PARTITIONING BEHAVIOR OF WHITE MAIZE UNDER VARYING FERTILIZER DOSES AND LEAF REMOVAL

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PARTITIONING BEHAVIOR OF WHITE MAIZE UNDER VARYING FERTILIZER DOSES AND LEAF REMOVAL

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CERTIFICATE

This is to certify that thesis entitled, ***"PARTITIONING BEHAVIOR OF WHITE MAIZE UNDER VARYING FERTILIZER DOSES AND LEAF REMOVAL"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS) in AGRONOMY****, embodies the result of a piece of bona-fide research work carried out by* **FARZANA AKHTER** *Registration no.* ***13-05494*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:
Place: Dhaka, Bangladesh

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DEDICATED TO MY

BELOVED PARENTS

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PARTITIONING BEHAVIOR OF WHITE MAIZE UNDER VARYING FERTILIZER DOSES AND LEAF REMOVAL

ABSTRACT

The experiment was conducted at the agronomy field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from July to November, 2018 in Kharif-II season to evaluate the effect of different level of fertilizer doses and leaf removal on the yield of white maize (SAUD 18-3-3). The experiment comprised of two factors, Factor A: four level of fertilizer doses i.e. F_0 = No fertilizer application (control), F_r = Recommended dose of fertilizer, F_1 = 25% more than recommended dose of fertilizer and F_2 = 25% less than recommended dose of fertilizer; and four level of leaf removal i.e. C_{sa} = 4 Leaves clipping above cobs at silking stage, C_{sb} = 4 Leaves clipping below cobs at silking stage, C_{ga} = 4 Leaves clipping above cobs at grain filling stage and C_{gb} = 4 Leaves clipping below cobs at grain filling stage. The experiment was laid out in Completely Randomized Design with five replications. Total 80 unit pots were for the experiment with 16 treatments. Effect of different fertilizer doses, different stage of leaf removal individually and their interaction effect showed significant variation on plant growth and yield. 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) combination showed the highest grain yield (7.92 t ha^{-1}), maximum leaf area $plant^{-1}$ (737.75 cm^2), highest leaf dry weight $plant^{-1}$ (26.25 g), longest cob (18.50 cm), highest cob circumference (22.00 cm), maximum number of grains cob^{-1} (441.50), highest grain weight cob^{-1} (157.50 g), maximum shell+chaff weight cob^{-1} (29.38 g), highest shelling percentage (83.54 %), maximum 1000-grains weight (356.58 g), highest stover yield (8.58 t ha^{-1}), maximum biological yield (16.50 t ha^{-1}) and maximum harvest index (47.99 %). Irrespective of treatments, most of the dry weight moved to grain (50.21%) which was then followed by stem (22.93%)**.** The leaf and shell+chaff had same amount of dry matter (around 13%) in each of them. F_0 had the total dry matter in leaf 35.35% of the total, In stem F_2 had highest dry weight (16.57%) of total plant and Csb treatment provides highest dry matter in leaf (15.93%) and stem (25.92%).

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
Agri.	Agriculture
Anon.	Anonymous
AIS	Agriculture Information Service
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BINA	Bangladesh Institute of Nuclear Agriculture
BNNC	Bangladesh National Nutrition Council
BARI	Bangladesh Agricultural Research Institute
CIMMYT	International Maize and Wheat Improvement Center
CV %	Percent of Coefficient of Variance
cv.	Cultivar (s)
HI	Harvest Index
DAS	Days After Sowing
eds.	Editors
et al.	et alii (and others)
etc.	et cetera (and other similar things)
FAO	Food and Agriculture Organization
IITA	International Institute of Tropical Agriculture
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
L.	Linnaeus
LSD	Least Significant Difference
i.e.	id est (that is)
MOP	Muriate of Potash
NPTs	New Plant Types
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
TDM	Total Dry Matter
TSP	Triple Super Phosphate
UNDP	United Nations Development Programme
var.	Variety
viz.	Namely

CHAPTER I

INTRODUCTION

Maize (*Zea mays* L.) is the widely grown cereal crop in the world. It was originated in America and first cultivated domestically in the area of southern Mexico more than 10,000 years ago (Benz, 2001). This cereal crop belongs to the family Poaceae. It is a typical monoecious and C4 plant. Maize is annual plant with high productivity and exceptional geographic adaptability. Maize is called the "Queen of cereals" due to its high yield potential (FAO, 2002). It ranks 1st in respect of yield per unit area, 2nd in respect total production and 3rd after wheat and rice in respect of acreage in cereal crops, (Zamir *et al.*, 2013).

Maize is grown as fodder, feed and food crop. Wheat, rice and maize are the most important cereal crops in the world but different uses of maize in agro-industry it has great economic value. Maize grain contains 70% carbohydrate, 10% protein, 4% oil, 10.4% albumin, 2.3% crude fiber, 1.4% ash (Nasim *et al*., 2012). Moreover, it contains 90 mg carotene, 1.8 mg niacin, 0.8 mg thiamin and 0.1 mg riboflavin per 100 g grains (Chowdhury and Islam, 1993). It provides many of the B vitamins and essential minerals along with fibre, but lacks some other nutrients, such as vitamin B_{12} and vitamin C. Maize oil is used as the best quality edible oil.

In Bangladesh, the cultivation of maize was started in the late 19th century. Introduction of maize for human food can be a viable alternative for sustaining food security as the productivity of maize much higher than rice and wheat (Ray *et al.*, 2013). Like many other parts in the world (Shiferaw *et al.,* 2011), market demand for maize in South Asia and Bangladesh has significantly increased in the last decade as a result of the expanding poultry and fish feed industries, and for use in processed foods (Ali *et al.*, 2008; Timsina *et al.*, 2011). Maize has been a recent introduction in Bangladesh. Maize production of Bangladesh increased from 3,000 tons in 1968 to 3.03 million tons in 2017 growing at an average annual rate of 28.35 % (FAO, 2019). In Bangladesh, it covers about 0.35 million hectares of land producing 2.3 million metric tons grains (BBS, 2016; Zamir *et al*., 2011).

Generally two kinds of maize in respect of grain colour; yellow and white. The difference between these two varieties of maize is color. White maize kernels does not have carotenoids while the yellow maize has carotenoids that shows kernels yellow colour. Worldwide, the yellow maize is mainly used as food and fodder while the white ones are consumed as human food (FAO, 2002). Yellow maize constitutes the bulk of world production and international trade. It is grown in northern hemisphere countries where it is traditionally used for animal feed and ethanol production (AMIS, 2015). Maize has attracted the attention in the world due to its importance being used as fodder and human food (Guruprasad *et al.,* 2016). The currently grown Maize in Bangladesh is of yellow type and is used in the feed industry. White maize covers only 12% of the total acreage of the world, which is mostly used as human food (FAO-CIMMYT, 1997). During 1970s, the productivity of grown white maize was lower compared to those of yellow ones. With the advanced breeding approaches, worldwide, recent reports demonstrate that the yield productivity of white maize is almost at par with those of the yellow ones (Akbar *et al.,* 2016). Bangladesh Agricultural Research Institute (BARI) has developed 2 hybrid varieties of white maize BARI Hybrid Bhutta-12 and BARI Hybrid Bhutta-13. Major enterprise on large-scale and small-scale farms. Small holder farmers grow only white maize, retaining part of it for home consumption and selling the remainder. Large-scale commercial farmers used to grow maize mostly as a cash crop and grew both white and yellow maize (Rukuni *et al*., 2006).

The low productivity of maize is attributed to many factors like decline of soil fertility, poor agronomic practices, and limited use of input, insufficient technology generation, poor seed quality, disease, insect, pest and weeds. Chemical fertilizers are attractive due to their convenience, ease application and reliable high yield. In general the yield productivity of any crop in this country is low which is generally attributed to the poor agronomic management (Ullah *et al.,* 2017). Highly fertilized soils are required for intensive cropping system and integrated plant nutrient management system helps to sustain those soils (Bationo and Koala, 1998). Chemical fertilizers become popular for their suitable, easy touse and satisfactory yield. According to Chowdhury and Bailey (1994), organic manure has many beneficial effects on soil such as improves soil fertility, aeration, water-holding capacity and activate micro-organisms in the soil that make the nutrient available to the plant. Inorganic fertilizer has strong influence on plant growth, development and yield (Stefano *et al*., 2004). Appropriate use of fertilizer leads to increased crop yields and high crop recovery of the applied nutrients. Efficient fertilization is therefore important in ensuring crops attain maturity within specific growing seasons (Okalebo, 1987).

Maize requires adequate supply of nutrients particularly nitrogen, phosphorus, potassium, calcium, sulphur, zinc and boron for good growth and high yield. Nitrogen is a vital plant nutrient and a major yield-determining factor required for good vegetative growth and grain development in maize production (Adediran and Banjoko, 1995).The quantity required of these nutrients particularly nitrogen depends on the pre-clearing vegetation, organic matter content, tillage method and light intensity (Kang, 1981).Grain yield was increased significantly with different levels of nitrogen applications in maize plants (Manzoor *et al*., 2010).

Phosphorus plays an important part in many physiological processes that occur within capable of causing nutrient imbalance and consequently a developing and maturing plant. It is involved in various enzymatic reactions in the plant. These include the form of native soil nucleoproteins which are involved in the cell reproduction. The response of maize plant to application of nitrogen and phosphorus fertilizers varies from variety to variety, location to location and also depends on the availability in nitrogen. Research results have shown that various maize cultivars differ markedly in grain yield in response to nitrogen fertilization (Bandy *et al.*, 1988). Potassium also plays a vital role as macronutrient in plant growth and sustainable crop production (Baligar *et al*., 2001). It maintains turgor pressure of cell, which is necessary for cell expansion. It plays a key role in activation of more than 60 enzymes (Bukhsh *et al*., 2011). The efficiency of gypsum in the improvement of chemical properties of soil has been demonstrated in many studies. These improvements result from the increase in the concentration of calcium (Caires *et al.*, 2003 ; Serafim, 2012) and sulfur (Neis *et al.*, 2010).Boron deficiency stop plant growing. Lack of boron actually causes a problem in the meristems, or the stem cells of the plant. Boron is essential for formation of tassel and kernels. The inability to transport boron weakened the structure of pectin, which is a fiber that the plant needs to remain physically stable. When this happened, the growing points in the plant that contain meristems withered, which hurt the kernels and tassels. These causes a great reduction occurs during the production of maize.

Maize produces a greater quantity of epigeous mass than other cereals, so it can be used as fodder. Depending on the variety, a maize plant produces 15 to 20 leaves during its life cycle (Goldsworthy *et al.*, 1974). Leaves are the major source of dry matter production through photosynthesis, and then accumulated into various plant parts through different physiological processes (Iqbal *et al*., 2014). Different types of leaf clipping have various influences on dry matter accumulation when the leaf clipping occurs at the primary stage of grain development (Wang *et al*., 1996). Maize leaf clipping at early season significantly decreased the stem length and leaf area but it did not have any effect on leaf emergence (Prioul and Dugue, 1992). It was noticed that when the maize defoliation is severe and its time is closer to silking stage, yield would be decreased greatly (Burton *et al.*, 1995). The balance nutrient provision along with removal of leaf increase the dry matter partitioning into various plant parts through its impact on more leaf area production and high photosynthetic rates (Gasim, 2001). The dry matter production highly influenced the plant biomass production and grain yield of the crop (Plaut *et al*., 2004).

OBJECTIVES OF THE RESEARCH WORK:

1. Observation of the performance of short duration maize variety under different levels of fertilizer and leaf clipping.

2. To Assess the dry matter distribution to different parts under different levels of fertilizer and leaf clipping.

3. To Evaluate the interaction effect of different fertilizer doses and leaf clipping.

CHAPTER II

REVIEW OF LITERATURE

White maize used as human foods where yellow maize for cattle and poultry feeds. Fertilizer management and agronomic practice influence the growth and yield of white maize. Biomass production of a crop largely depends on the function of leaf area development and consequential photosynthetic activity. Leaf clipping can influence the partitioning behaviour of the plants and growth and yield of the white maize plants. The thinking has received much attention by the researchers on various aspects of its production and utilization for different consumer's uses. Various workers in many parts of the globe have done research works to study the effect of different level of fertilizer combination and leaf clipping on maize. An attempt was made in this section to collect and study relevant information available in the country and abroad to gather knowledge helpful in conducting the present research work and subsequently writing up the result and discussion. Some of the important and informative works and research findings so far been done at home and abroad on regarding the effect of different level of fertilizer management and different degrees of leaf clipping on white maize have been reviewed in this chapter under the following headings and sub-headings:

2.1 Effect of different levels of fertilizers

A field experiment was conducted by Razu (2017) to study the effect of different level of fertilizer combination and spacing on the yield of white maize in kharif-2. The experiment comprised of two factors, Factor A: Different fertilizer doses, i.e. F_1 = 50% less than recommended doses of fertilizer, F_2= 25% less than recommended doses of fertilizer,F_3 = Recommended doses of fertilizer,F_4 = 25% more than recommended doses of fertilizer,F_5 = 50% more than recommended doses of fertilizer; and Factor B: four level of spacing, i.e. S_1 = 50 cm × 25 cm, S_2 = 60 cm × 25 cm, S_3 = 70 cm × 25 cm, S_4 = (30,70 cm) paired × 25 cm. Results revealed that, the highest plant height was observed in 25% more than recommended doses of fertilizer (268.55 cm) and 60 cm × 25 cm spacing (263.48 cm). Number of cobs plant^{-1} (2.33 and 2.08), cob length (18.61 cm and 17.62 cm), cob diameter (14.28 cm and 13.51 cm), number of seeds row^{-1} (32.02 and 28.96), number of rows cob^{-1}(13.15

and 12.84), number of seeds cob^{-1} (369.42 and 339.44), 1000-seeds weight (288.79 g and 276.41 g), and cob yield (8338.5 kg ha^{-1} and 7697.2 kg ha^{-1}) were the maximum in 50% more than recommended doses of fertilizer and 70 cm × 25 cm spacing. The combined effect of F_5 fertilizer and S_3 spacing on growth and yield of white maize indicated that the positive indication of using 50% more than recommended doses of fertilizer and 70 cm × 25cm spacing.

Islam (2015) conducted an experiment to study the growth and yield of white maize varieties under different fertilizer doses. The experiment consisted of two factors. Factor A: Fertilizer doses (5 levels); F_1 = Recommended dose (100%); F_2 = Below 25% of recommended dose (75%); F_3 = Below 50% of recommended dose (50%); F_4 = above 25% of recommended dose (125%) and F_5 = above 50% of recommended dose (150%) and factor B: Varieties (2 levels); V_1: KS-510 and V_2: PSC-121. Results showed that fertilizer dose of 50% above recommended value had the highest plant height (220 cm). Above 25% of recommended dose (125%) of fertilizer with PSC-121 variety (F_4V_2 treatment) showed the highest biological yield (21.78 t ha^{-1}), grain yield (7.98 t ha^{-1}). The highest seed yield from F_4V_2 treatment was attributed to either number of grains per cob (512) or 100 seed weight (41.0 g).

2.1.1 Plant height

Mukhtar *et al*. (2011) studied response of maize crop to various NP levels during kharif 2009. Six NP rates (0 - 0, 200-100, 250-125, 300-150, 350-175 and 400-200 kg ha^{-1}) were tested with two maize hybrids (YH-1898 and YH-1921) for growth and yield. Results showed that, maximum plant height (230.50 cm) was recorded in maize plants fertilized with NP @ 400-200 kg ha^{-1} followed by 350-175 kg ha^{-1} NP (230.0 cm) with non-significant difference, whereas the minimum plant height (187.50 cm) was recorded in control plot (0-0 kg ha^{-1}).

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. Among different treatments, F_3 (250-110-85 NPK kg ha^{-1}) gave maximum plant height (198.55 cm) against the minimum recorded (143.60 cm) in F_0 (control).

Law-ogbomoa and Law-ogbomo (2009) conducted field trials to estimate the effect of NPK 15:15:15 fertilizer on the growth and yield of maize, which were conducted over a two-year period. The treatments included four NPK fertilizer rates viz. 0 (0 kg N + 0 kg P + 0 kg K), 200 (30 kg N + 13.58 kg P + 24.90 kg K), 400 (60 kg N + 27.16 kg P + 49.80 kg K) and 600 (90 kg N + 40.70 kg P + 74.70 kg K) kg ha^{-1} of compound fertilizer. The results of the trials revealed that, plant height was increased with successive increment in fertilizer application rate up to 600 kg ha^{-1}. Maize plants were the tallest (168.35 cm) that received 600 kg NPK ha^{-1} and the shortest plant (148.20 cm) was recorded that received no fertilizers.

Onasanya *et al.* (2009) conducted an experiment to evaluate the effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays* L.)The results of the study showed that, the tallest plant height (192.50 cm) was recorded at 8 WAP (Week after transplanting) from T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}) whereas the shortest plant height (167.06 cm) was recorded from control treatment T_1.

Eltelib *et al.* (2006) studied the effect of nitrogen and phosphorus application on growth, forage yield and quality of fodder maize. The variety used was Giza 2. Nitrogen was applied at the rates of (0, 40 and 80 kg N ha^{-1}) while phosphorus levels were (0, 50 and 100 kg P_2O_5 ha^{-1}). Results showed that addition of nitrogen fertilizer significantly increased plant height.

2.1.2 Leaf area plant^{-1}

Law-ogbomoa and Law-ogbomo (2009) conducted field trials to estimate the effect of NPK 15: 15:15 fertilizer on the growth and yield of maize, which were conducted over a two-year period. The treatments included four NPK fertilizer rates viz. 0 (0 kg N + 0 kg P + 0 kg K), 200 (30 kg N + 13.58 kg P + 24.90 kg K), 400 (60 kg N + 27.16 kg P + 49.80 kg K) and 600 (90 kg N + 40.70 kg P + 74.70 kg K) kg ha^{-1} of compound fertilizer. The results of the trials revealed that, the highest leaf area plant^{-1} (1600.00 cm^2) was recorded from the maize plants that received 600 kg ha^{-1} NPK fertilizer and the lowest leaf area plant^{-1} (46.75 cm^2) was recorded from the maize plants that received no fertilizers.

Onasanya *et al.* (2009) conducted an experiment to evaluate the effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays* L.). They reported that, the highest leaf area plant^{-1} (964.71 cm^2) was recorded in T_{10} (120 kg N ha^{-1} + 20 kg P ha^{-1}) at 8 WAP. However, this was not significantly different from T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) and T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}). The control plot (T_1) gave the lowest value of leaf area $plant^{-1}$ (501.22 cm^2).

Kumar *et al*. (2007) conducted a field experiment to study the fertilizer requirement of sweet corn grown on Vertisols. Recommended doses of fertilizer (RDF) of grain maize was (150 :75 :37.5 kg ha^{-1} NPK, respectively). Treatment were consisting of varying levels of N, P and K to study the effect of N, P and K levels on sweet corn. The nutrient levels were three levels of N (100%, 75% and 50% RDN of grain maize), two P levels (100% and 75% RDP of grain maize) and three K levels (75%, 100% and 125% RDK of grain maize) and totally 18 different treatment combinations were laid out. The growth parameters of sweet corn *viz*., leaf area index and total dry matter production were influenced favourably with increasing levels of NPK application. The yield and yield components of sweet corn were also influenced favourably with increasing levels of NPK application. They reported that, irrespective of the growth stages, the treatments that received 75% RDN or more showed higher leaf area index than other treatments. The highest leaf area index was recorded in treatment which received 100% RDN + 100% RDP + 125% RDK (0.63, 3.35 and 3.05 at 30, 60 DAS and at harvest, respectively). The lowest leaf area index was recorded in treatment which received 50% RDN + 75% RDP + 75% RDK (0.35, 2.67 and 2.50 at 30, 60 DAS and at harvest, respectively).

2.1.3 Cob length, Number of rows cob^{-1}, Number of cobs $plant^{-1}$

An experiment was laid out by Gul *et al*.(2015) to investigate the response of rainfed maize to sowing methods and NPK levels, during kharif of 2011 and 2012 at Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Budgamn. A randomized block design with combination of 2 sowing methods (flat sowing, 75 cm apart rows, and ridge sowing, 75 cm apart ridges) and 3 fertility levels (60 : 40 : 20, 75 : 50 : 30, and 90 : 60 : 40 N : P_2O_5 : K_2O kg ha^{-1}) with three replications. Investigation revealed that yield contributing characters, namely, cob length, number of cobs per plant, grain rows, number of grains per cob increased significantly up to F_2 (75 : 50 : 30) level beyond which difference was non significant.

Higher cob length obtained at F_2 (75 : 50 : 30) level 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.

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars *viz.* Golden and Sultan. The maximum number of grain rows per cob (15.30) was produced by NPK application at the rate of 250-110-85 kg ha^{-1}, however, did not differ statistically when compared with treatment 175-80-60 kg ha^{-1} which gave 15.03 number of grain rows per cob. The treatment combination of 100-50-35 NPK kg ha^{-1} resulted in 14.30 rows $cob^{-1}$and seemed to be better than the control (13.53).

2.1.4 Number of grains cob^{-1}

Enujeke (2013) carried out a research work to evaluate the effects of variety, organic manure and inorganic fertilizer on number of grains cob^{-1} of maize. Four different rates of poultry manure, cattle dung and NPK 20: 10:10 fertilizer were applied to three different maize varieties sown at 75 cm × 15 cm and evaluated for number of grains cob^{-1}. The result of the study indicated that plants that received inorganic fertilizer NPK 20: 10:10 had the highest number of grains cob^{-1} (506.0) followed by plants that received poultry manure (468.0). Plants that received cattle dung had the lowest number of grains cob^{-1} (458.0).

