INFLUENCE OF WEEDING ON THE PERFORMANCE OF WHITE MAIZE VARIETIES

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CERTIFICATE

*This is to certify that the thesis entitled **"Influence of weeding on the performance of white maize varieties"** submitted to the Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agronomy**, embodies the result of a piece of bonafide research work carried out by **Mst. Shammi Akter**, Registration No. **12-04951** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

Dated:
Dhaka, Bangladesh

____

Professor Dr. Md. Jafar Ullah
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Dedicated To

My Beloved Parents

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INFLUENCE OF WEEDING ON THE PERFORMANCE OF WHITE MAIZE VARIETIES

ABSTRACT

The experiment was conducted at agronomy farm of Sher-e-Bangla Agricultural University, Dhaka during November 2017 to April 2018 to investigate the influence of weeding regimes on the performance of white maize varieties. The experiment comprised two varieties *viz*. YANGNUO-3000 and PSC-121, designated as V_1 and V_2 respectively combined with four weed control treatments *viz.* T_0 = No weeding, T_1= One hand weeding at 60 DAS, T_2= two hand weeding at 40 DAS and 60 DAS and T_3= Weed free after 40 DAS. The experiment was laid out in RCBD (factorial) with three replications. PSC-121 showed the superior performance in terms of plant height, leaf number plant^{-1}, leaf area plant^{-1}, base circumference, cob setting node position from ground, cob length (18.35 cm), number of grain row cob^{-1} (13.56), number of grains cob^{-1} (468.75), weight of grains cob^{-1} (99.78 g), 100 seed weight (35.0837 g), grain yield (8.28 t ha^{-1}), stover yield (6.56 t ha^{-1}) and harvest index (55.58%) over YANGNUO-3000. In case of weed control treatments, the highest plant height, leaf number plant^{-1}, leaf area plant^{-1}, base circumference, cob setting node position from ground, cob length (17.95 cm), number of grain row cob^{-1} (14), number of grains cob^{-1} (464.54), weight of grains cob^{-1} (111.44 g), 100 seed weight (37 g), grain yield (9.25 t ha^{-1}) and stover yield (7.46 t ha^{-1}) were reported from $T_{3.}$ All the parameters studied were found lowest with T_0. However, in terms of interaction, no single interaction was superior over other alternatives. But in most of the cases V_2T_3 showed the highest values regarding the maximum plant height, leaf number plant^{-1}, leaf area plant^{-1}, cob length (18.82 cm), number of grains cob^{-1} (494.97), weight of grain cob^{-1} (112.35 g) and 100 grain weight (38 g). V_2T_3 showed the highest grain yield (9.33 t ha^{-1}), whereas, V_1T_0 showed the lowest grain yield (5.49 t ha^{-1}). The lowest weed density and weed biomass (12.17 no. m^{-2} and 4.33 g m^{-2}) was recorded from T_3. The highest weed control efficiency (94.38%) was also recorded from T_3. In case of variety V_2 showed better performance in terms of weed density, weed biomass and WCE (46.32%).

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
Cm^2		Centimeter Square
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
e.g.	=	exempli gratia (L), for example
et al.,	=	And others
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
Fig.		Figure
g	=	Gram
i.e.	=	id est. (L), that is
kg	=	Kilogram (s)
L	=	Liter
LA		Leaf area
M.S.	=	Master of Science
m^2	=	Meter squares
mg	=	Milligram
mL	=	Milliliter
No.	=	Number
^oC	=	Degree Celsius
SAU	=	Sher-e-Bangla Agricultural University

CHAPTER I

INTRODUCTION

Among the cereal crops maize is the third most important one in the world providing major source of food in many countries. It is mainly grown as fodder and feed. In the industrialized countries it is used as raw material for manufacturing pharmaceutical and other industrial products (Akbar *et al.,* 2016). Rice is the major staple food in Bangladesh but globally the yield growth of rice has become either stagnated or slowed down (Cassaman *et al.,* 2010). At present, agricultural land is shrinking due to urbanization, industrialization and infrastructure development but the demand for food is increasing with growing population and rising income. Therefore, growing food keeping pace with the demand faces unprecedented challenges (Chen *et al.,* 2014) while raising the yield and production of rice remains questionable (Dass *et al*., 2012). It is against this backdrop, introduction of white maize in Bangladesh as human food can be a viable alternative for sustaining food security given the productivity of maize much higher than rice and wheat (Ray *et al*., 2013). Seed of white maize contains about 72% starch, 10% protein, and 4% fat, energy value of 365 Kcal/100g as compared to rice and wheat (Nuss and Tanumihardjo., 2010).

White maize provides many of the B vitamins and essential minerals along with fiber, but lacks some other nutrients, such as vitamin B12 and vitamin C, and is, in general, a poor source of calcium, folate, and iron (Ranum *et al*., 2014). People in many developed and developing countries produce and consume maize as staple food. White maize constitutes about 10% of the total maize production in the USA and is used for human food (Akbar *et al*., 2016).

Maize is a comparatively new crop in Bangladesh. It is suitable for rice-maize cropping system and has been expanded rapidly in the northern districts of Bangladesh (Timsina *et al*., 2010) mainly in response to increasing demand for poultry food (Ali *et al*., 2010). Currently maize is planted to about 307,000 ha producing 2.12 million tons of grains annually (BBS, 2016). In the Chittagong Hill Tracts (CHT) maize is grown since long as a secondary staple crop for the ethnic communities contributing to 2.1% of national production. With the advancement in breeding and biotechnology high yielding modern varieties and hybrids of maize are developed. In addition, Improvement in agronomic management practices also contributes greatly to increasing grain yields (Lee and Tollenaar, 2007).

However, the yield performance differs remarkably across hybrids depending on environmental conditions, agronomic management and choice of varieties. The growth and yield attributes of maize differs among and between local and hybrid maize varieties (Macharia *et al*., 2010 & Ullah *et al*., 2017).

Different agronomic management has different degrees of impact on growth and yield of maize. Among those agronomic management practices weeding is the most important one. Losses in grain yield could range from 18-25, 20-65, 20-45, 13-43, 10-35 and 25-55% in wheat, rice maize, cotton, sugarcane and pulses respectively from weed interference while, while monetary losses caused by weeds in agricultural production are estimated at more than 18.2 billion dollar (Alam, 2003). Worldwide maize production is decreased to about 40% due to competition from weeds, which are the most dominant pest groups (Oerke and Dehn, 2004). Another reports shows that yield losses in maize field due to weeds infestation range from 50-90% in Central and West Africa (Chikoye *et al*., 2002). There are different kinds of weed control methods (tratments) *viz*., Chemical weed control methods, biological weed control methods, hand weeding method etc. Different levels of hand weeding were used to conduct this experiment.

Therefore, the objective of this work was set:

1. To compare the growth and yield of different white maize varieties
2. To evaluate the performance of different weed control treatments on the performance of white maize varieties
3. To evaluate the interactions of white maize varieties and weed control treatments

CHAPTER II

REVIEW OF LITERATURE

At present maize is used mainly as livestock feed and it is consumed as second cycle produce in the form of meat, eggs and dairy products in Bangladesh. In this perspective, white maize is different one which is mainly introduced for meeting the direct food consumption demand. That's why the crop has an immense potentiality for supporting food stuff of the huge population of Bangladesh when other crop's contribution will fall due to change in climatic condition. However, a huge number of research reports so far published on this crop have been reviewed and some of the reviews related to the topic have been embellished below:

2.1 Maize

Zea mays belongs to *Gramineae (Poaceae*) family. It is tall, monoecious annual grass bearing overlapping sheaths and alternately arranged blades. Plants also have staminate spikelet with spike receme which extend over terminal panicles (tassels) and pistillate inflorescences. Spikelet bear 8 to 16 rows and ear is enclosed in numerous bract and a mass of silk which is extend towards the tip as a mass of silky thread (Hitcock and Chase,1971).

Maize leaf is simple, sessile contains two parts e.g. leaf sheath and leaf blade. Collar is a distinct join which pointed expansion of leaf blade from the stem. Appearance of collar signifies that leaf is fully expanded. Leaf is connected to the stem underneath the collar where leaf sheath is bound to the node. In male spikelet spike like racemose is arranged in terminal panicle (Tripathi *et al.*, 2011). Female spikelets which are arranged on a thickened rachis covered by many green spathes like bract. Each spikelet has two flowers which is surrounded by palea (Shaw, 1988). Calyx and corolla are transformed into lodicules which is look like scale (Maize bilogy, 2011 and Mia, 2016).

Pollen is shed in mid morning during normal cross pollination (Luna *et al*., 2001). Horizontal settling speed of maize pollen is 21-32 cm/s depending on how much pollen is dehydrated (Aylor, 2002). Baltazar *et al.* (2005) mentioned that pollen diameter is 94 to 103 µm. Maize pollen is well protected which is surrounded by double layer consisting of exine and intine.

Height of tassel is 2.5 m and height of silk is 1 m and settling distance between adjacent plants is approximately 1.5m which is required for pollination. Vertical movement of pollen in thermal and air turbulence could expand dispersal distances. It only occurs where condition do not favor horizontal dispersal (Bannert and Stamp, 2007).

In Biology Documents (2014), it was reported that maize can successfully be grown in areas where it receives an annual rainfall of 60 cm. Longer cloudy period is detrimental for crop but sporadic sunlight and cloud of rain is most suitable for its growth (Proline seeds, 2014). It needs bright suuny day for expediting photosynthetic activity and swift grows of plant. Maize is traditionally grown in monsoon (Kharif) season which is followed by high temperature ($<35^{\circ}$ C). Brown clay silt loam is ideal for maize cultivation. Soil pH range is 7.5 to 8.5.

Maize is a primarily warm weather crop which is grown in broad range of climatic conditions (ICAR, 2006).

2.2 White Maize

An experiment was conducted by Mannan (2018), taking two white maize varieties (PSC-121 and Yangnuo-3000) and six levels of weed control treatments, *viz.*, T_0 = No weeding, T_1= Carfentrazone + Isoproturon 500g @ 1.5 g/ha (Affinity 50.75% WP), T_2= Carfentrazone + Isoproturon 500g @ 2.0 g/ha (Affinity 50.75% WP), T_3= Pendimethalin @ 2.0 l/ha (Panida 50EC), T_4= Pendimethalin @ 3.0 l/ha (Panida 50EC) and T_5= One Hand Weeding at 45 DAS. In the experiment, PSC-121 was reported as better performer than Yangnuo-3000 in terms of most of the growth and yield parameters giving a grain yield of 7.758 t ha^{-1}. Whereas a grain yield of 6.44 t ha^{-1} was obtained from Yangnuo-3000.

In an experiment, conducted by Ullah *et al.* (2016); among four white mazie varieties (Chamgnuo-1, Changnuo-6, Q-xiannuo-1 and YANGNUO-7) YANGNUO-7 was reported as the earliest variety reaching to maturity in 108 days but showed the lowest performance in respect 100 seed yield, per hectare yield etc.

2.3 Weeds in Maize Field and Damage

The most commonly occurring weed species of maize are *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. Beauv, *Amaranthus retroflexus* L., Elymus repens (L.) Gould, *Fallopia convolvulus* (L.), A. Love and *Galinsoga parviflora* L (Golebiow-ska, 2006; Glowacka, 2007).

Most prominent weed species in maize crop are *Echinochloa crus-galli* (L.) P. Beauv and *Chenopodium album* L. whereas Echinochloa crusgalli (L.) P. Beauv is C_4 plant widespread throughout the year belonging grass family and considered most threatening weed (Rao *et al*., 2007; Chauhan and Jhonson, 2010).

Holm *et al*. (1991), reported that *Echinochloa crusgalli* is considered to be leading weed species in many crops including rice (*Oryza sativa* L.), cotton (*Gossypium hirsutum* L.), maize (*Zea mays* L.), soybean (*Glycine max* L.), sorghum (*Sorghum bicolor* L.), peanuts (*Arachis hypogaea* L.), sugarcane (*Saccharum officinarum* L.) and vegetables.

Weeds decreased crop yields and augment production cost by competing for space, water, light, nutrients and naturally acting as alternative hosts of other pests and pathogens. (Oerke, 2005; Ademiluyi and Abegunde, 2007). Chivinge (1983) and Tyr et al. (2015) reported that *Commelina benghalensis* is the most hostile weeds in farming sectors of Africa.

Ndam *et al*. (2014), reported that *Mariscus alternifolius* is one of the most destructive weeds having spread out worldwide distribution in tropical and temeperate regions. Yield losses in maize field due to weeds infestation range from 50-90% in Central and West Africa (Chikoye *et al*., 2002).

Worldwide maize production is decreased to about 40% due to competition from weeds, which are the most dominant pest groups (Oerke and Dehn, 2004). Due to the prolonged period of germination, swift growth and high rate of seed production *Amaranthus spinosus* species are considered to be invasive and noxious weeds (Ndam *et al*., 2014).

Ndam *et al*. (2014), concluded that most superior and widespread weed species of maize crop in the study were *Amaranthus spinosus, Bidens pilosa*, *Commelina benghalensis*, *Mariscus alternafolius* and *Cynodon dactylon*.

Due to the tough competitior, allelopathic effect, roots releasing noxious substance *Mariscus alternifolius* are known to be world's worst weeds because over 90 countries it infests over 50 crops worldwide (Ndam *et al*., 2014).

Chenopodium album L. is a regular weed infesting various crops on all types of soil. (Skrzyczynska *et al.,* 2002; Traba and Zieminska-Smyk, 2002). Lagoke *et al*. (1998), explored that due to weed infestation maize yield losses 60-81%. Initial stage of growth maize is highly susceptible to weed competition (Imoloame Eo and Omolaiye, 2017). Lagoke *et al*. (1998), concluded that ear number per plant and 100 seed weight of grains reduced with increasing duration of weed interference.

Stefan Tyr *et al.* (2015), reported that maize field is infested by *Amaranthus retroflexus*, *Chenopodium album*, *Abutilon theophrasti*, *Convolvulus arvensis, Sorghum halepense*, *Echinochloa crus-galli , Digitaria sanguinalis* and *Setaria* spp which are broad spectrum of grasses and and broadleaved weeds.

Application of different integrated and ecological farming systems which causes dynamics of occurance of individual weed species of maize (Sinha *et al.,* 2000). In 2012-2014 period total of 14 weed species like *Amaranthus retroflexus,Atriplex spp*, *Avena fatua, Cardaria draba, Circium arvense*, *Convolvulus arvensis, Datura stramonium, Echinochloa crus-galli, Chenopodium album, Chenopodium hybridum*, *Persicaria maculosa, Polygonum aviculare, Portulaca oleracea* and *Sonchus arvensis* occurred in both farming systems (Stefan Tyr *et al*., 2015). They also concluded that maximum weeds frequency of maize field was 123 plants per m^2 and minimum was 4 plants per m^2 due to the integrated and ecological farming systems (Sanodiya *et al.,* 2013).

Fuksa *et al*. (2004) explored that in maize field high level of weed infestation is caused due to the lack of water in soil. Tollenaar *et al.* (1994), reported that yield of maize is reduced due to the weed infestation throughout the whole vegetation period by 65%.

Total plant mass of maize is significantly reduced by weed infestation (Fuksa *et al*., 2004).

2.4 Performance of White Maize Varieties

Ullah *et al.* (2016) reported that YANGNUO-7 showed the highest plant height (35.83 cm) at 30 DAS over the other three varieties (Changnuo-1: 26.52 cm, Changnuo-6: 34,27 and Q-Xiannuo-1: 22.17 cm) when conducted an experiment to evaluate the performance seedling transplantation of four white maize hybrids.

Ullah *et al*. (2017) observed that the white maize variety Suvra showed the highest value of plant height over plough 201 and plough 202 while conducting an experiment to Compare modern varieties of white maize with landraces in Bangladesh.

Akbar *et al.* (2016) explored that the plant height ranged between 243 and 279 cm across treatments with an average of 263 cm. Generally plant height increased with increasing rate of fertilizer application and plants of hybrid PSC 121 were taller than KS 510.
Grain yield was found between 7.10 t ha^{-1} and 10.12 t ha^{-1} across hybrids and planting scheme. 19% more yield was obtained from PSC-121 than KS 510. In general, increasing planting density resulted in increased grain yield. Planting in twin-rows resulting in 80,000 plants per hectare produced 17.7% higher yield than planting in single rows having 66,667 plants per ha with 60 cm spacing. Identical result was found by the application of fertilizers at 100% and 50% of recommended rate but gave significantly higher grain yield compared to 25% of recommended doses.

Out of four varieties Changnuo-6 and YANGNUO-7 resulted in higher average number of leaves (4.00) than others (3.33-3.88). Changnuo-6 agve the highest number of grains per cob (419), while the lowest number of grains was obtained from Yangnuo-7 (276). Hoever, the lowest 100-seed weight was recorded from Yangnuo-7 (24.33 g, other varieties showed 31.83-34.67 g). The highest significant grain yield per hectare was resulted from Changnuo-6 (8.198 tons) which is preceded by Changnuo-1 (7.457 tons) and Q-Xinagnuo-1 (6.718 tons). The lowest grain yield per hectare was obtained from Yangnuo-7 (4.393 tons) than others (Ullah *et al.*, 2016).

Ullah *et al* (2017) conducted an experiment to compare modern varieties of white maize with land races. In the experiment it was found that the umber of leaves in the modern varieties differed from 11.66 to 13.66 per plant with a mean value of 12.88 per plant. Although the varieties did not vary significantly in producing number of leaves though two more leaves were exhibited in Plough-202 and Suvra (over 13 leaves per plant) as compared to that (11.66) of the Plough-201. Unlike the leaf number per plant, the stem base circumference varied significantly over the modern varieties. Significantly the highest stem base circumference was observed in Suvra (10 cm) which although was identical to that (9 cm) of the Plough-202. The variety Plough-201 had the narrowest stem showing significantly lower value (8.33 cm) than that of the Plough-202 but identical in comparison to that of the Plough-201.

Khan *et al.* (2016) performed an experiment considering three hybrid maize varieties, eg., P-3025, P-32T78 and P-3203. From the experiment he noted that among three hybrid maize varieties, plant height (247.188 cm) and grain yield (2.253 ton ha$^{-1)}$ was maximum in maize hybrid P-3025, while the minimum plant height (202.00) was recorded in P-32T78.

Ali *et al.* (1999) carried out an experiment taking three BARI released white maize varieties (Suvra, Savar-2 and Sadaf) and found that Suvra showed the medium plant height between the highest (163.1 cm by Savar-2) and the lowest (153.5 cm by Sadaf) plant height at 90 days.

Ali *et al.* (1999) conducted another experiment considering five varieties (Amper pop, Sadaf, Suvra, Savar-2 and Barnali) and reported that among the five varieties used in the experiment of water stress, Suvra, a white maize variety showed the maximum base diameter of 13.9 mm at 90 DAS.

Ahmed *et al.* (2010) conducted an experiment for two consecutive years taking three varieties(DK-919, DK-5219 and Pioneer-30Y87) and found that during both the years of experimentation, higher grain yield was obtained from the early maturing variety early DK-919 compared to that of mid and late maturity maize hybrids. Early (DK-919) and late (Pioneer-30Y87) maize hybrids gave the best outcome when row spacing was maintained to 45 cm, while mid season hybrid (DK-5219) performed best when the row spacing was 60 cm. Yield contributing characters like cob length, number of grains per cob and 100 grain weight significantly differed within the hybrids and with variation in row spacing.

2.5 Performance of Weed Control Treatments

Pandey *et al.* (2001) reported that growth and yield attributes in maize were increased under rainfed condition by the application of pre emergence atrazine (1.25 kg ha^{-1}), pendimethalin (1.50 kg ha^{-1}) and alachlor (2 kg ha^{-1}) along with combination of three post emergence control measures with hand weeding, paraquat (0.5 kg ha^{-1}) and earthing up. Among these treatments hand weeding showed best results for controlling weeds.

