VARIETAL PERFORMANCES OF WHITE MAIZE AS INFLUENCED BY DIFFERENT WEED MANAGEMENT PRACTICES

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CERTIFICATE

*This is to certify that the thesis entitled **"Varietal Performances of White Maize as Influenced by Different Weed Management Practices"** 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 **Muhammad Abdul Mannan**, Registration No. **12-04975** 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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VARIETAL PERFORMANCES OF WHITE MAIZE AS INFLUENCED BY DIFFERENT WEED MANAGEMENT PTACTICES

ABSTRACT

The experiment was conducted at the Agronomy Farm of Sher-e-Bangla Agricultural University, Dhaka during November 2017 to April 2018 to examine the varietal performances of white maize as influenced by different level of herbicides. The experiment comprised of two varieties *viz*. PSC-121 and YANGNUO-3000 designed as V_1 and V_2 respectively combined with six weed control measures *viz.* T_0 = No weeding, T_1= Carfentrazone + Isoproturon 500g @ 1.5 g ha^{-1} (Affinity 50.75% WP), T_2= Carfentrazone + Isoproturon 500g @ 2.0 g ha^{-1} (Affinity 50.75% WP), T_3= Pendimethalin @ 2.0 l ha^{-1} (Panida 50EC), T_4= Pendimethalin @ 3.0 l ha^{-1} (Panida 50EC) and T_5= One hand weeding at 45 DAS. The experiment was laid out in Split Plot Design with three replications. The highest plant height, leaf number per plant, leaf area index, crop growth rate, leaf area duration, 100-seed weight (35.67 g), grains per cob (426.5), grain yield (8.817 t ha^{-1}), stover yield (7.35 t ha^{-1}) and biological yield (16.17 t ha^{-1}), WCE (74.24%) were achieved from T_4. All the parameters studied were found lowest with T_0. In case of variety, PSC-121 showed the superior performance in terms of plant height, leaf number per plant, leaf area index, crop growth rate, leaf area duration, 100-seed weight (33.898g), grains cob^{-1} (412.0), grain yield (7.758 t ha^{-1}), stover yield (6.121 t ha^{-1}), biological yield (13.878 t ha^{-1}) and harvest index (55.651%) over YANGNUO-3000. However, in terms of interaction, no single interaction was superior over other alternatives. But in most of the cases T_4V_1 showed the highest findings regarding the maximum leaf area index, leaf area duration, 100-seed weight (40.33 g), grains per cob (445.6), grain yield (9.633 t ha^{-1}), biological yield (16.72 t ha^{-1}) were recorded from T_4V_1, which however, was not significantly higher than those of T_1V_1 (8.580 t ha^{-1}), T_3V_1 (8.593 t ha^{-1}) and T_4V_2 (8.000 t ha^{-1}) and the lowest performance almost in all the parameters was recorded from T_0V_1.

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ABBREVIATIONS AND ACRONYMS

%	=	Percentage
AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
CGIAR	=	Consultative Group for International Agricultural Research
CGR	=	Crop Growth Rate
CIMMYT	=	Centro Internacional de Mejoramiento de Maíz y Trigo
cm	=	Centimeter
CV %	=	Percent Co-efficient 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 (s)
GGDP		Ghana Grains Development Project
i.e.	=	id est. (L), that is
IITA		The International Institute of Tropical Agriculture
Kg	=	Kilogram (s)
L	=	Liter
LAD	=	Leaf Area Duration
LAI	=	Leaf Area Index
LSD	=	Least Significant Difference
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 food grains, maize (*Zea Mays* L.) is the oldest one and the only cultivated species in its genus. It is a member of the poaceae family formerly known as gramineae and a C_4 plant. Maize is known by various common names but the most popular name is maize or corn (Paliwal, 2000). Maize is a fully domesticated plant which has lived with man and evolved since ancient times. It is completely dependent on human husbandry, does not grow in the wild and cannot survive in nature (Paliwal, 2000). Maize is the top most important cereal crop in terms of production of cereals of the world (Statista, 2018).

Globally, 765 million metric tons of maize was harvested in 2010 from just less than 153 million hectares. About 73% of this area was located in the developing world. Maize is currently produced on nearly 100 million hectares in 125 developing countries and is among the three most widely grown crops in 75 of those countries (CGIAR, 2016). It occupies less land area than either wheat or rice but has a greater average yield per unit area of about 5.5 tonnes per hectare (Ofori *et al.,* 2004). According to Paliwal (2000), the grain of maize is the most important component for which maize is cultivated, though every part, leaves, stalk, tassel, husk and cob is employed for different purposes.

Maize has attracted the attention in the world due to its importance being used as fodder and human food (Guruprasad *et al*., 2016). In many countries it has been contributing to human food security (Katinila *et al*., 1998). It is used in several ways more than other cereals, its principal use include human feed, both home cooked and industrial; fodder, feed for animal, fermentation and various industrial products (Paliwal, 2000). The grain is very nourishing, with about 70-72% assimilable carbohydrates, 4-4.5% fats and oils and 9.5-11% proteins (Larger & Hill, 1991). Another report shows that maize is a significant source of proteins

(10.4%), fat (4.5%), starch (71.8%), fiber (3%), vitamins and minerals like Ca, P, S and also containing a small amount of Na. Flour obtained from maize is treated as a good diet for the patients with heart diseases due to its low gluten (protein) content (Hamayun, 2003).

Among the cereal crops, maize is comparatively a new crop in Bangladesh. It was incepted during 1960 after the Second World War through testing some varieties provided by the CIMMYT mainly for research purpose (Karim, 1992). At present its cultivated area accounts near about 0.304 million hectares with a production of over two million tons a year. Almost the sole of the produced maize is used as livestock or poultry feed (Ullah *et al.*, 2017). Owing to its increasing importance, it has become a staple and cash crop for smallholder farmers (CIMMYT & IITA, 2010). As a result of the nutrient nature of maize, it is a preferred diet for several million poor consumers as well as one third of all undernourished children. Maize demand in developing countries will double and become the crop with the greatest production globally by 2050 according to CIMMYT & IITA (2010) estimate.