Mukhtar *et al.* (2011) studied response of maize crop to various NP levels during kharif 2009. Six NP rates (0 - 0, 200 - 100, 250 - 125, 300 - 150, 350 - 175 and 400 - 200 kg ha^{-1}) were tested on two maize hybrids (YH-1898 and YH-1921) for growth and yield. Results revealed that, maize crop fertilized at 250-125 kg NP produced significantly maximum grains per ear (658.0) against minimum (217.0) in case of control plot.

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. Application of NPK at increase rate delayed the number of days taken to tasselling, silking and maturity of the crop. The data regarding number of grains cob^{-1} showed that various NPK applications significantly affected number of grains cob^{-1}. Treatment combination F_3 (250-110-85 NPK kg ha^{-1}) produced more number of grains (425.13) per cob. Treatment F_3 was followed by treatment F_2 (175-80-60 NPK kg ha^{-1}) (421.28) and F_1 (100-50-35 NPK kg ha^{-1}) (414.48). F_0 (0-0-0 NPK kg ha^{-1}) produced the lowest number of grains (391.29) per cob.

Onasanya *et al.* (2009) carried out an experiment to evaluate the effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays* L.). The results of the study revealed that, application of 120 kg N ha^{-1} + 40 kg P ha^{-1} (T_{11}) produced the maximum number of grains per ear which was significantly different from all other treatments. The minimum number of grains per ear was obtained in the control (T_1). Grain number varied from 262.28 in the control to 497.30 in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}), respectively.

2.1.5 1000 grains weight

Jan (2014) observed the effects of soil amendments on yield and yield attributes of maize (*Zea mays* L.) under different irrigation schedule.Two separated field experiments were set up. One field was specified for 6 irrigations while other had 3 irrigations. The treatments consisted of soil amendments [FYM (10 t ha^{-1}), crop residue (wheat straw 10 t ha^{-1}), gypsum (1000 kg ha^{-1}), qemisoyl (10 kg ha^{-1}) and humic acid (12 kg ha^{-1})].The results of the study revealed that, plots treated with FYM at 10 t ha^{-1} produced heavier 1000-grains weight (287.4 g) and statistically at par when plots treated with humic acid, while the lightest 1000-grains weight (164.1 g) were recorded in control plots.

Mukhtar *et al.* (2011) studied response of maize crop to various NP levels during kharif 2009. Six NP rates (0 - 0, 200 - 100, 250 - 125, 300 - 150, 350 - 175 and 400 - 200 kg ha^{-1}) were tested on two maize hybrids (YH-1898 and YH-1921) for growth and yield. Results showed that, maximum 1000-grain weight (430.00 g) was obtained in 250-125 kg ha^{-1} NP level against minimum (141.8 g) in case of control plot (0-0 kg ha^{-1}).

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. The NPK application @ 250-110-85 kg ha^{-1} produced the heaviest 1000-grain weight (255.92 g). Next to follow were treatment F_2 (175-80-60 NPK kg ha^{-1}) and F_1 (100-50-35

NPK kg ha^{-1}) resulted in 253.18 g and 245.13 g, respectively. The minimum 1000-grain weight (236.90 g) was recorded from plots receiving no fertilizer.

An experiment was carried out by Onasanya *et al.* (2009) to evaluate the effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays* L.). The results of the study revealed that, the treatment T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) produced the maximum 1000-grain weight (265.67 g) which was significantly different from rest of the treatments. T_8 (60 kg N ha^{-1} + 40 kg P ha^{-1}) also gave a higher 1000-grain weight over others. The minimum weight of 1000 grains (220.93 g) was obtained from T_1 (control).

2.1.6 Grain yield

Kareem *et al.* (2018) conducted a study to assess growth and yield performances of maize under the influence of inorganic fertilizer, population density and variety. Treatments combinations of two maize varieties (DMR-ESR-Y and Suwan-1-SR), (70 cm × 30 cm) and (100 cm × 40 cm) of plant spacing and three levels of NPK 15: 15: 15 (0, 60 and 120 kg NPK ha^{-1}) revealed that combination of 120 kg N ha^{-1} with DMR-ESR-Y and 47619 plants ha^{-1} could improve dry matter, yield and yield components. Therefore, production of DMR-ESR-Y maize variety with application of120 kg NPK ha^{-1} at population density of 47619 plants ha^{-1} can be used for better maize yield improvement.

Kumar *et al.* (2018) conducted an experiment to study the effect of integrated nutrient management in maize under rain fed condition during kharif season of 2014–15 and 2015–16. The maximum grain yield of maize (50.85, 38.28 q ha^{-1}) was recorded with T_{12} treatment (75 % NPK + FYM @ 6 t ha^{-1} + $ZnSO_4$ @ 25 Kg ha^{-1} as soil application + $FeSO_4$ @ 10 Kg ha^{-1} as soil application); which was significantly superior over all the treatments except T_{10} (75 % NPK + FYM @ 6 t ha^{-1} + $ZnSO_4$ @ 25 Kg ha^{-1} as soil application), T_{11} (75 % NPK + FYM @ 6 t ha^{-1} + $FeSO_4$ @ 10 Kg ha^{-1} as soil application) and T_9 treatment (75 % NPK + FYM @ 6 t ha^{-1}).

Ullah *et al.* (2019) conducted an experiment on October, 2015 at Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh to evaluate two white maize hybrids (PSC121 and KS-510) under five different fertilizer doses 50, 75, 100, 125 and 150% of the recommended dose. Results found that the variety KS510 performed better higher seed yield (7.762 t/ha) than PSC-121 (7.548 t/ha). Recommended dose of fertilizer F_{100} showed higher grain yield (8.284 t/ha) where F_{125} performed better yield (7.998 t/ha) than F_{150} obtained 7.582 (t/ha).

Mahamood *et al.* (2016) conducted a field experiment to evaluate the way of maximizing maize production through nutrient management. Five treatments *viz.* $T_1 = N_{300}\ P_{50}\ K_{150}\ S_{30}$, $T_2 = P_{50}\ K_{150}\ S_{30}$, $T_3 = N_{300}\ K_{150}\ S_{30}$, $T_4 = N_{300}\ P_{50}\ S_{30}$ and $T_5 = N_{300}\ P_{50}\ K_{150}$ were evaluated for this purpose. The result indicated that the highest grain yield (8.37 t ha^{-1}) was found from $T_1 = N_{300}\ P_{50}\ K_{150}\ S_{30}$ treatment. The lowest grain yield (7.33 t ha^{-1}) was obtained from $T_2 = P_{50}\ K_{150}\ S_{30}$ treatment. The gross return (Tk. 1, 00,107 ha^{-1}) and gross margin (Tk. 44,951 ha^{-1}) was higher with T_1 and T_3 treated plot.

Field experiments were conducted in two seasons by Usman *et al.* (2015) 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). Application of fertilizer significantly ($p<0.05$) increased the growth parameters and yield of the component crops in 2013 and 2014. Increasing the quantity of NPK fertilizer resulted in significant increase in the yield and growth parameters of maize and soybean.

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. Among different treatment, treatment F_3 (250-110-85 NPK kg ha^{-1}) produced maximum grain yield (6.03 t ha^{-1}). However, yield of plots of treatment F_3 did not differ statistically when compared with the yield of treatment F_2 (175-80-60 NPK kg ha^{-1}) which was 5.90 t ha^{-1}. Next to follow was treatment F_1 (100-50-35 NPK kg ha^{-1}) with yield of 4.53 t ha^{-1} while the plots without NPK application produced significantly the lowest grain yield (3.25 t ha^{-1}). Treatment F_2 (175-80-60 NPK kg ha^{-1}) seems to be the most appropriate level to obtain maximum grain yield. Too low or high NPK levels reduced the yield and yield parameters of maize crop. Application of NPK beyond treatment F_2 (175-80-60 NPK kg ha^{-1}) seems to be an un-economical and wasteful practice.

An experiment was carried out by Onasanya *et al.* (2009) to evaluate the effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays* L.). The results of the study revealed that, application of 120 kg N ha^{-1} + 40 kg P ha^{-1} (T_{11}) gave the highest significant (P = 0.05) grain yield. This was followed by T_8 (60 kg N ha^{-1} + 40 kg P ha^{-1}). The lowest yield was recorded in the control plot (T_1). The grain yield ranged from 3.08 t ha^{-1} in the control plot (T_1) to 7.13t ha^{-1} in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}).

Adeniyan and Ojeniyi (2005) set up a field experiment to evaluate the comparative effects of 300 kg ha^{-1} NPK 15-15-15 fertilizer, 7 t ha^{-1} poultry manure (Pm), six combinations of reduced levels of NPK 15-15-15 fertilizer and poultry manure, and control (no fertilizer) on maize growth, nutrients uptake and soil chemical properties. Application of poultry manure and combination of poultry manure and or NPK fertilizer significantly increased soil chemical composition, maize plant dry matter yield, grain yield, plant height, leaf area and nutrients uptake. The highest values were recorded from combined use of 3 t ha^{-1} poultry manure and 200 kg ha^{-1} NPK fertilizer in respect to dry matter yield, grain yield and nutrients uptake in maize.

Chandankar *et al.* (2005) conducted a field experiment to evaluate the effects of farmyard manure (FYM at 0 and 5 t ha^{-1}), N∶P ∶K rates (90∶45∶22.5, 120∶60 ∶30 and 150 ∶75 ∶37.5 kg ha^{-1}) and plant density (83,333 and 1,11,111 plants ha^{-1}) on maize yield and economics. The highest NPK rate showed 34.1% higher grain yield over the lowest rate.

Rasheed *et al*. (2004) laid out an experiment to evaluate the effect of nitrogen and sulfur on growth, yield and quality of double cross hybrid (DCH) maize (Cargil-707). Application of fertilizers @ 150 + 30 and 150 + 20 kg of nitrogen and sulfur per hectare respectively greatly increased dry weight per plant (DWP), plant grains number per ear (GNE) and grain weight per ear (GWE) over other treatments. Similarly, the highest grain yield of 8.59 tons per hectare was recorded from the plot fertilized @ 150 kg of N and 30 kg of S per hectare, while maximum grain oil content (GOC) and grain protein contents (GPC) were recorded from plot fertilized @ 150 + 30 and 150 + 20 kg of N and S per hectare, respectively.

2.1.7 Stover yield

Law-ogbomoa and Law-ogbomo (2009) conducted field trials to estimate the effect of NPK 15: 15:15 fertilizer on the growth and yield of maize, which were conducted over a two-year period. The treatments included four NPK fertilizer rates viz. 0 (0 kg N + 0 kg P + 0 kg K), 200 (30 kg N + 13.58 kg P + 24.90 kg K), 400 (60 kg N + 27.16 kg P + 49.80 kg K) and 600 (90 kg N + 40.70 kg P + 74.70 kg K) kg ha^{-1} of compound fertilizer. The results of the trials revealed that the highest stover yield (10.36 t ha^{-1}) was recorded from the maize plants that received 600 kg ha^{-1} NPK fertilizer and the lowest stover yield (4.82 t ha^{-1}) was recorded from the maize plants that received no fertilizers.

Kumar *et al*. (2007) conducted a field experiment to study the fertilizer requirement of sweet corn. Recommended doses of fertilizer (RDF) of grain maize was (150 :75 :37.5 kg ha^{-1} NPK, respectively). Treatment were consisting of varying levels of N, P and K to study the effect of N, P and K levels on sweet corn. The nutrient levels were three levels of N (100%, 75% and 50% RDN of grain maize); two P levels (100% and 75% RDP of grain maize) and three K levels (75%, 100% and 125% RDK of grain maize) and totally 18 different treatment combinations were laid out. They reported that, the treatments that received 100% RDN accounted for higher stover yield than other treatments. The highest being in case of T_{13} which received 100% RDN + 100% RDP + 125% RDK (12.70, 71.04 and 81.40 q ha^{-1} at 30, 60 DAS and at harvest, respectively). The treatment which received only 50% RDN + 75% RDP + 75% RDK recorded the lowest stover yield (10.22, 58.06 and 68.33 q ha^{-1} at 30, 60 DAS and at harvest, respectively).

Singh *et al*. (2013) carried out an experiment at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut (Uttar Pradesh) during 2008- 09. The experiment was laid out in Factorial RBD design with three replications. On succeeding maize crop, 25 treatment combinations comprising of five genotype (V1- Dekalb-Hishell, V2 -Dekalb-Double, V3 -Dekalb-900M-Gold, V4-Dekalb-DKC7074 and V5-Mahyco 3838) and five nitrogen levels (N0, N40, N80, N120 and N160) were imposed. The crop was fertilized with nitrogen as per the treatment (0, 40, 80, 120 and 160 N kg/ha) and uniformly with 60-40-20 P2 O5, K2 O and ZnSO4 kg/ha. Dekalb 900M Gold had significantly superior yield attributes, highest stover yield (8550 kg/ ha) over other genotypes and crop fertilized with 160 kg N/ha showed significantly highest stover yield (8630 kg/ha) than those given 40 kg N/ha or no nitrogen.

2.1.8 Biological yield

Dong *et al*. (2016) carried out an experiment to evaluate the effects of new coated release fertilizer on the growth of maize. To improve the use efficiency of inorganic fertilizers through the use of coated fertilizer and nitrification inhibitors, 3 newly developed fertilizers (FCRF1: coated fertilizer + 1% DCD, FCRF2: coated fertilizer + 2% DCD and FCRF3: coated fertilizer + 4% DCD) amended with nitrification inhibitors (DCD, $C_2H_4N_4$) and coated with fly ash were prepared by coating conventional compound fertilizer (N-P-K: 15 - 6.55 - 12.4). Using a coated fertilizer (resin coated compound fertilizer, N-P-K: 15 - 6.55 - 12.4, 90 day, CRF) and a conventional compound fertilizer (CCF) as checks, their effects on physiological characteristics, yield and quality of maize were examined in that field experiment. The results indicated that, compared to CCF, 3 new developed fertilizers kept higher ammonium nitrogen (NH_4^+-N) and nitrate nitrogen (NO_3^--N) content at later stages and FCRF3 had the highest content, being similar to CRF treatment. At tasselling stage (TS) and filling stage (FS), the chlorophyll content, photosynthetic rate, transpiration rate and chlorophyll fluorescence parameters were significantly increased upon FCRF1, FCRF2 and FCRF3 treatments. In addition, FCRF1, FCRF2 and FCRF3 treatments produced 24.0%–35.8% more grain yield, 57.2%–74.4% more total yield, increased 11.20%–49.55% starch, 61.38%–113% protein and 2.67%–9.33% Vitamine C content than CCF, respectively.

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. Among different NPK levels treatment F_3 (250-110-85 NPK kg ha^{-1}) gave the maximum biological yield (16.83 t ha^{-1}) as compared to rest of the treatments. Treatment F_3 was however, statistically at par with treatment F_2 (175-80-60 NPK kg ha^{-1}) (16.23 t ha^{-1}). Next to follow was the treatment F_1 (100-50-35 NPK kg ha^{-1}) (13.69 t ha^{-1}) and minimum biological yield was produced in treatment F_0 (10.81 t ha^{-1}).

2.1.9 Harvest index

Khan *et al.* (2017) set up an experiment to evaluate the effect of sheep manure (SM), its application timing (AT) and N fertilizer (urea) on dry matter partitioning and harvest index in maize. The study was conducted on RCBD split plots arrangement at Agronomic research farm, The University of Agriculture Peshawar, Pakistan during 2015. Sheep manure (SM1=3 t ha^{-1}, SM2=4 t ha^{-1}, SM3=5 t ha^{-1}) and application timing (AT1=15 days before sowing, AT2=At sowing time) were allotted to main plots however, fertilizer N (N1=0 kg ha-1, N2= 90 kg ha-1, N3=120 kg ha-1) were applied to sub-plots. Application of 5 t ha-1 of sheep manure at 15 days before sowing significantly enhanced pre-tasseling (stem and leaves) and physiological maturity (stem, leaves, cobs and grains) dry matter partitioning and harvest index. Pre-tassel and physiological maturity dry matter accumulation were higher with application of 120 kg N ha-1 however, Application of 5 t sheep manure ha-1 at 15 days before sowing and 120 kg N ha-1 observed higher dry matter accumulation and harvest index in maize.

Asghar *et al*. (2010) conducted a field study to investigate the effect of different NPK rates on growth and yield of maize cultivars viz. Golden and Sultan. Among different treatments, treatment F_2 (175-80-60 NPK kg ha^{-1}) resulted in higher harvest index (36.47%) but this treatment is statistically at par with treatment F_3 (250-110-85 NPK kg ha^{-1}) harvest index (35.96%), treatment F_3 is also statistically similar to treatment F_1 (100-50-35 NPK kg ha^{-1}) harvest index (33.19%). Similarly, treatment F_1 is statistically at par with treatment F_0 results (30.25%).

2.2 Effect of leaf clipping on maize

2.2.1 Plant height

Rokon *et al.* (2019) conducted a study to investigate the effect of leaf clipping and population density on fodder and grain yield in maize. Three population densities (D_1 = 75 cm × 25 cm, D_2 = 60 cm × 20 cm and D_3 = 50 cm × 20 cm) and three clipping treatments (C_1 = no clipping, C_2 = removal of all leaf blades below the lowermost cob and C_3 = removal of all leaf blades above the uppermost cob) at the silking stage were included as experimental treatments. Results revealed that D_1 required the maximum days to attain most of the phenological stages of maize. Higher population density (D_3) with C_3 clipping treatment gave the highest plant height, whereas D_1 with non-clipping treatment gave the lowest plant height.

Khaliliaqdam *et al.* (2012) set up an experiment to evaluate the influence of leaf defoliation on agronomical trials of corn (*Zea mays* L.). The experiment consisting of three growth stages of maize (vegetative, tasselling and flowering) and five levels of leaf defoliation (0, 25, 50, 75 and 100%). Results revealed that plant height and ear height was significantly affected by leaf defoliation.

2.2.2 Total dry matter

Rokon *et al.* (2019) conducted a study to investigate the effect of leaf clipping and population density on fodder and grain yield in maize. Three population densities (D_1 = 75 cm × 25 cm, D_2 = 60 cm × 20 cm and D_3 = 50 cm × 20 cm) and three clipping treatments (C_1 = no clipping, C_2 = removal of all leaf blades below the lowermost cob and C_3 = removal of all leaf blades above the uppermost cob at the silking stage were included as experimental treatments. Results revealed that D_1 required the maximum days to attain most of the phenological stages of maize. Highest total dry matter (TDM) was found in D_2 with C_1 and the lowest was found in D1 with C_1 treatment.

Ahmed *et al.* (2015) carried out a field experiment on hybrid maize to evaluate leaf clipping effect on grain and fodder yield of hybrid maize. Six treatments namely, T_1 =no leaf clipping (control), T_2 = all leaves clipping above cob, T_3 = all leaves clipping below cob, T_4 = T_2 + stem clipping above cob, T_5 = all leaves clipping, T_6 = keeping only ear leaf but other leaves clipping were used as treatments variable in that study. Leaves clipping were done at 20 days after silking. Leaf clipping provided a remarkable amount of fodder yield but it reduced total dry matter production as well as cob dry weight, which ultimately reduced grain yield.

Sharifi and Tajbakhsh (2007) set up an experiment to evaluate the effect of plant density and detopping on grain yield, protein content, biological yield, harvest index, growth indices, number of cob in each plant, No. of row per cob, No. of grain in each row, thousand grain weight of corn (*Zea mays* L. var. KSC 704). The treatments comprised of plant density at three levels (53000, 66000, and 88000 Plants ha^{-1}) and the detopping at three levels: (1) no detopping (control) (2) removing canopy only and (3) removing canopy and three leaves above the node. Analysis of Variance of data showed that both detopping treatment and plant density influenced total dry weight of biomass.

Tollenaar and Daynard (1982) from their experiment on effect of source-sink ratio on dry matter accumulation and leaf senescence of maize reported that dry matter accumulation during the grain-filling period could decline due to either an extremely high or extremely low source-sink ratio.

Egharevba *et al.* (1976) carried out an experiment on dry matter accumulation in maize in response to defoliation. They observed that defoliation significantly reduces dry matter accumulation and complete defoliation is more detrimental than partial defoliation.

2.2.3 Number of cobs m^{-2}

Sharifi and Tajbakhsh (2007) set up an experiment to evaluate the effect of plant density and detopping on grain yield, protein content biological yield, growth indices, number of cob in each plant, No. of row per ear, No. of grain in each row, thousand seed weight of corn (*Zea mays* L. var. KSC 704). The treatments comprised of plant density at three levels (53000, 66000, and 88000 Plants ha^{-1}) and the detopping at three levels: (1) no detopping (control) (2) removing canopy only and (3) removing canopy and three leaves above the node. The highest plant density evaluated, 88,000 plants ha^{-1} with detopping of three above leaves had the highest number of cobs m^{-2}.

2.2.4 1000-seeds weight

Jalilian and Delkhoshi (2014) conducted an experiment in order to study the role of leaf position on yield and yield component of maize. For determining the role of leaf position in maize yield, the leaf removing (clipping) treatments was used. Leaf clipping treatments contain ear leaf clipping, above ear leaf clipping, below ear leaf clipping and control (without leaf clipping) that imposed at one week after ear initiation. Leaf removing had a significant effect on all measured traits (number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield). The highest 1000-seed weight (274 g) was observed in plants without leaf clipping. Ear leaf clipping and below ear leaf defoliation ranked second for 1000-seed weight. The correlation analysis showed that all traits had positive correlation with seed yield. The most correlation was between ear length and number of row per ear (r = 0.89**). Also, number of seed per row (r = 0.71**), 1000-seed weight (r = 0.67**), ear length (r = 0.65**) showed the most correlation with seed yield, respectively.

