EFFECT OF INDIGENOUS MULCHES ON THE MORPHOPHYSIOLOGICAL AND YIELD ATTRIBUTES OF WHITE MAIZE (*Zea mays* L.)

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CERTIFICATE

This is to certify that the thesis entitled ***"EFFECT OF INDIGENOUS MULCHES ON THE MORPHOPHYSIOLOGICAL AND YIELD ATTRIBUTES OF WHITE MAIZE(Zea mays L.)"*** *submitted to the Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (MS) in AGRICULTURAL BOTANY****, embodies the results of a piece of bonafide research work carried out by* ***PARVIN AKTER BITHY,*** *Registration No.* ***10-03858*** *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 during the course of this investigation has been duly acknowledged and style of this thesis have been approved and recommended for submission.

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Dedicated to My

"Beloved Parents and Supervisor"

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EFFECT OF INDIGENOUS MULCHES ON THE MORPHOPHYSIOLOGICAL AND YIELD ATTRIBUTES OF WHITE MAIZE (*Zea mays* L.)

ABSTRACT

The experiment was conducted at the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, during the period from November 2015 to May 2016 to find out the effect of indigenous mulches on the morpho-physiological and yield attributes of white maize (*Zea mays* L.). This experiment was comprised of two factors. Factor A: Variety (2): V_1 = Shuvra; V_2 = KS-510 and Factor B: Indigenous mulch materials (5): T_1 = Control (without mulch); T_2 = Water hyacinth; T_3 = Rice straw; T_4 = Rice husk; T_5 = Ash. The two factor experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and the differences between means were separated by both Duncan's New Multiple Range Test (DMRT) and Least Significant Difference (LSD) test at 5% level of probability. Different morphophysiological data were recorded at different Days After Sowing (DAS) from 30 to 120 DAS and yield contributing data were recorded after harvesting of cob. In case of variety the highest plant height at 120DAS (221.34cm) was recorded from V_1 and the highest SPAD meter reading at 120DAS (40.05), soil moisture at 30cm depth in 120DAS (28.55%), total dry matter after harvest (381.24gm per plant), stem base diameter at harvest stage (25.07cm) and grain yield (12.963ton per ha) was recorded from $V_{2.}$ In case of indigenous mulch materials the highest values were recorded from T_3 for all morphophysiological and yield attributing characters at different DAS. Due to this (T_3) mulch material seedlings were quickly emerged and tasselling, silking, cob appearance were hastened by (10-12) days than T_1.The highest total dry matter after harvest (511.92gm per plant) was recorded from T_3. Weed growth were also the lowest (14.87gm per m^2) in T_3. The highest grain yield (17.407ton per ha) was recorded from T_3. The water retentive capacity of the mulched soil were higher at all the stages of plant growth and ranked in the order of rice straw > water hyacinth > rice husk > ash > control. In case of interaction the highest value of plant height (261.47cm), number of leaves per plant (17), Leaf Area Index (5.58), was recorded from V_1T_3 at 120DAS. The highest value of SPAD meter reading (72.3) at 60DAS, soil moisture (36.03%) in 30cm depth at 120DAS were recorded from V_2T_3. The highest value of total dry matter after harvest (544.72gm per plant), stem base diameter at harvest stage (32.41cm) and all yield attributing characters include grain yield(19.043ton per ha) was recorded from V_2T_3. So, KS-510 variety and rice straw mulch combinedly had outstanding superiority for morphophysiological and yield attributes in white maize over the other indigenous mulches.

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ABBREVIATIONS AND ACRONYMS

AEZ	: Agro-Ecological Zone
ANOVA	: Analysis of Variance
CV%	: Percentage of Coefficient of Variation
df	: Degrees of freedom
BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistics
et al	: And others
FAO	: Food and Agricultural Organization
%	: Percentage
DM	: Dry matter
DAS	: Days After Sowing
TDM	: Total Dry Matter
LAI	: Leaf Area Index
^0C	: Degree Celsius
gm	: Gram
pH	: Potential hydrogen

CHAPTER I

INTRODUCTION

Maize is one of the most important cereal crops in the world agricultural economy both as food for men and feed for animals including poultry. Maize is also known as the queen of cereals because of very high yield potential. The average production of maize is higher than other cereal. Maize can be considered and introduced as the first important cereal crop to meet up this requirement (BBS, 2011). Maize is the highest grain yielding cereal crop compared to wheat, rice and other cereals. The average global production of maize in 2010 was 840308214 tones as compared to 696324394 tones of rice and 653654525 tones of wheat respectively (FAO, 2012). The origin of maize in Mexico and now it is principle crop in many countries of temperate region. Bangladesh is densely populated country. It is one of the developing countries in the world. Many people live here under poverty line and they cannot consume proper calorie which they need. So, Bangladeshi policy makers face problem when they make policy to control malnutrition of our country. Maize is very important crop for malnutrition because it contains many nutrient such as carbohydrate, protein, fat, fiber, vitamin A, vitamin E, etc. which quantity is greater than wheat nutrient contains. So maize is highly nutritious. Maize has multipurpose uses. It is consumed as flakes, bread, chapatti, powder, popcorn, corn flower, corn soup, sucrose (2.5%), corn oil, boiled corn, corn hotchpotch, corn biscuit, corn curry, corn cake, corn sweet, corn starch, corn porridge, Horlicks, boost, corn syrup, maltova, canned sweet corn etc. Young maize plants are also used as the cattle feed and used for made thatched house, organic matter and fuel in different countries. For this multifarious efficiency maize should get serious attraction for cultivation of maize in Bangladesh. Now-a-days white maize is very important because it is cultivated to reduce pressure from rice and wheat. White maize is highly delicious and protinaceous. The flour of white maize is so finer than yellow maize as a result it is principle food of people of many countries in the world. More than 30 species have been discoverd from these white maize. The types of delicious food are made from rice and wheat, the similar types food are also made from white maize. The main characteristics of white maize is it needs only one irrigation where as other yellow maize varieties need 2 to 3 irrigation and when maize production is done by mulching its yield is so high. As a result farmers get more yield with less cost. In our country maize are normally cultivated in winter season. In the time of winter season the rainfall is scarce and for the lower rainfall the water is not distributed evenly in the maize field. Maize is a C_4 plant which can tolerate adverse condition and if irrigation facilities are not available the yield is reduced drastically because cob maturity of maize depends on physiological water. Though irrigation facilities are not available in our country in winter season the rainfed cultivation of maize become indispensible in those areas. Where irrigation facilities are available the cost of irrigation is high. Most of the farmers in our country are poor and this high cost irrigation is burden for them. For these reasons rainfed cultivation of maize with different mulches are very effective for drought prone areas. Mulching is a very useful practice to retain soil moisture in crop field. Mulching is a desirable management practices which regulate farm environment and increase crop production through regulating soil temperature (Khan, 2001) by reducing leaching and evapotranspiration (Liu *et. al.* 2000) by increasing soil organic matter content (Roldan *et. al.* 2003) and reduced nutrient loss due to run off (Smart and Bradford,1999). The lower cost indigenous mulches are water hyacinth, rice straw, rice husk, ash are effective to retain soil moisture in maize field. Water hyacinth *Eichhornia crassipes* (Pontederiaceae, Liliales) is a floating aquatic weed are considered as a valuable source of macronutrient such as phosphorous, nitrogen, potassium, that are indispensable for plant nutrition (Woomer *et. al*.; Sahu *et. al*. 2002; Center *et. al*. 2002; Gupta *et. al.* 2004). Different morpho-physiological characters of maize such as plant height, number of leaves/plant, leaf length and breadth, base diameter, root weight, tassel weight, Leaf Area Index (LAI), are positively and significantly influenced by all mulches but having maximum value of rice straw and water hyacinth mulches. Water hyacinth and rice straw treated plants had the minimum specific leaf area and root shoot ratio at most or all of the growth stages resulting in increased yield contributing attributes, grain yield and harvest index compared to other mulches and control. Tasseling and silking were hastened by 8-10 days and crop maturity by 6-7 days in water hyacinth and rice straw mulches. Straw mulch was effective in improving soil physical conditions if it was used as organic amendment to the soil surface in tropical environments including protection of the topsoil. Rice husk are similar effective to rice straw and ash are also effective for maize production in field without irrigation. Ash is good source of potash. Potash is helpful for reduction of necrosis. Mulching practice also enhanced the number of cob/plant, cob length, cob diameter, tassel length, number of seed row/cob, number of seed/row, weight of rachis/cob, 1000 grain weight, grain yield and higher Harvest Index (HI). The grain yield of rice straw and water hyacinth is more than double than un-mulched plant under non-tilth condition. The indigenous mulches suppress weed growth specially rice straw and water hyacinth. No research work has been carried out yet to investigate the effect of indigenous mulches on white maize. Considering the above facts this study has been undertaken to investigate the response of morpho-physiological and yield attributes of white maize plant using different indigenous mulches.

OBJECTIVES

- To find out the effect of different indigenous mulches on different morpho-physiological features of white maize.
- To evaluate the yield of white maize as influenced by different indigenous mulches.
- To identify the most effective mulch in respect of growth and yield performance of white maize.

CHAPTER II

REVIEW OF LITERATURE

Maize is an important cereal crop in the world as the first position in the production efficiency and the third in the cereal crop. As a result many research works have been conducted on maize by many researchers. Different investigator of home and abroad worked with different indigenous mulches on the production of maize concerning the morpho-physiological and yield attributes. Different informations available on this subject from various studies by different researchers have been reviewed in this chapter.

2.1 EFFECT OF MULCHES ON MORPHOPHYSIOLOGICAL CHARACTER OF MAIZE

An experiment was conducted to evaluate the effectiveness of indegenous mulches on the conservation of soil moisture and growth of maize. For that experiment five mulches rate such as 0, 2, 4, 6 and 8 ton/hawhich are arranged in Randomized Complete Block Design with four replications. In 8 ton/ha mulch rate high soil moisture conserve and then gradually decrease with the mulch rate. In case of growth highest plant height and no. of leaves were maximized at 8ton/ha rate where lowest plant height and lowest no. of leaves/plant was recorded in the unmulched control plots (Uwah and Iao, 2011).

A experiment was conducted to evaluate the efficacy of conservation tillage on the reproductive attributes (days to tasseling, days to cob appearance, days to silk appearance) development and production potentials of Quality Protein Maize (QPM) cv. Pozarica under organic mulches. That study encircle tillage and zero tillage condition with four indigenous mulches as water hyacinth, rice straw, rice husk, ash. Mulching practice increase the plant height, length of leaf and stem base diameter, tassel length etc. (Khan and Parvez, 2010).

A field experiment was conducted to evaluate the effect of different compost type mulching (maize stalk, cucumber canopy and rice straw) and methods of application of compost (25 cm deep +bed, 25 cm deep + turned and mulched) on the growth and yield of three maize hybrids (single cross 10, single cross 155 and three way cross 324). Highest result of plant height recorded from the mulch compost and cucumber canopy compost. Single cross 10×cucumber canopy compost×mulch application method interaction showed the highest significant results of plant height and N, P and K% content in leaves at 75DAS (Hassanein and Abul-Soud, 2010).

A field experiment was conducted on 7 year old guava tree based agri-horti system where treatments are row spacing (30 cm, 40 cm and 60 cm) and mulching (no mulch, rice straw mulch, green weed mulch and dust mulch). 3.15m, 21.50cm and 5.90m are the height, girth and canopy of 7 year old guava tree. The significantly highest plant height was recorded (215.06 cm) from rice straw mulch where lowest plant height (207.07cm) on control treatment. No. of leaves per plant was (12.71) showed significantly in rice straw mulch and it is statistically similar with green weed mulch (12.47) over the dust mulch and no mulch at 80DAS. At harvest stage higher dry matter accumulation /plant (65.33g) in 60 cm row spacing. In 45 cm row spacing with rice straw mulch showed highest uptake of nitrogen, pottassium and phosphorous by grain (Rajput *et, al*., 2014).

Mulching improves Leaf Area Index(LAI) and plant height. An experiment where wheat straw mulch was used (0 ton/ha and 6 ton/ha) and planting method (flat and cannel) was followed to find out the effect on maize which sown at different dates an improvement of LAI to 0.42 and plant height by 14 cm respectively were observed (Sidhu *et, al*., 2007).

A study showed that growth, yield attributes and yield as well as maize equivalent were significantly improved with farmyard manure (FYM) + dust mulch + straw mulch treatment over no mulch. Among the moisture conservation practices, higher WUE was recorded under FYM + dust mulch + straw mulch, closely followed by Kaolin + dust mulch + straw mulch (Rana *et, al*., 2006).

A field experiment was studied at Punjab Agriculture University, Ludhiana on maize and reported that dry matter production with rice straw mulch was higher by 138% than the dry matter production from bare plots (Bhatt *et, al.*, 2004).

It was reported that water hyacinth and rice straw mulched plants maintained higher chlorophyll stability indices which showed high SPAD meter reading indicating their greater ability to combat drought conditions (Khan, 2001).

A study showed that higher chlorophyll stability index (CSI) of maize in water hyacinth and rice straw mulched treatments compared to other mulched and non-mulched treatments (Rahman, 2002).

An experiment showed that when used rice straw mulch and water hyacinth in maize field it devloped morpho-physiological character such as plant height, no of leaves per plant, leaf length and breadth, no of roots per plant, leaf area index (LAI) , crop growth rate (CGR), net assimilation rate (NAR), total dry matter content etc. of maize plant (Rahman, 1999).

Plant height and crop growth rate of maize were improved considerably and significantly under paddy straw mulch as compared to saw dust, coir dust, rice husk and no mulch treatments (Pramanik, 1999).

A study showed that mulching with water hyacinth and rice straw increased the LAI of maize with their maximum at 90 DAS compared to control. LAI was also affected by environmental factors especially temperature and moisture (Awal and Khan, 1999).

Another study showed that sweet corn grown under clear plastic mulch shortened the time to maturity by 10 days on the silt loam site of Midwestern USA (Aguyoh *et, al.*, 1999).

An experiment was conducted about the weed suppression by using mulch material. For this experiment chaffed herbage (2-3) cm of four crops: sorghum+sunflower+rice+maize are used. Different combination are used where each crop at a rate of 6ton/ha and then applied as mulch material in the surface. An weedy check control are also used for comparison with mulching. A weedy check control consist with s-metachlor and atrazine. When applied mulching in the maize field weed infestation are suppressed drastically compare with the weedy check control and increase maize growth and yield (Mahmood, *et, al*., 2016).

A study was done to develop the management and protection of soil and water. The effect of rice husk as mulch was examined for maize production. The seeds of maize were planted in two different depths (4 and 6 cm) and the husk of rice was injected in different conditions (lateral part of row and sub row) by a mulch planter in a farm of Shahrkcord. Different mulches were placed in soil (without mulch, 200, and 300 g per a meter of length). A factorial design based on complete randomized block was performed. Indices of plant height, weight of ear, diameter of ear, length of ear, weight of ear sheath, height growth rate of plant, and seed numbers in each ear were measured. Results showed that differences were significant in the indices of plant height, height growth rate of plant, and seed numbers in each ear. In the other indices were not seen significant differences. The results also showed that there was no significant difference in the weight of ear and ear sheath. The depth of 6 cm, 300 g mulch per a meter, and injected mulch in the lateral part of row enhanced growth of plant height and seed numbers in each ear (Dehcordi *et. al*., 2015).

Mulching effects of sawdust, ash, rice straw and water hyacinth on growth, dry matter partitioning, earliness, yield attributes and yield of maize were studied. All mulches except sawdust significantly influenced the SLA, CGR, NAR and DM partitioning, but with no apparent effect on RGR. Water hyacinth and rice straw mulches hastened the tasseling, milking and maturity time by 6, 8 days respectively and produced double the amount of biological and economic yield as compared to the control and sawdust, the ash mulch behaved intermediately. Significantly higher harvest index was also observed under water hyacinth and rice straw mulches (Awal and Khan, 1998).

2.2 EFFECT OF MULCHES ON YIELD ATTRIBUTING CHARACTER OF MAIZE

A field to develop rainfed agriculture in northern China with three straw mulching rates (0, 6, and 12 t/ha) on two plant types (a compact type, Chaoshi1, and a flat type, Danyu86) during the summer maize–growing season in 2009 and 2010. In 2009, the results indicated that the grain yields of Danyu86 in 2009 and Chaoshi1 in 2010 were significantly (*LSD*, $P < 0.05$) higher with straw mulching at the rate of 12 t ha^{-1} than on the application of other treatments. Irrespective of whether precipitation was concentrated during the beginning or the latter half of the summer maize growing stage, straw mulching increased the WUE of Chaoshi1, but not of Danyu86. These results indicated that under rainfed conditions in northern China, straw mulching could increase the grain yield and WUE of compact–type maize (Shen *et, al*., 2012).

A field experiment was conducted to study the effect of field layout, tillage and straw mulch on crop performance, water use efficiency and economics for five years (2003–2008) in northwest India. Straw mulch reduced the maximum soil temperature at seed depth by about 3 ◦C compared to the no mulch. During the wheat emergence, raised beds recorded 1.3^{o}C higher soil temperature compared to the flat treatments. Both maize and wheat yields were similar under different treatments during all the years. Straw mulch showed no effect on water use and water use efficiency in maize. However, higher growth and yield and maximum net returns from the maize–wheat system were in straw mulch in no tillage and permanent raised beds than with conventional tillage (Ram *et, al*., 2012).

An experiment was conducted at the Department of Botany, University of Ibadan where the maize plants planted on soil treated with water hyacinth produced the best yield of maize (in terms of cob) of 80.3g with B.E. of 25.19% followed by those planted on the NPK treated soil with yield of 76.4 (B.E. of 23.96%) and Urea treated plants with yield of 66.2 (B.E 20.77%) (Asemoloye *et, al*., 2012).

An experiment was laid out in Randomized Complete Block (RCB) design in maize crop, having eight treatments and four replications. The treatments were wheat straw, saw dust, polyethylene (white), polyethylene (black), newspaper, PrimextraGold 720SC @1.0 lit ha^{-1}, hand weeding and weedy check were also included in the studies. Data were recorded on number of kernels cob-1, 100-kernel weight (g), biological yield of maize (t ha^{-1}) and grain yield (t ha^{-1}). For controlling weeds, the maximum grain yield was recorded in Primextra Gold 720SC, polyethylene (black), hand weeding and polyethylene (white) with grain yield of 2.98, 2.48, 2.06 and 2.03 t ha^{-1}, respectively. Minimum yield (1.36 t ha^{-1}) was recorded in the weedy check plots (Khan *et, al*., 2011).

Two field experiments were conducted during 2006 and 2007 in Peshawar, using open pollinated maize variety "Azam" in RCB design with split–split plot arrangements having three factors viz., tillage, maize populations and mulches. Higher grain yield (2863 kg) was recorded in hand weeding and statistically at par with black plastic mulch (2813 kg), followed by weeds mulch (2460 kg), white plastic (2398 kg) and living mulch (2145 kg ha^{-1}), respectively as compared to weedy check (1422 kg ha^{-1}). Less fresh weed biomass was observed in hand weeding (112 kg) which was at par with black plastic mulch (120 kg), followed by weeds mulch (164 kg), white plastic mulch (191 kg) and living mulch (195 kg) as compared to check (260 kg ha^{-1}). In light of two years study, conventional tillage with 90000 plants ha^{-1}along with hand weeding or black plastic mulch proved to be the best in terms of weed management and grain yield (Gul *et, al*., 2011).

A two–year field experiment was conducted at the Changwu agro–ecosystem research station to evaluate the effects of mulch and irrigation practices on moisture and temperature in the upper layers of the soil and on crop growth and yield performance in spring maize (*Zea mays L*) fields. Four mulching and irrigation treatments were examined: supplementary irrigation (SI), film mulching (FM), straw mulching (SM; in 2008 only) and a rain–fed (RF) control. Over the whole season, the average topsoil water content was significantly higher ($P < 0.05$) under the SM (23.3% in 2008), SI (21.4% in 2007, 22.5% in 2008) and FM (20.0% in 2007, 21.6% in 2008) treatments than under RF (17.1% in 2007, 19.6% in 2008). The seasonal trends in atmospheric and soil temperatures were similar under all treatments. The seasonally–averaged soil temperature at 07:00 and 14:00 h was the highest under the FM treatment and the lowest under the SM treatment. Both the FM and SI treatments significantly improved ($P < 0.05$) the crop grain yield (GY) and yield components (Yi *et, al*., 2011).

A field experiment was conducted at Selakui, Dehradun during 2001–04 to study the effect of tillage (conventional and minimum) and mulching practices (no mulching and live mulching) under artificially created varying land slopes (0.5, 2.5, 4.5 and 9.5%) on soil–moisture conservation, productivity and nutrient uptake in maize (*Zea mays* L.)–wheat (*Triticum aestivum* L.) cropping system. Sunnhemp (*Crotalaria juncea* L.) intercropped with maize gave 0.87–1.09 tonnes biomass (dry weight) and accumulated 24.8–31.4 kg N/ha at 30 days of growth when it was mulched. Intercropping of maize with sunnhemp and spreading the cut biomass as mulch at 30 days (live mulching) improved yield of maize (12.0%) as well as of following wheat (13.8%) compared with the no mulching (Ratan *et, al*., 2011).

A field experiment was conducted to study the effect of *in situ* grown live mulching with legumes viz. sunnhemp (*Crotalaria juncea* L.), dhaincha (Sesbania aculeata Pers.) and cowpea [*Vigna unguiculata* (L.) Walp.], besides weed mulching at 30 and 45 days of maize (*Zea mays* L.) growth on moisture conservation, crop productivity and soil properties in maize–wheat (*Triticum aestivum* L.) cropping system. Mulching at 45 days adversely affected maize growth and yield but was more beneficial to the following wheat due to addition of greater biomass and N. Maize productivity was 5.6–8.8% higher with legume mulching at 30 days when compared with no mulching (Sharma *et, al*., 2010).

A field trial was conducted on the four indigenous mulches viz. water hyacinth, rice straw, rice husk and ash were used for this study under tillage and zero tillage condition. Mulching practices enhanced the number of cob plant^{-1}, cob height, number of seed rows cob^{-1} and seeds row^{-1}, 1000–grains weight, weight of rachis cob^{-1}, grain yield and higher harvest index (HI) of Quality Protein Maize (QPM) cv. Pozarica. The grain yield of mulched plants notably water hyacinth was nearly double (8.73 t ha^{-1}) than unmulched plants (4.93 t ha^{-1}) under non-tilth condition (Khan and Parvej, 2010).

In the sub-mountainous northwestern Himalayan regions of India, observed that mulching is very beneficial for enhancing moisture and nutrient conservation, resulting in increased corn productivity and improved soil conditions for the maize–wheat cropping system(Sharma *et, al*., 2010).

Straw mulching reduced the latent heat flux, thereby decreasing soil evaporation. The LAI during the latter half of the growing season was higher on the application of the mulching treatments than on the application of the non–mulching treatments; thus, the transpiration ratio and phase evapotranspiration increased with mulching. As a result, the soil moisture content at maturity was much lower on the application of the mulching treatments than on the application of the non–mulching treatments (Li *et al*., 2008).

Straw mulching can improve soil nitrogen availability, increase plant growth and influence the physical and chemical properties of the soil. Hence, many researchers consider straw mulching for enhancing maize productivity (Govaerts *et al*., 2007).

An experiment trial on the maize crop was conducted on sandy loam soil for four years (1999–2002) to study the effect of wheat straw mulch (0 and 6 t ha^{-1}) and planting methods (flat and channel) on maize sown on different dates. Mulching, on an average, improved grain yield by 0.24 t ha^{-1} and biomass by 1.57 t ha^{-1}, respectively. Mulching improved grain yield only in flat sowing (Sidhu *et al*., 2007).

A field experiment trial during 2005–06 and 2006–07 to find out the effect of polythene mulch on sweet corn and revealed that the different yield attributes *viz*. cob length, cob girth, number of grains per cob, number of grain rows, weight of grains per cob and weight per cob during both the years and in the mean of two years were recorded significantly superior under polythene mulch over no mulch. He also find out the effect of polythene mulch on sweet corn and revealed that number of cobs per plant were significantly higher under polythene mulch during 2006–07 and in the mean of two years and during 2005–06 the differences was not significant. The cost of cultivation, gross returns, net returns were higher under polythene mulch and lowest with control during both the years. The B:C ratio under polythene mulch was at par with control (Pinjari, 2007).

A field study was conducted to evaluate the effect of different tillage systems and mulch levels on soil physical properties and growth of maize. Three tillage systems (minimum, deep & conventional tillage) and four mulch levels (control, wheat straw @ 4, 8 & 12 Mg ha^{-1}) were used. Mulch significantly affected the soil physical properties and growth of maize. Total dry matter (27.18 Mg ha^{-1}), number of cobs per plant (1.06), number of grains per cob (610.55), and 1000–grain weight (398.68 g) of maize were maximum when mulch was applied @ 12 Mg ha^{-1}, while maximum values of grain yield (5.77 Mg ha^{-1}) and soil bulk density (1.53 Mg m^{-3}) were obtained when mulch was applied @ 8 Mg ha^{-1} and in control, respectively (Khurshid *et. al*. 2006).