Nonetheless, maize has immense potential in the tropics and yield of up to 7.5 t / ha can be obtained if the crop is properly managed. Unfortunately, yields are still generally below 5 t ha^{-1} (FAO, 2007) and this low yield in tropical areas has been attributed to low nutrient status of tropical soils especially nitrogen, phosphorus and potassium resulting from the practice of slash and burn farming system associated with bush cultivated land and with excessive leaching of the soil nutrients. The low fertility status of most tropical soils hinders maize production as the crop is a heavy feeder (Steiner, 1991).

Maize although a robust growing plant in nature, is very sensitive to weed competition during the early stages of growth (Mabasa *et al.,* 1995; Kumar and Sundari, 2002). As a result the weeds cause low yields in maize by competing with the crop for nutrients, water, sunlight and space, the most critical resources for crop productivity. Sometimes, wide spacing and slow initial growth of maize favors the growth of weeds even before crop emergence. However, presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and thereby reduces sink capacity of crop resulting in poor grain yield. Thus yield losses due to season long weed infestation range from 30% to complete crop failure (Pandey *et al*., 2001). Uncontrolled weed growth may reduce maize yield as much as 90% (Ratta *et al.*, 1991). The critical period of crop weed competition is 3 to 6 weeks after sowing in case of maize. Hence, managing weeds during this period is the most critical for higher yields.

Weeds also pose severe problems for crop husbandry and infest fallow land, reduce soil fertility and moisture conditions and develop a potential threat to the succeeding crops (Khan *et al*., 2003). Thus, attention must be focused on weed control measures so as to maintain the competitive ability of the threatened crop by minimizing weed interference during the growth phases of crop. Accordingly, the nature of weed interference influences strongly the choice of weed control measures.

The methods of weed control include cultural, biological, chemical means among others. According to Singh *et al.* (1996), weeds control methods are divided into two: non-chemical and chemical methods. However, the conventional method of weed control such as hand weeding tends to be expensive especially where labor is not available during the peak workload (Khan *et al.*, 2000). Admittedly, chemical weed control in maize is the best method being used in the developing countries, as it is an effective and relatively inexpensive means for managing weeds in cereals (Ghana Grains Development Project, 1991).

Maize currently grown in Bangladesh is of yellow type and is used in the feed industry. The main source of our food crops are rice and wheat. Worldwide the maize grown for human consumption is called white maize which differs lacking anthocyanin compared to yellow maize. The flour of white maize is tastier than yellow maize. White maize is also superior to yellow maize in some nutrition especially protein content. White maize covers only 12% of the total acreage of the world which is mostly used as human food (FAO-CIMMYT, 1997). During 1970s the productivity of grown white maize was lower compared to those of yellow ones. With the advanced breeding approaches worldwide, recent reports demonstrate that the yield productivity of white maize is almost at par with those of the yellow ones (Akbar *et al.*, 2016). Since its inception the maize species grown in Bangladesh were yellow type except one variety named 'Suvra'. At present the yellow exotic hybrid maize is grown as a fodder crop which although mainly concentrate in the northern districts of Bangladesh (Ullah *et al.,* 2016). In comparison to the landraces, the modern improved varieties are higher yielders showing even 60% more seed yield (Kossou *et al*., 1993). The hybrid varieties show an average yield of 6.9 t ha^{-1} (BBS, 2016).

Growth and yield of maize are affected by varieties as well as on different management practices. Weed interference negatively affect the yield of maize. Weed directly competes with crops for nutrients, water, space and light. Weed crop competition is influenced by weed species, density and population in crops (Zanine and Santos, 2004). Very few or no research finding are available in our country on herbicidal application in white maize field. So, there is a wide scope to conduct research activities on the efficacy of herbicides controlling weed in white maize and to relate herbicides with varietal performance of white maize with the following objectives:

1. To evaluate the influence of herbicides on the performance of white maize varieties.
2. To compare the growth and yield of different white maize varieties.
3. To evaluate the interactions of white maize varieties and herbicides

CHAPTER II

REVIEW OF LITERATURE

In industrialized countries maize is largely used as livestock feed and as a raw material for industrial products, while in many developing countries, it is mainly used for human consumption. Maize is consumed mainly as second cycle produce in the form of meat, eggs and dairy products. The crop has immense potentiality for supporting food stuff of the huge population of Bangladesh in the near future when other crop's contribution will fall due to climate change. 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 Biology of maize

Maize or corn (*Zea mays*) is a plant that belongs to the family *Poaceae*. It is an emblematic tropical plant having a tall, leafy structure with a fibrous root system, supporting a single culm with as many as 30 leaves. It is susceptible to invasion by weeds *(*Paliwal, 2000*).*

Zea is a genus of the family *Poaceae*, commonly called as the grass family. Maize is a tall, monoecious annual grass with overlapping sheaths and broad signally distichous leaf blades (Biology Documents, 2014).

Maize is a plant of the tribe Maydeae of the grass family *Poaceae*. "*Zea*" (zeal) evolved from an ancient Greek name for a food grass. The genus *Zea* is composed of four species of which *Zea mays* L. is commercially important. The other species are referred to as teosintes, are largely wild grasses endemic to Mexico and Central America. The number of chromosomes in *Z. mays* is 2n = 20 (Tripathi *et al.*, 2011).

One or two lateral branches are developed more prominently by the leaf axils in the upper part of the plant (Paliwal, 2000). A female inflorescence resolves these lateral branches. The female inflorescence is known as silk which reveals into an ear which is well covered by the husk leaves that serves as the storage part of the plant. In addition, the plant is resolved by a male inflorescence. The male inflorescence is called tassel with prominent central spike and many lateral branches with male flowers, all of which produce abundant pollen grains (Paliwal, 2000).

Maize plants have staminate spikelets in long spike-like racemes that form terminal panicles (tassels) and pistillate inflorescence. Spikelets occur in 8 to 16 rows in the inflorescence, approximately 30 cm long. The complete structure (ear) is covered by numerous broad foliaceous bracts and a mass of long styles (silks) evolving from the tip as a mass of silky threads (Biology Documents, 2014).

