI value. The maximum harvest index was recorded in inter-tillage twice with Tarphali + earthing up. The minimum harvest index was recorded in control treatment. Increase in harvest index with deep tillage.

2.2 Effect of fertilizer application

Fertilizer management is one of the most important factors that influence the growth and yield of maize crop. Maize is considered as most exhaustive crop after sugarcane and requires both micro and macro inorganic nutrients to obtain high growth and yield. Supply of nutrients at an appropriate amount is always imperative for better growth and development of a crop (Ali and Anjum, 2017).

The yield of maize is governed by many agronomic factors among which using optimum population density (Iken and Anusa, 2004 Liu *et al*., 2004; Zeidane *et al*., 2006), fertilization is among the prime ones. Luxuriant growth resulting from fertilizer application leads to larger dry matter production (Obi *et. al*., 2005) owing better utilization of solar radiation and more nutrient (Saeed *et. al*., 2001). This availability of sufficient growth nutrients from inorganic fertilizers lead to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth (Fashina *et al*., 2002). Application of essential plant nutrients in optimum quantity and right proportion, through correct method and time of application, is the key to increased and sustained crop production (Cisse and Amar, 2000).

For good growth and high yield, the maize plant must be supplied with adequate nutrients particularly nitrogen, phosphorus and potassium. The quality required of these nutrients particularly nitrogen depends on the pre clearing vegetation, organic matter content, tillage method and light intensity (Kang, 1981).

2.2.1 Review effect on growth parameter:

2.2.1.1 Plant height

It was noticed from a field experiment conducted at the research farm of Haramaya University, Eastern Ethiopia that the mean values of plant height were linearly increased from 179.1 to 179.4 cm as N increased from 43.5 to 130.5 kg ha^{-1}. Getnet and Dugasa (2019) also reported that plant height of maize increased with N.

Plant height increased as N increased, this could be attributed to a mere fact that higher rates of nitrogen may have caused rapid cell division and elongation (Shamim *et al*., 2015).

Rambe (2014) reported that application of NPK as the most required macronutrient to promote both vegetative and generative growth. More application of N fertilizer will promote height of the plant. However, the application of 350 kg Urea + 550 kg NPK (15-10-20) that contains higher N will be followed by the increasing height of the plant.

Jeet *et al*., (2014) evaluated the effect of four nitrogen levels (0 kg N ha^{-1}, 50 kg N ha^{-1}, 100 kg N ha^{-1} and 150 kg N ha^{-1}) and three levels of sulphur (15 kg S ha^{-1}, 30 kg S ha^{-1} and 45 kg S ha^{-1}) in quality protein maize (QPM) and observed significantly highest plant height, leaf area index (LAI) and yield were recorded with 150 kg N ha^{-1} as compared to N100, N50 and N0.

Working on QPM maize at Varanasi, Jeet *et al*., (2012) reported significantly higher plant height, green leaves $plant^{-1}$, leaf area index and dry matter $plant^{-1}$ with application of increasing levels of sulphur up to 45 kg S ha^{-1}.

Rafiq *et al*., (2010) was investigated a field experiment in maize crop. The shortest plants were recorded from the lowest nitrogen level (120 kg ha^{-1}), while the tallest plants were recorded from the application of 240 kg Nha^{-1}. But no significant plant height difference was observed between the treatments that received a nitrogen level of 240 and 360 kg ha^{-1}. Increasing the general trend was observed for plant height with increasing nitrogen level from 120 to 360 kg ha^{-1}). Higher N applications increase the cell division, cell elongation, green foliage. This might increase the chlorophyll content to facilitate the rate of photosynthesis and extension of stem resulting in increased plant height. This result agreed with that plant height increased with increasing nitrogen levels.

A field experiment on maize was conducted on sandy loam soil during kharif season of 2000-2004 at IIPR Kanpur by Srinivasarao *et al*., (2010) and they noticed significantly higher plant height and dry matter production with increasing level of sulphur application up to 20 kg S ha^{1}.

In Nigeria, Onasanya *et al*., (2009) assessed the effect of different rates of N and P fertilization in maize and noticed that plant height, leaves $plant^{-1}$ and leaf area were increased significantly with application of 120 kg N + 0 kg P ha^{-1} but it remained at par with 60 kg N +40 kg P ha^{-1}. However, stem girth recorded maximum with 60 kg N + 40 kg P ha^{-1}.

Law-Ogbomo (2009) suggested that NPK compound fertilizer has significantly increased plant height and yield of seeds.

Babatola *et al.,* (2006) who reported that increasing level of fertilizer application was observed to increased growth and yield of crops. The significant increase in plant height reflects the effect of fertilizer nutrients, N, P and K. The untreated plants were almost stunted in growth as they had to rely on the native soil fertility which, from the result of chemical analysis was deficient in these nutrients. The height of plant is an important growth character directly linked with the productive potential of plants in terms of grains.

At Bahawalpur (Pakistan), Nazakat *et al*., (2004) evaluated the effect of combined application of N and P i.e., 60-40, 120-50,180- 60 and 240-70 kg ha-1 noticed marked increase in plant height up to 240 kg N +70 kg P ha-1 over control.

While working on fodder maize at Faisalabad (Pakistan), Ayub *et al*., (2003) noticed that application of 120 kg N ha^{-1} registered the tallest plant, leaves plant-1 and stem diameter of maize over the control and 80 kg N ha^{-1}.

Application of 100-100-100 kg NPK haG1 applied in treatment 100-100-100 kg NPK haG1 produced plants of maximum height than the plants produced in control. It will be therefore, an uneconomical and wasteful practice applying NPK beyond, treatment 100-100-100 kg NPK haG1. It can further be pointed out that the initial fertility level of soil used was not very low and that the NPK at the rate of 100-100-100 kg haG1 would be sufficient to obtain plants of optimum height under the conditions. Similar results were reported by El-Sharkawy *et al*., (1976) and Chao *et al*., (1982) observed that maize plant height was increased significantly with the application of 100 lbs N + 100 lbs P_2O_5 per acre.

2.1.1.2 Base circumference

At Varanasi, Kumar and Bohra (2014) evaluated the effect of nitrogen, phosphorus and potassium (NPK) (100% and 125% recommended dose of fertilizer), sulfur (0, 25 and 50 kg S ha^{-1}) and zinc (0, 5 and 10 kg Zn ha^{-1}) and found application of 125% RDF over 100% RDF resulted in significant growth in green leaves, stem girth, dry matter $plant^{-1}$, crop growth rate (CGR), chlorophyll content of leaves, yield attributes like number of baby cobs $plant^{-1}$, cob and corn weight, length and girth of corn as well as yield of cob, corn and green fodder.

Solomon *et al*., (2012) showed that the application of NPK could promote the growth of length and diameter of the stem.

2.1.1.3 Leaf area index

Jena *et al*., (2015) working at Rajendranagar, Hyderabad, observed that application of 240 kg $Nha^{-1}$and 100 kg P ha^{-1}gave taller plants and LAI of quality protein maize over the 0, 120 and 180 kg N ha^{-1}&80 kg P ha^{-1}.

According to Sarwar *et al*., (2012) increasing levels of zinc application up to 8 kg Zn ha^{-1} significantly increased leaf area index.

Working at Shalimar (JK), Mahdi *et al*., (2012) reported significantly taller plants and higher leaf area index of fodder maize with increasing levels of zinc application up to 10 kg Zn ha^{-1}.

Sarwargaonkar *et al*., (2008) reported significant increase in the plant height of kharif maize with 100% recommended fertilizer dose (RFD) compared to 75% RFD. Leaf area index, a vital photosynthetic character, was found significantly affected by fertility levels. Increase in level of fertility from F1 (60: 40: 20) to F2 (75: 50: 30) significantly improved leaf area index at different crop growth stages and beyond F2 (75: 50: 30) level, the difference was nonsignificant. Maximum leaf area was recorded at tasseling stage. F2 (75: 50: 30) level might have provided sufficient nitrogen to the crop for rapid cell division and cell elongation thereby resulting in increased leaf area.

Bindhani *et al*., (2007) observed that application of 120 N ha^{-1} resulted in tallest plants with maximum dry matter and leaf area index of maize which were significantly higher than those at remaining N levels (40 and 80 N ha^{-1}). Successive increase in nitrogen levels from 0 to 120 kg ha^{-1} significantly improved leaf area index and dry weight $plant^{-1}$ at 40 to 60 days after planting and maturity stages of white maize over other treatments.

Earlier Amin *et al*., (2006) was reported that higher leaf area index of maize under ridge sowing due to enhanced water and nutrient availability. The ridges significantly increased the period for crop to reach different phenological stages. This could be attributed to better uptake of nutrients especially nitrogen in loose fertile soil of ridges because nitrogen is known to lengthen vegetative period of crop thereby delaying maturity.

In a field experiment in Nigeria, Hussaini *et al*., (2001) evaluated response of maize to different levels of nitrogen (0, 60, 120 and 180 kg N ha^{-1}) and phosphorus (0 and 20 kg P ha^{-1}). They observed that plant height, dry matter plant-1, LAI and crop growth rate were increased significantly with increasing levels of nitrogen and phosphorus up to the highest level.

Shivay and Singh (2000) also found improvement in leaf area index with increasing levels of nitrogen. The decrease in leaf area index of crop irrespective of fertility levels after tasseling could be attributed to senescence of lower leaves. It was found that F3 (90: 60: 40) significantly increased number of days for crop to reach different phonological stages. Increased dose of nitrogen might have lengthened the vegetative phase of the crop, thereby delaying the reproductive period of the crop. The study revealed a gradual increase in dry matter production of crop from knee high to maturity stage irrespective of fertility levels and the magnitude of increase was highly pronounced from knee high to tasseling stage. This could be attributed to vigorous growth of crop in terms of gain plant height and higher number of functional leaves per plant.

The unfertilized plants had shown lower LA due to a smaller number of leaves resulting from premature leaf fall and early vine senescence (Okwuowulu, 1995). The higher LAI associated with the fertilized plants was probably due to higher number of leaves.

2.1.1.4 Dry matter weight

Kumar *et al*., (2016) reported that application of 50 kg S ha^{-1}, being at par with 25 kg S/ha, significantly enhanced the baby cob and baby corn yield by 17.1 and 22.8%, respectively, over control. And also reported that significant increase in root length; root dry weight and root volume at respective stage of crop growth were recorded with each increment of sulphur up to 50 kg S ha^{-1}.

Kumar *et al*., (2016c) noticed each successive level of zinc application up to 10 kg Zn ha^{-1} correspondingly improved root length, root dry weight and root volume at various growth stages.

At Budgam, Kashmir Gul *et al*., (2015) reported that application of NPK 90: 60: 40 kg ha-1 and 75: 50: 30 kg ha-1 both were at par and gave higher plant height, leaf area index, dry matter production at different growth stages of rainfed maize and significantly superior over the level of NPK 60: 40: 20 kg ha-1.

A field experiment conducted at Udaipur, Rajasthan during kharif season 2011 by Meena *et al*., (2013) to assess the response of different zinc levels (2.5, 5.0 and 7.5 kg ha^{-1}) to maize cv. PEHM-2 on sandy clay loam soil revealed that application of 5 kg Zn ha^{-1} produced significantly taller plants and dry matter plant-1 than 2.5 kg Zn ha^{-1} but it remained at par with 7.5 kg Zn ha-1.

At Bangalore, a field experiment on hybrid maize NHH-2049 with varying fertility levels was carried out during rainy season by Vishalu *et al*., (2009). He observed that plant height, total dry matter production and net assimilation rate were significantly higher with application of 150% NPK over 100% NPK (100% NPK:100-50-25 kg ha^{-1}).

Similarly, Zende *et al*., (2009) at Dapoli, studying the nutrient management on sweet corn cv. Sugar 75 revealed that plant height and dry matter $plant^{-1}$ were significantly superior with 150% RDF over 100% RDF (225-60-60 kg NPK ha^{-1}) and lower doses.

This may be attributed to NPK being part of the essential nutrients required for the production of the meristematic and physiological activities such as leaves, roots, shoots, dry matter production, etc. leading to an efficient translocation of water and nutrients, interception of solar radiation and carbon di-oxide. The activities promote greater photosynthetic activities of adequate assimilates for subsequent translocation to various sinks and hence the production of higher TDM (Jaliya *et al*., 2008).

Kalpana and Krishnarajan (2002) studied the effect of levels of K application on baby corn and noticed significantly higher plant height, LAI and dry matter production with application of 50 kg K ha^{-1} over 40 kg K $ha^{-1}$and also reported significantly higher cobs $plant^{-1}$, cob length, cob width as well as cob and stover yield of baby corn with 50 kg K ha^{-1}as compared to 40 kg Kha^{-1}.

2.1.2 Review on Yield contributing characters

2.1.2.1 Cob length

Cob length was significantly affected by the main effects of nitrogen level and planting density. The tallest cobs were recorded from the highest nitrogen level (360 kg ha^{-1}) whereas the shortest cobs were recorded from the lowest nitrogen level (120 $kgha^{-1}$). This result agrees with the result of Mahdi and Ismail (2015) who reported that cob length increased with increasing nitrogen level.

N rates increased from 43.5 to 130.5 kg ha^{-1} ear height was increased from 98.53 to 100.75 cm though significant variation was not recorded among rates. Similar results also reported by Olusegun (2015).

Evaluating fertilizer levels on hybrid maize COH (M)-5 at Coimbatore on sandy loam soil Sekar *et al*., (2012) noticed significantly higher cob length, girth and grain yield with application of 250-125-125 kg NPK ha^{-1} over 150-75-75 kg ha^{-1}but it remained comparable with 200-100-100 kg NPK ha^{-1}. The grain yield increase with 250-125-125 NPK kg $ha^{-1}$and 200-100-100 kg NPK ha^{-1}were 17.2 and 14.6%, respectively over fertilizers level of 150-75-75 kg ha^{-1}.

Bharathi and Poongothai (2008) noticed significantly higher growth attributes of maize with increasing levels of sulphur application up to 45 kg S ha^{-1} but it remained statistically on par with 30 kg S ha^{-1} and also noticed that cob length increased significantly with increasing rates of sulphur application up to 45 kg S ha^{-1} but grain and stalk yield of maize were increased significantly only up to 30 kg S ha^{-1}.

The length of cob is almost increased with increased level of NPK except the highest level, that is 300-100-100 kg NPK haG1 where the length of cob was rather depressed. The reason for more cob length in treatment 200-100-100 kg NPK haG1 and treatment 250-100-100 kg NPK haG1 may be due to the more photosynthetic activities of the plant on account of adequate supply of N in these treatments. These results are partly in agreement with Salem *et al*. (1982) and Hasan and Miro (1984).

2.1.2.2 Cob circumference

Studying the response of maize cv. Ganga Safed to different levels of nitrogen (0, 50,100 and 150 kg N ha^{-1}) at Hamirpur (U.P), Verma *et al.*, (2012) reported that plant height, total dry matter, leaf area index, number of days to silking and maturity were enhanced significantly with increasing nitrogen levels up to 150 kg N ha^{-1}. cob diameter, weight of cobs $plant^{-1}$ and grain yield increased significantly with application of increasing levels of nitrogen up to 150 N. ha^{-1}).

A field experiment was conducted at Coimbatore to study the effect of balanced fertilization on maize by Paramasivan *et al.*, (2011), they noticed increasing levels of NPKZn application up to 250+60+25+10 kg NPKZn ha^{-1} significantly increased cob length and girth, grain and stover yield.

Working on maize, Hussain *et al.*, (2007) at Peshawar (Pakistan) reported application of increasing rates of phosphorus and potassium significantly increased yield attributes viz. ear weight and 1000-grain weight. However, effect of application of potassium on grain yield was non-significant, but it increased significantly with application of phosphorus. A field experiment was conducted at Coimbatore to study the effect of fertilizer levels on maize and it was noticed that application of 250-125-125 kg NPK ha^{-1}gave significantly higher cob length, cob girth, grains row cob^{-1} and grain yield but it remained comparable with 200-100-100 kg NPK ha^{-1}.

2.1.2.3 Grain weight

Amanullah *et al.,* (2009) reported that application of different phosphorus sources can increased leaf area, grains per ear and grains weight in maize and also stated that phosphorus fertilizer affected plant growth, yield and also increased plant height, leaf area, grain weight, grains ear^{-1}, grain and stover yields, shelling percentage and harvest index of maize as compared with control. The application of phosphorus from TSP (triple super phosphate) increased the yield and yield components of maize.

Ram *et al.*, (2006) noticed that application of sulphur significantly increased yield attributes of maize viz. cob length, and girth, grain weigh cob-1 as well as grain and stover yield up to 60 kg S ha^{-1}.

2.1.2.4 cob weight

Singh *et al*., (2016a) studies the response of baby corn to integrated nutrient management results revealed that maximum baby corn length, baby corn girth, green cob weight, baby cob weight, number of cobs, baby corn yield and green fodder yield were recorded with application of 5t FYM + 100 kg N ha^{-1}followed by 100% recommended dose of nitrogen.

Singh *et al*. (2012) found that application of 120 kg N ha^{-1} being on par with 250 kg N ha^{-1} significantly improved all yield attributes, viz. number of cobs ha^{-1}, weight of green cob, number of kernel cob^{-1} and 1,000 kernel fresh weight over preceded levels from experiment at Wadura, Sapore, Jammu and Kashmir on well drained silty clay loam.

This is in line with the opinion of Tuberkih *et al*., (2008) that NPK fertilizer can increases the dry weight of corn. To achieve a nutrient balance, NPK still needs to be added to a single fertilizer, especially a source of N nutrients.

2.1.2.5 Number of $grain^{-1}$ cob

Working on maize Raskar *et al*., (2012) reported that increasing level of phosphorus increased the plant height up to 80 kg ha^{-1} but on par with 60 kg ha^{-1} and significantly superior over 40 kg ha^{-1}. application of 80 and 60 kg P2O5 ha^{-1} were at par and gave significantly higher No. of cobs plant-1, cob length, No. of grains row cob-1, test weight, shelling percentage, grain and stover yield of maize as compared to 40 kg P2O5 ha^{-1}.

Gul *et al*., (2009) at Budgam, Kashmir, assessing the effect of NPK levels on rainfed maize revealed that application of 90: 60: 40 kg ha-1 and 75: 50: 30 NPK kg ha-1 recorded significantly maximum cob length, number of cobs plant-1, number of grains cob-1 ,100-seed weight, grain and stover yield over NPK 60: 40: 20 kg ha-1.

According to Short *et al*. (1982), number of grains per cob as influenced by different NPK levels indicate that number of grains per cob was affected markedly by different levels of NPK used. Treatment 250-100-100 kg NPK haG1 resulted in a greater number of grains per cob but this treatment did not differ from treatment 200-100-100 kg NPK haG1 and treatment 150-100-100 kg NPK haG1. These treatments were followed by rest of the treatments which did not differ when compared among themselves. It can be concluded from the data that rather higher levels of nitrogen will help increase the size of cob and number of grains per cob. Too lower or too higher NPK levels will discourage the same. The minimum number of grains per cob in control and treatment 100-100-100 kg NPK haG1 may be due to requirement of nitrogen at different growth stages. The decreases in number of grains per cob in treatment 300-100-100 kg NPK haG1 may be due to excessive nitrogen which might have disturbed the physiological functioning of the crop plant. Application rate 150-100-100 kg NPK haG1 seems to be an optimum level to get optimum number of grains per cob under the conditions.

2.1.2.6 1000-grain weight

Amanullah *et al*., (2016) conducted a field experiment at Peshawar, Pakistan results revealed that among the foliar K levels, plant height, mean single leaf area and LAI were obtained with were recorded with the application of 2% foliar spray. And also revealed that among the foliar K levels, 1000- grain weight, No. of grains ear^{-1} and harvest index were obtained with were recorded with the application of 2% foliar spray, whereas, the highest grain yield and shelling percentage was recorded with the foliar spray of K @ 3%.

This is probably increased in grain yield per hectare in response to increasing levels of NPS and N is due to increased number of grains per ear and 1000-grain weight. Similar, findings also found by Shamim *et al*., (2015).

While evaluating the impact of nitrogen levels on maize at Peshawar (Pakistan), Arif *et al*., (2010a) noticed grains ear^{-1}, 1000-grain weight, grain and biological yield improved constantly with increasing levels of nitrogen application from 0-160 kg ha^{-1}. Grains and stover yields were significantly affected by the main effects of nitrogen level. The maximum and the minimum grain and stover yields were recorded from the highest (360 kgha^{-1}) lowest (120 kg ha^{-1}) nitrogen level, respectively. Variations in the level of nitrogen can powerfully affect grain and stover yields significantly. Many researchers have reported that as increased maize grain and stover yields due to increased nitrogen levels up to optimum levels (Arif *et al*., 2010; Moraditochaee *et al*., 2012; Satchithanantham and Bandara, 2001).