An experiment conducted at Aspee foundation, Thane on sweet corn reported that the data pertaining to yield attributes indicated that some of them were influenced significantly namely weight of cob, length of cob and kernels per cob by the mulches than no mulch treatments. Number of rows per cob and number of cobs per plant were not influenced significantly. Highest green cob and stover yield (246.69 and303.61 q/ha, respectively) were recorded under polythene mulch than control (194.38 and 235.11 q/ha, respectively). The gross return, net profit and B:C ratio were higher under polythene mulch (Gosavi,2006).

A field experiment conducted at Atlantic Cool Climate Crop Research Centre, Agriculture and Agri–food Canada on sweet corn reported that the plastic mulch increased the total biomass yield and cob yield by 8–17% and 3–6% over no mulch, respectively (Kwabiah,2004).

A field trial studied at Punjab Agriculture University, Ludhiana on corn that straw mulch increased the cob yield by 60.5% as compared to un-mulched treatment (Bhatt *et al*. 2004).

An experiment was studied to evaluate the effect of tillage and different modes of straw mulch application on corn yield was carried out in a submontaneous rainfed tract of Punjab, India. Minimum tillage was more effective in conserving soil moisture than the conventional tillage. Dry matter yield in unmulched plots was 138% higher as compared to the controlled plots whereas minimum tilled plots had 22% higher values of dry matter yield as compared to the conventionally tilled plots. Grain and straw yield was observed to be 4 and 3% higher in minimum tilled plots as compared to the conventionally tilled plots. Mulch spread on the whole plot increased the grain yield by 60.5% as compared to un- mulched control (Bhatt *et al*. 2004.)

It was reported in a study that sweet corn yields of ears was 1.5–2.0 times greater in plastic reflective mulch plots than from fallow plots. This was due to the larger cob (individual cob weight and length) rather than an increase in the number of cob (Summers and Stapleton, 2002).

An experiment showed that the water hyacinth and rice straw mulches conserved more soil moisture throughout the growing period compared to other treatments. Highest grain yield of 8.73 t ha^{-1} and the lowest of 4.93 t $ha^{-1}$with rice straw mulch and control treatments, respectively in maize field. The highest (Harvest Index) HI from the rice straw mulch treated plot (0.60) and the lowest from the control plot (0.49) in maize (Rahman, 2002).

Transplanting spring maize with plastic film mulching improved the ecological environment of the soil, increased soil temperature and soil water contents, promoted the growth and maturation of maize and increased crop yield (Liu *et al*., 2002).

A field Study was conducted at Entomolgical Society of America on sweet corn where it was reported that cob weight, cob length and number of cob per plant were significantly larger in transparent polythene mulch than from no mulch treatment. Cob yield of sweet corn was 1.5 to 2 times greater in transparent polythene mulch plots than from fallow plots (J–econ, 2002).

A field experiment was conducted at Banarus Hindu University, Varanasi on maize and reported that green cob yield, stover yield and benefit cost ratio were significantly higher under stover mulch as compared to the soil mulch and control treatments (Singh *et al*., 2002).

Inter–cropping of potato with maize under mulched conditions provided additional outcome with no or little effect on the yield of maize crop. Mentioned that water hyacinth and rice straw mulched plants produced more than 2–fold greater yield (7.0 to 12 t ha $^{-1}$) than that of the control (4 to 6 t ha^{-1}) both in local and QPM cultivars. Of the QPM lines, torpical lines, QPM2 (Pozarica 8763 QPM) and QPM–1 (Ibo perenda 8666 QPM) were more 18 productive than the local cv. Barnali. The other lines were either at par or superior to that of Barnali (Khan, 2001).

A experiment showed that plastic mulch, when compared with the un-mulched control, increased maize yield from 12.0–14.7 t DM/ha, cob yield from 3.7–6.6 t DM/ha and dry matter content from 230–270 g/kg. The effect of growing forage maize with or without plastic mulching treatments on the dry matter (DM) yield, cob yield and dry matter content was investigated in Northern Ireland in 1996–97 (Easson and Fearnehough, 2000).

A field experiment was conducted at Central Agriculture Research Institute, Andaman on maize and showed that mean cob yield and stover yield were significantly higher under paddy straw mulch than saw dust, coirdust, rice husk and control treatment (Pramanik, 1999).

The interaction between tillage and straw mulching was also observed to be significant. The average dry matter yield of corn in the mulched plots was significantly higher than the unmulched plots which is because of more favorable influence of mulching on the soil (Gajera *et al.*, 1998).

The increase in grain yield of corn under mulching conditions might be due to increased soil moisture storage and suppressing weed growth. The application of straw mulch also helps in providing optimum soil temperature resulting in better growth and yield (Bhardwaj and Sindwal, 1998).

It was observed in an experiment that 18% and 77% higher grain yields with sun grass mulch than soil mulch and no mulch treatment, respectively in the hilly areas of Chittagong. So the effect of mulch on the increase of yield contributing attributes of maize was using sun grass mulch is very effective (Alam *et al*., 1993).

It was also reported that synthetic mulches were also reported to influence the maize yield favorably. Mulching with plastic film or polyethylene or clear plastic or white and black polythene or semi–permanent plastic mulch significantly increased the grain yield (Wang *et al*., 1994). The intensity of cob setting was increased by linear low density polyethylene mulch with irrigation. Linear low density polyethylene mulching with irrigation at 50% depletion of available soil moisture, and grain yield 5.7 t ha^{-1} (Mohapatra *et al*.,1998).

Maize yield with polythene mulch treatment was 127.5% of those of direct sown maize (Chen and Chen, 1996). The highest grain yield with plastic or polythene mulching was 7.52 t ha^{-1} (Duhr and Dubas,1990).

An experiment showed that the polythene mulch has a positive effect on growth, yield and quality of maize. The experiment conducted at University of Agriculture Science, Dharwad that grain number per cob, grain weight per cop and 1000 grain weight were improved considerably and significantly under black polythene mulch as compared to rice straw mulch and no mulch treatments. Cob yield and stover yield were significantly higher under mulch over than rice straw mulch and no mulch treatment (Kulkarni *et al*., 1998).

In a study it was found that there was more than 50% increase in grain yield of maize in presence of straw mulch (Khera and Singh, 1998).

The similar results were also reported by in a field experiment where corn yield increased significantly with residue mulch application along with minimum tillage (Gill *et al*., 1992).

Polythene mulch increases the levels of available nutrients and moisture in the soil. Polythene mulch helps to improve soil structure and soil micro–flora, reduces fertilizer leaching, evaporation and weed problem. Polythene mulch has a positive effect on growth, yield and quality of maize (Kulkarni *et al*., 1998).

An experiment showed that wheat straw mulch increased the grain number ear^{-1}, ear length, grain weight ear^{-1} and 1000 grain weight in China when mulch was applied at 6 t ha^{-1}(Ma and Han, 1995). The increasing rate of straw mulch increased the number of ears plant^{-1}(Wicks *et. al*., 1994).

The highest grain number cob^{-1} and highest weight of 1000 grains in maize with rice straw mulches significantly increased grain yield of maize conventionally tilled plots at Regional Agricultural Research Station (RARS), Jamalpur. The yield contributing attributes of maize that is which contribute to the seed yield like number of ears plant^{-1}, ear length, ear diameter, grain number ear^{-1}, number of rows ear^{-1}, 1000 grain weight were markedly influenced by mulches (Quayyum and Ahmed, 1993).

A study showed that irrigation at 0.8 IW/CPE ratio with black polythene mulch spread between the rows significantly increased the number of grains/cob, grain weight/cob, 1000 grain weight of maize. The yield of maize was influenced by different organic mulches and the maximum or highest grain yield observed 6.78 t ha^{-1} with rice straw (Kalaghatagi *et al.* 1990).

From the above mentioned literature it may be concluded is realized that the use of mulch is essential for plant growth and yield. Different mulches also supply different micro and macro–nutrients to crop as well as humus to the soil. Mulch application also maintains the soil temperature, humidity and other climatic condition which will ensure the favorable condition to get better growth development and yield. The reviewed literatures reveal that the effects of mulch on white maize have not been studied in details in Bangladesh. For this reason such study is needed in Bangladesh.

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka-1207 during November, 2015 to May, 2016. A short discussion of experimental site, soil, climate and weather, plant materials used, treatments, experimental design and layout, fertilizer application, sowing of seed, application of mulch materials, intercultural operations, harvesting, data collection and statistical analysis have been described in this chapter.

3.1. Description of the experimental site

3.1.1. Location

The experiment was carried out at the research field of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during *Rabi* season from November 2015 to April 2016. Location of the site is 90°33/ E longitude and 23°77/ N latitude with an elevation of 8 meter from sea level (UNDP-FAO, 1988) in Agro-Ecological Zones of Madhupur` Tract (AEZ No. 28) (Appendix I).

3.1.2. Climate

Experimental site was in the geographical location under the subtropical climate, which is characterized by three distinct seasons such as winter season from November to February, the pre-monsoon period or hot season from March to April and monsoon period from May to October (Edris *et al*., 1979). Details of the meteorological data of air temperature, relative humidity, rainfall and sunshine hour during the period of the experiment were collected from the Weather Station of Bangladesh, Sher-e Bangla Nagar, Dhaka and have been presented in Appendix II.

3.1.3. Soil

The top soil of the experimental site is characterized by olive grey with common fine to medium specially dark yellowish brown mottle with silty clay in texture. Soil pH and organic carbon was sufficient for maize production. The experimental area was of good drainage and irrigation system and above from flood level and the plot of experimental field was medium to high land. The details have been presented in Appendix III.

3.2. Experimental materials

3.2.1 Plant material

Two white maize varieties Shuvra which is devloped by BARI and KS-510(IV) an Indian hybrid variety were used as plant materials in the present study. These varieties are recommended for *Rabi* season.

3.2.2. Indigenous mulch materials

I. Water hyacinth   II. Rice straw   III. Rice husk   IV. Ash

3.3. Factors and Treatments of the experiment

The experiment has two factors these are following:

Factor A: Varieties

- V_1= Shuvra
- V_2= KS-510

Factor B: Indigenous Mulch materials

- T_1= Control(without mulch)
- T_2= Water hyacinth
- T_3= Rice straw
- T_4= Rice husk
- T_5= Ash

The treatment combinations are as follows: **V_1T_1, V_1T_2, V_1T_3, V_1T_4, V_1T_5, V_2T_1, V_2T_2, V_2T_3, V_2T_4, V_2T_5**

3.4. Design and Layout of the experimental field

The experiment was set up in the field following the experimental design Randomized Complete Block Design (RCBD). The field was divided into 3 blocks to represent 3 replications. There were 30 unit plots altogether in the experiment. The size of each unit plot was 6 m^2 (3m × 2m). Distance maintained between replication to replication was 1m and plot to plot was 0.5m. Plant to plant distance maintained was 0.25 and row to row distance was 0.75m. The treatments were assigned in plot at random. Details layout of the experimental plot has been presented in Appendix XXIX.

3.5. Crop Management

3.5.1. Seed collection

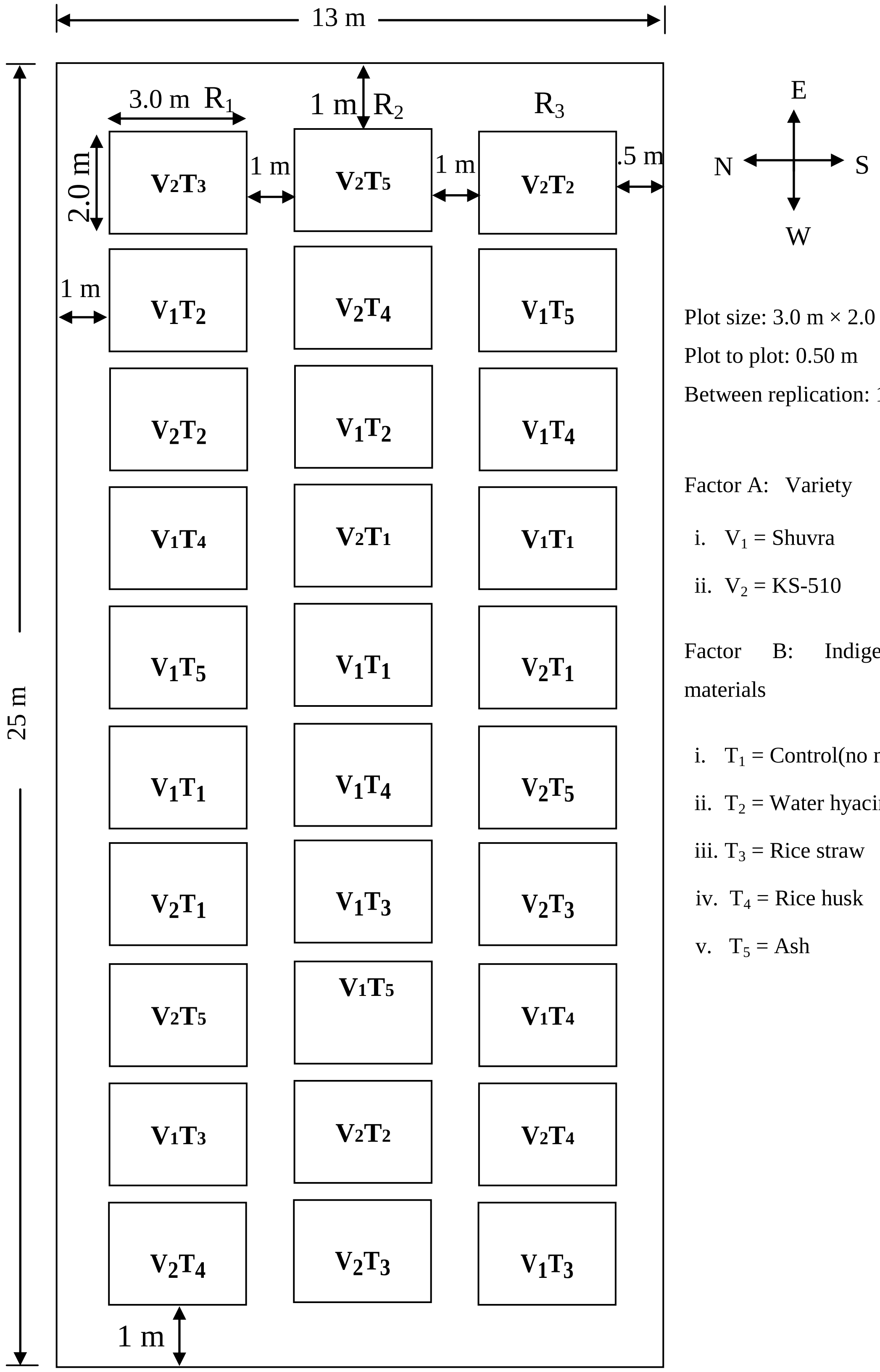
Healthy seeds of KS-510(IV) were collected from a private organization and Shuvra were collected from BARI.

3.5.2. Land preparation

The plot selected for the experiment was opened in the first week of November, 2015 with a power tiller and was exposed to the sun for a week, after one week the land was ploughed, harrowed and cross- ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed.

3.5.3. Application of manure and fertilizers

Cowdung was used as decomposed organic matter @ 6.0 ton per ha before final land preparation. Then the chemical fertilizers were applied as Urea, TSP, MOP, Gypsum, Zinc Sulphate and Boric acid at the rate of 172-168-96-144-10 and 5 kg per ha in case of Shuvra and 500-240-180-240-10 and 5 kg per ha in case of KS-510 hybrid variety. All fertilizers and one third portion of urea were applied as basal dose in the time of final land preparation. Rest of the Urea was applied after 30 DAS and 50 DAS at two installments.



Plot size: 3.0 m × 2.0 m

Plot to plot: 0.50 m

Between replication: 1.00 m

Factor A: Variety

i. V_1 = Shuvra

ii. V_2 = KS-510

Factor B: Indigenous mulch materials

i. T_1 = Control(no mulch)

ii. T_2 = Water hyacinth

iii. T_3 = Rice straw

iv. T_4 = Rice husk

v. T_5 = Ash

Figure 1.Design and layout of the experimental field

3.5.4. Seed treatment

For each treatment, dry, clean and homogenous air-dried seeds with about 12% moisture content were used. Seeds were treated with Vitavex at the rate of 0.2% to 0.3% of seed weight.

3.5.5. Seed sowing

Seeds of the variety Shuvra and KS-510 were sown on 13th November, 2015 in row maintaining a row to row distance as per treatments having 2 seeds hole^{-1} for Shuvra and 3 seeds hole^{-1} for KS-510.

3.5.6. Mulch materials application

Mulch materials were applied on the field after seed sowing. There were four types of mulch materials these were water hyacinth, rice straw, rice husk and ash. Mulches were applied at the rate of 10 ton/ha maintaining proper thickness in each plot.

3.5.7 Intercultural operations

3.5.7.1 Thinning, gap filling and weeding

Thinning and gap filling was done after 15 DAS. Weeding was done after 40 DAS of seed sowing and dry weight was taken for comparison with different treatments with mulch.

3.5.7.2. Spraying of insecticides and fungicides

In the time of seed sowing Diazinon 10G and Furadon 5G were applied in the rows. Seeds were also treated with Bavistin. Diazinon 10G and Furadon 5G were also applied for destruction of cutworm and maize stem borer. Darsban 20EC was applied for cutworm destruction. Ripcord 25EC was applied for the aphid destruction.

3.5.7.3. Protection of crop from other pests

Parrots are the main pest of maize field. Men are also important. For protection of maize crop in the field, continuous guard from 5.A.M. to 8 P.M was employed. Net was also used for protection of maize crop.

3.5.8. Harvesting

Harvesting was started when the husk cover was completely dried and black coloration was found on the grain base. Harvesting was started after 139DAS from control plot and it was over 151 DAS in rice straw mulch treated plot. Plants with cob were harvested from $3m^2$ area which represents a uniform area. Data were taken from 10 samples of each plot according to the requirement.

3.5.9. Drying

Harvested products were taken on the threshing floor. Then the seed were dried in the sun and yield per plot was recorded in 14% moisture basis and then converted to kg per ha.

3.6. Collection and procedure of data recording

Different morpho-physiological and yield attributing data were collected in the following way-

3.6.1. Emergence of seedling in the field

50% and 100% seedling emergence were recorded from 3DAS to 15DAS.

3.6.2. Plant height

Plant heights were recorded at 30DAS, 40DAS, 50DAS, 60DAS, 70DAS, 80DAS, 90DAS, and 120DAS. The height of 10 randomly selected plants in each plot were collected from ground level to top portion of the plant and the mean value of plant height was recorded in cm.

3.6.3. No. of leaves per plant

No. of leaves per plant were collected at 30DAS, 40DAS, 50DAS, 60DAS, 70DAS, 80DAS, 90DAS, and 120DAS. All existing leaves of a stem were collected from 10 randomly selected plants from each plot.

3.6.4. Leaf length

Leaf length was collected at 30DAS, 40DAS, 50DAS, 60DAS, 70DAS, 80DAS, 90DAS, and 120DAS. Leaf length was measured from the base to the tip of the leaf, which was collected from 5 randomly selected plants from each plot and then the mean were recorded in cm.

3.6.5. Leaf breadth

The wider part along with base and tip portion of the maize leaves were streached and measured in cm and average was calculated. Such measurement was taken from 5 randomly selected plants in each plot. Three leaves from each plants were taken under consideration for length and breadth measurement.

3.6.7. Leaf Area

Leaf area was estimated manually by counting the total number of leaves per plant and measuring the length and average width of leaf and multiplying by a factor of 0.70 (Keulen and Wolf, 1986). It was done at 30DAS, 40DAS, 50DAS, 60DAS, 70DAS, 80DAS, 90DAS, and 120DAS. Data were recorded from 5 randomly selected plants from each plot.

.3.6.8. Leaf Area Index (LAI)

LAI was measured by the following formula at the time of 30DAS, 40DAS, 50DAS, 60DAS, 70DAS, 80DAS, 90DAS and 120DAS. Data were recorded from 5 randomly selected plants in each plot.

Leaf area = (Surface area of leaf sample m^2 ×correction factor) ÷ Ground area from where the leaves were collected

3.6.9. SPAD reading

SPAD reading was taken at 40DAS, 60DAS, 80DAS, 100DAS and 120DAS from 5 randomly selected plants in each plot by SPAD meter.

3.6.10. Days to tasselling

Time required for first tasselling (Days After Sowing, DAS) and 50% and 100% tasselling were recorded from each plot.

3.6.11. Days to cob appearance

Time required for first cob appearance (Days After Sowing, DAS) and 50% and 100% cob appearance were recorded from each plot.

3.6.12. Days to silk appearance

Time required for first silk appearance (Days After Sowing, DAS) and 50% and 100% silk appearance were recorded from each plot.

3.6.13. Days to harvesting

Time required for harvesting (Days After Sowing, DAS) was recorded from each plot.

3.6.14. Stem base diameter at harvest (cm)

Stem base diameter was measured in cm at the thickest portion of the stem base at the lowest inter-node near the ground with the help of slide calipers in the time of harvest stage from 10 randomly selected plants from each plot.

3.6.15. Total Dry Matter

For data recording at first 10 plants were selected from each plot after harvesting with root enough. Then leaf, stem, tassel, sterile cob, cob sheath, cob rachis, seeds, roots were separated. Then these all parts were cut into small pieces and packed in paper bags for oven dry. These samples were kept in oven at 70^0C for 72 hours. Then dry weight were taken from these samples where each bag contain 10 plant parts sample. Then dry weight (gm per plant) was calculated from of different parts and lastly total dry matter in gm was calculated. Then the total dry matter (gm per plant) was converted to kg per ha. For TDM calculation need seed wt per plant was also included which have been described later.

3.6.16. Root shoot ratio

The root shoot ratio was calculated by dividing the oven dry weight of root with the oven dry weight of shoot.

Root shoot ratio=Dry weight of root (gm) ÷ Dry weight of shoot (gm)

Dry weight of shoot includes leaf, stem, tassel, sterile cob, seeds.

3.6.17. Number of cob in 3m^2 area

The mature cob of 3m^2 area was counted and harvested from each plot.

3.6.18. Number of cob per plant in 3m^2 area

No. of cob per plant =No. of cob in 3m^2 area ÷ No. of plant in 3m^2 area.

3.6.19. Weight per cob

Weight of 10 cobs of 10 randomly selected plants in each plot were recorded and then averaged in gm.

3.6.20. Weight of cob per plant

Weight of cob per plant (gm) = No. of cob per plant × Per cob weight (gm).

3.6.21. Length per cob

Cob length was measured in cm from the base of the cob to the apex. For this data calculation 10 cobs from each plot were selected then measured and then averaged.

3.6.22. Diameter per cob

Measurement of widest part of the cobs was recorded in cm with the help of slide calipers. For this data calculation 10 cobs from each plot were selected then measured and then averaged.

3.6.23. Thousand seed weight

Composite sample of 10 cob 1000 seeds were counted from each plot and weighed.

3.6.24. Number of rows per cob

The no. of rows of 10 cobs was counted at each of the 10 randomly selected plants in each plot and averaged.

3.6.25. No of seeds per row

The no. of seeds per row of 10 cobs was counted at each of the 10 randomly selected plants in each plot and averaged.

3.6.26. No. of seeds per cob

No. of seeds per cob = No. of rows per cob × No. of seeds per row.

3.6.27. Seed weight per cob

Weight of 10 randomly selected cobs from 10 plants and their seed weight were recorded from each plot and averaged in gm.

3.6.28. Seed weight per plant

Seed weight per plant (gm) = No. of cob per plant × Per cob seed weight (gm).

3.6.29. Seed weight (gm) per 3m^2

Seed wt. (gm) per 3m^2 = Per cob seed wt. (gm) × No. of cob in 3m^2 area.

3.6.30. Seed weight (kg) per ha

Seed weight (kg) per ha = (Seed wt. per 3m^2 × 10000) ÷ (1000 × 3).

3.6.31. Seed wt. (ton) per ha

Seed wt. (ton) per ha = Seed wt. (kg) per ha ÷ 1000

3.6.32. Harvest Index (HI)

It is the ratio between seed wt. per ha (kg) and TDM per ha (kg).

HI = Seed wt. per ha (kg) ÷ Total Dry Matter per ha (kg).

3.6.33. Weed growth

Weed from 1m^2 area of different treatments of each plot were collected at 40DAS and were dried in oven at 70^0 C for 72 hours. The dried weeds were weighed and data were recorded.

3.6.34. Soil moisture content

The soil samples from (0-10) cm, (10-20) cm, (20-30) cm depths were collected at 50DAS, 80DAS and 120DAS to measure the soil moisture content using soil screw auger. Soil samples were dried in oven at 103 ^{0}C for 48 hours and were weighed to find out the differences between the initial and final moisture contents.

3.7. Statistical analysis

The data obtained for different characters were statistically analyzed with the computer based software MSTAT-10 to find out effect of indigenous mulches on the performance of white maize and the mean values of all characters were evaluated and analysis of variances were performed by the F-test. The significance of the difference among treatment means were separated by the both Least Significant Difference (LSD) test at 5% level of probability and Duncan’s New Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The present experiment was conducted to find out the effect of indigenous mulches on the morphophysiological and yield attributes of white maize (*Zea mays* L.). The findings obtained from the study have been presented, discussed and compared in this chapter through different tables and figures. The analyses of variance (ANOVA) and other table on different parameters have been presented in Appendices IV-XXVIII. The results have been presented and discussed with the help of tables and graphs and possible interpretations have been given under the following headings.