Maize develops inflorescences with unisexual flowers which are always borne in different parts of the plant. The female inflorescence is known as ear that arises from the axillary bud apices and the male inflorescence is known as tassel that develops from the apical growing point at the top of the plant (Mienwipia, 2013). Paliwal (2000), however, revealed that maize resembling other plants tends to maintain homeostasis symmetry between the roots mass and shoot mass. If a soil-acquired resource, such as water or nutrients is insufficient or deficit, more assimilate goes to the root system, and root growth is preferred over shoot growth. Likewise, if radiation is insufficient for growth as a result of shading or cloudy conditions more assimilate become allotted for shoot growth and the root to shoot ratio declines.

2.2 Ecology of maize

Maize can be grown in a wide range of climates. In world aspects, it is sown at the beginning of the rain, but due to its wide variation an adaptation capability, the crop flowers at different times depending on the cultivar selected. Some of the cultivars mature as early as 60 days after emergence while others need over 40 weeks. Maize will perform well on most textural soils, particularly a nutrient rich soil with adequate drainage to allow for the maintaining sufficient oxygen for good root growth and activity, and necessary water-holding capacity to provide adequate moisture throughout the growing period with a pH ($CaCl_2$) in the range of 5.5 and 7.0 (Farrell and O'Keeffe, 2007).

In addition, maize is grown over a range of agro climatic conditions. In fact the adaptability of maize to diverse environmental condition is exclusively different from any other crop (Dowswell *et al.,* 1996). Beside this, maize can be cultivated on a wide variety of soils, but do its best on well-drained, well-aerated, deep warm loams and silt loams having enough organic matter and well supplied with available nutrients.

Notwithstanding, it grows on a wide range of soils, it does not provide good result in respect of yield when grown on poor sandy soils, unless provided with heavy application of fertilizers. When the crop is grown on heavy clay soils, deep cultivation and ridging is necessary for maintaining good drainage condition. Maize also can be grown in swamps with the condition of providing adequate drainage. Maize can't grow on water logging condition; the crop will die if it stands in water for a period of two days (Dowswell *et al.,* 1996).

Maize is mainly grown in a warm weather condition and it can withstand a wide range of climatic conditions. Maize can be cultivated in areas having a well distributed annual precipitation of 60 cm throughout its growing stages. More than 50% of total water requirements of maize is needed in about 30 to 35 days following tasseling. A poor yield and shriveled grain in maize may be found if soil moisture is inadequate at grain filling stage. It cannot tolerate frost irrespective of its growth stages. A cloudy period for long time may damage the crop but a alternate fashion of sunlight and clouds of rain may favor the crop growth. In the subcontinent, maize is normally grown in Kharif season due to the availability of high temperature and rain required for optimum growth and of maize. However, due to the introduction of new verities and advanced crop production technology, maize now most popularly is grown in winter (Rabi) season (Tripathi *et al.,* 2011).

2.3 Biology and ecology of white maize varieties

PSC-121 is one of the recently developed hybrid white maize varieties with medium Duration with a maturity period of 90-100 days. However, the maturity duration may be prolonged in winter growing season. Genetically the variety is a double cross hybrid having bold grain quality which remains green at maturity. This variety is mostly suitable for growing in kharif season planting with a outstanding characteristic of tolerating drought. The crop shows good stand ability (Proline seeds, 2014)**.** Direct review of literature on biology and ecology of the variety YANGNUO-3000 used in this experiment is not available yet in Bangladesh as very few or no experiments are conducted on this variety. But review of literature on the variety YANGNUO-7 is available which a related variety to YANGNUO-3000. In an experiment conducted at the farm of Sher-e-Bangla Agricultural University to evaluate the performance of seedling transplantation of four white maize hybrid varieties (Chamgnuo-1, Changnuo-6, Q-xiannuo-1 and YANGNUO-7) was shown that YANGNUO-7 is the earliest variety reaching to maturity in 108 days giving the lowest performance in respect 100-seed weight, per hectare yield etc. (Ullah *et al.*, 2016).

2.4 Weeds as pest in crop production

A number of factors are involved in reducing maize growth and yield by making a competition with the crop for nutrients, water, sunlight and space and weed is the most critical one. The Photosynthetic efficiency, dry matter production and distribution to economical parts of maize plant are hindered due to the presence of weed. Because the presence of weed reduces sink capacity of crop resulting in poor grain yield. The yield loss may reach up to 30% in maize due to weed infestation (Pandey *et al*., 2001).

Zimdahl (2007) indicated that weeds are unique plants with some particular adaptations which make them capable to sustain and prosper in disturbed environments.

Navas (1991) demonstrated that weeds as a plant forms populations that are capable to take entry in the habitats cultivated, disturbed or occupied by man and potentially depress or displace the plant populations which are intentionally cropped for the fulfillment of ecological and or aesthetic interest.

Avery (1997) reported weeds as the oldest pest in agriculture and considered it as one of the main limiting factors in profitable production of crop.

To consider a plant as weed must have the characteristics that make it unique from other plants with successful invading, establishment and persisting capability in an agricultural setting (Monaco *et al*., 2002).

Weeds are classified as annual, biennial or perennial. The weeds that complete their life cycle (seed to seed) in less than one year or in one growing season are considered as annual weeds. A biennial weed lives between one and two year but not more than two years; while, perennial weed lives more than two years and is usually divided into simple and creeping perennials. Simple perennial weed propagates by spreading seed and through vegetative parts but the normal mode of reproduction is seed. On the other hand, creeping perennial also reproduce by seed and vegetative plant parts but vegetative part is of prime importance (Monaco *et al.*, 2002).

According to Ziska and Dukes (2011) many plant species that are (crop) cultivated intentionally by farmers are commenced from weed species and show similar characteristic features both genetically and ecologically and as such some weeds behaves as crops depending on location and purpose. In like of this weeds may play role as the alternative host for several crop insect pests such as nematodes, aphids, thrips, weevils, flies and etc. by giving shelter to these pests and pathogens rendering difficulty in controlling the pests.

2.5 Chemical weed control

Some weeds are very difficult to control using hand weeding. In those cases chemical weeding can be used very easily and comfortably. In some cases, pre-planting tillage may also be reduced by using herbicides. Herbicides have the capability to cover huge space in a specific growth stage while more labor and time are needed to do same coverage in hand weeding among several advantages (Singh *et al.*, 1996).