Khaliliaqdam*et al.* (2012) set up an experiment to evaluate the influence of leaf defoliation on agronomical trials of corn (*Zea mays* L.). The experiment consisting of three growth stages of maize (vegetative, tasselling and flowering) and five levels of leaf defoliation (0, 25, 50, 75 and 100%). Interaction of leaf defoliation × growth stage on 1000-grain weight was significant. Leaf defoliation diminished 1000-grain weight in all growth stages.

2.2.5 Grain Yield

Liu *et al.* (2020) carried out a field experiment to study the effects of leaf removal on maize morphology and grain yield. Increasing planting density is an important practice associated with increases in maize yield, but densely planted maize can suffer from poor light conditions. In a two-year field experiments, two morphologically different cultivars, ZD958 (less compact) and DH618 (more compact), were planted at 120,000 plants ha^{-1} and 135,000 plants ha^{-1}, respectively. Different leaf area index (LAI) treatments which were established by removing leaves three days after silking: (1) control, no leaves removed (D_0), (2) the two uppermost leaves removed (D_1), (3) the four uppermost leaves removed (D_2), (4) the leaves below the third leaf below the ear removed (D_3), (5) the leaves of D_1 and D_3 removed (D_4) and (6) the leaves of D_2 and D_3 removed (D_5). Optimal leaf removal improved light distribution, increased photosynthetic capacity and the post-silking source-sink ratio, and thus the grain yield, with an average LAI of 5.9 (5.6 and 6.2 for ZD958 and DH618, respectively) for the highest yields in each year. Therefore, less-compact cultivars should have smaller or fewer top most leaves or leaves below the ear that quickly senesce post-silking, so as to decrease leaf area and thus improve light distribution and photosynthetic capacity in the canopy under dense planting conditions. However, for more compact cultivars, leaves below the ear should senesce quickly after silking to reduce leaf respiration and improve the photosynthetic capacity of the remaining top residual leaves.

Rokon *et al.* (2019) conducted a study to investigate the effect of leaf clipping and population density on fodder and grain yield in maize. Three population densities (D_1 = 75 cm × 25 cm, D_2 = 60 cm × 20 cm and D_3 = 50 cm × 20 cm) and three clipping treatments (C_1 = no clipping, C_2 = removal of all leaf blades below the lowermost cob and C_3 = removal of all leaf blades above the uppermost cob) at the silking stage were included as experimental treatments. Results revealed that D_1 required the maximum days to attain most of the phenological stages of maize. The highest yield (8.88 t ha^{-1}) were found in D_3 treatment whereas the lowest yield (5.92 t ha^{-1}) in D_1 population density. The highest yield (8.33 t ha^{-1}) were obtained from C_1 treatment and the lowest yield (6.55 t ha^{-1}) were obtained from C_3 treatment. The highest fodder yield (3.33 t ha^{-1}) was obtained from D_3 treatment and the lowest (2.11 t ha^{-1}) in D_1 treatment. In C_2 treatment, the highest amount of fodder (4.67 t ha^{-1}) was obtained. The interaction between population density and leaf clipping treatment showed a significant variation among the yield and yield attributes in maize. It was recorded from the field that D_3 and C_1 combination showed the best performance in respect of grain yield (9.67 t ha^{-1}) of maize. However, for both grain and fodder yield, D_3 with C_2 showed the best performance.

Ahmed *et al.* (2007) carried out a field experiment on hybrid maize to evaluate leaf clipping effect on grain and fodder yield of hybrid maize. Six treatments namely, T_1 = no leaf clipping (control), T_2 = all leaves clipping above cob, T_3 = all leaves clipping below cob, T_4 = T_2 + stem clipping above cob, T_5 = all leaves clipping, T_6 = keeping only ear leaf but other leaves clipping were used as treatments variable in that study. Leaves clipping were done at 20 days after silking. The highest grain yields (11.66, 10.15 and 10.75 t ha^{-1}) were recorded in no leaf clipping treatment (control) while the lowest (5.59, 5.22 and 4.90 t ha^{-1}) in all leaves clipping treatment. The highest fodder yields (10.71, 9.95 and 9.07 t ha^{-1}) were recorded in all leaves clipping treatment but it reduced grain yield drastically (49 to 54%). The lowest fodder yields (3.47, 4.40 and 5.06 t ha^{-1}) were recorded in all leaves clipping above cob treatment. Grain yields were less affected (6.09% to 14.28% reduction) by all leaves clipping below cob treatment, which provided about 6 ton fodders ha^{-1} in addition to grain yield. Therefore, all leaves clipping below cob at 20 days after silking would be an option for the farmers who usually practice leaf clipping in maize for fodder purpose.

Jalilian and Delkhoshi (2014) conducted an experiment in order to study the role of leaf position on yield and yield component of maize. For determining the role of leaf position in maize yield, the leaf removing (clipping) treatments was used. Leaf clipping treatments contain ear leaf clipping, above ear leaf clipping, below ear leaf clipping and control (without leaf clipping) that imposed at one week after ear initiation. Removing of above leaves decreased 6.68% the number of grain on cob compare to control**.** Whereas plants without any leaf clipping had the utmost seed yield (8.77 t ha^{-1}) but defoliating of leaf above ear lead to lower seed yield (6.77 t ha^{-1}). Results revealed that the most reduction in all traits accrued in maize plants with above ear leaf clipping, this indicated that the important roles of leaves position especially the role of above ear leaves in yield and yield components of maize.

Khaliliaqdam *et al.* (2012) set up an experiment to evaluate the influence of leaf defoliation on agronomical trials of corn (*Zea mays* L.). The experiment consisting of three growth stages of maize (vegetative, tasselling and flowering) and five levels of leaf defoliation (0, 25, 50, 75 and 100%). Interaction of leaf defoliation × growth stage on seed depth and grain yield was significant. Leaf defoliation diminished grain yield in all growth stages.

Faruque *et al.* (2007) carried out a field experiment to evaluate the different source-sink manipulation technique on the grain and fodder yield of hybrid maize. Six source-sink manipulation treatments viz. T_1 = no leaf (source) or cob/ear (sink) removal (control), T_2 = maintaining apical ear with sub-apical ear (s) removal, T_3 = maintaining apical ear with removal of all sub-apical ear(s) and leaves below apical ear leaf, T_4 = removal of all leaves below ear leaf, T_5 = maintaining apical ear with sub-apical ear(s) removal and detopping (keeping two leaves above ear) and T_6 = detopping (keeping two leaves above ear). Source-sink manipulation (detopping, leaf and ear removal) was done at 10 days after silking. Grain yield was significantly affected by different source-sink manipulation treatments. The highest grain yield (9.5 to 9.7 t/ha) was obtained from control (T_1) treatment while the lowest (7.5 to 7.8 t/ha) in T_3 treatment. Fodder yield varied among different treatments. The highest fodder yield was recorded in T_3 treatment with the highest grain yield reduction (20%) and the lowest fodder yield was recorded in T_6 treatment with the lowest grain yield reduction (1.33 to 2%). Results revealed that detopping (keeping two leaves above ear) at 10 days after silking could provide a remarkable amount of fodder (5 to 6 t/ha) without a significant grain yield reduction (1.33 to 2%) of hybrid maize.

Sharifi and Tajbakhsh (2007) set up an experiment to evaluate the effect of plant density and detopping on grain yield, protein content biological yield, growth indices, number of cob in each plant, No. of row per ear, No. of grain in each row, thousand seed weight of corn (*Zea mays* L. var. KSC 704). The treatments comprised of plant density at three levels (53000, 66000, and 88000 Plants ha^{-1}) and the detopping at three levels: (1) no detopping (control) (2) removing canopy only and (3) removing canopy and three leaves above the node. Analysis of Variance of data showed that both detopping treatment and plant density influenced the number of kernel per ear, ear weight, seed yield. Canopy detopping led to a marked increase in photo-assimilation import grains. In plant density of 53,000 plants ha^{-1} and canopy detopping treatment, the number of grain ear^{-1} was greater than other densities. It was concluded that major increase in grain yield under high plants density and tassel detopping was due to improvement of physiological indices.

Subedi and Ma (2005) carried out a field experiment to determine whether additional leaves above the ear in a Leafy hybrid contribute more to grain yield than in a conventional hybrid and to assess the importance of individual leaves above and below the ear. At silking, 10 defoliation treatments were imposed in a conventional (Pioneer 3893) and a Leafy (Maizex LF850-RR) hybrid. Total number of leaves per plant, position of the primary ear height, and the area and DM of each removed leaf were measured at silk stage. At physiological maturity, number of kernels per plant, kernel DM and whole plant DM were determined. Removal of all leaves below the ear-leaf and ear-leaf alone in the conventional hybrid caused 19% to 26% and 17% to 25% reduction in grain yield, respectively, while there was no any notable effect of these treatments in the Leafy hybrid. When all leaves above the ear-leaf were removed, kernel number and kernel DM were reduced by 84% to 94% in the Leafy hybrid compared with a 40% to 50% reduction in the conventional hybrid.

Yao *et al.* (1991) from their research work on effect of intensity and timing of defoliation on growth, yield components and grain yield in maize concluded that the magnitude of yield reduction was affected by the time and severity of leaf removal.

Elsahookie and Wuhaib (1988) conducted an experiment to study the effect of leaf clipping on maize (*Zea mays* L.) performance. Nine different treatments were tested on an open-pollinated genotype of maize. The treatments were; a) clipping off upper half leaves (CUL), b) clipping off lower half leaves (CLL), c) clipping off all leaves (CAL), d) clipping off the upper plant half but not the lower leaves (CUP), e) clipping off the upper plant half and lower leaves (CUPLL), f) pulling off the three apical leaves with clipping off lower leaves (PALCLL), g) pulling off the three apical leaves but not the lower leaves (PAL), h) clipping off the whole plant at 4–5 cm above ground surface (CWP) and i) the control treatment. Clipping of leaf and plant was done when plants were at 6–8 leaves stage. In the spring grown maize, grain yield plant^{-1} was increased up to 38% for plants with their upper half leaves cut. Root weight plant^{-1} was also increased. Cutting the whole plant decreased grain yield and caused death of about 50% of plants. Meanwhile, leaf clipping decreased several agronomic traits in the fall grown maize.

Hicks *et al.* (1977) conducted an experiment to determine the effect of leaf blade defoliation at varying stages of development on corn grain yield, test weight, kernel weight, shelling percentage, and ear moisture content at harvest. Plants were completely defoliated (blade only) at the five-leaf stage (LS). Both 50 and 100% of leaf blades were removed at 13 LS, tasselling, early milk, and full dent growth stages. The 3-year study included two hybrids, a full-season [115 relative maturity (RM)] and a short-season (90 RM) hybrid. Complete leaf removal of the 90-RM hybrid at the five LS caused an average 48% grain yield increase compared with no defoliation. The same treatment caused an average 7% yield reduction of the 115-RM hybrid. At later defoliation dates, grain yield reductions were greater for plants that were 100% defoliated than for plants that were 50% defoliated. The yield responses to defoliation at various stages of development for both 50 and 100% leaf blade removal were similar for the 90- and 115-RM hybrids. Although yield reductions were comparable when the two hybrids were 100% defoliated for all stages of development, 50% defoliation did not cause as great a yield reduction on the 90-RM hybrid as it did on the 115-RM hybrid.

Tollenaar and Daynard (1978) conducted to evaluate the effect of leaf removal on kernel dry matter accumulation, kernel moisture content, and rate of black layer formation in kernels, in relation to changes in soluble-solid content of the stem of maize (*Zea mays* L.). In 1970, defoliation was begun at mid-silking and continued at 2-wk intervals until 6 wk after mid-silking. The treatments consisted of (l) no leaf removal, (2) 50Vo of leaf blades removed, and (3) all leaf blades removed. In 1971, a treatment with complete leaf remova at 1 week after mid-silking was added. Kernel number was greatly affected by the treatments during the first 2 week after mid-silking, whereas later defoliation affected mainly kernel weight. Soluble-solid content in the stem declined rapidly after leaf removal, indicating an accelerated utilization of soluble carbohydrates from the stem for grain growth. Maturity, expressed as both kernel-moisture content and rate of black layer formation, was affected significantly by the defoliation treatments. The data presented indicate that a decrease in the source-sink ratio during grain-filling advances date of maturity.

Hanway (1969) conducted an experiment on defoliation effects on corn (*Zea mays* L.) hybrids as influenced by plant population and stage of development and reported that a 50% defoliation at 10th leaf, 16th leaf and blister stage reduced the average yield to 85, 75, and 80 % of the check, respectively. Removal of all leaves at these stages decreased the average yield by 30%, 98%, and 69%, respectively.

Dungan (1930) from his study in relation of blade injury to the yielding ability of corn plants found that complete defoliation, when 56% of the plants had silked, decreased yield by 92% and complete defoliation at the dent stage had no effect on yield.

2.2.6 Biological Yield

Jalilian and Delkhoshi (2014) conducted an experiment in order to study the role of leaf position on yield and yield component of maize. For determining the role of leaf position in maize yield, the leaf removing (clipping) treatments was used. Leaf clipping treatments containing ear leaf clipping, above ear leaf clipping, below ear leaf clipping and control (without leaf clipping) were imposed at one week after ear initiation. Leaf removing had a significant effect on all measured traits (number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield and biological yield). Leaf removal above ear decreased 22.80% biological yield compared to control.

2.2.7 Harvest Index

Rokon *et al.* (2019) conducted a study to investigate the effect of leaf clipping and population density on fodder and grain yield in maize. Three population densities (D_1 = 75 cm × 25 cm, D_2 = 60 cm × 20 cm and D_3 = 50 cm × 20 cm) and three clipping treatments (C_1 = no clipping, C_2 = removal of all leaf blades below the lowermost cob and C_3 = removal of all leaf blades above the uppermost cob) at the silking stage were included as experimental treatments. Results revealed that the highest harvest index (36.2%) was recorded in D_3 treatment whereas the lowest harvest index (32.6%) was in D_2. The highest harvest index (35.5%) were obtained from C_1 treatment and the lowest harvest index (33.5%) were obtained from C_3 treatment. The interaction between population density and leaf clipping treatment showed a significant variation among the yield and yield attributes in maize. It was recorded from the field that $D_3$and C_1 combination showed the best performance in respect of harvest index (38.3 %) of maize.

Jalilian and Delkhoshi (2014) conducted an experiment in order to study the role of leaf position on yield and yield component of maize. For determining the role of leaf position in maize yield, the leaf removing (clipping) treatments was used. Leaf clipping treatments contain ear leaf clipping, above ear leaf clipping, below ear leaf clipping and control (without leaf clipping) that imposed at one week after ear initiation. Leaf removing had a significant effect on all measured traits (number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield, biological yield), except harvest index. Harvest index (r = 0.59**) showed significant correlation with seed yield.

Sharifi and Tajbakhsh (2007) set up an experiment to evaluate the effect of plant density and detopping on grain yield, protein content biological yield, harvest index, growth indices, number of cob in each plant, No. of row per ear, No. of grain in each row, thousand seed weight of corn (*Zea mays* L. var. KSC 704). The treatments comprised of plant density at three levels (53000, 66000, and 88000 Plants ha^{-1}) and the detopping at three levels: (1) no detopping (control) (2) removing canopy only and (3) removing canopy and three leaves above the node. Analysis of Variance of data showed that both detopping treatment and plant density influenced harvest index. The efficiency of harvest index increased under corn detopping compared with control and this increase with an increase in photosynthesis contributed to grain yield.

2.3 Interaction effects of fertilizer doses and leaf clipping on maize

Kolari *et al.* (2014) carried out an experiment to study yield, yield component phenological and growth aspects of NS640 variety of maize. Factor were five defoliation rates, D: (0, 20, 40, 60, 80 %), two nitrogen levels, N: (0 and 150 kg/ha) and two vermicompost levels, V: (0 and 150 ton/ha). Days to 4th, 8th and 11th leaf appearance, day to anthesis, days to silking, leaf area index, leaf dry weight, stem dry weight, total dry matter accumulation, kernel/ear, 100 kernels weight and ear yield was measured. Results showed that applying vermicompost decreased the needed time for 8th and 11th leaves appearance. Days to tasselling was not affected by applied treatment but applying vermicompost accelerates silking stage. The highest dry matter production belonged to 40% defoliation rate. Applying nitrogen and vermicompost had a compensation effect on leaf elimination. Kernel/ear and 100 kernels weight was higher by application of nitrogen and vermicompost. The highest ear yield produced by 60% defoliation rate. Results showed that adequate defoliation may enhance ear yield and nitrogen and vermicompost could compensate lower leaf number in defoliated plants.

Remison and Omueti (1982) planted a field experiment to examine the effect of leaf clipping after mid-silk on yield and protein content of maize (*Zea mays* L.) cultivar 'Farz 23'. Planting of maize seed was completed without ridges on the flat at the rate of two seeds per hole, which later thinned after 2 week to one seedling per stand. Six defoliations and two nitrogen treatments were used. The following defoliation treatments were applied from 7 days after 50% silk on plants: control, in which no leaves were removed (D_0); half leaves below ear removed (D_1); all leaves below ear removed (D_2); half leaves above ear removed (D_3);all leaves above ear removed (D_4) and all leaves on plant removed (D_5). Nitrogen treatments comprised the application of 100 kg N ha^{-1} in the form of ammonium sulphate (N_1) and the unfertilized control (N_0). Nitrogen fertilization increased ear weight, grain weight, total plant weight and crude protein content by 26, 25, 24 and 11%, respectively. Harvest index, moisture and ash contents were unaffected. The effects of defoliation on weight of ears, grains and total weight per plant were similar. Generally, removing all leaves and leaves above the ear were the most severe in reduction of these traits. Removing half or all leaves below the ear had no significant effect on these yield components. Similarly, harvest index and moisture content were reduced significantly compared with the control (no leaves removed) by removing all leaves on the plant (D_5) and all leaves above the ear (D_4). On the other hand, protein content increased for D_4 and D_5 treatments. The removal of leaves above the ear affected yield trait and harvest index more than the removal of all leaves below the ear presumably because the lower leaves senesced faster especially in plots where nitrogen fertilizer was not applied.

CHAPTER III

MATERIALS AND METHODS

This chapter presents a brief description about experimental period, site description, climatic condition, crop or planting materials, treatments, experimental design, crop growing procedure, intercultural operations, data collection and statistical analyses.

3.1 Experimental period

The experiment was conducted during the period from July to November 2018 in Kharif-II season.

3.2 Site description

3.2.1 Geographical location

The experiment was conducted at the Agronomy field of Sher-e-Bangla Agricultural University (SAU). The experimental site is geographically situated at 23°77′ N latitude and 90°33′ E longitude at an altitude of 8.6 meter above sea level.

3.2.2 Agro-Ecological Zone

The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. 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. For better understanding about the experimental site has been shown in the Map of AEZ of Bangladesh in Appendix-I.

3.3 Climate

The climate of the experimental site 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). Meteorological data related to the temperature, relative humidity and rainfall during the experiment period of was collected from Bangladesh Meteorological Department (Climate division), Sher-e-Bangla Nagar, Dhaka and has been presented in Appendix-III.

3.4 Soil

The soil of the experimental field belongs to the General soil type, Shallow Red Brown Terrace Soils under Tejgaon soil series. Soil pH ranges from 5.4–5.6. The land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0–15 cm depths were collected from the experimental field. The soil analyses were done at Soil Resource and Development Institute (SRDI), Dhaka. The physicochemical properties of the soil are presented in Appendix II.

3.5 Planting materials and features

Seeds: For this research work the seeds of white maize SAUD 18-3-3 were collected from White maize project, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

Identifying character: SAUD 18-3-3 is a improved white maize genotype, further several trials it has been released as a variety named SAU White Maize 3 which is bold grain quality and drought tolerant, stay green at maturity. Crop duration: short duration, 110–120 days. Plant height: 180-200cm. Suitable for rabi and kharif season. Grain colour: White, 1000 grains weight**:** 280–310 g, Yield: 8.20–10.50 t ha^{-1}.

Source: Personal communication with Prof. Dr. Md. Jafar Ullah, Dept.of Agronomy, SAU, Dhaka.

3.6 Collection of Fertilizer

Urea, TSP, MOP, Gypsum, $ZnSO_4$, Boric Acid, Cowdung and vermicompost. Vermicompost was collected from a project named — Krishan Ghor Agro, Shonamukhi Bazar, Kazipur, Sirajgonj. All chemical fertilizer and cowdung were collected from the farm office of Sher-e-Bangla Agricultural University (SAU).

3.7 Experimental treatments

There were two sets of treatments in the experiment. The treatments were fertilizer doses and leaf removal. Those are shown below:

Factor A: Fertilizer doses (4 levels)

i. F_0 – No fertilizer application (Control),

ii. F_r – Recommended dose of fertilizer (100 %)*,

iii. F_1 – 25% more thanrecommended dose offertilizer (125 %) and

iv. F_2 – 25% less than recommended dose offertilizer (75 %).

***The Recommended dose of fertilizer**: Urea, Triple Super Phosphate (TSP), Muriate of potash (MOP), Gypsum, Zinc sulphate and Boric acid at the rate of 500-250-200-250-15-5 kg ha^{-1} following (BARI, 2011). The whole amounts of fertilizers were applied as basal doses except Urea. Only one-third of Urea was applied as basal doses and the rest amount was applied at 15 DAS interval for three instalments.

Factor B: Leaf removal (4 levels)

i. C_{sa} – 4 Leaves clipping above cobs at silking stage,

ii. C_{sb} – 4 Leaves clipping below cobs atsilking stage,

iii. C_{ga} – 4 Leaves clipping above cobs at grain filling stage and

iv. C_{gb} – 4 Leaves clipping below cobs atgrain filling stage.