4.1 Soil moisture (%)

Soil moisture content varied insignificantly for different maize varieties except in 30 cm soil depth at 80 and 120 DAS (Appendix IV). The highest soil moisture content was performed by variety V_2 (37.205, 42.64, 49.50%) at 50DAS in 0-10, 10-20 and 20-30 cm of soil depth, respectively. At 80 DAS this variety showed the highest 24.08, 26.99 and 41.68% soil moisture content in 0-10, 10-20 and 20-30 cm of soil depth respectively. Soil moisture content was the highest as 22.65, 25.09 and 28.55% at 120 DAS for the soil depth ranges 0-10, 10-20 and 20-30 cm in V_2.

Significant variation was recorded for mulch materials in soil moisture of different depth. (Appendix IV). The highest soil moisture was observed from the treatment T_3 (45.61, 52.08 and 60.80%) at 50DAS in 0-10, 10-20 and 20-30 cm of soil depth, respectively (Table 1). At 80 DAS T_3 showed the highest 28.59, 31.46 and 49.22% soil moisture in 0-10, 10-20 and 20-30 cm of soil depth respectively. Soil moisture content was the highest as 27.24, 29.83 and 31.60% at 120 DAS for the soil depth ranges 0-10, 10-20 and 20-30 cm in T_3.The lowest soil moisture was observed by treatment T_1 (29.34, 33.24 and 37.52%) at 50DAS in 0-10, 10-20 and 20-30 cm of soil depth, respectively. At 80 DAS T_1 showed the lowest 22.13 and 29.06% in 20 and 30 cm of soil depth respectively and

18.83% in 10 cm soil depth at $T_{5.}$ Soil moisture content was the lowest as 17.29, 20.47 and 21.07% at 120 DAS for the soil depth ranges 0-10, 10-20 and 20-30 cm. Similar result was found by Khan and Parvez, (2010) that there were significant changes in soil moisture content with time due to non-tilth condition and application of different indigenous mulches. The initial higher soil moisture content at 40 DAS decreased gradually up to crop maturity. It was always higher in non-tilth than the tilth conditions. Rice straw and water hyacinth mulches contained maximum soil moisture throughout the entire period of growth when compared to other mulches and control under both conditions. The performance of rice husk and ash in retaining soil moisture was intermediate. The effectiveness of mulches with regards to soil moisture content was in the order of rice straw>water hyacinth>rice husk>ash>control. Govaerts *et al*. (2007) show the similar result that straw mulching can improve soil nitrogen availability, increase plant growth and influence the physical and chemical properties of the soil. Hence, many researchers consider straw mulching for enhancing maize productivity.

Interaction effect of different varieties and mulches materials showed significant variation on soil moisture (Appendix IV). At 50 DAS the highest soil moisture content (46.98, 52.46 and 62.02%) was recorded from the combination of V_2T_3 in 0-10, 10-20 and 20-30 cm of soil depth, respectively. At 80 DAS V_2T_3 showed the highest 30.27, 34.15 and 51.65% soil moisture in 10, 20 and 30 cm of soil depth respectively (Table 2). Soil moisture content was the highest as 29.15, 32.30 and 36.03% at 120 DAS for the soil depth ranges 0-10, 10-20 and 20-30 cm. The lowest soil moisture was observed by treatment combination V_1T_1 (28.85, 32.63 and 37.51%) at 50DAS in 0-10, 10-20 and 20-30 cm of soil depth, respectively. At 80 DAS treatment V_1T_1 showed the lowest 17.66, 20.96 and 26.45% in 0-10, 10-20 and 20-30 cm of soil depth respectively. Soil moisture content was the lowest as 14.99, 19.82 and 19.67% at 120 DAS for the soil depth ranges 0-10, 10-20 and 20-30 cm by treatment combination V_1T_1.

Table 1. Effect of varieties and mulch materials on soil moisture content in different depths at different DAS of white maize

Variety	Soil moisture (%)								
	50 DAS			80 DAS			120 DAS		
	(0-10) cm	(10-20) cm	(20-30) cm	(0-10) cm	(10-20) cm	(20-30) cm	(0-10) cm	(10-20) cm	(20-30) cm
V_1	36.078	41.57	48.34	21.46	24.52	37.43 b	20.07	22.96	24.46 b
V_2	37.205	42.64	49.50	24.08	26.99	41.68 a	22.65	25.09	28.55 a
LSD $_{(0.05)}$	ns	ns	ns	ns	ns	2.968	ns	ns	1.583
Mulch material									
T_1	29.34 d	33.24 d	37.52 e	19.86 b	22.13 b	29.06 d	17.29 c	20.47 b	21.07 d
T_2	42.09 b	48.56 b	54.70 b	23.27 b	24.93 b	43.30 b	21.78bc	23.69 b	26.42 bc
T_3	45.61 a	52.08 a	60.80 a	28.59 a	31.46 a	49.22 a	27.24 a	29.83 a	31.60 a
T_4	35.35 c	42.42 c	50.92 c	23.32 b	25.51 b	41.16 b	22.59 b	23.66 b	28.45 b
T_5	30.82 d	34.22 d	40.66 d	18.83 b	24.76 b	35.04 c	17.91 c	22.48 b	24.98 c
LSD $_{(0.05)}$	2.368	1.731	2.698	4.716	4.312	4.692	4.510	3.587	2.503
CV (%)	5.33	3.39	4.55	17.07	13.80	9.78	17.41	12.31	7.79

ns=non-significant, V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Values followed by same letter(s) did not differ significantly at 5% level of probability.

Table 2. Interaction effect of varieties and mulch materials on soil moisture content in different depths at different DAS of white maize

Variety × Mulch material	Soil moisture (%)								
	50 DAS			80 DAS			120 DAS		
	(0-10) cm	(10-20) cm	(20-30) cm	(0-10) cm	(10-20) cm	(20-30) cm	(0-10) cm	(10-20) cm	(20-30) cm
V_1T_1	28.85 d	32.63 d	37.51 e	17.66 d	20.96 c	26.45 e	14.99 d	19.82 c	19.67 e
V_1T_2	42.00 b	48.15 b	54.03 bc	21.32 b-d	23.73bc	41.93bc	19.70 b-d	22.75 bc	25.83 cd
V_1T_3	44.23 ab	51.70 a	59.58 a	26.92 ab	28.77ab	46.79ab	25.32 ab	27.36 ab	27.17 c
V_1T_4	35.35 c	41.55 c	50.64 c	22.95 b-d	24.88bc	36.98 cd	22.11 bc	23.10 bc	25.28 cd
V_1T_5	29.96 d	33.83 d	39.94 de	18.47 d	24.25bc	35.00 d	18.21 cd	21.77 c	24.33 cd
V_2T_1	29.84 d	33.85 d	37.52 e	22.05 b-d	23.30bc	31.67 de	19.59 b-d	21.11 c	22.47 de
V_2T_2	42.18 b	48.96 b	55.38 b	25.21 a-c	26.12 bc	44.67 b	23.86 a-c	24.62 bc	27.00 c
V_2T_3	46.98 a	52.46 a	62.02 a	30.27 a	34.15 a	51.65 a	29.15 a	32.30 a	36.03 a
V_2T_4	35.35 c	43.30 c	51.20 c	23.69 a-d	26.13 bc	45.33ab	23.06 a-c	24.21 bc	31.62 b
V_2T_5	31.68 d	34.61 d	41.38 d	19.18 cd	25.26 bc	35.08 d	17.61 cd	23.18 bc	25.63 cd
$LSD_{(0.05)}$	3.348	2.448	3.815	6.670	6.098	6.636	6.379	5.073	3.540
CV (%)	5.33	3.39	4.55	17.07	13.80	9.78	17.41	12.31	7.79

V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.2 Plant height (cm)

Significant variation was observed of plant height among the test maize varieties at 30, 40, 70, 80, 90 and 120 DAS and insignificant in 50 and 60 DAS (Appendix V). At 30, 40, 50, 60, 70, 80, 90 and 120 DAS, the tallest plant (72.21, 125.57, 152.94, 170.23, 189.72, 210.53, 221.17 and 221.34 cm, respectively) were shown by V_1 (Shuvra), while the shortest plant represented by V_2 (KS-510) (Appendix VI). Two varieties performed different plant height and the basis for this that of their varietal characters. The varietal traits mainly genetically inherent but environmental such as different management practices also influences plant height

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Significant variation was observed of plant height influenced for different mulch materials in the growth period over control (Appendix V). Application of mulch in soil and it preserve the soil moisture and influence on plant height. Among the mulches materials treatment T_3 (Rice straw) mulch produced the tallest plant (83.57, 139.96, 169.71, 194.93, 209.20, 237.58, 249.55 and 249.83 cm) at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively and it was statistically similar with the treatment T_2 (Water hyacinth) mulch for all the different days after sowing (Appendix VI). The shortest plant was observed for the treatment T_1 (control) and they were 54.12, 103.41, 124.55, 132.59, 138.12, 150.12, 153.98 and 154.18 cm at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively. It was statistically similar with the plant height of treatment T_5 (ash) at 30, 40, 50 and 60 DAS. It was practically shown that the rice straw was the best mulch for more plant height followed by water hyacinth, rice husk, ash and control because of rice straw work as insulation system on soil and don`t permit soil water evaporation eventually soil microbial activity increased and improved the soil condition, and maize plant can uptake more available nutrients from soil for its growth and development. Similar results were also obtained by Rahman (2002) where he reported increased plant height in water hyacinth and rice straw treated plots. Mondal (2003) also reported the similar trend who observed that the rice straw and water hyacinth mulched plots gave the higher morphological growth compared to other mulches

Interaction effect of different mulches and maize varieties showed significant variation on plant height at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix V). The tallest plant height (84.57, 142.88, 172.25, 198.60, 217.84, 244.57, 261.23 and 261.47 cm) was observed at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively from the combination of V_1T_3 (Shuvra maize verity with straw mulch) (Appendix VII). It was statistically similar with the treatment combination V_1T_2 and V_2T_3 for all the specific days were observed after sowing. Whereas, the shortest plant (52.84, 102.58, 124.31, 135.73, 139.70, 141.97 and 142.13 cm, respectively) were recorded from the combination of V_2T_1 (KS510 with Control treatment) but V_1T_1 (Shuvra with control treatment) showed the shortest plant height (130.63 cm) at 60 DAS.

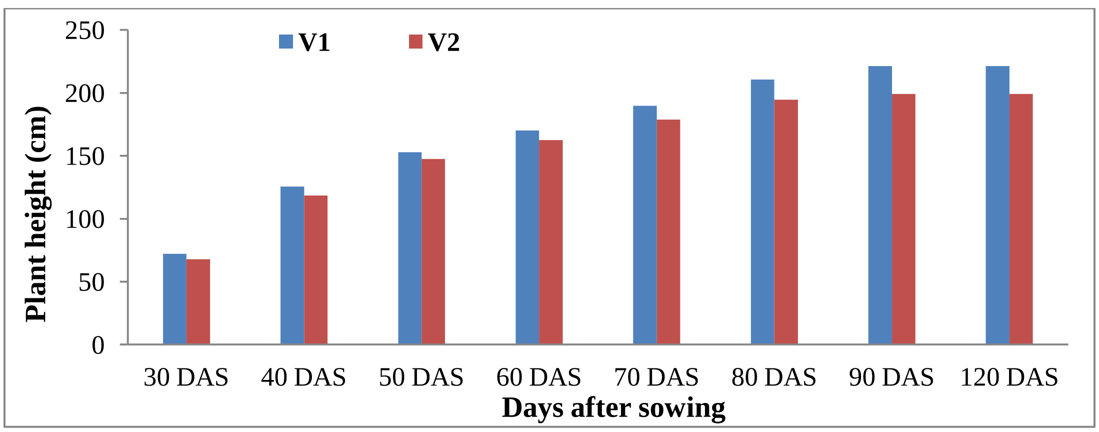

Figure 2. Effect of varieties on plant height of white maize at different DAS (LSD $_{0.05}$ value= 3.943, 6.172, 10.219, 9.311, 11.115 and 11.139 at 30, 40, 70, 80, 90 and 120 DAS, respectively). V_1 = Shuvra, V_2 = KS-510(IV)

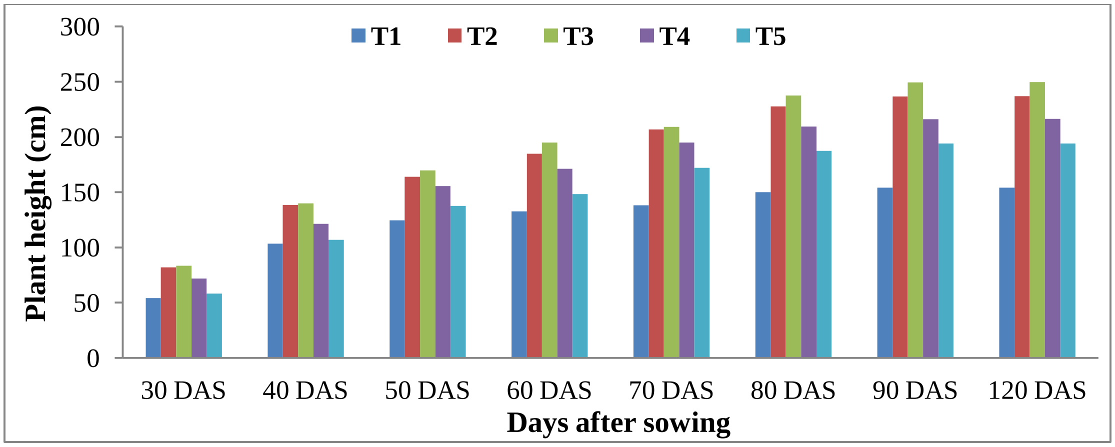

Figure 3. Effect of mulch materials on plant height of white maize at different DAS ($LSD_{0.05}$ value= 6.234, 9.758, 9.927, 13.086, 16.157, 14.722, 17.575 and 17.612 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

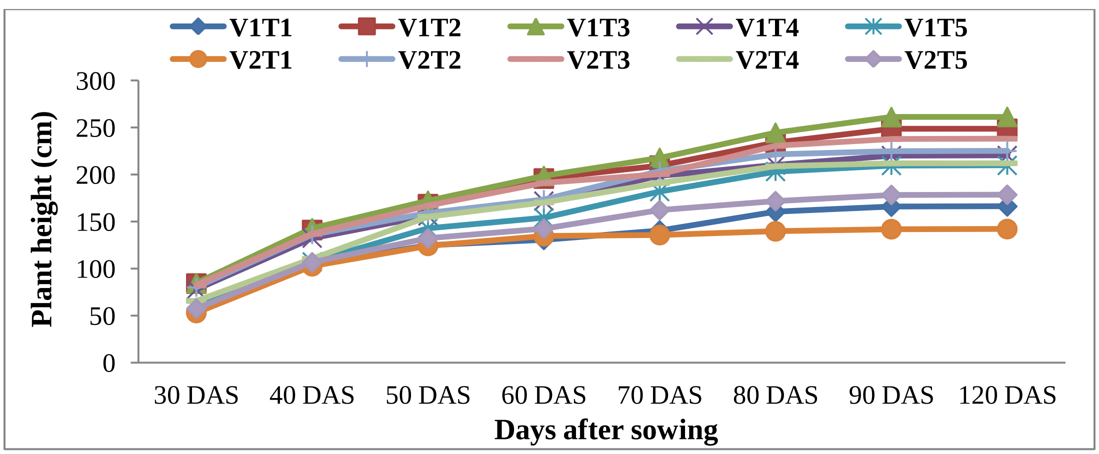

Figure 4. Interaction effect of varieties and mulch materials on plant height of white maize at different DAS ($LSD_{0.05}$ value= 8.816, 13.800, 14.039, 18.506, 22.850, 20.820, 24.855 and 24.907 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively). V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4. 3 Number of leaves plant^{-1}

Number of leaves per plant of maize varied insignificantly variation among the test maize varieties except at 90 DAS under the present trial (Appendix VIII). At 30, 40, 50, 60, 70, 80, 90 and 120 DAS, the maximum number of leaves per plant (7.28, 8.34, 11.86, 12.53, 13.55, 14.20, 15.96 and 14.49) were found from V_1 (Shuvra) while minimum number of leaves per plant (7.02, 8.12, 11.42, 12.17, 13.41, 13.83, 14.57 and 13.83) were obtained from V_2 (KS-510) (Appendix IX).

Significant variation was recorded due to different mulch materials in terms of number of leaves per plant of maize at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix VIII). At 30, 40, 50, 60, 90 and 120 DAS, the maximum number of leaves per plant (7.84, 8.80, 12.41, 13.15, 16.75 and 15.52) was attained from T_3 (rice straw) which was statistically similar (7.75, 8.58, 12.21, 12.88, 16.58 and 14.42) with T_2 (water hyacinth) (Figure 4). The maximum number of leaves per plant (14.11 and 14.76) at 70 and 80 DAS was shown by mulch treatment T_2 (water hyacinth). While the minimum number of leaves per plant (6.32, 7.30, 10.58, 11.42, 12.70, 13.25, 14.03 and 13.42) at 30, 40, 50, 60, 70, 80, 90 and 120 DAS was found from T_1 (control) (Appendix IX). Similar result was found Rahman (1999), when used rice straw mulch and water hyacinth in maize field it devloped morpho-physiological character such as plant height, no of leaves per plant, leaf length and breadth, no of roots per plant, leaf area index(LAI) , crop growth rate(CGR), net assimilation rate(NAR), total dry matter content etc. of maize plant.

Different varieties and mulches materials showed significant differences due to their interaction effect on number of leaves per plant of maize at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix VIII). The maximum number of leaves per plant At 30, 40, 50, 60 and 120 DAS was recorded 7.92, 9.02, 12.57, 13.38 and 17.00, respectively from treatment combination V_1T_3 while the minimum number of leaves per plant at 30, 40, 50, 60, 80, 90 and 120 DAS were 6.22, 7.20, 10.08, 11.17, 13.13, 13.95 and 13.23, respectively from V_2T_1 (Appendix X).

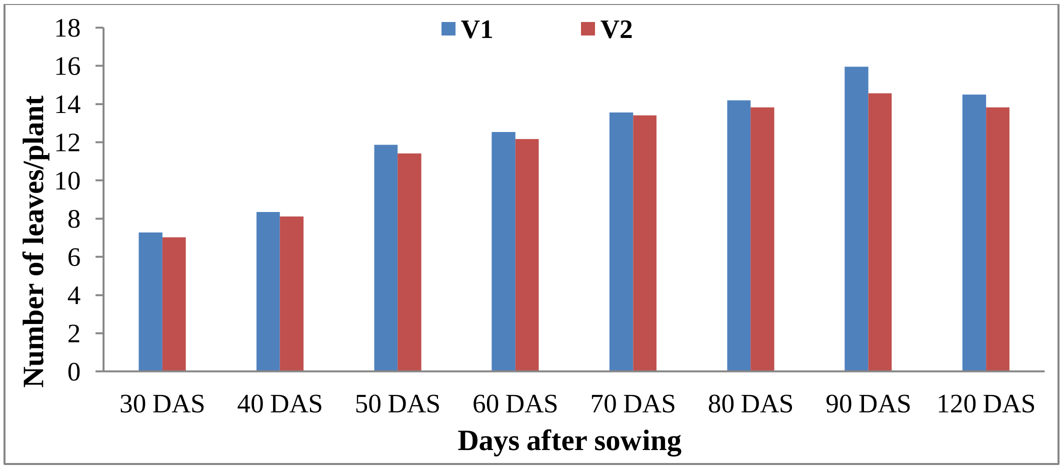

Figure 5. Effect of varieties on number of leaves palnt^{-1} of white maize at different DAS (LSD $_{0.05}$ value= 0.760 at 90 DAS). V_1 = Shuvra, V_2 = KS-510(IV)

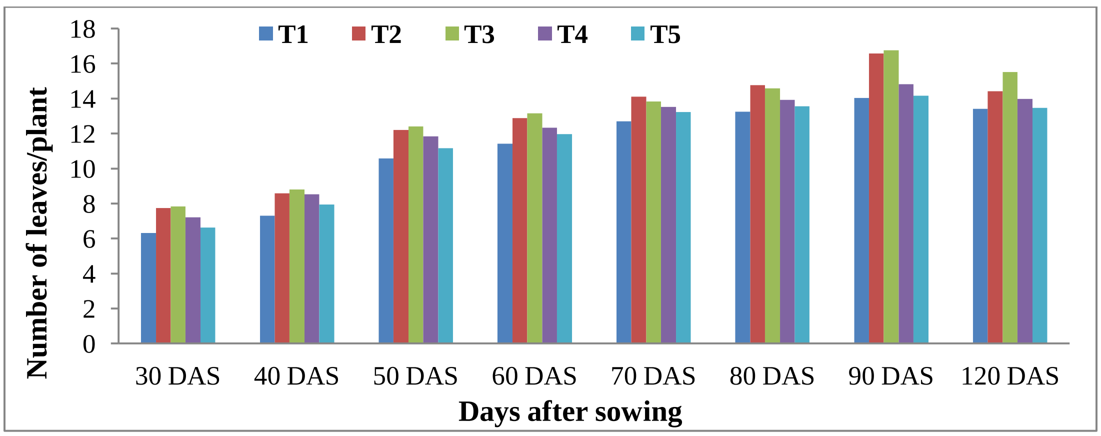

Figure 6. Effect of mulch materials on number of leaves palnt^{-1} of white maize at different DAS (LSD $_{0.05}$ value= 0.562, 0.428, 0.710, 0.574, 0.686, 0.854, 1.201 and 1.316 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively). T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash.

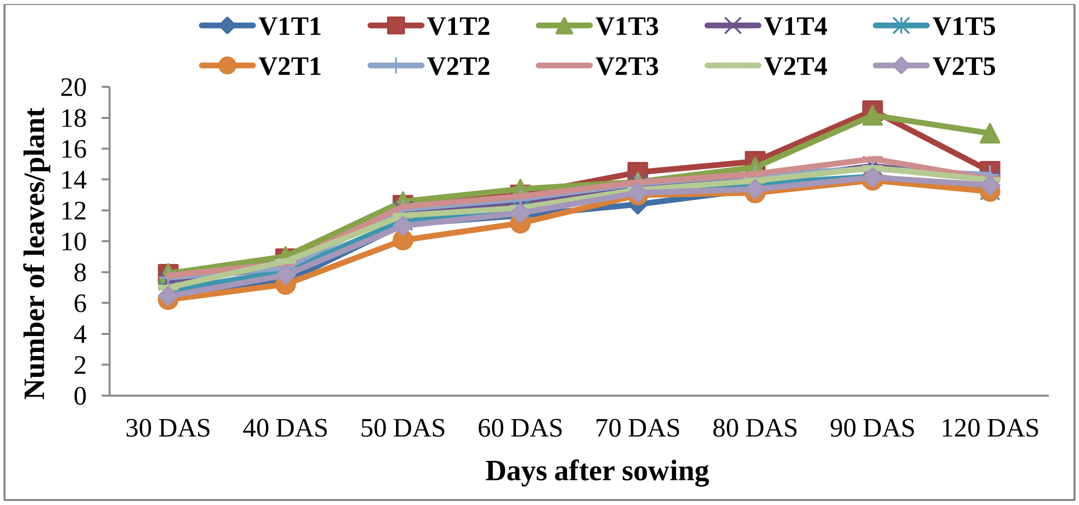

Figure 7. Interaction effect of varieties and mulch materials on number of leaves palnt^{-1} of white maize at different DAS (LSD $_{0.05}$ value= 0.795, 0.605, 1.004, 0.812, 0.971, 1.208, 1.699 and 1.861 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively) V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.4 Leaf area (cm^2)

Leaf area varied insignificantly for different maize varieties except for 30 and 70 DAS (Appendix XI). In 30 and 70 DAS leaf area was highly significant. The highest leaf area at 30, 40, 50, 60, 70, 80, 90 and 120 DAS was observed as 1215.0, 1702.7, 3293.5, 4714.6, 8325.5, 8898.9, 9152.5 and 8529.9 cm^2, respectively for the variety V_1 (Appendix XII).

Significant variation was observed for leaf area due to the different mulches materials (Appendix XI). The highest leaf area was recorded at 30, 40, 50, 60, 70 and 120 DAS was 1376.8, 1965.6, 3674.8, 5157.6, 9135.1 and 9164.3 cm^2 from treatment T_3, which was statistically similar to 1317.6, 1885.1, 3610.2, 5122.2, 8833.3 and 9069.4 cm^2 recorded from treatment T_2 (Appendix XII). The lowest leaf area was observed from mulch treatment T_1 for all the days after sowing. Rahman (1999) observed the highest leaf length and breadth in water hyacinth treated plots followed by rice straw treated plots and the lowest performance in control plots.

Interaction effect of different maize varieties and different mulch materials showed significant variation on leaf area (Appendix XI). The highest leaf area was observed (1493.9, 1968.1, 3742.6, 5292.7, 9398.1, 9876.8, 9947.2 and 9328.8 cm^2) from the combination of V_1T_3, at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix XIII). It was statistically similar (1387.5, 1965.1, 3686.6, 5249.9, 9221.3, 9522.9, 9728.8 and 9077.0) with the combination V_1T_2 at same days respectively. The lowest leaf area (881.7, 1292.3, 2528.3, 3225.8, 6137.5, 7403.6 and 7188.0 cm^2) was recorded from the combination of V_2T_1 (KS510 with control treatment) at 30, 40, 50, 60, 70, 80 and 120 DAS. The lowest value was obtained 7909.8 cm2 at 90 DAS from the combination V_1T_1 from this trait.