The selectivity characteristics of chemical herbicides have been found to be immensely helpful to kill particularly targeted species (weeds) despite of the presence of economic crops. In addition, using chemical herbicides for controlling weeds have several advantages over other weed control methods and these are: herbicides can control inter and intra row weeds; use of pre-emergence herbicides kill weeds before the germination of the crop and thus the crop get rid of weed competition that result in vigorous growth of the crop by enabling the plant capacity to suppress weed; herbicides control weeds when the soil is not workable due to interminable rains (Singh *et al.*, 1996).

In spite of the above mentioned advantages of using herbicides in controlling weeds, back-to-back they have some disadvantages which can be beaten by understanding the proper application methods. There is no self-regulated momentous that can stop a farmer from applying chemicals in an improper fashion until he observes negative impact in the crops sprayed or in the rotation crops that come after. Herbicides may drift, wash off and run off and cause significant damage to neighboring desirable organisms. Rich farmers store various types of herbicides and apply depending on the diversity of farming. But low income farmers have no capability to make a stock of several herbicides. That's why they use a single type of fertilizer year after year and thus weed develops resistance power to those herbicides. So, gathering knowledge for the identification of the proper type of herbicides and their proper usages should be considered very carefully as an error in the use of herbicides may result in fatal loss in crop economy (Singh *et al.*, 1996).

Low yield in maize is primarily attributed by poor weed management. The conventional method of controlling weed which is popularly known as hand weeding is costly and always not available at critical stages to control weed. In the first few weeks of crop growth, application of herbicide is a combative and auspicious way to manage weeds (Baker and Terry, 1991).

Akobundu (1987) indicated that mare than one weed species can be controlled by applying herbicides. Weed management strategies to be succeed completely should match the particular problems that are found in a field with a primary knowledge on weed and crop ecology and biology like weed-crop growth characteristics and the dynamics of weeds emergence (Akobundu, 1987; Labrada, 1998).

2.6 Performance of varieties

Akbar *et al.* (2016) reported that the plant height of PSC-121 was 259 cm, 257 cm and 288 cm when plant spacing was maintained to 60 cm × 25 cm, 50 cm × 25 cm and two plants in a row, respectively when the experiment was set to show the effect of hybrids and planting arrangements on plant morphological characters of maize. The result indicated that the wider the spacing taller the plant and PSC-121 was more responsive to the wider spacing than the other variety KS-510.

Ullah *et al.* (2016) conducted an experiment to evaluate the performance seedling transplantation of four white maize hybrids and found 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).

Ullah *et al.* (2017) observed that the plant height of the modern white maize varieties varied significantly giving a wide range of 167 to 222 cm. Among the varieties, the Suvra showed the highest value while the Plough-201given the lowest plant height value. The Plough-202 gave identical result to that of the Plough-201 but a higher value as compared to that of the Plough-201 (172 cm) which was significantly lower than that of the white maize variety Suvra.

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 7.103 t ha^{-1} and 10.126 t/ha per ha 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.

An experiment was carried out by Ullah *et al.* (2016) for showing the effect of planting geometry on the performance of white maize varieties and where it was shown that out of four varieties Changnuo-6 and YANGNUO-7 resulted in more average number of leaves (4.00) than others (3.33-3.88). Changnuo-6 showed the highest number of grains per cob (419), while the lowest number of grains was obtained from Yangnuo-7 (276). Consequently, 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.

Number of leaves in the modern varieties differed from 11.66 to 13.66 per plant with a mean value of 12.88 per plant. Notwithstanding, 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 (Ullah *et al.*, 2017).

Khan *et al.* (2016) noted that among three hybrid maize varieties- P-3025, P-32T78, P-3203, 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 a) recorded that BARI released white maize variety 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. In the experiment, it was also reported that among the five varieties used (Amper pop, Sadaf, Suvra, Savar-2 and Barnali) 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) narrated that among three varieties (DK-919, DK-5219 and Pioneer-30Y87) late maturing maize hybrid Pioneer-30Y87 exhibited not only maximum leaf area index, but exceeded in crop growth rate and plant height. 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. Even though, yield of individual plant diminished with decreasing row spacing from 75 to 45 cm, but it was well recouped in early maturing hybrid (DK-919) than mid and late by increase in number of cobs and number of grains per unit area.

2.7 Performances of herbicides

Tahir *et al.* (2009) carried out a field experiment to examine the effect of pre-emergence herbicide Penthalin plus-35EC (Pendimethalin 20 % + prometryn 15 %) on weeds, growth and yield of maize (*Zea mays* L.). The experiment was set with eight treatments: weedy check, Penthalin plus-35EC @ 2000, 2500, 3000, 3500, and 4000 ml ha^{-1} (Pendimethalin + prometryn @ 700, 875, 1050, 1225 and 1400 g a.i ha^{-1}), Stomp-35EC @ 3000 ml ha^{-1} (Pendimethalin @ 1050 g a.i. ha^{-1}) and manual hoeing. Major weeds found in the field were *Cyperus rotundus*, *Tribulus terrestris*, *Dactyloctenium aegyptium* and *Cyndon dactylon*. In the experiment it was shown that all the growth and yield parameters were recorded highest in the plot where hand weeding was done following stomp 35-EC (Pendimethalin @ 1050 g a.i. ha^{-1}) and Penthalin plus-35EC (Pendimethalin + Prometryn @ 1225 g a.i. ha^{-1}). In case of grain yield in hand weeding, Stomp 35-EC (Pendimethalin @ 1050 g a.i. ha^{-1}) and Penthalin plus-35EC (Pendimethalin +

Prometryn @ 1225 g a.i. ha^{-1} was 8.05, 7.92 and 7.671 t ha^{-1}, respectively as compared to 4.561 t ha^{-1} for no control plot. The study was concluded by reporting that for controlling weed in maize field, use of pendimethalin group herbicides are effective to give yield to satisfactory level.