A field experiment was conducted to study the growth and yield attributes in maize different methods like chemical, hand weeding and their integration for controlling various type of weed species under rainfed condition. Chemical weeding applied 2-3 life stage of weeds and hand weeding at 50 DAS. Among these treatments hand weeding showed promising results (1.7 g m^{-2}) for minimizing weed population (Riaz *et al.,* 2007).

Alok and Bhagwan (2007) explored that growth and yield attributes in maize were augmented under rainfed condition by the application of pre emergence alachlor (2 kg ha^{-1}), pendimethalin (1 kg ha^{-1}) and atrazine (1 kg ha^{-1}) along with combination of one hand weeding 30 DAS , two hand weeding 20 and 40 DAS and earthing up. Among these treatments two hand weeding proved most effective (weed control efficiency 60.74 and 71.78%) for mitigating weed population.

A field experiment was carried out to explore the growth and yield attributes in maize. There are different methods like 2 hand weeding, paddy straw mulching, black polythene mulching, atrazine 0.75 kg ha^{-1}, atrazine 1 kg $ha^{-1}$and atrazine 1 kg $ha^{-1}$with hand weeding apply the maize field. Among these treatments best results were found by atrazine 1 kg $ha^{-1}$with hand weeding and 2 hand weeding with paddy straw mulching that helps to minimize weed population (Abdullahi e*t al.*, 2016).

Amosun *et al.* (2015) abstracted that growth and yield attributes were increased by the application of different strategies like maize and macuna combination, maize and sweet potato combination, maize and primextra (1.45 kg ha^{-1}S-metachlor and 1.85 kg ha^{-1}) combination and hand weeding 3 to 6 weeks after planting were applied. Among these treatments hand weeding showed best result for controlling weed population at a minimal rate.

Olatunji *et al*. (2016) cited that growth and yield attributes were promoted by the application of different measures like glyphosate at 1.44 kg ha^{-1}, glyphosate at 1.44 kg $ha^{-1}$and weeding at 4 weeks after planting, paraquat at 0.4 kg ha^{-1}, paraquat at 0.4 kg $ha^{-1}$and weeding at 7 weeks after planting, atrazine at kg ha^{-1}, primextra at 3 kg ha^{-1}, hand weeding 3 and 7 weeks after planting. Among these measures hand weeding showed optimistic results for controlling weed population.

Din *et al*. (2016) showed that growth parameters (Plant height), and yield parameters (Number of grains/cob, 1000 grain wt, grain yields t ha^{-1}, biological yield t ha^{-1} etc) were increased by the application of hand weeding and chemical weed control at 14, 21, 28, 35,42,49 days after sowing along with un weeded control. Among these treatments hand weeding showed best results for controlling weed population.

A field experiment was conducted to evaluate the growth attributes (Plant height, ground biomass) and yield attributes (Cob length, rows per cob, yield ha^{-1} etc) in maize. Different methods like applying Lunar 537.5 SE at 3 L ha^{-1}, Venus 500 SC at 6 L ha^{-1}, Prima gram dual Gold 660sc at 3 L ha^{-1} and two times hand weeding at 25 and 40 DAS. Among these treatments hand weeding showed remarkable results for controlling weed population (Kebed and Anbasa, 2017).

Patel *et al*. (2006) explored that growth and yield attributes were promoted by the application of different treatments like atrazine, alachlor and metachlor each @ 1 kg a.i. ha^{-1}, metribuzin @ 0.30 kg a.i. ha^{-1}, pendimethalin @ 0.5 kg a.i. ha^{-1} and their mixtures were applied half of the doze , weed free (2 hand weeding at 20& 40 DAS) and weedy check. It was detected that maximum weed control efficiency was obtained by the application of atrazine @ 0.5 a.i. ha^{-1} combination with pendimethalin @0.25 kg a.i. ha^{-1}, atrazine and alachlor each applied @0.5 kg a.i. $ha^{-1}$and twice hand weeding carried out 20 and 40 DAS.

A field experiment was conducted to explore the growth and yield attributes in maize. *Echinochloa colona, Panicum dichotomiflorum, Cyperus iria, Commelina benghalensis, Ageratum conyzoides, Digitaria sanguinaris and Polygonum alatum* were prominent weeds. Different measures like Pendimethalin 1.50 kg ha^{-1}, atrazine 0.75 kg ha^{-1}, atrazine 0.75/1+ pendimethalin 0.75/0.50 fb metsulfuron methyl 4g/ha effectively checked *Echinochloa colona*. Atrazine fb effectively controlled *Panicum dichotomiflorum* up to 60 DAS. Pendimethalin fb atrazine , atrazine 1.0+ Pendimethalin 0.50 fb, 2,4-D 0.75 kg ha^{-1} and hand weeding twice effectively minimized the population of *Commelina* up to 60 DAS. Pendimethalin/atrazine, atrazine+pendimethalin fb, 2,4-D/metsulfuron reduced *Ageratum conzoides* up to 60 DAS (Kumar *et al*., 2012).

Tahir *et al.* (2009) observed that growth and yield parameters were augmented by the application of different treatments like weedy check, Penthalin plus-35EC @ 2000,2500,3000,3500 and 4000 ml/ha (Pendimethalin+ prometryn @ 700,875,1050,1225 and 1400 g a.i./ha), stomp-35EC @3000ml/ha (Pendimethalin @1050 g a.i. ha^{-1}) and manual hoeing. Most prominent weed population were *Cyperus rotundus, Tribulus terrestris, Dactyloctenium aegyptium and Cynodon dactylon.* Most effective control was manual hoeing, stomp 35-EC (Pendimethalin @1050 g a.i. ha^{-1}) and Penthalin plus-35EC (Pendimethalin+Prometryn @ 1225 g a.i. ha^{-1}) that will help to check most dominant weed population.

A field experiment was carried out to observe the growth and yield attributes in maize. Parthenium and associated weeds were dominant in maize field. Different treatments were applied like Aatrax (atrazine) @ 1.0, Buctril super (bromoxynil+MCPA) 60EC@ 0.80, Dual gold (s-metolachlor) 960EC @1.92, Sencor extra (metribuzin) @ 2.0, Primextra gold 720 SC (atrazine+s-metachlor), @1.50 Stomp (Pendimethalin) 330EC@ 1.50kg a.i./ha and hand weeding.Higher weed termination was observed primextra gold followed by hand weeding and dual gold. Finally it was observed that primextra gold could provide efficient control of parthenium weed and associated weeds in maize (Khan *et al*., 2014).

Nadeem *et al*. (2010) reported that growth (Plant height) and yield (Number of cobs/plant, cob length, number of grains cob^{-1}, 1000 grain weight, grain yield etc) attributes of maize were promoted by the application of different methods like manual hoeing and earthing up alone in combination with metachlor+atrazine @ 1100+740 g a.i. ha^{-1}, acetachlor @618 g a.i. ha^{-1}along with weedy check. Maximum weed control efficiency was found manual hoeing along with metachlor +atrazine @1100+740 a.i. ha^{-1}.

Singh *et al*. (2009) cited that growth and yield attributes of maize were boosted up by the application of different control measures like alachlor (2 kg ha^{-1}), simazine (1 kg/ha) and pendimethalin (1 kg ha^{-1}) alone in combination with one hand weeding at 30 DAS , two hand weeding at 20 and 40 DAS . Finally it was revealed that two hand weeding at 20 and 40 DAS most effective control weed population along with alachlor 2 kg ha^{-1}+ hand weeding at 30 DAS.

A field experiment was conducted to explore the growth and yield attributes of maize. Different treatments were used such as weedy check, herbicide (nicosulfuron 80 g ha^{-1}), hand weeding at all growth season, hand weeding up to 3 and 6 weeks after emergence, hydropriming, hydropriming+ nicosulfuron 40g/ha and hydropriming+hand weeding up to 6 weeks after emergence. Result proved that significant weed was reduced by the application of hydropriming+ hand weeding at 6 weeks after emergence, hydropriming+ nicosulfuron at 40 g ha^{-1} and nicosulfuron herbicide 40 g ha^{-1} + hand weeding after 6 weeks (Hamid *et al*., 2012).

Abouziena *et al*. (2017) reported that growth and yield attributes of maize were accelerated by the application of different controlling measures like hand hoeing twice, hand hoeing three times, fluroxypr+ hoeing once, hoeing once+ bispyribac-Na and non weeded check. Among these measures hand weeding showed superior performance than herbicide for checking weed population.

Rasool and Khan (2016), carried out an experiment considering four weed management practices, such as W_0= No weeding, W_1 = Hand weeding 20 and 50 days after sowing, W_2 = atrazine @ 1.0 kg a.i ha^{-1} PRE + hand weeding 20 days after sowing and W_3 = atrazine @ 1.0 kg a.i ha^{-1} PRE + Isoproturon @ 1.0 kg a.i ha^{-1} POST to study the effect of integrated weed management practices on the growth and yield of maize. The results indicated that weed management practice W_2 was at par with W_3 which significantly boosted up plant height, number of functional leaves, leaf area index and dry matter production at different growth stages as compared to the weedy check (W_0). In the same manner, W_2 was statistically similar with W_3 and recorded significant improvement in all yield determining parameters over W_1 and W_0. W_2 showed significantly higher grain and stover yields over W_1 and W_0. W_3 recorded significantly higher biological yield and harvest index than the rest of treatments during both the years of experimentation.

Hossain *et al.* (2009) carried out an experiment with Six treatment combinations i.e. Affinity @1.5 kg ha^{-1}, Hammer @ 104 ml ha^{-1}, 2-4, D Amine @ 1200 ml ha^{-1}, U 46 @1200 ml ha^{-1}at 25 day after sowing (DAS), one hand weeding at 24 DAS and control (no weeding) to reveal effect of newly developed herbicides on the growth and yield of wheat. From the research it was found that Affinity @1.5 kg ha^{-1}at 25 DAS gave the maximum weed control efficiency (77.4%) which is statistically similar with hand weeding (78.2%). All of the herbicide treatments significantly influenced grain yield and yield attributes of wheat. The highest grain yield (4.28 t ha^{-1}) was recorded from Affinity @ 1.5 kg ha^{-1}at 25 DAS and hand weeding (4.35t ha^{-1}).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during November, 2017 to April, 2018 to study the influence of weeding on the performance of white maize varieties. In this chapter the details of different materials used and methodology followed during the experimental period are presented under the following heads:

3.1 Experimental site

The present experiment was conducted at Agronomy farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is $23^{0}74'$ N latitude and $90^{0}35'$ E longitude and at an elevation of 8.2 m from sea level.

3.2 Climate

The experimental area was under the sub-tropical climate characterized by high temperature, high humidity, and heavy rainfall with occasional gusty winds during April - September (kharif season) and less rainfall associated with moderately low temperature during October-March (rabi season). The weather data of the experimental site during the study period have been presented in Appendix I.

3.3 Characteristics of the soil of experimental site

The soil of the experimental area is medium high land having red brown terrace soil, which belongs to the Modhupur Tract under AEZ no. 28 and the Tejgaon soil series. The soil characteristics of the experimental plot are presented in Appendix II.

3.4 Methods

3.4.1 Treatments

Two factors were used in the present experiment to get 8 treatment combinations which were as follows:

Factor A: Variety (02)

1. V_1 = Yangnuo-3000
2. V_2 = PSC-121

Factor B: Weed control treatments (04)

1. T_0= No Weeding
2. T_1= One hand weeding at 60 DAS
3. T_2= Two hand weeding at 40 DAS and 60 DAS
4. T_3= Weed free after 40 DAS

Treatment combinations: Eight treatment combinations are as follows-

V_1T_0, V_1T_1, V_1T_2, V_1T_3, V_2T_0, V_2T_1, V_2T_2 and V_2T_3

3.4.2 Experimental design and layout

The experiment was laid out in factorial RCBD with three replications. Each block, representing a replication, was divided into 8 unit plots. The total number of unit plots was 24. The size of each unit plot was 2.40 m × 2.50 m. The distance maintained between the unit plots and blocks were 0.70 m and 1.0 m respectively. Layout of the experimental field is presented in Appendix III.

3.5 Collection of seeds

Healthy seeds of PSC-121 and Yangnuo-3000 were collected from the seed store of the project titled Collection, Evaluation and Introduction of White Maize for Human Consumption in Bangladesh, co-implemented by Sher-e-Bangla Agricultural University and funded by Krishi Gobesona Foundation.

3.6 Germination test

Germination test was performed before sowing the seeds in the field. For laboratory test, petridishes were used. Filter paper was placed on petridishes and the papers were soaked with water. Seeds were distributed at random in petridishes. Data on emergence were calculated expressed as percentage by using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of germinated seeds}}{\text{Number of seeds set for germination}} \times 100$$

3.7 Land preparation

The experimental field was first opened on September, 2017 with the help of a power tiller and prepared by three successive plowing and cross- plowing. Each plowing was followed by laddering to have a desirable fine tilt. The visible larger clods were hammered to break into small pieces. All kinds of weeds and residues of previous crop were removed from the field. Individual plots were cleaned and finally leveled with the help of wooden plank.

3.8 Fertilizer application

Manures and fertilizers that were applied to the experimental plot presented in Table1. Total amount of TSP, MoP, Gypsum, Zinc sulphate, Boric acid and half of Urea were applied as basal dose at the time of land preparation. The rest amount of Urea was applied at 25 days after seed sowing and before flowering.

Table1. Dose and method of application of fertilizers in white maize field

Name of manure and fertilizer	Doses	Methods of application
Cow dung	5 t ha^{-1}	Total as basal
Urea	525 kg ha^{-1}	1/3rd as basal and 2/3rd as top dressing
TSP	250 kg ha^{-1}	Total as basal
MoP	200 kg ha^{-1}	Total as basal
Gypsum	250 kg ha^{-1}	Total as basal
$ZnSO_4$	12.5 kg ha^{-1}	Total as basal
Boric acid	6.0 kg ha^{-1}	Total as basal

Source: KGF, 2016

3.9 Sowing of seeds

Seeds were sown on the 23rd November, 2017 in line sowing method. Seeds were sown by maintaining the spacing of 60cm × 20 cm with two seeds per hill. Thinning was done to keep one seedling $hill^{-1}$ 25 days after emergence maintaining the spacing properly.

3.10 Intercultural operations

The following intercultural operations were done for ensuring the normal growth of the experimental crop:

3.10.1 Irrigation

No irrigation was provided during seed germination as there was enough moisture in the field for the seedlings. The first flood irrigation was provided in each plot using a pipe connected to the water source at 45 DAS. Other two irrigations were provided at flowering and at dough stage.

3.10.2 Weeding

Weeding was done as a part of the treatment factor B.

3.11 Harvesting and post harvest processing

The crop was harvested at 10^{th} April, 2018 when the leaves, stems become yellowish and the base of the grain turns into black color. Less than 22 to 25 per cent moisture in grain, husk color turns pale brown 25 to 30 days after tasseling. Five sample plants from each of the plots were harvested for recording the yield data. The harvested plants were tied into bundles and carried to lab to recording data.

3.12 Sampling

The sampling was done consecutively at 40, 60 and 80 DAS and finally at harvest. At each sampling, five plants were selected randomly from each plot. The selected plants for the first sample were uprooted carefully by hand as the root system was not so strong. But the samples collected later on were cut from the ground using a sickle. After collecting the necessary data Stover and grains (at final harvest) were oven dried at 60^oC for 72 hours to record constant dry weights.

3.13 Recording of data

The data on the following parameters were recorded at each harvest.

3.13.1 Weed data

1. Weed species present in the field
2. Weed density (no. m^{-2})
3. Weed biomass (g m^{-2})
4. Weed control efficiency (WCE %)

3.13.2 Growth parameters

1. Plant height (cm)
2. Number of leaves $pant^{-1}$
3. Leaf Area (m^2)
4. Base circumference (cm)

5. Cob setting node position from ground

3.13.3 Yield parameters

1. Cob length (cm)
2. Number of grain row cob^{-1}
3. Number of grains cob^{-1}
4. Weight of grains cob^{-1} (g)
5. 100 seed weight (g)
6. Grain yield (t ha^{-1})
7. Stover yield (t ha^{-1})
8. Harvest index (%)

3.14 Procedure of recording data (Weed features, growth and yield parameters)

Randomly selected five plants at harvest were used to collect data or the parameter chosen. The procedure of recording data at harvest is given below:

3.14.1 Weed features

One square meter area was selected from each of the treated plots and all the individuals within a species present in the area were collected and counted. After that oven dry weight of weeds per square meter was taken by keeping at 60^0C for 72 hours. Weed control efficiency was analyzed by following the formula given below-

WCE% = $\{(W_0-W_t)/W_0\times100\}$

Where, WCE=Weed control efficiency

W_0= No. weed present in per square meter of weedy check plot

W_t= No. of weed present in per square meter of treated plot

3.14.2 Plant height (cm)

The plant height was measured from the ground level to the tip of the individual plant. Mean value of five selected plants was calculated for each unit plot and expressed in centimeter (cm).

3.14.3 Number of leaves plant^{-1}

Number of leaves per plant was counted and the data were recorded from 5 selected plants and then calculated and mean value was recorded.

3.14.4 Leaf area plant^{-1} (m^2)

The length and width of all green leaves of record plants were measured using a meter rule. The product of the length and width of each leaf was multiplied by 0.75 to give the area for each leaf. Then the total number of leaves per plant was established after the flag leaf. The total leaf area per plant was obtained by summing up the leaf area of the recorded plants and then the mean leaf area of a plant was determined for each treatment.

3.14.5 Base circumference (cm)

Base diameter of each sampled plant was taken by measuring the diameter of the first inter node nearest to ground using a measuring tape.

3.14.6 Cob setting node position from ground

The position of cob setting node was determined by counting the nodes from ground to the node where the first cob was set.

3.14.7 Cob length (cm)

Cob length was measured by setting a measuring tape from base to the tip of the cob

3.14.8 Number of grain row cob^{-1} and number of grains cob^{-1}

Each cob was composed of a number of rows of grains. Those rows of grains were counted manually. After that the number of grains per row was counted and multiplied with the total number of rows to get the total number grains per cob.

3.14.9 Weight of grains cob^{-1} (g) and 100 seed weight (g)

Firstly, the threshed grains of each cob was taken in paper bags and kept in an oven at 60^0C for 24 hours. After drying, the grains from each paper bag were measured using digital electric balance. After that, one hundred cleaned and dried seeds were counted randomly from each of the harvested samples and weighed by using a digital electric balance and the mean weight was expressed in gram.

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

The yield per hectare was computed by converting the yield per plant to yield per hectare by using the following relation:

Yield per hectare = {(mean grain yield per plant x 83000) ÷ 1000 ÷1000} [83000 plants stand when planting spacing is maintained to 60cm × 20cm *(Adeboyee et al., 2006)*]

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

After separating cobs from the selected plants each of the palnts were dried and weight was taken using electric balance. After that the stover yield of the mean dry weight value of the five plants was derived by using the followimg formula:

Stover Yield = {(mean dry weight of shoot excluding cob × 83000) ÷1000÷1000} [83000 plants stand when planting spacing is maintained to 60cm × 20cm *(Adeboyee et al., 2006)*]

3.14.12 Harvest Index (%)

It denotes the ratio of grain yield to biological yield and is expressed in percentage. The following formula was used to calculate harvest index:

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

3.15 Statistical analysis

The data recorded on different parameters were tabulated as per block laid out in the experimental field. The analyses of variance were done following RCBD (factorial) with the help of a computer package program Statistix-10. The mean values were compared using LSD at 5% level of significance.