2.1.3 Review on Yield characters

A field experiment was conducted by Kumar *et al*. (2018) on maize (*Zea mays* L.) to assess the effect of balanced fertilization (NPKS and Zn) on productivity, quality of maize. Results revealed that application of 125% RDF (187.5, 93.75, 75.0 kg NPK ha^{-1}) produced significantly higher yields of total baby cob yield with husk (9.55 tons ha^{-1}) and total maize yield without husk (2.15 tons ha^{-1}). Among different levels of S and Zn, application of 50 kg S and 10 kg Zn ha1 produced significantly higher yields of total baby cob with husk (9.38 and 9.24tons ha^{-1}) and total maize without husk (2.15 and 2.10tons ha^{-1}), respectively.

Khan *et al*., (2012) have also reported maximum plant height under ridge sowing. It was also found that ridge sowing resulted in higher leaf area index of crop at different stages. Better and developed root system in loose fertile soil of ridges might have improved water availability and nutrient uptake resulting in maximum leaf area index. Various aspects of the present investigation and observation generated showed that all growth and yield and yield attributing traits were discernibly influenced by manipulation in sowing methods and NPK level. Results clearly suggested that, for temperate environment of Kashmir Valley, the application of 75 kg N ha^{-1}, 50 kg P ha^{-1}, and 30 kg K ha^{-1}under ridge method of sowing was found to be an appropriate treatment for growing rainfed maize and can be recommended for farmers of Kashmir Valley.

Sathish *et al*., (2011) reported that the application of NPK on sandy soil at the Station of Agricultural Research has significantly increased yield of maize, and nutrient absorption of N, P, and K.

2.1.3.1 Grain yield (t ha^{-1}) P_2O_5

Singh and Daoudi (2017) reported that grain yield of hybrid maize varieties was increased as N increased.

Kumar *et al*., (2017) found that for gaining higher productivity of maize, it requires very high quantities of nitrogen during the period of efficient utilization. Application of 120 kg N ha^{-1} reduced the days to corn initiation but prolonged the harvesting period over 80 kg N ha^{-1}. Application of 30 kg P ha^{-1} is reported to beneficial and economical for maize production under the normal management. Potassium regulates the osmotic potential of cells and imparts resistance to biotic and abiotic stresses. Application of S and Zn has resulted in significant improvement for crude protein, Ca, ash in maize. Application of 125% RDF (187.5-93.7-75 kg ha^{-1}) and 50 kg S ha^{-1} along with 10 kg Zn ha^{-1} has great impact on corn production in maximizing corn yield, fodder yield, nutrient content and monetary returns to the growers.

Mahamood *et al*., (2016) was conducted a field experiment (2009–2010) at FSRD site Lahirirhat, OFRD, Rangpur during rabi season 2009-2010 to evaluate Maximizing maize production through nutrient management. Five treatments viz. T1=$N_{300}P_{50}K_{150}S_{30}$, T2= $P_{50}K_{150}S_{30}$, T3= $N_{300}K_{150}S_{30}$, T4= $N_{300}P_{50}S_{30}$ and T5= $N_{300}P_{50}K_{150}S_{30}$ were evaluated for this purpose. The result indicated that the highest grain yield (8.37 t ha^{-1}) was found from T1= $N_{300}P_{50}K_{150}S_{30}$ treatment. The lowest grain yield (7.33 t ha^{-1}) was obtained from T2= $P_{50}K_{150}S_{30}$ treatment. It may be concluded that proper nutrient management may be the good alternatives for maximizing maize yield and management of soil health at Rangpur region in Bangladesh**.**

Olusegun (2015) reported that application of the combination of N at 90 kg ha^{-1} and P at 30 kg ha^{-1} gave the highest grain yield of maize.

Field experiments were conducted by Usman *et al*., (2015) at University of Agriculture, Makurdi to determine the effect of three levels of NPK fertilizer on growth parameters and yield of maize-soybean intercrop. The experimental design consisted of two factors: cropping system at two levels (sole and intercrops) and NPK fertilizer at three levels (0, 150 and 300 kg ha-1 of NPK 20:10:10). Increasing the quantity of NPK fertilizer resulted in significant increase in the yield and growth parameters of maize and soybean in both years. Intercropping resulted in yield advantage in 2013 and 2014 showing 35 % and 26 % land saved respectively.

Kumar *et al.,* (2015) reported that baby corn and green fodder yields, economics and nutrient uptake (N, P, K, S and Zn) were significantly higher with application of 125% recommended dose of fertilizer (RDF).

This study was conducted by Asghar *et al*., (2010) to investigate the effect of different NPK rates on growth and yield of maize cultivars; Golden and Sultan. Application of NPK at increase rate delayed the number of days taken to tasseling, silking and maturity of the crop. The plant height was significantly affected by different rates of NPK. Treatment F_3 (250-110-85) of NPK produced tallest plants than two other treatments in both the varieties. Too low or high NPK levels reduced the yield and yield parameters of maize crop. Treatment F_2 (175-80-60) seems to be the most appropriate level to obtain maximum grain yield under the prevailing conditions. Application of NPK beyond treatment F_2 (175-85-60) seems to be an un-economical and wasteful practice. Varieties (Golden& Sultan) seem to have similar production potential under uniform and similar growing condition.

The grain yield increase at 250 N -125 P-125 K and 200 N-100 P-100 K kg ha^{-1} was 17.7 and 17.1%, respectively over 150 N-75 P-75 K kg ha^{-1} (Srikant *et al*., 2009).

Murni and Arief, R.W., (2008) reported that higher NPK will significantly increase plant height and productivity (yield of grain).

Asif *et al*., (2007) carried out a field experiment at Peshawar, Pakistan to study the penology and leaf area of spring maize cv. Azam to different levels of potassium (0, 30, 60 and 90 kg K ha^{-1})and reported that tasseling, silking and physiological maturity were delayed when potassium application was increased up to 60 kg Kha^{-1}, while increase in potassium level up to 90 kg K ha-1 significantly enhanced tasseling, silking and maturity as well as flag leaf area and leaf area and yield of maize .

At Rakh Diandar (Jammu) Abrol *et al*., (2007) reported that application of 100% RDF (NPK: 60-40-20 kg ha^{-1}) + ZnSO4 @ 20 kg ha^{-1} significantly increased grain yield of maize to the tune of 120% over control.

At Chitwan valley Rampur, Adhikary and Pandey (2007) evaluated the response of maize to levels of sulphur (0, 10, 20, 30 and 40 kg S ha^{-1}) noticed that sulphur application at 20 Kg S ha^{-1} significantly increased grain yield over control, which was 63.4%.

At Peshawar (Pakistan), Amin *et al*., (2006) evaluated the response of sweet corn to N-P levels and noticed significant increase in grain yield with increasing level of N-P up to 300-150 kg ha^{-1}.

Sadiq *et al*., (2005) while working on maize noticed that application of highest level of N-P i.e., 180-90 kg ha^{-1} significantly increased cobs plant-1, test weight and grain yield over 120-60 kg N-P ha^{-1}.

Phosphorus can significantly increase vegetative growth and grain yield Reghuram K *et.al.,* (2000).

It is revealed from the data that the maximum grain yield (68.4 g haG1) was recorded in treatment 250-100-100 kg NPK haG1, which did not statistically differ from treatment 200-100-100 kg NPK haG1, Treatment 200-100-100 kg NPK haG1, was further found at be at par with 150-100-100 kg NPK haG1.Next to follow were treatments 300-100-100 kg NPK haG1,100-100-100 kg NPK haG1 and control in a descending order. It is again confirmed that rather higher NPK levels will help increase grain yield per ha on account of increased number of grains per cob, Treatment 200-100-100 kg NPK haG1 seems to be the best level and going beyond this level will not bring any economic benefits. This may partly be due to increased nitrogen use efficiency in treatment 200-100-100 kg NPK haG1 and treatment 250-100-100 kg NPK haG1. Similar results were reported by Gardner *et al*., (1990).

2.1.3.2 Stover yield (t ha^{-1})

Jena *et al*., (2015) working at Rajendranagar, Hyderabad, observed that application of 240 kg Nha^{-1} gave taller plants and LAI of quality protein maize over the 0, 120 and 180 kg N ha^{-1}. grain yield, stover yield and total dry matter production of QPM increase up to increasing level i.e 240 kg ha^{-1} and reported that grain yield was not affected by interaction effect of N by P but grain yield was increased as N increased.

Dibaba *et al*., (2014) carried out field experiment at Dharwad, reported that among Sulphur levels, application of 40 kg ha^{-1} gave the highest grain and stover yield of maize was at par with 30 kg ha^{-1} and significantly superior to 20 kg S ha^{-1}.

At Kota (Rajasthan), Shivran *et al*., (2013) reported significantly higher grain and stover yield of maize with application of increasing levels up to 40 kg P2O5 ha^{-1}& Sulphur application up to 60 kg S ha^{-1}.

At Vadodara (Gujarat) Raskar *et al*., (2012) found that application of 120 and 160 kg N ha^{-1}were at par and produced significantly higher no. of cobs plant-1, cob length, no. of grains row cob-1, test weight, shelling percentage, grain and stover yield of maize as compared to 80 kg N ha^{-1} and also reported that increasing level of nitrogen significantly increased the plant height up to 160 kg ha^{-1}but it was at par with 120 $kgha^{-1}$.

Karki *et al*., (2005) reported significant increase N, P, K and Zn content as well as uptake in grain and stover of maize with application of 100% RDF (120 kg N+26.2 kg P +41.5 kg K ha^{-1}) over 60 kg N+ 13.2 kg P +20.8 kg K ha^{-1} and lower doses.

2.1.3.3 Biological yield (t ha^{-1})

A field experiment was conducted by Azeem *et al*., (2018) investigated the impact of different P sources (DAP (Diammonium Phosphate), NP (Nitrophos), TSP (Triple Super Phosphate) and SSP (Single super phosphate)) on growth, yield and yield component at two maize varieties (Azam vs. Jalal) at Dargai Malakand during summer. The experiment was laid out in randomized plants complete block design having three replications. Application of DAP delayed than other P-sources, application of TSP increased plant height, number of grains ear^{1}, thousand grains weight, biological and grain yields. Azam had taller with higher thousand grains weight than Jalal, while Jalal with delayed maturity had a greater number of grains ear^{1} and higher biological and grain yields. Application of TSP and use of variety Jalal could increase maize productivity in the study area**.**

Shivran *et al*., (2013) reported that application of RDF + 60 kg S ha^{-1} recorded significantly higher seed, stover and biological yields over control.

In accordance with Ahmad *et al*., (2003) the highest above-ground biomass yield (24.2 t ha^{-1}) was obtained from the highest N (130.5 kg) level and the lowest biomass yield (21.8 t ha^{-1}) was obtained where plots treated with the lowest N (43.5 kg). Above-ground biomass yield was increased by 5.6% and 9.9% from the application of 87 and 130.5 kg N over 43.5 kg N, respectively. Generally, above-ground biomass yield was increased as both fertilizers increased.

2.1.3.4 Harvest Index (%)

Ahmad *et al*., (2018) was conducted an experiment to study the effect of different nitrogen rates on the yield and yield components of maize cultivars (Azam and Jalal), at the New Developmental Form of The University of Agriculture Peshawar, during summer. The treatments comprised 0, 30, 60, 90, 120, 150, 180 and 210 kg N ha-1 assigned to main plot and maize cultivars (Azam and Jalal) to sub plots. Results revealed that maximum harvest index (27.66 %) were recorded in Azam cultivar. However, maximum ear length (16.33 cm), biological yield (14250 kg ha^{-1}) and thousand grains weight (258.65 g) were observed in Jalal cultivar. Maximum biological yield (16277.78 kg ha^{-1}) was recorded with the application of 180-210 kg N ha^{-1}. However maximum ear length (17.18 cm), grain ear^{-1} (411.32), grain yield (4888.9 kg ha^{-1}) and thousand grains weight (264.96 g) were observed with the application of 180 kg N ha^{-1}.

Azab (2015) reported that combined application of Zn (2%) and NPK fertilizer significantly increased the plant height, leaf area, fresh weigh and dry weight of corn as compared to the treatment fertilized only with NPK. And also reported that combined application of Zn (1.5%) and NPK fertilizer significantly improved cob length, no. of rows, cob girth, 1000-grain weight, grain yield and harvest index as compared to the treatment fertilized only with NPK.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during kharif season, March to June, 2021 at the Agronomy research field of Sher-e-Bangla Agricultural University, Dhaka-1207. The materials used and methodology followed in the investigation have been presented details in this chapter.

3.1 Experimental Site

The experiment was done at the Agronomy field of Sher-e-Bangla Agricultural University (SAU). It is situated at 23°74/ North latitude and 90°35/ East longitude (Anon, 1989).

3.1.1 Agro-ecological region

The experimental field belongs to Madhupur Tract (AEZ 28). The land was 8.6 m above the sea level. This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as islands surrounded by floodplain (UNDP, 1988). For better understanding about experimental site.It is shown in the Map of AEZ of Bangladesh in **Appendix- I.**

3.2 Climate

The area has subtropical climate, characterized by high temperature, high relative humidity and heavy rainfall with occasional gusty winds in Kharif season. The experimental site climate was subtropical, characterized by the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al*., 1979). Climatic parameters of the experimental site are presented in **Appendix II.**

3.3 Soil

The soil of the experimental site belongs to the general soil type, shallow red brown terrace Soils under Tejgaon Series. The experimental area was flat having available irrigation and drainage system and above flood level. Soil sample was collected from 15 cm depth of the experimental site and was sent to SRDI, Dhaka for analysis. The result of analysis was given in **Appendix-III**.

3.4 Planting materials

(a) Seeds- SAUWMOPT variety was used as plant materials and the seeds were collected from Dr. Prof. Md. Jafar Ullah.

(b) Fertilizers- Urea, TSP, MP, Gypsum, $ZnSO_4$, Boric Acid, Cow dung etc. All chemical fertilizer and cow dung were collected from the Farm Office of Sher-e-Bangla Agricultural University (SAU).

3.5 Description of the variety

Variety/line: SAUWMOPT (White)

Identifying character: Bold grain quality, good crop stand ability.

Type: Medium duration, open pollinating tall variety.

Crop duration: 90-100days.

Yield: 10 t ha^{-1}

Suitable area: All over Bangladesh.

Sowing time: 28th March

Harvesting time: After attaining physiological maturity.

Maturity period: 75-80 days and stay green at maturity.

Major diseases and Management

Diseases: Mainly leaf blight disease occurs at vegetative stage.

Management: Seed treatment with vitavax- 200 @ 2.5g kg^{-1} seed, spraying with Tilt or Folicure @ 0.5% and burning of crop residues.

Major insect/pest and Management

Insect pests: Cut worm and Stem borer attack at vegetative stage of maize as well as Ear worm attack in cob at reproductive stage in maize. Fall army warm attack both the vegetative and reproductive stage.

Management

For cut worm: The larvae are killed after collecting from soil near the cut plants in morning. Dursban or Pyrifos 20 EC 5 ml $liter^{-1}$ water sprayed especially at the base of plants to control cutworms

For ear worm: The larvae are killed after collecting from the infested cobs. Cypermethrin (Ripcord 10 EC/Cymbush 10 EC) @ 2 ml litre^{-1} water sprayed to control this pest.

For stem borer: Marshall 20 EC or Diazinon 60 EC @ 2 ml litre^{-1} water sprayed properly to control the pest. Furadan 5 G or Carbofuran 5 G @ 20kg ha^{-1} applied on top of the plants in such a way so that the granules stay between the stem and leaf base. Such type of application of insecticides is known as whorl application.

For FAW: Treasure 7ml from auto crop care ltd. 2ml/ 20L water was applied for controlling fall army warm.

3.6 Experimental details

Treatments

Factor A: Earthing up–Three levels

1. E_0 = No earthing up
2. E_1 = earthing up at 25DAS
3. E_2 =earthing up at 25DAS + 50 DAS

Factor B: Fertilizer – Four levels

1. F_1 = 50% of recommended doses of fertilizer
2. F_2 =75% of recommended doses of fertilizer
3. F_3 =100% of recommended doses of fertilizer

4.F_4 = 125% of the recommended doses of fertilizer

As such there were 12 treatment combinations as follows:

E_0F_1, E_0F_2, E_0F_3, E_0F_4, E_1F_1, E_1F_2, E_1F_3, E_1F_4, E_2F_1, E_2F_2, E_2F_3, E_2F_4

3.7 Layout of the experiment

The experiment was laid out into Split-plot design with three replications. Fertilizer in the main plot considered as Factor-B and earthing up levels in the sub-plot considered as Factor-A. The treatment combination of both main plots and sub plots were allotted randomly in a block having 12 experimental plots. This procedure was repeated randomly and separately for each replication. The total numbers of unit plots were 36. The size of unit plot was 3.36 m^2(2.4 m ×

1.4 m). The distances between replication to replication and plot to plot were 1m and 0.5m, respectively. The layout of the experiment is presented in **Appendix IV.**

3.8 Detail of the experimental field

The land was opened with the help of a tractor drawn disc harrow on march 25, 2021 and then ploughed with rotary plough twice followed by laddering to achieve a medium tilth required for the crop under consideration. All weeds and other plant residues of previous crop were removed from the field.

3.8.1 Fertilizer application

During final land preparation, the land was fertilized as per treatment. Four levels of fertilizer treatments were used under the present study based on recommended doses of fertilizers. The recommended doses of nutrients through fertilizers were as below:

Name of Fertilizer Rate (ha^{-1}) Nutrients (ha^{-1})

Urea 300 kg N = 138 kg

TSP 150 kg P = 67.5 kg

MoP 100kg K = 60 kg

Gypsum 150 kg S = 27 kg, Ca = 33 kg

ZnSO4 10 kg Zn = 4 kg

Source: BARI, 2014 (Krisi Projukti Hat Boi, P. 54)

Full amount of P, K, Zn and B fertilizers and 1/3rd of N was applied as basal dose i.e., at the time of sowing and remaining urea as per treatment was applied in two equal installments as side dressed in two equal splits at knee high stage and pre tasseling stage. At knee high stage the N side dressing was done along with earthing up practice. Whole amount of P, K, S and Zn through TSP, MoP, Gypsum, ZnSO4 and Boric acid, respectively were applied at the time of final land preparation.

3.8.2 Seed sowing

The white maize seeds were sown in lines. Plant to plant and row to row spacing was maintained at 25cm & 50cm in order to obtain the recommended plant population of maize.

3.9 Intercultural operations

3.9.1 Irrigation

Maize crop was irrigated as per the crop requirement. First irrigation was given on 4th April, 2021 which was 7 days after sowing. Irrigation was done most of the time for the plant to live. Irrigation water was added to each plot as and when necessary.

3.9.2 Thinning and gap filling

The plots were thinned out and gap filled on 15 days after sowing having single plant hill^{-1} to maintain a uniform plant stand.

3.9.3 Weeding

The crop field was infested with some weeds during the early stage of crop establishment. Weed control operations were performed manually. Two hand weeding were done; first weeding was done at 25 days after sowing followed by second weeding at 45 days after sowing.

3.9.4 Earthing up

Earthing up is a major intercultural operation for better establishment and anchorage of crown root of maize. It was done two times, 1st one at 25 days after sowing, 2nd one at 50 days after sowing.

3.9.5 Drainage

Drainage channels were also properly prepared for easy and quick draining out of excess water.

3.9.6 Plant protection measures

Insecticides Diazinon 60 EC @ 2 ml litre^{-1} water was sprayed to control and Ripcord 10 EC @2 ml litre^{-1} water were sprayed to control and to protect the crop.

3.9.7 Harvesting

The crops were harvested when the husk cover was completely dried and black coloration was found in the grain base. The cobs of five randomly selected plants of each plot were separately harvested for recording yield attributes and other data. The inner two lines were harvested for recording grain yield and stove yield. Harvesting was done on 6 and 7th June, 2021.

3.9.8 Drying

The harvested products were taken on the threshing floor and it was dried for about 4-5 days.

3.10 Recording of data

Experimental data were collected at different growth stages and also at the time of harvest. At harvesting, 5 plants were selected randomly from each plot to record the following data,

3.10.1Growth parameters

1. Plant height (cm)
2. Base circumference plant^{-1} (cm)
3. Leaf area index
4. Dry matter weight plant^{-1}

3.10.2 Yield contributing characters

1. Cob length plant^{-1} (cm)
2. Cob circumference plant^{-1} (cm)
3. Chaff weight cob^{-1}
4. Shell weight cob^{-1}
5. Grain weight cob^{-1}
6. Cob weight plant^{-1}
7. Number of grains cob^{-1}
8. 1000 grains weight (g)

3.10.3 Yield characters

1.Grain yield (t ha^{-1})

2. Stover yield (t ha^{-1})
3. Biological yield (t ha^{-1})
4. Harvest index (%)

3.11 Procedures of recording data

Brief outlines of the data recording procedure are given below:

3.11.1 Plant height (cm)

The height of plant was recorded in centimeter (cm) at harvest. Data were recorded as the average of 5 plants selected from the inner rows of each plot. The height was measured from the ground level to the tip of the plant.

3.11.2 Base circumference of plant (cm)

The base diameter was measured from randomly selected five plants in each plot and average was recorded in centimeter (cm).