A field experiment was conducted by Arif *et al*. (2011) to study the performance of some herbicides on the growth and yield of maize in terms of controlling weeds in maize field. The parameters studied in the experiment were plant height (cm), days to 50% silking, cob length (cm), number of grains per ear, 1000 grain weight (g) and grain yield (kg ha^{-1}). In the experiment it was very prominent that weed population was considerably reduced in the herbicide treated plots over the weedy check plots and it was noted the Primextra gold 720 SC @ 2000 ml ha^{-1} was effective in controlling broad leave weeds. On the other hand, Equip 2.25% OD @ 2000 ml ha^{-1} was more effective in controlling sedges. The herbicides showed a significant impact on ear height (cm), number of grains per cob, 1000 grain weight (g) and grain yield (kg ha^{-1}) while other parameters were found non-significant. The highest number of grains per cob (298.8), 1000 grain weight (268.8 g) and grain yield (7187 kg ha^{-1}) were reported in plots treated with Equip 2.25 OD @ 2000 ml ha^{-1} that was succeeded by Primextra gold 720 SC @ 2000 ml ha^{-1}. In the concluding remark it was noted that application of Equip 2.25 OD @ 2000 ml ha^{-1} and Primextra gold 720 SC @ 2000 ml per hectare reduces weed density significantly and boosts up grain yield.

Mize *et al.* (1998) performed an experiment and gave suggestion about the use of carfentrazone-ethyl herbicide for controlling broad leaf herbicide in maize field. Thompson *et al.* (2000) carried out an experiment for studying the absorption behavior and ultimate fate of carfenntrazone-ethyl herbicides when applied for controlling weed in maize field.

Hassan *et al.* (2010) conducted an experiment for studying the effect of three herbicides pendimethalin (Stomp 330E) @ 1.32 and 0.66 kg a.i. ha^{-1}; s-metolachlor (Dual gold 960 EC) @ 1.44 and 0.72 kg a.i ha^{-1} and atrazine (Atrazine

38 SC) @ 1.57 and 0.78 kg a.i ha^{-1} and a weedy check treatment on the growth and yield of maize considering weed density (after 30 days of herbicides application), fresh weed biomass, plant height, leaf area, 1000- kernel weight, kernel yield and phytotoxicity of herbicides on maize plant parameters. Herbicide treated plots showed significant differences in all parameters over the weedy check plots. The best performance was recorded from s-metolachlor (Dual gold 960 EC) @ 0.72 kg a.i. ha^{-1} treated plots in respect of all parameters considered.

Ali *et al*. (2014) performed an experiment using eight treatments such as weedy check (control), manual hoeing, bentazon @ 720, 840, 960, 1080 and 1200 g ha^{-1}, (as post-emergence), and pendimethalin @ 1031 g ha^{-1} (as pre-emergence). In the experiment, it was shown that all the herbicide treated plots showed decreased weed density by 46-93%, weeds fresh weight by 39-98% and weeds dry weight by 42-88%. Manual hoeing gave the highest grain yield followed by the treatment with pendimethalin. Although higher rates of bentazon were found inefficient to manage weeds, but the result was satisfactory giving a yield of 5.60 t ha^{-1}.

Khatam *et al.* (2013) reported that plant height, number of cobs plant-1, number of grains cob^{-1}, cob length, 1000 grain weight, biological yield and grain yield of maize were all significantly affected by the applied weed control treatments- weedy check, hoeing, Dual gold (smetolachlor @ 600 mL ac^{-1}), Heera (propisochlor 40% SE @ 600 mL ac^{-1}), Portico (nicosulfuron 75% WG @ 30 g ac^{-1}) and Atrazine 38% SC @ 400 mL ac^{-1} when the field was infested with *Cynodon dactylon, Cyperus rotundus, Dactyloctenium aegyptium, Trianthema portulacastrum and Achyranthus aspera*. Hoeing showed in 85.5% weed control and held first position which was followed by Dual gold as the most efficient herbicide and placed second among the treatments with 72.35% weed control over weedy check.

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.

Kandasamy (2018) conducted an field experiment taking eleven different weed management practices to study the feedback of irrigated maize *(Zea mays* L.) to different weed management practices. Among the various weed management practices, pre-emergence application of atrazine 1.0 kg ha^{-1} on 3 DAS + post emergence application of 2,4-D @ 0.75 kg ha^{-1} on 21 DAS showed significantly higher result compared to that of other treatments by recording higher values of growth and yield attributes such as plant height, LAI, DMP, cob length, number of grains cob^{-1}, cob diameter etc., and the minimum weed population, weed biomass and nutrient depletion by weeds with the maximum weed control index (91.38%) promoting higher yield attributes and grain yield (6342 kg ha^{-1}) and it was pursued by pre-emergence application of metribuzin 1.0 kg ha^{-1} on 3 DAS + post emergence application of 2,4-D @ 0.75 kg ha^{-1} on 21 DAS. The weedy check plot showed the highest weed population rendering the lowest grain yield (2.8 t ha^{-1}).

Akram *et al.* (2012) ran an experiment to examine the effect of some pre- and post-emergence herbicides to manage the weeds in maize (*Zea mays* L.) field. The experiment consisted of eight different treatments including six herbicides, hand weeding and untreated control. Among six, two herbicides were used as pre-emergence i.e., Relax 50EC (Acetochlor) @ 1250 ml ha^{-1}, Primextra Gold 720EC

(Atrazine + S-metolachlor) @ 1000 ml ha^{-1}; while rest four of the herbicides were used as post emergence i.e., Bestrazine 38 SC (Atrazine) @ 500 ml ha^{-1}, Valent 470EW (Bromoxynil + MCPA + Metribuzin) @ 1250 ml ha^{-1}, Clincher 60EC (Bromoxynil + MCPA) @ 750 ml ha^{-1} and Rebound 52% WP (Atrazine + Nichosulfuron) @ 1250 g ha^{-1}. All the herbicide treated plots became affected significantly in terms of weed density, dry weeds biomass, 1000 grain weight and grain yield. The most efficient pre emergence herbicide in diminishing weed dry biomass and promotimg maize grain yield was Primextra Gold 720 EC @ 1000 ml ha^{-1} which resulted in grain yield of 3267 kg ha^{-1}. On the other hand, Rebound @ 750 ml ha^{-1} (post emergence) decreased weed dry weight to 38.33 g m^{-2} and produced grain yield of 3000 kg ha^{-1}. More grain yield per hectare was recorded from Valent, Bestrazin and Clincher as compared to untreated plots.

Mienwipia (2013), performed an experiment using nine different treatments considering four groups of herbicides with control plots of hand weeding and noted that all the herbicide treated plots increased will mortality, leaf area duration (LAD), crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) along with grain yield per hectare most especially in case of pre emergence herbicides.