CHAPTER IV

RESULTS AND DISCUSSION

The results obtained from the study have been presented, discussed and explained in this chapter through different tables, graphs and appendices. The possible interpretation has also been given under the following headings:

4.1 Weed Parameters

Effect of variety on weed parameters

Figure 1 shows the effect of variety on weed parameters. From the experiment it was found that though there was a numerical difference between the varieties in terms of weed parameters but the difference was not statistically similar. Higher weed population (118.33 no. m^{-2}) and weed biomass (74.42 g m^{-2}) was found from V_1 as compared to that of V_2. On the other hand, the maximum weed control efficiency (46.32%) was recorded from V_2 as compared to that of V_1 (44.92%). This finding was very close to the findings of Mannan (2018).

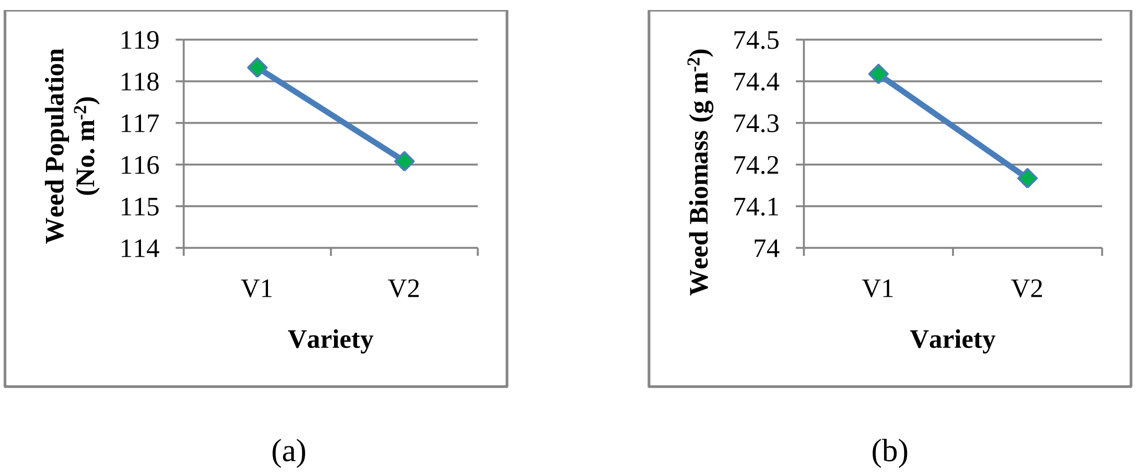
Effect of weed control treatments on weed parameters

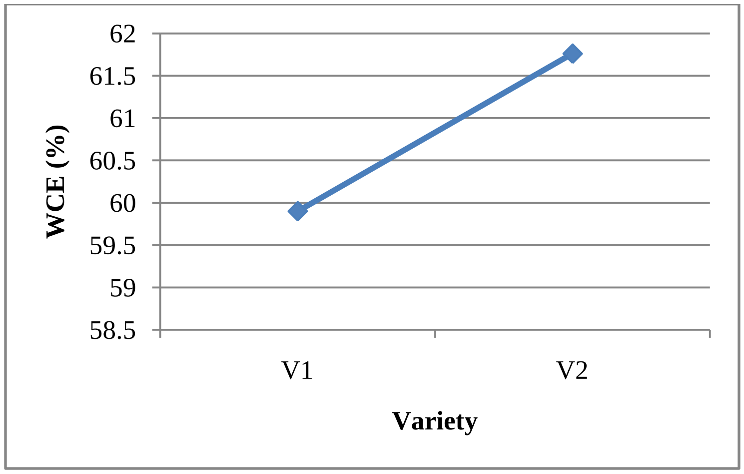
The weed community of the experimental field was comprised of *Eleusine indica, Cyperus rotundus, Cynodon dactylon, Jussiaea repens, Commelina benghalensis, Physalis heterophylla*, *Desmodium trifolia*, *Brassica kaber.* Among the weed species, *Eleusine indica* was of most abundant one counting more than fifty percent of total weed community were present in per square meter of the experimental field. From the experiment it was revealed that the T_3 (Weed free after 40 DAS) treated plots showed supreme result regarding reduced weed density (12.17 no. m^{-2}), minimum weed biomass (4.33 g m^{-2}) and weed control efficiency (94.38%) and it was follwed by T_2 (two hand weeding at 40 DAS and 60 DAS) (Table 2). However, T_0 gave the worst result giving the highest weed density in terms of both weed number and biomass per meter square. All the four treatments were significantly different from each other in terms of weed density (no. m^{-2}), weed biomass (g m^{-2}) and weed control efficiency. This finding can be thrust to the findings of Abdullahi *et al*. (2016) and Mannan (2018).

Table 2. Effect of weed control treatments on weed density, biomass and weed control efficiency at harvest

Treatments	Weed density (No. m^{-2})	Weed biomass (g m^{-2})	WCE (%)
T_0	216.00 a	153.17 a	0.00 d
T_1	154.83 b	96.33 b	27.94 c
T_2	85.83 c	43.33 c	60.16 b
T_3	12.17 d	4.33 d	94.38 a
$LSD_{(0.05)}$	**13.58**	**8.21**	**4.99**
CV (%)	**9.36**	**8.93**	**8.83**

T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS.





(c)

V_1= YANGNUO-3000, V_2= PSC-121 ($LSD_{0.05}$= 9.60, 5.80 and 3.52 for a, b and c respectively)

Fig. 1. Effect of variety on weed parameters [(a): Weed Population (no. m^{-2}); (b): Weed Biomass (g m^{-2}); (c): Weed Control Efficiency (WCE%)]

Interaction effect of variety and weed control treatments on weed parameters

Interaction effect of variety and weed control treatments are presented in the Table 3. Statistically significant difference among the treatment means was recorded. From the experiment it was observed that V_2T_0 showed the maximum weed density (211.67 no. m^{-2}) and it was statistically similar with that of V_1T_0. However, the lowest weed density (11.67 no. m^{-2}) was recorded from V_1T_3. In case of weed biomass, the highest result (153.33 g m^{-2}) was recorded from V_1T_0 whereas the lowest one was recorded from V_1T_3 and V_2T_3 simultaneously. On other hand, the highest weed control efficiency (94.72%) was recorded from V_2T_3 which aws statistically similar with that of V_1T_3. This finding was in line with the findings of Abdullahi *et a*l. (2016).

Table 3. Interaction effect of variety and weed control treatments on weed parameters

Treatments	Weed density ($No.m^{-2}$)	Weed biomass ($g\ m^{-2}$)	WCE (%)
V_1T_0	220.33 a	153.33a	0.0000d
V_1T_1	157.67 b	99.33b	27.516c
V_1T_2	83.67 c	40.67c	58.132b
V_1T_3	11.67 d	4.33d	94.043a
V_2T_0	211.67 a	153.00a	0.0000d
V_2T_1	152.00 b	93.33b	28.366c
V_2T_2	88.00 c	46.00c	62.193b
V_2T_3	12.67 d	4.33d	94.720a
$LSD_{(0.05)}$	**19.20**	**11.61**	**7.05**
CV (%)	**9.36**	**8.93**	**8.83**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.2 Growth parameters

4.2.1 Plant height (cm)

Effect of variety on plant height (cm)

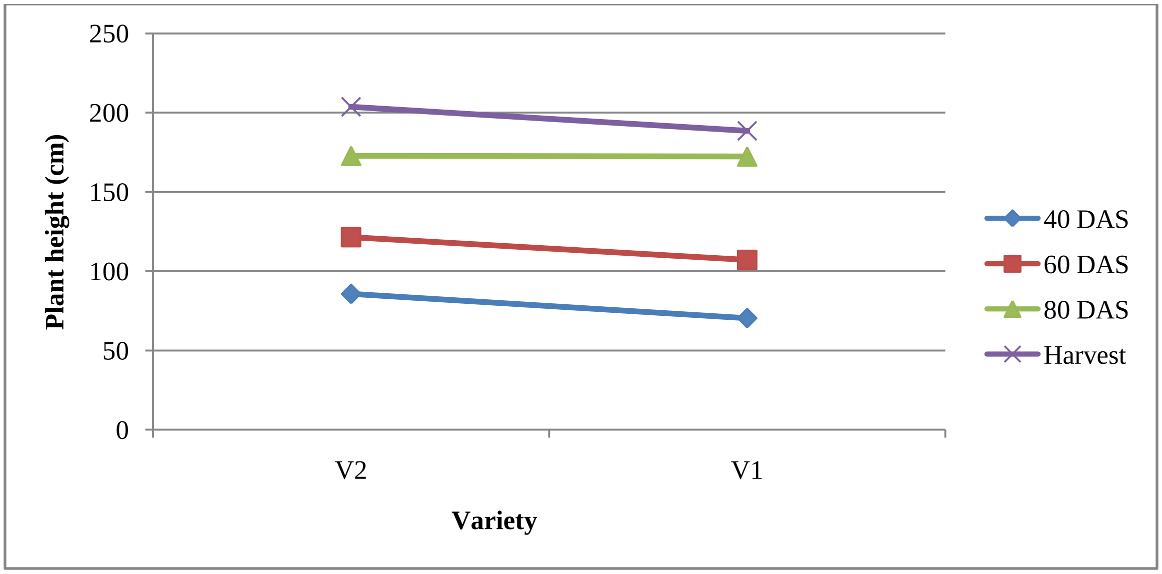
Figure 2 shows the effect of variety on plant height. From the experiment it was found that the varieties have a significant effect on plant height at all four stages except 80 DAS. In all four stages (40, 60, 80 DAS and at harvest) V_2 showed the highest plant height (85.627 cm, 121.38cm, 172.75 cm and 203.68 cm at 40, 60, 80 DAS and at harvest respectively) over V_1 which showed plant height of 70.449 cm, 107.12 cm, 172.35 cm and 188.58 cm at 40, 60, 80 DAS and at harvest respectively. This finding can be thrust to that of Ullah *et al.* (2017) who reported very closer plant height in white maize variety Suvra.

Effect of weed control treatments on plant height (cm)

Influence of weed control treatments on plant height is shown on the Figure 3. The highest plant heights (83.00 cm, 121.25cm, 180.33cm and 204.03 cm at 40, 60, 80 DAS and at harvest respectively) were recorded from T_3 followed by T_2 (80.204 cm, 116.25cm, 176.83cm and 197.57 cm at 40, 60, 80 DAS and at harvest respectively). Both T_3 and T_2 were statistically similar to each other. The lowest plant heights (72.675 cm, 106.85cm, 156.92 cm, and 188.89 cm at 40, 60, 80 DAS and at harvest respectively) were recorded from T_0 and it was statistically similar with T_1 at all four stages except 80 DAS. Similar fashion of plant height increase was reported by Deewana *et al.* (2017).

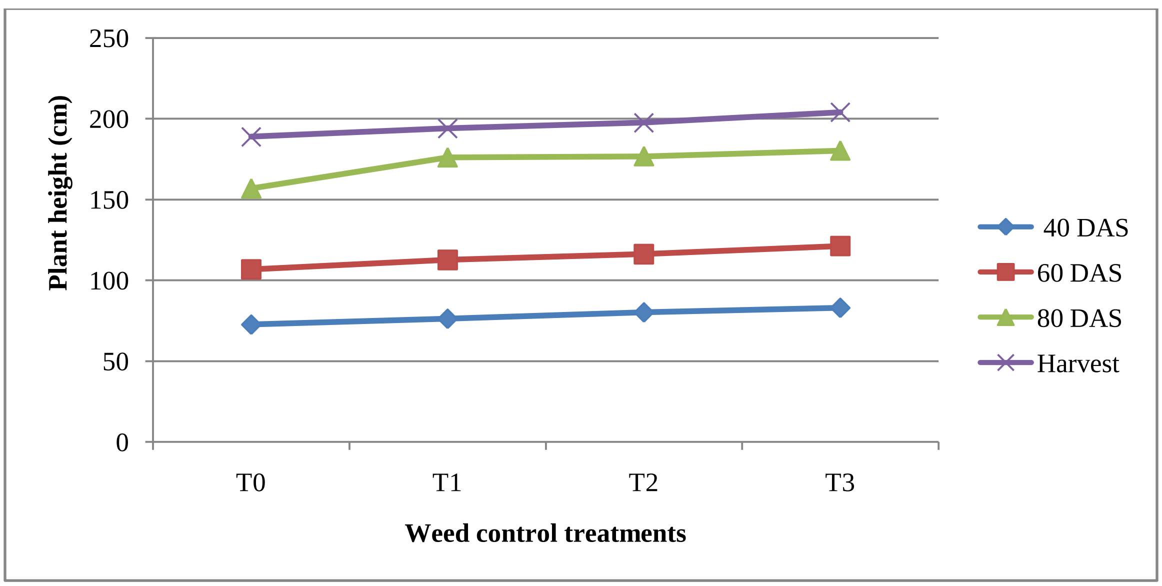
Interaction effect of variety and weed control treatments on plant height (cm)

Interaction effect of variety and weed control treatments are listed in the Table 4. No significant difference among the means was recorded. In case of plant height at 40 DAS and at harvest, the highest (90.89 cm and 217.00 cm respectively) and the lowest (63.23 cm and 176.58 cm respectively) plant height was found from V_2T_3 and V_1T_0. While, the maximum and the minimum plant height of 128.5 (V_2T_1) cm and 96.83 cm (V_1T_1) respectively were recorded at 60 DAS. In case of 80 DAS, V_2T_3 showed the highest plant heigh (184.00 cm) and V_2T_0 showed the lowest plant height of 150.00 cm. This result was in line with that of Deewan *et al.* (2017).



V_1= YANGNUO-3000, V_2= PSC-121 ($LSD_{0.05}$= 3.60, 7.92, 9.27 and 9.80 at 40, 60, 80 and harvest respectively)

Fig. 2. Effect of variety on plant height (cm)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$= 5.09, 11.20, 13.12 and 13.86 at 40, 60, 80 and harvest respectively)

Fig. 3. Effect of weed control treatments on plant height (cm)

Table 4. Interaction effect of variety and weed control treatments on plant height (cm)

Treatment combination	Plant height (cm)			
	40 DAS	**60 DAS**	**80 DAS**	**At harvest**
V_1T_0	63.239 e	110.83 b-d	163.83 bc	176.58 c
V_1T_1	68.667 de	96.83 d	176.57 ab	194.00 bc
V_1T_2	74.778 d	104.83 cd	172.33 ab	192.67 bc
V_1T_3	75.111 cd	116.00 a-c	176.67 ab	191.07 bc
V_2T_0	82.111 bc	102.87 cd	150.00 c	201.20 ab
V_2T_1	83.874 ab	128.50 a	175.67 ab	194.07 bc
V_2T_2	85.630 ab	127.67 a	181.33 ab	202.47 ab
V_2T_3	90.894 a	126.50 ab	184.00 a	217.00 a
$LSD_{(0.05)}$	**7.20**	**15.84**	**18.55**	**19.60**
CV (%)	**5.27**	**7.92**	**6.14**	**5.71**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.2.2 Leaf number plant^{-1}

Effect of variety on leaf number plant^{-1}

Figure 4 represents the effect of variety on leaf number per plant. From the experiment it was found that there was significant difference between varieties regarding leaf number per plant at 60 DAS and at harvest. At 40 and 80 DAS the parameter was not significant between varieties. The maximum leaf number per plant (4.75, 11.04, 12.5 and 13.29 at 40, 60, 80 DAS and at harvest respectively) was recorded from $V_2$and the lowest result was obtained from V_1 (4.611, 8.75, 111.83 and 12.4 at 40, 60, 80 DAS and harvest respectively). The result was in line with that of of Ullah *et al*. (2017).

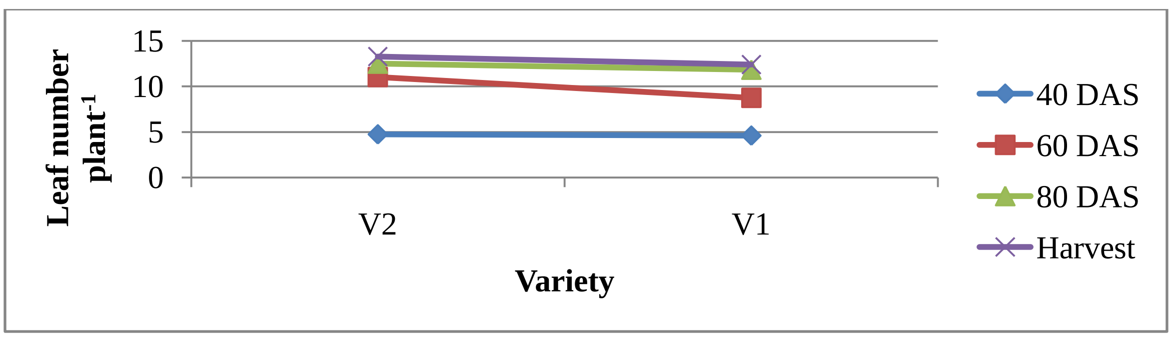
Effect of weed control treatments on leaf number plant^{-1}

Influence of different weed control treatments are shown in the Figure 5. There was no significant difference among the weed control treatments regarding leaf number per plant.

The highest leaf number per plant (4.77, 10.75, 12.33 and 13.03 at 40, 60, 80 DAS and at harvest respectively) was recorded from T_3 followed by T_2. The lowest outcome (4.61, 9.41, 12, 12.73 at 40, 60, 80 DAS and at harvest respectively) was recorded from T_0. This finding was in line with that of Imoloame and Omolaiye (2017).