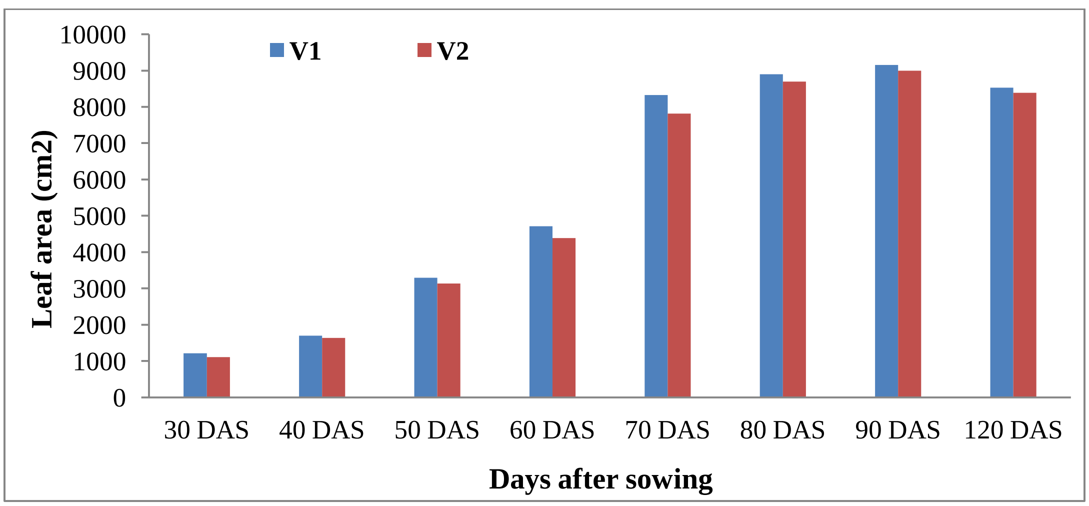

Figure 8. Effect of varieties on leaf area of white maize at different DAS (LSD $_{0.05}$ value= 95.550 and 495.52 at 30 and 70 DAS, respectively) V_1 = Shuvra, V_2 = KS-510(IV).

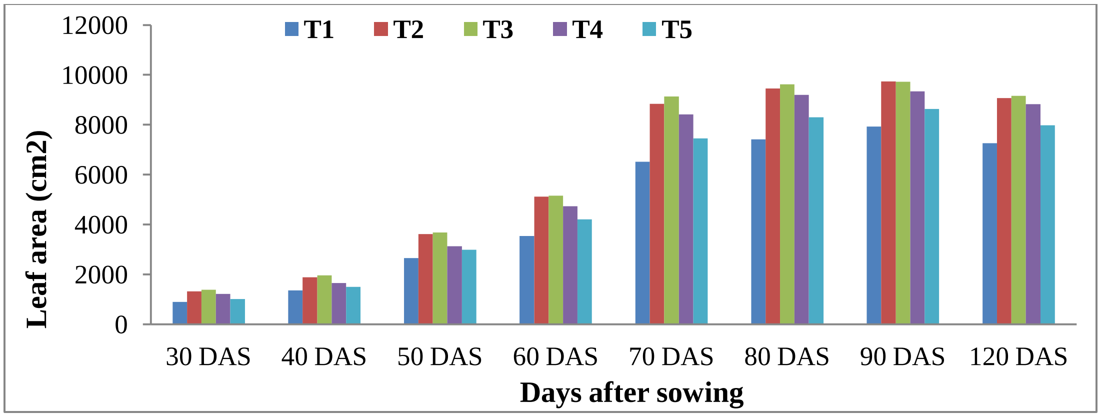

Figure 9. Effect of mulch materials on leaf area of white maize at different DAS (LSD $_{0.05}$ value= 151.08, 311.86, 291.16, 577.41, 783.49, 687.80, 516.64 and 615.89 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively). T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

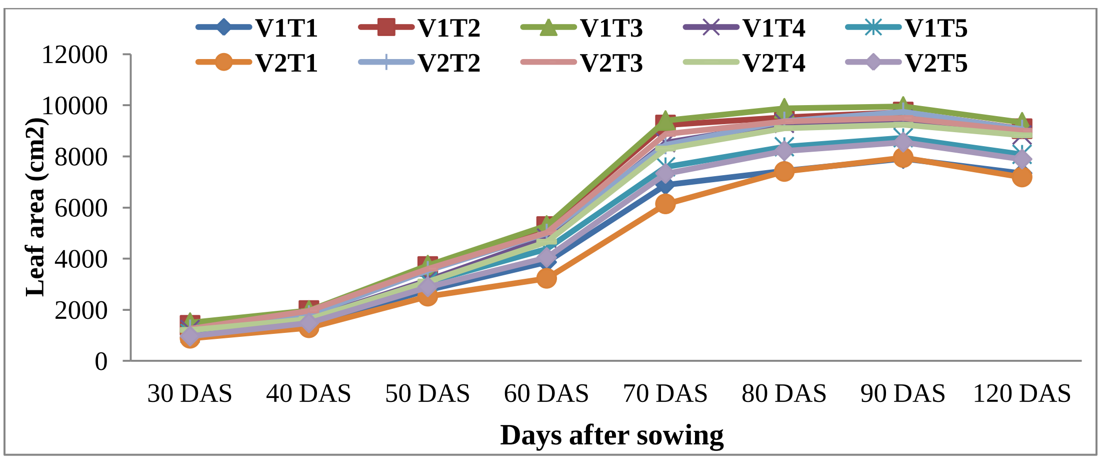

Figure 10. Interaction effect of varieties and mulch materials on leaf area of white maize at different DAS (LSD $_{0.05}$ value= 213.66, 441.03, 411.77, 816.58, 1108.0, 972.70, 730.64 and 871.00 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively).V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.5 Stem base diameter at harvest (cm)

Significant variation was recorded for stem base diameter at harvest due to different maize varieties under the present study (Appendix XIV). The highest stem base diameter at harvest stage (25.07 cm) was obtained from V_2, while the lowest (22.95 cm) was found from V_1 (Table 3).

Different mulches materials showed significant variation for stem base diameter at harvest (Appendix XIV). The highest stem base diameter at harvest stage (30.63) was found from T_3 which was followed by (28.13cm and 22.72 cm) to T_2 and T_4, whereas the lowest stem base diameter at harvest (18.64 cm) was recorded from T_1. Khan and Parvez, (2010) showed the similar that when used rice straw and water hyacinth mulch it increase stem base diameter of maize plant.

Due to combined effect of different maize varieties and mulches materials showed significant differences on stem base diameter at harvest of maize (Appendix XIV). The highest stem base diameter at harvest (32.41 cm) was obtained from V_2T_3 and the lowest stem base diameter at harvest (18.43 cm) was found from V_1T_1 (Table 4)

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Table 3. Effect of varieties and mulch materials on stem base diameter of white maize at harvest

Variety	Stem base diameter at harvest stage(cm)
V_1	22.95 b
V_2	25.07 a
LSD $_{(0.05)}$	1.0996
Mulch material	
T_1	18.64 d
T_2	28.13 b
T_3	30.63 a
T_4	22.72 c
T_5	19.91 d
LSD $_{(0.05)}$	1.739
CV (%)	5.97

ns=non-significan V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 4. Interaction effect of varieties and mulch materials on stem base diameter of white maize at harvest

Variety × Mulch material	Stem base diameter at harvest stage(cm)
V_1T_1	18.43 f
V_1T_2	26.39 c
V_1T_3	28.84 bc
V_1T_4	22.21 d
V_1T_5	18.86 ef
V_2T_1	18.85 ef
V_2T_2	29.86 b
V_2T_3	32.41 a
V_2T_4	23.23 d
V_2T_5	20.97 de
$LSD_{(0.05)}$	2.459
CV (%)	5.97

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.6 Reproductive attributes

Days to tasselling varied insignificantly for different maize varieties (Appendix XV). The maximum days to tasselling (62.33, 73.73 and 87.53 days) was found from V_2 (Table 5).

Significant variation was recorded for days to tasselling due to different mulches materials (Appendix XV). The maximum days to tasselling (65.00, 80.67 and 94.83 days) was recorded from T_1 treatment, whereas the minimum (58.83, 68.67 and 79.17 days) was recorded T_3 (Table 5). Similar result was found Rahman,(2002) showed increase tassel length and decrease time for tasselling, silking in rice straw and water hyacinth treated mulch compared to other mulches and control.

Interaction effect of different maize varieties and mulches materials showed significant variation on days to tasselling (Appendix XV). The maximum days to tasselling (66.00, 81.33 and 99.00 days) were obtained from the combination V_2T_1 and the minimum (58.67, 68.00 and 78.00 days) from the combination V_1T_3 (Table 6).

Days to cob appearance varied insignificantly for different maize varieties (Appendix XV). The maximum days to cob appearance was performed as 63.33, 76.53 and 89.80 days at 1st, 50% and 100% respectively.

Significant variation was recorded for days to cob appearance due to different mulches materials (Appendix XV). The maximum days to cob appearance (66.33, 81.67 and 97.00 days) was recorded from T_1 treatment, whereas the minimum (60.67, 71.00 and 81.33 days) was recorded from T_3 (Table 5).

Interaction effect of different maize varieties and mulches materials showed significant variation on days to cob appearance (Appendix XV). The maximum days to cob appearance (66.67, 83.00 and 101.33 days) was obtained from the combination V_2T_1 at 1st, 50% and 100%, respectively and the minimum (60.00 days) from V_2T_3 at 1st cob appearance and 70.00 and 80.00 days from combination V_1T_3 at 50% and 100% cob appearance, respectively (Table 6).

Days to silk appearance varied significantly for different maize varieties (Appendix XV). The maximum days to silk appearance (80.13, 93.20 and 104.47 days) were found from V_2 in 1st, 50% and 100% silk appearance, respectively (Table 5). Awal and Khan, (1998) Water hyacinth and rice straw mulches hastened the tasseling, Bilking and maturity time by 6, 8 and 8 days respectively.

Significant variation was recorded for days to silk appearance due to different mulches materials (Appendix XV). The maximum days to silk appearance (81.50 and 95.33 days) was recorded from T_5 treatment in 1st and 50% appearance and 109.17 days from treatment T_1 in 100% appearance, whereas the minimum (77.33, 90.67 and 99.83 days) was recorded T_3 in 1st, 50% and 100% silk appearance.

Interaction effect of different maize varieties and mulches materials showed significant variation on days to silk appearance (Appendix XV). The maximum days to silk appearance (81.67 days) was obtained from the both combination V_1T_5 and V_2T_1 at 1st appearance, 96.00 days from V_2T_5 at 50% appearance and 110.00 days from V_1T_1 at 100% appearance and the minimum (77.00, 90.67 and 99.33 days) from the combination $V1T_3$ at 1st, 50 and 100%, respectively (Table 6).

Table 5. Effect of varieties and mulch materials on reproductive attributes of white maize

Variety	Reproductive attributes								
	Days to tasselling			Days to cob appearance			Days to silk appearance		
	1st	50 %	100 %	1st	50 %	100 %	1st	50 %	100 %
V_1	61.60	74.07	86.40 b	63.47	75.87	88.13 b	78.87 b	92.13 b	102.73 b
V_2	62.33	73.73	87.53a	63.33	76.53	89.80 a	80.13 a	93.20 a	104.47 a
LSD $_{(0.05)}$	ns	ns	1.114	ns	ns	1.281	0.920	0.649	0.662
Mulch material									
T_1	65.00 a	80.67 a	94.83 a	66.33 a	81.67 a	97.00 a	80.67ab	93.00 b	109.17 a
T_2	60.33 c	70.50 c	83.33d	63.67 b	74.33 c	84.67 d	79.67bc	91.33 c	100.67 d
T_3	58.83 d	68.67 d	79.17e	60.67 c	71.00 d	81.33 e	77.33 d	90.67 c	99.83 d
T_4	62.83 b	75.17 b	86.33c	63.33 b	75.50 c	88.67 c	78.33 cd	93.00 b	102.33 c
T_5	62.83 b	74.50 b	91.17b	63.00 b	78.50 b	93.17 b	81.50 a	95.33 a	106.00 b
LSD $_{(0.05)}$	1.202	1.067	1.761	1.614	1.863	2.026	1.454	1.026	1.047
CV (%)	1.60	1.19	1.67	2.10	2.02	1.88	1.51	0.91	0.83

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 6. Interaction effect of varieties and mulch materials on reproductive attributes of white maize

Variety × Mulch material	Reproductive attributes								
	Days to tasselling			Days to cob appearance			Days to silk appearance		
	1st	50 %	100 %	1st	50 %	100 %	1st	50 %	100 %
V_1T_1	64.00 b	80.00 a	90.67bc	66.00 ab	80.33 b	92.67bc	79.67 a-c	92.00 c	110.00 a
V_1T_2	60.00 de	71.33 d	83.67 d	64.00bc	75.33 d-f	84.00 d	79.00 b-d	91.33 c	99.67 e
V_1T_3	58.67 e	68.00 f	78.00 f	61.33 de	70.00 h	80.00 e	77.00 d	90.67 c	99.33 e
V_1T_4	62.33bc	75.67 b	90.00 c	63.00 cd	76.33 de	92.33bc	77.00 d	92.00 c	101.67 cd
V_1T_5	63.00 b	75.33 b	89.67 c	63.00 cd	77.33 cd	91.67 c	81.67 a	94.67ab	103.00 c
V_2T_1	66.00 a	81.33 a	99.00 a	66.67 a	83.00 a	101.33 a	81.67 a	94.00 b	108.33 b
V_2T_2	60.67 cd	69.67 e	83.00 d	63.33 cd	73.33fg	85.33 d	80.33ab	91.33 c	101.67 cd
V_2T_3	59.00 de	69.33ef	80.33ef	60.00 e	72.00gh	82.67 de	77.67 cd	90.67 c	100.33 de
V_2T_4	63.33 b	74.67bc	82.67 de	63.67 c	74.67ef	85.00 d	79.67 a-c	94.00 b	103.00 c
V_2T_5	62.67 b	73.67 c	92.67 b	63.00 cd	79.67bc	94.67 b	81.33 a	96.00 a	109.00ab
$LSD_{(0.05)}$	1.699	1.509	2.490	2.282	2.635	2.865	2.056	1.450	1.480
CV (%)	1.60	1.19	1.67	2.10	2.02	1.88	1.51	0.91	0.83

V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.7 Days to seedling emergence

Days to seedling emergence varied insignificantly for different maize varieties (Appendix XVI). The maximum days to seedling emergence was performed as 5.40 and 10.73 days at 50% and 100% respectively (Table 7).

Significant variation was recorded for days to seedling emergence due to different mulches materials (Appendix XVI). The maximum days to seedling emergence (7.33 and 14.50 days) was recorded from T_1 treatment, whereas the minimum (4.00 and 9.17 days) was recorded from T_2 (Table 7). Rahman (1999) observed that rice straw and water hyacinth mulch treatment took lesser time for maximum or constant maize seedling emergence and had higher emergence percentage and emergence velocity compared to other mulches and control.

Interaction effect of different varieties and mulches materials showed significant variation on days to seedling emergence (Appendix XVI). The maximum days to seedling emergence (9.00 and 14.67 days) was obtained from the combination V_2T_1 and the minimum (3.33 and 7.00) from the combination of V_2T_3 and V_1T_3 respectively (Table 8).

Table 7. Effect of varieties and mulch materials on days to seedling emergence of white maize

Variety	Days to seedling emergence	
	50 %	100 %
V_1	5.07	10.27
V_2	5.40	10.73
$LSD_{(0.05)}$	ns	ns
Mulch material		
T_1	7.33 a	14.50 a
T_2	4.00 c	9.17 c
T_3	4.00 c	7.50 d
T_4	5.50 b	9.33 c
T_5	5.33 b	12.00 b
$LSD_{(0.05)}$	0.913	1.188
CV (%)	14.38	9.33

ns=non-significant V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 8. Interaction effect of varieties and mulch materials on days to seedling emergence of white maize

Variety × Mulch material	Days to seedling emergence	
	50 %	100 %
V_1T_1	5.67 bc	14.33 a
V_1T_2	4.00 de	9.00 c
V_1T_3	4.67 cd	7.00 d
V_1T_4	6.00 b	9.00 c
V_1T_5	5.00 b-d	12.00 b
V_2T_1	9.00 a	14.67 a
V_2T_2	4.00 de	9.33 c
V_2T_3	3.33 e	8.00 cd
V_2T_4	5.00 b-d	9.67 c
V_2T_5	5.67 bc	12.00 b
$LSD_{(0.05)}$	1.291	1.680
CV (%)	14.38	9.33

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.8 SPAD reading

Leaf SPAD meter reading was analyzed and presented for an idea about relative leaf chlorophyll content per unit area of maize varieties. Highly significant chlorophyll content was observed in 100 and 120 DAS for maize varieties (Appendix XVII). The highest leaf SPAD value (42.71, 52.95, 53.02, 46.44 and 40.05) at 40, 60, 80, 100 and 120 DAS respectively were found from variety V_2 (Table 9).

A significant difference was observed for different mulch materials in maize on relative chlorophyll content of leaf during growth period. (Appendix XVII). At 40, 60, 80, 100 and 120 DAS the maximum SPAD value (44.62, 61.85, 57.88, 52.77 and 46.57, respectively) were found from T_3. It was statistically similar (43.58, 53.57, 56.07, 50.72 and 44.68) at the same gowrth duration after sowing from the mulch treatment T_2. The minimum SPAD value (37.90, 42.13, 43.55, 34.15 and 26.77) at 40, 60, 80, 100 and 120 DAS, respectively were found from T_1 (control treatment) (Table 9). Similar result was showed by Khan, (2001) that water hyacinth and rice straw mulched plants maintained higher chlorophyll stability indices which showed high SPAD meter reading indicating their greater ability to combat drought conditions.

The effect of interaction of maize varieties and mulches materials showed significant variation on leaf SPAD value at different growth duration (Appendix XVII). The combination of V_2T_3 showed the maximum SPAD value (46.47, 72.30, 59.73, 54.23 and 48.93) at 40, 60, 80, 100 and 120 DAS, respectively, which was statistically similar to V_2T_2 (44.40, 55.67, 56.47, 53.60 and 46.63) at same days after sowing. The minimum SPAD value (37.30, 41.20, 40.97, 32.37 and 25.20) at 40, 60, 80, 100 and 120 DAS respectively were obtained from the combination of V_1T_1 (Table 10).

Table 9. Effect of varieties and mulch materials on SPAD reading at different DAS of white maize

Variety	SPAD meter reading				
	40 DAS	60 DAS	80 DAS	100 DAS	120 DAS
V_1	41.42	47.32	50.06	42.92 b	36.31 b
V_2	42.71	52.95	53.02	46.44 a	40.05 a
$LSD_{(0.05)}$	ns	ns	ns	3.263	3.388
Mulch material					
T_1	37.90 b	42.13 b	43.55 d	34.15 c	26.77 c
T_2	43.58 a	53.57 ab	56.07 ab	50.72 a	44.68 a
T_3	44.62 a	61.85 a	57.88 a	52.77 a	46.57 a
T_4	42.20 a	47.75 b	51.45 bc	44.32 b	38.30 b
T_5	42.03 a	45.37 b	48.75 cd	41.45 b	34.60 b
$LSD_{(0.05)}$	2.676	12.186	6.015	5.159	5.357
CV (%)	5.24	20.04	9.62	9.52	11.57

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 10. Interaction effect of varieties and mulch materials on SPAD reading at different DAS of white maize

Variety × Mulch material	SPAD meter reading				
	40 DAS	60 DAS	80 DAS	100 DAS	120 DAS
V_1T_1	37.30 d	41.20 b	40.97 d	32.37 f	25.20 e
V_1T_2	42.77 ab	51.47 b	55.67 ab	47.83 a-c	42.73 a-c
V_1T_3	42.77 ab	51.40 b	56.03 ab	51.30 ab	44.20 a-c
V_1T_4	41.77bc	47.60 b	49.37 b-d	43.10 c-e	37.07 cd
V_1T_5	42.50 b	44.93 b	48.27 b-d	40.00 de	32.37 de
V_2T_1	38.50 cd	43.07 b	46.13 cd	35.93ef	28.33 e
V_2T_2	44.40 ab	55.67 ab	56.47 ab	53.60 a	46.63 ab
V_2T_3	46.47 a	72.30 a	59.73 a	54.23 a	48.93 a
V_2T_4	42.63 b	47.90 b	53.53 a-c	45.53 b-d	39.53 b-d
V_2T_5	41.57bc	45.80 b	49.23 b-d	42.90 c-e	36.83 cd
$LSD_{(0.05)}$	3.785	17.233	8.506	7.295	7.577
CV (%)	5.24	20.04	9.62	9.52	11.57

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.9 Leaf area index

Insignificant variation was observed for leaf area index for different maize varieties except 30 DAS (Appendix XVIII). In 30 DAS leaf area index was highly significant. The highest leaf area index at 30, 40, 50, 60, 70, 80, 90 and 120 DAS was found as 0.73, 1.02, 1.98, 2.83, 5.00, 5.34, 5.49 and 5.12, respectively for the variety V_1 (Appendix XIX).

Significant difference was observed for leaf area index for different mulches materials (Appendix XVIII). The highest leaf area index was recorded at 30, 40, 50, 60, 70, 80, 90 and 120 DAS was 0.83, 1.18, 2.21, 3.09, 5.49, 5.78, 5.83 and 5.48 from mulch treatment T_3, which was statistically similar to treatment T_2 (Appendix XIX). The lowest leaf area index was observed from mulch treatment T_1 for all the recorded days after sowing. Similar result was showed by Khan, (2001) that water hyacinth and rice straw mulched plants maintained higher chlorophyll stability indices which showed high SPAD meter reading indicating their greater ability to combat drought conditions. Awal and Khan,

(1999) showed that mulching with water hyacinth and rice straw increased the LAI of maize with their maximum at 90 DAS compared to control. LAI was also affected by environmental factors especially temperature and moisture.

Interaction effect of different maize varieties and different mulch materials represented significant variation on leaf area index (Appendix XVIII). The highest leaf index area was observed (0.90, 1.18, 2.25, 3.18, 5.64, 5.93, 5.97 and 5.58) from the treatment combination V_1T_3, at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix XX). It was statistically similar (0.83, 1.18, 2.23, 3.15, 5.53, 5.71, 5.84 and 5.47) with the combination V_1T_2 at same days after sowing, respectively. The lowest leaf area index (0.53, 0.78, 1.52, 1.93, 3.68, 4.44, 4.77 and 4.31) was recorded from the combination of V_2T_1 (variety KS510 with control mulch) at 30, 40, 50, 60, 70, 80, 90 and 120 DAS (Appendix XX).