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}). Punia *et al.* (2005) reported the highest grain yield and number of tillers control treatment and carfentrazone-ethyl at 25 g ha^{-1} but were statistically similar with carfentrazone-ethyl at 15 and 20 g $ha^{-1}$and significantly higher than 2,4-D treatments.

Mustari *et al.* (2014) revealed that among four tested herbicides (Pendimethalin, Carfentrazone-ethyl + Isoproturon, Carfentrazone-ethyl and 2,4-D), Carfentrazone-ethyl gave the best finding in terms of weed control efficiency (79.68%), while Pendimethalin showed the worst (52.74%). Carfentrazone-ethyl + Isoproteuron attributed to the maximum tillers per unit area (226.3 m^{-2}) and the maximum total dry matter (1342 g m^{-2}). At the end, Carfentrazone-ethyl + Isoproteuron also accompanied with the highest grain yield of 3.56 t ha^{-1} and with the maximal harvest index of 0.42. Carfentrazone-ethyl + Isoproteuron carried out by one hand weeding also contributed to statistically similar grain yield of 3.33 t ha^{-1}.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during November, 2017 to April, 2018 to study the varietal performances of white maize as influenced by different weed management practices. 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 in the 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 treatment factors were used in the present experiment to get 12 treatment combinations which were as follows:

Factor A: Variety: Levels: 02

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

Factor B: Weed control measures: Levels: 06

1. T_0= No Weeding
2. T_1= Carfentrazone + Isoproturon 500g @ 1.5 g/ha (Affinity 50.75% WP)
3. T_2= Carfentrazone + Isoproturon 500g @ 2.0 g/ha (Affinity 50.75% WP)
4. T_3= Pendimethalin @ 2.0 l/ha (Panida 50EC)
5. T_4= Pendimethalin @ 3.0 l/ha (Panida 50EC)
6. T_5= One Hand Weeding at 45 DAS

Treatment combinations: Twelve treatment combinations are as follows-

V_1T_0, V_1T_1, V_1T_2, V_1T_3, V_1T_4, V_1T_5, V_2T_0, V_2T_1, V_2T_2, V_2T_3, V_2T_4, V_2T_5

3.4.2 Experimental design and layout

The experiment was laid out in Split Plot design with three replications. Each block, representing a replication, was divided into 12 unit plots where treatment factor A was given in the main plot and treatment factor B was placed in the sub plot in a random fashion. The total number of unit plots was 36. The size of each unit plot was 2.40 m × 1.50 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 25, 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 Table 1. 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 before flowering.

Table 1. 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

Table 1 (cont'd)

Name of manure and fertilizer	Doses	Methods of application
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 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 dough stages.

3.10.2 Weeding

Weeding was done as a part of the treatment factor B (one hand weeding at 45 days after sowing).

3.11 Harvesting and post harvest processing

The crop was harvested at 10th 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 record data.

3.12 Sampling

The sampling was done consecutively at 60, 80 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 of five plants were recorded at each harvest.

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 %)
5. Relative weed density (%)

Growth parameters

1. Plant height (cm)
2. Number of leaves $pant^{-1}$
3. Leaf Area Index (LAI)
4. Crop growth rate (CGR)

5. Leaf area Duration (LAD)

Yield parameters

1. 100 seed weight (g)
2. Number of grains per cob
3. Grain yield (t ha^{-1})
4. Stover yield (t ha^{-1})
5. Biological yield (t ha^{-1})
6. Harvest index (%)

3.14 Procedure of recording data

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 data collection and analysis

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 parameters were analyzed by following the formulae 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

RWD% = $(W_i-W_t)\times100$

Where, RWD = Relative weed density

W_i = No. individual weed species present in the plot

W_t = Total no. of weeds present in the plot

3.14.2 Growth parameters

3.14.2.1 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).

3.14.2.2 Number of leaves plant^{-1}

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

3.14.2.3 Leaf area index

The length and width of all green leaves of selected plants were measured using a meter scale. The product of the length and width of each leaf was multiplied by 0.75 to give the area for each leaf (Fageria *et al*., 2006). 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 selected plants and then the mean leaf area of a plant was determined for each treatment. Leaf Area Index was determined using the relation:

Leaf area index = Total leaf area of plant / inter row spacing x intra row spacing (cm), (Maddonni & Otegui, 1996).

3.14.2.4 CGR and LAD

For each treatment plot, five maize plants were selected and identified for data collection. The plants height was measured from the base at soil level to the crest of the uppermost leaf. The mean value was calculated for the determination of the growth rate. The crop growth rate (CGR), leaf area duration (LAD) of each treatment plant was calculated using the formulae below:

- Crop growth rate = $(W_2 – W_1) / (T_2 – T_1)$

 Leaf area duration =[{(LAI_1 + LAI_2)/2}* (T2-T1)]

Where ΔT is changed in time, T2, T1=time in days, W2, W1 =dry weight of crops per meter square and LAI_1 and LAI_2 refers to leaf area index at time T2 and T1and (Hunt, 1979).

3.14.3 Yield parameters

3.14.3.1 100 seed weight (g)

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.

3.14.3.2 Number of grains per cob

The total number of kernels per ear of the five selected plants was ascertained by multiplying the number of kernel rows by number of kernels per row.

3.14.3.3 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} [As 83000 plants stand when planting spacing is maintained to 60cm × 20cm. (Adeboyee *et al.*, 2006)]

3.14.3.4 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} [As 83000 plants stand when planting spacing is maintained to 60cm × 20cm. (Adeboyee *et al.*, 2006)]

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

Biological yield was determined by summing up the total grain yield (t/ha) with the total stover yield (t/ha).