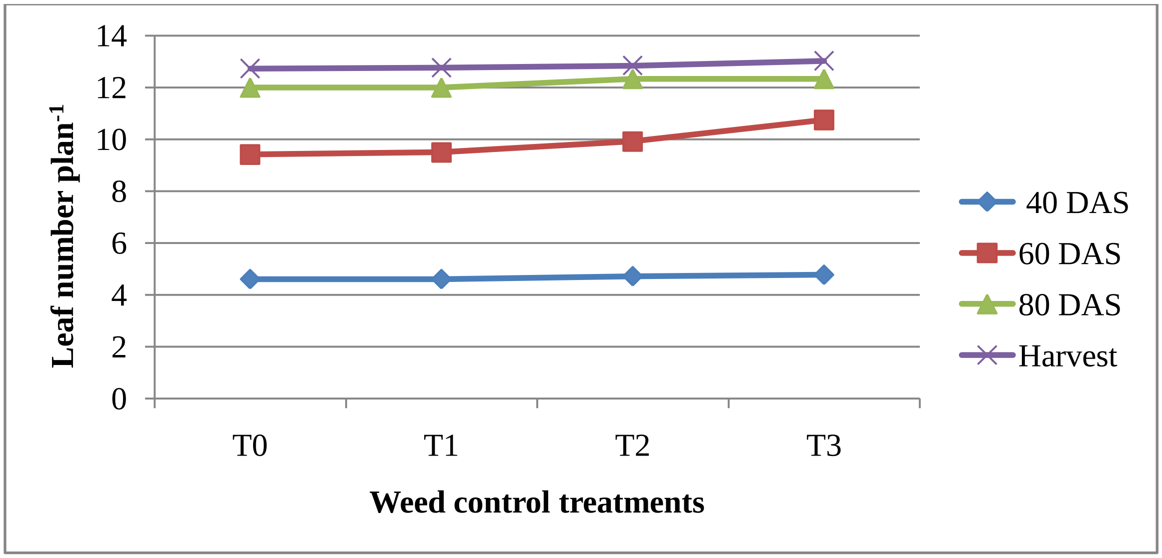
Interaction effect of variety and weed control treatments on leaf number plant^{-1}

Table 5 shows the interaction effect of variety and plant height on leaf number per plant. From the experiment it was found that there was no significant difference among the interaction regarding leaf number per plant in all four stages except 60 DAS. The maximum number of leaf per plant (5.00, 12.17 and 12.67) at 40, 60 and 80 DAS respectively from V_2T_3 while, at harvest, the maximum number of leaf per plant was recorded from V_2T_1 (13.67). The minimum number of leaf per plant was recorded from V_1T_0 (4.44 and 7.67 at 40 and 60 DAS respectively) and V_1T_1 (11.33 and 11.87 at 80 DAS and at harvest respectively). This finding was in line with that of Imoloame and Omolaiye (2017).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$= 0.38, 0.88, 0.79 and 0.64 at 40, 60, 80 and harvest respectively)

Fig. 4. Effect of variety on leaf number plant^{-1}



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$= 0.55, 1.24, 1.12 and 0.90 at 40, 60, 80 and harvest respectively)

Fig. 5. Effect of weed control treatments on leaf number plant^{-1}

Table 5. Interaction effect of variety and weed control treatments on leaf number plant^{-1}

Treatment combination	Leaf number plant^{-1}			
	40 DAS	**60 DAS**	**80 DAS**	**At harvest**
V_1T_0	4.44 a	7.66 e	12.00 a	12.40 ab
V_1T_1	4.56 a	9.00 de	11.33 a	11.86 b
V_1T_2	4.89 a	9.00 de	12.00 a	12.46 ab
V_1T_3	4.56 a	9.33 c-e	12.00 a	12.86 ab
V_2T_0	4.78 a	11.16 ab	12.00 a	13.06 ab
V_2T_1	4.67 a	10.00 b-d	12.67 a	13.66 a
V_2T_2	4.56 a	10.83 a-c	12.67 a	13.23 a
V_2T_3	5.00 a	12.16 a	12.67 a	13.20 a
$LSD_{(0.05)}$	**NS**	**1.76**	**NS**	**1.28**
CV (%)	**9.50**	**10.20**	**7.48**	**5.70**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.2.3 Leaf area plant^{-1} (m^2)

Effect of variety on leaf area plant^{-1} (m^2)

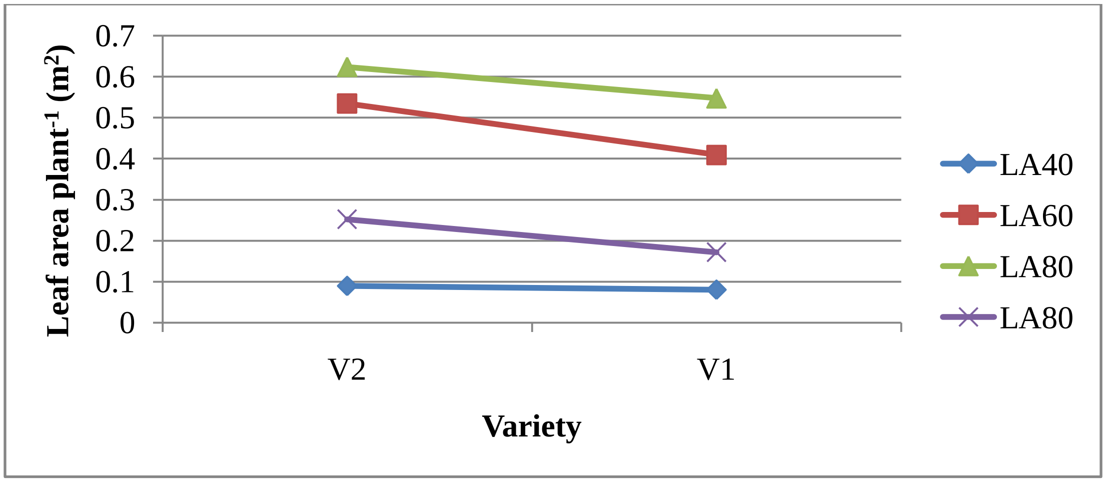
Figure 6 shows the effect of variety on leaf area plant^{-1}. In all for stages (60, 80,100 DAS and harvest), there was a significant difference between two varieties in terms of leaf area plant^{-1}. V_2 showed the highest leaf area plant^{-1} (0.0896 m^2, 0.5344 m^2, 0.6239 m^2 and 0.2522 m^2 at 40, 60, 80 DAS and at harvest respectively) over V_1 which showed the leaf area plant^{-1} of 0.0804 m^2, 0.4093 m^2, 0.5475 m^2 and 0.1718 m^2 at 40, 60, 80 DAS and at harvest respectively. This finding was in line with that of Imoloame and Omolaiye (2017) who stated the similar pattern of leaf area increase in 60 and 80 DAS.

Effect of Weed control measures on leaf area plant^{-1} (m^2)

Influence of weed control treatments on leaf area is shown on the Figure 7.The highest leaf area plant^{-1} (0.0961 m^2, 0.5533 m^2, 0.6630 m^2 and 0.2453 m^2 at 40, 60, 80 DAS and at harvest respectively) was recorded from T_3 followed by T_2 (0.0931 m^2, 0.4926 m^2, 0.6558 m^2 and 0.2312 m^2 at 40, 60, 80 DAS and at harvest respectively). Both T_3 and T_2 were statistically similar to each other. The lowest leaf area plant^{-1} (0.0708 m^2, 0.4104 m^2, 0.4890 m^2 and 0.1746 m^2 at 40, 60, 80 DAS and at harvest respectively) was recorded from T_0 and there was statistically significant difference between T_0 and T_2. This result can be thrust to that of Imoloame and Omolaiye (2017).

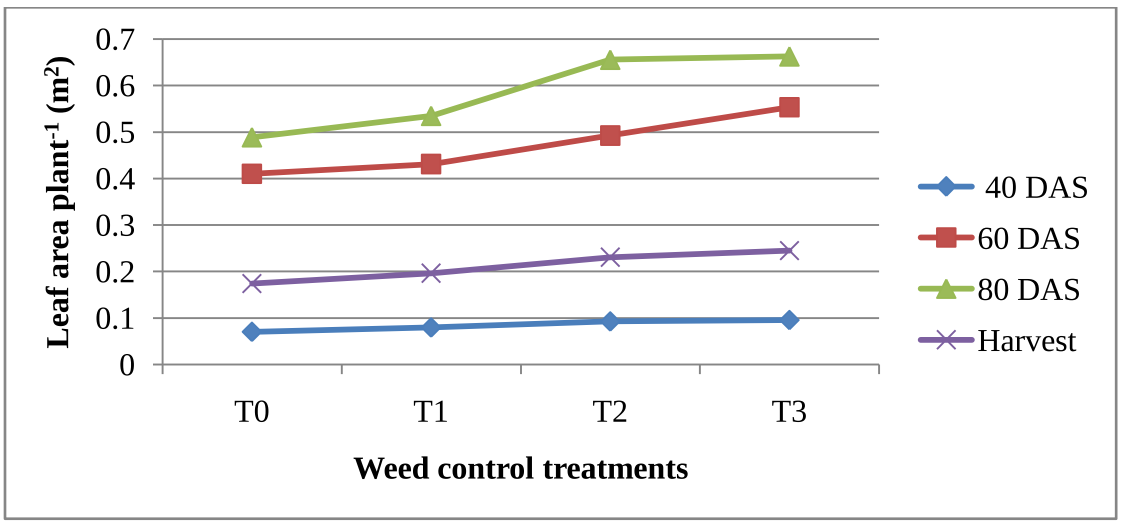
Interaction effect of variety and weed control treatments on leaf area plant^{-1} (m^2)

Interaction effect of variety and weed control treatments is shown in the Table 6. From the experiment it was found that there was no significant difference among different interaction in terms of leaf area plant^{-1} irrespective of numerical difference. The highest leaf area plant^{-1} was recorded from V_2T_3 (0.1005 m^2, 0.5849 m^2 and 0.2908 m^2 at 40 DAS, 60 DAS and at harvest respectively) whereas leaf area plant^{-1} of 0.7067 m^2 was reported from V_2T_2 at 80 DAS. The lowest leaf area (0.0656 m^2, 0.2726 m^2, 0.4270 m^2 and 0.1375 m^2) was recorded from V_1T_0 at 40, 60, 80 DAS and at harvest respectively. This finding was similar with that of Imoloame and Omolaiye (2017) who reported the similar trend in leaf area increase over time.



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$= 0.01, 0.05, 0.03 and 0.01 at 40, 60, 80 and harvest respectively)

Fig. 6. Effect of variety on leaf area plant^{-1} (m^2)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$= 0.01, 0.07, 0.05 and 0.01at 40, 60, 80 and harvest respectively)

Fig. 7. Effect of weed control treatments on leaf area plant^{-1} (m^2)

Table 6. Interaction effect of variety and weed control treatments on leaf area plant^{-1} (m^2)

Treatment combination	Leaf area plant^{-1} (m^2)			
	40 DAS	**60 DAS**	**80 DAS**	**At harvest**
V_1T_0	0.065 d	0.272 d	0.427 e	0.137 d
V_1T_1	0.073 cd	0.394 c	0.493 de	0.145 d
V_1T_2	0.090 ab	0.448 bc	0.6049bc	0.204 c
V_1T_3	0.091 a	0.521 ab	0.665 ab	0.199 c
V_2T_0	0.075 b-d	0.548 ab	0.551 cd	0.211 c
V_2T_1	0.086 a-c	0.467 bc	0.577 c	0.248 b
V_2T_2	0.095 a	0.536 ab	0.706 a	0.257 b
V_2T_3	0.100 a	0.584 a	0.660 ab	0.290 a
$LSD_{(0.05)}$	**0.01**	**0.11**	**0.07**	**0.02**
CV (%)	**10.04**	**13.58**	**7.51**	**6.53**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.2.4 Stem base circumference

Effect of variety on stem base circumference (cm)

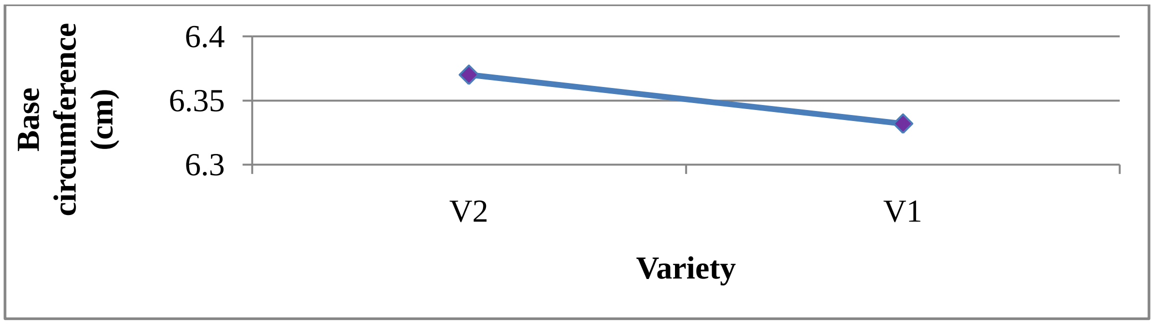
Figure 8 shows the effect of variety on stem base circumference. There was no significant difference between two varieties in terms of stem base circumference. V_2 showed the higher stem base circumference 6.37 cm over V_1 which showed the stem base circumference of 6.33 cm. This finding can be thrust to that of Ullah *et al.* (2017) who reported maximum stem base circumference from the white maize variety Suvra.

Effect of weed control measures on stem base circumference (cm)

Influence of weed control treatments on stem base circumference is shown on the Figure 9.The stem base circumference (6.52 cm) was recorded from T_3 followed by T_2 (6.34 cm). The lowest leaf area (6.25 cm) was recorded from T_0. There was no statistically significant difference among the weed control treatments. The closer finding was reported by Iderawumi and Friday (2018) and Olatunji *et al.* (2016)

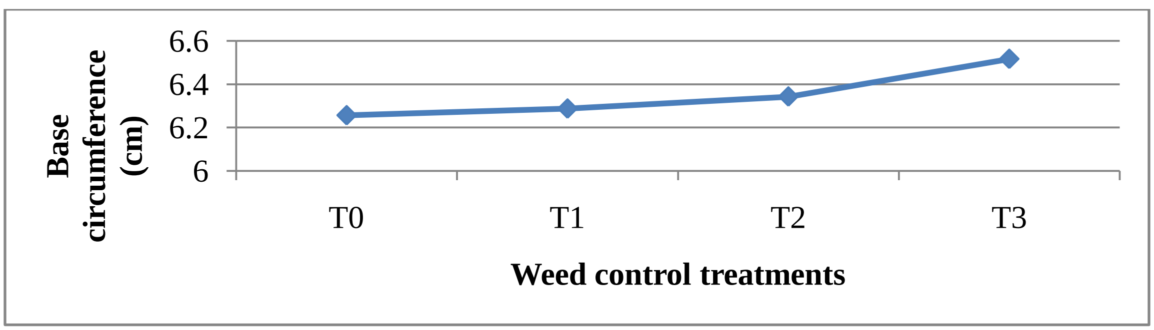
Interaction effect of variety and weed control treatments on stem base circumference (cm)

Interaction effect of variety and weed control treatments is placed in the Table 7. From the experiment it was found that the treatment combinations had no significant effect on stem base circumference. The maximum stem base circumference (6.77 cm) was found from V_2T_2 and the minimum one (6.18 cm) was reported from V_2T_0. This finding can be thrust to that of Olabode and Sangodele (2015).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 0.42)

Fig. 8. Effect of variety on base circumference (cm)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 0.60)

Fig. 9. Effect of weed control treatments on base circumference (cm)

Table 7. Interaction effect of variety and weed control treatments on stem base circumference (cm)

Treatment Combinations	Base circumference (cm)
V_1T_0	6.33 ab
V_1T_1	6.67ab
V_1T_2	5.91ab
V_1T_3	6.40 ab
V_2T_0	6.18ab
V_2T_1	5.90 b
V_2T_2	6.76 a
V_2T_3	6.63 ab
$LSD_{(0.05)}$	**0.85**
CV (%)	**7.67**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.2.5 Cob setting node position from ground

Effect of variety on position of cob setting node from ground

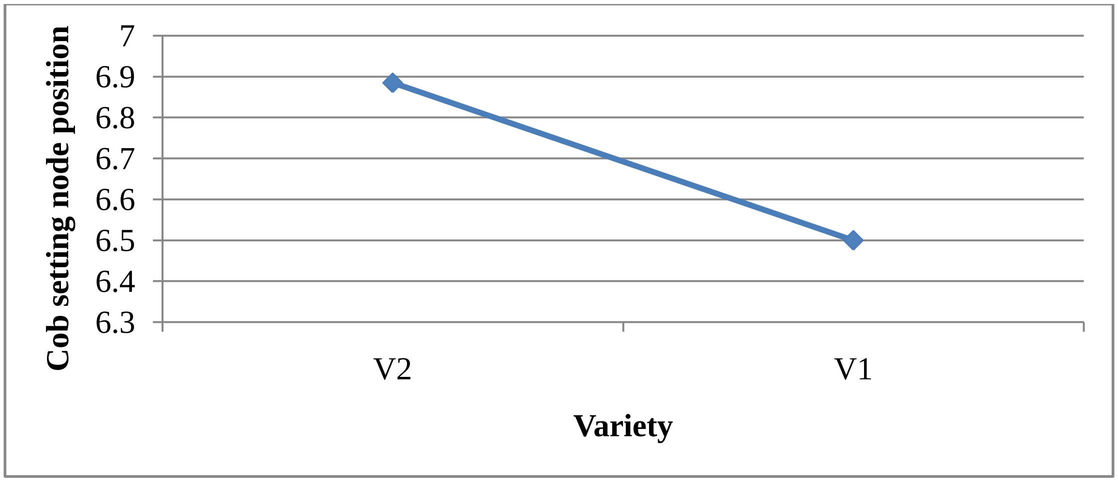
Effect of variety on cob setting node position is given in the Figure 10. From the experiment it was found that the varieties have significant effect on the cob setting node position. In case of V_1, the cob was set to the 6.8847 (7^{th}) node while it was about 6.50 (6^{th}) in case of V_2 referring that cobs in V_1 set to higher positioned node than that of V_2. This finding was similar with that of Ullah *et al.* (2017) who also showed that the cob in white maize variety Suvra set to the 7^{th} node.

Effect of weed control measures on position of cob setting node from ground

Figure 11 shows the effect of weed control treatments on position of cob setting node from ground. From the experiment it was revealed that though there was slight numerical difference among the weed control treatments regarding position of cob setting node from ground but it was not significant statistically. However, the highest cob setting node position ($6.76 \approx 7^{th}$) was recorded from T_3 while the lowest one ($6.63 \approx 7^{th}$) was recorded from T_0. This result was at par with that of Ullah *et al.* (2017).

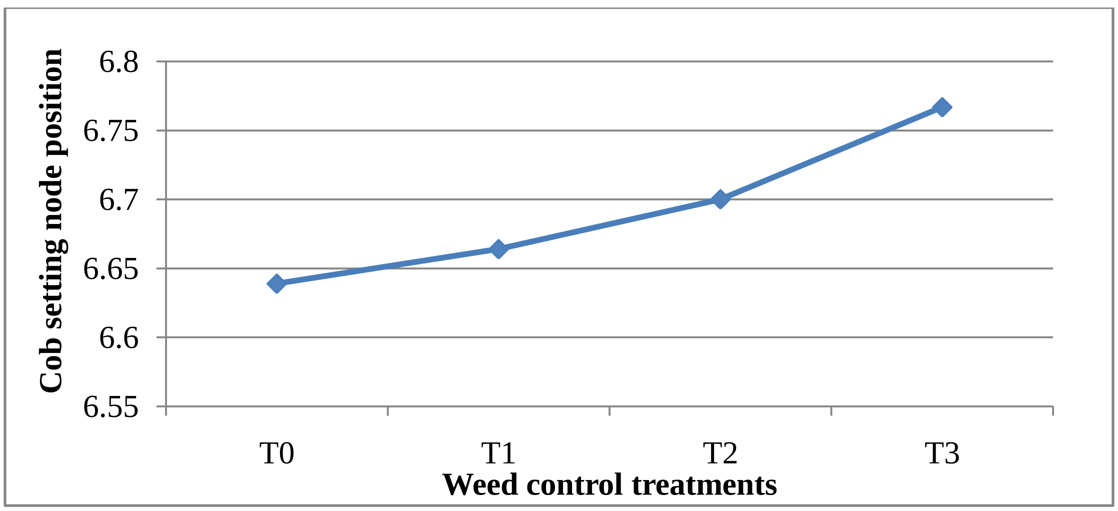
Interaction effect of variety and weed control treatments on position of cob setting node from ground

Interaction effect of variety and weed control treatments on position of cob setting node from ground is placed in the table 8. From the experiment it was found that the treatment combinations had no significant on stem base circumference. For more than 50% of the combinations cob was set to the 7^{th} node from ground. The highest cob setting node position ($7.14 \approx 7^{th}$) was reported from V_2T_0 following V_2T_3 and V_2T_2. The similar pattern of cob setting node position from ground was reported by Ullah *et al.* (2017) while conducting experiment on comparing modern varieties of white maize with landraces in Bangladesh: phenotypic traits and plant characters.