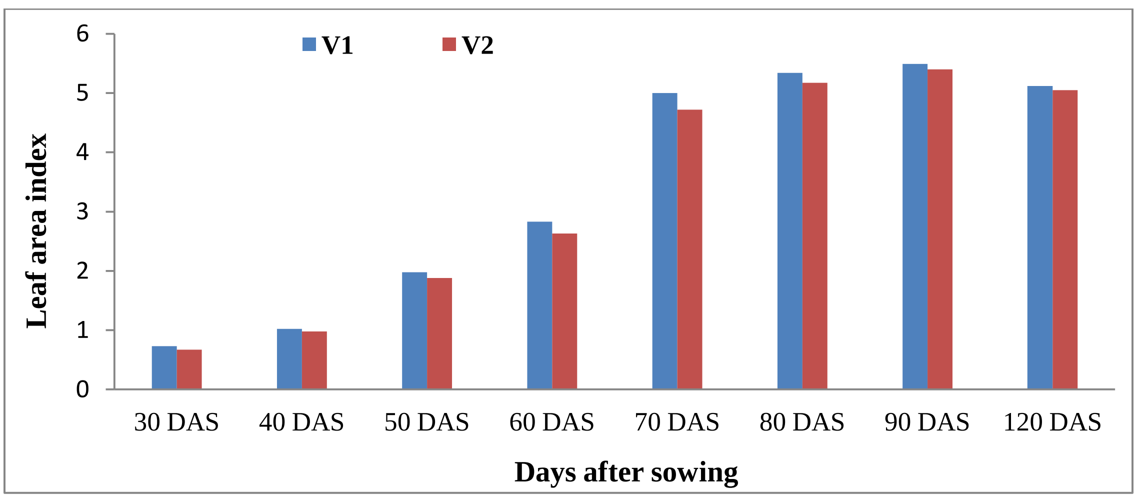


Figure 11. Effect of varieties on leaf area index of white maize at different DAS (LSD $_{0.05}$ value= 0.058 at 30 DAS). V_1 = Shuvra, V_2 = KS-510(IV)

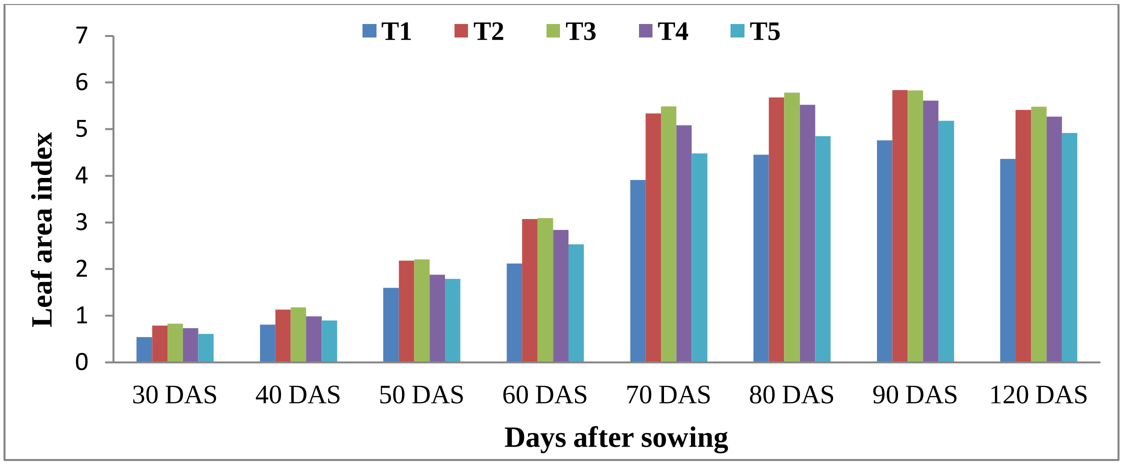


Figure 12. Effect of mulch materials on leaf area index of white maize at different DAS (LSD $_{0.05}$ value= 0.091, 0.186, 0.176, 0.348, 0.481, 0.379, 0.310 and 0.393 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively). T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

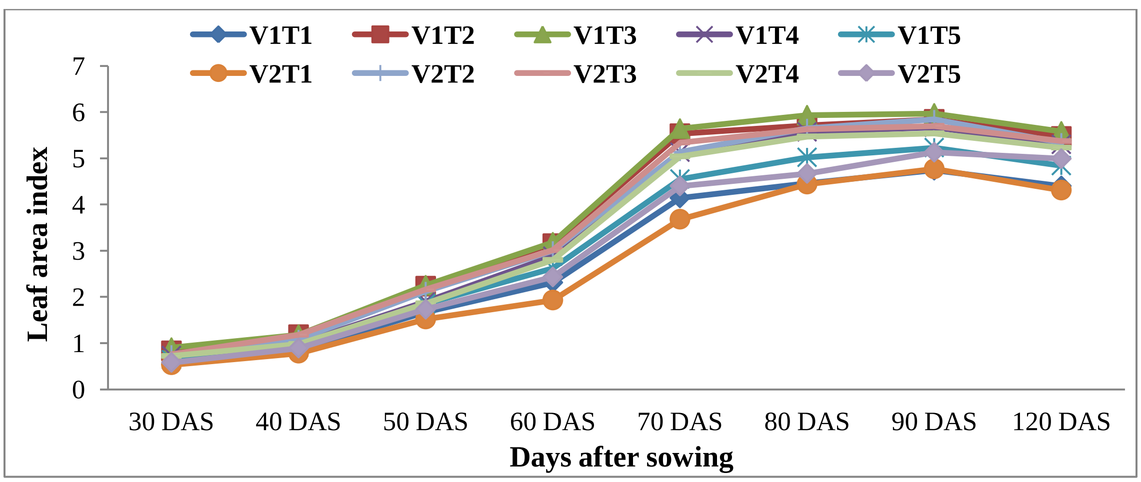


Figure 13. Interaction effect of varieties and mulch materials on leaf area index of white maize at different DAS (LSD $_{0.05}$ value= 0.129, 0.263, 0.249, 0.492, 0.680, 0.536, 0.439 and 0.556 at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively). V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.10 Days to harvesting

Days to harvest varied insignificantly for different maize varieties (Appendix XXI). The maximum days to harvest (145.80 days) were found from V_2 (Table 11).

Significant variation was recorded for days to harvest due to different mulches materials (Appendix XXI). The maximum days to harvest (150.33 days) was recorded from T_3 treatment, whereas the minimum (140.33 days) was recorded T_1. Because in control plot lower content of moisture so plant become straw color quickly as well cob. But in rice straw mulch treated plot plant get water from soil moisture and they get more time to devlop so harvesting time lengthy in rice straw treated plots.

Interaction effect of different maize varieties and mulches materials showed significant variation on days to harvest (Appendix XXI). The maximum days to silk appearance (151.33 days) was obtained from the both combination V_2T_3 and the minimum (139.33 days) from the combination V_1T_1 (Table 12).

Table 11. Effect of varieties and mulch materials on days to harvesting of white maize

Variety	Days to harvesting
V_1	143.73
V_2	145.80
LSD $_{(0.05)}$	Ns
Mulch material	
T_1	140.33 c
T_2	147.50 b
T_3	150.33 a
T_4	147.50 ab
T_5	141.83 c
LSD $_{(0.05)}$	3.844
CV (%)	2.19

ns=non-significant

V_1 = Shuvra, V_2 = KS-510(IV),T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 12. Interaction effect of varieties and mulch materials on days to harvesting of white maize

Variety × Mulch material	Days to harvesting
V_1T_1	133.33 e
V_1T_2	146.33 a-d
V_1T_3	149.33 ab
V_1T_4	143.33 c-e
V_1T_5	140.33 e
V_2T_1	141.33 de
V_2T_2	148.67 a-c
V_2T_3	151.33 a
V_2T_4	144.33 b-e
V_2T_5	143.33 de
$LSD_{(0.05)}$	5.437
CV (%)	2.19

V_1 = Shuvra, V_2 = KS-510(IV) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.11 Dry weight (gm/plant) at different plant parts at mature stage

Varieties had a significant effect on leaf dry weight (Appendix XXI). The highest values of this character (40.26 g/plant) were resulted from variety V_2 and lowest values of leaf dry weight (38.68 g/plant) from V_1 (Table 13). V_2 may be attributed to the suitable weather condition during vegetative growth, which contributed to good foliage growth and formation ample canopy able to make best photosynthesis, hence increase leaf dry matter accumulation.

Leaf dry weight was significantly affected by mulches materials treatments (Appendix XXI). Mulches treatment T_2 performed maximum (54.02 g/plant) average means of leaf dry weight. The lowest values of this trait (25.18 g/plant) were recorded for the control treatment.

Variety and mulches combination significantly affected leaf dry weight (Appendix XXI). Maximum means of this character (53.33 g/plant) obtained from V_1T_2 (Table 14). The lowest values in this term (24.05 g/plant) were produced from application V_2T_1. The increase in leaf dry weight with the changed in mulches materials and variety combination may be attributed to the role of it in stimulatory leaf growth, increase in chlorophyll content and causing canopy regeneration and directs photosynthates into top production rather than root storage.

Statistically significant variation was recorded for stem dry weight of maize due to different varieties under the present trial (Appendix XXI). The highest dry matter content of stem (53.79 g) was found from V_2, while the lowest dry matter content of stem (52.27 g) was recorded from V_1.

Different mulches materials showed significant variation for stem dry weight of maize (Appendix XXI). The highest stem dry weight (63.35 g) was found from T_2, whereas the lowest stem dry weight (40.97 g) was recorded from T_1.

Interaction effect of different varieties and mulches materials showed significant differences on stem dry weight of maize (Appendix XXI). The highest stem dry weight (65.36 g) was recorded from V_2T_2 and the lowest stem dry weight (40.31 g) was found from V_2T_1.

Statistically significant variation was recorded for tassel and sterile cob dry weight of cabbage due to different maize varieties under the present trial (Appendix XXI). The highest tassel and sterile cob dry weight (5.51 g/plant) was recorded from V_2, whereas the lowest tassel and sterile cob dry weight (5.42 g/plant) was recorded from V_1.

Different mulches materials showed significant variation for tassel and sterile cob dry weight of cabbage (Appendix XXI). The highest tassel and sterile cob dry weight (7.82 g) was recorded from T_3 which was followed by T_2 (7.23 g), while the lowest tassel and sterile cob dry weight (3.72 g) was recorded from T_1.

Interaction effect of different varieties and mulches materials showed significant differences on tassel and sterile cob dry weight of cabbage (Appendix XXI). The highest tassel and sterile cob dry weight (8.20 g) was recorded from V_2T_3 and the lowest tassel and sterile cob dry weight (3.43 g) was found from V_2T_1.

Statistically significant variation was recorded for cob sheath dry weight of maize due to different varieties under the present trial (Appendix XXI). The highest cob sheath dry weight (23.80 g) was recorded from V_2, while the lowest cob sheath dry weight (22.09 g) was recorded from V_1.

Different mulches materials showed significant variation for cob sheath dry weight of maize (Appendix XXI). The highest cob sheath dry weight (31.01 g) was found from T_3 which was followed by T_2 (26.01 g), whereas the lowest cob sheath dry weight (16.26 g) was recorded from T_1.

Interaction effect of different varieties and mulches materials showed significant differences on cob sheath dry weight of cabbage (Appendix XXI). The highest cob sheath dry weight (32.56 g) was recorded from V_2T_3 and the lowest cob sheath dry weight (15.23 g) was found from V_1T_1.

Statistically significant variation was recorded for cob rachis dry weight of maize due to different varieties under the present trial (Appendix XXII). The highest cob rachis dry weight of maize (25.06 kg) was recorded from V_2, while the lowest cob rachis dry weight of maize (23.68 kg) was recorded from V_1.

Different mulches materials showed significant variation for cob rachis dry weight of maize (Appendix XXII). The highest cob rachis dry weight of maize (35.05 kg) was recorded from T_3 which was followed by 30.31 kg with T_2, whereas the lowest cob rachis dry weight of maize (15.84 kg) was recorded from T_1.

Interaction effect of different varieties and mulches materials showed significant differences on cob rachis dry weight of maize (Appendix XXII). The highest cob rachis dry weight of maize (35.83 kg) was found from V_2T_3 and the lowest cob rachis dry weight of maize (16.01 kg) was found from V_1T_1.

Different variety exhibited significant effect on root dry weight **(**Appendix XXII**)**. The maximum averages of root dry weight (16.51 g/plant) were achieved from the variety V_2. On the other side, the lowest one was obtained from variety V_1. The increase in root dry weight caused by V_2 may be ascribed to the more suitable growth period of plant, consequently enhance establishment and growth as well as development roots.

Regarding the effect of different mulches materials on root dry weight, it was significant effect **(**Appendix XXII**)**. Root dry weight was markedly increased and achieved maximum values in treatment of T_3 (22.48 g) and it was statistically similar with T_2 (21.05 g) treatments. The increase in root dry weight as a result of mulches treatments may be has the same reason for increasing root fresh weight, which mentioned before.

A significant effect of maize varieties and mulches combination on root dry weight was found (Appendix XXII). Variety and mulches combination caused significant increase in root dry weight. The highest values of root dry weight (23.53 g) were recorded due to V_2T_3 and it was statistically similar with V_1T_2 and V_1T_3. On opposition to, the lowest ones (6.10 g) were proceeded from combination V_1T_1. This increase in root dry weight by changing the mulches items might have been resulted from increasing photosynthetic area per plant, which led to more photosynthates production and therefore increasing dry matter accumulation with variety V_2.

Statistically significant variation was recorded for seed dry weight due to different varieties under the present trial (Appendix XXII). The highest seed dry weight (218.80 g) was recorded from V_2, while the lowest seed dry weight (188.13 g) was found from V_1.

Different mulches materials showed significant variation for seed dry weight (Appendix XXII). The highest seed dry weight (304.35 g) was found from T_3 which was statistically similar (267.13 g) with T_2, whereas the lowest seed dry weight (95.35 g) from T_1.

Interaction effect of different varieties and mulches showed significant differences on seed dry weight (Appendix XXII). The highest seed dry weight (330.67 g) was recorded from V_2T_3 and the lowest seed dry weight (92.43 g) was found from V_1T_1.

Significant variation was found on shoot dry weight due to different varieties under the present trial (Appendix XXII). The highest shoot dry weight (364.73 g) was found from V_2, while the lowest shoot dry weight (330.36 g) was recorded from V_1.

Different mulches showed significant variation for shoot dry weight (Appendix XXII). The highest shoot dry weight (330.36 g) was found from T_3 which was followed by T_2 (440.16 g), whereas the lowest shoot dry weight (199.06 g) was recorded from T_1 (Table 5).

Combined effect of different varieties and mulches showed significant differences on shoot dry weight (Appendix XXII). The highest shoot dry weight (521.19 g) was recorded from V_2T_3 and the lowest shoot dry weight (195.70 g) was found from V_1T_1.

Significant variation was recorded for total dry matter content due to different varieties under the present trial (Appendix XXII). The highest dry matter content (381.24 g) was recorded from V_2, while the lowest dry matter content (344.71 g) was found from V_1.

Different mulches showed significant variation for dry matter content (Appendix XXII). The highest dry matter content (511.92 g) was found from T_3 which was closely followed (461.21 g) T_2, whereas the lowest dry matter content (204.72 g) was found from T_1. Bhatt *et al.* (2004) reported that dry matter production on maize with rice straw mulch was higher by 138% than the dry matter production from bare plots.

Significant difference was observed on dry matter content due to combined effect of different varieties and mulches (Appendix XXII). The highest dry matter content (544.72 g) was recorded from V_2T_3 and the lowest dry matter content (198.80 g) was found from V_1T_1.

Data in table 13 are in concern with the effect of varieties and mulches materials on root/top ratio. It is found from that varieties had insignificant effect on root/top ratio (Appendix XXII). Variety V_2 represented the highest values of root/top ratio. On contrary, the lowest values of root/top ratio (0.044) were resulted from variety V_1.

There were significant effects for mulches treatments on root/top ratio (Appendix XXII). The highest root shoot ratio was found in mulches treatment T_2 (0.048) and T_4 (0.048), while the lowest root shoot ratio was observed by the mulches treatment T_1 (0.036).

Significant difference was observed on root shoot ratio due to combined effect of different varieties and mulches (Appendix XXII). The highest root shoot ratio (0.051) was recorded from V_1T_2 and the lowest dry matter content (0.032) was found from V_1T_1.

Table 13. Effect of varieties and mulch materials on dry weight of different plant parts at mature stage of white maize

Variety	Dry weight (g/plant) of different parts at mature stage									
	Leaf	Stem	Tassel+sterile cob	Cob sheath	Cob rachis	Root	Seed	Shoot	Total dry matter	Root shoot ratio
V_1	38.68 b	52.27 b	5.42	22.09 b	23.68 b	14.95 b	188.13 b	330.36 b	344.71 b	0.044
V_2	40.26 a	53.79 a	5.51	23.80 a	25.06 a	16.51 a	218.80 a	364.73 a	381.24 a	0.045
LSD $_{(0.05)}$	1.139	1.307	ns	0.817	1.171	1.268	23.568	23.503	23.493	ns
Mulch material										
T_1	25.18 e	40.97 e	3.72 d	16.26 d	15.84 e	7.16 d	95.35 d	199.06 e	204.72 e	0.036 b
T_2	54.02 a	63.35 a	7.23 b	26.01 b	30.31 b	21.05 a	267.13 a	440.16 b	461.21 b	0.048 a
T_3	50.82 b	60.32 b	7.82 a	31.01 a	35.05 a	22.48 a	304.35 a	489.44 a	511.92 a	0.046 a
T_4	34.71 c	52.02 c	4.51 c	21.01 c	21.45 c	16.21 b	208.60 b	342.36 c	358.58 c	0.048 a
T_5	32.63 d	48.51 d	4.04 cd	20.45 c	19.20 d	11.75 c	141.90 c	266.72 d	278.47 d	0.045ab
LSD $_{(0.05)}$	1.801	2.066	0.486	1.292	1.852	2.004	37.264	37.162	37.145	0.008
CV (%)	3.76	3.21	7.33	4.64	6.26	10.50	15.10	8.82	8.44	15.39

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 14. Interaction effect of varieties and mulch materials on dry weight of different plant parts at mature stage of white maize

Variety × Mulch material	Dry weight (g/plant) of different parts at mature stage									
	Leaf	Stem	Tassel+sterile cob	Cob sheath	Cob rachis	Root	Seed	Shoot	Total dry matter	Root shoot ratio
V_1T_1	26.31 e	41.63 f	4.00 de	15.23 g	16.01 e	6.10 g	92.43 d	195.70 e	198.80 e	0.032 b
V_1T_2	53.33 a	61.34 b	7.09 b	24.76 d	29.17 b	21.50ab	247.07 b	422.76bc	444.26bc	0.051 a
V_1T_3	48.40 b	59.92 b	7.44 b	29.46 b	34.27 a	21.43ab	278.03ab	457.68 b	479.11 b	0.047 a
V_1T_4	33.80 cd	50.76 cd	3.94 de	20.40 e	19.90 d	14.90 cd	181.13 c	310.08 d	324.98 d	0.048 a
V_1T_5	31.57 d	47.70 e	4.63 cd	20.61 e	19.07 d	10.83 ef	142.00 cd	265.58 d	276.41 d	0.041 ab
V_2T_1	24.05 e	40.31 f	3.43 e	17.29 f	15.67 e	8.22 fg	98.28 d	202.42 e	210.64 e	0.041 ab
V_2T_2	54.70 a	65.36 a	7.37 b	27.26 c	31.45 b	20.60 b	287.20ab	457.55 b	478.16 b	0.046 a
V_2T_3	53.23 a	60.72 b	8.20 a	32.56 a	35.83 a	23.53 a	330.67 a	521.19 a	544.72 a	0.045 a
V_2T_4	35.63 c	53.27 c	5.07 c	21.61 e	23.00 c	17.53 c	236.07 b	374.64 c	392.17 c	0.047 a
V_2T_5	33.68 cd	49.31 de	3.45 e	20.29 e	19.33 d	12.67 de	141.80 cd	267.86 d	280.53 d	0.048 a
LSD (0.05)	2.547	2.922	0.687	1.827	2.619	2.835	52.699	52.554	52.531	0.012
CV (%)	3.76	3.21	7.33	4.64	6.26	10.50	15.10	8.82	8.44	15.39

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.12 Total dry matter in per 3m^2 (gm) and (kg/ha)

Significant variation was found on total dry matter/3m^2 due to different maize varieties under the present studies (Appendix XXIII). The highest total dry matter/3m^2 (6862.4 g) was found from V_2; while the lowest total dry matter/3m^2 (6215.6 g) was recorded from V_1 (Table 15).

Different mulches materials showed significant variation for total dry matter/3m^2 (Appendix XXIII). The highest total dry matter/3m^2 (9214.5 g) was found from T_3 which was followed by T_2 (8301.8 g), whereas the lowest total dry matter/3m2 (3712.0 g) was recorded from T_1 (Table 15).

Combined effect of different maize varieties and mulches materials showed significant differences on total dry matter/3m^2 (Appendix XXIII). The highest total dry matter/3m^2 (9805.0 g) was recorded from V_2T_3 and the lowest total dry matter/3m^2 (3632.5 g) was found from V_1T_1 (Table 16).

Significant variation was recorded for total dry matter per ha in maize field due to different maize varieties under the present study (Appendix XXIII). The highest total dry matter per ha in maize field (26917 kg/ha) was recorded from V_2, while the lowest total dry matter per ha (20719 kg/ha) was found from V_1 (Table 15).

Different mulches materials showed significant variation for total dry matter per ha (Appendix XXIII). The highest total dry matter per ha (30715 a kg/ha) was found from T_3, whereas the lowest total dry matter per ha (12373 kg/ha) was found from T_1 (Table 15).

Significant difference was observed on total dry matter per ha due to combined effect of different maize varieties and mulches materials (Appendix XXIII). The highest total dry matter per ha (37044 kg/ha) was recorded from V_2T_5 and the lowest total dry matter per ha (12108 kg/ha) was found from V_1T_1 (Table 16).

Table 15. Effect of varieties and mulch materials on total dry matter of white maize

Variety	Total dry matter $3m^{-2}$ (g)	Total dry matter (kg/ha)
V_1	6215.6 b	20719
V_2	6862.4 a	26917
$LSD_{(0.05)}$	419.80	ns
Mulch material		
T_1	3712.0 e	12373 b
T_2	8301.8 b	27673 a
T_3	9214.5 a	30715 a
T_4	6454.4 c	21515 ab
T_5	5012.4 d	26814 a
$LSD_{(0.05)}$	663.75	13194
CV (%)	8.37	45.67

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Table 16. Interaction effect of varieties and mulch materials on total dry matter of white maize

Variety × Mulch material	Total dry matter $3m^{-2}$ (g)	Total dry matter (kg/ha)
V_1T_1	3632.5 e	12108 c
V_1T_2	7996.7bc	26656 a-c
V_1T_3	8624.0 b	28747 a-c
V_1T_4	5849.6 d	19499 a-c
V_1T_5	4975.4 d	16585bc
V_2T_1	3791.6 e	12639 c
V_2T_2	8606.8 b	28689 a-c
V_2T_3	9805.0 a	32683 ab
V_2T_4	7059.1 c	23530 a-c
V_2T_5	5049.5 d	37044 a
$LSD_{(0.05)}$	938.69	18659
CV (%)	8.37	45.67

V_1 = Shuvra, V_2 = KS510(IV) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

4.13 Yield components, yield and harvest index

Seed weight/3m^2 varied significantly for different maize varieties (Appendix XXIV). The highest seed weight (3888.9 g) was observed from V_2, whereas the lowest (3331.7 g) was observed from V_1. Variety V_2 was superior for this trait it might be genetically superior (Table 17).

Statistically significant variation was recorded for seed weight due to different mulches materials (Appendix XXIV). The highest seed weight (5222.0 g) was observed from T_3, which was statistically similar to T_2 (4806.1 g), whereas the lowest (1718.0 d g) was recorded from control treatment. Treatment T_3 that means rice straw mulches provide the best environment to the plant for nutrient uptake, so that plant can achieve the best growth rate and potential. However, water hyacinth mulches also performed the same results.

Interaction effect of different maize varieties and mulches materials showed significant variation on seed weight (Appendix XXIV). The highest seed weight (5712.7 g) was found from the combination V_2T_3. On the other hand, the lowest (1663.2 g) was recorded from the combination V_1T_1, which was statistically similar to V_2T_1 (1772.9 g) (Table 18).

Varietal effect significantly influence on seed weight/cob of maize (Appendix XXIV). The maximum seed weight/cob (148.17 g) was found from V_2. On the other hand, the minimum seed weight/cob (139.61 g) was found from V_1. Variety V_2 performed better than V_1, it might be genetically influence (Table 17).

Different mulches materials significantly influenced on seed weight/cob of maize (Appendix XXIV). The maximum seed weight/cob (168.47 g) was found in mulches treatment T_3 and it was statistically similar with T_2 (159.53 g) and T4 (146.97 g). On the other hand, the minimum seed weight/cob (114.07 g) was found in T_1.

Seed weight/cob significantly influence by the interaction effect of different mulches and maize varieties (Appendix XXIV). The maximum seed weight/cob (176.87 g) was recorded from the combination of V_2T_3 and it was statistically similar with V_2T_2 (5166.7

g). On the other hand, the minimum seed weight/cob (1663.2 g) was recorded from the combination of V_1T_1 (Table 18).

Per cob weight varied significantly for different maize varieties (Appendix XXIV). The highest per cob weight (258.16 g) was obtained from V_2. On the other hand, the lowest per cob weight (242.37 g) was found from V_1 (Table 17).

Statistically significant variation was recorded for per cob weight due to different mulches (Appendix XXIV). The highest per cob weight (299.77 g) was found from T_3, which was statistically similar to T_2 (284.17 g), whereas the lowest (189.17 g) was recorded from control treatment.

Interaction effect of different mulches materials and maize varieties showed significant variation on per cob weight (Appendix XXIV). The highest per cob weight (310.87 g) was found from the combination $V_2T_{3,}$ which was statistically similar to V_2T_3 (297.13 g), whereas the lowest (185.27 g) was observed from the combination V_1T_1 (Table 18).

Significant variation in no. of seeds/cob was observed for maize varieties (Appendix XXIV). V_2 was produced increased number (218.80) of seeds/cob than V_1 (188.13) (Table 17).

Significant variation was observed for number of seeds/cob due to different mulches materials (Appendix XXIV). The maximum number of seeds/cob (304.35) was found from T_3, which was statistically similar to T2 (267.13), whereas the minimum number (95.35) was found from control treatment. Rice straw mulches improved the soil condition and provide the best environment to the plant for nutrient uptake, so that plant can achieve the best growth rate and potential.

Interaction effect of different mulches materials and maize varieties showed significant variation on no. of seeds/cob (Appendix XXIV). The highest no. of seeds/cob (572.13 g) was found from the combination $V_2T_{3,}$ which was statistically similar to V_1T_3 (522.93 g), V_2T_2 (521.20) and V_2T_4 (517.47), whereas the lowest (408.60 g) was observed from the combination V_1T_1 (Table 18).

Seed weight/plant varied significantly for different maize varieties (Appendix XXIV). The highest seed weight/plant (218.80 g) was recorded from V_2, whereas the lowest (188.13 g) was found from V_1.

Statistically significant variation was recorded for seed weight/plant to different mulches materials (Appendix XXIV). The highest seed weight/plant (304.35 g) was recorded from T_3, whereas the lowest (95.35 g) was obtained from T_1 (Table 17).

The combined effect of different mulches materials and maize varieties showed significant variation on seed weight/plant (Appendix XXIV). The highest seed weight/plant (330.67 g) was recorded from the combination of $V_2T_{3,}$ while the lowest (92.43 g) was found from the combination of V_1T_1 (Table 18).