3.11.3 Leaf Area Index

Leaf area index were estimated manually by counting the total number of leaves per plant and measuring the length and average width of leaf and multiplying by a factor of 0.70 (Kluen and Wolf, 1986). It was done at 90 days after sowing (DAS).

$$\text{Leaf area index} = \frac{\text{Surface area of leaf sample (m}^2\text{) x correction}}{\text{Ground area from where the leaves are collected}}$$

3.11.4 Dry matter weight plant^{-1}

Five plants are selected from each plot and uprooted carefully then each and every part of the plants were cut into pieces and various pieces of the plant were put into paper packet at 40,80 DAS and harvest respectively. Cob was also put into packet and placed in oven (at 72degree centigrade for 72 hours) then the sample was transferred into desiccators and allowed to cool down at room temperature. Then the sample weight was taken and then calculate the total dry matter of a plant for each plot.

3.11.6 Cob length and cob diameter

Five randomly selected cobs were taken from each plot to measure the length from the base to the tip of the ear. The average result was recorded in cm.

$$\text{Diameter of cob (cm)} = \frac{\text{Cob circumference}}{\pi}$$

3.11.7 Chaff weight cob^{-1}

Whole chaff without grains of five cobs were randomly taken from each plot and the weight was taken in an electrical balance then the average chaff weight was recorded in gram.

3.11.8 Shell weight cob^{-1}

Firstly, removing the grain from five randomly selected cobs from each plot. Secondly, weighted in an electrical balance of each shell and average weight was recorded in gram.

3.11.9 Grain weight cob^{-1}

Five randomly selected cobs were collected from the five selected plant in each plot then weighted in an electrical balanced and average weight was recorded in gram.

3.11.10 Cob weight $plant^{-1}$

Five randomly selected cobs were collected from the five selected plant in every plot then weighted in an electrical balanced including chaff, shell & grain and average weight was recorded in gram.

3.11.11 Number of grains cob^{-1}

The numbers of grains cob^{-1} were measured from the base to tip of the ear collected from five randomly selected cobs of each plot and finally averaged.

Total no. of grain per cob = No. of grain rows per cob× No. of grain per row

3.11.12 1000-grain weight

From the seed stock of each plot 1000 seed were counted and the weight was measured by an electrical balance. It was recorded in gram.

3.11.13 Grain yield

From each experimental plot grain yield was recorded. The data was converted and reported as grain yield kg ha-1. The moisture content of grains of each plot was measured by automated moisture meter and final grain yield was adjusted at 13% moisture level by using the formula as given below:

$$\text{Grain yield (kg/ha)} = \frac{(100\text{-MC}) \times \text{plot yield} \times 1000\text{m}^2}{(100\text{-}13) \times \text{net plot area m}^2}$$

Where, MC is the moisture content percentage of grain.

3.11.14 Stover yield

All maize plants were harvested at base from the net cultivated area and maize stem was weighted immediately after harvesting. Husk was also included while taking Stover yield. Stover yield was calculated on hectare basis in kg ha-1.

3. 11. 15 Biological yield

It was the total yield including both the economic and stover yield.

3.11.16 Harvest index (HI)

Harvest index is the ratio of economic (grain) yield and biological yield. It was calculated by dividing the economic yield grain from the harvested area by the biological yield of the same area (Donald, 1963) and multiplying by 100.

$$\text{Harvest Index (\%)} = \frac{\text{Grain(economic) yield}}{\text{Biological yield}} \times 100$$

Here, Biological yield (t ha-1) = Grain yield (t ha^{-1}) + Stover yield (t ha^{-1})

3.12 Data analysis method

The obtained data for different characters were statistically analyzed with the computer -based software Statistics 10 to find out performance of white maize variety under varying levels of earthing up and fertilizer application and the mean values of all characters were evaluated and analysis of variances were performed by the F-test. The significance of the difference among treatment means were estimated by the Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

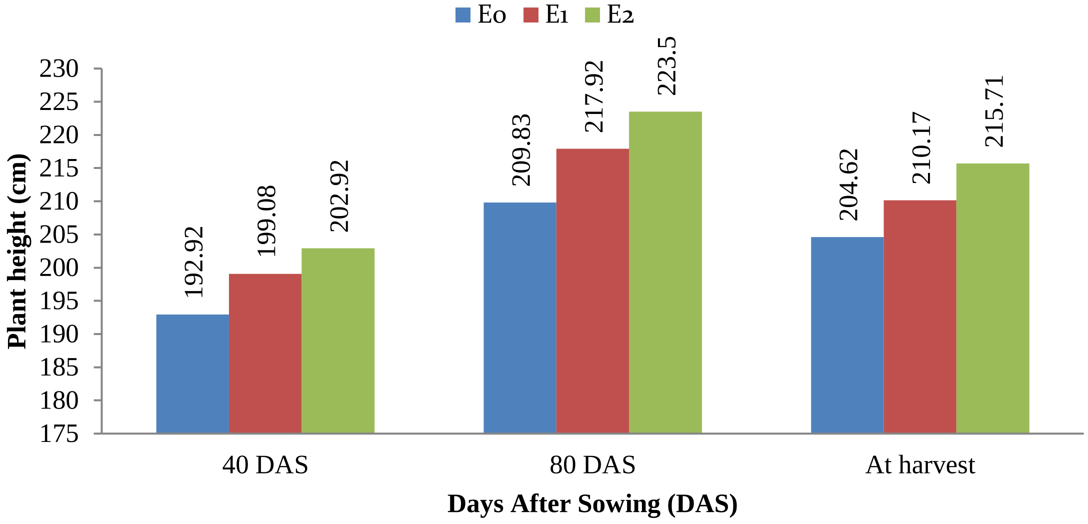
Results obtained from the present study have been presented and discussed in this chapter with a view to study the performance of white maize under varying levels of earthing up and fertilizer application. The results have been discussed, and possible interpretations are given under the following headings.

4.1 Plant growth parameters

4.1.1 Plant height (cm)

Effect of different earthing up practices

Plant height of white maize showed significant variation due to the effect of different earthing up practices applied at different DAS (Figure 1). Experimental result showed that the highest plant height (202.92, 223.50 and 215.71 cm) at 40, 80 DAS and at harvest respectively was observed in E_2 (Earthing up at 25 DAS and 50 DAS) treatment. While the lowest plant height (192.92, 209.83 and 204.62 cm) at 40, 80 DAS and at harvest respectively was observed in E_0 (Control) treatment. The variation of plant height could be mainly attributed to the beneficial effect of earthing up and proper placement of top-dressed fertilizers on the growth of maize plants.

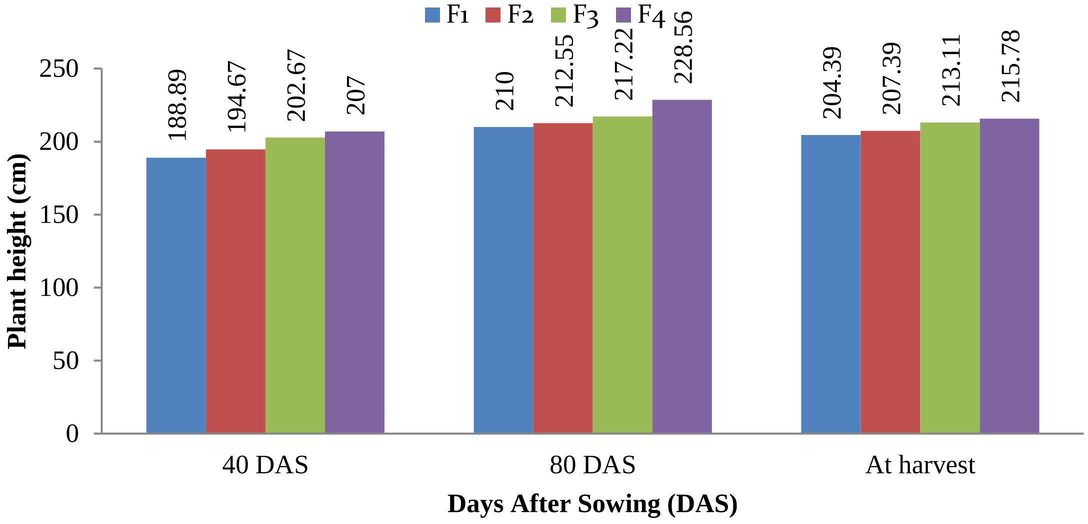


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 1. Effect of earthing up practices on plant height of white maize at different DAS (LSD $_{(0.05)}$ =62.67, 4.98 and 2.55cm at 40, 80 DAS and at harvest, respectively)

Effect of fertilizer application

Plant height is an essential character of the vegetative stage of the crop plant and indirectly impacts on yield of crop plants. Different rate of fertilizer application significantly influenced on plant height of white maize at different days after sowing (DAS). It was seen that height increased more and more with the age of the crop up to harvest. The plant height reached the highest value at maturity (Figure 2). Experimental result revealed that the highest plant height (207.00, 228.56 and 215.78 cm) at 40, 80 DAS and at harvest, respectively was observed in F_4 treatment (125 % recommended dose of fertilize) which was statistically similar with F_3 treatment (202.67,217.22 and 213.11 cm) at 40 DAS and at harvest, respectively. Whereas the lowest plant height (188.89, 210.00 and 204.39 cm) at 40, 80 DAS and at harvest, respectively was observed in F_1 (50 % recommended dose of fertilize) treatment which was statistically similar with F_2 treatment (194.67, 212.55 and 207.39 cm) at 40, 80 DAS and at harvest, respectively. The more fertilizer a crop receives, the faster it grows. If a crop is provided with too little fertilizer, plant growth response is poor; but if fertilizer rates are excessive, plant growth slows and there is a potential for root damage or death from high fertilizer salts. If fertilizer application rates are maintained between these extremes, then plant growth can be manipulated based on the fertilizer application rate.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer. F_4 = 125 % recommended dose of fertilizer.

Figure 2. Effect of fertilizer application on plant height of white maize at different DAS (LSD $_{(0.05)}$ =6.98, 3.57, and 6.86 cm at 40, 80 DAS and at harvest, respectively)

Combined effect of fertilizer application and earthing up practices

Different rate of fertilizer application along with earthing up practices, significantly influenced plant height of white maize at different DAS (Table 1). Experimental result revealed that the highest plant height (210.00, 236.67 and 219.83 cm) was observed in E_2F_4 treatment combination at 40, 80 DAS and at harvest, respectively which was statistically similar with E_1F_4 (206.00 cm), E_0F_4 (205.00 cm), E_2F_3 (206.67 cm) and E_1F_3 (203.00 cm) at 40 DAS; with E_1F_4 (231.67 cm) at 80 DAS and with E_1F_4 (216.17 cm) and E_2F_3 (222.33 cm) at harvest respectively. While the lowest plant height (176.67, 206.67 and 198.33 cm) at 40, 80 DAS and at harvest respectively was observed in E_0F_1 treatment combination, which was statistically similar with E_1F_1 (210.00 cm), E_2F_1 (213.33 cm), E_0F_2 (206.00 cm), E_1F_2 (214.33 cm) at 80 DAS and with E_0F_2 (203.33 cm) E_0F_3 (205.50 cm) at harvest respectively.

Table 1. Combined effect of fertilizer doses and different earthing up practices on plant height of white maize at different DAS.

Treatment combinations	Plant height (cm) at		
	40 DAS	80 DAS	At harvest
E_0F_1	176.67 f	206.67 d	198.33 f
E_1F_1	193.33 de	210.00 cd	205.50 c-e
E_2F_1	196.67 c-e	213.33 cd	209.33 b-e
E_0F_2	191.67 e	206.00 d	203.33 ef
E_1F_2	194.00 de	214.33 cd	207.50 c-e
E_2F_2	198.33 b-d	217.33 c	211.33 b-d
E_0F_3	198.33 b-e	209.33 cd	205.50 d-f
E_1F_3	203.00 a-c	215.67 c	211.50 bc
E_2F_3	206.67 a	226.67 b	222.33 a
E_0F_4	205.00 ab	217.33 c	211.33 b-e
E_1F_4	206.00 ab	231.67 ab	216.17 ab
E_2F_4	210.00 a	236.67 a	219.83 a
LSD (0.05)	8.21	8.87	8.02
CV (%)	3.55	4.65	4.41

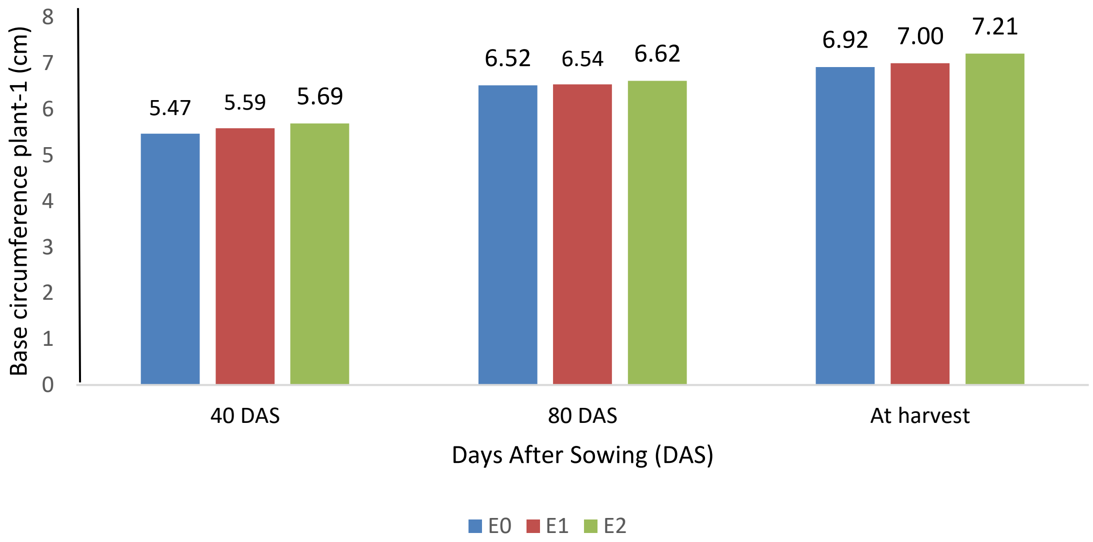
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.1.2 Base circumference plant^{-1} (cm)

Effect of different earthing up practices

The base circumference plant^{-1} of white maize was significantly influenced by various earthing up practices at different DAS (Figure 3). Experimental result, showed that the highest base circumference plant^{-1} (5.77, 6.92 and 7.67 cm) at 40 and 80 DAS and at harvest respectively was observed in E_2 treatment (Earthing up at 25 DAS and 50 DAS). While the E_0 treatment (Control) had the lowest base circumference plant^{-1} (4.39, 5.98 and 6.67 cm) at 40 and 80 DAS and at harvest, respectively. This higher base circumference plant^{-1} was mainly because of the beneficial effect of earthing up on growth and development of maize plants and proper placement of top-dressed fertilizers.

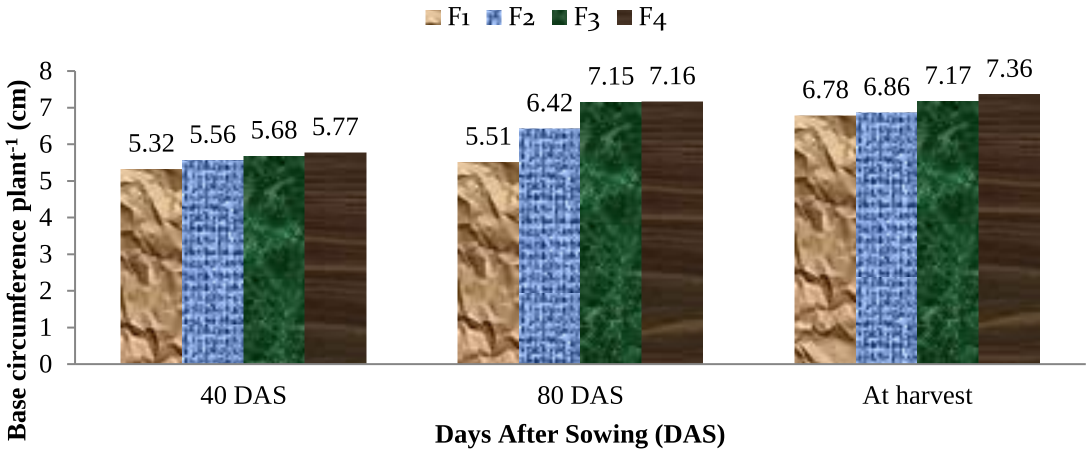


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 3. Effect of earthing up practices on base circumference plant^{-1}of white maize at different DAS (LSD $_{(0.05)}$ = NS, NS and NS at 40, 80 DAS and at harvest, respectively)

Effect of fertilizer application

Due to different rate of fertilizer application base circumference plant^{-1} of white maize varied significantly at different DAS (Figure 4). Experimental result showed that the highest base circumference plant^{-1} (5.66, 7.17 and 7.56 cm) at 40 and 80 DAS and at harvest respectively was observed in F_4 treatment (125 % recommended dose of fertilize) which was statistically similar with F_3 (7.33 cm) treatment at harvest respectively. While the lowest base circumference plant^{-1} (4.68, 5.24 and 6.39 cm) at 40 and 80 DAS and at harvest respectively was observed in F_1 treatment (50 % recommended dose of fertilize). The effect of fertilizers managements on base circumference plant^{-1} was due to the increased availability of nutrients, especially nitrogen and phosphorus. Nitrogen increases the growth of aerial organs, phosphorus increases the energy transfer for the growth of plant vegetative organs, in general, it improves photosynthesis and thus increased base circumference of the plant.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 4. Effect of fertilizer application on base circumference plant^{-1}of white maize at different DAS (LSD $_{(0.05)}$ = 0.10, 0.12 and 0.32cm at 40, 80 DAS and at harvest, respectively)

Combined effect of fertilizer application and earthing up practices

The combined effect of fertilizer application and earthing up practices had shown significant effect on base circumference plant^{-1} of white maize at different DAS (Table 2). Experimental result, showed that the highest base circumference plant^{-1} (5.97, 7.58 and 8.17 cm) at 40 and 80 DAS, and at harvest respectively was observed in E_2F_4 treatment combination which was similar with E_2F_3 (5.97 cm) and E_2F_1 (5.73 cm) at 40 DAS; with E_2F_3 (7.28 cm) and E_2F_2 (7.18 cm) at 80 DAS and E_2F_3 (7.83 cm) at harvest respectively. While the lowest base circumference plant^{-1} (3.63, 4.47 and 5.67 cm) at 40, 80 DAS and at harvest respectively was observed in E_0F_1 treatment combination.

Table 2. Combined effect of fertilizer doses and different earthing up practices on base circumference plant^{-1} white maize at different DAS.

Treatment combinations	Base circumference plant^{-1}at		
	40 DAS	80 DAS	At harvest
E_0F_1	3.63 g	4.47 f	5.67 f
E_1F_1	4.67 e	5.63 e	6.50 e
E_2F_1	5.73 ab	5.63 e	7.00 de
E_0F_2	4.23 f	6.43 cd	6.83 de
E_1F_2	5.33 d	6.85 b	6.83 de
E_2F_2	5.40 cd	7.18 ab	7.67 a-c
E_0F_3	4.37 f	6.18 d	7.00 de
E_1F_3	5.67 bc	7.08 b	7.17 cd
E_2F_3	5.97 a	7.28 ab	7.83 ab
E_0F_4	5.33 d	6.83 bc	7.17 cd
E_1F_4	5.67 bc	7.10 b	7.33 b-d
E_2F_4	5.97 a	7.58 a	8.17 a
LSD $_{(0.05)}$	0.29	0.46	0.55
CV (%)	3.10	3.69	4.19

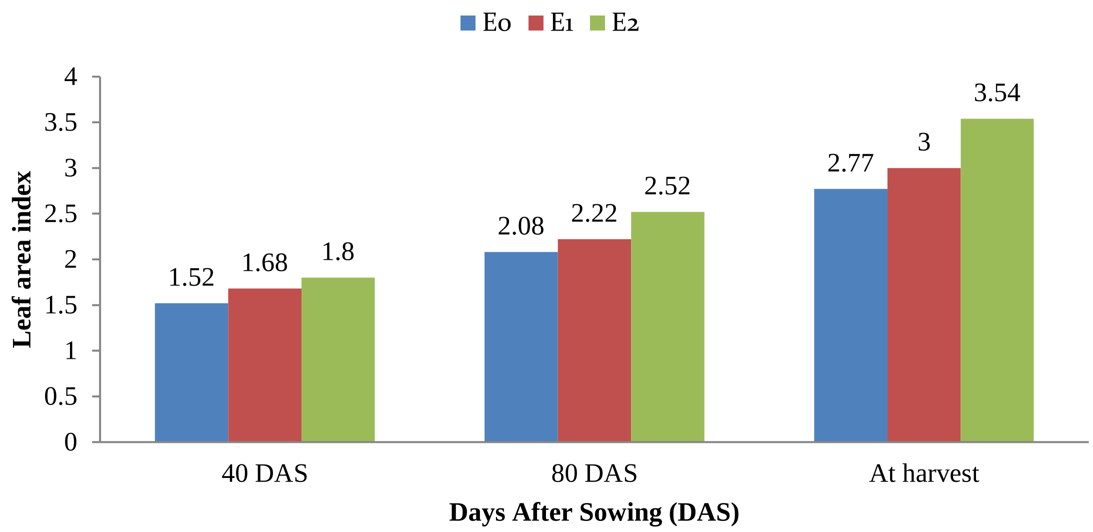
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.2.3 Leaf area index

Effect of different earthing up practices

The diverse earthing up techniques used at different DAS had shown significant effect on the leaf area index of white maize (Figure 5). The results of the experiment revealed that the E_2(Earthing up at 25 DAS and 50 DAS) treatment had the highest leaf area index (1.80, 2.52, and 3.54 respectively) at 40, 80 DAS, and harvest. At 40, 80, and harvest, respectively, the E_0 treatment (Control) exhibited the lowest leaf area index (1.52,2.08, and 2.77). The good impact of earthing up on the growth and development of maize plants as well as the right positioning of top-dressed fertilizers were the key contributors to this increased leaf area index.