Biological yield (t/ha) = Grain yield (t/ha) + Stover yield (t/ha)

3.14.3.6 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 split plot design with the help of a computer package program MSTAT-C. The significance of the difference among treatment means were estimated by the Least Significant Difference (LSD) test at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

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

4.1 Weed parameters

Effect of weed control measures on the weed features

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 56.85% of total weed community present in per square meter of the experimental field. From the experiment it was revealed that the pendimethalin @ 3.0 l/ha treated plots showed supreme result regarding reduced weed density (85.92 nos. m^{-2}), reduced weed biomass (42.25 gm^{-2}) and weed control efficiency (74.24%) over the other weed control measures used in the experiment (Table 2). It is satisfactory to mention that all the herbicide treated plots performed better than the manual weeding at 45 days and weedy check. In the experiment it was also revealed that *Eleusine indica, Cyperus rotundus, Cynodon dactylon, Jussiaea repens* togetherly contrinuted above 75% of the total weed density. It was also found that *Eleusine indica* had the maximum relative weed density followed by *Cyperus rotundus, Cynodon dactylon* and *Jussiaea repens*. The relative weed density (%) of all the weed species was most efficiently reduced by pendimethalin @ 3.0 l/ha inferring that the treatment can be used effectively to control this group of weed species. These findings were in line with those of Patell *et al.* (2006), Tahir *et al.* (2009) and Khan *et al.* (2016) who also reported the best outcome from pendimethalin treated plots.

Effect of variety on the weed features

Figure 1 shows the varietal performances of white maize variety in respect of weed features. Between two varieties, V_1 showed lower weed density (No. m^{-2}) (175. 306), weed biomass (95.056 gm^{-2}) and relative weed density (%) of *Eleusine indica*, *Cyperus rotundus*, *Cynodon dactylon*, and *Jussiaea repens.* Higher weed control efficiency (47.20%) was also showed by V_1 as compared to that of V_2. Though there was numerical difference between the varieties, no statistically significant difference was found. The result was in line with that of Khan *et al* (2016).

Interaction effect of weed control measures variety on the weed features

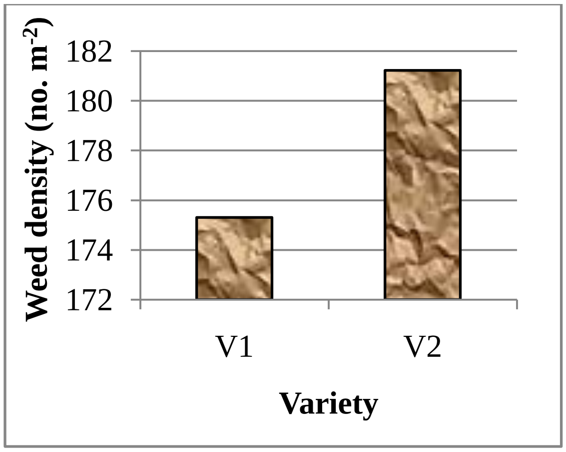
Data placed on Table 3 shows the interactive influence of variety and weed control measures on weed features. From the experiment, the highest weed density (348.3 no. weed m^{-2}) and the maximum weed biomass (185.67 g m^{-2}) were recorded from V_2T_0 and it was statistically similar with V_1T_0. The minimum weed density (83.17 no. m^{-2}) and biomass was (43.17 g m^{-2}) was reported from V_1T_4. On the other hand, the maximum weed control efficiency (74.54%) was obtained from V_1T_4 and it was statistically similar with V_2T_4 taking V_1T_0 V_2T_2 as the base of weed control efficiency (0%). In the experiment it was also revealed that *Eleusine indica, Cyperus rotundus, Cynodon dactylon, Jussiaea repens* togetherly contrinuted above 73% of the total weed density. However, the weed with maximum relative weed density was *Eleusine indica* showing maximum relative weed density (67.81 %) in V_1T_0 treated plots and it was statistically similar with $V_2T_{0.}$ The minimum relative weed density was recorded from V_1T_4 referring the interaction as the superior one. The result was in line with that of Khan *et al* (2016).

Table 2. Effect of weed control measures on the weed density, biomass, weed control efficiency and relative weed density

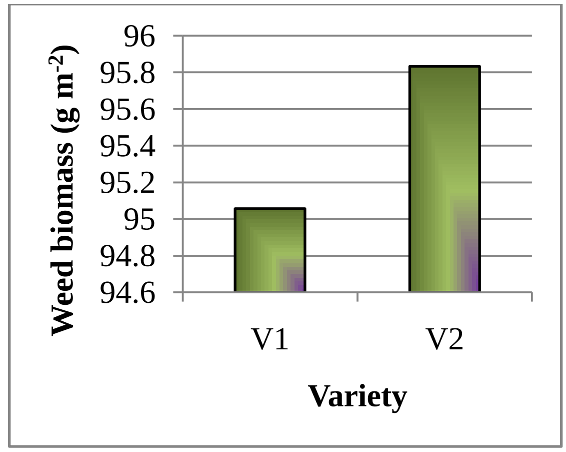
Measures	Weed density (No. m^{-2})	Weed biomass (g m^{-2})	WCE* (%)	Relative weed density (%)			
				Eleusie indica	***Cyperus rotundus***	***Cynodon dactylon***	***Jussiaea repens***
T_0	333.3a	179.8a	0.0d	66.51a	6.783c	7.947bc	2.508e
T_1	129.7c	97.17c	53.82b	45.2de	16.41a	13.84a	8.342c
T_2	153.2c	69.17d	60.23b	55.86bc	17.34a	9.375b	9.368bc
T_3	130.5c	65.58d	60.84b	51.4cd	9.248c	12.50a	12.99a
T_4	85.92d	42.25e	74.24a	42.60e	12.96b	12.57a	11.44ab
T_5	237.0b	118.7b	28.72c	58.78b	7.957c	6.712c	5.537d
$LSD_{(0.05)}$	30.64	13.96	9.028	6.851	3.025	2.419	2.795
CV (%)	14.27	12.15	16.15	10.65	21.32	19.14	27.74

*weed control efficiency

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), T_5= One hand weeding at 45 DAS.