The maximum number of cobs/3m^2 was significantly produced in response. However, the number of cobs/3m^2 obtained in response to use different maize varieties. That higher value of number of cobs/3m^2 was produced in response to the variety V_2 in vegetative growth stage might be attributed with higher uptake of nutrient by the plant to maximum no. of cobs/3m^2 productions. Similarly, the main effect of mulches materials significantly ($P \leq 0.01$) influenced to no. of cobs/3m^2 (Appendix XXIV). Pramanik, (1999) showed that mean cob yield and stover yield were significantly higher under paddy straw mulch than saw dust, coirdust, rice husk and control treatment.

The interaction effect of varieties and mulches materials showed significant effect to influence no. of cobs/3m^2 (Appendix XXIV).

No. of cobs/plant varied significantly for different maize varieties (Appendix XXIV). The highest no. of cobs/plant (1.42) was recorded from V_2, whereas the lowest (1.31) was found from V_1.

Statistically significant variation was recorded for no. of cobs/plant due to different mulches materials (Appendix XXIV). The highest no. of cobs/plant (1.81) was recorded from T_3 treatment, whereas the lowest (0.84) was obtained from T_1 (Table 17). Bhatt *et al*. (2004) showed that straw mulch increased the cob yield by 60.5% as compared to un-mulched treatment. Kulkarni *et al*., (1998) cob yield and were significantly higher under mulch over than rice straw mulch and no mulch treatment.

Interaction effect of different mulches materials and maize varieties showed significant variation on no. of cobs/plant (Appendix XXIV). The highest no. of cobs/plant (32.33) was recorded from the combination V_2T_3, which was statistically similar to V_2T_2 (31.67), V_1T_3 (31.33) and followed by V_1T_2 (28.67), while the lowest (15.00) was found from the combination of V_1T_1 (Table 18).

The main effect of variety significantly affected cob length of maize. However, the main effect of mulches as well as the interaction effect of variety significantly effects this parameter (Appendix XXIV).

Cob length increased significantly when the mulches was changed from control to water hyacinth to rice straw. Changing the mulches application beyond the rice straw didn't affect this parameter. Maximum cob length (21.62 cm) was recorded at treatment T_3 and minimum cob length (17.98 cm) was at T_5 treatment (Table 17).

The tallest cob diameter (5.08 cm) was obtained at the mulches treatment T_3 and the lowest (4.52 cm) was obtained at the mulches treatment of T_1. The lower cob diameter obtained at the control mulches treatments might be due to retarded growth owing to limited moisture and nutrient availability. The result generally showed an increase in cob diameter of maize when mulches application from control to water hyacinth and rice straw application. Similar result was also found by Rahman (2002) who reported that control or untreated plant gave the lower length and breadth of cob.

Number of row varied significantly for different maize varieties (Appendix XXV). The minimum number of row/cob (4.72) was found from V_1, whereas the maximum number (4.84) was obtained from V_2 (Table 17).

Different mulches varied significantly for number of row/cob (Appendix XXV). The maximum number of row/cob (15.57) was recorded from T_3, whereas the minimum number (13.07) was from control treatment.

Significant variation was recorded due to interaction effect of different mulches materials and maize varieties in terms of number of row/cob (Appendix XXV). The maximum number of row/cob (15.73) was found from the combination of V_2T_3, which was statistically similar to V_1T_3 (15.40), whereas the minimum number (12.93) was observed from the combination of V_1T_1 (Table 18).

No. of seeds/row varied significantly for different maize varieties (Appendix XIV). The highest no. of seeds/row (34.96) was recorded from V_2, whereas the lowest (33.17) was found from V_1.

Statistically significant variation was recorded for no. of seeds/row due to different mulches materials (Appendix XIV). The highest no. of seeds/row (37.87) was recorded from T_3, whereas the lowest (28.63) was obtained from control treatment.

Interaction effect of different mulches materials and maize varieties showed significant variation on no. of seeds/row (Appendix XXV). The highest no. of seeds/row (39.80) was recorded from the combination of V_2T_3, which was statistically similar to 36.602T2 (36.60), V_1T_2 (35.93) and V_1T_3 (35.93), while the lowest (27.40) was found from the combination of V_1T_1, which was statistically similar to V_2T_1 (29.87) (Table 18).

Mulches application had significant ($P \leq 0.01$) effect on thousand seed weight. The main effect of varieties and the mulches materials and interaction effect of the two factors influenced thousand seed weight of maize (Appendix XXV).

When the mulches changes from control to water hyacinth to rice straw the thousand seed weight was increased. On the whole, plants grown at the rice straw mulches supply had seed weight highest than the seed weights of plants in the control treatment (Table 13). Increased kernel weight in rice straw mulches might be due to the formation of more leaf area which might have intercepted more light and produced more carbohydrates in the source which was probably translocated into the sink (the grain) and resulted in more increased kernel weight than the control. Also, in rice straw increases the enzyme activity in maize which may result in higher seed weight. Quayyum and Ahmed, (1993) highest weight of 1000 grains in maize with rice straw mulches significantly increased grain yield of maize conventionally tilled plots.

The results of the analysis of variance showed that seed weight/ha of maize was significantly ($P \leq 0.01$) influenced by the main effect of varieties as well as by the main effect mulches materials ($P \leq 0.05$). There was present significant interaction effect of varieties and mulches application on this parameter (Appendix XXV).

The highest seed weight (12963 kg/ha) was recorded from V_2, while the lowest (11106 kg/ha) was obtained from V_1 (Table 17).

Mulches materials highly and significantly ($P \leq 0.01$) affected seed weight. (Appendix XXV). The highest seed weight (17407 kg/ ha) was recorded from T_3, while the lowest (5727 kg /ha) was obtained from the T_1 (Table 17). When the mulches was changed from control to water hyacinth to rice straw, seed weight of the crop was increased than decreased. Seed weight is a function of photosynthetic rate and proportion of the assimilatory surface area. Mulches application significantly influenced seed weight. Khera and Singh, (1998) showed that there was more than 50% increase in grain yield of maize in presence of straw mulch. Kalaghatagi *et al.* (1990) showed that the yield of maize was influenced by different organic mulches and the maximum or highest grain yield observed 6.78 t ha^{-1} with rice straw.

Interaction effect between maize varieties and mulches materials was significantly effect on seed weight. The highest seed weight was observed in combination of V_2T_3 (19042 kg/ha), whereas the lowest seed weight was observed from the combination of V_1T_1 (5544 kg/ha) (Table 18).

The main effect of variety and mulches materials was significantly (($P \leq 0.01$) affected seed weight of the crop. However, the two factors also interact significantly to influence grain yield (Appendix XXV). The highest seed weight ton/ha was observed by variety V_2 (12.963ton/ha) (Table 17).

Mulches materials highly and significantly ($P \leq 0.01$) affected seed weight (t/ha) (Appendix XXV). The highest seed weight (17.407 ton/ ha) was recorded from T_3, while the lowest (5.727 ton /ha) was obtained from the T_1 (Table 17). When the mulches was changed from control to water hyacinth to rice straw, seed weight of the crop was increased than decreased. Seed weight is a function of photosynthetic rate and proportion of the assimilatory surface area. Shen *et al*. (2012) showed that mulches application significantly influenced seed weight. grain yields of Danyu86 in 2009 and Chaoshi1 in 2010 were significantly (*LSD*, $P < 0.05$) higher with straw mulching at the rate of 12 t ha^{-1} than on the application of other treatments.

Interaction effect between maize varieties and mulches materials was significantly effect on seed weight. The highest seed weight was observed in combination of V_2T_3 (19.043 ton/ha), whereas the lowest seed weight was observed from the combination of V_1T_1 (5.543 ton/ha) (Table 18).

The physiological efficiency and ability of a crop for converting the total dry matter into economic yield is known as harvest index.

The main effect of varieties significantly ($P \leq 0.01$) affected harvest index of the crop (Appendix XXV). The highest harvest index was recorded for V_1 (0.53) (Table 17). This indicates significantly higher biomass partitioning to grain production by this variety. The lower mean HI values in this experiment might indicate the need for the enhancement of biomass partitioning through genetic improvement.

Significant differences in HI due to mulches materials were observed (Appendix XXV). Mulches treatment T_2 & T_4 both showed higher HI (0.58) (Table 17). The lowest HI was observed by the treatment T_5 (0.44).

Khan and Parvej,(2010) showed that by a field trial which was conducted on the four indigenous mulches viz. water hyacinth, rice straw, rice husk and ash were used for this study under tillage and zero tillage condition. Mulching practices enhanced the number of cob plant^{-1}, cob height, number of seed rows cob^{-1} and seeds row^{-1}, 1000–grains weight, weight of rachis cob^{-1}, grain yield and higher harvest index (HI) in maize. The grain yield of mulched plants notably rice straw and water hyacinth was nearly double (8.73 t ha^{-1}) than unmulched plants (4.93 t ha^{-1}) under non–tilth condition. Sharma *et al*. (2010) also reported that mulching increase corn productivity.

Rahman, (2002) showed that highest grain yield of 8.73 t ha^{-1} and the lowest of 4.93 t ha^{-1} with rice straw mulch and control treatments, respectively in maize field. The highest (Harvest Index) HI from the rice straw mulch treated plot (0.60) and the lowest from the control plot (0.49) in maize.

Table 17. Effect of varieties and mulch materials on yield components, yield and harvest index of white maize.

Variety	Seed wt/3m² (g)	Seed wt/cob (g)	per cob wt (g)	No. of seeds/cob	Seed wt/plant (g)	No. of cobs/3m²	No. of cobs/plant in 3m²	Cob length (cm)	Cob diameter (cm)	No. of row/cob	No. of seeds/row	1000-seed weight (g)	Wt of cob/plant (g)	Seed wt/ha (kg)	Seed wt (t/ha)	Harvest Index (%)
V_1	3331.7 b	139.61	242.37	462.96 b	188.13 b	23.53 b	1.31 b	18.23 b	4.72	14.11	33.17 b	283.53	328.90 b	11106 b	11.105 b	0.53
V_2	3888.9 a	148.17	258.16	510.37 a	218.80 a	25.33 a	1.42 a	20.70 a	4.84	14.49	34.96 a	308.67	383.90 a	12963 a	12.963 a	0.52
LSD $_{(0.05)}$	402.70	ns	ns	36.149	23.568	0.967	0.041	0.780	ns	ns	1.771	ns	36.553	1342.5	1.343	ns
Mulch material																
T_1	1718.0 d	114.07 c	189.17 d	417.03 c	95.35 d	15.17 e	0.84 e	18.11 b	4.52 b	13.07 d	28.63 c	257.33 c	159.68 e	5727 d	5.727 d	0.46 bc
T_2	4806.1 a	159.53 a	284.17 ab	507.53 ab	267.13 a	30.17 b	1.68 b	20.86 a	4.95 a	14.70 b	36.27 a	311.33 ab	479.07 b	16020 a	16.022 a	0.58 a
T_3	5222.0 a	168.47 a	299.77 a	547.53 a	304.35 a	31.83 a	1.81 a	21.62 a	5.08 a	15.57 a	37.87 a	336.50 a	541.86 a	17407 a	17.407 a	0.56 ab
T_4	3755.1 b	146.97 ab	248.33 bc	494.10 ab	208.60 b	25.50 c	1.42 c	18.73 b	4.78 ab	14.40 bc	35.13 ab	297.83 ab	352.31 c	12516 b	12.515 b	0.58 a
T_5	2550.5 c	130.43 bc	229.90 c	467.13 bc	141.90 c	19.50 d	1.09 d	17.98 b	4.56 b	13.77 c	32.43 b	277.50 bc	249.07 d	8502 c	8.502 c	0.44 c
LSD $_{(0.05)}$	636.73	24.421	37.983	57.157	37.264	15.17 e	0.84 e	1.232	0.3252	0.636	2.801	39.865	57.796	2122.8	2.123	0.106
CV (%)	14.54	13.99	12.51	9.68	15.10	30.17 b	1.68 b	5.22	5.61	3.67	6.78	11.10	13.37	14.54	14.54	16.69

ns=non-significant

V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3= Rice straw, T_4 = Rice husk, T_5 = Ash

Table 18. Combined effect of varieties and mulch materials on yield components, yield and harvest index of white maize

Variety × Mulch material	Seed wt/3m^2 (g)	Seed wt/cob (g)	per cob wt (g)	No. of seeds/cob	Seed wt/plant (g)	No. of cobs/3m^2	No. of cobs/plant in 3m^2	Cob length (cm)	Cob diameter (cm)	No. of row/cob	No. of seeds/row	1000-seed weight (g)	Wt of cob/plant (g)	Seed wt/ha (kg)	Seed wt (t/ha)	Harvest Index (%)
V_1T_1	1663.2 e	111.73 d	185.27 f	408.60 d	92.43 d	15.00 e	0.83 f	16.46 e	4.36 c	12.93 d	27.40 e	249.33 c	154.93 g	5544 e	5.543 e	0.46 ab
V_1T_2	4445.5 bc	154.93 a-c	271.20 a-d	493.87 a-c	247.07 b	28.67 b	1.59 c	20.15 bc	4.84 ab	14.47 b	35.93 ab	298.33 bc	432.38 bc	14818 bc	14.820 bc	0.56 a
V_1T_3	4731.2 bc	160.07 a-c	288.67 a-c	522.93 ab	278.03 ab	31.33 a	1.74 b	20.23 bc	5.07 a	15.40 a	35.93 ab	305.00 bc	502.46 ab	15771 bc	15.770 bc	0.54 a
V_1T_4	3263.7 d	141.80 b-d	244.20 b-e	470.73 b-d	181.13 c	23.00 c	1.28 d	17.34 de	4.74 a-c	14.40 b	34.80 bc	297.33 bc	311.83 de	10878 d	10.877 d	0.56 a
V_1T_5	2555.1 de	129.53 cd	222.53 d-f	418.67 cd	142.00 cd	19.67 d	1.09 e	16.97 e	4.57 bc	13.33 cd	31.80 cd	267.67 c	242.90 ef	8517 de	8.517 de	0.51 ab
V_2T_1	1772.9 e	116.40 d	193.07 ef	425.47 cd	98.28 d	15.33 e	0.85 f	19.76 c	4.67 a-c	13.20 d	29.87 de	265.33 c	164.42 fg	5910 e	5.910 e	0.46 ab
V_2T_2	5166.7 ab	164.13 ab	297.13 ab	521.20 ab	287.20 ab	31.67 a	1.76 b	21.58 ab	5.06 a	14.93 ab	36.60 ab	324.33 ab	525.77 a	17222 ab	17.223 ab	0.60 a
V_2T_3	5712.7 a	176.87 a	310.87 a	572.13 a	330.67 a	32.33 a	1.87 a	23.02 a	5.09 a	15.73 a	39.80 a	368.00 a	581.27 a	19042 a	19.043 a	0.58 a
V_2T_4	4246.5 c	152.13 a-c	252.47 b-d	517.47 ab	236.07 b	28.00 b	1.56 c	20.12 bc	4.81 a-c	14.40 b	35.47 bc	298.33 bc	392.80 cd	14155 c	14.153 c	0.60 a
V_2T_5	2545.9 de	131.33 b-d	237.27 c-f	515.60 ab	141.80 cd	19.33 d	1.08 e	19.00 cd	4.55 bc	14.20 bc	33.07 b-d	287.33 bc	255.23 e	8486 de	8.487 de	0.38 b
LSD $_{(0.05)}$	900.48	34.536	53.716	80.832	52.699	2.162	0.092	1.743	0.460	0.899	3.961	56.378	81.736	3002.0	3.002	0.150
CV (%)	14.54	13.99	12.51	9.68	15.10	5.16	3.94	5.22	5.61	3.67	6.78	11.10	13.37	14.54	14.54	16.69

ns=non-significant

V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3= Rice straw, T_4 = Rice husk, T_5 = Ash

4.14 Weed dry weight (g m^{-2})

Insignificant variation was recorded for weed dry weight per square meter in maize field due to different maize varieties under the present study (Appendix XXVI). The highest weed dry weight per square meter in maize field (39.07 g) was recorded from V_2, while the lowest dry weight (35.14 g) was found from V_1 (Appendix XXVII).

Different mulches materials showed significant variation for weed dry weight per square meter (Appendix XXVI). The highest weed dry weight per square meter (63.94 g) was found from T_1, whereas the lowest weed dry weight per square meter (14.87) was found from T_3 (Appendix XXVII). An experiment was conducted about the weed suppression by using mulch material. Mahmood, (2016) conducted an experiment where chaffed herbage (2-3) cm of four crops: sorghum+sunflower+rice+maize are used. Different combination are used where each crop at a rate of 6 ton/ha and then applied as mulch material in the surface. An weedy check control are also used for comparison with mulching. A weedy check control consist with s-metachlor and atrazine. When applied mulching in the maize field weed infestation is suppressed drastically compare with the weedy check control and increase maize growth and yield.

Significant difference was observed on weed dry weight per square meter due to combined effect of different maize varieties and mulches materials (Appendix XXVI). The highest weed dry weight per square meter (66.28 g) was recorded from V_1T_1 and the lowest weed dry weight per square meter (14.33 g) was found from V_2T_3 (Appendix XXVIII).

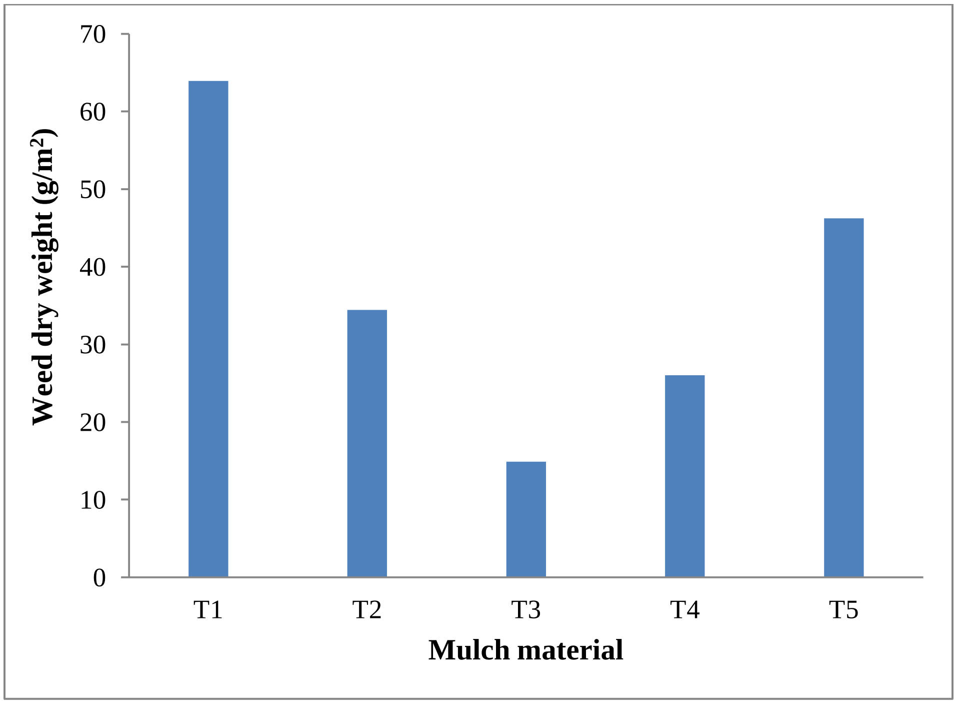


Figure 14. Effect of mulch materials on weed dry weight (LSD $_{o.o5}$ value= 22.218). T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

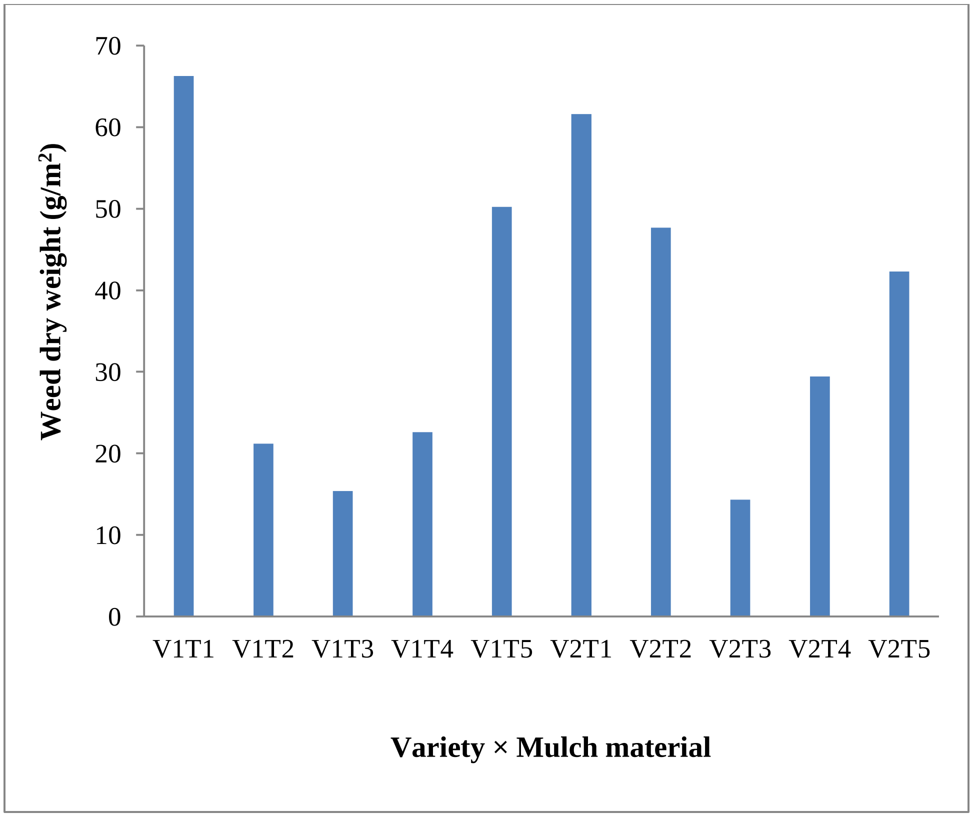


Figure 15. Interaction effect of varieties and mulch materials on weed dry weight (LSD $_{o.o5}$ value= 31.421). V_1 = Shuvra, V_2 = KS-510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

CHAPTER V

SUMMARY AND CONCLUSIONS

The present experiment was conducted in the research field of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from November, 2015 to March, 2016 to evaluate the effect of different mulches materials on the growth, development and yield attributes of white maize varieties. The experiment consisted of two white maize varieties (shuvra and KS-510) and five different mulch materials (control, water hyacinth, rice straw, rice husk and ash). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and the differences between means were separated by both Least Significant Difference (LSD) at 5% level of probability and Duncan's New Multiple Range Test (DMRT). Data on different microclimatic, morphophysiological and yield contributing characters were recorded and significant variation was observed.

Results showed that soil moisture, plant height (cm), leaves per plant, stem base diameter, SPAD meter reading, leaf area index, leaf dry weight, stem dry weight, cob sheath dry weight, root dry weight, seed dry weight, shoot dry weight, total dry matter, seed weight, cob weight, seeds per cob, cob length, 1000 seed weight were significantly influenced by maize varieties.