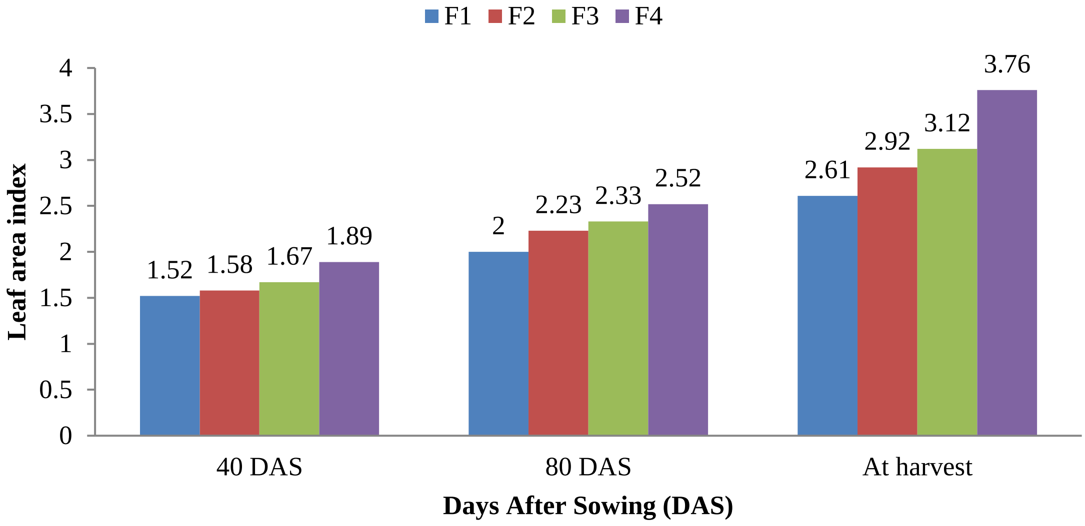


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 5. Effect of earthing up practices on leaf area index of white maize at different DAS (LSD $_{(0.05)}$ = 0.07, 0.08 and 0.13at 40, 80 DAS and at harvest, respectively)

Effect of fertilizer application

The leaf area index of white maize considerably changed at different DAS due to varying fertilizer application treatments (Figure 6). The results of the experiment indicated that the F_4 treatment (125% recommended dose of fertilizer) had the highest leaf area index (1.89, 2.52 and 3.76) at 40, 80 DAS, and at harvest, respectively. While the F_1 treatment (using 50% of the recommended dose fertilizer dose) had the lowest leaf area index (1.52,2.00 and 2.61) at 40, 80, and harvest, respectively which was statistically comparable to F_2 treatment (1.58) at 40 DAS. The LAI of maize reduced under lower level of fertilizer and the lowest LAI was found in plants grown without fertilizer. The increase in LAI with the increase in fertilizer might be due to increase in availability of plant nutrients.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 6. Effect of fertilizer application on leaf area index of white maize at different DAS (LSD $_{(0.05)}$ = 0.10, 0.12 and 0.04at 40, 80 DAS and at harvest, respectively)

Combined effect of fertilizer application and earthing up practices

Applying different dose of fertilizer and earthing up practices together had shown significant effect on the leaf area index of white maize at various DAS (Table 3). According to experimental findings, the E_2F_4 treatment combination had the highest leaf area index (1.33, 1.78, and 2.33) at 40, 80 DAS, and harvest, respectively. However, the E_0F_1 treatment combination had the lowest leaf area index (1.33, 1.78, and 2.33, respectively) at 40, 80 DAS, and harvest.

Table 3. Combined effect of fertilizer doses and different earthing up practices on leaf area index of white maize at different DAS.

Treatment combinations	Leaf area index at		
	40 DAS	80 DAS	At harvest
E_0F_1	1.33 f	1.78 e	2.33 e
E_1F_1	1.57 de	1.97 d	2.64 d
E_2F_1	1.66 cd	2.26 c	2.85 d
E_0F_2	1.46 ef	1.97 d	2.77 d
E_1F_2	1.63 cd	2.26 c	2.78 d
E_2F_2	1.65 cd	2.46 b	3.20 c
E_0F_3	1.63 cd	2.22 c	2.63 d
E_1F_3	1.63 cd	2.27 c	3.25 bc
E_2F_3	1.75 bc	2.49 b	3.48 b
E_0F_4	1.67 cd	2.34 bc	3.33 bc
E_1F_4	1.88 b	2.38 bc	3.33 bc
E_2F_4	2.12 a	2.85 a	4.61 a
LSD (0.05)	0.16	0.18	0.22
CV (%)	5.34	4.51	4.96

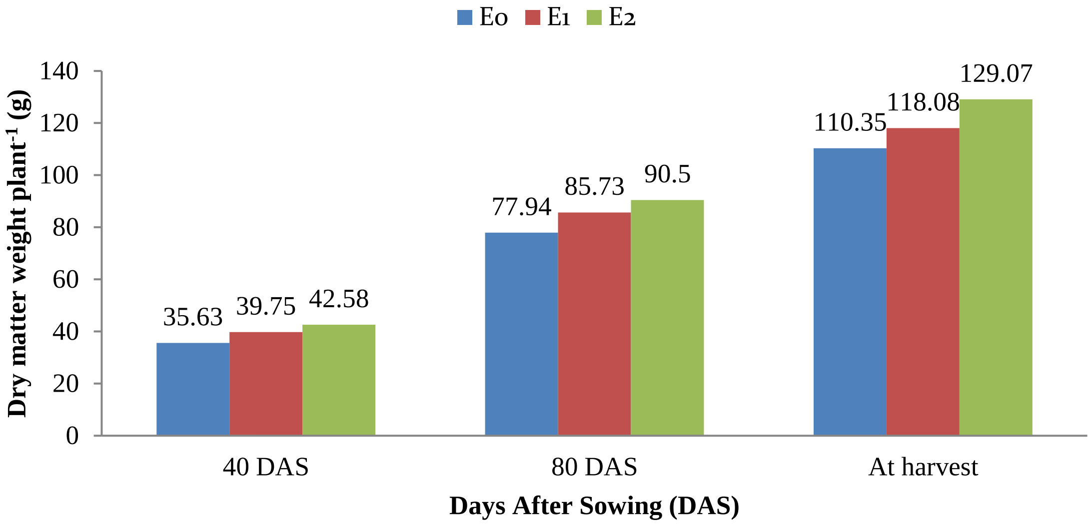
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.1.4 Dry matter weight plant^{-1} (g)

Effect of different earthing up practices

The dry weight plant^{-1} of white maize had significantly changed as a result of the various earthing up techniques used at various DAS (Figure 7). The experiment's findings showed that the E_2 treatment (Earthing up at 25 DAS and 50 DAS) had the highest dry weight plant^{-1} (42.58, 90.50 and 129.07 g, respectively) 40 and 80, and at harvest. At 40 and 80 DAS and at harvest, respectively, the E_0 treatment (Control) demonstrated the lowest dry weight plant^{-1} (35.63, 77.94 and 110.35 g). Dry weight plant^{-1} might have varied because early earthing up during the plant's active growth period enhanced the soil's nutrient absorption capabilities.

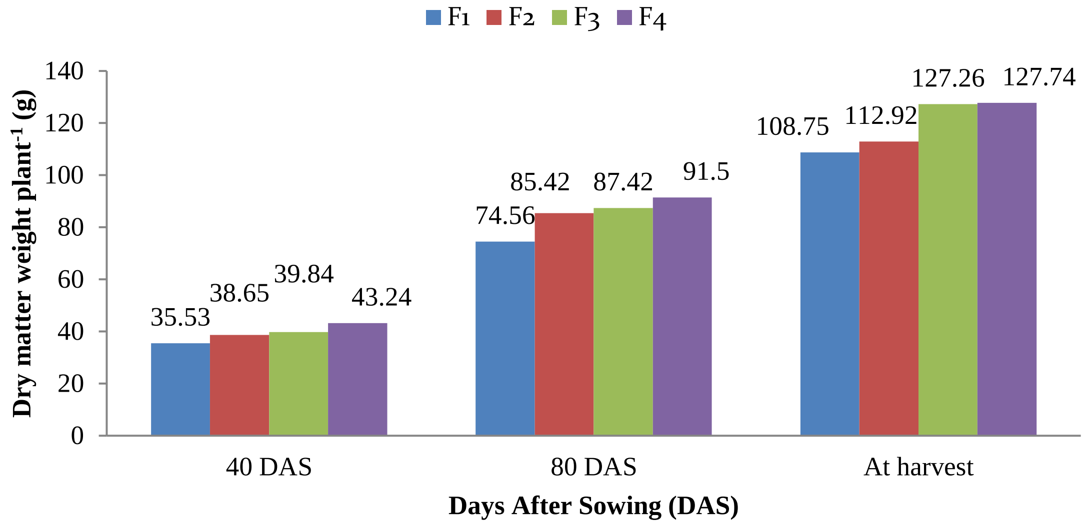


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 7. Effect of earthing up practices on leaf area index of white maize at different DAS (LSD $_{(0.05)}$ = 1.79, 3.75 and 4.40 g at 40 and 80 DAS and at harvest, respectively)

Effect of fertilizer application

The experimental findings demonstrated that different rate of fertilizer application had a significant effect on dry weight plant^{-1} of maize at various DAS (Figure 8). Experimental result revealed that the F_4 treatment had the highest dry matter weight plant^{-1} (43.24, 91.50 and 127.74 g) at 40 and 80 DAS, and at harvest, respectively which was statistically similar with F_3 treatment (127.26 g) at harvest. While F_1 treatment showed the lowest dry matter weight plant^{-1} (35.53, 74.56 and 108.75 g) at 40 and 80 DAS, and at harvest, respectively. The effect of different rate of fertilizers on plant growth is due to the increased availability of nutrients, especially nitrogen and phosphorus. Nitrogen increases the growth of aerial organs, phosphorus increases the energy transfer for the growth of plant vegetative organs, in general, it improves photosynthesis and thus increased dry matter weight plant^{-1}.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 8. Effect of fertilizer application on leaf area index of white maize at different DAS (LSD $_{(0.05)}$ = 2.47, 0.92 and 0.97 g at 40 and 80 DAS and at harvest, respectively)

Combined effect of fertilizer application and earthing up practices

Different fertilizer doses combined with earthing up techniques had a significant impact on the dry weight plant^{-1} of white maize at various DAS (Table 4).

According to experimental results, the E_2F_4 treatment combination had the highest dry weight plant^{-1} (45.69, 98.83, and 138.52 g) at 40 and 80 DAS, and at harvest, respectively. This combination was statistically similar with E_2F_3 (42.61 g) and E_2F_3 (42.59 g) treatment combinations at 40 DAS and with E_2F_3 (94.00 and 136.61 g) at 80 DAS, and with harvest. Although it was statistically comparable to E_0F_2 (105.33 g) at harvest, the E_0F_1 treatment combination had the lowest dry weight plant^{-1} (31.41, 67.25, and 98.66 g) at 40 and 80 DAS, and at harvest, respectively.

Table 4. Combined effect of fertilizer doses and different earthing up practices on dry matter weight plant^{-1} white maize at different DAS.

Treatment combinations	Dry matter weight plant^{-1}at		
	40 DAS	80 DAS	At harvest
E_0F_1	31.41 f	67.25 f	98.66 h
E_1F_1	35.76 e	78.25 e	110.01 fg
E_2F_1	39.42 b-d	78.17 e	117.59 d-f
E_0F_2	35.85 de	77.33 e	105.33 gh
E_1F_2	37.51 c-e	87.92 bc	109.85 g
E_2F_2	42.59 ab	91.00 bc	123.57 c-e
E_0F_3	36.15 de	81.08 de	117.23 ef
E_1F_3	40.77 bc	87.17 b-d	127.94 bc
E_2F_3	42.61 ab	94.00 ab	136.61 ab
E_0F_4	39.09 b-e	86.08 cd	120.17 de
E_1F_4	44.94 a	89.58 bc	124.52 cd
E_2F_4	45.69 a	98.83 a	138.52 a
LSD $_{(0.05)}$	3.82	6.19	7.26
CV (%)	5.27	5.12	4.27

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

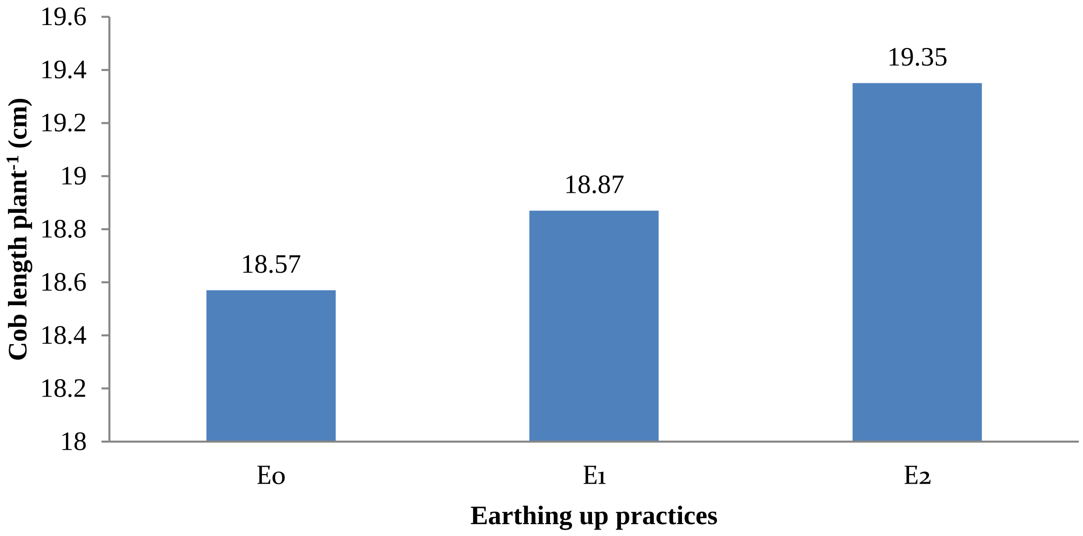
Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.2 Yield contributing characters

4.2.1 Cob length plant^{-1} (cm)

Effect of different earthing up practices

The different earthing up practices had shown non-significant effect on the cob length plant^{-1} of white maize (Figure 9). Experimental result revealed that the highest cob length plant^{-1} (19.35 cm) was found in E_2 treatment. Whereas the lowest cob length plant^{-1} (18.57) was found in E_0 treatment. This is also attributed to the fact that number of cob length plant^{-1} is a genetic character of maize plant and it does not get affected by external influence.

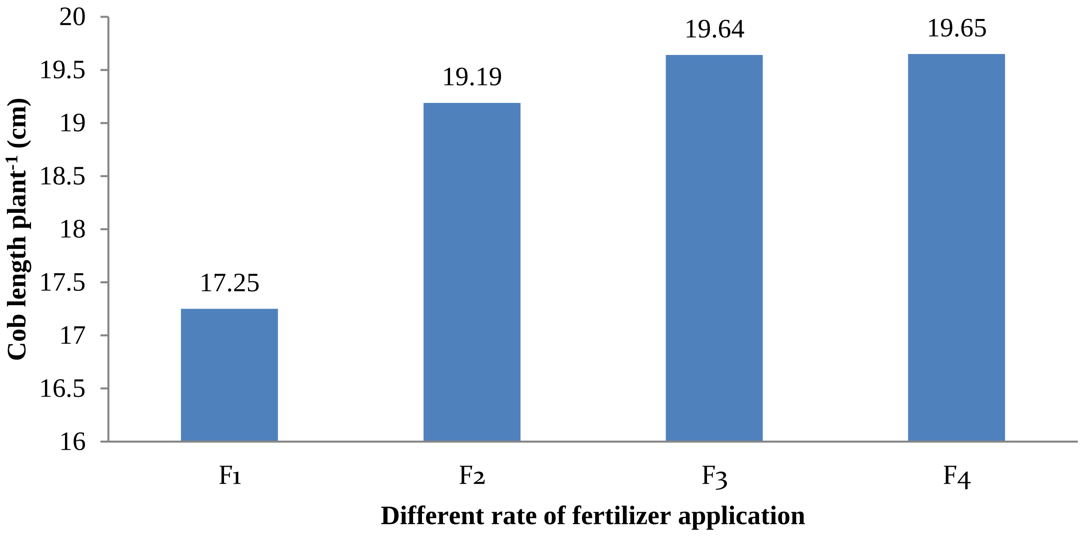


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 9. Effect of earthing up practices on cob length plant^{-1}of white maize (LSD $_{(0.05)}$ = NS)

Effect of fertilizer application

The different rate of fertilizer application significantly affected the cob length plant^{-1} of white maize (Figure 10). Experimental result revealed that the highest cob length plant^{-1} (19.65 cm) was found in F_4 treatment which was comparable to F_3 (19.64 cm). Whereas the lowest cob length plant^{-1} (17.25) was found in F_1 treatment. This might be due to an increase in cell elongation and more vegetative growth attributed to crop requirements of the additional fertilizer nutrients (*i.e.*, NPK) for its normal physiological growth. On the other hand, the shortest cob length in the lower fertilized plots might have been due to the low level of those essential nutrients in the soil for crop requirements.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer; F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 10. Effect of fertilizer application on cob length plant^{-1}of white maize (LSD $_{(0.05)}$ = 0.44 cm)

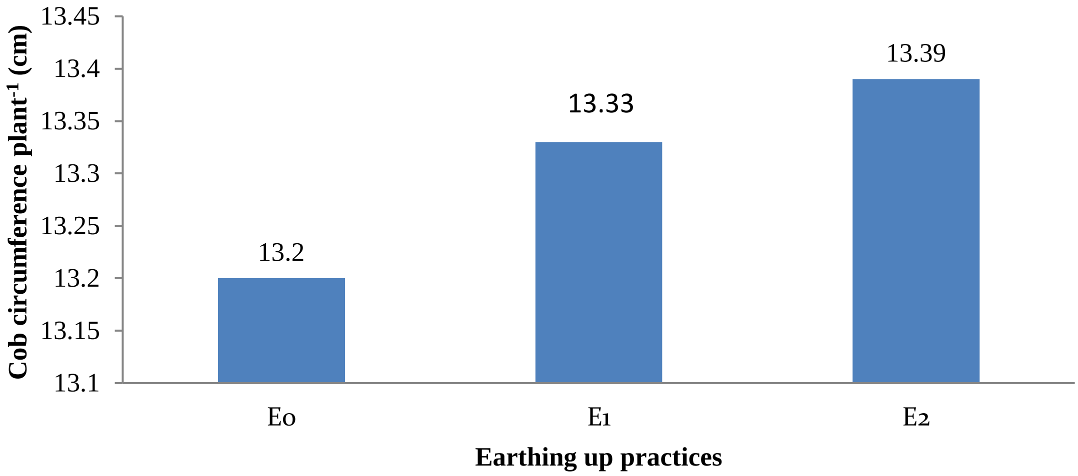
Combined effect of fertilizer application and earthing up practices

Combined effect of fertilizer application doses and earthing up practices had shown significant effect on the cob length plant^{-1} of white maize (Table 5). Experimental result showed that the highest cob length plant^{-1} (20.72) was found in E_2F_4 treatment combination which was statistically similar with E_1F_4 (19.67 cm), E_0F_4 (19.62 cm), E_2F_3 (19.62 cm) and E_1F_3 (19.62 cm). While the lowest cob length plant^{-1} (17.12) was found in E_0F_1 treatment combination which was statistically similar with F_1E_1 (17.22 cm), E_2F_1 (17.40 cm).

4.2.2 Cob circumference plant^{-1} (cm)

Effect of different earthing up practices

The cob circumference plant^{-1} of white maize has not significantly been influenced by the various earthing up practices (Figure 11). According to the results of the experiment, the highest cob circumference plant^{-1} (13.39 cm) was exposed to the E_2 treatment. While the E_0 treatment had the lowest cob circumference plant^{-1} (13.20 cm).