3.7.1 Treatment combinations

This two factor experiments were included 16 treatment combinations.

F_0C_{sa}	:	No fertilizer application × 4 Leaves clipping above cobs at silking stage
F_0C_{sb}	:	No fertilizer application × 4 Leaves clipping below cobs at silking stage
F_0C_{ga}	:	No fertilizer application × 4 Leaves clipping above cobs at grain filling stage
F_0C_{gb}	:	No fertilizer application × 4 Leaves clipping below cobs at grain filling stage
F_rC_{sa}	:	Recommended dose of fertilizer × 4 Leaves clipping above cobs at silking stage
F_rC_{sb}	:	Recommended dose of fertilizer × 4 Leaves clipping below cobs at silking stage
F_rC_{ga}	:	Recommended dose of fertilizer × 4 Leaves clipping above cobs at grain filling stage
F_rC_{gb}	:	Recommended dose of fertilizer × 4 Leaves clipping below cobs at grain filling stage
F_1C_{sa}	:	25% more than recommended dose of fertilizer× 4 Leaves clipping above cobs at silking stage
F_1C_{sb}	:	25% more than recommended dose of fertilizer × 4 Leaves clipping below cobs at silking stage

F_1C_{ga}	:	25% more than recommended dose of fertilizer × 4 Leaves clipping above cobs at grain filling stage
F_1C_{gb}	:	25% morethan recommended dose of fertilizer× 4 Leaves clipping below cobs at grain filling stage
F_2C_{sa}	:	25% less than recommended dose of fertilizer × 4 Leaves clipping above cobs at silking stage
F_2C_{sb}	:	25% less than recommended dose of fertilizer × 4 Leaves clipping below cobs at silking stage
F_2C_{ga}	:	25% less than recommended dose of fertilizer × 4 Leaves clipping above cobs at grain filling stage
F_2C_{gb}	:	25% less than recommended dose of fertilizer × 4 Leaves clipping below cobs at grain filling stage

3.7.2 Experimental design

The experiment was laid out in Completely Randomized Design with (CRD) with five replications. Total 80 unit pots will be made for the experiment with 16 treatments. Each pot will be of required size.

3.8 Detail of experimental preparation

3.8.1 Preparation of the pot

Earthen pots of having 12 inches' diameter, 12 inches' height with a hole at the centre of the bottom were used. Silt soil was used in the experiment. The upper edge diameter of the pots was 30 cm (r=15 cm). Each pot was filled with the soil (15 kg in each pot) on 1 July 2018. The soil of the pots was mixed with fertilizers as per the treatment using the recommended dose of 500-250-200-250-15-5 kg ha^{-1} urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid following BARI (2011). While filling with soil, the upper one inch of the pot was kept vacant so that irrigation can be provided using a hose pipe. As such the diameter of the upper soil surface was 15 inch (30 cm) and the area of the upper soil surface was (πr^2 = 3.14x 0.015x 0.015=0.07 m^2). Fertilizer was calculated following the above mentioned rate and was mixed with the soil before sowing the seeds.

3.8.2 Sowing of seeds in the pot

The seeds of SAUD 18-3-3 were sown in the pot on 05 July 2018 having a depth of 4–5 cm. During seed sowing 0.5 g Bavistin were mixed with seeds. The seed was sowing in 3 seeds $hole^{-1}$.

3.9 Intercultural operations

3.9.1 Irrigation

Although the crop was grown in kharif II season when the rainfall supplies most of the moisture demands. However, in dry spell some irrigation needed to provide as the experiment was set in pots. Irrigation was provided when the top soil of 90% of the pots dried. First irrigation was given on 5 August, 2018 which was 30 days after sowing, Second irrigation was given on 6 September, 2018 which was 60 days after sowing and third irrigation was given on 5 October, 2018 which was 90 days after sowing.

3.9.2 Weeding and thinning

During plant growth period one thinning and two weeding were done, thinning was done on 21 July, 2018 which was 16 days after sowing and the weeding was done on 10 August, 2018 and 10 September which was 35 and 65 days after sowing.

3.9.3 Earthing up

Earthing up was done on 5 August, 2018 which was 30 days after sowing. It was done to protect the plant from lodging and for better nutrition uptake.

3.9.4 Pest and disease control

Insecticides Diazinon 60 EC @ 2 ml $litre^{-1}$ water was sprayed to control Stem borer and Ripcord 10 EC @ 2 ml $litre^{-1}$ water were sprayed to control earworm to protect the crop. Diseased or off type plants were uprooted as and when required.

Major diseases and Management

Diseases: Mainly leaf blight disease occurs at vegetative stage.

Management: Clean cultivation with timely sowing and balance fertilizer application. 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 Earworm attack in cob at reproductive stage in maize.

Management

For cutworm: The larvae were 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 @ 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

3.9.5 General observations of the experimental site

Regular observations were made to see the growth stages of the crop. In general, the pot looked nice with normal green plants, which were vigorous and luxuriant.

3.9.6 Crop sampling and data collection

One pot from each replication were randomly selected and marked with sample card. Plant height and leaf area along with other data were recorded from selected plants both at vegetative, reproductive stage and harvesting time.

3.10 Harvesting, threshing and cleaning

The mature cobs 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 pot were separately harvested for recording yield attributes and other data. Harvesting was done on 4, November 2018.

3.11 Drying

The harvested products were taken on the threshing floor and it was dried for about 3–4 days.

3.12 Collection of data

Data were collected on the following parameters-

A. Crop growth characters

1. Plant height (cm) at 30, 60, 90 DAS and at harvest
2. Leaf area plant^{-1} (cm^2) at 90 DAS
3. Leaf dry weight plant^{-1} (g) at harvest
4. Stem (node+internode) dry weight plant $^{-1}$ (g) at harvest
5. Average single node unit dry weight plant^{-1} (g) at harvest

B. Yield contributing characters

1. Cob length (cm)
2. Cob circumference (cm)
3. Number of cobs plant^{-1} (no.)
4. Number of grain rows cob^{-1} (no.)
5. Number of grains cob^{-1} (no.)
6. Grain weight cob^{-1} (g)
7. Shell+Chaff weight cob^{-1} (g)
8. Shelling (%)
9. Weight of 1000 grains (g)

C. Yield characters

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

3.13 Procedure of recording data

A brief outline on data recording procedure followed during the study is given below:

3.13.1 Plant height

At different stages of crop growth 30, 60, 90 DAS and harvesting time the height of selected plants pot^{-1} was measured from ground level to the tip of the plant portion and the mean value of plant height was recorded in cm.

3.13.2 Leaf area plant^{-1}

Leaf area was measured from leaf length and leaf breadth from each plants and then averaged as leaf area/plant in cm^2.

3.13.3 Leaf dry weight plant^{-1}

From each pot 1 plant were uprooted randomly. Then the leaves, stem and roots were separated. Leaves were separated from the shoot sliced into very thin pieces and put into envelop and placed in oven maintaining 70°C for 72 hours. Then the shoot sample was transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. It was performed at harvesting stage.

3.13.4 Stem (node+internode) dry weight plant^{-1}

From each pot 1 plant were uprooted randomly. Then the leaves, bud, appendages were separated. The sample (node with internode) was sliced into very thin pieces and put into envelop and placed in oven maintaining 70°C for 72 hours. Then the sample was transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. It was performed after harvesting of plant.

3.13.4 Average Single node unit dry weight plant^{-1}

From each pot 1 plant were uprooted randomly. Then nodes are separated. The sample was sliced into very thin pieces and put into envelop and placed in oven maintaining 70°C for 72 hours. Then the sample was transferred into desiccators and allowed to cool down at room temperature. The final weight of the sample was taken. It was performed after harvesting of plant.

3.13.5 Cob length

Two randomly selected cobs were taken from each pot to measure the length from the base to the tip of the ear. The average result was recorded in cm. It was done at harvesting time

3.13.6 Cob circumference

Two cobs were randomly selected pot^{-1} after harvest and the circumference was taken from each cob. Then average result was recorded in cm.

3.13.7 Number of cobs plant^{-1}

The mature cob was counted at each of the two randomly selected plants in each pot at harvest and averaged.

3.13.8 Number of grain rows cob^{-1}

Two cobs from each pot were selected randomly and the number of rows was counted and then the average result was recorded.

3.13.9 Number of grains cob^{-1}

Two cobs from each pot were selected randomly and the number of grains was counted and then the average result was recorded.

3.13.10 Grain weight cob^{-1}

Whole grain of two cobs were randomly taken from each pot and the weight was taken in an electrical balance.

3.13.11 Shell +Chaff weight cob^{-1}

After separation of whole grain from cob full Shell+chaff of two cobs were randomly taken from each pot and the weight was taken in an electrical balance. It was recorded in gram.

3.13.12 Shelling percentage

Shelling percentage was calculated dividing grain weight by total cob weight and multiply with hundred.

$$\text{Shelling percentage} = \frac{\text{Grain weight}}{\text{Cob weight}} \times 100$$

3.13.13 1000-seeds weight

One thousand clean and dried seeds were randomly taken from each pot and the weight was taken in an electrical balance. It was recorded in gram.

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

After harvested final grain yield was adjusted at 14% moisture. Placed in threshing floor for sun drying then grains were removed and oven dried and taken weight. It was converted tot $ha.^{-1}$

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

After removing the grain other plant parts placed in threshing floor for sun drying then oven dried and taken weight. It was converted tot $ha.^{-1}$

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

Grain yield together with straw yield was regarded as biological yield and calculated with the following formula:

$$\text{Biological yield (t ha}^{-1}\text{)} = \text{Grain yield (t ha}^{-1}\text{)} + \text{Stover yield (t ha}^{-1}\text{)}$$

3.13.17 Harvest Index (%)

Harvest Index denotes the ratio of Grain yield (economic yield) to biological yield and was calculated with the following formula:

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

3.14 Statistical analysis

The collected data were compiled and analysed following the analysis of variance (ANOVA) techniques by Completely Randomized Design with 2 factor to find out the statistical significance of experimental results. The collected data were analysed by computer package program MSTAT-C software (Russell. 1986). The significant differences among the treatment means were compared by Least Significant Difference (LSD) at 5% levels of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

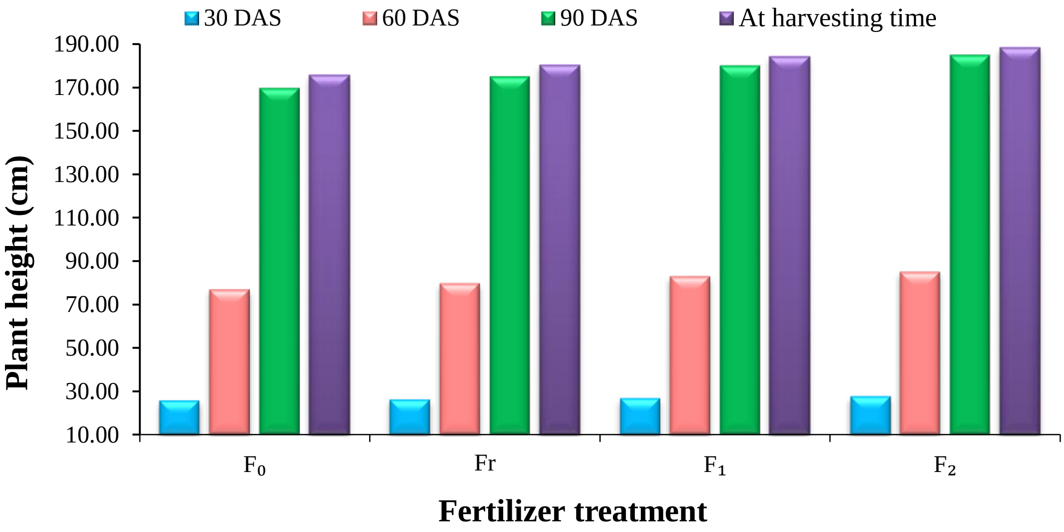
The experiment was conducted to study the effect of different level of fertilizer doses and leaf removal on the yield of white maize. Data on different growth and other parameters, yield attributes and yield were recorded. The analysis of variance on different growth and yield contributing characters as well as yield of white maize was influenced by different fertilizer doses and leaf removal combinations treatment presented in Appendix IV-VIII. The results have been presented with the help of graphs and table, and possible interpretations given under the following headings and sub-headings.

4.1 Growth Parameters

4.1.1 Plant height (cm) at 30, 60, 90 DAS and at harvest

4.1.1.1 Effect of fertilizer doses

Fertilizer doses showed significant variation on plant height at 30, 60, 90 DAS and at harvesting time of white maize (Figure 1). 25% more than recommended dose of fertilizer (F_1) showed the tallest plant at different growth stages (27.60, 85.16, 184.96 and 188.45 cm at 30, 60, 90 DAS and at harvesting time, respectively). On the other hand, no fertilizer application (F_0) showed the shortest plant at different growth stages (25.68, 77.00, 169.81 and 175.77 cm at 30, 60, 90 DAS and at harvesting time, respectively). Application of all chemical fertilizer in 25% more than recommended dose ensured the essential macro and micro nutrients for the vegetative growth of the maize and the ultimate results were the longest plant. The increase in plant height with different nitrogen sources can be attributed to the fact that nitrogen promotes plant growth. This result also is in agreement with the finding of Omara (1989), Adhikary *et al.* (2010) and Mona E. El-Azab (2010) reported that micronutrients in contribution with NPK showed the tallest plant in maize.

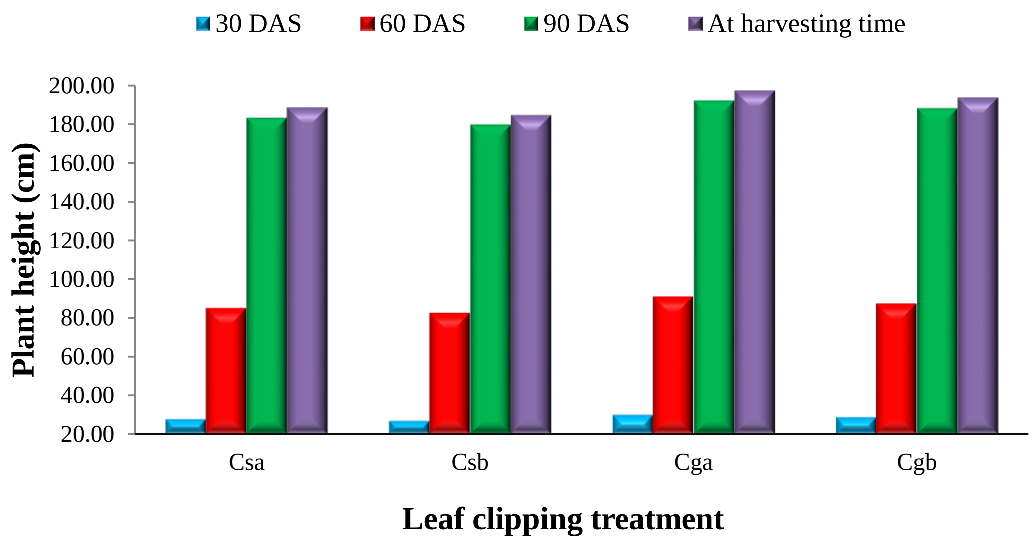


F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

Figure 1. Effect of fertilizer dose on plant height (cm) of white maize (LSD value = 0.42, 0.98, 1.45 and 1.87 at 30, 60, 90 DAS and at harvesting time)

4.1.1.2 Effect of leaf clipping

Effect of leaf removal showed significant variation on plant height at 30, 60, 90 DAS and at harvesting time of white maize (Figure 2). 4 leaves clipping above cobs at grain filling stage (C_{ga}) showed the tallest plant at different growth stages 29.66cm, 90.86cm, 192.33cm and 197.44cm at 30, 60, 90 DAS and at harvesting time, respectively. On the other hand, 4 leaves clipping below cobs at silking stage (C_{sb}) showed the shortest plant at different growth stages 26.72cm, 82.48cm, 179.83cm and 184.77cm at 30, 60, 90 DAS and at harvesting time, respectively. The result was corroborated with Rokon *et al.* (2019) reported that lower leaf defoliation showed the drastic reduction in plant height.



C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

Figure 2. Effect of leaf clipping on plant height (cm) of white maize (LSD value = 0.42, 0.98, 1.45 and 1.87 at 30, 60, 90 DAS and at harvesting time)

4.1.1.3 Interaction effect of fertilizer doses and leaf clipping

Combined effect of fertilizer doses and leaf clipping showed significant results of plant height (Table 1). 25% more fertilizer dose with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) combination showed the tallest plant at different growth stages 35.07cm, 107cm, 210cm and 220cm at 30, 60, 90 DAS and at harvesting time, respectively); whereas no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) combination showed the shortest plant at different growth stages 25.00cm, 72.15cm, 165cm and 171.15 cm at 30, 60, 90 DAS and at harvesting time, respectively.

Table 1: Interaction effect of fertilizer dose and leaf clipping on plant height (cm) of white maize at different growth stages

Fertilizer x Leaf clipping treatment combinations	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	Harvest
F_0C_{sa}	25.52 j	75.95 l	167.65 m	174.00 l
F_0C_{sb}	25.00 k	72.15 m	165.00 n	171.15 m
F_0C_{ga}	26.25 h	81.52 ij	175.55 k	180.25 j
F_0C_{gb}	25.96 i	78.38 k	171.05 l	177.68 k
F_rC_{sa}	27.48 f	87.00 g	189.00 g	192.33 g
F_rC_{sb}	26.90 g	85.25 h	185.05 i	187.25 h
F_rC_{ga}	30.05 d	90.00 e	194.75 d	196.52 e
F_rC_{gb}	28.65 e	88.56 f	190.33 f	195.00 ef
F_1C_{sa}	30.55 c	95.00 c	196.00 c	203.00 c
F_1C_{sb}	28.98 e	92.25 d	193.25 e	198.00 d
F_1C_{ga}	35.07 a	107.00 a	210.00 a	220.00 a
F_1C_{gb}	32.15 b	97.85 b	205.02 b	212.00 b
F_2C_{sa}	26.35 h	82.00 i	180.55 j	185.55 h
F_2C_{sb}	26.00 hi	80.25 j	176.00 k	182.68 i
F_2C_{ga}	27.25 f	85.05 h	189.00 g	193.00 g
F_2C_{gb}	27.00 fg	84.15 hi	187.05 h	190.45 gh
$LSD_{(0.05)}$	0.42	0.98	1.45	1.87
CV (%)	7.34	8.46	5.13	6.73

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

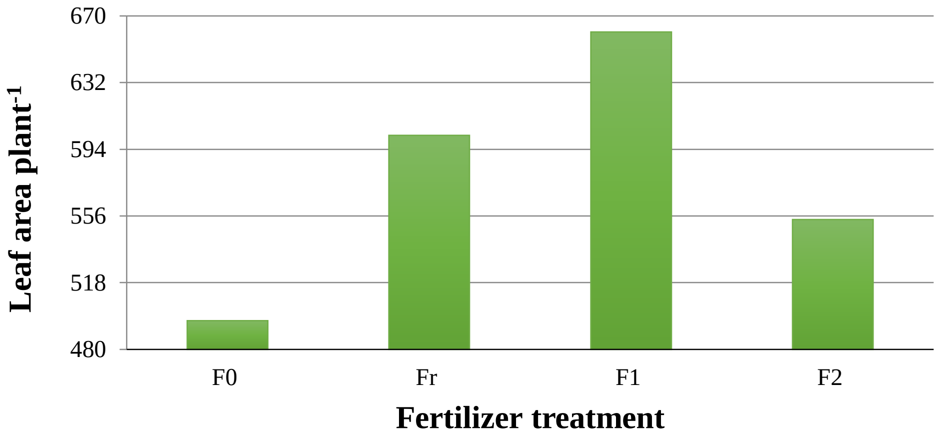
F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer.

C_{sa} – 4 leaves clipping above cobs of silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at of grain filling stage

4.1.2 Leaf area plant^{-1} (cm^2)

4.1.2.1 Effect of fertilizer doses

Fertilizer doses showed a significant variation on leaf area plant^{-1} of white maize (Figure 3). At 90 DAS, 25% more fertilizer application (F_1) showed the maximum leaf area plant^{-1} (660.80 cm^2). On the other hand, no fertilizer application (F_0) showed the minimum leaf area plant^{-1} (496.33 cm^2). This is similar to the findings of Amanullah *et al*. (2007) found that the leaf area of maize were also influenced favorably with increasing levels of NPK application.

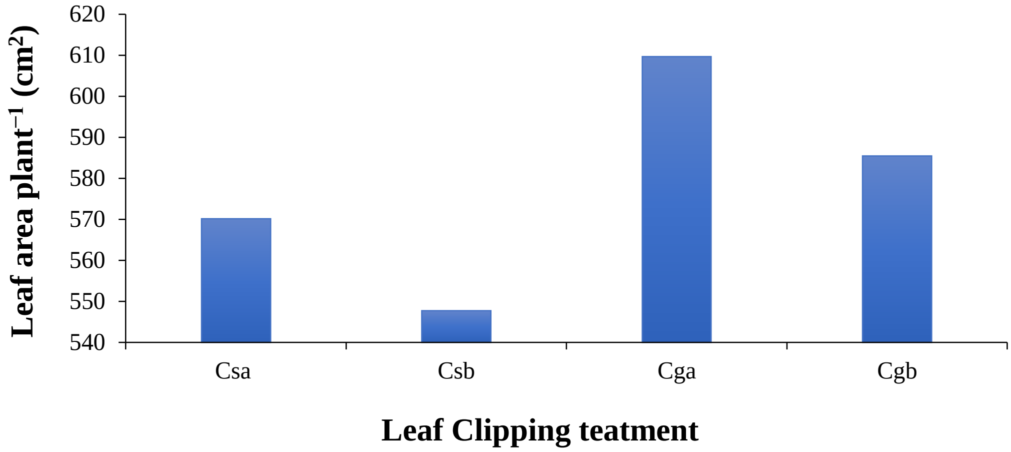


F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

Figure 3. Effect of fertilizer dose on leaf area plant^{-1} (cm^2) of white maize (LSD value = 7.10 at harvesting time)

4.1.2.2 Effect of leaf clipping

Significant variation was recorded for leaf area plant^{-1} of white maize at harvesting stage for leaf clipping (Figure 4). The maximum leaf area plant^{-1} (609.65 cm^2) was recorded from 4 leaves clipping above cobs at grain filling stage (C_{ga}) treatment. On the other hand, the minimum leaf area plant^{-1} (547.73 cm^2) from 4 leaves clipping below cobs at silking stage (C_{sb}) treatment. This finding was quite similar with Liu *et al*. (2020).