Maize varieties, at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, the tallest plant (72.21, 125.57, 152.94, 170.23, 189.72, 210.53, 221.17 and 221.34 cm, respectively) were shown by V_1 (Shuvra), while the shortest plant represented by V_2 (KS510). The highest stem base diameter at harvest stage (25.07 cm) was obtained from V_2, while the lowest (22.95 cm) was found from $V_{1.}$ The maximum days to silk appearance (80.13, 93.20 and 104.47 days) were found from V_2 in 1^{st}, 50% and 100% silk appearance, respectively. The highest leaf SPAD value (42.71, 52.95, 53.02, 46.44 and 40.05) at 40, 60, 80, 100 and 120 DAS respectively were found from variety $V_{2.}$ The highest values of leaf dry weight (40.26 g/plant) were resulted from variety V_2 and lowest values of leaf dry weight (38.68 g/plant) from $V_{1.}$ The highest dry matter content of stem (53.79 g) was found from $V_{2.}$

The highest cob sheath dry weight (23.80 g) was recorded from $V_{2.}$ The maximum averages of root dry weight (16.51 g/plant) were achieved from the variety V_2. The highest seed dry weight (218.80 g) was recorded from $V_{2.}$ The highest shoot dry weight (364.73 g) was found from $V_{2.}$ The highest dry matter content (381.24 g) was recorded from $V_{2.}$ The highest total dry matter/3m^2 (6862.4 g) was found from $V_{2.}$ The highest total dry matter per ha in maize field (26917 kg/ha) was recorded from $V_{2.}$ The maximum seed weight/cob (148.17 g) was found from $V_{2.}$ The highest seed weight/plant (218.80 g) was recorded from $V_{2.}$ The highest number of seeds/row (34.96) was recorded from $V_{2.}$ The highest seed weight (12963 kg/ha) was recorded from $V_{2.}$ The highest seed weight 12.963 ton/ha was observed by variety V_2. The highest harvest index was recorded for V_1 (0.53). The highest weed dry weight per square meter in maize field (39.07 g) was recorded from $V_{2.}$

In case of different mulches materials, The highest soil moisture was observed by treatment T_3 (45.61, 52.08 and 60.80%) at 50DAS in 0-10, 10-20 and 20-30 cm of soil depth, respectively. Mulches materials treatment T_3 (Rice straw) mulch produced the tallest plant (83.57, 139.96, 169.71, 194.93, 209.20, 237.58, 249.55 and 249.83 cm) at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively. At 30, 40, 50, 60, 90 and 120 DAS, the maximum number of leaves per plant (7.84, 8.80, 12.41, 13.15, 16.75 and 15.52) was attained from T_3 (rice straw). The highest leaf area was recorded at 30, 40, 50, 60, 70 and 120 DAS was 1376.8, 1965.6, 3674.8, 5157.6, 9135.1 and 9164.3 cm^2 from treatment $T_{3.}$ The maximum days to tasselling (65.00, 80.67 and 94.83 days) was recorded from T_1 treatment. The maximum days to seedling emergence (7.33 and 14.50 days) was recorded from T_1 treatment. At 40, 60, 80, 100 and 120 DAS the maximum SPAD value (44.62, 61.85, 57.88, 52.77 and 46.57, respectively) were found from T_3. The highest leaf area index was recorded at 30, 40, 50, 60, 70, 80, 90 and 120 DAS was 0.83, 1.18, 2.21, 3.09, 5.49, 5.78, 5.83 and 5.48 from mulch treatment T_3. The maximum days to harvest (150.33 days) was recorded from T_3 treatment. Mulches treatment T_2 performed maximum (54.02 g/plant) average means of leaf dry weight. The highest stem dry weight (63.35 g) was found from $T_{2.}$ Root dry weight was markedly increased and achieved maximum values in treatment of T_3 (22.48 g). The highest seed dry weight (304.35 g) was found from $T_{3.}$ The highest shoot dry weight (330.36 g) was found from $T_{3.}$ The highest dry matter content (511.92 g) was found from $T_{3.}$ The highest root shoot ratio was found in mulches treatment T_2 (0.048) and T_4 (0.048). The highest total dry matter per ha (30715 a kg/ha) was found from $T_{3.}$ The highest seed weight (5222.0 g/3m$_2$) was observed from $T_{3.}$ The maximum seed weight/cob (168.47 g/cob) was found in mulches treatment $T_{3.}$ The maximum number of seeds/cob (304.35) was found from $T_{3.}$ Maximum cob length (21.62 cm) was recorded at treatment $T_{3.}$ The maximum number of row/cob (15.57) was recorded from $T_{3.}$ The highest seed weight (17407 kg/ ha) was recorded from $T_{3.}$ The highest seed weight (17.407 ton/ ha) was recorded from $T_{3.}$ Mulches treatment T_2 and T_4 both showed higher HI (0.58). The highest weed dry weight per square meter (63.94 g) was found from $T_{1.}$

Due to the interaction effect of different mulches materials and maize varieties, at 50DAS the highest soil moisture content (46.98, 52.46 and 62.02%) was recorded from the combination of V_2T_3 in 0-10, 10-20 and 20-30 cm of soil depth, respectively. At 80DAS V_2T_3 showed highest 30.27, 34.15 and 51.65% soil moisture in 10, 20 and 30 cm of soil depth respectively. The tallest plant height (84.57, 142.88, 172.25, 198.60, 217.84, 244.57, 261.23 and 261.47 cm) was observed at 30, 40, 50, 60, 70, 80, 90 and 120 DAS, respectively from the combination of V_1T_3 (Shuvra maize veriety with straw mulch). The maximum number of leaves per plant At 30, 40, 50, 60 and 120 DAS was recorded 7.92, 9.02, 12.57, 13.38 and 17.00, respectively from treatment combination $V_1T_{3.}$ The highest leaf area was observed (1493.9, 1968.1, 3742.6, 5292.7, 9398.1, 9876.8, 9947.2 and 9328.8 cm^2) from the combination of $V_1T_{3,}$ at 30, 40, 50, 60, 70, 80, 90 and 120 DAS. The highest stem base diameter at harvest stage (32.41 cm) was obtained from $V_2T_{3.}$ The maximum days to tasselling (66.00, 81.33 and 99.00 days) were obtained from the combination $V_2T_{1.}$ The maximum days to seedling emergence (9.00 and 14.67 days) was obtained from the combination $V_2T_{1.}$ The combination of V_2T_3 showed the maximum SPAD value (46.47, 72.30, 59.73, 54.23 and 48.93) at 40, 60, 80, 100 and 120 DAS, respectively. The highest leaf index area was observed (0.90, 1.18, 2.25, 3.18, 5.64, 5.93, 5.97 and 5.58) from the treatment combination $V_1T_{3,}$ at 30, 40, 50, 60, 70, 80, 90 and 120 DAS. The maximum days to silk appearance (151.33 days) was obtained from the both combination V_2T_3 and the minimum (139.33 days) from the combination $V_1T_{1.}$ Maximum leaf dry weight (53.33 g/plant) obtained from V_1T_2. The highest stem dry weight (65.36 g) was recorded from V_2T_2. The highest cob sheath dry weight (32.56 g) was recorded from V_2T_3. The highest values of root dry weight (23.53 g) were recorded due to V_2T_3. The highest seed dry weight (330.67 g) was recorded from V_2T_3. The highest shoot dry weight (521.19 g) was recorded from V_2T_3. The highest dry matter content (544.72 g) was recorded from V_2T_3. The highest root shoot ratio (0.051) was recorded from V_1T_2. The highest total dry matter per ha (37044 kg/ha) was recorded from V_2T_5. The highest seed weight/3m^2 (5712.7 g) was found from the combination V_2T_3. The maximum seed weight/cob (176.87 g) was recorded from the combination of V_2T_3. The highest number of seeds/cob (572.13 g) was found from the combination V_2T_3. The highest seed weight/plant (330.67 g) was recorded from the combination of V_2T_3. The highest number of cobs/plant (32.33) was recorded from the combination V_2T_3. The maximum number of row/cob (15.73) was found from the combination of V_2T_3. The highest number of seeds/row (39.80) was recorded from the combination of V_2T_3. The highest seed weight was observed in combination of V_2T_3 (19042 kg/ha). The highest weed dry weight per square meter (66.28 g) was recorded from V_1T_1.

Conclusions

Among the combination of different mulch materials and maize varieties, the rice straw mulching and variety KS-510 performed superior in respect of growth, yield contributing characters and yield of white maize. Similar trend of results were found in case of variety Shuvra which were next to KS-510 and were remarkable. Improved yield was also found from the use of water hyacinth mulch in case of both the varieties. Straw mulch provided the highest yield and water hyacinth mulch provided the better yield and reasonable amount. Both the straw and water hyacinth mulches performed better than the other mulches. Use of mulch is recommended for better yield and saving irrigation cost.

Recommendation

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study may be conducted in different agro-ecological zones (AEZ) and seasons of Bangladesh for exploitation of regional adaptability and other performances;
2. Some other maize varieties and different mulch materials may be included in future program for more confirmation of the results.

REFERENCES

Aguyoh, J., Taber, H.G. and Lawson, V. (1999). Maturity of fresh–market sweet corn with direct seeded plants, transplants, clear plastic mulch and row cover combinations. *Hort. Technol*. **9**(3): 420-424.

Alam, M.M., Torofder, G.S. and Nahar, S. (1993). Influence of mulches under no–tillage on growth and yield of maize in slopes of Chittagong Hill Tract. *Bangladesh J. Bot*. **22**(2): 203-208.

Asemoloye, M.D., Nwaokolo, V.M and Babalola, B.J. (2012). Efficiency of water hyacinth *Eichhornia crassipes* Mart (Solm) compost among three norganic Farm Yard Manure (FYM) used for the cultivation of *Zea mays* L. *Nat Sci*. **10**(11): 115-122.

Awal, M.A. and Khan, M.A.H. (1999). Alteration of soil temperature and moisture through mulching on the morpho–physiological differentiation in maize. *Pak. J. Biol. Sci*. **2**(4): 1164-1167.

Awal, M. A. and Khan, M.A. H. (1998). Mulch induced eco-physiological growth and yield of Maize. *Pak. J. Biol. Sci*. Monthly: 1128-8880.

BBS. (2011). Annual Agricultural Statistics 2009–10. Bangladesh Bureau of Statistics, Statistic Division, Ministry of Planning, Government people's Republic of Bangladesh, Dhaka, p. 37.

Bhardwaj, S.P. and Sindwal, N.S. (1998). Zero tillage and weed mulch for erosion control on sloping farmland in Doon valley. *Indian J. Soil Cons*. **26**: 81-5.

Bhatt, R., Khera, K.L. and Arora, S. (2004). Effect of tillage and mulching on yield of corn in the submontaneous rainfed region of Punjab, India. *Intl. J. Agric. Biol*. **6**(1): 26-28.

Center, T. D., Hill, M. P., Cordo, H. and Julien, M. H. (2002). Water hyacinth. In Van Driesche, R. (ed.) Biological control of invasive plants in the eastern United States. USDA Forest Service Publication FHTET, 41-46.

Chen, X. and Chen, X.J. (1996). The effects of polythene mulch on production of a maize hybrid. *J. Jilin Agril. Univ*. **18**(1): 10-14

Dehcordi, N. S. and Farhadi, R. (2015). Mulch treatment with mulch planter and its effect on maize production. *Agri. Cons. Sci*. **80**(4):247-252.

Easson, D.L. and Fearnehough, W. (2000). Effect of plastic mulch, sowing date and cultivar on the yield and maturity of forage maize grown under marginal climatic conditions in Northern Ireland. *Grass and Forage Sci*. **55**(3): 221-231.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haque, A. K. M. M. (1979). Detailed Soil Survey of Bangladesh, Dept. Soil Survey, Govt. People's Republic of Bangladesh. p.118.

FAO (Food and Agricultural Organization). (2012). Production report of agricultural crop 2010. (Online available at http://faostat.fao.org/site/339/default.aspx)

Gajera, M.S., Ahlawat, R.P.S., and Ardashna, R.B. (1998). Effect of irrigation schedule, tillage depth and mulch on growth and yield of winter pigeonpea (*Cajanuscajan*). *Indian J. Agron*. **43**: 689-93.

Gill, K.S., Arshad, M.A., Chivunda, B.K., Phiri, B. and Gumbo, M. (1992). Influence of residue mulch, tillage and cultural practices on weed mess and corn yield from three field experiments. *Soil and Tillage Res*. **24**: 211-23.

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for agricultural research (2 ed.). John wiley and sons, NewYork. p. 680.

Gosavi, A. (2006). Effect of mulches, fertilizer and levels of organic manure on the performance of *rabi*sweet corn (*Zea mays saccharata*). M.Sc. Thesis, Dr. BalasahebSawant Konkan KrishiVidyapeeth, Dapoli, Dist. Ratnagiri (M.S.).

Govaerts B., Sayre K.D., Lichter K., Dendooven L., Deckers J. (2007). Influence of permanent raised bed planting & residue management on physical and chemical soil quality in rain fed maize–wheat systems. *Plant and Soil*, **291**: 39-54.

Gul, B., Marwat, K.B., Saeed, M., Hussain, Z. and Ali, H. (2011). Impact of tillage, plant population and mulches on weed management and grain yield of maize. *Pak. J. Bot*. **43**(3): 1603-1606.

Gupta, P., Indurani C., Ahlawat, O. P., Vijay, B. and Mediratta, V. (2004). Physicochemical properties of spent mushroom substrates of Agaricusbisporus. *Mushroom Res*. **13**(2): 84-94.

Hassanein, M.K. and Abul–Soud, M. (2010). Effect of different compost types and application methods on growth and yield of three maize hybrids. *J. App. Sci. Res*. **6**(9): 1387-1399.

J–Econ. (2002). Management of corn leafhopper and corn stunt disease in sweet corn using polythene mulch. *Entom. Soc. America*, **95**(2): 325-330.

Kalaghatagi, S.B., Kulkarni, G.N., Prabhakar, A.S. and Palled, Y.B. (1990). Effect of mulch on the use of irrigation water and grain yield in maze. *Karnataka J. Agric. Sci*. **3**(3&4): 183-188.

Keulen, H. V. and Wolf, J. (1986). Modelling of agricultural production: weather soils and crops. Simulation monographs. Pudoc, Wageningen, The Netherlands. p. 478.

Khan, M.A.H. (2001). Microclimatic manipulation and adaptation of quality protein maize (QPM) under dryland conditions. Final Report, BARC/ARMP funded Contract Res. Project, pp.72+2+3.

Khan, M.A.H. (2001). Microclimatic manipulation and adoption of quality protein maize (QPM) under dry land conditions. A report of Contract Research Project, submitted to the Bangladesh Agricultural Research Council (BARC).

Khan, M.A.H. and Parvej, M.R. (2010). Impact of conservation tillage under organic mulches on the reproductive efficacy and yield of quality protein maize. *J. Agril. Sci*. **5**(2): 52-63.

Khan, I. A., Ullah, Z., Hassan, G., Marwat, K. B., Jan, A., Shah, S. M. A. and Khan, S.A. (2011). Impact of different mulches on weed flora and yield of maize. *Pak. J. Bot*. **43**(3): 1601-1602.

Khera, K.L. and Singh, G. (1998). Effect of crop cover and field slope on soil erosion in northern plain hot sub–humid Punjab. *Indian J. Soil Cons*. **26**: 19-21

Khurshid, K, Iqbal, M., Arif, M.S. and Nawaz, A. (2006). Effect of tillage and mulch on soil physical properties and growth of maize. *Intl. J. Agric. Biol*. **8**(5): 594-596.

Kulkarni, G.N., Kalaghatagi, S.B. and Mutanal, S.M. (1998). Effect of various mulches and scheduling of irrigation on growth and yield of summer maize. *J. Maharashtra agric. Univ*. **13**(2): 223-224.

Kwabiah, A.B. (2004). Growth and yield of sweet corn cultivars in response to planting date and plastic mulch in a short season environment. *Scientia Hort*. **102**(2): 147-166.

Li, Q.Q., Chen, Y.H., Liu, M.Y., Zhou, X.B., Yu, S.L. and Dong, B.D. (2008). Effects of irrigation and straw mulching on microclimate characteristics and water use efficiency of winter wheat in North China. *Plant Prodn. Sci*. **11**: 161-170.

Liu, J., Xu, S.A., Zhou, G.Y. and Lu, H.H. (2002). Effects of transplanting multi–cropping spring maize with plastic film mulching on the ecological effect, plant growth and grain yield. *J. Hubei Agri. College*, **2**: 100.

Liu, Z., Wang, G., Liu, H.Y., Lei, L. and Wu, Y. (2000). The effect of different mulching methods with whole maize straw in dryland on maize yield. *Shanxi Agric. Sci*. **28**: 20-22.

Ma, Y.Q. and Han, Q.H. (1995). Effect of wheat straw mulching on the growth, development and yield of maize. *Acta Agric. Boreali–Sinica*, **10**(1): 106–110.

Mahmood, A., Ihsan, M.Z.. Khaliq, A., Hussain, S., Cheema, Z. A., Naeem, M., Daur, I., Hussain, H. A. and Alghabari, F. (2016) .Crop residue mulch as organic weed management strategy in maize. *Clean-Soil, Air, Water*,**44**(3): 317-324.

.

Mohapatra, B.K., Lenka, D. and Naik, P. (1998). Effect of plastic mulching on yield and water use efficiency in maize. *Ann. Agril. Res*. **19**(2): 210-211.

Mondal, M.N.A. (2003). Performance of dry land crops as influenced by mulching and tillage. A Ph.D. Thesis, Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh

Pinjari, S.S. (2007). Effect of integrated nutrient management and polythene mulch on the performance of sweet corn under lateratc soils of Konkan. Ph. D. Thesis, Dr. BalasahebSawant Konkan KrishVidyaeeth, Daoli and Dist. Ratnagiri.

Pramanik, S.C. (1999). *In situ* conservation of residual soil moisture through tillage and mulch for maize (*Zea mays* L.) in tropical Bay islands. *Indian J. Agric. Sci*. **69**(4): 254-257.

Quayyum, M.A. and Ahmed, A. (1993). Effect of tillage and mulching methods on growth and yield of maize. *Bangladesh J. Agril. Res*. **18**(2): 161-165.

Rahman, M.M. (2002). Efficacy of indigenous mulches on the growth and development quality protein maize under zero tillage condition. MS Thesis, Dept. of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Rahman, M.A. (1999). Morpho–physiological adoption of quality protein maize (QPM) as influenced by indigenous mulches. MS Thesis, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Rajput, B. S.; Shukla, N. N.; Sen, A. and Singh, R. K. (2014). Row spacing and mulching effect on growth and nutrient uptake of maize (*Zea mays* L.) under Guava (*Psidium guajava* L.) based Agri-horti System.*Online Int. Interdis. Res. J.* **4**(3): 2249-9598.

Ram, H., Singh, H., Saini, K.S., Kler, D.S. Timsina, S. and Humphreys, E.J. (2012). Agronomic and economic evaluation of permanent raised beds, no tillage and straw mulching for an irrigated maize–wheat system in northwest India. *Expl. Agric*. **48**(1): 21-38.

Rana, K.S., Shivran, R.K. and Kumar, A. (2006). Effect of moisture conservation practices on productivity and water use in maize (*Zea mays*)–based intercropping systems under rainfed conditions. *Indian J. Agron*. **51**(1): 24-26.

Ratan Singh, A., Sharma, R., Dhyani, S.K., and Dube, R.K. (2011). Tillage and mulching effects on performance of maize (*Zea mays*)-wheat (*Triticum aestivum*) cropping system under varying land slopes. *Indian J. Agril. Sci*. **81**(4): 61-63.

Roldan, A., Carabaca, F., Elernandez, M.L., Garcia, C., Sanchez–Brito, C., Velasquez, M. and Tiscareno, M. (2003). No–tillage, crop residue additions and legume cover cropping effects on soil quality characteristics under maize in Patzcuaro watershed (Mexico). *Soil Till. Res*. **72**: 65-73.

Sahu, A.K., Sahoo, S. K., and Giri, S. S. (2002). Efficacy of water hyacinth compost in nursery pond for larval rearing of Indian major carp, Labeorobitta. *Bioresource Tech*. **85**: 309-311.

Sharma, A.R. and Ratan, S. (Singh) and Dhyani, S.K. and Dube, R.K. (2010). Effect of live mulching with annual legumes on performance of maize (*Zea mays*) and residual effect on following wheat *(Triticum aestivum). Indian J. Agron*. **55**(3): 177-184.

Shen, J.Y., Zhao, D.D., Han, H.F., Zhou, X.B. and Li, Q.Q. (2012). Effects of straw mulching on water consumption characteristics and yield of different types of summer maize plants. *Plant Soil Environ*. **58**(4): 161-166.

Sidhu, A.S. and Sekhon, N.K. and Thind, S.S. and Hira, G.S. (2007). Soil temperature, growth and yield of maize (*Zea mays* L.) as affected by wheat straw mulch. Archives. *Agron. Soil Sci*. **53** (1): 95-102.

Singh, K., Singh, U.N., Singh, V., Singh, S.R., Chandel, R.S. and Singh, K.K. (2002). Effect of tillage, inter terrace and mulching on yield and nutrient uptake by maize (*Zea mays*) and chick pea (*Cicer arietinum*) cropping system. *Indian J. Agric. Sci.* **72**(12): 728-730.

Smart, J.R. and Bradford, J.M. (1999). Conservation tillage corn production for a semi–arid, subtropical environment. *Agron. J*. **91**: 116-121.

Summers, C.G. and Stapleton, J.J. (2002). Management of corn leaf hopper and corn stunt disease in sweet corn using reflective mulch. *J. Eco. Entom*. **95**(2): 325-330.

UNDP-FAO. (1988). Land Resources Appraisal of Bangladesh for Agricultural Development. Report to Agro-ecologicalregions of Bangladesh. UNDP-FAO, BGD/81/035 Technical Report 2. p. 570.

Uwah, D.F. and Iwo, G.A. (2011). Effectiveness of organic mulch on the productivity of maize (*Zea mays* l.) and weed growth. *J. Animal & Plant Sci*. **21**(3): 525-530.

Wang, X.F., Xu, F.A. and Shani, U. (1994). Corn growth as affected by plastic cover under drip irrigation condition in the desert. *Pedosphere*, **4**(3): 243-249.

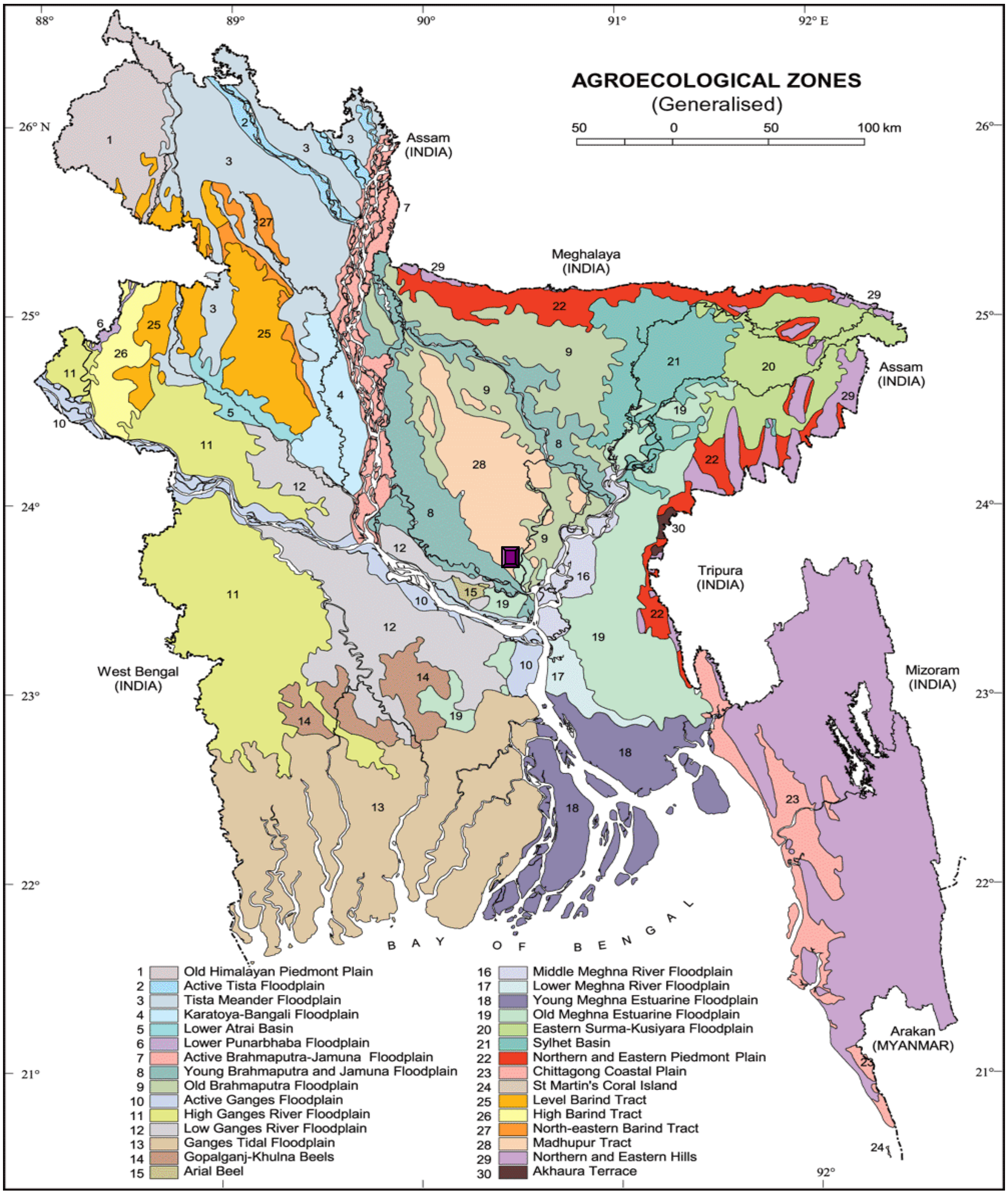
Wicks, G.A., Crutchfield, D.A. and Burnside, O.C. (1994). Influence of wheat (*Triticumaestivum*) straw mulch and metolachlor on corn (*Zea mays*) growth and yield. *Weed Sci*. **42**(1): 141-147.

Woomer, P. L. Muzira, R., Bwamiki, D., Metutikka, D., Amoding, A. and Bekunda, M. A. (2000). Biological management of water hyacinth waste in Uganda. *Biol. Agric. Hort*. **17**: 181 - 1.

Yi, Liu, Yufang, S., Shenjiao, Y., Shiqing, L. and Fang, C. (2011). Effect of mulch and irrigation practices on soil water, soil temperature and the grain yield of maize (*Zea mays L*) in Loess Plateau, China. *African J. Agril. Res*. **6**(10): 2175-2182.