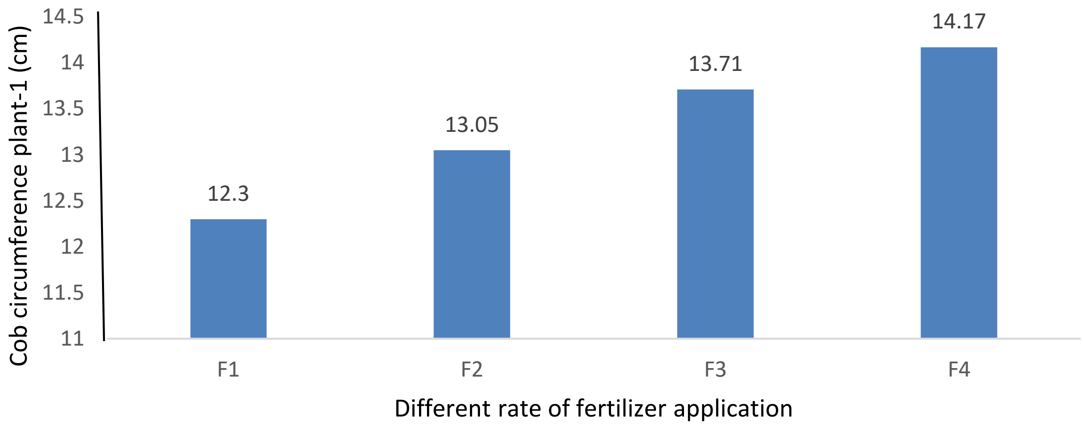


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 11. Effect of earthing up practices on cob circumference plant^{-1}of white maize (LSD $_{(0.05)}$ = NS cm)

Effect of fertilizer application

The cob circumference plant^{-1} of white maize was significantly influenced by the various rate of fertilizer application (Figure 12). The results of the experiment showed that the F_4 treatment had the highest cob circumference plant^{-1} (14.17 cm). However, the F_1 treatment had the lowest cob circumference plant^{-1} (12.30 cm).



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 12. Effect of fertilizer application on cob circumference plant^{-1}of white maize (LSD $_{(0.05)}$ = 0.37 cm)

Combined effect of fertilizer application and earthing up practices

The cob circumference plant^{-1} of white maize has significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 5). The experimental results revealed that E_2F_4 treatment combination had the maximum cob circumference plant^{-1} (14.43 cm), which was statistically similar to E_1F_4 (14.15 cm) treatment combination. While E_0F_1 treatment combination, which was statistically identical to E_1F_1 (12.30 cm) and E_2F_1 (12.30cm) treatment combination, had the lowest cob circumference plant^{-1} (12.30cm).

Table 5. Combined effect of fertilizer doses and different earthing up practices on cob length and cob circumference of white maize.

Treatment combinations	Cob length (cm)	Cob circumference (cm)
E_0F_1	17.12 c	12.30 e
E_1F_1	17.22 c	12.30 e
E_2F_1	17.40 c	12.30 e
E_0F_2	18.62 b	12.90 d
E_1F_2	18.92 b	13.13 cd
E_2F_2	19.35 b	13.13 cd
E_0F_3	19.30 b	13.68 bc
E_1F_3	19.62 ab	13.72 b
E_2F_3	19.62 ab	13.72 b
E_0F_4	19.62 ab	13.92 b
E_1F_4	19.67 ab	14.15 ab
E_2F_4	20.72 a	14.43 a
LSD (0.05)	1.21	0.55
CV (%)	4.22	4.17

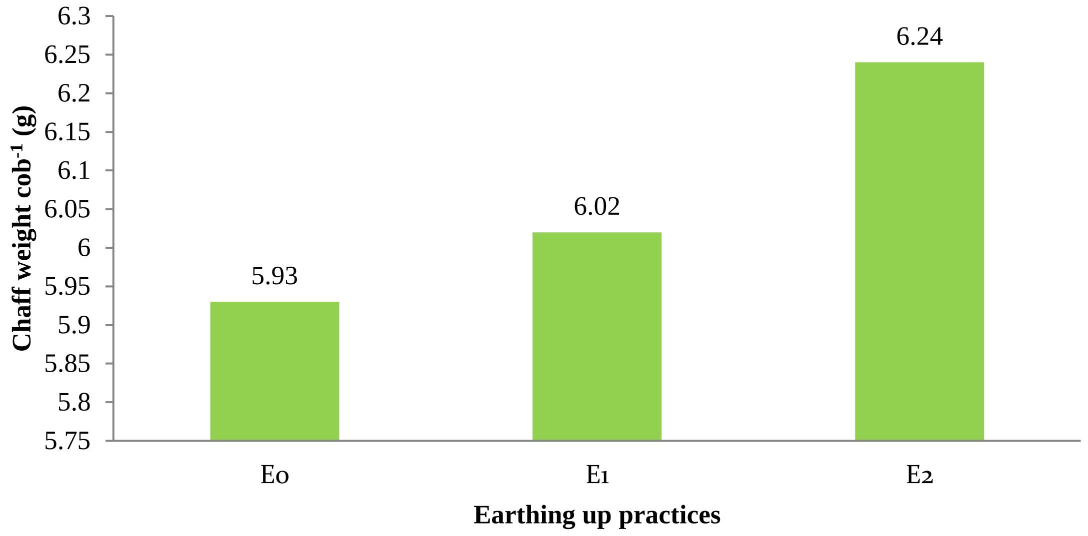
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.2.3 Chaff weight cob^{-1}(g)

Effect of different earthing up practices

The various earthing up practices had shown non-significant effect on the chaff weight cob^{-1} of white maize (Figure 13). The experiment's findings revealed that the E_2 treatment had the highest cob^{-1} chaff weight (6.24 g). However, the chaff weight cob^{-1} was lowest in the E_0 treatment (5.93 g).

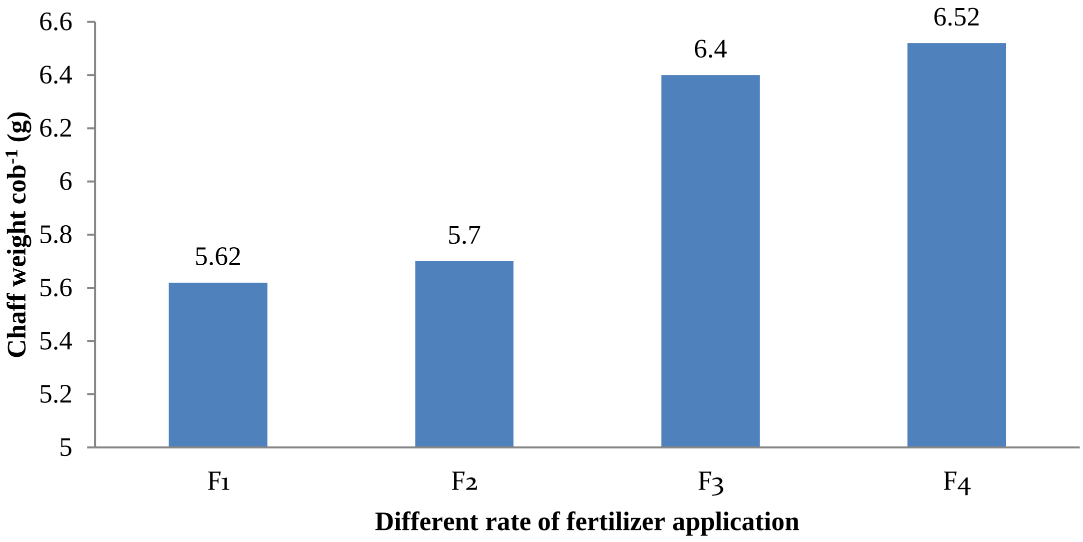


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 13. Effect of earthing up practices on chaff weight cob^{-1}of white maize (LSD $_{(0.05)}$ = 0.45 g)

Effect of fertilizer application

The different rates of fertilizer treatment had a substantial impact on the chaff weight cob^{-1} of white maize (Figure 14). The results of the experiment showed that the F_4 treatment had the highest chaff weight cob^{-1} (6.52 g) which was statistically similar with F_3 (6.40 g) treatment. However, the lowest chaff weight cob^{-1} (5.62 g) was found in the F_1 treatment, which was statistically comparable to the F_2 (5.70 g) treatment.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 14. Effect of fertilizer application on chaff weight cob^{-1}of white maize (LSD $_{(0.05)}$ = 0.45 g)

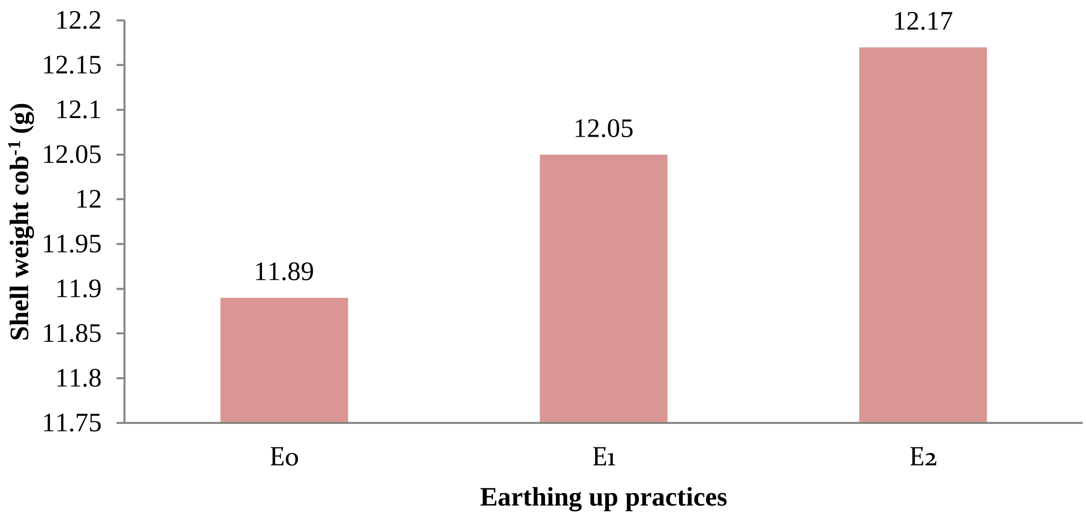
Combined effect of fertilizer application and earthing up practices

The chaff weight cob^{-1} of white maize had significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 6). The experimental results revealed that E_2F_4treatment combination had the highest chaff weight cob^{-1} (6.67 g), which was statistically similar to E_1F_4 (6.54 g), F_3E_2 (6.54 g) and E_1F_3 (6.54 g) treatment combination, while E_0F_1 treatment combination, which was statistically identical to E_1F_1 (5.56 g), E_2F_1 (5.75g), E_0F_2 (5.56 g) and E_1F_2 (12.30 g) treatment combination, had the lowest chaff weight cob^{-1} (5.56 g).

4.2.4 Shell weight cob^{-1}(g)

Effect of different earthing up practices

The various earthing up techniques had shown non-significant effect on the shell weight cob^{-1} of white maize (Figure 15). The results of the investigation showed that the E_2 treatment had the highest shell weight cob^{-1} (12.17 g). However, the E_0 treatment had the lowest shell weight cob^{-1} (11.89 g).

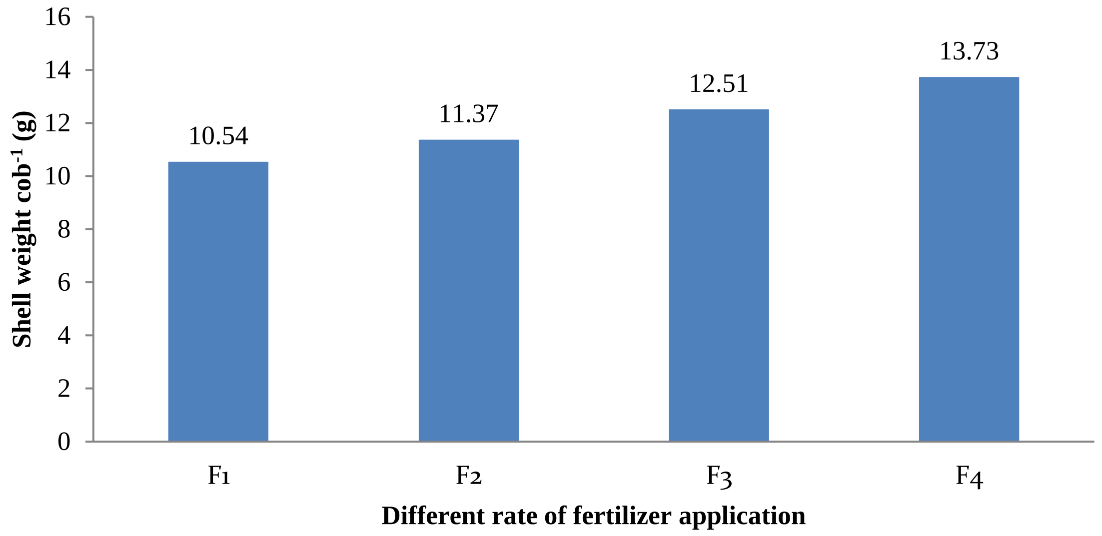


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 15. Effect of earthing up practices on shell weight cob^{-1}of white maize (LSD $_{(0.05)}$ = NS)

Effect of fertilizer application

The shell weight cob^{-1} of white maize was significantly influenced by the various fertilizer application rates (Figure 16). The experiment's findings revealed that the F_4 treatment had the highest shell weight cob^{-1} (13.73 g). However, the F_1 treatment had the lowest shell weight cob^{-1} (10.54 g).



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 16. Effect of fertilizer application on shell weight cob^{-1}of white maize (LSD $_{(0.05)}$ = 0.62 g)

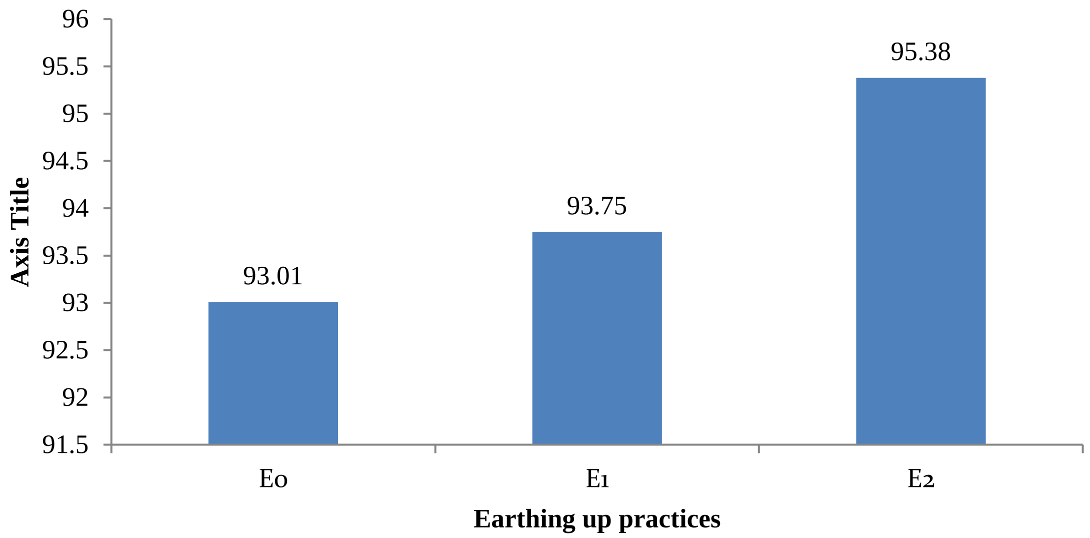
Combined effect of fertilizer application and earthing up practices

The shell weight cob^{-1}of white maize had significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 6). The experimental results revealed that E_2F_4 treatment combination had the highest shell weight cob^{-1} (13.88 g), which was statistically similar to E_1F_4 (13.78 g) and E_0F_4 (13.52 g). While E_0F_1treatment combination, which was statistically identical to E_1F_1 (10.58 g), E_2F_1 (10.58 g), E_0F_2 (11.33 g), E_1F_2 (11.35 g) and E_2F_2 (11.42 g) treatment combination, had the lowest shell weight cob^{-1} (10.47 g).

4.2.5 Grain weight cob^{-1} (g)

Effect of different earthing up practices

In grain weight cob^{-1} of white maize, had significantly influenced as a result of the various earthing up practices (Figure 17). The investigation's findings revealed that the E_2 treatment had the highest grain weight cob^{-1} (95.38 g). However, the grain weight cob^{-1} of the E_0 treatment was the lowest (93.01 g). Earthing-up provides fine tilth with better aeration in root zone which ensures favorable conditions to root development. Moreover, it also provides anchorage of the lower whorls of adventitious roots above the soil level which then function as absorbing roots. These conditions result into higher water and nutrient uptake by roots from soil. Earthing up also improves the nutrient use efficiency by reducing the losses in the form of volatilization result in increased grain weight cob^{-1}.

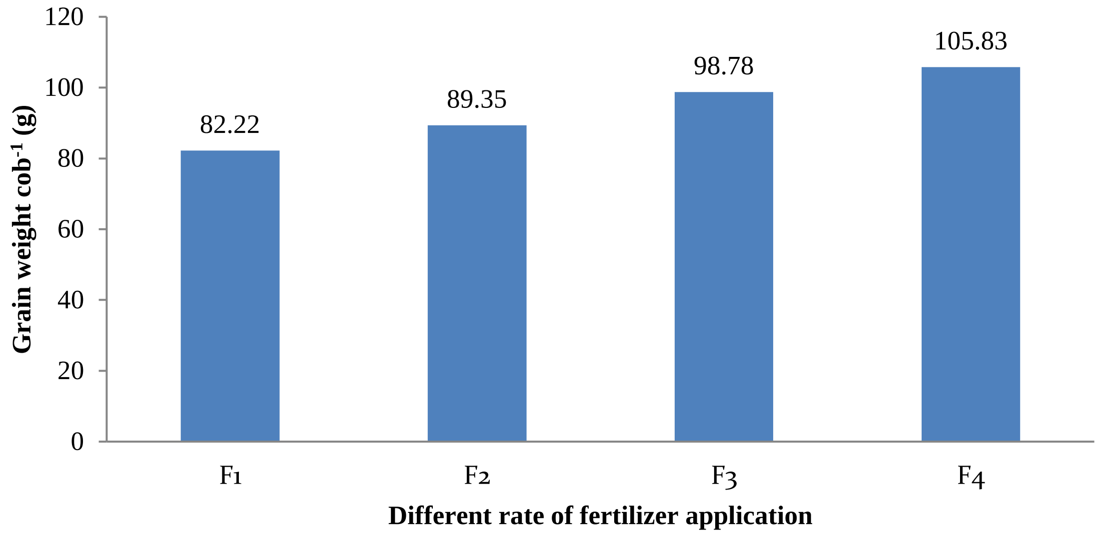


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS

Figure 17. Effect of earthing-up practices on grain weight cob^{-1} of white maize (LSD $_{(0.05)}$ = 0.67 g)

Effect of fertilizer application

The various fertilizer application rates had shown significant effect on the grain weight cob^{-1} of white maize (Figure 18). According to the experiment's results, the F_4 treatment had the highest grain weight cob^{-1} (105.83 g). However, the grain weight cob^{-1} for the F_1 treatment was the lowest (82.22 g). The plants grown with less fertilizer produced the lowest grain weight cob^{-1}and it increased with the increase of fertilizer levels. In general, higher the level of fertilizer, greater was the grain weight cob^{-1} production of the crops at all the growth stages. The increased level of added fertilizer might be due to increased photosynthetic rate resulting in higher leaf area and thereby increased grain weight cob^{-1}. It indicates that a greater amount of fertilizer was needed to sustain growth and development of the crop.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 18. Effect of fertilizer application on grain weight cob^{-1}of white maize (LSD $_{(0.05)}$ = 1.34 g)

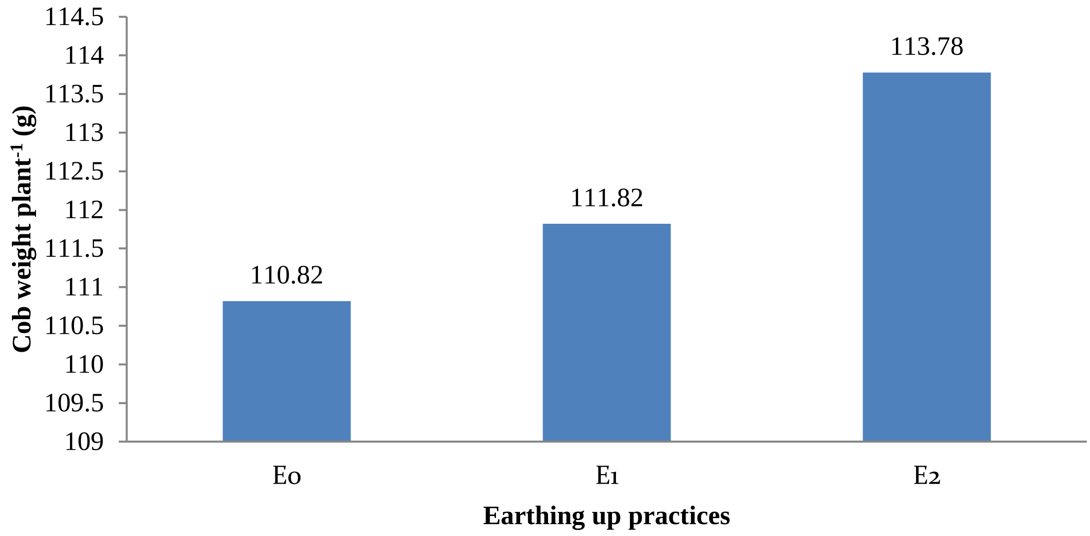
Combined effect of fertilizer application and earthing up practices

The grain weight cob^{-1} of white maize had significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 6). The experimental results revealed that E_2F_4 treatment combination had the highest grain weight cob^{-1} (106.33 g), which was statistically similar to E_1F_4 (105.67 g) and E_0F_4 (105.50 g). While E_0F_1 treatment combination, which was statistically identical to E_1F_1 (82.08 g) treatment combination, had the lowest grain weight cob^{-1} (81.08 g).