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 0.37)

Fig. 10. Effect of variety on position of cob setting node from ground



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 0.52)

Fig. 11. Effect of weed control treatments on position of cob setting node from ground

Table 8. Interaction effect of variety and weed control treatments on position of cob setting node from ground

Treatment Combinations	Cob setting node position (Nos.)
V_1T_0	6.13 a
V_1T_1	6.86 ab
V_1T_2	6.53 ab
V_1T_3	6.46 ab
V_2T_0	7.14 a
V_2T_1	6.46 ab
V_2T_2	6.86 ab
V_2T_3	7.06 a
$LSD_{(0.05)}$	**0.74**
CV (%)	**6.37**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3 Yield parameters

4.3.1 Cob length (cm)

Effect of variety on cob length (cm)

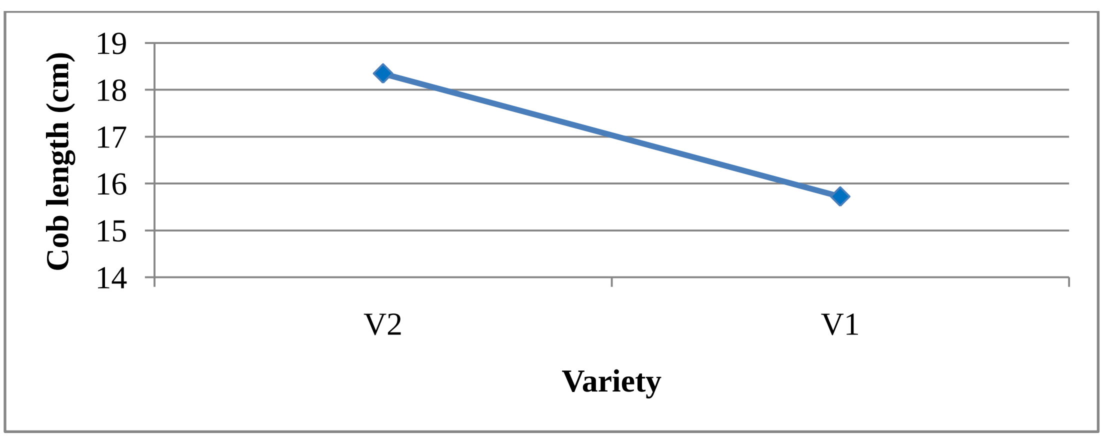
Effect of variety on cob length is shown in the Figure 12. A statistically significant difference between varieties was revealed regarding cob length. The maximum cob length (18.349 cm) was reported from V_2 over V_1 which showed the cob length of about 15.727 cm. All most similar figure of cob length was reported by Kebede and Anbasa (2017).

Effect of weed control measures on cob length (cm)

Figure 13 shows the effect of weed control treatments on cob length. From the experiment it was revealed that T_3 is the best treatment giving 17.948 cm long cob which was followed by T_2 producing cob of about 17.625 cm. However, T_3 and T_2 were statistically similar with each other. The lowest length of cob (15.90 cm) was recorded from T_0. There was a statistical difference of T_0 with T_3 and T_2. The result was similar with that of Olabode and Sangodele (2015).

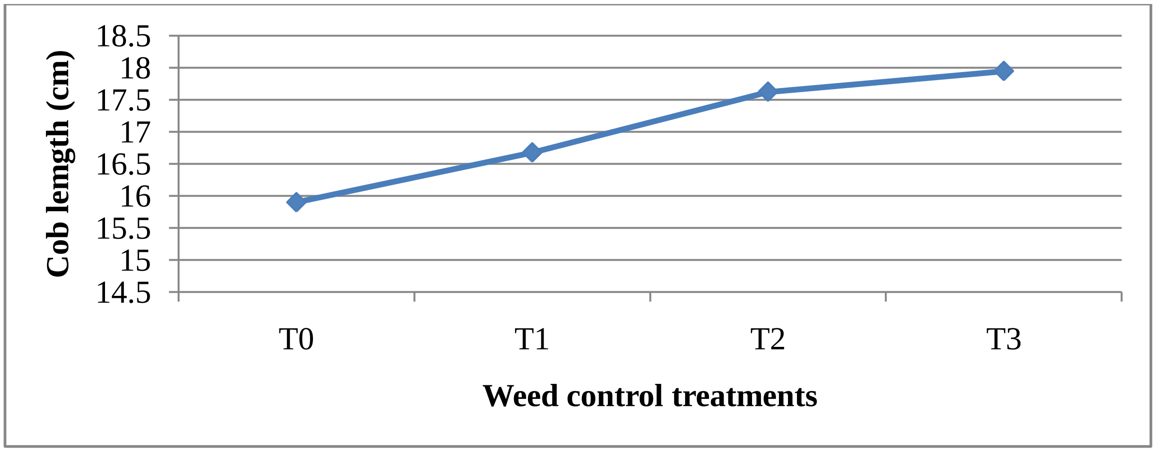
Interaction effect of variety and weed control treatments on cob length (cm)

Interaction effect of variety and weed control treatments on cob length is placed in the Table 9. The maximum cob length of about 18.82 cm was recorded from V_2T_3 and it was followed by V_2T_2 (18.38 cm). However, V_2T_3 and V_2T_2 were statistically similar with each other. The lowest value of cob length was recorded from V_1T_0 (13.77 cm). There was a statistically significant difference of V_1T_0 with V_2T_3 and V_2T_2. The result was at par with that of Subbulakshmi *et al.* (2009) who also found the very closer value of cob length (16.1 cm).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 0.57)

Fig. 12. Effect of variety on cob length (cm)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS ($LSD_{0.05}$ = 0.80)

Fig. 13. Effect of weed control treatments on cob length (cm)

Table 9. Interaction effect of variety and weed control treatments on cob length (cm)

Treatment Combinations	Cob length (cm)
V_1T_0	13.767 e
V_1T_1	15.200 d
V_1T_2	16.867 c
V_1T_3	17.073 bc
V_2T_0	18.033 ab
V_2T_1	18.156 ab
V_2T_2	18.383 a
V_2T_3	18.822 a
$LSD_{(0.05)}$	**1.14**
CV (%)	**3.82**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3.2 Number of grain row cob^{-1}

Effect of variety on number of grain row cob^{-1}

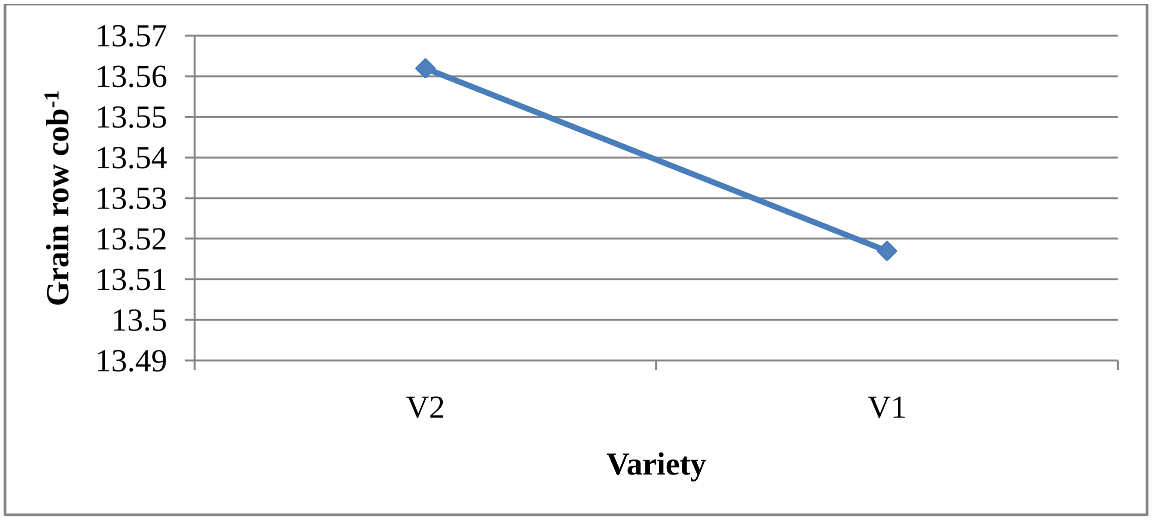
Effect of variety on number of grain row per cob is shown in the Figure 14. The experiment revealed that there was no significant statistical difference between varieties. V_2 showed more number of grain row per cob (13.56) over V_1 (13.51). This result was at par with that of Akbar *et al.* (2016) who also reported the maximum number of grain row per cob from PSC-121 (V_2).

Effect of weed control measures on number of grain row cob^{-1}

Effect of weed control treatments on number of grain row per cob is shown in the Figure 15. The experiment revealed that there was no significant statistical difference among weed control treatments irrespective of numerical difference among treatments. T_3 showed the maximum number of grain row per cob (14.00) and it was followed by T_2 (13.61). The minimum number of grain row per cob was reported from T_0 (12.97). This result was at par with that of Kebede and Anbasa (2017) who reported 14.64 grain row per cob.

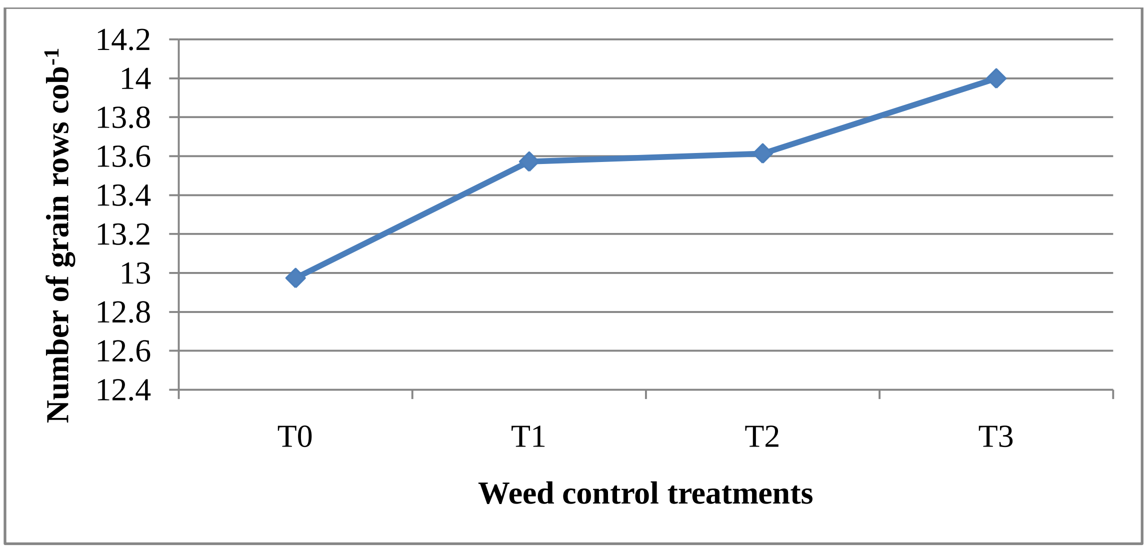
Interaction effect of variety and weed control treatments on number of grain row cob^{-1}

Interaction effect of variety and weed control treatments on grain row per cob is placed in the Table 10. The experiment revealed that there was no significant statistical difference among weed control treatments irrespective of numerical difference among treatments. V_1T_3 showed the maximum number of grain row per cob (14.26) and it was followed by V_2T_1 (14.13). The minimum number of grain row per cob was reported from V_2T_0 (12.87). This result was at par with that of Kebede and Anbasa (2017) who reported 14.64 grain row cob^{-1}.



V_1= YANGNUO-3000, V_2= PSC-121(LSD$_{0.05}$ = 0.69)

Fig. 14. Effect of variety on number of grain row cob^{-1}



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. (LSD$_{0.05}$ = 0.97)

Fig. 15. Effect of weed control treatments on number of grain row cob^{-1}

Table 10. Interaction effect of variety and weed control treatments on number of grain row cob^{-1}

Treatment Combinations	Number of grain row per cob
V_1T_0	13.080 ab
V_1T_1	13.011 ab
V_1T_2	13.711 ab
V_1T_3	14.267 a
V_2T_0	12.867 b
V_2T_1	14.133 ab
V_2T_2	13.517 ab
V_2T_3	13.733 ab
$LSD_{(0.05)}$	**1.38**
CV (%)	**5.83**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3.3 Number of grains cob^{-1}

Effect of variety on number of grains cob^{-1}

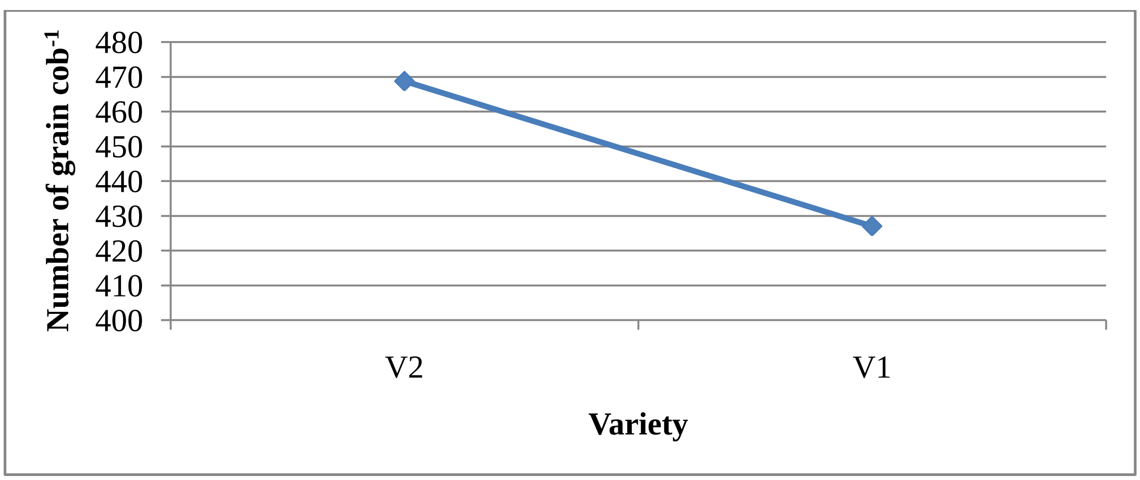
Variety has a great impact on the number of grains per cob. Effect of variety on number of grains per cob is given the Figure 16. From the experiment it was found that there was significant difference between varieties regarding the number of grains per cob. V_2 showed the maximum number of grains per cob (468.75) over V_1 (427.6). The result was at par with that of Akbar *et al.* (2016) who also reported the similar number of grains per cob from PSC-121 (V_2).

Effect of weed control measures on number of grains cob^{-1}

Figure 17 represents the effect of weed control treatments on number of grains per cob. The highest number of grain per cob was recorded from T_3 (464.54) which was followed by T_2 (461.41). The lowest number of grain per cob was obtained from T_0 (418.53). T_3 and T_2 were statistically significant over T_0. This finding was in line with that of Ali *et al*. (2014) who also reported the highest number of grain per cob from hand weeded plot over the No weeding and other treatment plots.

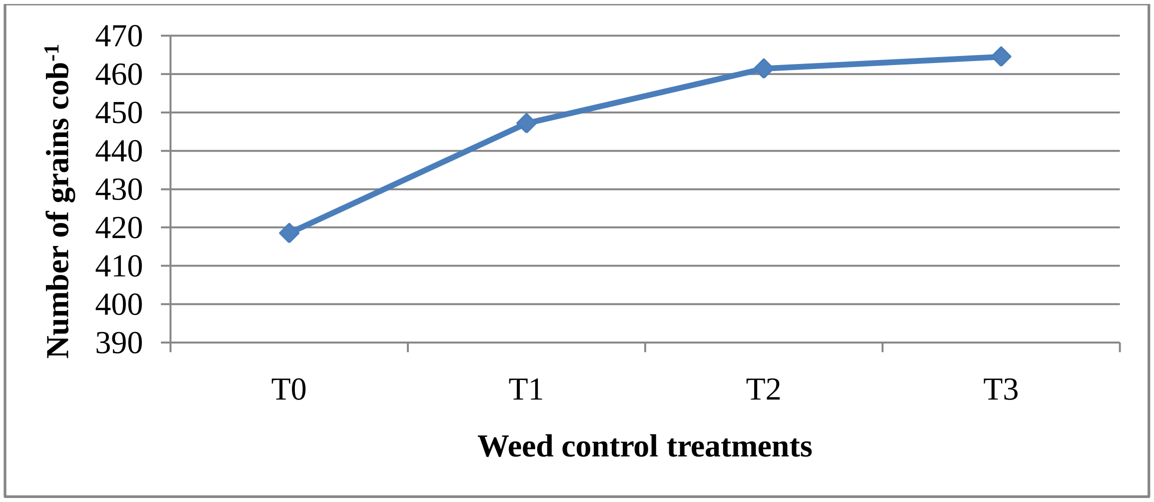
Interaction effect of variety and weed control treatments on number of grain row cob^{-1}

Interaction effect of variety and weed control treatments on grain row per cob is placed in the Table 11. From the experiment it was revealed that the maximum number of grain per cob (494.97) was given by V_2T_3. The second highest value was recorded from V_1T_2 (465.94). However, V_2T_3 and V_1T_2 were statistically similar with each other. The minimum number of grain per cob (375.72) was recorded from V_1T_0. The result was in line with that of Olabode and Sangodele (2015).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 16.793)

Fig. 16. Effect of variety on number of grains cob^{-1}



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 23.74)

Fig. 17. Effect of weed control treatments on number of grain row cob^{-1}

Table 11. Interaction effect of variety and weed control treatments on number of grain row cob^{-1}

Treatment Combinations	Number of grains per cob
V_1T_0	375.72 c
V_1T_1	432.48 b
V_1T_2	465.94 ab
V_1T_3	434.11 b
V_2T_0	461.33 b
V_2T_1	461.82 ab
V_2T_2	456.87 b
V_2T_3	494.97 a
$LSD_{(0.05)}$	**33.58**
CV (%)	**4.28**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3.4 Weight of grains cob^{-1} (g)

Effect of variety on weight of grains cob^{-1} (g)

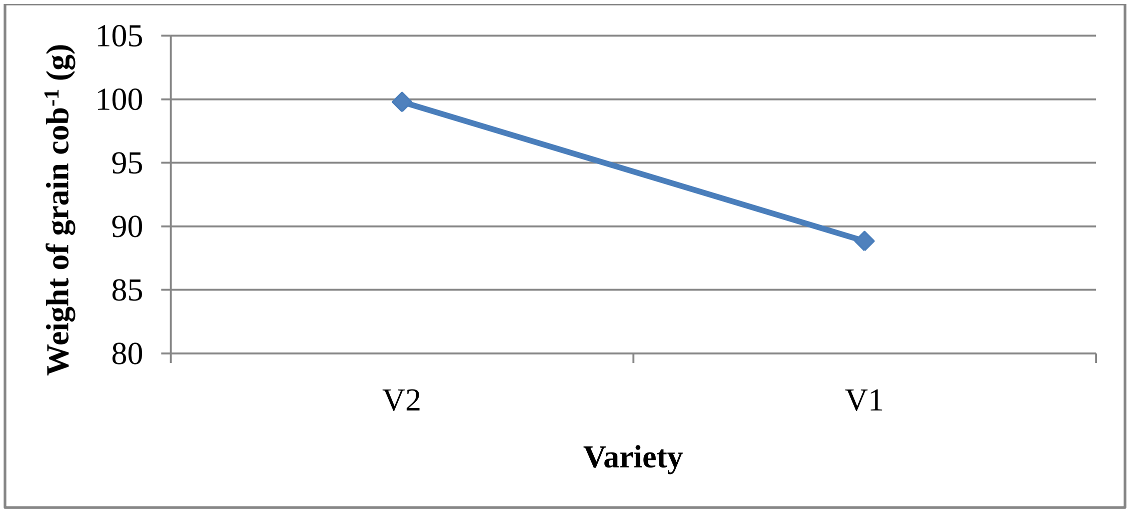
Figure 18 shows the effect of variety on weight of grains per cob. A statistically significant difference between varieties was found regarding the weight of grains per cob. The maximum weight of grains (99.78 g) per cob was found from V_2. V_1 showed the grain weight of about 88.84 g. This finding varied greatly with that of Akbar *et al.* (2016) though he also reported maximum weight of grains per cob from PSC-121 (V_2).

Effect of weed control measures on weight of grains cob^{-1} (g)

Figure 19 represents the effect of weed control treatments on weight of grains per cob. The highest weight of grains per cob was recorded from T_3 (111.44 g) which was followed by T_2 (97.36 g). The lowest number of grain per cob was obtained from T_0 (81.51 g). T_3, T2 and T_0 were statistically different from each other respectively. This finding was in line with that of Imoloame and Omolaiye (2017).