C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

Figure 4. Effect of leaf clipping on leaf area plant^{-1} (cm^2) of white maize (LSD value = 7.10 at harvesting time)

4.1.2.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of fertilizer doses and leaf clipping showed significant results of leaf area plant^{-1} of white maize (Table 2). At 90 DAS, 25% more fertilizer dose with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) combination showed the maximum leaf area plant^{-1} (737.75 cm^2); whereas no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) combination showed the minimum leaf area plant^{-1} (464.53 cm^2).

Table 2: Interaction effect of fertilizer dose and leaf clipping on leaf area plant^{-1} (cm^2) of white maize

Fertilizer x Leaf clipping treatment combinations	Leaf area plant^{-1} (cm^2)
F_0C_{sa}	495.26 l
F_0C_{sb}	464.53 m
F_0C_{ga}	517.91 j
F_0C_{gb}	507.60 k
F_rC_{sa}	604.29 e
F_rC_{sb}	581.70 f
F_rC_{ga}	616.10 d
F_rC_{gb}	605.42 e
F_1C_{sa}	628.27 c
F_1C_{sb}	613.04 d
F_1C_{ga}	737.75 a
F_1C_{gb}	664.13 b
F_2C_{sa}	552.90 h
F_2C_{sb}	531.65 i
F_2C_{ga}	566.83 g
F_2C_{gb}	564.75 g
$LSD_{(0.05)}$	7.10
CV (%)	5.87

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

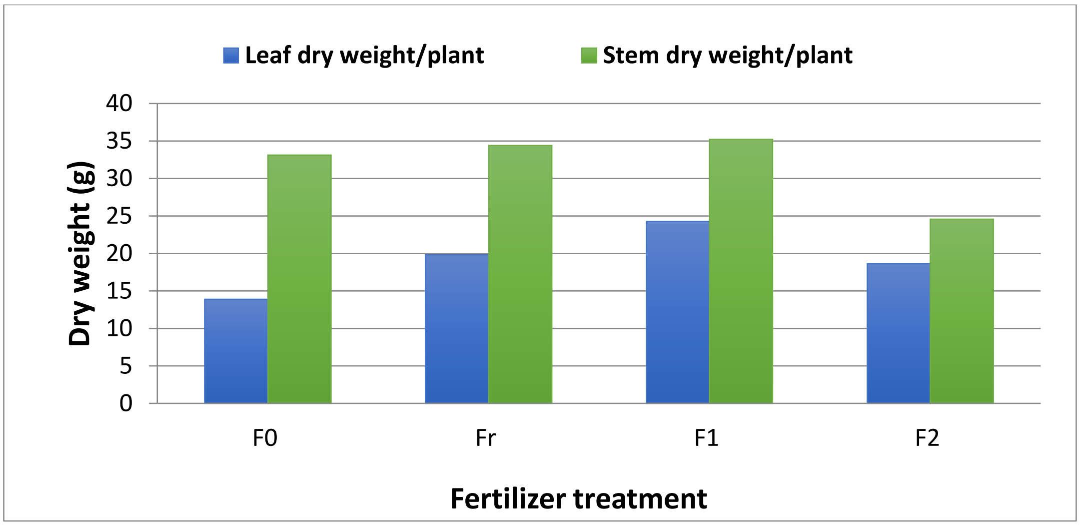
F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

4.1.3 Leaf dry weight plant^{-1} (g)

4.1.3.1 Effect of fertilizer doses

Application of fertilizer doses had significant effect on leaf dry weight plant^{-1} of white maize (Figure 5). The figure exhibits that 25% more fertilizer application (F_1) showed the highest leaf dry weight plant^{-1} (24.27 g) at harvest. However, the lowest values of leaf dry weight plant^{-1} (13.88 g) was found with no fertilizer application (F_0) at harvest. This finding was line in Petrus et *al.* (2010), (Adiloglu and Adiloglu, 2006). Increase doses of fertilizer increase dry matter production in maize leaf.

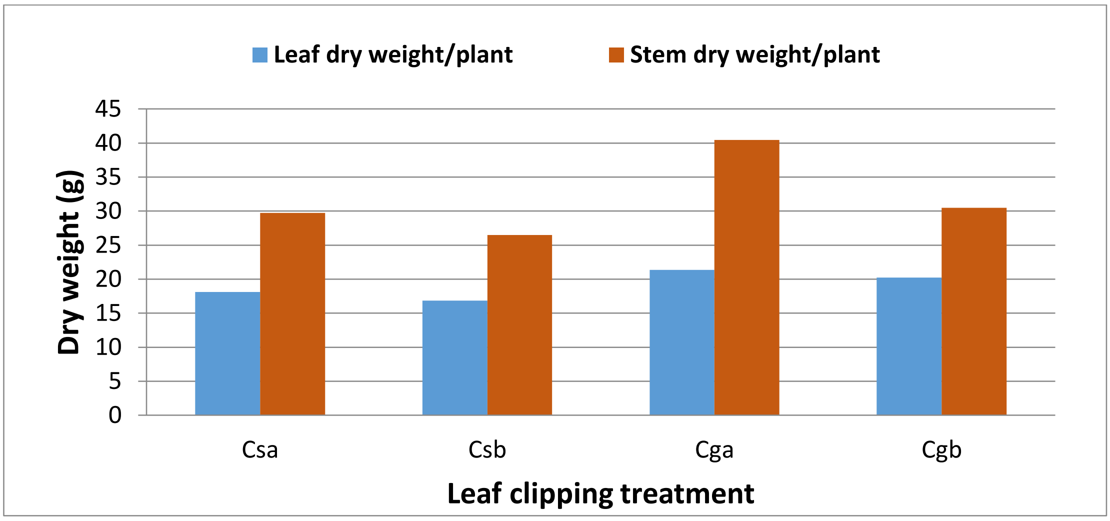


F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

Figure 5. Effect of fertilizer dose on leaf dry weight plant^{-1}(g) and stem dry weight plant^{-1} (g) of white maize (LSD value = 0.17 and 0.15 at harvesting time)

4.1.3.2 Effect of leaf clipping

Significant variation was recorded in case of leaf dry weight plant^{-1} for different levels of leaf clipping of white maize (Figure 6). Numerically, leaf dry weight plant^{-1} ranges from 16.85 g to 21.36 g. The figure exhibits that 4 leaves clipping above cobs at grain filling stage (C_{ga}) treatment showed the highest leaf dry weight plant^{-1} (21.36 g) whereas, the lowest values of leaf dry weight plant^{-1} (16.85 g) was found with 4 leaves clipping below cobs of silking stage (C_{sb}) treatment. Rokon *et al.* (2019) recorded that the removal of all leaf blades below cobs at silking stage gave the lowest results. Barimavandi *et al*. (2010) reported that reduced total dry matter production as well as leaf dry weight, which ultimately reduced grain yield.



C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

Figure 6. Effect of leaf clipping on leaf dry weight plant^{-1} (g) and stem dry weight plant^{-1} (g) of white maize (LSD value = 0.17 and 0.15 at harvesting time)

4.1.3.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and leaf removal determined the leaf dry weight plant^{-1} of white maize (Table 3). Results in table 3 showed that the highest leaf dry weight plant^{-1} (26.25 g) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the lowest leaf dry weight plant^{-1} (12.05 g) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

Table 3: Interaction effect of fertilizer dose and leaf clipping on leaf dry weight plant^{-1} (g) and Stem (node+internode) dry weight plant^{-1} (g) of white maize

Fertilizer x Leaf clipping treatment combinations	Leaf dry weight plant^{-1} (g)	Stem dry weight plant^{-1} (g)
F_0C_{sa}	13.25 n	28.82 i
F_0C_{sb}	12.05 o	25.49 k
F_0C_{ga}	15.65 l	46.30 bc
F_0C_{gb}	14.56 m	29.71 h
F_rC_{sa}	18.75 i	29.83 g
F_rC_{sb}	16.45 k	35.68 e
F_rC_{ga}	22.32 d	46.82 b
F_rC_{gb}	21.68 f	25.25 l
F_1C_{sa}	23.50 c	27.82 j
F_1C_{sb}	22.50 e	23.37 n
F_1C_{ga}	26.25 a	48.33 a
F_1C_{gb}	24.78 b	43.24 d
F_2C_{sa}	16.88 j	32.51 f
F_2C_{sb}	16.35 k	21.51 o
F_2C_{ga}	21.20 g	20.41 p
F_2C_{gb}	20.00 h	23.81 m
LSD $_{(0.05)}$	0.17	0.15
CV (%)	10.69	8.56

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

F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer.

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

4.1.4 Stem dry weight (node+ internode) plant^{-1} (g)

4.1.4.1 Effect of fertilizer doses

Fertilizer doses showed a significant variation in respect of stem dry weight plant^{-1} of white maize (Figure 5). At harvest, the figure exhibits that 25% more than recommended dose of fertilizer application (F_1) showed the highest stem dry weight plant^{-1} (35.19 g). However, the lowest values of stem dry weight plant^{-1} was found with 25% less than recommended dose of fertilizer (F_2) at harvest (24.56 g). The more nutrient uptake by plant assimilates more dry matter accumulation in stem. This observation is closely related to Khan *et al.* (2017).

4.1.4.2 Effect of leaf clipping

Significant variation was recorded in case of stem dry weight plant^{-1} for different levels of leaf clipping of white maize (Figure 6). Numerically, stem dry weight plant^{-1} ranges from 26.51 g cm to 40.48 g. The figure exhibits that 4 leaves clipping above cobs of grain filling stage (C_{ga}) treatment showed the highest average single node unit dry weight plant^{-1} (40.48 g). On the other hand, the lowest values of stem dry weight plant^{-1} (26.51 g) was found with 4 leaves clipping below cobs at silking stage (C_{sb}) treatment. Raza *et al.* (2018b) carried out an experiment on increase dry matter accumulation in maize in response to defoliation. They observed that defoliation significantly reduces dry matter accumulation and complete defoliation is more detrimental than partial defoliation.

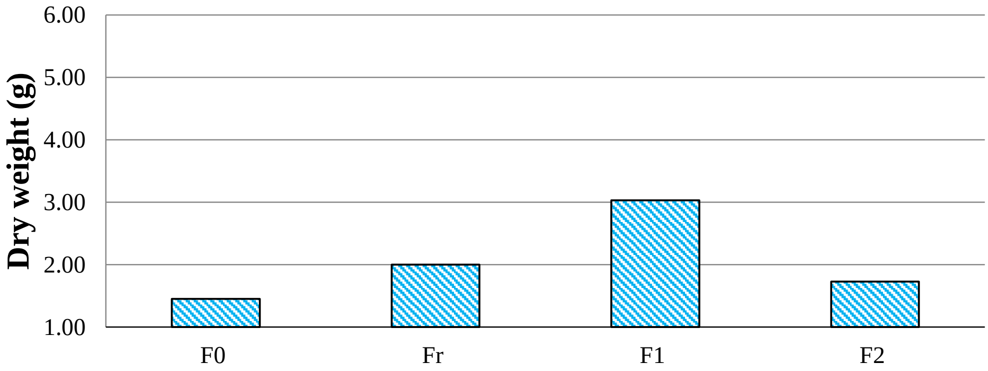
4.1.4.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and leaf removal determined the average single node unit dry weight plant^{-1} of white maize (Table 3). Results in table 3 showed that the highest stem dry weight plant^{-1} (48.33 g) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment which is statically similar with F_rC_{ga} and F_0C_{ga}. On the other hand, the lowest stem dry weight plant^{-1} (20.41 g) was observed by 25% less than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_2C_{ga}) treatment.

4.1.5 Average single node unit dry weight plant^{-1}(g)

4.1.5.1 Effect of fertilizer doses

Fertilizer doses showed a significant variation in respect of average single node unit dry weight plant^{-1} of white maize (Figure 7). At harvest, the figure exhibits that 25% more than recommended dose of fertilizer application (F_1) showed the highest average single node unit dry matter weight plant^{-1} (3.03 g). However, the lowest values average single node unit dry weight plant^{-1} was found with no fertilizer application (F_0) at harvest (1.45 g).

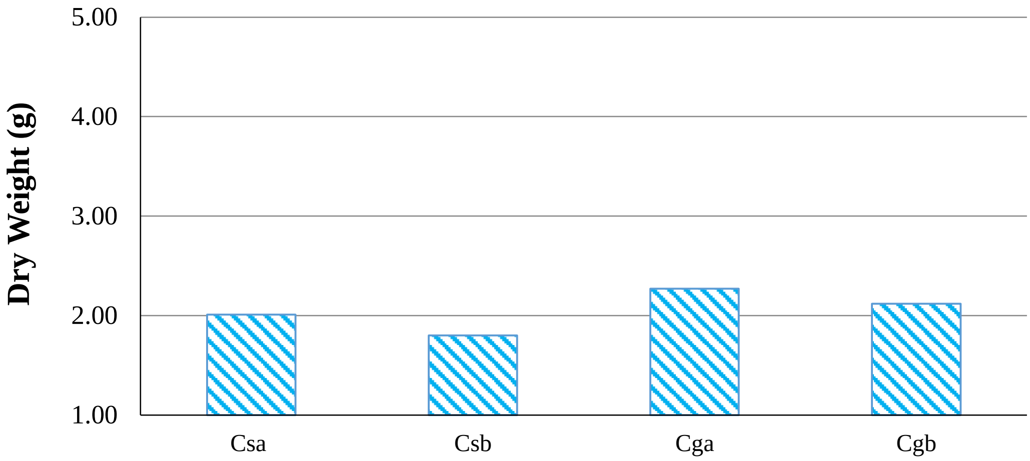


F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

Figure 7. Effect of fertilizer average single node unit dry weight plant^{-1} (g) of white maize (LSD value = 0.15 at harvesting time)

4.1.5.2 Effect of leaf clipping

Different levels of leaf clipping of white maize has significant variation was recorded in case of average single node unit dry weight plant^{-1} for (Figure 8). The figure exhibits that 4 leaves clipping below cobs at grain filling stage (C_{ga}) treatment showed the highest average single node unit dry weight plant^{-1} (2.27 g). On the other hand, the lowest values of average single node unit node dry weight plant^{-1} (1.80 g) was found with 4 leaves clipping below cobs at silking stage (C_{sb}).



C_{sa} – 4 leaves clipping above cobs of silking stage, C_{sb} – 4 leaves clipping below cobs of silking stage, C_{ga} – 4 leaves clipping above cobs of grain filling stage and C_{gb} – 4 leaves clipping below cobs of grain filling stage

Figure 8. Effect of leaf clipping on average single node unit dry weight plant^{-1} (g) of white maize (LSD value = 0.15 at harvesting time)

4.1.5.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and leaf removal determined the average single node unit dry weight plant^{-1} of white maize (Table 4). Results in table 4 showed that the highest single node unit dry weight plant^{-1} (3.41 g) was achieved with the combined effect of 25% more than recommened dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the lowest average single node unit dry weight plant^{-1} (1.28 g) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

Table 4: Interaction effect of fertilizer dose and leaf clipping on average single node unit dry weight plant^{-1} (g) of white maize

Fertilizer x Leaf clipping treatment combinations	Average single node unit dry weight plant^{-1} (g)
F_0C_{sa}	1.37 j
F_0C_{sb}	1.28 k
F_0C_{ga}	1.60 h
F_0C_{gb}	1.54 i
F_rC_{sa}	1.82 f
F_rC_{sb}	1.82 f
F_rC_{ga}	2.29 d
F_rC_{gb}	2.06 e
F_1C_{sa}	3.11 b
F_1C_{sb}	2.47 c
F_1C_{ga}	3.41 a
F_1C_{gb}	3.13 b
F_2C_{sa}	1.74 g
F_2C_{sb}	1.62 h
F_2C_{ga}	1.77 g
F_2C_{gb}	1.77 g
LSD $_{(0.05)}$	0.15
CV (%)	8.56

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

F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

4.2 Yield Contributing Parameters

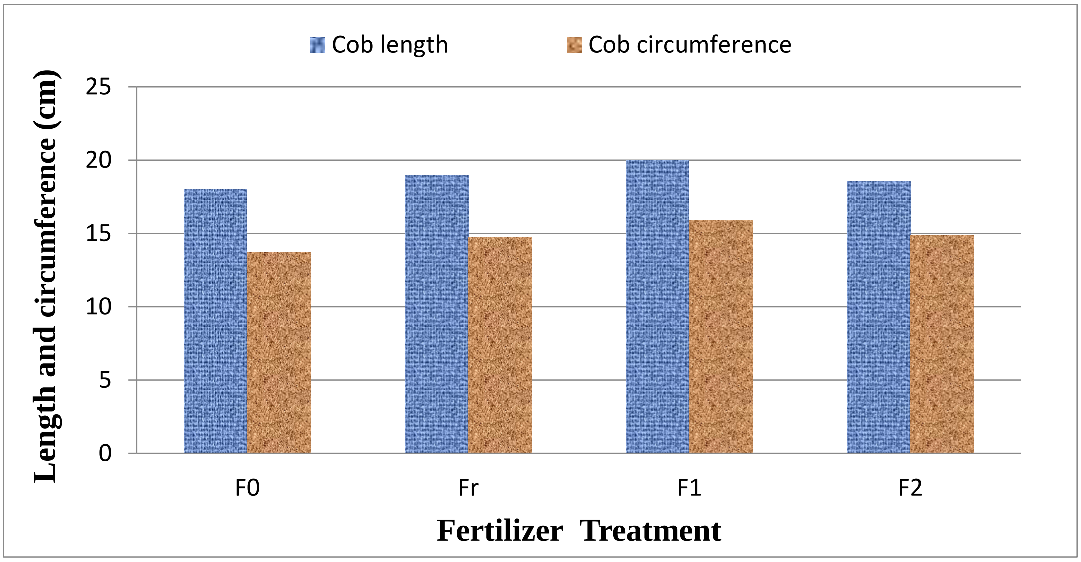
4.2.1 Cob length (cm)

4.2.1.1 Effect of fertilizer doses

Significant variation was recorded in case of cob length for different fertilizer doses (Figure 9). Due to application of fertilizer the cob length showed similar trend with fertilizer doses. Cob length ranges from 15.88 cm to 13.71 cm. The longest cob (15.88 cm) was recorded in 25% more than recommended dose of fertilizer (F_1) treatment and the shortest (13.71 cm) was recorded in no fertilizer application (F_0) treatment. From the recorded data, finding showed that F_r and F_2 treatment gave the statistically similar finding. This might be due to the proper supply of nutrient from F_1 treatment facilitated proper reproductive growth of plant. The present finding close conformity with the findings of Ademba *et al*. (2015), Hill (2014), Nasim *et al*. (2012) and Agba *et al.* (2005). With the reduction of fertilizer doses, the cob length was also reduced.

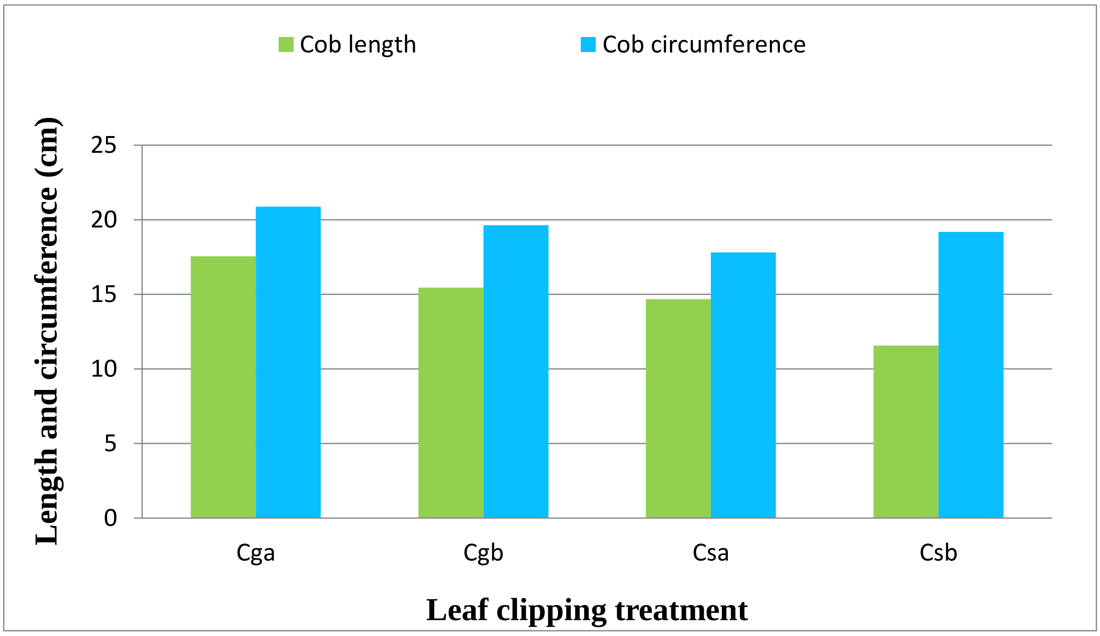
4.2.1.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on cob length of white maize (Figure 10). Results represented in Figure 10 indicated that the longest cob (17.54 cm) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage) treatment where the shortest (11.56 cm) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment. The four treatments showed significantly different results in respect of longest to shortest value of cob length. Rokon *et al.* (2019) found that no leaf clipping given the longest cob of maize.