4.2.6 Cob weight plant^{-1} (g)

Effect of different earthing up practices

The various earthing up practices had shown significant effect on cob weight plant^{-1} of white maize (Figure 20). The results of the experiment showed that cob weight plant^{-1} was highest in the E_2 treatment (113.78 g). However, the E_0 treatments had the was the lowest (110.82 g) cob weight plant^{-1}.

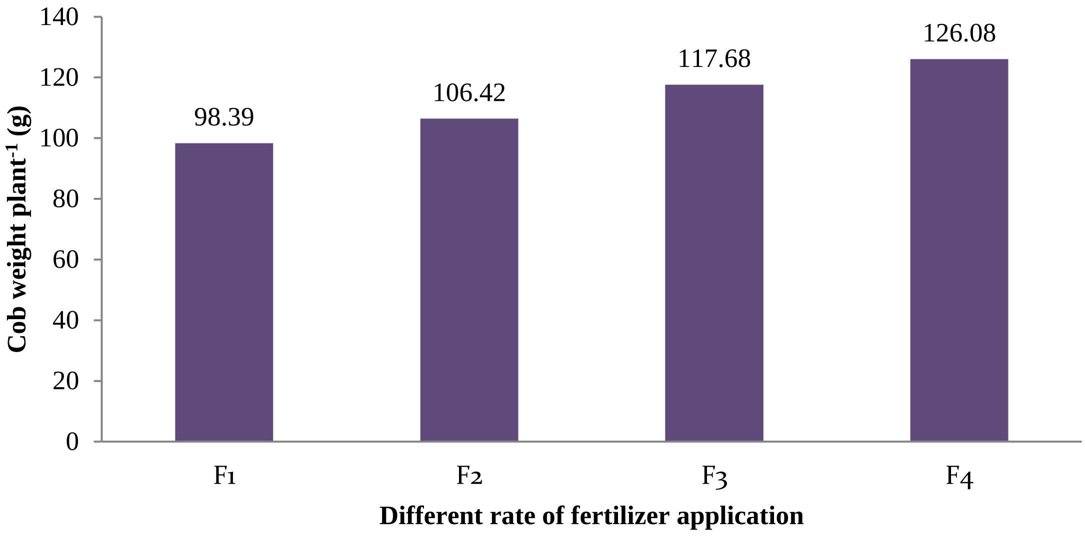


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 19. Effect of earthing up practices on cob weight plant^{-1} of white maize (LSD $_{(0.05)}$ = 1.34 g)

Effect of fertilizer application

The cob weight plant^{-1} of white maize was significantly influenced by the various fertilizer application rates (Figure 20). The experiment's findings revealed that the F_4 treatment had the highest cob weight plant^{-1} (126.08 g). However, the F_1 treatment had the lowest cob weight plant^{-1} (98.39 g). The differences of cob weight plant^{-1} might be due to sufficient supply of nitrogen to the crop because nitrogen being an essential constituent of plant tissue is involved in cell division and cell elongation.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 20. Effect of fertilizer application on cob weight plant^{-1} of white maize (LSD $_{(0.05)}$ = 1.34 g)

Combined effect of fertilizer application and earthing up practices

The cob weight plant^{-1}of white maize had significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 6). The experimental results revealed that E_2F_4 treatment combination had the highest cob weight plant^{-1} (126.88 g), which was statistically similar to E_1F_4 (125.99 g) and E_0F_4 (125.36 g), while E_0F_1 treatment combination had the lowest cob weight plant^{-1} (97.11 g) which was statistically identical to E_1F_1 (98.22 g) treatment combination.

Table 6. Combined effect of fertilizer doses and different earthing up practices on chaff weight cob^{-1}, shell weight cob^{-1}, grain weight cob^{-1} and cob weight $plant^{-1}$ (g) of white maize at harvest.

Treatment combinations	Chaff weight cob^{-1} (g)	Shell weight cob^{-1} (g)	Grain weight cob^{-1} (g)	Cob weight $plant^{-1}$ (g)
E_0F_1	5.56 f	10.47 f	81.08 h	97.11 h
E_1F_1	5.56 f	10.58 f	82.08 h	98.22 gh
E_2F_1	5.75 ef	10.58 f	83.50 g	99.83 g
E_0F_2	5.56 f	11.33 ef	88.63 f	105.52 f
E_1F_2	5.56 f	11.35 ef	88.67 f	105.58 f
E_2F_2	5.98 de	11.42 ef	90.75 e	108.15 e
E_0F_3	6.24 cd	12.22 de	96.83 d	115.29 d
E_1F_3	6.42 a-c	12.50 cd	98.58 c	117.50 c
E_2F_3	6.54 ab	12.80 b-d	100.92 b	120.26 b
E_0F_4	6.34 bc	13.52 a-c	105.50 a	125.36 a
E_1F_4	6.54 ab	13.78 ab	105.67 a	125.99 a
E_2F_4	6.67 a	13.88 a	106.33 a	126.88 a
LSD (0.05)	0.29	1.02	1.73	2.79
CV (%)	6.66	4.79	4.83	4.00

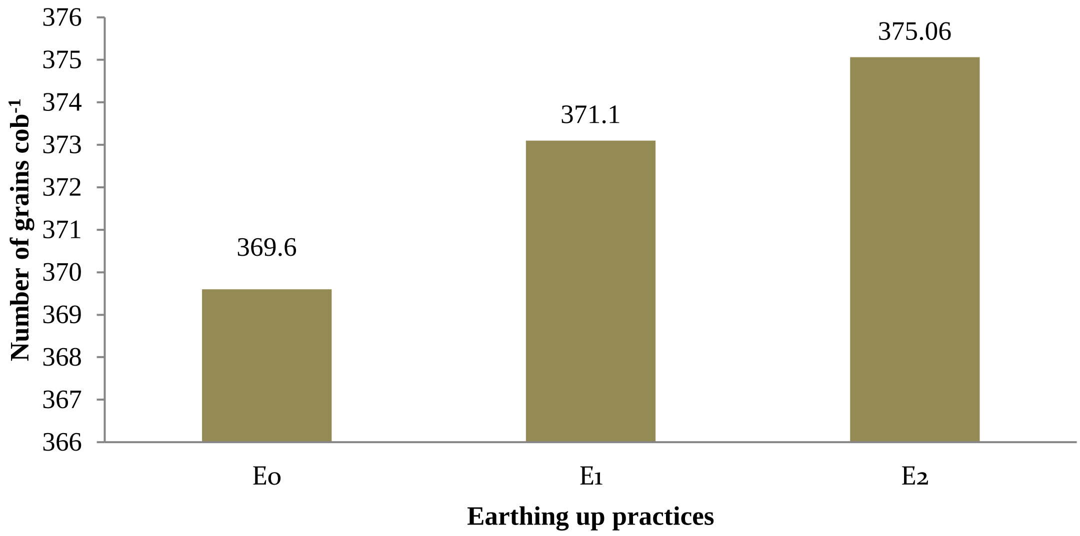
In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

4.2.7 Number of grains cob^{-1}

Effect of different earthing up practices

The various earthing up practices had shown non-significant effect on number of grains cob^{-1} of white maize (Figure 21). The experiment's findings revealed that the E_2 treatment had the highest number of grains cob^{-1} (375.06). However, the E_0 treatments had the lowest (375.06) number of grains cob^{-1}.

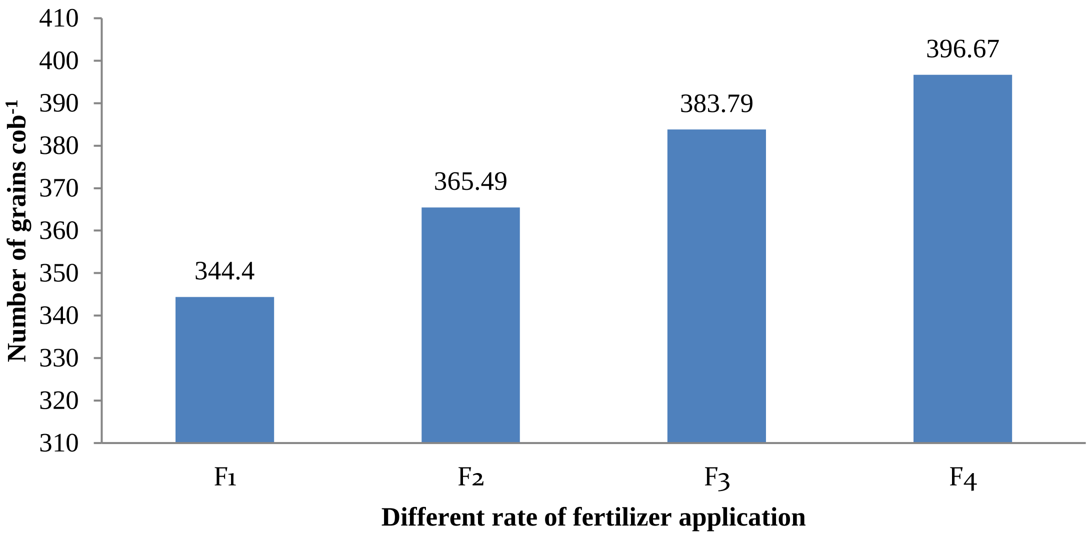


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 21. Effect of earthing up practices on number of grains cob^{-1} of white maize (LSD $_{(0.05)}$ =NS)

Effect of fertilizer application

The number of grains cob^{-1} of white maize was significantly influenced by the various fertilizer application rates (Figure 22). The experiment's findings revealed that the F_4 treatment had the highest number of grains cob^{-1} (396.67) which was statistically similar with F_3 (383.79) treatment. However, the F_1 treatment had the lowest number of grains cob^{-1} (344.40).



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 22. Effect of fertilizer application on number of grains cob^{-1} of white maize (LSD $_{(0.05)}$ = 13.74)

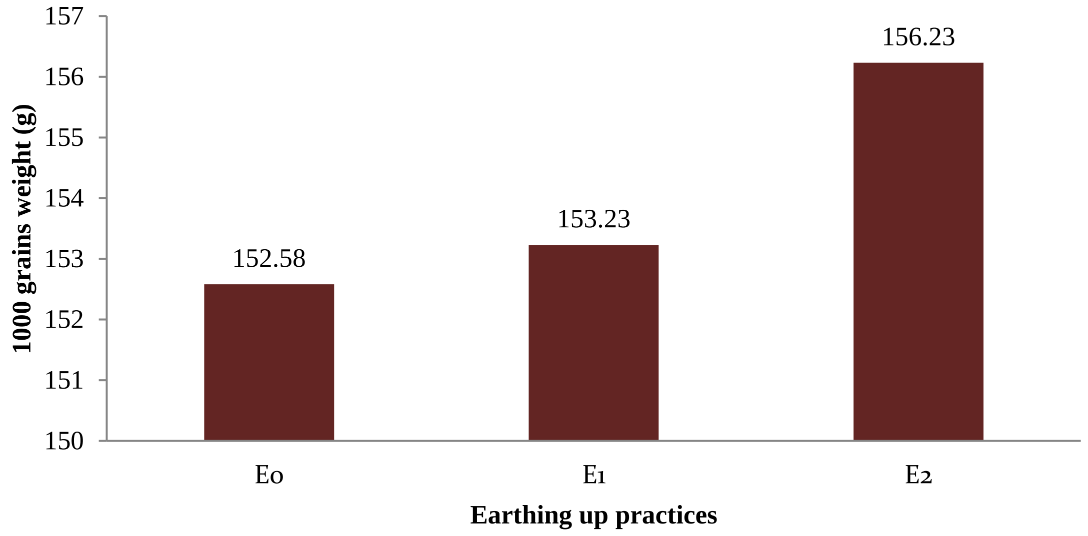
Combined effect of fertilizer application and earthing up practices

The number of grains cob^{-1} of white maize had significantly changed as a result of the combined effects of fertilizer treatment and earthing up practices (Table 7). The experimental results revealed that E_2F_4 treatment combination had the highest number of grains cob^{-1} (404.04), which was statistically similar to E_1F_4 (396.20) and E_0F_4 (389.76). While E_0F_1 treatment combination had the lowest number of grains cob^{-1} (344.40) which was statistically identical to E_1F_1 (344.40) and E_2F_1 (344.40) treatment combination.

4.2.8 1000 grain weight (g)

Effect of different earthing up practices

The various earthing up techniques had shown significant effect on the weight of 1000 grains of white maize (Figure 23). The results of the experiment showed that the E_2 treatment had the highest 1000 grains weight (156.23 g). While the lowest 1000 grain weight of white maize (152.58) was found in the E_0 treatments which was statistically similar with E_1 treatment (153.23 g). This increase in grain weight may be attributed to the beneficial effects of earthing up and uniform application of top-dressed fertilizers by the human labor.

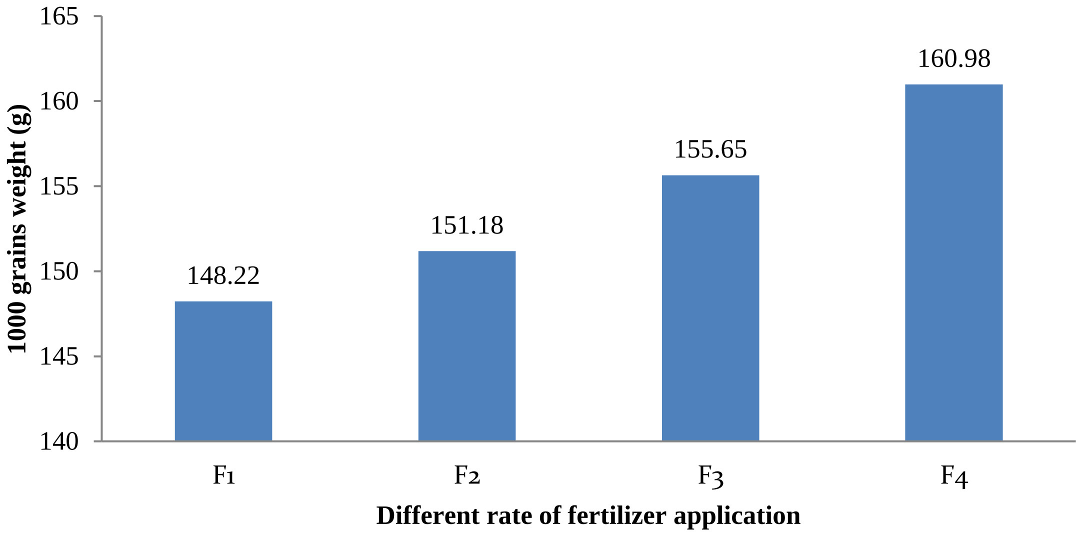


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 23. Effect of earthing up practices on 1000 grains weight of white maize (LSD $_{(0.05)}$ = 3.18)

Effect of fertilizer application

The various fertilizer application rates had shown significant effect in respect of 1000 grain weight of white maize (Figure 24). The results of the experiment showed that the F_4 treatment had the highest weight of 1000 grain weight (160.98 g). The F_1 treatment, however, had the lowest weight in 1000 grain weight (148.22 g) which was statistically comparable to F_2 treatment (151.18 g). 1000 grain weight of maize increased with increased rates of fertilizer dose might be due to the fact that application of increased fertilizer dose to the maize plants-maintained greenness of leaves for longer period which in turn helped in greater dry matter accumulation and this might have contributed much as a major source for the development of sink and thereby improved the1000 grains weight of white maize.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer., F_3 = 100 % recommended dose of fertilizer. F_4 = 125 % recommended dose of fertilizer.

Figure 24. Effect of fertilizer application on 1000 grains weight of white maize (LSD $_{(0.05)}$ = 3.18)

Combined effect of fertilizer application and earthing up practices

The combined effects of fertilizer treatment and earthing up techniques had significantly influenced the 1000 grains of white maize (Table 7). According to the experimental findings, the E_2F_4 treatment combination had the highest 1000 grains of white maize (163.30 g), which was statistically comparable to the E_1F_4 treatment combination (160.47). The lowest 1000 grains of white maize (147.33 g) were recorded by the E_0F_1 treatment combination, which was statistically equivalent to the E_1F_1 (147.53 g), E_2F_1 (149.80 g), E_0F_2 (149.97 g), and E_1F_2 (150.20 g) treatment combinations.

Table 7. Combined effect of fertilizer doses and different earthing up practices on no. of grains cob^{-1} and 1000 grains weight of white maize.

Treatment combinations	Number of grains cob^{-1}	1000 grain weight (g)
E_0F_1	344.40 e	147.33 f
E_1F_1	344.40 e	147.53 f
E_2F_1	344.40 e	149.80 f
E_0F_2	361.20 d	149.97 ef
E_1F_2	367.64 cd	150.20 ef
E_2F_2	367.64 cd	153.37 de
E_0F_3	383.04 bc	153.83 de
E_1F_3	384.16 bc	154.70 cd
E_2F_3	384.16 bc	158.43 bc
E_0F_4	389.76 ab	159.17 b
E_1F_4	396.20 ab	160.47 ab
E_2F_4	404.04 a	163.30 a
LSD (0.05)	16.67	3.98
CV (%)	3.20	4.87

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

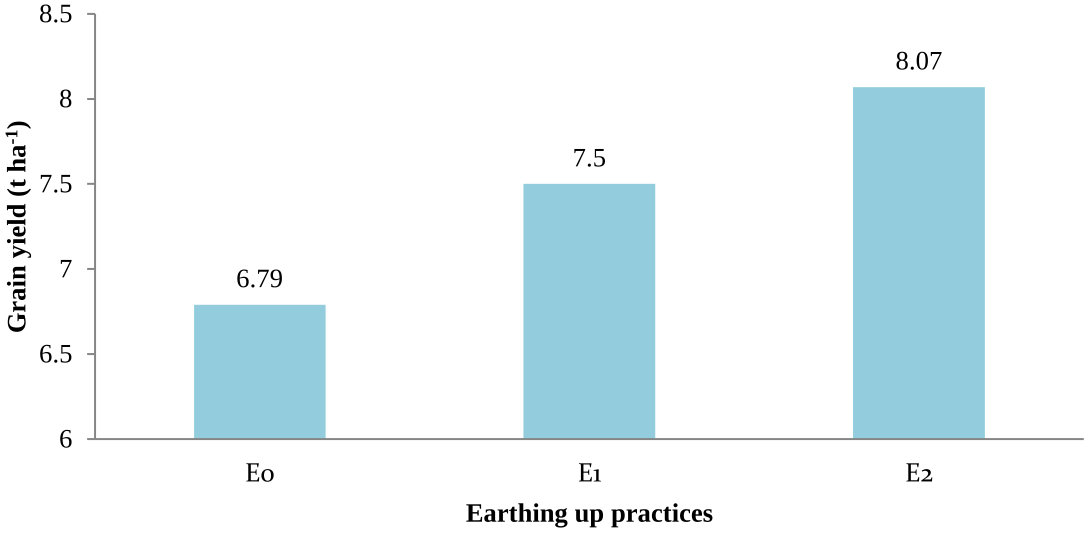
4.3 Yield characters

4.3.1 Grain yield (t ha^{-1})

Effect of different earthing up practices

The grain yield of white maize had been significantly influenced by the various earthing up practices (Figure 25). The experiment's findings revealed that the E_2 treatment had the highest grain yield (8.07 t ha^{-1}). While the grain yield of white maize (6.79 t ha^{-1}) was obtained in the

E_0treatments.This increase in grain yield may be attributed to the beneficial effects of earthing up and uniform application of top-dressed fertilizers by the human labor.