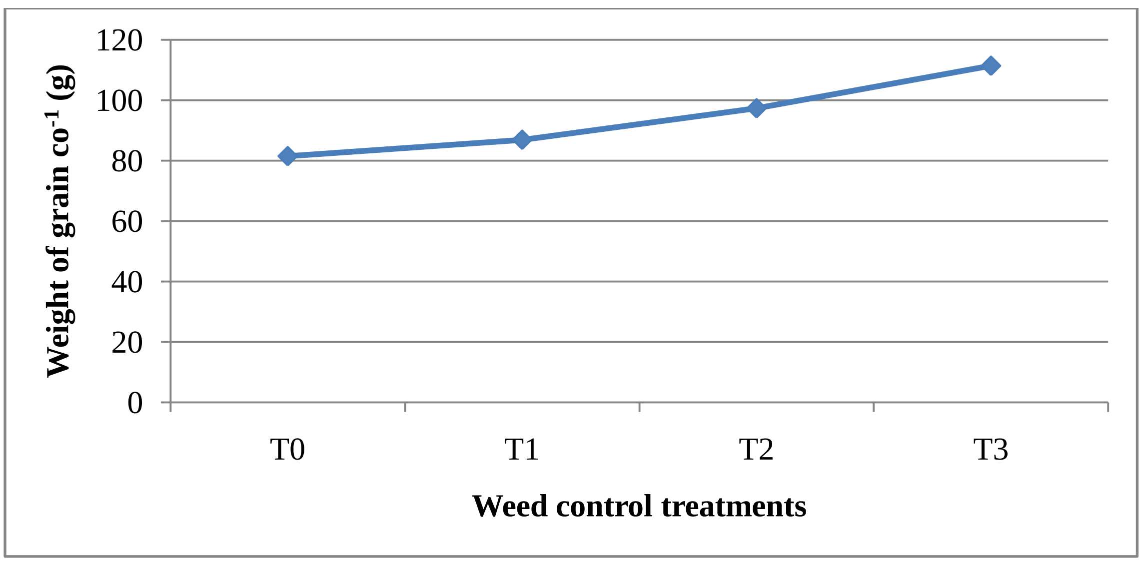
Interaction effect of variety and weed control treatments on weight of grains cob^{-1} (g)

Interaction effect of variety and weed control treatments on weight of grains per cob is placed in the Table 12. From the experiment it was obtained that the maximum number of weight of grains per cob (112.35 g) was given by V_2T_3. The second and third highest result was recorded from V_1T_3 (110.53 g) and V_1T_2 (101.75 g). However, V_2T_3, V_1T_3 and V_1T_2 were statistically similar to each other. The minimum number of grain per cob (66.19) was recorded from V_1T_0. This result can be forwarded to that of Imoloame and Omolaiye (2017).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 6.98)

Fig. 18. Effect of variety on weight of grains cob^{-1} (g)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 9.88)

Fig. 19. Effect of weed control treatments on weight of grains cob^{-1} (g)

Table 12. Interaction effect of variety and weed control treatments on number of grain row cob^{-1}

Treatment Combinations	Weight of grains cob^{-1} (g)
V_1T_0	66.19 d
V_1T_1	76.87 d
V_1T_2	101.75 a-c
V_1T_3	110.53 ab
V_2T_0	96.83 bc
V_2T_1	96.99 bc
V_2T_2	92.96 c
V_2T_3	112.35 a
$LSD_{(0.05)}$	**13.97**
CV (%)	**8.46**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3.5 100 grain weight (g)

Effect of variety on 100 grain weight (g)

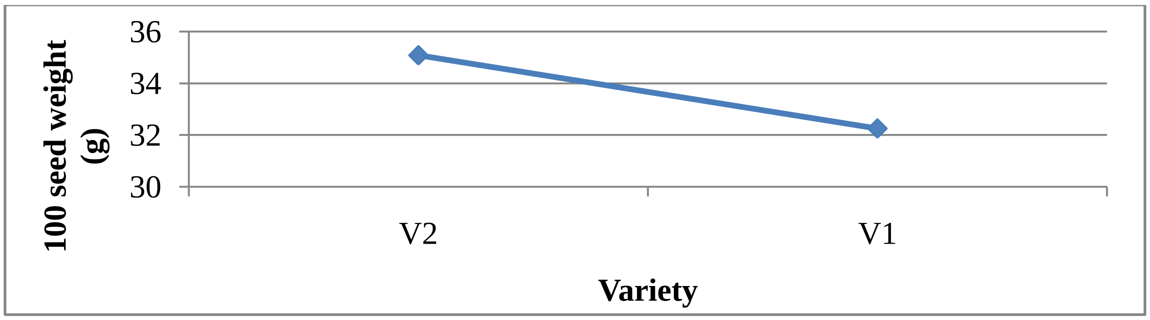
100 grain weight in maize has a direct impact on the crop yield. Figure 20 shows the effect of variety on 100 grain weight. A statistically significant difference between varieties was found regarding the weight of grains per cob. The maximum weight of grains (35.08 g) per cob was found from V_2. V_1 showed the grain weight of about 32.25 g. The result was in line with that of Akbar *et al.* (2016).

Effect of weed control measures on 100 grain weight (g)

Figure 21 represents the effect of weed control treatments on 100 grain weight. From the experiment it was found that the treatments were significant statistically. The highest 100 grain weight was recorded from T_3 (37.0 g) which was followed by T_2 (35.0 g).The lowest number of grain per cob was obtained from T_0 (29.67 g). This finding was almost similar with that of Mannan (2018).

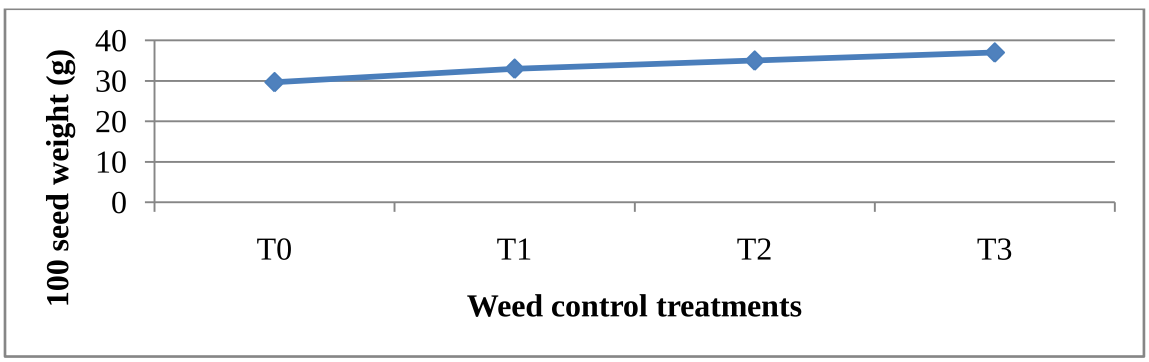
Interaction effect of variety and weed control treatments on 100 grain weight (g)

Interaction effect of variety and weed control treatments on 100 grain weight is placed in the Table 13. From the experiment it was obtained that the maximum number of 100 grain weight (38.0 g) was obtained from V_2T_3 and V_2T_2 simultaneously and they were statistically similar with each other. The minimum number of grain per cob (28.67 g) was recorded from V_1T_0. This finding can be forwarded to the finding of Akbar *et al.* (2016).



V_1= YANGNUO-3000, V_2= PSC-121($LSD_{0.05}$ = 1.39)

Fig. 20. Effect of variety on 100 grain weight (g)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 1.97)

Fig. 21. Effect of weed control treatments on 100 grain weight (g)

Table 13. Interaction effect of variety and weed control treatments on 100 grain weight (g)

Treatment Combinations	100 grain weight (g)
V_1T_0	28.667 e
V_1T_1	32.333 cd
V_1T_2	32.000 cd
V_1T_3	36.000 ab
V_2T_0	30.667 de
V_2T_1	33.667 bc
V_2T_2	38.000 a
V_2T_3	38.000 a
$LSD_{(0.05)}$	**2.79**
CV (%)	**4.74**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

4.3.6 Grain yield (t ha^{-1}) and stover yield (t ha^{-1})

Effect of variety on grain yield (t ha^{-1}) and stover yield (t ha^{-1})

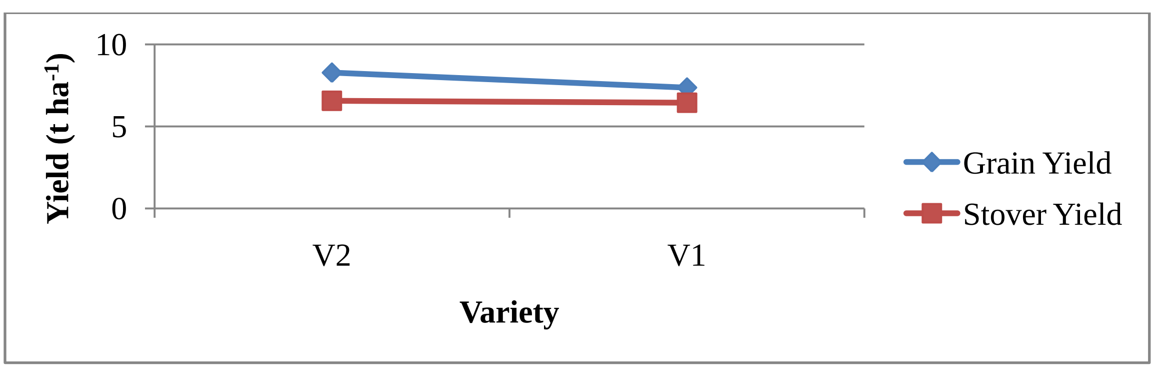
Figure 22 represents the effect of variety on grain and stover yield. In case of grain yield, a significant difference between varieties was found. However, the difference was not significant in case of stover yield. The maximum grain yield (8.28 t ha^{-1}) and stover yield (6.56 tha^{-1}) were recorded from V_2. On the other hand, the minimum grain yield (7.37 t ha^{-1}) and stover yield (6.45 t ha^{-1}) was obtained from V_1. This finding was at par with that of Akbar *et al* (2016) and Nazreen *et al.* (2018).

Effect of weed control measures grain yield (t ha^{-1}) and stover yield (t ha^{-1})

Effect of weed control measures on grain yield (t ha^{-1}) and stover yield (t ha^{-1}) is showed in the Figure 23. In case of grain yield, the best result (9.25 t ha^{-1}) was obtained from T_3 and it was followed by T_2 (8.08 t ha^{-1}). There was a statistically significant difference between T_3 and T_2. On the other hand, the maximum stover yield was given by T_3 (7.46 t ha^{-1}) which was followed by T_2 (6.76 t ha^{-1}). However, the difference between T_3 and T_2 was not significant. In case of both grain yield and stover yield the minimum finding was recorded from T_0 (6.76 t ha^{-1} and 5.33 t ha^{-1} respectively). T_0 varied from other weed control treatments significantly in respect of grain yield and stover yield. The similar figure of grain yield and straw yield was also obtained by Akbar *et al.* (2016) and Nazreen *et al.* (2018) respectively.

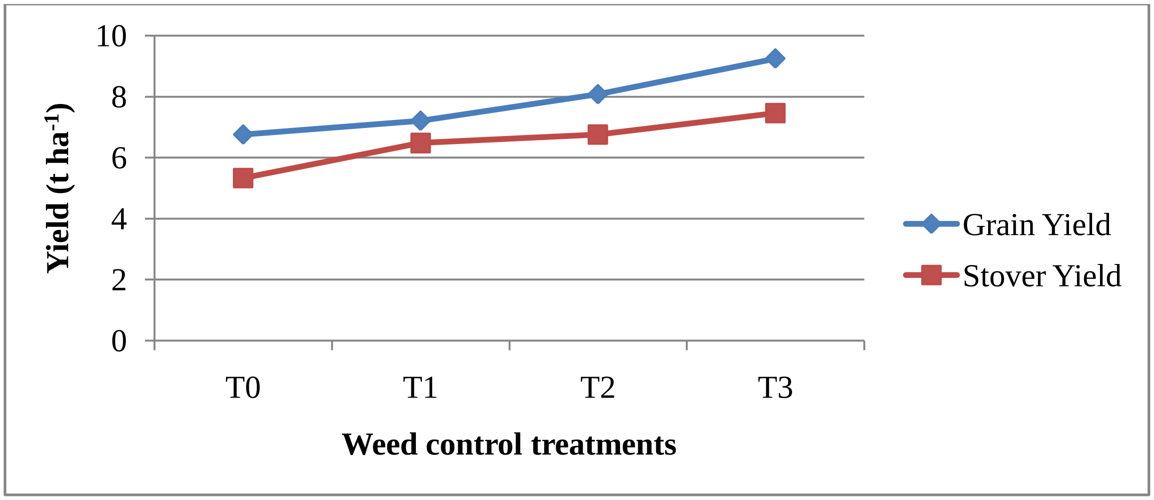
Interaction effect of variety and weed control treatments on grain yield (t ha^{-1}) and stover yield (t ha^{-1})

Interaction effect of variety and weed control treatment interaction on grain yield (tha^{-1}) and stover yield (tha^{-1}) is shown in the Table 14. From the experiment it was found that the maxim grain yield (9.33 t ha^{-1}) and stover yield (7.61 t ha^{-1}) was obtained from V_2T_3 and V_1T_3 respectively. V_1T_2 interactions showed the best result out of V_1T_3 and V_2T_3 interactions in case of both grain yield and stover yield. The minimum grain yield (5.49 t ha^{-1}) and stover yield (5.08 t ha^{-1}) was given by V_1T_0. There were a statistically significant difference among V_1T_0 with V_1T_3 and V_2T_3. This finding can be thrust to that of Akbar *et al* (2016) and Nazreen *et al.* (2018).



V_1= YANGNUO-3000, V_2= PSC-121 ($LSD_{0.05}$ = 0.58 and 0.55 for grain and stover yield respectively)

Fig. 22. Effect of variety on grain yield (t ha^{-1}) and stover yield (t ha^{-1})



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 0.82 and 0.78 for grain and stover yield respectively)

Fig. 23. Effect of weed control treatments on grain yield (t ha^{-1}) and stover yield (t ha^{-1})

Table 14. Interaction effect of variety and weed control treatments on grain yield (t ha^{-1}) and stover yield (t ha^{-1})

Treatment Combinations	**Yield (t ha^{-1})**	
	Grain yield	**Stover yield**
V_1T_0	5.4937 d	5.0820 d
V_1T_1	6.3800 d	6.1467 bcd
V_1T_2	8.4453 abc	6.9767 ab
V_1T_3	9.1743 ab	7.6083 a
V_2T_0	8.0367 bc	5.5881 cd
V_2T_1	8.0500 bc	6.8060 ab
V_2T_2	7.7156 c	6.5457 abc
V_2T_3	9.3253 a	7.3083 a
$LSD_{(0.05)}$	**1.16**	**1.11**
CV (%)	**8.46**	**9.78**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 4

4.3.7 Harvest index (%)

Effect of variety on harvest index (%)

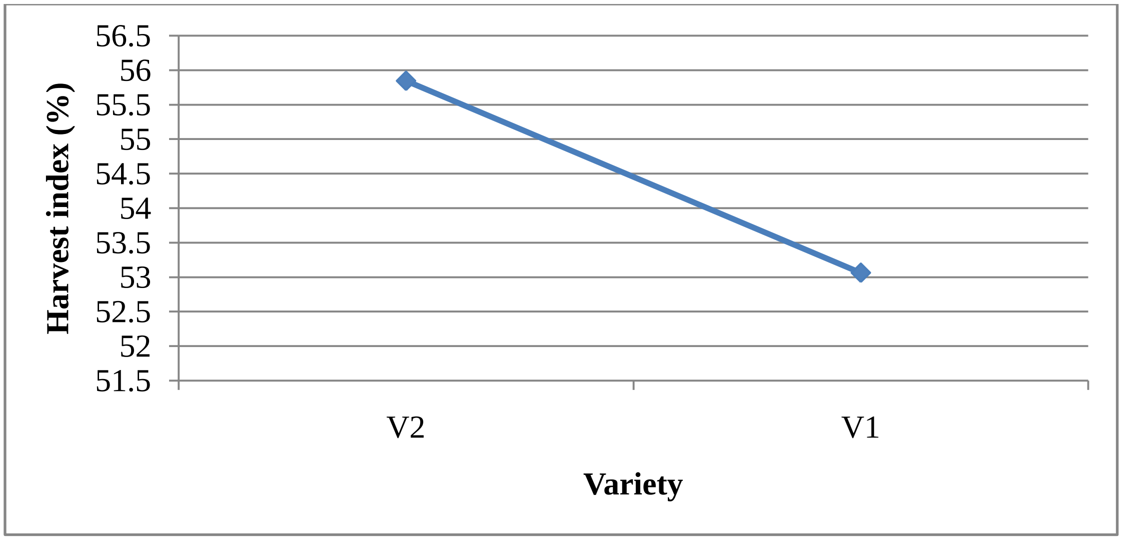
Effect of variety on harvest index is shown in the Figure 24. The experiment revealed that there was no significant statistical difference between varieties regarding harvest index. V_2 showed the maximum harvest index (55.85%) over V_1 (53.06%). This finding was at par with that of Mannan (2018) who also reported the maximum harvest index from PSC-121 (V_2).

Effect of weed control measures on harvest index (%)

Effect of weed control treatments on harvest index is shown in the Figure 25. The experiment revealed that there was no significant statistical difference among weed control treatments irrespective of numerical difference. T_3 showed the maximum harvest index (55.46%) and it was followed by T_2 (55.36%). The minimum harvest index was reported from T_0 (52.64%). The similar figure of harvest index was also reported by Mannan (2018).

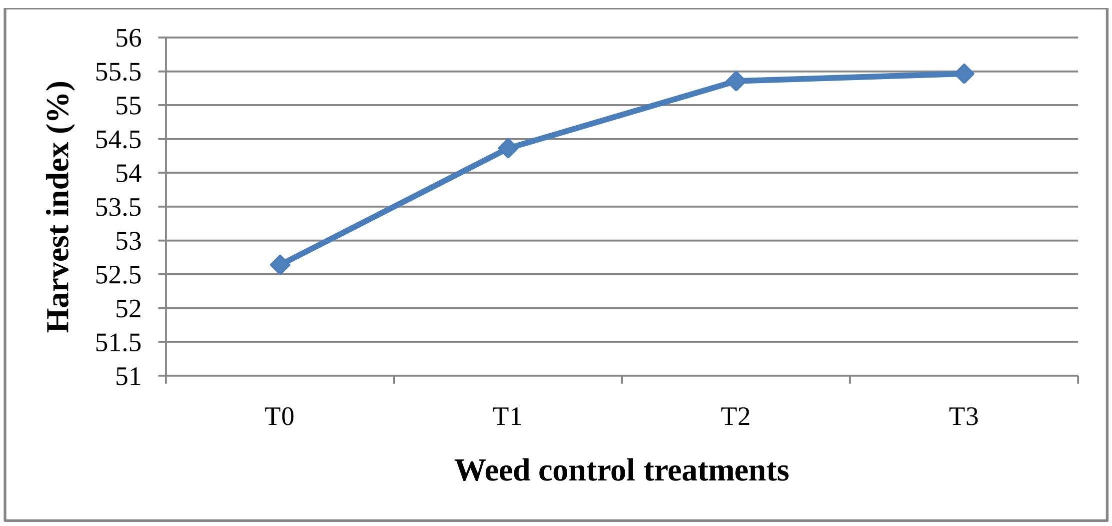
Interaction effect of variety and weed control treatments on harvest index (%)

Interaction effect of variety and weed control treatments on harvest index is placed in the Table 15. The experiment revealed that there was no significant statistical difference among weed control treatments irrespective of numerical difference. V_2T_0 showed the maximum harvest index (56.09%) and it was followed by V_2T_3 (56.09%). The minimum harvest index was reported from V_1T_1 (50.94%). This finding can be thrust to the finding of Mannan (2018).