F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

Figure 9. Effect of fertilizer dose on cob length (cm) and cob diameter (cm) of white maize (LSD value = 0.27 and 0.20)



C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

Figure 10. Effect of leaf clipping on cob length (cm) and cob circumference (cm) of white maize (LSD value = 0.27 and 0.20)

4.2.1.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and different stage of leaf removal influenced the cob length of white maize (Table 5). Results in Table 4 showed that the longest cob (18.50 cm) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment whereas, the shortest cob (10.00 cm) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.2 Cob circumference (cm)

4.2.2.1 Effect of fertilizer doses

Cob circumference showed positive significant difference at different doses of fertilizer application in white maize (Figure 9). Agba *et al.* (2005) reported that the similar higher cob circumference was found due to the various level fertilizer application. Due to application of different levels of fertilizer, the range of cob circumference was found 19.97 cm to 18.00 cm. The highest cob circumference (19.97 cm) was recorded in 25% more fertilizer dose (F_1) treatment while lowest cob diameter (18.00 cm) was recorded in no fertilizer application (F_0). The highest cob length in F_1 might be due to adequate nutrient was in F_1 treatment. The finding is close conformity with the findings of Abebe and Feyisa (2017) and Dong *et al*. (2016).

4.2.2.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on cob circumference of white maize (Figure 10). Due to different stage of leaf removal, the cob circumference range from 17.81 cm to 20.88 cm. The highest cob circumference (20.88 cm) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage) treatment where the lowest (17.81cm) was with C_{sa} (4 leaves clipping above cobs at silking stage) treatment. Rokon *et al.* (2019) found that no leaf clipping of maize given the maximum value of cob.

Table 5. Interaction effect of fertilizer dose and leaf clipping on cob length (cm) and cob circumference (cm) of white maize

Fertilizer x Leaf clipping treatment combinations	Cob length (cm)	Cob circumference (cm)
F_0C_{sa}	13.50 h	17.00 j
F_0C_{sb}	10.00 l	16.00 k
F_0C_{ga}	16.85 c	20.00 d
F_0C_{gb}	14.50 f	19.00 f
F_rC_{sa}	13.85 g	17.85 gh
F_rC_{sb}	11.50 k	17.75 h
F_rC_{ga}	17.80 b	21.00 b
F_rC_{gb}	16.00 d	19.25 e
F_1C_{sa}	16.25 d	18.88 f
F_1C_{sb}	12.75 i	18.00 g
F_1C_{ga}	18.50 a	22.00 a
F_1C_{gb}	16.00 d	21.00 b
F_2C_{sa}	15.13 e	17.50 i
F_2C_{sb}	12.00 j	17.00 j
F_2C_{ga}	17.00 c	20.50 c
F_2C_{gb}	15.25 e	19.25 e
$LSD_{(0.05)}$	0.27	0.20
CV (%)	6.28	7.74

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

F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more fertilizer dose and F_2 – 25% less fertilizer dose

C_{sa} – 4 leaves clipping above cobs of silking stage, C_{sb} – 4 leaves clipping below cobs of silking stage, C_{ga} – 4 leaves clipping above cobs of grain filling stage and C_{gb} – 4 leaves clipping below cobs of grain filling stage

4.2.2.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and different stage of leaf removal influenced the cob diameter of white maize (Table 5). The highest cob circumference (22.00 cm) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the lowest cob circumference (16.00 cm) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.3 Number of cobs plant^{-1}

4.2.3.1 Effect of fertilizer doses

The number of cobs plant^{-1} was affected due to fertilizer doses (Table 6). The maximum cobs (1.55) were found from 25% more than recmmended dose of fertilizer (F_1) treatment, which is statistically similar (1.52) with 25% less than recommended dose of fertilizer (F_2) treatment. On the other hand, the minimum cobs (1.20) were given by the no fertilizer application (F_0) treatment. The second highest number of cobs (1.49) were recorded from the recommended fertilizer doses (F_r) treatment. This result was closely similar to the result of the experiment of Mona E. El-Azab (2015).

4.2.3.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on number of cobs plant^{-1} of white maize (Table 6). Results represented in Table 6 indicated that the maximum cob (1.72) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage). On the other hand, the minimum cob (1.25) was with C_{sb} (4 leaves clipping below cobs at silking stage) which is statistically similar (1.29) with C_{sa} (4 leaves clipping above cobs at silking stage) treatment. (Sharifi and Tajbakhsh, 2007) recorded that when leaf removal then increased the number of cobs plant^{-1} of maize.

4.2.3.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of application of fertilizer doses and different stage of leaf removal regulated the number of cobs plant^{-1} of white maize (Table 6). The maximum cobs plant^{-1} (1.93) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga})

treatment whereas, the minimum cobs plant^{-1} (1.07) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.4 Number of grain rows cob^{-1}

4.2.4.1 Effect of fertilizer doses

Number of grain rows cob^{-1} showed positively significant result due to application of fertilizer doses (Table 6). The number of grain rows cob^{-1} range from 9.08 to 14.34. The highest grain rows cob^{-1} (14.34) was recorded in 25% more fertilizer dose (F_1) treatment whereas, lowest (9.08) was recorded in no fertilizer application (F_0) treatment. This might be due to the proper supply of nutrient from F_1 treatment facilitated proper reproductive growth of plant. The present result is in agreement with the findings of Singh *et al*. (2013), Woldesenbet and Haileyesus (2016) and Jolokhava *et al*. (2016).

4.2.4.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on number of grain rows cob^{-1} of white maize (Table 6 and Appendix VI). The number of grain rows cob^{-1} range from 9.92 to 13.92. Results represented in Table 6 indicated that the highest grain rows cob^{-1} (13.92) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage) treatment. On the other hand, the lowest grain rows cob^{-1} (9.92) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment. Jalilian and Delkhoshi (2014) was recorded that leaf removing had a significant effect on number of row per cob.

4.2.4.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of application of fertilizer doses and different stage of leaf removal regulated the number of grain rows cob^{-1} of white maize (Table 6). The highest grain rows cob^{-1} (17.67) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment whereas, the lowest grain rows cob^{-1} (8.33) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

Table 6. Interaction effect of fertilizer dose and leaf clipping on number of cobs plant^{-1}, number of grain rows cob^{-1} and number of grains cob^{-1} of white maize

Treatment	No. of cobs plant^{-1}	No. of grain rows cob^{-1}	No. of grains cob^{-1}
Effect of fertilizer dose			
F_0	1.20 c	9.08 d	227.10 d
F_r	1.49 b	12.75 b	318.70 b
F_1	1.55 a	14.34 a	358.30 a
F_2	1.52 ab	11.33 c	283.30 c
LSD (0.05)	0.05	0.46	1.85
CV (%)	7.06	7.75	8.44
Effect of leaf clipping			
C_{sa}	1.29 c	11.25 c	281.30 c
C_{sb}	1.25 c	9.92 d	247.90 d
C_{ga}	1.72 a	13.92 a	347.80 a
C_{gb}	1.51 b	12.42 b	310.40 b
LSD (0.05)	0.05	0.46	1.85
CV (%)	7.06	7.75	8.44
Interaction effect of fertilizer dose and leaf clipping			
F_0C_{sa}	1.13 j	9.00 h	225.00 m
F_0C_{sb}	1.07 k	8.33 i	208.30 n
F_0C_{ga}	1.40 g	9.67 gh	241.80 k
F_0C_{gb}	1.21 i	9.33 h	233.30 l
F_rC_{sa}	1.47 f	11.33 ef	283.30 g
F_rC_{sb}	1.31 h	11.00 f	275.00 h
F_rC_{ga}	1.67 d	15.67 b	391.40 b
F_rC_{gb}	1.51 ef	13.00 d	325.00 d
F_1C_{sa}	1.33 h	13.67 c	342.00 c
F_1C_{sb}	1.13 j	10.33 g	258.40 i
F_1C_{ga}	1.93 a	17.67 a	441.50 a
F_1C_{gb}	1.80 c	15.67 b	391.50 b
F_2C_{sa}	1.21 i	11.00 f	275.00 h
F_2C_{sb}	1.47 f	10.00 g	250.00 j
F_2C_{ga}	1.87 b	12.67 d	316.60 e
F_2C_{gb}	1.53 e	11.67 e	291.70 f
LSD (0.05)	0.05	0.46	1.66
CV (%)	7.06	7.75	8.44

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

F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

4.2.5 Number of grains cob^{-1}

4.2.5.1 Effect of fertilizer doses

Due to application of fertilizer, number of grains cob^{-1} varied significantly in white maize (Table 6). Number of grains cob^{-1} increased steadily with the increment of fertilizer doses from the lowest to highest doses. The number of grains cob^{-1} range from 227.10 to 358.30 due to different levels of fertilizers. The maximum number of grains cob^{-1} (358.30) was recorded in F_1 (25% more than recommended doses of fertilizer) treatment and the minimum number of grains cob^{-1} (227.10) was recorded in F_0 (no application of fertilizer) treatment. This might be due to the steady supply of nutrient from F_1 treatment facilitated proper growth of plant. The present finding is close conformity with the findings of Singh *et al.* (2013), Nasim *et al*. (2012) and Mukhtar *et al.* (2011) also recorded that maize crop fertilized at 250−125 kg NP produced significantly maximum grains cob^{-1} (658.0) against minimum (217.0) in case of control plot.

4.2.5.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on number of grains cob^{-1} of white maize (Table 6). The number of grains cob^{-1} range from 247.90 to 347.80 due to different stage of leaf removal. The maximum grains cob^{-1} (347.80) was attained with C_{ga} (4 leaves clipping above cobs of grain filling stage) treatment whereas, the minimum grains cob^{-1} (247.90) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment. Rokon *et al.* (2019) found that removal of all leaf blades below the lowermost cob at silking stage was given the highest value of grains cob^{-1} of maize. Jalilian and Delkhoshi (2014) recorded that leaf removing had a significant effect on number of seed per cob.

4.2.5.3 Interaction effect of fertilizer doses and leaf clipping

Table 6 represent the result of interaction effect on number of grains cob^{-1}. Results in table 6 showed that the maximum number of grains cob^{-1} (441.50) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the minimum number of grains cob^{-1} (208.30) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

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

4.2.6.1 Effect of fertilizer doses

Significant variation was recorded in case of grain weight cob^{-1} for different fertilizers doses of white maize (Table 7). The grain weight cob^{-1} range from 33.11 g to 111.30 g due to different levels of fertilizer. The highest grain weight cob^{-1}(111.30 g) was recorded from 25% more than recommended dose of fertilizer (F_1) treatment. The second highest grain weight cob^{-1} (82.55 g) were recorded from the recommended fertilizer doses (F_r) treatment. On the other hand, the lowest grain weight cob^{-1} (33.11 g) was recorded from no application of fertilizer (F_0) treatment. When the application of fertilizer doses was increased then grain weight cob^{-1} was increased.

4.2.6.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on grain weight cob^{-1} at white maize (Table 7). Due to leaf removal, the grain weight cob^{-1} range from 51.25 g to 93.35 g. Results represented in Table 7 indicated that the highest grain weight cob^{-1} (93.35 g) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage) whereas, the lowest (51.25 g) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment.

4.2.6.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and different stage of leaf removal determined the grain weight cob^{-1} of white maize (Table 7). Results in Table 7 showed that the highest grain weight cob^{-1} (157.50 g) was achieved with the combined effect of 25% more than recommended dose of fertilizer with4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment, where the lowest grain weight cob^{-1} (24.94 g) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.7 Shell+chaff weight cob^{-1} (g)

4.2.7.1 Effect of fertilizer doses

Shell weight cob^{-1} showed positive significant difference at different doses of fertilizer application in white maize (Table 7). The shell+chaff weight cob^{-1} range from 12.12 g to 23.04 g due to different levels of fertilizers. The maximum shell+chaff weight cob^{-1}(23.04 g) was recorded from 25% more than recommended dose of fertilizer (F_1) treatment. The second maximum shell+chaff weight cob^{-1} (20.91 g) were recorded from the recommended fertilizer doses (F_r) treatment. On the other hand, the minimum shell weight cob^{-1}(12.12 g) was recorded from no application of fertilizer (F_0) treatment.

4.2.7.2 Effect of leaf clipping

Different stage of leaf clipping had significant effect on shell+chaff weight cob^{-1} of white maize (Table 7). Due to leaf removal, the shell+chaff weight cob^{-1} range from 13.65 g to 23.58 g. The maximum shell+chaff weight cob^{-1} (23.58 g) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage). The second maximum shell weight cob^{-1} (18.66 g) were recorded from the C_{gb} (4 leaves clipping below cobs at grain filling stage) treatment. On the other hand, the minimum shell weight cob^{-1} (13.65 g) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment.

4.2.7.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and different stage of leaf removal determined the shell weight cob^{-1} of white maize (Table 7). The maximum chaff weight cob^{-1} (29.38 g) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the minimum shell weight cob^{-1} (7.47 g) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.8 Shelling (%)

4.2.8.1 Effect of fertilizer doses

Due to application of fertilizer doses shelling percentage showed positively significant result (Table 7). The shelling percentage range from 75.58 % to 81.39 % among the fertilizer doses. The highest shelling percentage (81.39) was recorded in F_1(25% more than recommended dose of fertilizer) treatment and lowest percentage (75.58) was recorded in F_0 (no application of fertilizer dose) treatment. This research result is close conformity with the findings of Abebe and Feyisa (2017), Soro *et al*. (2015) and Adeniyan and Ojeniyi (2005).

4.2.8.2 Effect of leaf clipping

Different stage of leaf removal influenced shelling percentage. However, remarkable change observed four leaf clipping in term of shelling percentage. Results represented in Table 7 indicated that the highest shelling percentage (79.88) was attained with 4 leaves clipping above cobs at grain filling stage (C_{ga}) treatment. However, the lowest values of shelling percentage (76.88) was with 4 leaves clipping below cobs at silking stage (C_{sb}) treatment.

4.2.8.3 Interaction effect of fertilizer doses and leaf clipping

Table 7 represent the result of interaction effect on shelling percentage of white maize. Results in table 7 showed that the highest shelling percentage (83.54) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment. On the other hand, the lowest shelling percentage (73.00) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination.

4.2.9 1000-seeds weight (g)

4.2.9.1 Effect of fertilizer doses

Application of fertilizer doses showed a significant variation in respect of 1000 seeds weight (Table 7). Among the fertilizer doses, 25% more than recommended dose of fertilizer application (F_1) showed the maximum 1000 seeds weight (306.02 g); whereas no fertilizer application (F_0) showed the minimum 1000 seeds weight (144.82 g). This is similar to the findings of Mukhtar *et al.* (2011), Asghar *et al*. (2010) and Onasanya *et al.* (2009) found that the increasing level of fertilizer increases the 1000 grain weight of maize. Law-ogbomoa and Law-ogbomo (2009) also found that the minimum 1000 grains weight was recorded from the maize plants that received no fertilizers.

4.2.9.2 Effect of leaf clipping

1000 seeds weight did significantly change due to different stage of leaf removal (Table 7). The 1000 seeds weight range from 201.87 g to 252.94 g among the leaf clipping. Among the leaf clipping, 4 leaves clipping above cobs at grain filling stage (C_{ga}) showed the maximum 1000 seeds weight (252.94 g); whereas 4 leaves clipping below cobs at silking stage (C_{sb}) treatment showed the minimum 1000 seeds weight (201.87 g). Similar results was found in Rokon *et al.* (2019).

4.2.9.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and different stage of leaf removal determined the 1000 grains weight of white maize (Table 7). Results in Table 7 showed that the maximum 1000 grains weight (356.58 g) was achieved with the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment, where the minimum 1000 grains weight (199.76 g) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination. The result under the present study was conformity with Ahmed *et al.* (2007). But dissimilar result was found in Rokon *et al.* (2019) and Jalilian and Delkhoshi (2014) shown in no leaf clipping given the highest value of 1000 seeds weight.

Table 7. Interaction effect of fertilizer dose and leaf clipping on grain weight cob^{-1} (g), Shell+chaff weight cob^{-1} (g), shelling (%) and 1000-seeds weight (g) of white maize

Treatment	Grain weight cob^{-1} (g)	Shell+chaff weight cob^{-1} (g)	Shelling (%)	1000-seeds weight (g)
Effect of fertilizer dose				
F_0	33.11 d	12.12 d	75.58 d	144.82 d
F_r	82.55 b	20.91 b	79.49 b	256.65 b
F_1	111.30 a	23.04 a	81.39 a	306.02 a
F_2	52.71 c	16.99 c	77.55 c	185.20 c
$LSD_{(0.05)}$	0.35	0.21	0.35	1.64
CV (%)	8.35	7.79	8.31	6.52
Effect of leaf clipping				
C_{sa}	62.78 c	17.15 c	78.31 c	214.85 c
C_{sb}	51.25 d	13.65 d	76.88 d	201.87 d
C_{ga}	93.35 a	23.58 a	79.88 a	252.94 a
C_{gb}	72.25 b	18.66 b	78.95 b	223.04 b
$LSD_{(0.05)}$	0.35	0.21	0.35	1.64
CV (%)	8.35	7.79	8.31	6.52
Interaction effect of fertilizer dose and leaf clipping				
F_0C_{sa}	30.49 o	14.00 k	75.98 k	135.51 n
F_0C_{sb}	24.94 p	7.470 o	73.00 l	119.76 o
F_0C_{ga}	40.50 m	16.00 j	77.00 i	167.51 l
F_0C_{gb}	36.51 n	11.00 m	76.36 j	156.49 m
F_rC_{sa}	71.65 g	20.30 g	79.16 f	252.94 g
F_rC_{sb}	63.46 i	17.00 i	78.50 g	230.69 h
F_rC_{ga}	109.30 c	23.94 c	80.51 d	279.18 e
F_rC_{gb}	85.74 e	22.38 d	79.81 e	263.80 f
F_1C_{sa}	99.60 d	21.13 f	80.97 c	291.43 c
F_1C_{sb}	73.07 f	20.15 g	79.54 e	282.93 d
F_1C_{ga}	157.50 a	29.38 a	83.54 a	356.58 a
F_1C_{gb}	114.80 b	21.50 e	81.52 b	293.13 b
F_2C_{sa}	49.37 k	13.19 l	77.11 i	179.52 j
F_2C_{sb}	43.52 l	10.00 n	76.50 j	174.10 k
F_2C_{ga}	66.03 h	25.00 b	78.45 g	208.47 i
F_2C_{gb}	51.93 j	19.75 h	78.12 h	178.72 j
$LSD_{(0.05)}$	0.31	0.21	0.31	1.64
CV (%)	8.35	7.79	8.31	6.52

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

F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

C_{sa} – 4 leaves clipping above cobs of silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

4.3 Yield Parameters

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

4.3.1.1 Effect of fertilizer doses

Application of fertilizer doses showed a significant variation in respect of grain yield of white maize (Table 8). The 25% higher dose of fertilizers (F_1) increased grain yield significantly than recommended dose (F_r) in white maize. On the others hand, lower doses (F_2) produced lower grain yield than recommend doses (F_r) in white maize. Due to application of different levels of fertilizer, the range of grain yield of maize was 5.79 t ha^{-1} to 7.32 t ha^{-1}. Among the fertilizer doses, 25% more than recommended dose of fertilizer application (F_1) showed the highest grain yield (7.32 t ha^{-1}). On the other hand, no fertilizer application (F_0) showed the lowest grain yield (5.36 t ha^{-1}). This might be due to adequate nutrient was in F_1 treatment. This is similar to the findings of Singh *et al.*(2013), Mukhtar *et al.* (2011), Asghar *et al*. (2010) and Kumar *et al*. (2007) found that the increasing level of fertilizer increases the grain yield due to vegetative and reproductive growth of the crop.

4.3.1.2 Effect of leaf clipping

Different stages of leaf clipping significantly affected the result of grain yield of white maize. Results represented in Table 8 indicated the grain yield range 5.82 t ha^{-1} to 6.52 t ha^{-1}. Among the leaf removal, the highest grain yield (6.52 t ha^{-1}) was obtained with C_{ga} (4 leaves clipping above cobs of grain filling stage) treatment where the lowest (5.82 t ha^{-1}) was with C_{sb} (4 leaves clipping below cobs at silking stage) treatment. Similar results were also found by Liu *et al.* (2020). The effect of leaf clipping treatment showed a significant variation among the yield and yield attributes in maize (Rokon *et al.*, 2019; Jalilian and Delkhoshi, 2014; Faruque *et al.*, 2007) shown that the highest grain yields (11.66 t ha^{-1}) were recorded in no leaf clipping treatment (control) while the lowest (5.59 t ha^{-1}) in all leaves clipping treatment recorded that the highest grain yield was observed in all cultivars under control treatment. Kolari *et al.* (2014) observed that the highest grain yield produced by 60% defoliation rate.