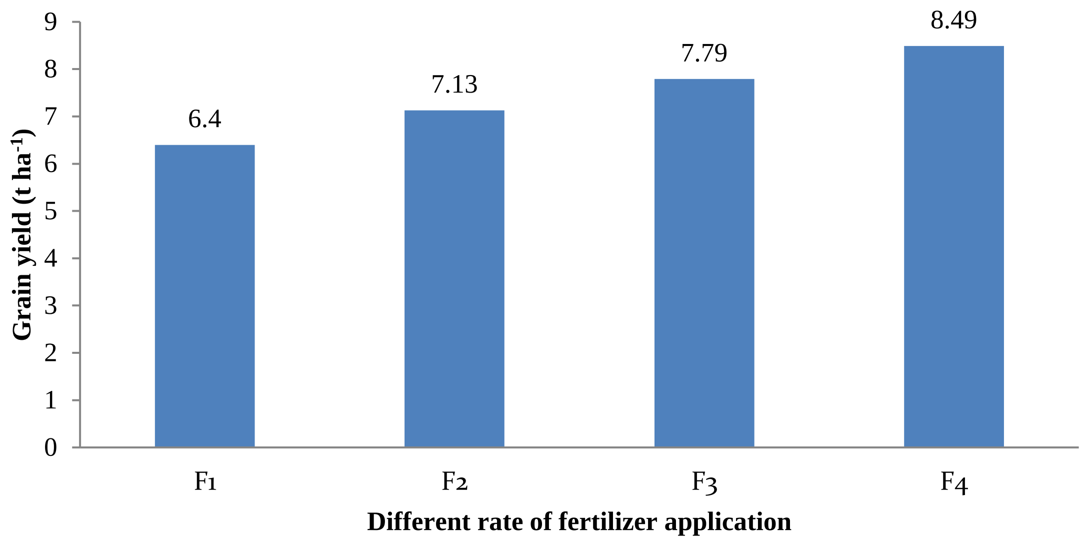


Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 25. Effect of earthing up practices on grain yield of white maize (LSD $_{(0.05)}$ = 0.33)

Effect of fertilizer application

Due to different doses of fertilizer application, grain yield of white maize was significantly influenced (Figure 26). In this experiment result revealed that the F_4 treatment recorded the highest grain yield (8.49 t ha^{-1}). While F_1 treatment had the lowest grain yield (6.40 t ha^{-1}). The result confirmed that higher levels of fertilizers enhanced grain yield on account of higher leaf area index and leaf area duration that leads to more radiation interception, photosynthetic efficiency, growth rate and therefore grain number and grain weight per cob.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 26. Effect of fertilizer application on grain yield of white maize (LSD $_{(0.05)}$ = 0.47)

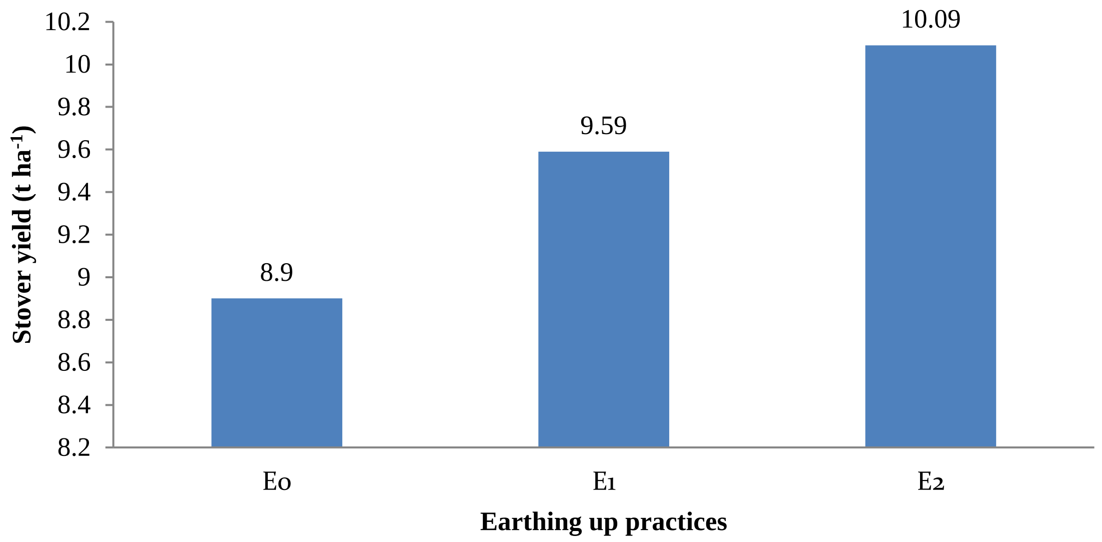
Combined effect of fertilizer application and earthing up practices

The combined effects of fertilizer treatment and earthing up techniques had significantly influenced the grain yield of white maize (Table 8). According to the experimental findings, the E_2F_4 treatment combination had the highest grain yield of white maize (8.98 t ha^{-1}), which was statistically comparable to the E_1F_4 treatment combination (8.45 t ha^{-1}). The lowest grain yield of white maize (5.33 t ha^{-1}) was recorded by the E_0F_1treatment combination.

4.3.2 Stover yield (t ha^{-1})

Effect of different earthing up practices

The various earthing up practices had shown significant effect on the stover yield of the white maize (Figure 27). The results of the experiment demonstrated that the E_2 treatment produced the highest stover yield (10.09 t ha^{-1}). While the E_0 treatments had the lowest stover yield (8.90 t ha^{-1}) of the white maize. Earthing up was done when a plant is actively growing, improved soil conditions at this time through earth up facilitate optimal nutrient absorption, which encourages increased plant growth and development and, eventually, increased stover yield production.



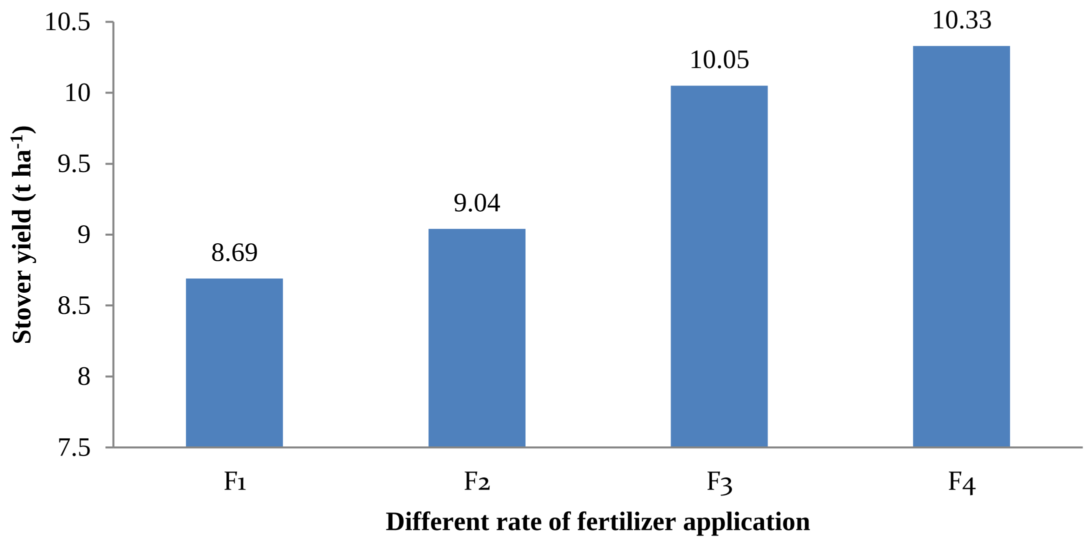
Here, E_0 = Control, E_1 = Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 27. Effect of earthing up practices on stover yield of white maize

(LSD $_{(0.05)}$ = 0.47)

Effect of fertilizer application

The stover yield of white maize was significantly influenced by varying fertilizer application treatment (Figure 28). The F_4 treatment resulted in the highest stover yield in this experiment (10.33 t ha^{-1}). While the F_1 treatment produced the lowest stover yield (8.69 t ha^{-1}). This might be due to the favorable soil condition created by increased fertilizer treatment resulting in better root development thereby enabling plants to uptake more moisture and nutrients to produce high LAI meaning bigger assimilatory system and hence more dry matter production leading to higher stover yield.



Here, F_1 = 50 % recommended dose of fertilize, F_2 =75 % recommended dose of fertilize, F_3 = 100 % recommended dose of fertilize, F_4 = 125 % recommended dose of fertilizer.

Figure 28. Effect of fertilizer application on stover yield of white maize (LSD $_{(0.05)}$ = 0.07)

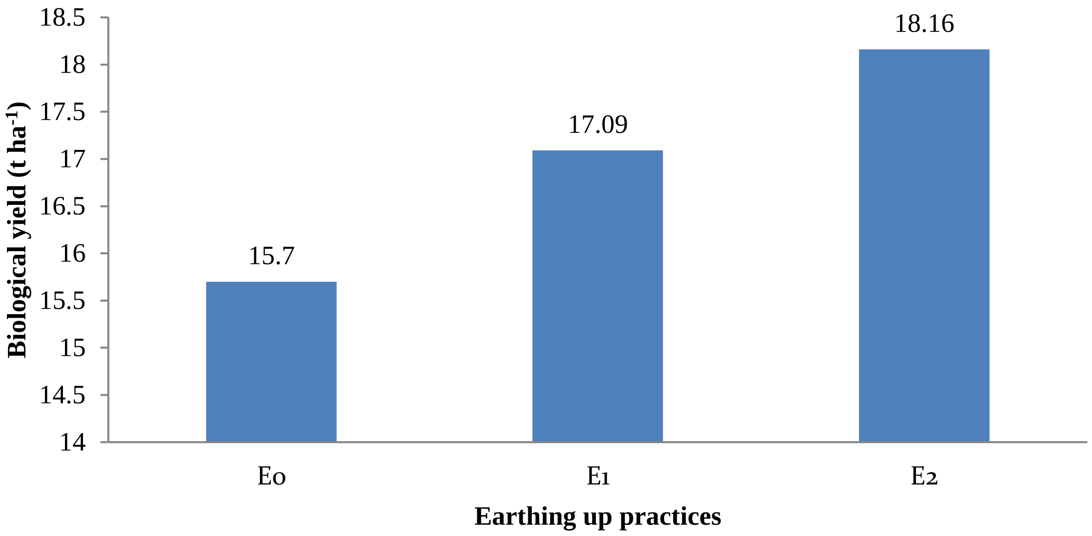
Combined effect of fertilizer application and earthing up practices

The combined effects of fertilizer treatment and earthing up techniques had significantly influenced the stover yield of white maize (Table 8). According to the experimental findings, the E_2F_4 treatment combination had the highest grain yield of white maize (10.56 t ha^{-1}), which was statistically comparable to the E_1F_4 (10.52 t ha^{-1}), E_2F_3 (10.53 t ha^{-1}) and E_1F_3 (10.24 t ha^{-1}) treatment combination. The lowest stover yield of white maize (7.89 t ha^{-1}) was recorded by the E_0F_1 treatment combination.

4.3.3 Biological yield (t ha^{-1})

Effect of different earthing up practices

The different earthing up practices had shown significant effect on the biological yield of white maize (Figure 29). The experiment results showed that the E_2 treatment gave the highest biological yield (18.16 t ha^{-1}). While the E_0 treatments had the lowest biological yield of white maize (15.70 t ha^{-1}). Higher biological yield is the result of higher grain and stover yield. This might be due to the fact that a plant provided with earthing can get more porous soil as compared to a flat planted crop, which ultimately promotes the better growth and development of plants.

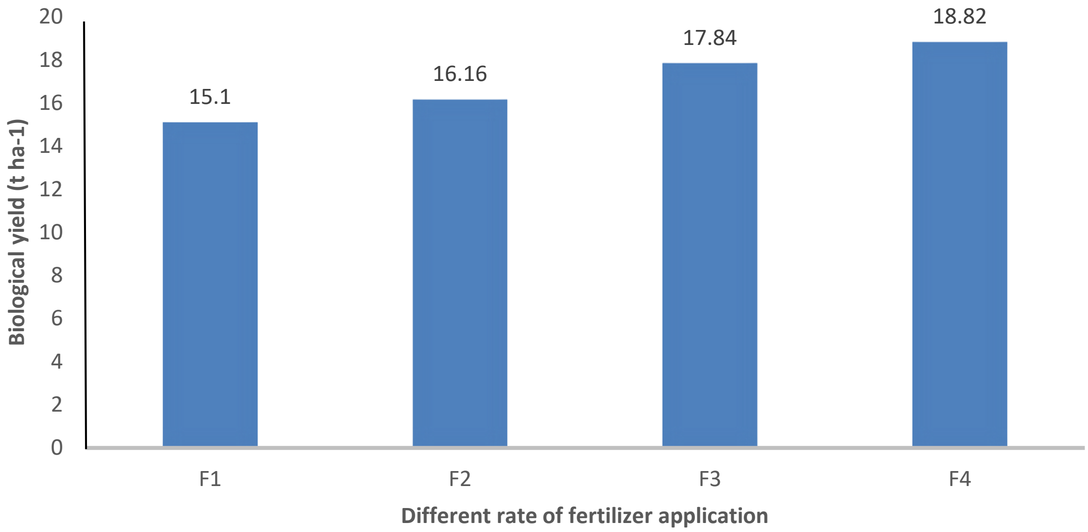


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 29. Effect of earthing up practices on biological yield of white maize (LSD $_{(0.05)}$ = 0.76)

Effect of fertilizer application

The biological yield of white maize was significantly influenced by varying fertilizer application treatment (Figure 30). The F_4 treatment resulted in the highest biological yield in this experiment (18.82 t ha^{-1}) which was statistically similar with F_3 treatment (17.84 t ha^{-1}). While the F_1 treatment produced the lowest stover yield (16.16 t ha^{-1}) which was statistically similar with F_2 treatment (15.10 t ha^{-1}). The substantial increased in biological yield due to greater fertilizer doses may be attributable to the plant's favorable effect on absorbing additional nutrition, which ultimately influenced growth features such as increased dry matter accumulation per plant and its subsequent translocation towards sink.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 30. Effect of fertilizer application on biological yield of white maize (LSD $_{(0.05)}$ = 1.07)

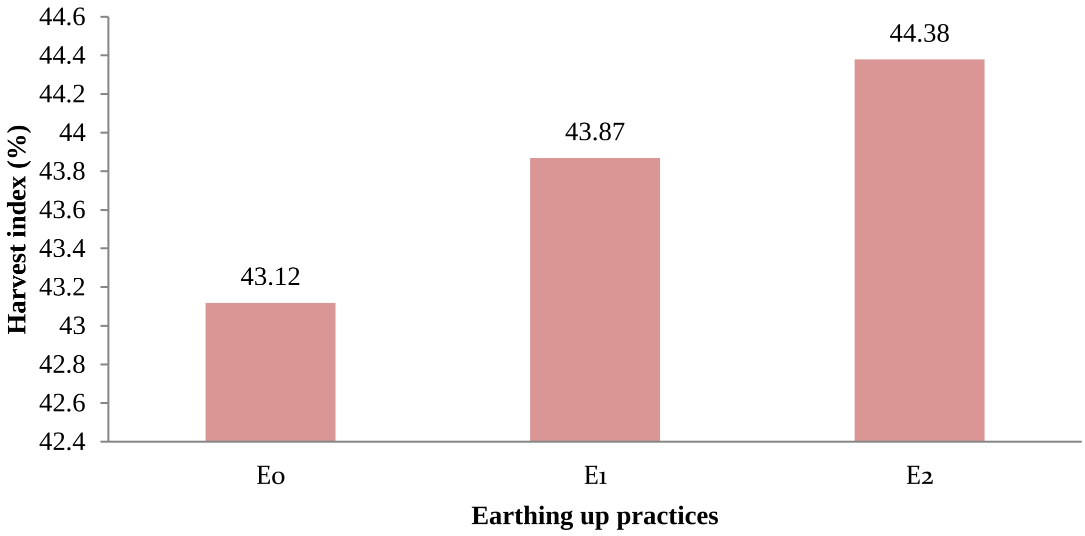
Combined effect of fertilizer application and earthing up practices

The combined effects of fertilizer treatment and earthing up practices had shown significant effect on white maize biological yield (Table 8). According to the experimental results, the E_2F_4 treatment combination had the highest biological yield of white maize (19.54 t ha^{-1}) which was statistically comparable to the E_1F_4 (18.97 t ha^{-1}), E_2F_3 (18.68 t ha^{-1}) and E_1F_3 (18.13 t ha^{-1}) treatment combinations. The E_0F_1 treatment combination had the lowest biological yield of white maize (13.22 t ha^{-1}).

4.3.4 Harvest index (%)

Effect of different earthing up practices

The different earthing up practices had shown non-significant effect on the harvest index of white maize (Figure 9). According to the experiment results the E_2 treatment had the highest harvest index (44.38 %). While the E_0 treatments had the lowest harvest index of white maize (43.12 %).

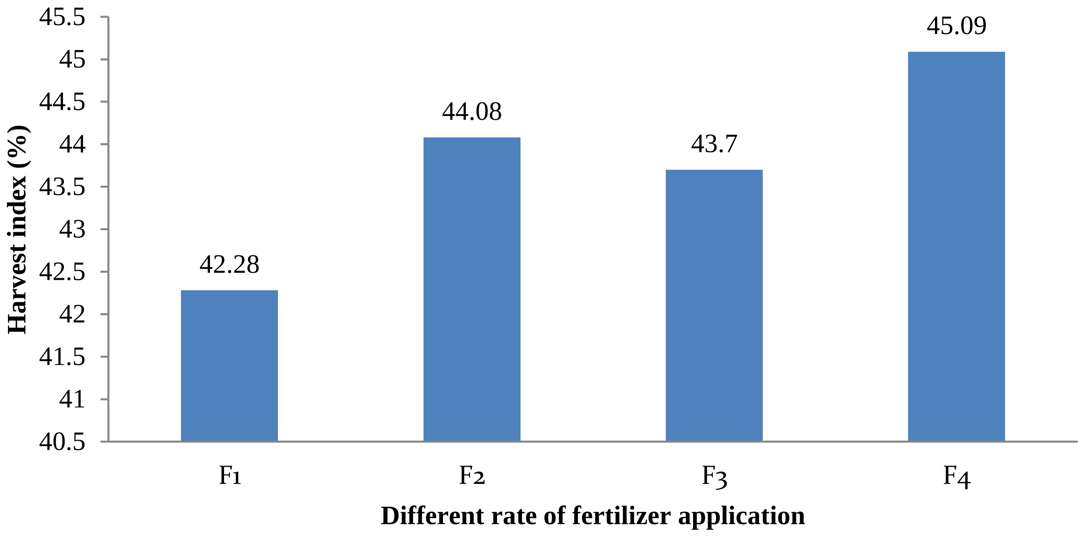


Here, E_0 = Control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

Figure 31. Effect of earthing up practices on harvest index of white maize (LSD $_{(0.05)}$ = NS)

Effect of fertilizer application

The harvest index of white maize was significantly influenced by varying fertilizer application treatment (Figure 32). The F_4 treatment resulted in the highest harvest index in this experiment (45.09 %). While the F_1 treatment had the lowest harvest index (42.28 %). Scientific fertilizer application is a key tool for increasing crop growth, conserving the environment, and ensuring agricultural sustainability. Plant fresh and dry weight, which reflect plant biomass accumulation to some extent, are key measures of growth vigor. Fertilizer application enhanced NPK availability in the root zone, resulting in greater nutrient uptake by the plant, resulting in increased grain and biological yield, which influences crop harvest index.



Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer.

Figure 32. Effect of fertilizer application on harvest index of white maize (LSD $_{(0.05)}$ = 0.72)

Combined effect of fertilizer application and earthing up practices

The combined effects of fertilizer treatment and earthing up practices had shown significant effect on white maize harvest index (Table 8). Experimental results, revealed that the E_2F_4 treatment combination had the highest harvest index of white maize (45.96 %), which was statistically comparable to the E_0F_4 (44.79 %) and E_1F_2 (44.65 %) treatment combinations. The E_0F_1 treatment combination had the lowest white maize harvest index (40.32 %).

Table 8. Combined effect of fertilizer doses and different earthing up practices on grain, stover, biological yield and harvest index of white maize.

Treatment combinations	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
E_0F_1	5.33 f	7.89 e	13.22 f	40.32 e
E_1F_1	6.57 e	8.80 d	15.37 de	42.75 d
E_2F_1	7.32 cd	9.40 c	16.72 cd	43.78 b-d
E_0F_2	6.47 e	8.43 d	14.90 e	43.42 cd
E_1F_2	7.09 de	8.79 d	15.88 de	44.65 a-c
E_2F_2	7.82 bc	9.89 b	17.71 bc	44.16 bc
E_0F_3	7.35 cd	9.37 c	16.72 cd	43.96 b-d
E_1F_3	7.89 bc	10.24 ab	18.13 a-c	43.52 b-d
E_2F_3	8.15 b	10.53 a	18.68 ab	43.63 b-d
E_0F_4	8.04 bc	9.91 b	17.95 bc	44.79 ab
E_1F_4	8.45 ab	10.52 a	18.97 ab	44.54 bc
E_2F_4	8.98 a	10.56 a	19.54 a	45.96 a
LSD (0.05)	0.72	0.42	1.64	1.35
CV (%)	5.21	5.32	5.23	3.62

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

Here, F_1 = 50 % recommended dose of fertilizer, F_2 =75 % recommended dose of fertilizer, F_3 = 100 % recommended dose of fertilizer, F_4 = 125 % recommended dose of fertilizer, E_0 = control, E_1 =Earthing up at 25 DAS and E_2 = Earthing up at 25 DAS and 50 DAS.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted to evaluate the effect of different levels of earthing up and fertilizer application on the performance of white maize (SAUWMOPT) variety. Significantly higher values of growth attributes of maize were recorded in earthing up E_2 (earthing up at 25 days after sowing + earthing up at 50 DAS) and higher fertilizer application F_4 (125%), and combined E_2F_4 treatment combination on white maize SAUWMOPT.