V_1= YANGNUO-3000, V_2= PSC-121 ($LSD_{0.05}$ = 2.96)

Fig. 24. Effect of variety on harvest index (%)



T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS. ($LSD_{0.05}$ = 4.19)

Fig. 25. Effect of weed control treatments on harvest index (%)

Table 15. Interaction effect of variety and weed control treatments on harvest index (%)

Treatment Combinations	Harvest Index (%)
V_1T_0	51.928 b
V_1T_1	50.942 b
V_1T_2	54.767 ab
V_1T_3	54.617 ab
V_2T_0	59.002 a
V_2T_1	54.337 ab
V_2T_2	53.960 ab
V_2T_3	56.095 ab
$LSD_{(0.05)}$	**5.93**
CV (%)	**6.22**

V_1= YANGNUO-3000, V_2= PSC-121; T_0 =No weeding, T_1 = One hand weeding at 60 DAS, T_2 = Two hand weeding at 40 DAS and 60 DAS, T_3 = Weed free after 40 DAS

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at agronomy farm of Sher-e-Bangla Agricultural University, Dhaka during November 2017 to April 2018 to examine the influence of weeding on the performance of white maize varieties. The experiment was set taking two treatment factors. The treatment factors are: (1) Variety; having two levels, viz. YANGNUO-3000 & PSC-121; (2) Weed control treatments having four levels, viz. T_0 = No weeding, T_1= One hand weeding at 60 DAS, T_2= Two hand weeding at 40 DAS and 60 DAS and T_3= Weed free. The experiment was conducted in factorial RCBD with three replications. Data on different parameters were recorded and analyzed statistically.

Results revealed that variety, weed control treatments and their interaction had a significant effect on growth, yield attributes and yield parameters of white maize in terms of controlling weed population in the experimental field. The highest plant height (83.00 cm, 121.25 cm, 180.33 cm and 204.03 cm at 40, 60, 80 DAS and at harvest respectively), number of leaf per plant (4.78, 10.75, 12.33 and 13.03 at 40, 60, 80 DAS and at harvest respectively), leaf area plant^{-1} (0.0961 m^2, 0.5533 m^2, 0.6630 m^2 and 0.2453 m^2 at 40, 60, 80 DAS and at harvest respectively), base circumference (6.52 cm), cob setting node position from ground (6.77th), cob length (17.95 cm), number of grain row cob^{-1} (14), number of grains cob^{-1} (464.54), weight of grains cob^{-1} (111.44 g), 100 seed weight (37 g), grain yield (9.25 t ha^{-1}), stover yield (7.46 t ha^{-1}), WCE (94.38%) were reported from T_3. The lowest weed density (12.17 no. m^{-2}) and biomass (4.33 g m^{-2}) was also reported from T_3. In almost every case the second highest result was followed by T_2 with a statistically similar relationship with T_3. However, the highest harvest index (55.46%) was recorded from T_0. Weedy check treatment T_0 showed the least performance in respect of all parameters studied in the experiment except harvest index.

In terms of varietal performance, The highest plant height (85.63 cm, 121.38 cm, 172.75 cm and 203.68 cm at 40, 60, 80 DAS and at harvest respectively), number of leaf per plant (4.75, 11.04, 12.5 and 13.29 at 40, 60, 80 DAS and at harvest respectively), leaf area plant^{-1} (0.0896 m^2, 0.5344 m^2, 0.6239 m^2 and 0.2522 m^2 at 40, 60, 80 DAS and at harvest respectively), base circumference (6.37 cm), cob setting node position from ground (6.88^{th}), cob length (18.35 cm), number of grain row cob^{-1} (13.56), number of grains per cob (468.75), weight of grains cob^{-1} (99.78 g), 100 seed weight (35.0837 g), grain yield (8.28 t ha^{-1}), stover yield (6.56 t ha^{-1}) and harvest index (55.58%) were reported from V_2 as compared to that of V_1.

In case of variety and weed control treatments interaction, the highest plant height, and leaf number per plant were recorded from V_2T_3 (90.89 cm), V_2T_3 (5.00) at 40 DAS; V_2T_1 (128.5 cm) and V_2T_3 (12.17) at 60 DAS; V_2T_1 (184.00 cm), and V_2T_3 (12.67) at 80 DAS and V_2T_3 (176.58 cm), and V_2T_1 (13.67) at harvest respectively. The highest leaf area $plant^{-1}$ of 0.1005 m^2, 0.5849 m^2 and 0.2908 m^2 were recorded from V_2T_3 at 40 DAS, 60 DAS and at harvest respectively and whereas leaf area $plant^{-1}$ of 0.7067 m^2 was reported from V_2T_2 at 80 DAS. In most of the cases, the shortest plant, minimum number of leaf per plant and leaf area was recorded from $V_1T_{0,}$ V_2T_0 and V_1T_1. The maximum and minimum base circumference were recorded from V_2T_2 (6.77 cm) and V_2T_0 (6.17 cm) respectively. The upper most cob setting position was 7^{th} node in case of V_2T_0, V_2T_3 and the lowest node was 6^{th} for most of the interactions. The maximum cob length (18.82 cm), number of grains cob^{-1} (494.97), weight of grains per cob (112.35 g), 100 grain weight (38 g) and grain yield (9.33 t ha^{-1}) was recorded from V_2T_3. The maximum number of grain row cob^{-1} (14.26) and stover yield (7.61 t ha^{-1}) was recorded from V_1T_3. The minimum cob length, number of grains cob^{-1}, weight of grains cob^{-1}, 100 grain weight, grain yield and stover yield was recorded from V_1T_0. While, the minimum number of grain row per cob was recorded from V_2T_0. However, the maximum (59.0%) and minimum (50.94%) harvest index were reported from V_2T_0 and V_1T_1.

However, from the above findings it can be concluded that

1. PSC-121 is the best performer regarding growth and yield attributes of white maize
2. Weed free (T_3) is the most suitable one to control weeds in white maize field but almost in all cases T_2 was statistically similar with T_3
3. Treatments V_2T_3 and V_1T_3 were the most effective combination offering the maximum growth and yield in white maize. On the other hand, in the

consideration of weed tolerance capacity the best interaction to be recommended is V_1T_2.

Recommendation

Though the weed free treatment was found as the best one to be practiced in the white maize field but it will be costly for the farmers to carry out. In that case, two hands weeding at 40 and 60 DAS practiced in this experiment was noticeable, because it is statistically similar with the weed free treatment. So, in the consideration of cost benefit ratio, two hand weeding at 40 and 60 DAS is recommendable over the weed free treatment in consideration to economic return in case of white maize cultivation.

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REFERENCES

Abdullahi, S., Ghosh, G. and Dawson, J. (2016). Effect of different weed control methods on growth and yield of maize (*Zea mays* l.) Under rainfed condition in Allahabad. *J. Agril. Vet. Sci*. **9**(4): 44-47.

Abouziena, H.F., El-Karmany, M.F., Singh, M. and Sharma, S.D. (2017). Effect of nitrogen rates and weed control treatments on maize yield and associated weeds in sandy soils. *Weed Sci. Soc. America*. **21**(4): 1049-1053.

Adebooye, O.C., Ajadi, S.O. and Fagbohun, A.B. (2006). An accurate mathematical formula for estimating plant population in a four dimensional field of sole crop. *J. of Agronomy*. **5**: 289-292.

Ademiluyi, B.O. and Abegunde, C.M. (2007). Evaluation of herbicide spray programmes and hoeing for weed control in maize (*Zea mays* L.) in a South Western Nigerian location. *Res. J. Agron*. **1**(2): 38-41.

Ahmed, M., Khaliq, A., Ahmad, R. and Ranjha, A.M. (2010). Allometery and Productivity of Autumn Planted Maize Hybrids under Narrow Row Spacing. *Int. J. Agril. Biol.* **12**(5):661-667.

Akbar, M.A., Siddique, M.A., Marma, M.S. & Ullah, J.M. (2016). Planting Arrangement, Population Density and Fertilizer Application Rate for White Maize Production in Bandarban Valley. *Agric. For. and Fish.* 5(6):215.

Alam, S.M. (2003). Weed and their ill effects on main crop. Retrieved from: http://dawn.com

Ali, M.A., Sarwar, A.K. M.G. and Prodhan, A.K.M.A. (1999). Effect of water stresses on growth features of different maize (*Zea mays* L.) cultivars. *Pak. J. Bot.* **31**(2): 455-460.

Ali, M.Y, Waddington, S.R, Timsina, J.,D. Hodson, D., Dixon, J. (2010). Maize-rice cropping systems in Bangladesh: Status and research needs. *J. Agric. Sci. Technol*. **3**(6): 35-53.

Ali, S., Shahbaz, M. Nadeem, M.A., Ijaz, M., Haider, M.S., Anees, M. and Khan, H.A. A. (2014). The relative performance of weed control practices in September sown maize. *Mycopath.* **12**(1): 43-51.

Alok, M., and Bhagwan, S. (2007). Weed dynamics, productivity and economics of maize (*Zea mays*) as effected by integrated weed management under rainfed condition. *Indian J. Agro*. **52**(4): 321-324.

Amare, T., Mohammed, A., Negeri, M. and Sileshi, F. (2015). Effect of weed control methods on weed density and maize (*Zea* mays *L*.). *African. J. Pl. Sci.* **9**(1): 8-12.

Amosun, J.O., Aluko, O.A., and Adeniyan, O.A. (2015). Effect of weed mangement strategies on maize yield. *Inter. J. Agril. Agril. Sci*. **2**(1): 18-20.

Aylor, D.E. (2002). Settling speed of corn (*Zea mays*) pollen *J. Aer. Sci.* **33**: 1601-1607.

Baltazar, B.M., de jesus Sanches-Gonzalez, j., Cruz-Larios, L., Schoper, J.B. (2005). Pollination between maize and teosinte: an important determinant of gene flow in Mexico. *Theor. Appl. Genet.* **110**: 519-526.

Bannert, M. and Stamp, P. (2007). Cross-pollination of maize at long distance. *European J. Agro.* **27:** 44-51.

BBS. (2016). Yearbook of Agricultural Statistics 2014. Ministry of Planning, Government of Bangladesh, Dhaka.

Biology Documents. (2014). Canadian food inspection agency. Retrieved from http://www.inspection.gc.ca/plants/plants-with-novel-traits/applicants/directive-94-08/biology-documents/zea-mays-l-/eng/1330985739405/1330985818367

Cassman, K.G., Grassini, P., and Van Wart, J. (2010). Crop yield potential, yield trends and global food security in a changing climate. In: Rosenzweig, C., Hillel, D. (Eds.), Handbook of Climate Change and Agroecosystems. Imperial College Press, London, p. 37.

Chauhan, B.S. and Johnson, D.E. (2010). Implications of narrow crop row spacing and delayed *Echinochloa colona* and *Echinochloa cruss-galli* emergence for weed growth and crop yield loss in aerobic rice. *Field Crop Res*. **117**: 177-182.

Cheng, X., Gao, Q., Zhang, Q., Guo, S., Ren, J., Li, S., Ye, Y., Wang, Z., Huang, J., Tang, Q., Sun, Y., Peng, X., Zhang, J., He, M., Zhu, Y., Xue, J., Wang, G., Wu, L., An, N., Wu, L., Ma, L., Zhang, W., Zhang, F. (2014). Producing more grain without environmental costs. *Nature* 514, 486, October 13.

Chikoye, D., Manywong, V. M., Carsky, R. J., Gbehounou, G. and Ahanchede, A. (2002). Response of speargrass (Imperata cylindrical) to cover crops integrated with hand weeding and chemical control in maize and cassava. *Crop Prot.* **19**: 481-497.

Chivinge, O.A. (1983). Aweed survey of arable lands in the commercial sector of Zimbabwe. Zimbabwe *Agric. J.* **1**: 39-41.

Dass, S., Kumar, A., Jat, S. L., Parihar, C.M., Singh, A.K., Chikkappa, G.K. Jat, M.L. (2012). Maize holds potential for diversification and livelihood security. *Indian J. Agron.* **57**: 86-91.

Deewan, P., Mundra, S.L. Singh, D., Meena, M., Verma, R. and Sharma, N.K. (2017). Effect of weed and nutrient management on growth, productivity and protein content of quality protein maize (*Zea mays* L*.). J. Pharmaco. and Phytochem*. **6**(1): 271-274.

Din, W.U., Naveed, k., Iqbal, S., Ali, A., and Khan, S.M. (2016). Effect of Different Weeding Intervals and Methods On the Yield and Yield components of Maize Hybrid. *ARPN. J. Agril. and Biol. Sci*.**11**(3): 100-106.

Fageria, N.K., Baligar, R.V.C., & Clark, R.B. (2006). Physiology of crop growth and yield components. Chapter 3. In: Physiology of crop production. Haworth Press, 16-94.

Fuksa, P., Hakl, J., Kocourkova, D. and Vesela, M. (2004). Influence of weed infestation on morphological parameters of maize (*Zea mays* L.). *Plant Soil Environ.* **50**(8): 371-378.

Glowacka, A. (2007). Effect of the strip intercropping system on weed infestation in maize. *Acta Agrophys.***10**(3): 573-582.

Golebiowska, H. (2006). Influence of grain maize monoculture on weed infestation. *Pam. Pul.* **142** : 127-136.

Hamid, A., Hasan, M., Ahmad, G. and Iran, S. (2012). The Study Of Integrated Weed Management (IWM), Emphasizing The Effect of Seed Priming on Yield and Yield Components of Maize *(Zea mays L*.). *Weed Res. J.* **4**(2): 63-76.

Hitchcock, A. S. and Chase, A. (1971).Manual of the grasses of the United States. Dover Publications: NY. **2**: 790-796.

Holm, L.G., Plucknett, D.L., Pachno, J.V. and Her-berger J.P. (1991). The world's worst weeds, distribution and biology. The university press of Hawaii, Malabar, Florida: 609.

Hossain M.I., Barma N.C.D., Rafiqul Islam A.T.M., Uddin M.Z. and Rahman M.M. (2009). Effect of newly developed herbicides on the growth and yield of wheat. *Int. J. Sustain. Crop Prod*. **4**(1):1-4. https://dx.doi.org/10.1590/s0100-83582016340400013

ICAR (2006). A handbook of agriculture. Indian Council of Agricultural Research.New Delhi. pp 870-886.

Iderawumi, A.M. and Friday, C.E. (2018). Characteristics effects of weed on growth performance and yield of maize (*zea mays*). *Biomed . Sci. and Tech. Res.* **7**(3): 01-04.

Imoloame, E.O. and Omolaiye, J.O. (2017). Weed infestation, growth and yield of maize (zea mays l.) as influenced by periods of weed interference. *Adv. Crop Sci. Tech.* **5**:2.

Kebede, M. and Anbasa, M. (2017). Efficacy of Pre-emergence Herbicides for the control of Major Weeds in Maize (*Zea mays L*.) at Bako, Western Oromia, Ethiopia. *American J. Agril. For*. **5**(5): 173-180.

Khan, H., Marwat, K.B., Khan, M.A. and Hashim, S. (2014). Herbicidal Control of Parthenium Weed in Maize. *Pakistan J. Bot.* **46**(2): 497-504.

Khan, I.A., Hassan, G., Malik, N., Khan, R., Khan, H., And Khan, S.A. (2016). Effect of herbicides on yield and yield components of hybrid maize (zea mays). *Planta Daninha*. **34**(4): 729–736.

Kumar, S., Rana, S.S., Chander, N and Angiras, N.N. (2012). Management Of Hardy Weeds In Maize Under Mid-Hill Conditions Of Himachal Pradesh. *Indian J. Weed. Sci.* **44**(1): 11-17.

Lagoke, S.T.O., Adeosun, S.O., Elemo, K.A., Chude, V.O. and Shebayan, J.A.Y. (1998). Herbicide evaluation for the control of weeds in maize at Samaru. In: Report on cereals research cropping scheme meeting held at IAR/ABU Samaru, Zaria, Nigeria. pp. 90-91.

Lee, E. and Tollenbar, M. (2007). Physiological basis of successful breeding strategies for maize grain yield. *Crop Sci.* **47**(3):202-215.

Luna, S., Figueroa, J., Baltazar, B., Gomez, R., Townsend, R. and Schoper, J.B. (2001). Maize pollen longevity and distance isolation requirements for effective pollen control. *Crop Sci* . **41**: 1551-1557.

Macharia, C.N., Njeru, C.M., Ombakho, G.A. and Shiluli, M.S. (2010). Comparative performance of advanced generations of maize hybrids with a local maize variety: Agronomic and financial implications for smallholder farmers. *J. Animal & Plant Sci*. **7**(2): 801- 809.

Maize biology. (2011). Retrieved from http://maize.teacherfriendlyguide.org/index.php/biology-and-genetics-of-maize

Mannan, M.A. (2018). Varietal performances of white maize as influenced by different level of herbicides (Unpublished master's thesis). Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

Mia, M.A.B. (2016). *Maize*. Retrieved from -http://dhcrop.bsmrau.net/maize/

Nadeem, M.A., Awais, M., Ayub, M., Tahir, M. and Maqbool, M.M. (2010). Integrated Weed Management Studies For Autmn Planted Maize. *Pakistan. J. Life Soc. Sci.* **8**(2): 98-101.

Nazreen, S., Subramanyam, D., Sunitha, N. and Umamahesh, V. (2018). Growth and yield of maize as influenced by sequential application of herbicides. *Int. J. Curr. Microbiol. App. Sci.* **7**(5): 2764-2770.

Ndam, LM., Enang, J.E., Mih, A.M. and Egbe, A.E. (2014). Weed diversity in maize (*Zea mays* L.) fields in South Western Cameroon. *Int. J. Curr. Microbiol. App.Sci.* **3**(11): 173-180.

Nuss, E.T. and Tanumihardjo, S.A. (2010). Maize: a paramount staple crop in the context of global nutrition. *Compr. Rev. Food Sci. Food Saf.* 9: 417–436.

Oerke, E.C. and Dehne, W.H. (2004). Safeguarding production losses in major crops and the role of crop production. *Crop Prot.* **23**: 275-285.

Oerke, E.C. (2005). Crop losses to pest. *J. Agri. Sci*. **143**: 1-13.

Olabode, O.S. and Sangodele, A.O. (2015). Effect of weed control methods on the performances of sweet corn (*Zea mays saccharata*) in Ogbomoso, South-east Nigeria *J. of Global Biosciences.* **4**(1): 1145-1150.

Olatunji, A., Adejoro, S. A., Ayelari, O.P. and Aladesanwa, R.D. (2016). Evaluation of selected weeding methods for weed control and performance of maize in south western Nigeria. *Appl. Tropical Agril.* **21**(1): 15-23.

Pandey, A.K., Prakash, V., Singh R.D. and Mani V.P. (2001). Integrated weed management in maize (*Zea mays). Indian J. Agro*. **46**(2): 260-265.

Patel, G.N., Patel, G.J., Goyal, S.N. and Patel, B.G. 2000). Integrated Weed Management In Rabi Maize. *Gujarat. Agril. Uni. Res. J.* **25**(2): 88-90.

Patel, V.J., Upadhyay, P.N., patel, J.B. and Patel, B.D. (2006). Evaluation of herbicide mixtures for weed control in maize (*zea mays l.*). Under middle gujarat condition*se. J. Agril. Sci*. **2**(1): 81-86.

Proline seeds. (2014). Prolin Seeds Company (India) Pvt. Ltd. Retrieved from :http://www.prolineseeds.com/maize.htm

Ranum, P., Pe˜Na-Rosas, J.P. and Garcia-Casal, M.N. (2014). Global maize production, utilization, and consumption. *Ann. N. Y. Acad. Sci.* 1312 (2014) 105–112 C doi: 10.1111/nyas.12396.