4.3.1.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and leaf removal influenced significantly the grain yield of white maiz. Results in Table 8 showed that the highest grain yield (7.92 t ha^{-1}) was recorded from the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment whereas, the lowest grain yield (4.88 t ha^{-1}) was observed by no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment combination. The second highest grain yield (7.39 t ha^{-1}) was recorded from the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping below cobs at grain filling stage (F_1C_{gb}) treatment. These results are in conformity with Kolari *et al.* (2014).

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

4.3.2.1 Effect of fertilizer doses

Fertilizer doses showed a significant variation in respect of stover yield of white maize (Table 8). Among the fertilizer doses, 25% more than recommended dose of fertilizer application (F_1) showed the highest stover yield (8.33 t ha^{-1}). Again, the lowest stover yield (7.30 t ha^{-1}) was recorded from no fertilizer application (F_0) treatment which was statistically distinct from other treatments. Other treatments were showed intermediate result. This is similar to the findings of Yadav *et al.* (2006) and Vadivel *et al*. (2001) found that the increasing level of fertilizer increases the stover yield due to vegetative growth of the crop.

4.3.2.2 Effect of leaf clipping

Different level of leaf removal had significant effect on stover yield (t ha^{-1}) of white maize (Table 8). Among the leaf clipping, the stover range 7.92 t ha^{-1} to 7.56 t ha^{-1}. 4 leaves clipping above cobs at grain filling stage (C_{ga}) showed the highest stover yield (7.92 t ha^{-1}). The second highest stover yield (7.76 t ha^{-1}) was found in 4 leaves clipping below cobs at grain filling stage (C_{gb}) treatment which was statistically similler with 4 leaves clipping above cobs at silking stage (C_{sa}) treatment. Again, the lowest stover yield (7.56 t ha^{-1}) was recorded from 4 leaves clipping below cobs at silking stage (C_{sb}) treatment which was statistically distinct from other treatments. The result obtained by Jalilian and Delkhoshi (2014) was similar with the present findings. They showed that the leaf removal above ear decreased 22.80% stover yield compared to control.

4.3.2.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of different doses of fertilizer application and leaf removal regulated stover yield of white maize (Table 8). The highest stover yield (8.58 t ha^{-1}) was recorded from the combined effect of 25% more fertilizer dose with 4 leaves clipping above cobs of grain filling stage (F_1C_{ga}) treatment, where the lowest stover yield (7.00 t ha^{-1}) was observed by no fertilizer application with 4 leaves clipping below cobs of silking stage (F_0C_{sb}) treatment combination. The second highest stover yield (8.34 t ha^{-1}) was recorded from the combined effect of 25% more fertilizer dose with 4 leaves clipping below cobs of grain filling stage (F_1C_{gb}) treatment which was statistically similar (8.26 t ha^{-1}) with 25% more fertilizer dose with 4 leaves clipping above cobs of silking stage (F_1C_{sa}) treatment.

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

4.3.3.1 Effect of fertilizer doses

Application of fertilizer doses showed a significant variation in respect of biological yield of white maize (Table 8). Among the fertilizer doses, 25% more fertilizer application (F_1) showed the maximum biological yield (15.65 t ha^{-1}) whereas, no fertilizer application (F_0) treatment showed the minimum biological yield (12.66 t ha^{-1}) which was statistically different from others. Application of fertilizer in recommended doses ensured the essential macro and micro nutrients for the vegetative and reproductive growth of white maize and the ultimate results were the highest grain and straw yield as well as maximum biological yield. This is similar to the findings of Ahmad *et al.* (2018) and Asghar *et al*. (2010) who found that the increasing level of fertilizer increases the biological yield. Ziaeyana and Rajaiea (2009) reported that Zn and B fertilization significantly increased grain yield, Stover yield and plant biological yield of maize, which corroborate the present findings.

4.3.3.2 Effect of leaf clipping

Effect of leaf clipping on biological yield of white maize was remarkable (Table 8). Among the different levels of leaf clipping, 4 leaves clipping above cobs at grain filling stage (C_{ga}) treatment showed the maximum biological yield (14.44 t ha^{-1}). On the other hand, 4 leaves clipping below cobs at silking stage (C_{sb}) treatment showed the minimum biological yield (13.38 t ha^{-1}) which was statistically different from others. Jalilian and Delkhoshi (2014) concluded that the leaf removing had a significant effect on all measured traits (number of seed per row, row number per ear, ear length, 1000 seed weight, seed yield and biological yield). Leaf removal above ear decreased 22.80 % biological yield compared to control.

4.3.3.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of application of fertilizer doses and different stage of leaf clipping had remarkable effect on biological yield of white maize (Table 8). Results in Table 8 showed that the maximum biological yield (16.50 t ha^{-1}) was recorded from the combined effect of F_1C_{ga} (25% more than recommended dose of fertilizer with 4 leaves clipping above cobs at grain filling stage) treatment. The second maximum biological yield (15.73 t ha^{-1}) was recorded from the combined effect of F_1C_{gb} (25% more than recommended dose of fertilizer with 4 leaves clipping below cobs at grain filling stage) treatment. Again, the lowest biological yield (11.88 t ha^{-1}) was observed from F_0C_{sb} (no fertilizer application with 4 leaves clipping below cobs at silking stage) treatment. The results obtained from all other treatments showed intermediate results compared to the highest and the lowest value of biological yield. This finding was indirectly related with Remison and Omueti (1982).

4.3.4 Harvest index (%)

4.3.4.1 Effect of fertilizer doses

Harvest index of white maize for different application of fertilizers doses showed significant differences (Table 8). Among the fertilizer doses, the maximum harvest index (46.76 %) was recorded from 25% more than recommended dose of fertilizer application (F_1) treatment. On the other hand, the minimum harvest index (42.35 %) was recorded from no fertilizer application (F_0) treatment. The result was consistence with the findings of Esmaeili *et al.* (2016) reported that fertilizer doses supplement increased harvest index of maize crop. Afroja (2018) shown that the lowest harvest index was found when no fertilizer was applied.

4.3.4.2 Effect of leaf clipping

Harvest index did significantly change due to different stage of leaf removal (Table 8). Results represented in Table 8 indicated that the maximum harvest index (45.16 %) was attained with C_{ga} (4 leaves clipping above cobs at grain filling stage) treatment, where the minimum harvest index (43.53 %) was from C_{sb} (4 leaves clipping below cobs at silking stage) treatment. Rokon *et al.* (2019) recorded that the highest harvest index (35.50 %) were obtained from no leaf clipping treatment and the lowest harvest index (33.50 %) were obtained from Removal of all leaf blades above the uppermost cob at silking stage treatment. Dissimilar result was found from Jalilian and Delkhoshi (2014) they shown that leaf removal had non-significant effect on harvest index. The efficiency of harvest index increased under corn detopping compared to control.

4.3.4.3 Interaction effect of fertilizer doses and leaf clipping

Interaction effect of application of fertilizer doses and different stage of leaf clipping on harvest index of white maize is presented in Table 8. The combination of 25% more than recommended dose of fertilizer and 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) treatment shown the maximum harvest index (47.99 %). The second maximum harvest index (46.96 %) was recorded from the combined effect of 25% more than recommended dose of fertilizer with 4 leaves clipping below cobs at grain filling stage (F_1C_{gb}) treatment. On the other hand, the combination of no fertilizer application with 4 leaves clipping below cobs at silking stage (F_0C_{sb}) treatment was shown the minimum harvest index (41.04 %). The results obtained from all other treatments showed intermediate results compared to the highest and the lowest value of harvest index.

Table 8. Interaction effect of fertilizer dose and leaf clipping on grain yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest Index (%) of white maize

Treatment	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Effect of fertilizer dose				
F_0	5.36 d	7.30 c	12.66 d	42.35 d
F_r	6.27 b	7.69 b	13.96 b	44.93 b
F_1	**7.32 a**	**8.33 a**	**15.65 a**	**46.76 a**
F_2	5.79 c	7.64 b	13.43 c	43.12 c
LSD (0.05)	0.09	0.16	0.11	0.25
CV (%)	8.82	9.19	8.44	8.40
Effect of leaf clipping				
C_{sa}	6.09 c	7.73 b	13.81 c	44.06 c
C_{sb}	5.82 d	7.56 c	13.38 d	43.53 d
C_{ga}	**6.52 a**	**7.92 a**	**14.44 a**	**45.16 a**
C_{gb}	6.31 b	7.76 b	14.06 b	44.84 b
LSD (0.05)	0.09	0.16	0.11	0.25
CV (%)	8.82	9.19	8.44	8.40
Interaction effect of fertilizer dose and leaf clipping				
F_0C_{sa}	5.35 m	7.43 h	12.79 n	41.86 j
F_0C_{sb}	4.88 n	7.00 j	11.88 o	41.04 k
F_0C_{ga}	5.67 k	7.47 gh	13.14 l	43.16 hi
F_0C_{gb}	5.55 l	7.29 i	12.84 m	43.22 hi
F_rC_{sa}	6.18 g	7.65 ef	13.83 g	44.67 f
F_rC_{sb}	5.83 i	7.57 fg	13.40 j	43.50 g
F_rC_{ga}	6.59 e	7.81 d	14.41 e	45.76 de
F_rC_{gb}	6.48 f	7.69 e	14.17 f	45.71 e
F_1C_{sa}	7.05 c	8.26 b	15.31 c	46.03 c
F_1C_{sb}	6.92 d	8.14 c	15.06 d	45.97 cd
F_1C_{ga}	**7.92 a**	**8.58 a**	**16.50 a**	**47.99 a**
F_1C_{gb}	7.39 b	8.34 b	15.73 b	46.96 b
F_2C_{sa}	5.77 j	7.56 fg	13.32 k	43.28 gh
F_2C_{sb}	5.67 k	7.49 gh	13.16 l	43.08 hi
F_2C_{ga}	5.91 h	7.81 d	13.73 h	43.07 hi
F_2C_{gb}	5.81 ij	7.69 e	13.51 i	43.05 i
LSD (0.05)	0.08	0.14	0.10	0.23
CV (%)	8.82	9.19	8.44	8.40

In a column, means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

On the dry matter partitioning perspectives, reviewing the data, it was observed that increasing the fertilizer dose, the dry matter partitioning from the vegetative stage towards the reproductive organs happened which was reflected in the data of the shelling percentage and that of the harvest index.

It was noted that with the increase in the fertilizer dose, the shelling percentage increased (Table 7). Similar situation was also happened with the harvest index, that is with the increase in the fertilizer dose, the harvest index also increased (Table 8).

In respect of leaf clipping, it was noticed that clipping the leaves underneath the cob caused more reduction in the shelling percentage (Table 7). The effect of the leaf clipping on the harvest index was also observed showing the results that when the underneath leaves of the cob were removed the harvest index was more reduced (Table 8). This was true in both the stages of silking and grain filling stage. However, more reduction was seen when the leaves were clipped in the silking stage, which indicates that the leaves should not be clipped at the silking stage.

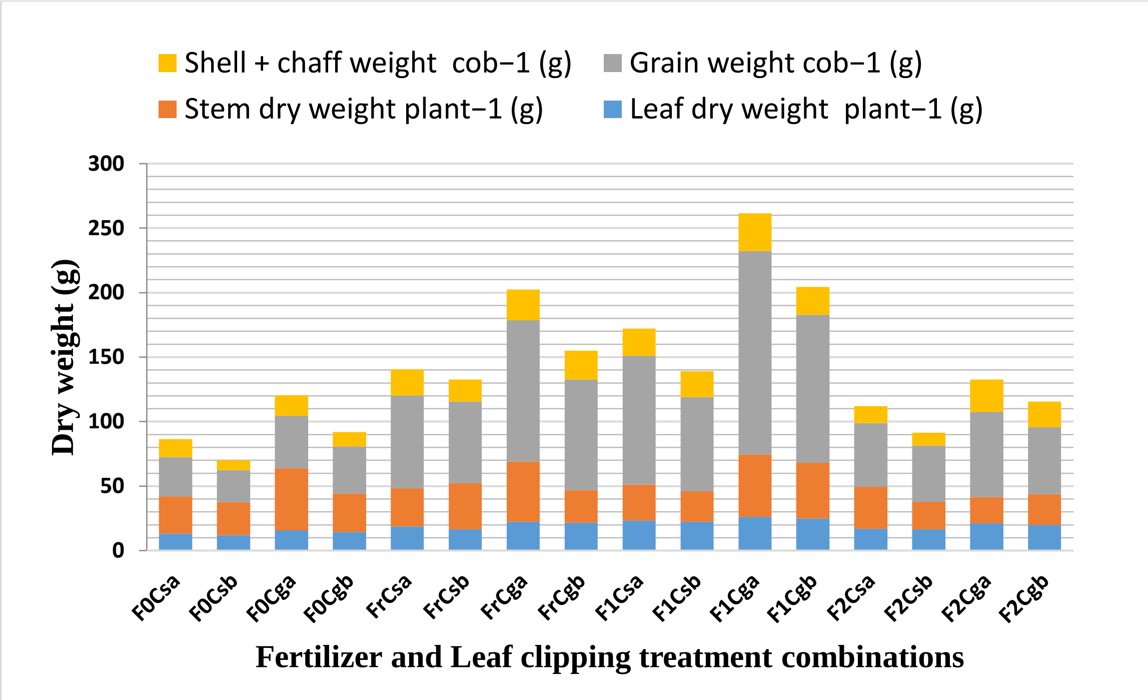
Table 9: Decrement of the values in grain yield/ha from the maximum obtained with the fertilizer and leaf clipping treatment. **

	The highest value	**Decrement from the highest value**		
Grain yield ha^{-1}	F125	F100	F75	F0
	7.32	− 1.05	− 1.53	− 1.96
	Cga	Cgb	Csa	Csb
	6.52	− 0.21	− 0.43	− 0.70

** In accordance with the data of Table -8

Again, when the per hectare grain yield is considered, the highest grain yield was obtained with F125 that is when 25% more than recommended dose of fertilizer was used. The grain yield gradually decreased with the decrease in the fertilizer dose showing 1.05, 1.53 and 1.96 t/ha, respectively from the doses F100, F75 and F0 than the maximum grain yield of F125 (Table 9). Likewise, from the table below, it may be seen that the grain yield per hectare decreased more with the clipping of the leaves below the cob at grain filling stage (0.21 t/ha) followed by that clipping the leaves above and below the cobs at silking stage (0.43 and 0.70 t/ha, respectively) than the maximum value of 6.52 tons' ha^{-1} obtained with the Cga treatment. Such results indicate that the removing leaves below the cob is more harmful in respect of grain yield/ha.

4.4 Partitioning of dry matter in plant components



F_0 – Control, F_r – Recommended dose of fertilizer, F_1 – 25% more than recommended dose of fertilizer and F_2 – 25% less than recommended dose of fertilizer.

C_{sa} – 4 leaves clipping above cobs at silking stage, C_{sb} – 4 leaves clipping below cobs at silking stage, C_{ga} – 4 leaves clipping above cobs at grain filling stage and C_{gb} – 4 leaves clipping below cobs at grain filling stage

Figure 11. Showing partitioning of dry matter into leaf, stem (node+internode), grain and shell+chaff in different treatment combinations of white maize (g/plant)

It was observed that irrespective of treatments, most of the dry matter was contained by the grain component followed by stem (node+internode), leaf and then by shell+chaff components of the white maize (Fig. 11).

Irrespective of treatments, most of the dry weight moved to grain (50.21%) which was then followed by stem (22.93%)(Fig. 12).The leaf and shell+chaff had same amount of dry matter (around 13%) in each of them

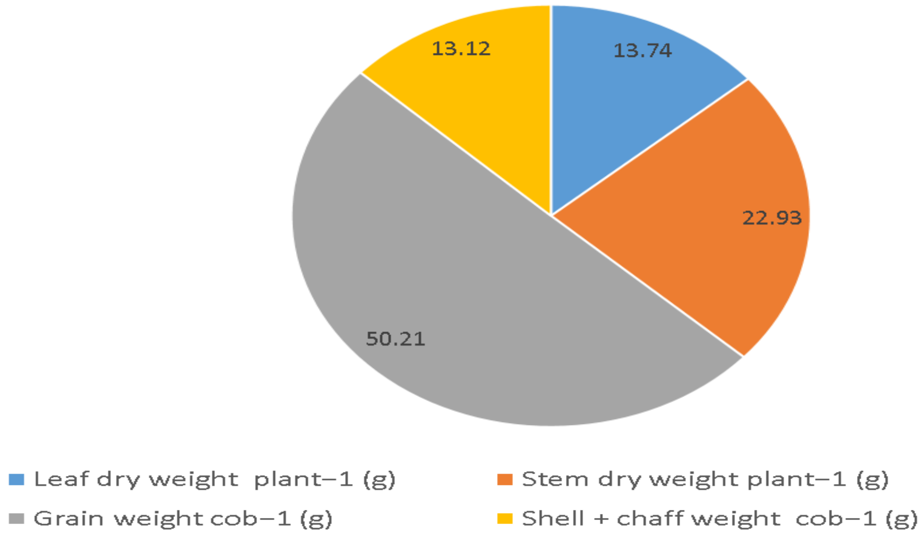


Figure 12: Showing partitioning of dry weight of a plant in leaf, stem (node+internode), grain and shell+chaff components of white maize (%)

It is observed from the Fig. 13that fertilizer treatment F_0 had the highest portion of dry matter in leaf of total (35.55%) which was significantly higher than those of F_r and F_2 (around 22%). The F_1 had the least (18.15%). Probably the unfertilized leaves could not transport dry weight to the grain due to some reasons.

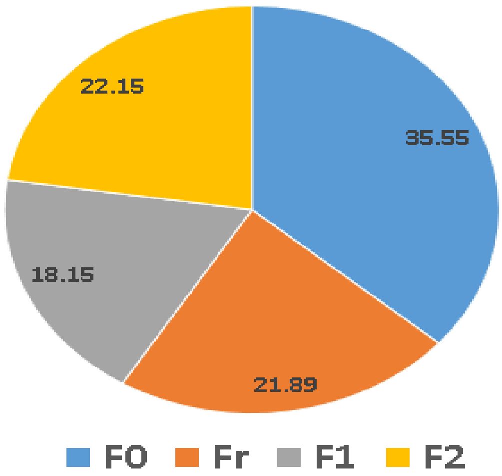


Figure 13: Showing partitioning of total dry matter per plant in leaf under varying fertilizer treatments (%)

The stem treated with F_2 had the highest dry weight (16.57% of total of a plant) which was a bit higher than that (15.35%) (Fig. 14). The treatments F_1 and F_r had similar level of dry matter (around 13% of total) in a single plant**.**

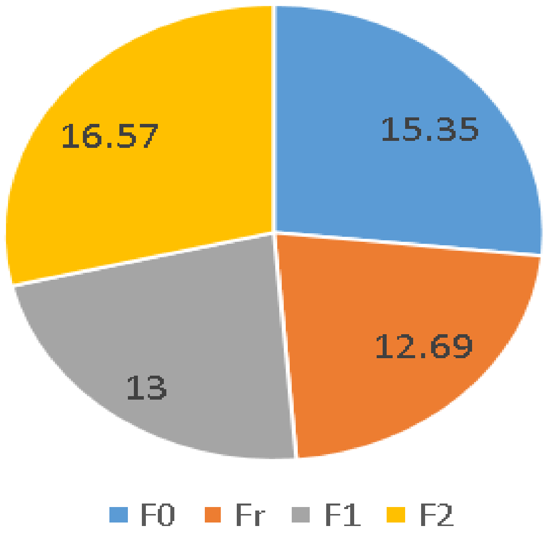


Figure 14. Showing partitioning of total dry matter per plant in stem (node+internode) under varying fertilizer treatments (%)

In figure 15, it is seen that F_1 had the most dry matter of the total (56.71% of the total) in the grain which was then followed by F_r (52.03%). F_2 had 46.62% of the dry matter in grain of the total and the least with F0 (36.07%).

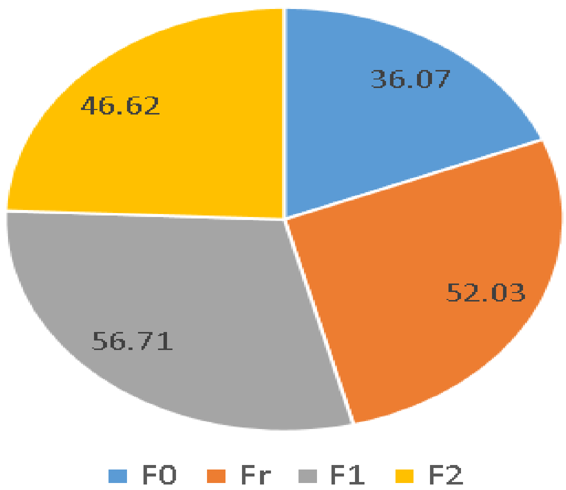


Figure 15. Showing partitioning of total dry matter per plant in grain under varying fertilizer treatments (%)

In figure 16, The shell+chaff with F_2 showed the highest partitioning of dry matter (14.67% of the total) and F_0 and F_r had similar share of dry matter (13.03 – 13.38%). The F_0 had the least shell+chaff dry weight (12.13%).

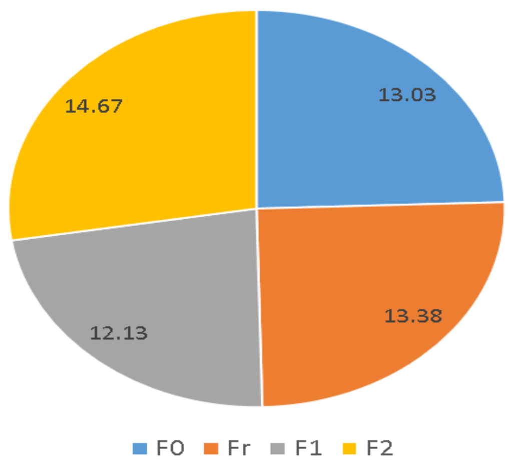


Figure 16. Showing partitioning of total dry matter per plant in shell + chaff under varying fertilizer treatments (%)

The leaf clipping treatment Csb had the highest portion of dry matter (15.93%) of the total dry matter per plant (100%) (Fig. 17).The share of dry matter in leaf under Csb was the highest (15.93% of total) which was then followed by Cgb and Csa (14.82 and 14.35% of total) and leaf clipping above cobs at grain filing stage Cga had the least (12.51%).