The study has been presented and discussed about the performance of white maize under varying levels of earthing up and fertilizer application. The results have been discussed, and possible interpretations viz. plant growth parameters, yield contributing characters and yields attribute respectively, which showed individually or combined significant effects in respect of various characteristics of this variety.

Significantly higher values of growth attributes of maize were recorded in earthing up at 25 and 50 days after showing and higher fertilizer application F_4 (125%).

The highest plant height (202.92, 223.50 and 215.71 cm) was observed in E_2 (Earthing up at 25 DAS and 50 DAS) treatment and the highest plant height (207.00, 228.56 and 215.78 cm) at 40, 80 DAS and at harvest respectively was observed in F_4 treatment (125 % recommended dose of fertilize) and also (210.00, 236.67 and 219.83 cm) was observed in E_2F_4 treatment combination at 40 and 80 DAS and at harvest respectively. Whereas the lowest plant height was observed (192.92, 209.83 and 204.62 cm) in E_0 (Control) treatment and (188.89, 210.00and 204.39 cm) in F_1 (50 % recommended dose of fertilize) treatment and (176.67, 206.67 and 198.33 cm) in E_0F_1 treatment combination at 40 and 80 DAS and at harvest, respectively.

The highest base circumference plant^{-1} was observed (5.77, 6.92 and 7.67 cm) in E_2 (Earthing up at 25 DAS and 50 DAS) treatment and (5.66, 7.17 and 7.56 cm) in F_4 treatment (125 % recommended dose of fertilize) and also (5.97, 7.58 and 8.17 cm) in E_2F_4 treatment combination at 40 and 80 DAS and at harvest respectively. Whereas the lowest base circumference plant^{-1} was observed (4.39, 5.98 and 6.67 cm) in E_0 (Control) treatment and (4.68, 5.24 and 6.39 cm) in F_1 (50 % recommended dose of fertilize) treatment and (3.63, 4.47 and 5.67 cm) in F_1 treatment combination at 40 and 80 DAS and at harvest, respectively.

The highest leaf area index was observed (1.80, 2.52, and 3.54) in E_2 (Earthing up at 25 DAS and 50 DAS) treatment and (1.89, 2.52 and 3.76) in F_4 treatment (125 % recommended dose of fertilize) and also (1.33, 1.78, and 2.33) in E_2F_4 treatment combination at 40 and 80 DAS and at harvest respectively. Whereas the lowest leaf area index was observed (1.52, 2.08, and 2.77) in E_0 (Control) treatment and (1.52, 2.00 and 2.61) in F_1 (50 % recommended dose of fertilize) treatment and (1.33, 1.78, and 2.33) in E_0F_1 treatment combination at 40 and 80 DAS and at harvest, respectively.

The highest dry matter weight plant^{-1}was observed (42.58, 90.50 and 129.07 g) in E_2 (Earthing up at 25 DAS and 50 DAS) treatment and (43.24, 91.50 and 127.74 g) in F_4 treatment (125 % recommended dose of fertilize) and also (45.69, 98.83, and 138.52 g) in E_2F_4 treatment combination at 40 and 80 DAS and at harvest respectively. Whereas the lowest dry matter weight plant^{-1} was observed and (35.63, 77.94 and 110.35 g) in E_0 (Control) treatment and (35.53, 74.56 and 108.75 g) in F_1 (50 % recommended dose of fertilize) treatment and (31.41, 67.25, and 98.66 g) in E_0F_1 treatment combination (35.53, 74.56 and 108.75 g) at 40 and 80 DAS and at harvest respectively.

The highest cob length plant^{-1} was observed (19.35 cm) in E_2 (Earthing up at 25 DAS and 50 DAS) treatment and (19.65 cm) in F_4 treatment (125 % recommended dose of fertilize) and also (20.72) in F_4E_2 treatment combination respectively. Whereas the lowest cob length plant^{-1} was observed (18.57) in E_0 (Control) treatment and (17.25) in F_1 (50 % recommended dose of fertilize) treatment and (17.12) in F_1E_0 treatment combination. The different earthing up practices had shown non-significant effect on the cob length plant$^{-1.}$ The highest cob length plant^{-1} (20.72) was found in E_2F_4 treatment combination and the lowest cob length plant^{-1} (17.12) was found in E_0F_1 treatment combination.

The cob circumference plant^{-1} of white maize has not significantly been influenced by the various earthing up practices. The highest cob circumference plant^{-1} (13.39 cm) was exposed to the E_2 treatment. While the E_0 treatment had the lowest cob circumference plant^{-1} (13.20 cm). The F_4 treatment had the highest cob circumference plant^{-1} (14.17 cm). However, the F_1 treatment had the lowest cob circumference plant^{-1} (12.30 cm). E_2F_4 treatment combination had the maximum cob circumference plant^{-1} (14.43 cm), while E_0F_1 treatment combination had the lowest cob circumference plant^{-1} (12.30cm).

The chaff weight cob^{-1} of white maize has not significantly been influenced by the various earthing up practices. The highest was exposed to the E_2 treatment. While the E_0 treatment had the lowest chaff weight cob^{-1} (5.62 g). The F_4 treatment had the highest chaff weight cob^{-1} (6.52 g). However, the F_1 treatment had the lowest chaff weight cob^{-1} (5.62 g). E_2F_4 treatment combination had the maximum chaff weight cob^{-1} (6.67 g), while E_0F_1 treatment combination had the lowest chaff weight cob^{-1} (5.56 g).

The highest shell weight cob^{-1} (12.17 g) was exposed to the E_2 treatment. While the E_0 treatment had the lowest shell weight cob^{-1} (11.89 g). The F_4 treatment had the highest shell weight cob^{-1} (13.73 g). However, the F_1 treatment had the lowest shell weight cob^{-1} (10.54 g). E_2F_4 treatment combination had the maximum shell weight cob^{-1} (13.88 g, while E_0F_1 treatment combination had the lowest shell weight cob^{-1} (10.47 g).

The highest grain weight cob^{-1} (95.38 g) was exposed to the E_2 treatment. While the E_0 treatment had the lowest grain weight cob^{-1} (93.01 g). The F_4 treatment had the highest grain weight cob^{-1} (105.83 g). However, the F_1 treatment had the lowest grain weight cob^{-1} (82.22 g). The E_2F_4 treatment combination had the maximum highest grain weight cob^{-1} (106.33 g), while E_0F_1 treatment combination had the lowest grain weight cob^{-1} (81.08 g).

The highest cob weight plant^{-1} (113.78 g) was exposed to the E_2 treatment. While the E_0 treatment had the lowest (110.82 g) cob weight plant^{-1}. The F_4 treatment had the highest cob weight plant^{-1} (126.08 g). However, the F_1 treatment had the lowest cob weight plant^{-1} (98.39 g). E_2F_4 treatment combination had the maximum cob weight plant^{-1} (126.88 g), while E_0F_1treatment combination had the lowest cob weight plant^{-1} (97.11 g).

The various earthing up practices had shown non-significant effect on number of grains cob^{-1}of white maize. The highest number of grains cob^{-1} (375.06) was exposed to the E_2 treatment. While the E_0 treatment had the lowest (375.06) number of grains cob^{-1}. The F_4 treatment had the highest number of grains cob^{-1} (396.67). However, the F_1 treatment had the lowest number of grains cob^{-1} (344.40). E_2F_4 treatment combination had the maximum number of grains cob^{-1} (404.04), while E_0F_1 treatment combination had the lowest number of grains cob^{-1} (344.40).

The highest 1000 grain weight (156.23 g) was exposed to the E_2 treatment. While the E_0 treatment had the lowest 1000 grain weight of white maize (152.58g). The F_4 treatment had the highest weight of 1000 grain weight (160.98 g). However, the F_1 treatment had the lowest weight in 1000 grain weight (148.22 g). E_2F_4 treatment combination had the maximum 1000 grain of white maize (163.30 g), while E_0F_1 treatment combination had the lowest 1000 grains of white maize (147.33 g).

The E_2 treatment had the highest grain yield (8.07 t ha^{-1}). While the grain yield of white maize (6.79 t ha^{-1}) was obtained in the E_0 treatments. The F_4 treatment recorded the highest grain yield (8.49 t ha^{-1}). While F_1 treatment had the lowest grain yield (6.40 t ha^{-1}). The E_2F_4 treatment combination had the highest grain yield of white maize (8.98 t ha^{-1}). The lowest grain yield of white maize (5.33 t ha^{-1}) was recorded by the E_0F_1 treatment combination.

The E_2 treatment produced the highest stover yield (10.09 t ha^{-1}). While the E_0 treatments had the lowest stover yield (8.90 t ha^{-1}) of the white maize. The F_4 treatment resulted in the highest stover yield in this experiment (10.33 t ha^{-1}). While the F_1 treatment produced the lowest stover yield (8.69 t ha^{-1}). The E_2F_4 treatment combination had the highest grain yield of white maize (10.56 t ha^{-1}) and the lowest stover yield of white maize (7.89 t ha^{-1}) was recorded by the E_0F_1 treatment combination.

The E_2 treatment gave the highest biological yield (18.16 t ha^{-1}). While the E_0 treatments had the lowest biological yield of white maize (15.70 t ha^{-1}). The F_4 treatment resulted in the highest biological yield in this experiment (18.82 t ha^{-1}). While the F_1 treatment produced the lowest biological yield (16.16 t ha^{-1})**.** The E_2F_4 treatment combination had the highest biological yield of white maize (19.54 t ha^{-1}) which was statistically comparable to the E_1F_4 (18.97 t ha^{-1}), E_2F_3 (18.68 t ha^{-1}) and E_1F_3 (18.13 t ha^{-1}) treatment combinations. The E_0F_1 treatment combination had the lowest biological yield of white maize (13.22 t ha^{-1}).

The different earthing up practices had shown non-significant effect on the harvest index of white maize. According to the experiment results the E_2 treatment had the highest harvest index (44.38 %), while the E_0 treatments had the lowest harvest index of white maize (43.12 %). The F_4 treatment resulted in the highest harvest index in this experiment (45.09 %). While the F_1 treatment had the lowest harvest index (42.28 %). The E_2F_4 treatment combination had the highest harvest index of white maize (45.96 %), which was statistically comparable to the E_0F_4 (44.79 %) and E_1F_2 (44.65 %) treatment combinations. The E_0F_1 treatment combination had the lowest white maize harvest index (40.32 %).

CONCLUSION

1. The highest cob weight plant^{-1} (113.78 g), grain yield (8.07 t ha^{-1}) was exposed in the E_2 treatment (Earthing up at 25 DAS and 50 DAS).

2. The highest cob length plant^{-1} (19.65 cm), grain weight cob^{-1} (105.83 g), cob weight plant^{-1} (126.08 g), number of grains cob^{-1} (396.67), grain yield (8.49 t ha^{-1}), harvest index in this experiment (45.09 %) was observed in F_4 treatment (125 % recommended dose of fertilize).

3. Combined effect: The F_4E_2 treatment combination (F_4= 125% dose of fertilizer, E_2= Earthing up at 25 DAS and 50 DAS) had perform the best for maximum grain yield of white maize (8.98 t ha^{-1}) comparable to other treatment combination. But the yield of F_4E_1 and F_4E_2 did not significantly differ.

RECOMMENDATION

- The trial should be repeated in the proceeding studies along with evaluating the interaction effect of fertilizer application and earthing up in Kharif season across different agro- ecological regions.
- At the time of my experiment due to heavy rainfall crop yield was reduced drastically. So, I recommend it should be cultivated in other seasons also to increase crop productivity.

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APPENDICES

Appendix I. Agro -Ecological Zone of Bangladesh showing the experimental location

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from March to June 2021.

Year	Month	Air temperature (°C)			Relative humidity (%)	Total rainfall(mm)
		Max	Min	Mean		
2021	March	34.4	23.1	28.8	57	3
2021	April	36.1	25.2	30.7	60	39
2021	May	34.9	25.9	30.5	69	216
2021	June	32.5	25.8	29.2	83	546

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

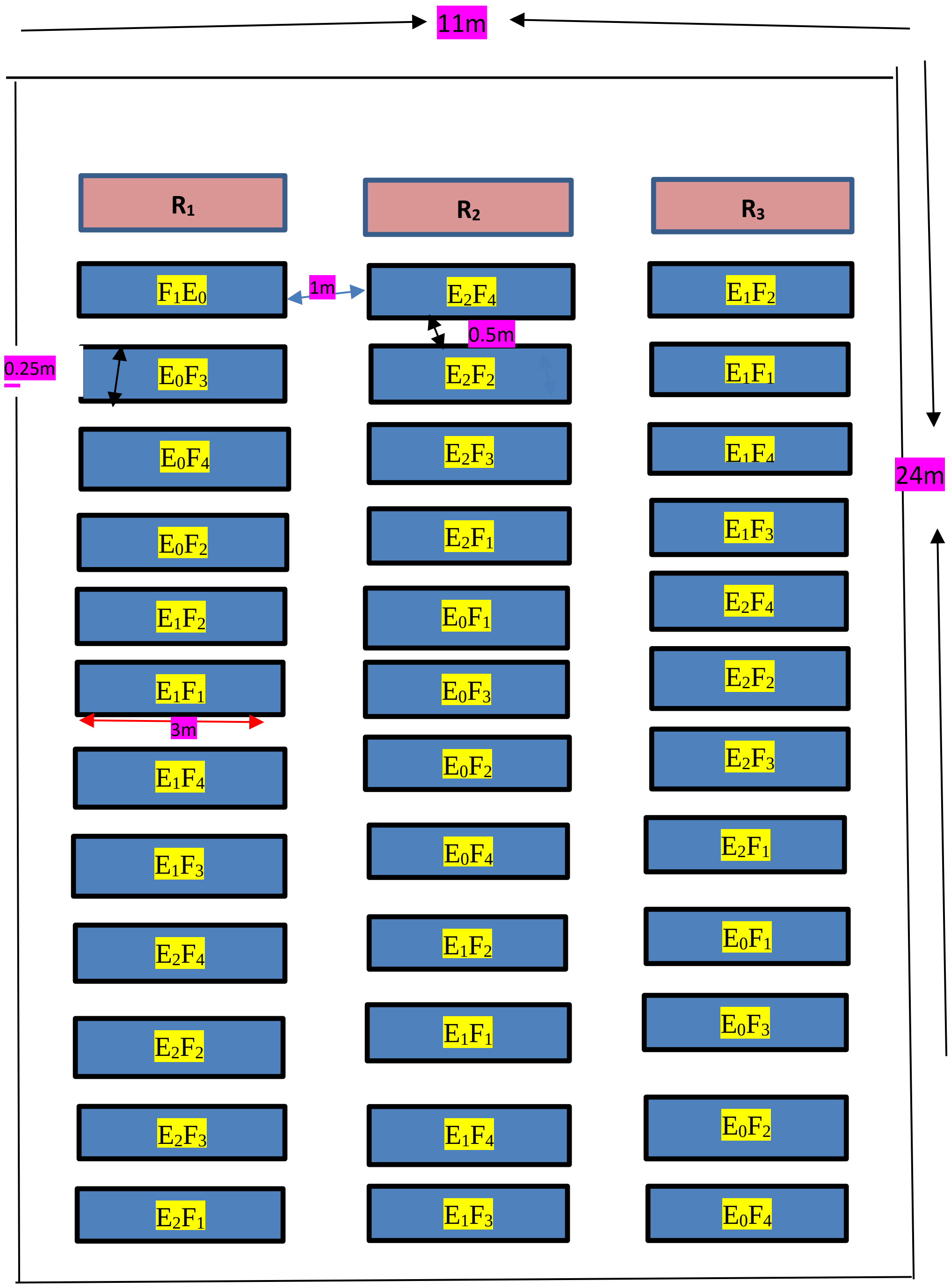
Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	Value
Partical size analysis % sand	27
% Silt	43
%clay	30
Textural class	Silty Clay Loam (ISSS)
P^H	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experiment field



LEGEND

R= Replication

Plot length= 24m

Plot breadth= 11m

Plant to plant distance= 25cm

Row to row distance= 50cm

Drain= 1m

F_1 = 50% RDF

F_2 = 75% RDF

F_3 = 100% RDF

F_4 =125% RDF

E_0= no earthing up,

E_1 = earthing up at 25 DAS,

E_2 = earthing up at 25 +50 DAS.

Appendix V. Analysis of variance of the data of plant height of white maize at different DAS

Source	DF	Mean square of plant height		
		40 DAS	80 DAS	At harvest
Replication (R)	2	1359.73	1313.55	148.25
Fertilize (F)	3	589.52*	607.05*	243.82*
Error	6	36.71	9.59	35.46
Earthing up (E)	2	305.43*	566.66*	368.47*
F×E	6	48.87*	34.42*	15.30*
Error	16	9.50	33.15	8.73

NS: Non significant
*:Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data of base circumference of white maize at different DAS

Source	DF	Mean square		
		40 DAS	80 DAS	At harvest
Replication (R)	2	1.21094	1.43520	1.92297
Fertilize (F)	3	0.34076*	5.47883*	0.64537*
Error	6	0.05014	0.01090	0.07951
Earthing up (E)	2	0.15542*	0.03182*	0.26792*
F×E	6	0.02656*	0.01603*	0.01809*
Error	16	0.05293	0.01325	0.08271

NS: Non significant
*:Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data of leaf area index of white maize at different DAS

Source	DF	Mean square of no. of leaves plant^{-1}		
		40 DAS	80 DAS	At harvest
Replication (R)	2	0.06569	0.13975	0.28830
Fertilize (F)	3	0.23670*	0.42029*	2.12580*
Error	6	0.00842	0.01136	0.00177
Earthing up (E)	2	0.22418*	0.59748*	1.86870*
F×E	6	0.02078*	0.02104*	0.24520*
Error	16	0.00792	0.01048	0.02362

NS: Non significant

*: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data of dry matter weight plant^{-1} of white maize at different DAS

Source	DF	Mean square of dry matter weight plant^{-1}		
		40 DAS	80 DAS	At harvest
Replication (R)	2	36.695	211.180	426.02
Fertilize (F)	3	91.360*	470.922*	859.34*
Error	6	4.601	0.645	0.72
Earthing up (E)	2	146.669*	482.788*	1062.50*
F×E	6	3.656*	15.703*	13.01*
Error	16	4.296	18.789	25.94

NS: Non significant

*: Significant at 0.05 level of probability

Appendix IX. Analysis of variance of the data of cob length and cob circumference of white maize at harvest

Source	DF	Mean square of	
		Cob length	Cob circumference
Replication (R)	2	9.7966	4.73002
Fertilize (F)	3	11.7531*	5.93147*
Error	6	0.1458	0.10505
Earthing up (E)	2	1.8684*	0.11710^{NS}
F×E	6	0.5659*	0.04437*
Error	16	0.6379	0.08339

NS: Non significant

*: Significant at 0.05 level of probability

Appendix X. Analysis of variance of the data of chaff weight cob^{-1}, shell weight cob^{-1}, grain weight cob^{-1} and cob weight $plant^{-1}$ of white maize at harvest

Source	DF	**Mean square of**			
		Chaff weight cob^{-1}	Shell weight cob^{-1}	Grain weight cob^{-1}	Cob weight $plant^{-1}$
Replication (R)	2	1.68924	5.8828	285.476	423.32
Fertilize (F)	3	1.93327*	17.2678*	969.681*	1340.61*
Error	6	0.15476	0.2980	1.353	3.98
Earthing up (E)	2	0.30270^{NS}	0.2462^{NS}	17.563*	27.20*
F×E	6	0.02037*	0.0429*	1.498*	1.84*
Error	16	0.16285	0.3325	0.605	1.26

NS: Non significant

*: Significant at 0.05 level of probability

Appendix XI. Analysis of variance of the data of number of grains cob^{-1} and 1000-grain weight of white maize at harvest

Source	**DF**	Mean square of	
		Number of grains cob^{-1}	1000 grains weight
Replication (R)	2	3577.04	796.895
Fertilize (F)	3	4650.27*	278.443*
Error	6	142.06	7.601
Earthing up (E)	2	91.81^{NS}	45.490*
F×E	6	34.78*	0.760*
Error	16	120.37	8.288

NS: Non significant

*: Significant at 0.05 level of probability

Appendix XII. Analysis of variance of the data of on grain, stover, biological yield and harvest index of white maize at harvest

Source	**DF**	**Mean square of**			
		Grain yield	Stover yield	Biological yield	Harvest index
Replication (R)	2	1.32357	2.72320	6.8548	53.4813
Fertilize (F)	3	7.18430*	5.53423*	24.9592*	12.2013*
Error	6	0.16953	0.00461	0.8648	0.3937
Earthing up (E)	2	4.85693*	4.31648*	18.3279*	4.8134^{NS}
F×E	6	0.23633*	0.21488*	0.7117*	2.5623*
Error	16	0.15074	0.25672	0.7896	2.5152

NS: Non significant

*: Significant at 0.05 level of probability