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha J.K. and Mortimer, A.M. (2007). Weed management in direct-seeded rice. *Adv. Agron*. **93**: 153-255.

Rasool, S. and Khan, M.H. (2016). Growth and yield of maize (*zea mays* l.) As influenced by integrated weed management under temperate conditions of north western himalayas. *AJEA.* **14**(1): 1-9.

Ray, D.K., Mueller, N.D., West, P.C., Foley, J.A. (2013). Yield trends are insufficient to double global crop production by 2050. PLoS ONE 8, e66428.

Riaz, M., Jamil, M. and Mahmood T.Z. (2007). Yield and Yield Components of Maize as Affected by Various Weed Control Methods Under rain-fed Conditions of Pakistan*. Inter. J. Agril. and Biol.* **9**(1): 152-155.

Sanodiya,P., Jha, A.K. and Shrivastava, A. (2013). Effect Of Integrated Weed Management On Seed Yield Of Fodder Maize. *Indian. J. Weed. Sci.* **45**(3): 214-216.

Shaw, R.H. (1988). Climate requirement. In: Sprague G.F., Dudly J.W eds. Corn and Corn 638 Improvement, 3rd ed. Madison, WI: ASE 609.

Singh, M., Prabhukumar, S., Sairam, C.V. and Kumar, A. (2009). Evaluation of different weed management practices in rainfed maize on farmers' fields. *Pakistan J. Weed Sci. Res.* **15**(2-3): 183-189.

Sinha, S.P., Prasad, S.M. and Singh, S.J. (2000). Effect of weed management on growth, yield attributes and yield of winter maize. *J. Appl. Biol*. **10**(2): 158-162.

Skrzyczynska, J., Rzymowska, Z. and Skrajna, T. (2002). *Chenopodium album* L. and *Echinochloa crus-galli* (L.) P. Beauv infestation of spring cereals and root crops in central-eastern Poland. *Pam.Pul*. **129**:81-92.

Stefan, T., Ludmila, L. and Veronika, C. (2015). Weed infestation of maize grown in sustainable farming systems. *Acta fytotechn zootechn*. **SI**: 25-27.

Subbulakshmi, S., Subbian, P. and Prabhakaran, N.K. (2009). Effect of tillage and weed management practices on performance of maize sunflower. *Inter. J. Agril. Sci.* **5**(1):35-39.

Subhan, F., Din, N.U., Azim, A. and Shah, Z. (2007). Response of maize crop to various herbicides. *Pakistan J. Weed Sci. Res*. **13**(1/2): 9-15.

Tahir,M., Jabed, M.R., Tanveer, A., Nadeem, M.A. and Wasaya, A. (2009). Effect of different herbicides on weeds, growth and yield of spring planted maize (*Zea mays L*.). *Pakistan J. Life Soc. Sci.* **7**(2): 168-174.

Timsina, J., Jat, M.L., Majumdar, K. (2010). Rice-maize systems of South Asia: current status, future prospects and re- search priorities for nutrient management. *Plant Soil*. **335**: 65–82.

Tollenaar, M., Nissanka, S.P., Aguilera, A., Weise, S.F. and Swanton, C.J. (1994). Effect of weed interference and soil-nitrogen on 4 maize hybrids. *Agron. J.* **86**: 596-601.

Traba, C. and Zieminska-Smyk, M. (2002). Weed infestation of spring grains and root crops by *Chenopodium album, Echinochloa crus-galli* and *Amaranthus retroflexus* in buffer zone of the Roztocze National Park. *Pam. Pul.* **129**:217-221.

Tripathi, K.K., Warrier, R. and Ahuja, V. (2011). Biology of *Zea mays* (Maize). M. F. Farooqui, (ed.). Department of Biotechnology, Lodhi Road, New Delhi-110003: Govt. of India. pp. 1-13.

Tyr, S., Levakova, L. and Curna, V. (2015). Weed infestation of maize grown in sustainable farming systems. *Acta fytotechn, zootechn.* **18**: 25-27.

Ullah M.J., Islam, M.M., Fatema, K., Mahmud, M. S. and Rahman, J. (2017). Comparing modern varieties of white maize with land races in Bangladesh: Phenotypic traits and plant charachters. *J. Expt. Biosci*. **8**(1): 27-40.

Ullah, M.J., Islam, M.M., Fatima, K., Mahmud, M.S. and Rahman, J. (2016). Evaluating yield and yield performance of transplanted white maize varieties under varying planting geometry. *J. Expt. Biosci*. **7**(2): 21-30.

APPENDICES

Appendix I: Monthly records of air temperature, relative humidity and rainfall during the period from November, 2017 to April 2018.

Month	RH (%)	Air temperature (C)			Total Rainfall (mm)
		Max.	Min.	Mean	
November	65.00	32.00	19.00	26.00	35.00
December	74.00	29.00	15.00	22.00	15.00
January	68.00	26.00	10.00	18.00	7.00
February	57.00	15.00	24.00	25.42	25.00
March	57.00	34.00	16.00	28.00	65.00
April	66.00	35.00	20.00	28.00	155.00

(Source: timeanddate.com)

Appendix II: Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka

A. Morphological characteristics of the experimental field

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

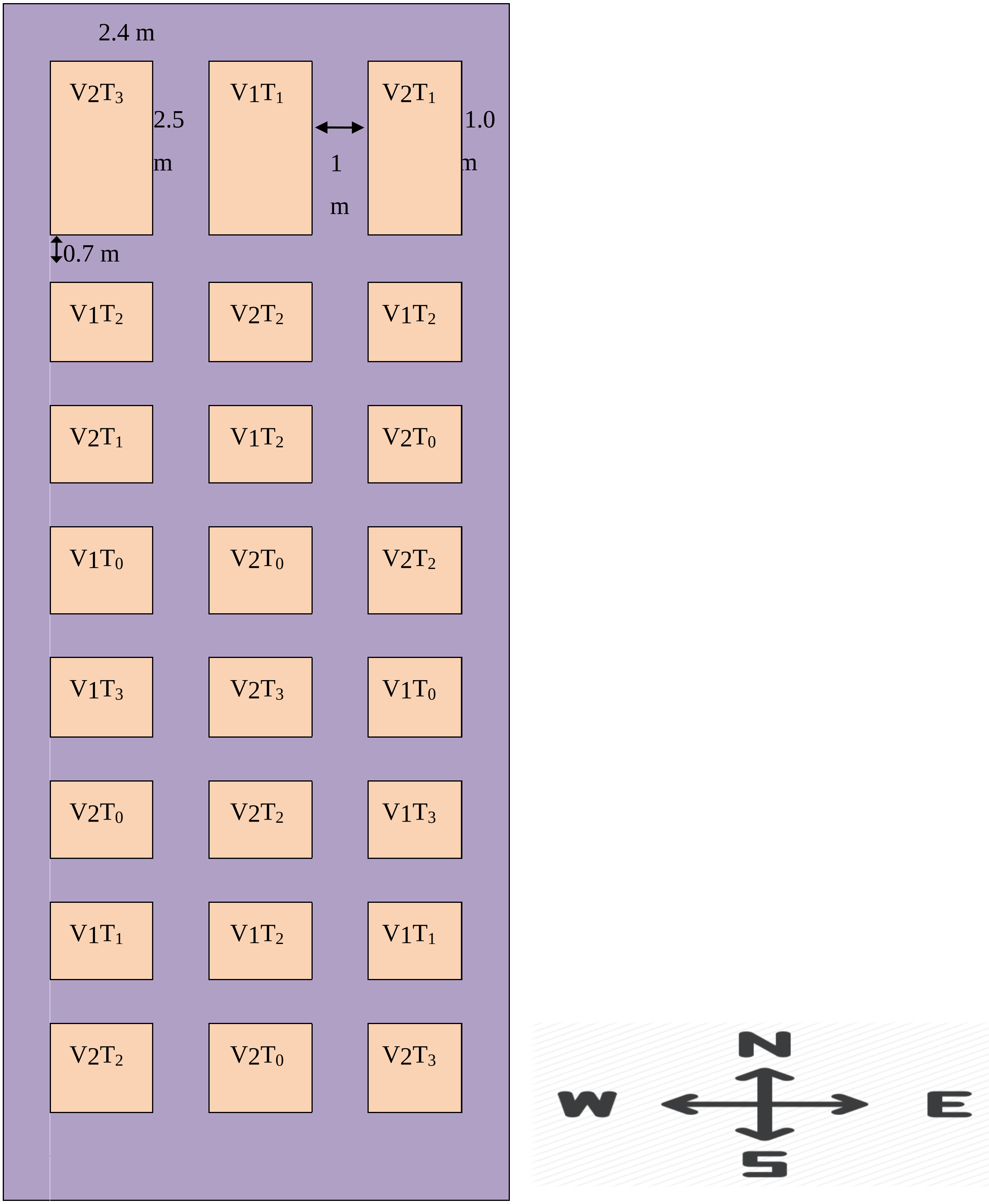
Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of initial soil

Characteristics	Value
Partical size analysis % Sand	27.00
%Silt	43.00
% Clay	30.00
Textural class	Silty Clay Loam (ISSS)
pH	5.60
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)	45.00

(As per soil test)

Appendix III: Layout of experimental field



Appendix IV: Analysis of variance of the data on weed parameters

A. Weed density

Source of variation	DF	SS	MS	F	P
Replication	2	412	206.2		
Variety	1	30	30.4	0.25	0.6231
Weed control	3	139161	46387.2	385.72	0.0000
Variety*Weed control	3	160	53.4	0.44	0.7254
Error	14	1684	120.3		
Total	23	141448			

Grand Mean 117.21

CV 9.36

B. Weed biomass

Source of variation	DF	SS	MS	F	P
Replication	2	192.3	96.2		
Variety	1	0.4	0.4	0.01	0.9277
Weed control	3	75358.1	25119.4	571.20	0.0000
Variety*Weed control	3	96.5	32.2	0.73	0.5504
Error	14	615.7	44.0		
Total	23	76263.0			

Grand Mean 74.292

CV 8.93

C. **Weed control efficiency**

Source of variation	DF	SS	MS	F	P
Replication	2	75.6	37.78		
Variety	1	11.7	11.71	0.72	0.4098
Weed control	3	29897.4	9965.80	614.09	0.0000
Variety*Weed control	3	14.8	4.93	0.30	0.8221
Error	14	227.2	16.23		
Total	23	30226.7			

Grand Mean 45.621

CV 8.83

Appendix V: Analysis of variance of the data on plant height of white maize

A. **Plant height at 40 DAS**

Source of variation	DF	SS	MS	F	P
Replication	2	92.97	46.49		
Variety	1	1382.38	1382.38	81.76	0.0000
Weed control	3	367.36	122.45	7.24	0.0036
Variety*Weed control	3	49.09	16.36	0.97	0.4354
Error	14	236.70	16.91		
Total	23	2128.50			

Grand Mean 78.038

CV 5.27

B. Plant height at 60 DAS

Source of variation	DF	SS	MS	F	P
Replication	2	587.18	293.59		
Variety	1	1219.80	1219.80	14.90	0.0017
Weed control	3	661.60	220.53	2.69	0.0861
Variety*Weed control	3	1326.98	442.33	5.40	0.0111
Error	14	1146.20	81.87		
Total	23	4941.76			

Grand Mean 114.25

CV 7.92

C. Plant height at 80 DAS

Source of variation	DF	SS	MS	F	P
Replication	2	289.12	144.560		
Variety	1	0.96	0.960	0.01	0.9276
Weed control	3	2016.30	672.099	5.99	0.0076
Variety*Weed control	3	489.46	163.154	1.45	0.2698
Error	14	1571.64	112.260		
Total	23	4367.48			

Grand Mean 172.55

CV 6.14

D. **Plant height at harvest**

Source of variation	DF	SS	MS	F	P
Replication	2	5013.58	2506.79		
Variety	1	1369.07	1369.07	10.92	0.0052
Weed control	3	728.14	242.71	1.94	0.1702
Variety*Weed control	3	693.19	231.06	1.84	0.1857
Error	14	1755.14	125.37		
Total	23	9559.12			

Grand Mean 196.13

CV 5.71

Appendix VI: Analysis of variance of the data on number of leaf per plant of white maize

A. **Leaf number per plant at 40 DAS**

Source of variation	DF	SS	MS	F	P
Replication	2	0.56481	0.28241		
Variety	1	0.11574	0.11574	0.59	0.4570
Weed control	3	0.12500	0.04167	0.21	0.8873
Variety*Weed control	3	0.53241	0.17747	0.90	0.4669
Error	14	2.76852	0.19775		
Total	23	4.10648			

Grand Mean 4.6806

CV 9.50

B. Leaf number per plant at 60 DAS

Source of variation	DF	SS	MS	F	P
Replication	2	0.0833	0.0417		
Variety	1	31.5104	31.5104	30.96	0.0001
Weed control	3	6.6979	2.2326	2.19	0.1342
Variety*Weed control	3	5.4479	1.8160	1.78	0.1963
Error	14	14.2500	1.0179		
Total	23	57.9896			

Grand Mean 9.8958

CV 10.20

C. **Leaf number per plant at 80 DAS**

Source of variation	DF	SS	MS	F	P
Replication	2	1.0833	0.54167		
Variety	1	2.6667	2.66667	3.22	0.0942
Weed control	3	0.6667	0.22222	0.27	0.8470
Variety*Weed control	3	1.3333	0.44444	0.54	0.6644
Error	14	11.5833	0.82738		
Total	23	17.3333			

Grand Mean 12.167

CV 7.48

D. **Leaf number per plant at harvest**

Source of variation	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	0.3908	0.19542		
Variety	1	4.7704	4.77042	8.89	0.0099
Weed control	3	0.3246	0.10819	0.20	0.8935
Variety*Weed control	3	1.8046	0.60153	1.12	0.3738
Error	14	7.5092	0.53637		
Total	23	14.7996			

Grand Mean 12.846

CV 5.70

Appendix VII: Analysis of variance of the data on leaf area of white maize

A. Leaf area at 40 DAS

Source of variation	**DF**	**SS**	**MS**	**F**	**P**
Replication	2	1.511	7.553		
Variety	1	5.155	5.155	7.08	0.0187
Weed control	3	2.501	8.336	11.44	0.0005
Variety*Weed control	3	4.422	1.474	0.20	0.8930
Error	14	1.020	7.284		
Total	23	4.096			

Grand Mean 0.0850

CV 10.04

B. Leaf area at 60 DAS

Source of variation	DF	SS	MS	F	P
Replication	2	0.00229	0.00115		
Variety	1	0.09379	0.09379	22.86	0.0003
Weed control	3	0.07492	0.02497	6.09	0.0072
Variety*Weed control	3	0.04587	0.01529	3.73	0.0369
Error	14	0.05744	0.00410		
Total	23	0.27432			

Grand Mean 0.4719

CV 13.58

C. Leaf area at 80 DAS

Source of variation	DF	SS	MS	F	P
Replication	2	0.00529	0.00265		
Variety	1	0.03500	0.03500	18.08	0.0008
Weed control	3	0.13685	0.04562	23.57	0.0000
Variety*Weed control	3	0.01420	0.00473	2.45	0.1070
Error	14	0.02710	0.00194		
Total	23	0.21845			

Grand Mean 0.5857

CV 7.51

D. Leaf area at harvest

Source of variation	DF	SS	MS	F	P
Replication	2	0.00018	0.00009		
Variety	1	0.03883	0.03883	202.77	0.0000
Weed control	3	0.01866	0.00622	32.48	0.0000
Variety*Weed control	3	0.00217	0.00072	3.78	0.0354
Error	14	0.00268	0.00019		
Total	23	0.06251			

Grand Mean 0.2120

CV 6.53

Appendix VIII: Analysis of variance of the data on base circumference of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	0.45906	0.22953		
Variety	1	0.00869	0.00869	0.04	0.8509
Weed control	3	0.24264	0.08088	0.34	0.7959
Variety*Weed control	3	2.08586	0.69529	2.93	0.0701
Error	14	3.31770	0.23698		
Total	23	6.11394			

Grand Mean 6.3510

CV 7.67

Appendix IX: Analysis of variance of the data on position of cob setting node from ground of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	1.27669	0.63834		
Variety	1	0.88807	0.88807	4.89	0.0442
Weed control	3	0.05550	0.01850	0.10	0.9576
Variety*Weed control	3	1.59883	0.53294	2.93	0.0702
Error	14	2.54424	0.18173		
Total	23	6.36332			

Grand Mean 6.6924

CV 6.37

Appendix X: Analysis of variance of the data on cob length of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	0.7176	0.3588		
Variety	1	41.2476	41.2476	97.13	0.0000
Weed control	3	15.5824	5.1941	12.23	0.0003
Variety*Weed control	3	7.2004	2.4001	5.65	0.0094
Error	14	5.9455	0.4247		
Total	23	70.6935			

Grand Mean 17.038

CV 3.82

Appendix XI: Analysis of variance of the data on number of grain row per cob of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	1.8937	0.94684		
Variety	1	0.0123	0.01230	0.02	0.8903
Weed control	3	3.2353	1.07842	1.73	0.2068
Variety*Weed control	3	2.4284	0.80947	1.30	0.3140
Error	14	8.7295	0.62354		
Total	23	16.2992			

Grand Mean 13.540

CV 5.83

Appendix XII: Analysis of variance of the data on number of grains per cob of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	1539.1	769.6		
Variety	1	10425.8	10425.8	28.35	0.0001
Weed control	3	7935.8	2645.3	7.19	0.0037
Variety*Weed control	3	7540.3	2513.4	6.83	0.0046
Error	14	5149.4	367.8		
Total	23	32590.4			

Grand Mean 447.91

CV 4.28

Appendix XIII: Analysis of variance of the data on weight of grains per cob of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	151.30	75.65		
Variety	1	718.99	718.99	11.29	0.0047
Weed control	3	3127.16	1042.39	16.36	0.0001
Variety*Weed control	3	1417.26	472.42	7.42	0.0033
Error	14	891.79	63.70		
Total	23	6306.49			

Grand Mean 94.309

CV 8.46

Appendix XIV: Analysis of variance of the data on 100 grain weight of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	3.083	1.5417		
Variety	1	48.167	48.1667	18.95	0.0007
Weed control	3	176.000	58.6667	23.08	0.0000
Variety*Weed control	3	20.500	6.8333	2.69	0.0865
Error	14	35.583	2.5417		
Total	23	283.333			

Grand Mean 33.667

CV 4.74

Appendix XV: Analysis of variance of the data on grain yield of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	1.0423	0.52115		
Variety	1	4.9531	4.95314	11.29	0.0047
Weed control	3	21.5430	7.18099	16.36	0.0001
Variety*Weed control	3	9.7635	3.25449	7.42	0.0033
Error	14	6.1435	0.43882		
Total	23	43.4454			

Grand Mean 7.8276

CV 8.46

Appendix XVI: Analysis of variance of the data on stover yield of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	0.9941	0.49704		
Variety	1	0.0708	0.07076	0.17	0.6823
Weed control	3	14.0645	4.68816	11.57	0.0004
Variety*Weed control	3	1.3791	0.45970	1.13	0.3689
Error	14	5.6718	0.40513		
Total	23	22.1803			

Grand Mean 6.5077

CV 9.78

Appendix XVII: Analysis of variance of the data on harvest index of white maize

Source of variation	DF	SS	MS	F	P
Replication	2	35.072	17.5359		
Variety	1	46.524	46.5241	4.05	0.0638
Weed control	3	30.816	10.2721	0.89	0.4683
Variety*Weed control	3	50.065	16.6885	1.45	0.2698
Error	14	160.762	11.4830		
Total	23	323.239			

Grand Mean 54.456

CV 6.22