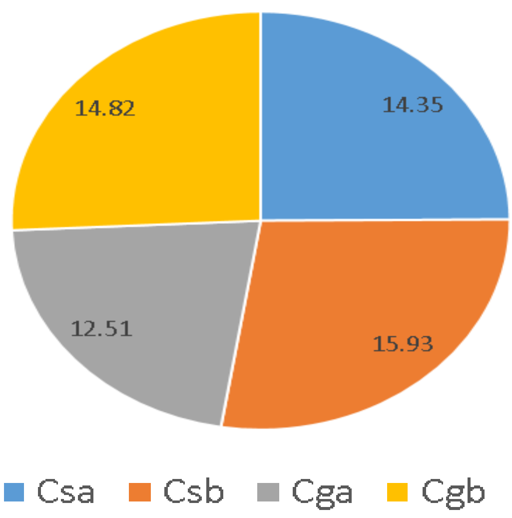


Figure 17. Showing partitioning of total dry matter per plant in leaf under varying leaf clipping treatments (%)

Csb had the maximum share of dry matter of the total in stem (25.92% of the total. (Fig. 18) which was then followed by Csa and Cga (24.93 and 24.28%) which were not highly lower as compared to that of Csb (Fig. 18). The least dry matter was found with Cgb (22.61%)

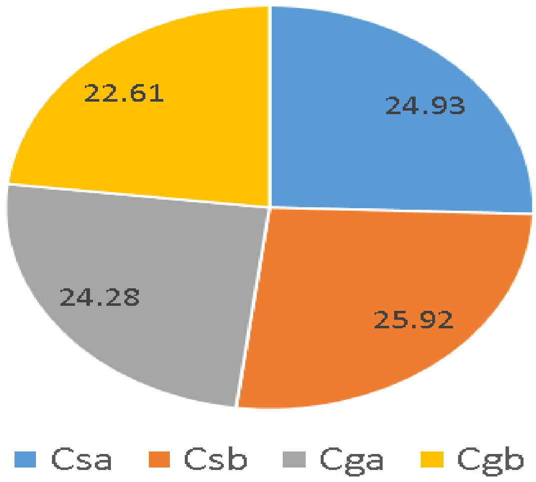


Figure 18. Showing partitioning of total dry matter per plant in stem under varying leaf clipping treatments (%)

The leaf clipping treatment Cga and Cgb had identical dry matter shares (49.06-49.41% of the total) in grain (Fig. 19). The second position was with Csa (47.05%) and the least with Csb (45.92%).

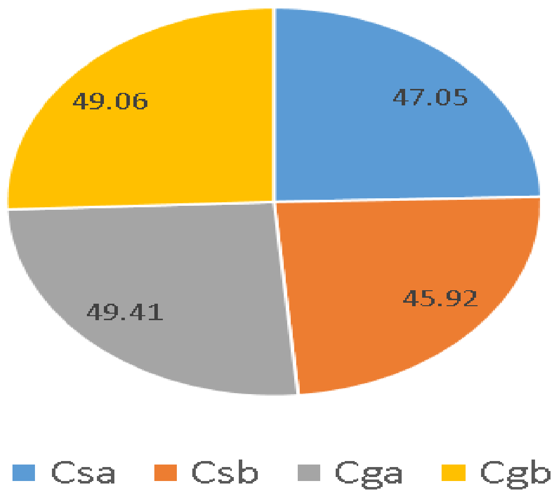


Figure 19. Showing partitioning of total dry matter per plant in grain under varying leaf clipping treatments (%).

Leaf clipping treatment of Csa, Cgb and Cga had almost similar share of dry matter in Shell+chaff (between 13 and 14% of the total). The Csb had the least (12.23%).

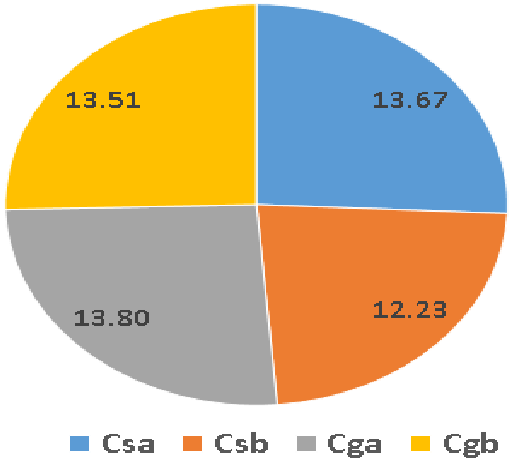


Figure 20. Showing partitioning of total dry matter per plant in shell+chaff under varying leaf clipping treatments (%)

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at Agronomy field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from July to November, 2018 in Kharif-II to study the effect of different level of fertilizer doses and leaf removal on the yield of white maize. The experimental field belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28. The planting materials was SAUD 18-3-3. The seeds were collected from White maize project, Sher-e-Bangla Agricultural University, Dhaka-1207.

The experiment comprised of two factors, Factor A: four level of fertilizer doses i.e. F_0 = No fertilizer application (control), F_r = Recommended doses of fertilizer,F_1 = 25% more than recommended doses of fertilizer and F_2= 25% less than recommended doses of fertilizer and four level of leaf removal i.e. C_{sa} = 4 Leaves clipping above cobs at silking stage, C_{sb} = 4 Leaves clipping below cobs at silking stage,C_{ga}= 4 Leaves clipping above cobs at grain filling stage and C_{gb} = 4 Leaves clipping below cobs at grain filling stage. The experiment was laid out in Completely Randomized Design with five replications. Total 80 unit pots were for the experiment with 16 treatments.

Effect of different level of fertilizer doses showed significant variation on growth, yield attributes and dry matter partitioning. 25% more than recommended dose of fertilizer (F_1) showed the tallest plant (27.60 cm, 85.16cm, 184.96cm and 188.45cm) at 30,60,90 DAS and harvesting time, respectively. Maximum leaf area plant^{-1} (660.80 cm^2), highest leaf dry weight plant^{-1} (24.27g), stem dry weight (35.19g), highest average single node unit dry matter weight plant^{-1} (3.03 g), longest cob (15.88 cm), highest cob circumference(19.97 cm), maximum cobs plant^{-1} (1.55), highest grain rows cob^{-1} (14.34), maximum number of grains cob^{-1} (358.30), highest grain weight cob^{-1}(111.30 g), maximum shell+chaff weight cob^{-1}(23.04 g), highest shelling percentage (81.39), maximum 1000 seeds weight (306.02 g), highest grain yield (7.32 t ha^{-1}), highest stover yield (8.33 t ha^{-1}), maximum biological yield (15.65 t ha^{-1}) and maximum harvest index (46.76%). On the other hand, no fertilizer application (F_0) showed the shortest plant , minimum leaf area plant^{-1} (496.33 cm^2), lowest leaf dry weight plant^{-1} (13.88 g), stem dry weight plant^{-1}(24.56), lowest average single node unit dry weight plant^{-1} (1.45 g), shortest cob (13.71 cm), lowest cob circumference (18.00 cm), minimum cobs plant^{-1} (1.20), lowest grain rows cob^{-1} (9.08), minimum number of grains cob^{-1} (227.10), lowest grain weight cob^{-1}(33.11 g), maximum shell+chaff weight cob^{-1} (12.12 g), lowest shelling percentage (75.58), minimum 1000 seeds weight (144.82 g), lowest grain yield (5.36t ha^{-1}), lowest stover yield (7.30 t ha^{-1}), minimum biological yield (12.66 t ha^{-1}) and minimum harvest index (42.35 %). The results obtained from all other treatments showed intermediate results compared to the highest and the lowest value of all growth and yield parameters.

Effect of leaf removal showed significant variation on grain filling stage (C_{ga}) showed the tallest plant (29.66cm, 90.86cm,192.33cm and 197.44cm) at 30,60,90 DAS and harvesting time, respectively. maximum leaf area plant^{-1} (609.65 cm^2), highest leaf dry weight plant^{-1} (21.36g), stem dry weight plant^{-1}(40.48g), highest average single node unit dry weight plant^{-1} (2.27 g), longest cob (17.54 cm), cob circumference (17.54 cm), maximum cobs plant^{-1}(1.72), highest grain rows cob^{-1} (13.92), maximum grains cob^{-1} (347.80), highest grain weight cob^{-1} (93.35 g), maximum shell weight cob^{-1} (23.58 g), highest shelling percentage (79.88), maximum 1000 seeds weight (252.94 g), highest grain yield (6.52 t ha^{-1}), highest stover yield (7.92 t ha^{-1}), maximum biological yield (14.44 t ha^{-1}) and maximum harvest index (45.16%). On the other hand, 4 leaves clipping below cobs of silking stage (C_{sb}) showed the shortest plant at different stages. minimum leaf area plant^{-1} (547.73 cm^2), lowest leaf dry weight plant^{-1} (16.85 g), stem dry weight (26.51g), lowest average single node unit dry weight plant^{-1} (1.80 g), shortest cob (11.56 cm), lowest cob circumference (11.56 cm), minimum cob (1.25), lowest grain rows cob^{-1} (9.92), minimum grains cob^{-1} (247.90), lowest grain weight cob^{-1} (51.25 g), minimum shell weight cob^{-1} (13.65 g), lowest shelling percentage (76.88), minimum 1000 seeds weight (201.87 g), lowest grain yield (5.82 t ha^{-1}), lowest stover yield (7.56 t ha^{-1}), minimum biological yield (13.38 t ha^{-1}) and minimum harvest index (43.53 %). The results obtained from all other treatments showed intermediate results compared to the highest and the lowest value of all growth and yield parameters.

Interaction effect of different doses of fertilizer application and different stage of leaf clipping showed significant results 25% more than recommende dose of fertilizer with 4 leaves clipping above cobs at grain filling stage (F_1C_{ga}) combination showed the tallest plant (35.07cm,107cm, 210cm and 220cm) at 30,60,90 DAS and harvesting time, respectively. maximum leaf area plant^{-1} (737.75 cm^2), highest leaf dry weight plant^{-1} (26.25g), stem dry weightplant^{-1}(48.33g), highest average single node unit node dry weight plant^{-1} (3.41 g), longest cob (18.50 cm), highest cob circumference (22.00 cm), maximum cobs plant^{-1} (1.93), highest grain rows cob^{-1} (17.67), maximum number of grains cob^{-1} (441.50), highest grain weight cob^{-1} (157.50 g), maximum shell weight cob^{-1} (29.38 g), highest shelling percentage (83.54), maximum 1000 grains weight (356.58 g),highest grain yield (9.78 t ha^{-1}), highest stover yield (8.58 t ha^{-1}), maximum biological yield (16.50 t ha^{-1}) and maximum harvest index (47.99 %). On the other hand, no fertilizer application with 4 leaves clipping below cobs of silking stage (F_0C_{sb}) combination showed the shortest plant at different stages, minimum leaf area plant^{-1} (464.53 cm^2), lowest leaf dry weight plant^{-1}(12.05g), stem dry weight plant^{-1}(20.41g), lowest average single node unit node dry weight plant^{-1} (1.28 g), shortest cob (10.00 cm), lowest cob circumference (16.00 cm), minimum cobs plant^{-1} (1.07), lowest grain rows cob^{-1} (8.33), minimum number of grains cob^{-1} (208.30), lowest grain weight cob^{-1} (24.94 g), minimum shell+chaff weight cob^{-1} (7.47 g), lowest shelling percentage (73.00), minimum 1000 grains weight (119.76 g), lowest grain yield (4.88 t ha^{-1}), lowest stover yield (7.00t ha^{-1}), maximum biological yield (11.88 t ha^{-1}) and minimum harvest index (41.04 %).In dry matter partitioning most of the dry weight moved to grain (50.21%) followed by stem 22.93%. The leaf and shell+chaff had same amount of dry matter (around 13%) in each of them. fertilizer treatment F_0 had the highest portion of dry matter in leaf of total (35.55%) which was significantly higher than those of F_r and F_2 (around 22%). Csb had the maximum share of dry matter of the total in stem (25.92% of the total plant). The leaf clipping treatment Cga and Cgb had identical dry matter shares (49.06-49.41% of the total) in grain and Csa, Cgb and Cga had almost similar share of dry matter in Shell+chaff (between 13 and 14% of the total). The Csb had the least (12.23%). The results obtained from all other treatments showed intermediate results compared to the highest and the lowest value of all growth and yield parameters.

It may be concluded from the results that application of fertilizer and leaf removal is very much promising for higher white maize yield.

The best fertilizer dose was 25% more than application of fertilizer and 4 leaves clipping above cobs at grain filling stage was showed better performance on growth and yield under the present study. More reduction was seen when the leaves were clipped in the silking stage, which indicates that the leaves should not be clipped at the silking stage.

The present experiment was conducted in one season and in a single location. Therefore, it is difficult to recommend this finding without further study. By considering the results of the present experiment, further studies in the following areas are suggested below:

1. Studies of similar nature could be carried out in different Agro Ecological Zones (AEZ) in different seasons of Bangladesh for the evaluation of zonal adaptability.
2. In this study, minimum ten levels of fertilizer doses with FYM and micronutrient and all stage of leaf removal in white maize should used to get accurate result.

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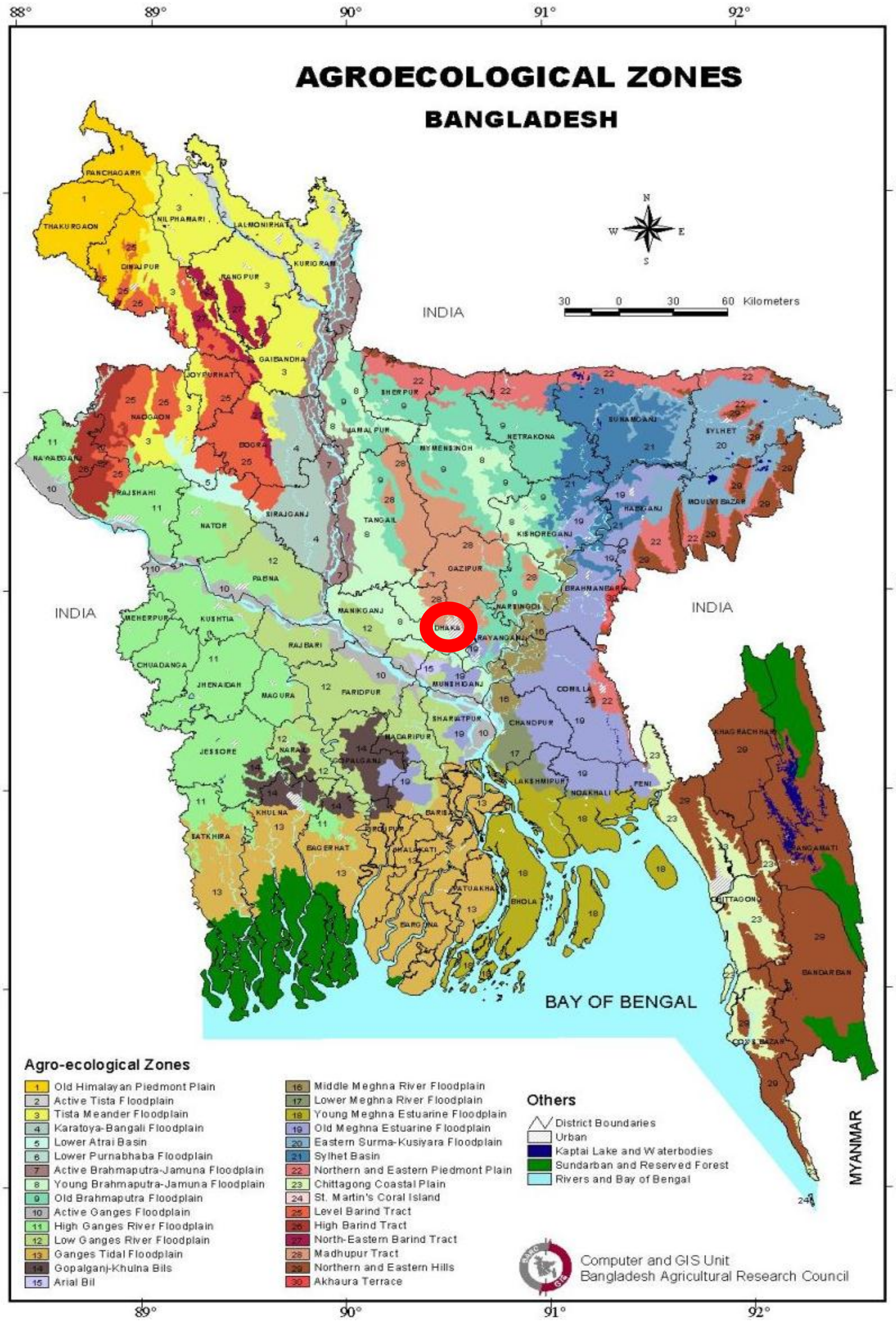
APPENDICES

Appendix I: Map showing the experimental sites under study



Appendix II: Characteristics of Agronomy Field soil is analysed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy Field, SAU, Dhaka
AEZ	Modhupur Tract (28)
General 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	Potato-Aman rice-Maize

A. Physical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
% Clay	30

B: Chemical properties of the initial soil

Characteristics	Value
Textural class	Silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (me/ 100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI) 2018

Appendix III: Monthly average temperature, relative humidity and total rainfall of the experimental site during the period from July to November 2018

Year	Month	Air Temperature (°C)			Relative Humidity (%)	Total Rainfall (mm)	Sunshine (Hour)
		Max (°C)	Min (°C)	Mean (°C)			
2018	July	34	28	31	74	380.6	194
	August	34	27	31	73	254.8	203.5
	September	32	25	29	73	316.5	158.5
	October	32	25	30	69	221.6	214.5

Source: Bangladesh Metrological Department (Climate and weather division) Agargaon, Dhaka.

Appendix IV: Analysis of variance (ANOVA) of data on plant height (cm) of white maize

Source of variation	Df	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
Fertilizer(A)	3	90.227*	353.293*	501.283*	682.253*
Clipping (B)	3	603.291*	892.382*	956.283*	1035.873*
A × B	9	1021.293**	1352.381*	1592.934*	1809.714*
Error	64	0.011	0.45	0.79	1.691

*Significant at 5% level of probability

** Significant at 1% level of probability

Appendix V: Analysis of variance (ANOVA) of data on leaf area plant^{-1} (cm^2), leaf dry weight plant^{-1} (g), stem dry weight plant^{-1} (g) and average single node unit dry weight plant^{-1} (g) of white maize

Source of variation	Df	Leaf area plant^{-1} (cm^2)	Leaf dry weight plant^{-1} (g)	Stem dry weight plant^{-1} (g)	Average single node unit dry weight plant^{-1} (g)
Fertilizer(A)	3	26689.103*	13.243*	80.570*	1.304**
Clipping (B)	3	62051.824*	6.171*	193.45**	1.222**
A × B	9	9900.416*	0.654**	0.81*	2.733**
Error	64	25.227	0.015	2.02	0.001

*Significant at 5% level of probability

** Significant at 1% level of probability

Appendix VI: Analysis of variance (ANOVA) of data on cob length (cm), cob circumference (cm), number of cobs plant^{-1}, number of grain rows cob^{-1} and number of grains cob^{-1}of white maize

Source of variation	Df	Cob length (cm)	Cob circumference (cm)	No. of Cobs plant^{-1}	No. of grain rows plant^{-1}	No. of grains cob^{-1}
Fertilizer (A)	3	15.602*	18.437*	0.509**	91.230*	62024.214*
Clipping (B)	3	122.636*	52.104*	0.959**	16.818*	36110.026*
A × B	9	1.521**	0.525**	0.112**	24.453*	4480.655*
Error	64	0.036	0.020	0.001	0.107	1.717

*Significant at 5% level of probability

** Significant at 1% level of probability

Appendix VII: Analysis of variance (ANOVA) of data on grain weight cob^{-1} (g), Shell weight cob^{-1} (g), shelling (%) and 1000-seeds weight (g)of white maize

Source of variation	Df	Grain weight cob^{-1} (g)	Shell +chaff weight cob^{-1} (g)	Shelling (%)	1000-seeds weight (g)
Fertilizer (A)	3	23459.596*	2.987**	125.047*	32944.259*
Clipping (B)	3	6359.720*	2.011**	31.629*	91.337*
A × B	9	864.195*	1.536**	1.879**	27366.618*
Error	64	0.060	0.001	0.061	1.344

*Significant at 5% level of probability
** Significant at 1% level of probability

Appendix VIII: Analysis of variance (ANOVA) of data on grain yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}) and harvest Index (%) of white maize

Source of variation	Df	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Fertilizer (A)	3	21.601*	5.670*	50.084*	74.081*
Clipping (B)	3	2.755**	0.694**	6.212*	10.173*
A × B	9	0.221**	0.050**	0.309**	1.738**
Error	64	0.004	0.013	0.006	0.032

*Significant at 5% level of probability

** Significant at 1% level of probability

Plate 1. Photograph showing 4 leaves clipping above cobs at silking stage

Plate 2. Photograph showing 4 leaves clipping below cobs at silking stage

Plate 3. Photograph showing general view of reproductive stage of white maize

Plate 4. Photograph showing cobs of white maize