APPENDICES

Appendix I: Map showing the experimental site under study



The experimental site under study

Appendix II. Monthly record of air temperature, relative humidity, rainfall and sunshine hour of the experimental site during the period of experiment in the field

Month	*Air temperature (°c)		*Relative Humidity (%)	Total Rainfall (mm)	*Sunshine
	Maximum	Minimum			
November, 2015	25.8	16.0	78	00	6.8
December, 2015	22.4	13.5	74	00	6.3
January, 2016	24.5	12.4	68	00	5.7
February, 2016	27.1	1.7	67	11	6.7
March, 2016	31.4	19.6	54	30	8.2
April, 2016	33.7	23.8	69	185	7.8
May, 2016	27.0	19.2	63	54	7.2
June, 2016	27.1	16.7	67	147	8.0

*, Monthly average
Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka –1212

Appendix III.Characteristics of soil of the experimental field as (analyzed by Soil Resources Development Institute, SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Research field, Sher-e-Bangla Agricultural University, Dhaka-1207
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	Medium High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: Soil Resources Development Institute (SRDI**)**

Appendix IV. Mean square values of the soil moisture content at different depths of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square								
		Soil moisture (%)								
		50 DAS			80 DAS			120 DAS		
		10 cm	20 cm	30 cm	10 cm	20 cm	30 cm	10 cm	20 cm	30 cm
Replication	2	1.142	8.874	56.039	13.1066	28.6080	76.051	4.8031	23.9899	12.177
Variety	1	9.532^{ns}	8.459^{ns}	10.092^{ns}	51.4306^{ns}	45.7815^{ns}	135.554**	50.2072^{ns}	33.8778^{ns}	125.911**
Mulch material	4	298.313**	422.949**	565.213**	87.7518**	71.1975**	360.851**	97.0379**	73.5169**	92.494**
Variety ×Mulch	4	1.945*	0.277*	1.276*	4.6684*	4.5553*	14.185*	7.8497*	3.8491*	17.180**
Error	18	3.810	2.037	4.946	15.1177	12.6350	14.964	13.8274	8.7454	4.260

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix V. Mean square values of the plant height of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Plant height (cm)							
		30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
Replication	2	65.09	198.80	346.99	43.32	543.10	22.94	37.34	36.26
Variety	1	151.74**	371.57**	214.48^{ns}	452.10^{ns}	907.17**	1925.92**	3669.71**	3665.29**
Mulchmaterial	4	1084.65**	1754.53**	2122.06**	3967.66**	5280.73**	7334.84**	8566.58**	8572.33**
Variety × Mulch	4	28.90*	113.76*	33.56*	150.95*	73.39*	185.32*	105.81*	105.59*
Error	18	26.41	64.72	66.98	116.39	177.44	147.31	209.94	210.83

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix VI: Effect of varieties and mulch materials on plant height of white maize at different DAS

Variety	Plant height (cm)							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1	72.21 a	125.57 a	152.94	170.23	189.72 a	210.53 a	221.17 a	221.34 a
V_2	67.71 b	118.53 b	147.59	162.47	178.72 b	194.51 b	199.05 b	199.23 b
LSD $_{(0.05)}$	3.943	6.172	ns	ns	10.219	9.311	11.115	11.139
Mulch material								
T_1	54.12 c	103.41 c	124.55 d	132.59 d	138.12 c	150.12 d	153.98 d	154.18 d
T_2	82.11 a	138.55 a	163.86ab	184.75 a	206.78 a	227.83 a	236.78 a	236.92 a
T_3	83.57 a	139.96 a	169.71 a	194.93 a	209.20 a	237.58 a	249.55 a	249.83 a
T_4	71.74 b	121.43 b	155.64 b	171.19 b	194.93 a	209.54 b	216.15 b	216.28 b
T_5	58.28 c	106.93 c	137.56 c	148.29 c	172.08 b	187.54 c	194.07 c	194.22 c
LSD $_{(0.05)}$	6.234	9.758	9.927	13.086	16.157	14.722	17.575	17.612
CV (%)	7.35	6.59	5.45	6.49	7.23	5.99	6.90	6.90

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5= Ash

Appendix VII: Interaction effect of varieties and mulch materials on plant height of white maize at different DAS

Variety × Mulch material	Plant height (cm)							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1T_1	55.41 c	104.23 b	124.78 e	130.63 f	140.50ef	160.53 e	166.00ef	166.23ef
V_1T_2	84.12 a	141.08 a	168.58ab	195.88 a	209.60ab	234.03ab	248.60ab	248.73ab
V_1T_3	84.57 a	142.88 a	172.25 a	198.60 a	217.84 a	244.57 a	261.23 a	261.47 a
V_1T_4	77.83 a	132.48 a	156.12bc	171.90 cd	198.70 a-c	210.24 cd	220.30 cd	220.43 cd
V_1T_5	59.13bc	107.20 b	142.94 cd	154.17 de	181.97 cd	203.30 d	209.70 d	209.83 d
V_2T_1	52.84 c	102.58 b	124.31 e	134.55 f	135.73 f	139.70 f	141.97 f	142.13 f
V_2T_2	80.09 a	136.02 a	159.13ab	173.63bc	203.95 a-c	221.63 b-d	224.97 b-d	225.10 b-d
V_2T_3	82.57 a	137.04 a	167.17ab	191.27ab	200.57 a-c	230.60 a-c	237.87 a-c	238.20 a-c
V_2T_4	65.64 b	110.38 b	155.17bc	170.48 cd	191.17bc	208.83 d	212.00 d	212.13 d
V_2T_5	57.42bc	106.65 b	132.17 de	142.42ef	162.20 de	171.78 e	178.43 e	178.60 e
$LSD_{(0.05)}$	8.816	13.800	14.039	18.506	22.850	20.820	24.855	24.907
CV (%)	7.35	6.59	5.45	6.49	7.23	5.99	6.90	6.90

V_1 = Shuvra, V_2 = KS510 (IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix VIII. Mean square values of the number of leaves plant^{-1} of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Number of leaves palnt^{-1}							
		30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
Replication	2	0.22224	0.96627	0.21675	0.12658	1.58053	0.88873	4.9099	3.22525
Variety	1	0.53067^{ns}	0.36741^{ns}	1.49633^{ns}	0.97200^{ns}	0.15696^{ns}	1.01936^{ns}	14.4769**	3.20133^{ns}
Mulchmaterial	4	2.70437**	2.20928**	3.43696**	2.91054**	1.79779**	2.53755**	10.2593**	4.45633**
Variety × Mulch	4	0.01808*	0.19322*	0.14529*	0.02096*	0.35959*	0.15661*	4.6809**	2.61300*
Error	18	0.21473	0.12443	0.34268	0.22381	0.32020	0.49554	0.9807	1.17655

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix IX: Effect of varieties and mulch materials on number of leaves plant^{-1} of white maize at different DAS

Variety	Number of leaves palnt^{-1}							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1	7.28	8.34	11.86	12.53	13.55	14.20	15.96 a	14.49
V_2	7.02	8.12	11.42	12.17	13.41	13.83	14.57 b	13.83
LSD $_{(0.05)}$	ns	ns	ns	ns	ns	ns	0.760	ns
Mulch material								
T_1	6.32 c	7.30 c	10.58 c	11.42 d	12.70 c	13.25 b	14.03 b	13.42 b
T_2	7.75ab	8.58 a	12.21 a	12.88 ab	14.11 a	14.76 a	16.58 a	14.42 ab
T_3	7.84 a	8.80 a	12.41 a	13.15 a	13.84ab	14.58 a	16.75 a	15.52 a
T_4	7.21 b	8.52 a	11.83ab	12.33bc	13.53 ab	13.92 ab	14.82 b	13.98 b
T_5	6.62 c	7.95 b	11.17bc	11.96 cd	13.23bc	13.55 b	14.17 b	13.47 b
LSD $_{(0.05)}$	0.562	0.428	0.710	0.574	0.686	0.854	1.201	1.316
CV (%)	6.48	4.29	5.03	3.83	4.20	5.02	6.49	7.66

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix X: Interaction effect of varieties and mulch materials on the number of leaves plant^{-1} of white maize at different DAS

Variety × Mulch material	Number of leaves palnt^{-1}							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1T_1	6.42 d	7.40ef	11.08 c-e	11.67fg	12.40 c	13.36 cd	14.12 b	13.60 b
V_1T_2	7.86 a	8.87 ab	12.33ab	13.00ab	14.47 a	15.18 a	18.46 a	14.53 b
V_1T_3	7.92 a	9.02 a	12.57 a	13.38 a	13.85ab	14.80 ab	18.16 a	17.00 a
V_1T_4	7.42 a-c	8.34 b-d	12.00 a-d	12.50 b-e	13.72 ab	13.90 b-d	14.88 b	14.00 b
V_1T_5	6.79 cd	8.07 cd	11.33 b-d	12.08 d-f	13.33bc	13.73 b-d	14.20 b	13.30 b
V_2T_1	6.22 d	7.20 f	10.08 e	11.17 g	13.00bc	13.13 d	13.95 b	13.23 b
V_2T_2	7.65 ab	8.29 b-d	12.08 a-c	12.75 a-d	13.75ab	14.33 a-d	14.70 b	14.30 b
V_2T_3	7.76ab	8.58 a-c	12.25ab	12.92 a-c	13.83ab	14.37 a-c	15.33 b	14.03 b
V_2T_4	7.00 b-d	8.70ab	11.67 a-d	12.17 c-f	13.33bc	13.93 b-d	14.75 b	13.97 b
V_2T_5	6.45 d	7.82 de	11.00 de	11.83 e-g	13.13 bc	13.37 cd	14.13 b	13.63 b
$LSD_{(0.05)}$	0.795	0.605	1.004	0.812	0.971	1.208	1.699	1.861
CV (%)	6.48	4.29	5.03	3.83	4.20	5.02	6.49	7.66

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XI. Mean square values of the leaf area of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Leaf area (cm^2)							
		30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
Replication	2	6479	230620	64600	823666	544878	1460003	806189	558104
Variety	1	79025**	32944^{ns}	194399^{ns}	796940^{ns}	1938814**	318754^{ns}	190153^{ns}	143300^{ns}
Mulchmaterial	4	251323**	394450**	1108072**	2792855**	6958867**	5126189**	3638250**	3998252**
Variety × Mulch	4	12436*	7977*	7229*	51199*	100851*	49658*	58671*	26299*
Error	18	15513	66102	57620	226605	417226	321534	181417	257817

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XII: Effect of varieties and mulch materials on leaf area of white maize at different DAS

Variety	Leaf area (cm^2)							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1	**1215.0 a**	**1702.7**	**3293.5**	**4714.6**	**8325.5 a**	**8898.9**	**9152.5**	**8529.9**
V_2	1112.3 b	1636.4	3132.5	4388.6	7817.1b	8692.8	8993.3	8391.7
LSD $_{(0.05)}$	95.550	ns	ns	ns	495.52	ns	ns	ns
Mulch material								
T_1	891.8 c	1357.2 c	2653.8 c	3542.1 c	6512.3 c	7418.5 c	7929.8 c	7262.3 c
T_2	1317.6ab	1885.1ab	3610.2 a	5122.2 a	8833.3 a	**9450.6 a**	**9732.7 a**	9069.4 a
T_3	**1376.8 a**	**1965.6 a**	**3674.8 a**	**5157.6 a**	**9135.1 a**	9619.8 a	9721.7 a	**9164.3 a**
T_4	1216.0 b	1645.7bc	3133.7 b	4728.7ab	8417.9 a	9196.6 a	9342.9 a	8826.7 a
T_5	1016.1 c	1494.1 c	2992.3 b	4207.4 b	7457.8 b	8293.8 b	8637.4 b	7981.4 b
LSD $_{(0.05)}$	151.08	311.86	291.16	577.41	783.49	687.80	516.64	615.89
CV (%)	10.70	15.40	7.47	10.46	8.00	6.45	4.69	6.00

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XIII: Interaction effect of varieties and mulch materials on leaf area of white maize different DAS

Variety × Mulch material	Leaf area (cm^2)							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1T_1	901.8 d	1422.2bc	2779.4 cd	3858.3 de	6887.2 de	7433.3 d	7909.8 d	7336.6 cd
V_1T_2	1387.5ab	1965.1 a	3686.6 a	5249.9 a	9221.3 a	9522.9 a	9728.8 a	9077.0 a
V_1T_3	1493.9 a	1968.1 a	3742.6 a	5292.7 a	9398.1 a	9876.8 a	9947.2 a	9328.8 a
V_1T_4	1223.7bc	1652.5 a-c	3166.9bc	4798.9 a-c	8533.5ab	9288.5ab	9451.5ab	8832.4ab
V_1T_5	1068.1 cd	1505.5bc	3091.9 c	4373.1 b-d	7587.6 b-d	8373.1 b-d	8725.4bc	8074.8bc
V_2T_1	881.7 d	1292.3 c	2528.3 d	3225.8 e	6137.5 e	7403.6 d	7949.9 d	7188.0 d
V_2T_2	1247.7bc	1805.0ab	3533.8ab	4994.5ab	8445.3ab	9378.2 a	9736.7 a	9061.7 a
V_2T_3	1259.6bc	1963.1 a	3607.1 a	5022.5ab	8872.2 a	9362.8 a	9496.1 a	8999.7 a
V_2T_4	1208.4bc	1638.9 a-c	3100.6 c	4658.6 a-d	8302.3 a-c	9104.8 a-c	9234.4 a-c	8821.1ab
V_2T_5	964.2 d	1482.7bc	2892.6 cd	4041.6 c-e	7328.1 cd	8214.4 cd	8549.4 cd	7887.9 cd
$LSD_{(0.05)}$	213.66	441.03	411.77	816.58	1108.0	972.70	730.64	871.00
CV (%)	10.70	15.40	7.47	10.46	8.00	6.45	4.69	6.00

V_1 = Shuvra, V_2 = KS510 (IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XIV. Mean square values of the stem base diameter at harvest of white maize

Sources of variation	Degrees of freedom	Mean Square
		Stem base diameter at harvest stage (cm)
Replication	2	0.079
Variety	1	33.666**
Mulch material	4	162.064**
Variety × Mulch	4	3.012*
Error	18	2.054

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XV. Mean square values of the days to reproductive attributes of white maize

Source of variaiton	DF	Mean Square								
		Days to tasselling			Days to cob appearance			Days to silk appearance		
		1^{st}	50 %	100 %	1^{st}	50 %	100 %	1^{st}	50 %	100 %
Replication	2	0.8333	0.700	1.033	0.4000	2.1000	0.233	0.4000	1.2333	1.3000
Variety	1	4.0333^{ns}	0.833^{ns}	9.633**	0.1333^{ns}	3.3333^{ns}	20.833**	12.0333**	8.5333**	22.5333**
Mulchmaterial	4	34.7833**	130.050**	230.950**	24.4667**	99.2833**	238.533**	17.1667**	19.6667**	91.7167**
Variety × Mulch	4	1.1167*	3.583**	49.383**	1.1333*	7.9167**	49.833**	2.0333*	1.5333*	11.4500**
Error	18	0.9815	0.774	2.107	1.7704	2.3593	2.789	1.4370	0.7148	0.7444

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XVI. Mean square values of the days to seedling emergence of white maize

Source of variaiton	DF	Mean Square	
		Days to seedling emergence	
		50 %	100 %
Replication	2	2.2333	0.7000
Variety	1	0.8333^{ns}	1.6333^{ns}
Mulchmaterial	4	11.3000**	45.5833**
Variety × Mulch	4	5.1667**	0.2167*
Error	18	0.5667	0.9593

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XVII. Mean square values of the SPAD reading of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square				
		SPAD meter reading				
		40 DAS	60 DAS	80 DAS	100 DAS	120 DAS
Replication	2	14.8743	352.169	164.793	101.056	86.436
Variety	1	12.5453^{ns}	237.389^{ns}	65.712^{ns}	92.928**	104.907**
Mulchmaterial	4	39.2742**	362.263**	198.541**	334.922**	383.587**
Variety × Mulch	4	4.1462*	112.641*	5.817*	2.610*	1.324*
Error	18	4.8673	100.926	24.588	18.087	19.508

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XVIII. Mean square values of the Leaf Area Index of white maize at different DAS

Sources of variation	Degrees of freedom	Mean Square							
		Leaf area index							
		30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
Replication	2	0.00252	0.08297	0.02137	0.30014	0.21684	0.32766	0.28787	0.41508
Variety	1	0.02945**	0.01240^{ns}	0.07600^{ns}	0.28812^{ns}	0.57685^{ns}	0.20303^{ns}	0.06529^{ns}	0.03605^{ns}
Mulchmaterial	4	0.09129**	0.14313**	0.40842**	1.00754**	2.58594**	2.01462**	1.31351**	1.26507**
Variety × Mulch	4	0.00424*	0.00257*	0.00276*	0.01846*	0.03491*	0.03283*	0.02097*	0.02647*
Error	18	0.00564	0.02347	0.02100	0.08210	0.15705	0.09762	0.06536	0.10521

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XIX: Effect of varieties and mulch materials on Leaf Area Index at of white maize different DAS

Variety	Leaf area index							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1	0.73 a	1.02	1.98	2.83	5.00	5.34	5.49	5.12
V_2	0.67 b	0.98	1.88	2.63	4.72	5.17	5.40	5.05
$LSD_{(0.05)}$	0.058	ns	ns	ns	ns	ns	ns	ns
Mulch material								
T_1	0.54 c	0.81 c	1.60 c	2.12 c	3.91 c	4.45 c	4.76 c	4.36 c
T_2	0.79ab	1.13ab	2.18 a	3.07 a	5.34 a	5.68 a	5.84 a	5.41 a
T_3	0.83 a	1.18 a	2.21 a	3.09 a	5.49 a	5.78 a	5.83 a	5.48 a
T_4	0.73 b	0.99 bc	1.88 b	2.84 ab	5.08 a	5.52 a	5.61 a	5.27 ab
T_5	0.61 c	0.90 c	1.79 b	2.53 b	4.48 b	4.85 b	5.18 b	4.92 b
$LSD_{(0.05)}$	0.091	0.186	0.176	0.348	0.481	0.379	0.310	0.393
CV (%)	10.76	15.29	7.51	10.49	8.16	5.94	4.70	6.38

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XX: Interaction effect of varieties and mulch materials on Leaf Area Index at of white maize different DAS

Variety × Mulch material	Leaf area index							
	30 DAS	40 DAS	50 DAS	60 DAS	70 DAS	80 DAS	90 DAS	120 DAS
V_1T_1	0.54 d	0.85bc	1.67 cd	2.31 de	4.14 de	4.46 d	4.74 d	4.40 d
V_1T_2	0.83ab	1.18 a	2.23 a	3.15 a	5.53 a	5.71 a	5.84 a	5.47ab
V_1T_3	0.90 a	1.18 a	2.25 a	3.18 a	5.64 a	5.93 a	5.97 a	5.58 a
V_1T_4	0.73bc	0.99 a-c	1.90 bc	2.88 a-c	5.13 ab	5.57 a	5.67ab	5.30 a-c
V_1T_5	0.64 cd	0.90bc	1.85 c	2.62 b-d	4.55 b-d	5.02bc	5.23bc	4.84 cd
V_2T_1	0.53 d	0.78 c	1.52 d	1.93 e	3.68 e	4.44 d	4.77 d	4.31 d
V_2T_2	0.75bc	1.08ab	2.12ab	3.00 ab	5.14ab	5.65 a	5.84 a	5.34 a-c
V_2T_3	0.76 bc	1.18 a	2.16 a	3.01ab	5.34 a	5.63 a	5.70 a	5.37 a-c
V_2T_4	0.72bc	0.98 a-c	1.86 c	2.80 a-d	5.04 a-c	5.47 ab	5.54 a-c	5.23 a-c
V_2T_5	0.58 d	0.89bc	1.73 cd	2.43 cd	4.40 cd	4.67 cd	5.13 cd	4.99bc
$LSD_{(0.05)}$	0.129	0.263	0.249	0.492	0.680	0.536	0.439	0.556
CV (%)	10.76	15.29	7.51	10.49	8.16	5.94	4.70	6.38

V_1 = Shuvra, V_2 = KS510(IV), T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XXI. Mean square values of the days to harvesting and dry weight of different plant parts at mature stage of white maize

		Days to harvesting	Dry weight (g/plant) of different parts at mature stage			
			Leaf	Stem	Tassel+sterile cob	Cob sheath
Replication	2	524.933	15.988	2.554	0.1313	2.681
Variety	1	32.033^{ns}	18.550**	17.358**	0.0538^{ns}	21.897**
Mulch material	4	101.383**	920.925**	489.933**	22.0268**	193.640**
Variety × Mulch	4	0.783*	9.620**	5.915*	1.3485**	2.647*
Error	18	10.044	2.205	2.900	0.1603	1.135

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXII. Mean square values of the dry weight of different plant parts at mature stage of white maize

Sources of variation	Degrees of freedom	Mean Square					
		Dry weight (g/plant) of different parts at mature stage					
		Cob rachis	Root	Seed	Shoot	Total dry matter	Root shoot ratio
Replication	2	3.020	1.418	1369.6	1449.8	1460.3	0.00005063
Variety	1	14.159**	18.174**	7054.3**	8861.1**	10008.7^{ns}	0.00001763^{ns}
Mulchmaterial	4	385.894**	245.141**	44603.7**	85974.0**	96057.3**	0.0001397 **
Variety × Mulch	4	3.008*	2.954*	1023.7*	1333.1*	1294.8*	0.00005972 *
Error	18	2.331	2.731	943.8	938.6	937.8	0.00004704

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXIII. Mean square values of the total dry matter $3m^{-2}$, total dry matter at harvest of white maize

Sources of variation	Degrees of freedom	Mean Square	
		Total dry matter $3m^{-2}$ (g)	Total dry matter (kg/ha)
Replication	2	461423	114200000
Variety	1	3137161**	288100000*
Mulch material	4	30890000**	311500000*
Variety × Mulch	4	438394*	98500000*
Error	18	299445	118300000

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXIV. Mean square values of the yield components of white maize

Sources of variation	Degrees of freedom	Mean Square							
		Seed wt/3m^2 (g)	Seed wt/cob (g)	Per cob wt (g)	No. of seeds/cob	Seed wt/plant (g)	No. of cobs/3m^2	No. of cobs/plant in 3m^2	Cob length (cm)
Replication	2	618812	1474.70	2049.1	926.8	1369.6	3.033	0.01351	5.8628
Variety	1	2328539**	549.55*	1869.1*	16860.2**	7054.3**	24.300**	0.09976**	45.6580**
Mulchmaterial	4	13130000**	2893.06**	11626.8**	14138.7**	44603.7**	298.467**	0.96852**	16.7671**
Variety × Mulch	4	340908*	49.62*	99.6*	1422.1*	1023.7*	7.133**	0.02142**	0.8073*
Error	18	275559	405.34	980.6	2220.5	943.8	1.589	0.00289	1.0324

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXV. Mean square values of the yield components, yield and Harvest Index of white maize

Sources of variation	Degrees of freedom	Mean Square							
		Cob diameter (cm)	No. of row/cob	No. of seeds/row	1000-seed weight (g)	Wt of cob/plant (g)	Seed wt/ha (kg)	Seed wt (t/ha)	Harvest Index (%)
Replication	2	0.00292	0.16300	0.4013	972.30	8718	6872032	6.880	0.00937
Variety	1	0.11285*	1.12133*	23.9413**	4737.63*	22685**	25880000**	25.891**	0.00001*
Mulchmaterial	4	0.35708**	5.37000**	78.9100**	5574.05**	149524**	145900000**	145.887**	0.02655**
Variety × Mulch	4	0.02919*	0.15133*	2.8380*	798.88*	2478*	3789280*	3.788*	0.00848*
Error	18	0.07190	0.27485	5.3317	1080.15	2270	3062676	3.062	0.00765

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXVI. Mean square values of the weed dry weight

Source of variation	Degrees of Freedom	Mean Square
		Weed dry weight (g m^{-2})
Replication	2	259.49
Variety	1	115.92^{ns}
Mulch material	4	2142.59**
Variety × Mulch	4	284.09*
Error	18	335.51

**: significant at 0.01 level *: significant at 0.05 level ns: non-significant

Appendix XXVII: Effect of varieties and mulch materials on weed dry weight

Variety	Weed dry weight (g m^{-2})
V_1	35.14
V_2	39.07
LSD $_{(0.05)}$	ns
Mulch material	
T_1	63.94 a
T_2	34.42 bc
T_3	14.87 c
T_4	26.03 bc
T_5	46.25 ab
LSD $_{(0.05)}$	22.218
CV (%)	49.37

ns=non-significant

V_1 = Shuvra, V_2 = KS510(IV) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

Appendix XXVIII: Interaction effect of varieties and mulch materials on weed dry weight

Variety × Mulch material	Weed dry weight (g m^{-2})
V_1T_1	66.28 a
V_1T_2	21.17bc
V_1T_3	15.40 c
V_1T_4	22.61 bc
V_1T_5	50.22 ab
V_2T_1	61.61 a
V_2T_2	47.67ab
V_2T_3	14.33 c
V_2T_4	29.44 bc
V_2T_5	42.28 a-c
$LSD_{(0.05)}$	31.421
CV (%)	49.37

V_1 = Shuvra, V_2 = KS510(IV) T_1 = Control, T_2 = Water hyacinth, T_3 = Rice straw, T_4 = Rice husk, T_5 = Ash

PLATES

Plate 1. Field View

Plate 2(A). Shuvra maize variety in a control treatment plot at 90 DAS

Plate 2(B). Shuvra maize variety in a water hyacinth mulch treatment at 90 DAS

Plate 3(A). Shuvra maize variety in a rice straw mulch treatment at 90 DAS

Plate 3(B). Shuvra maize variety in a rice husk mulch treatment at 90 DAS

Plate 4(A). Shuvra maize variety in a ash mulch treatment at 90 DAS

Plate 4(B). KS-510 maize variety in a control treatment plot at 90 DAS

Plate 5(A). KS-510 maize variety in a water hyacinth treatment plot at 90DAS

Plate 5(B). KS-510 maize variety in a rice straw treatment plot at 90DAS

Plate 6(A). KS-510 maize variety in a rice husk treatment plot at 90DAS

Plate 6(B). KS-510 maize variety in a ash treatment plot at 90DAS

Plate7. Some human food made from white maize

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BELOVED PARENTS

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