(a)



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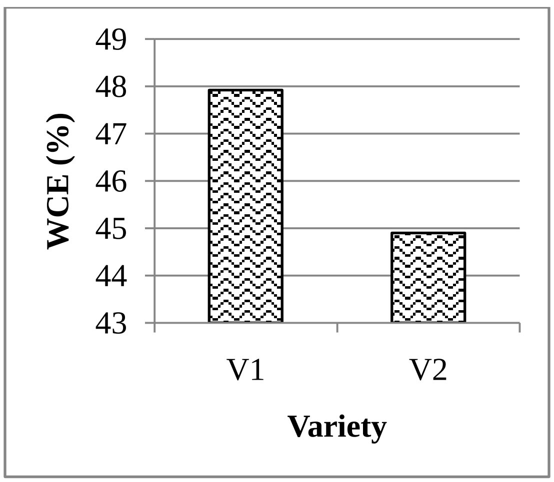
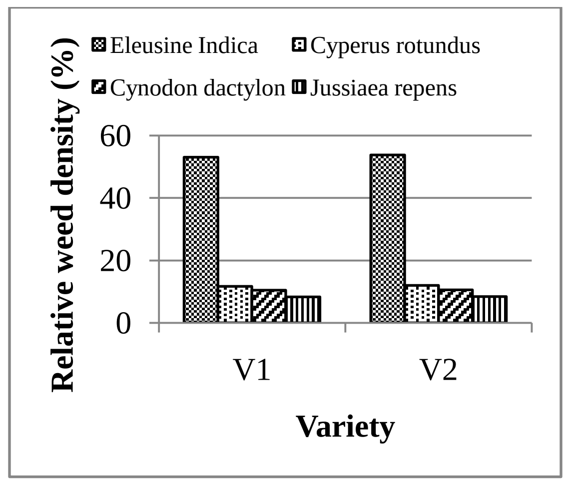


(c)



(d)

V_1 = PSC-121, V_2 = Yangnuo-3000 [$LSD_{0.05}$ = 25.46, 8.0367, 5.07, 3.13, 1.33, 0.078 and 0.307 for weed density (no m^{-2}), weed biomass (g m^{-2}), WCE (%), Relative weed density (%), Relative weed density of *Eleusine indica*, *Cyperus rotundus*, *Cynodon dactylon*, and *Jussiaea repens*, respectively]

Fig. 1. Effect of variety on the weed features [(a): Weed density; (b): Weed biomass; (c): WCE and (d): Relative weed density]

Table 3. Interaction effect of weed control measures and variety on the weed features

Treatment Comb.*	Weed density (No. m^{-2})	Weed biomass (g m^{-2})	WCE (%)	Relative weed density (%)			
				Eleusine indica	***Cyperus rotundus***	***Cynodon dactylon***	***Jussiaea repens***
T_0V_1	318.3 a	174.00a	0.0e	67.81a	5.53e	7.667ef	2.53e
T_1V_1	125.3cd	97.33c	57.0c	46.07de	18.09a	15.01a	7.74cd
T_2V_1	157.0 c	73.83d	61.3bc	55.7b-d	17.74a	8.49c-f	9.12b-d
T_3V_1	126.3cd	64.67d	61.3b	56.25bc	7.48de	11.90a-c	13.29a
T_4V_1	83.17 d	43.17e	74.5a	36.14f	11.92bc	13.61ab	11.87ab
T_5V_1	241.7 b	117.33b	33.2d	56.26bc	9.00c-e	6.217f	5.42de
T_0V_2	348.3 a	185.67a	0.00e	65.20ab	8.03de	8.227d-f	2.48e
T_1V_2	134.0 c	97.00c	50.5c	44.39ef	14.73ab	12.68ab	8.94b-d
T_2V_2	149.3 c	64.50d	60.3c	55.97bc	16.94a	10.0b-e	9.61a-c
T_3V_2	134.7 c	66.50d	60.3c	46.7cde	11.02b-d	13.10ab	12.70ab
T_4V_2	88.67 d	41.33e	73.9b	49.0cde	13.99ab	11.54b-d	11.02a-c
T_5V_2	232.3 b	120.00b	24.2d	61.30ab	6.91de	7.207ef	5.65de
$LSD_{(0.05)}$	43.34	19.68	12.76	9.68	4.27	3.42	3.95
CV (%)	14.27	12.15	16.15	10.65	21.32	19.1z	27.74

*** Combination**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.2. Growth parameters

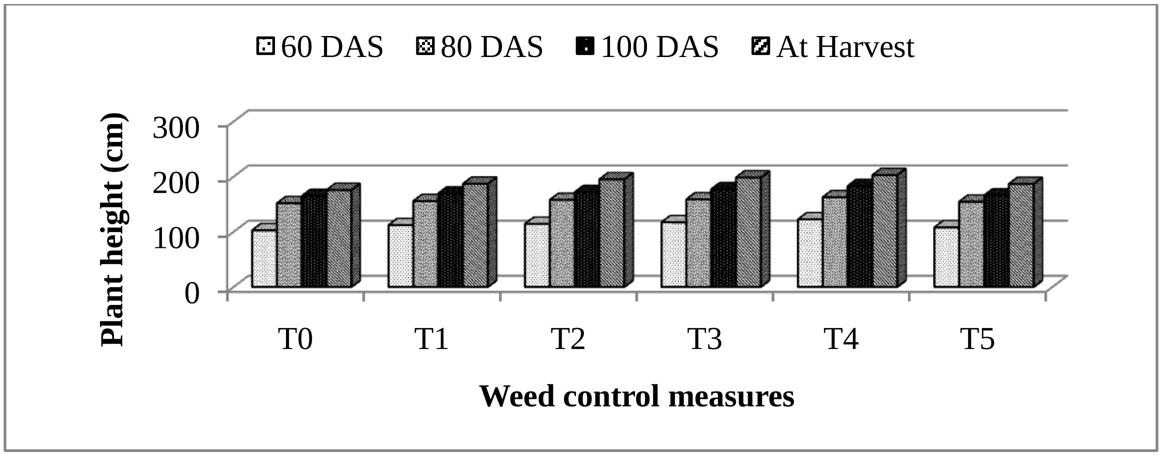
4.2.1. Plant height (cm)

Effect of weed control measures

Plant height is an important parameter of plant growth and development. Generally, the higher the plant height the more is the chance to intercept photosynthetic radiation. The data on plant height recorded at 60, 80and 100 DAS and harvest are given in the Figure 2. The plant height was influenced significantly by different weed control measures. The maximum plant height (122.6 cm, 162.8 cm, 183.0 cm and 202.9 cm at 60, 80, 100 DAS and at harvest, respectively) was recorded from T_4 treatment which was statistically at par with $T_{3;}$ $T_{3,}$ T_2, T_1 & T_5; T_3, T_2 and T_3, T_2 at 60, 80, 100 DAS and harvest respectively. The minimum plant height (102.8 cm, 151.8 cm, 164.9cm and 175.8 cm at 60, 80, 100 DAS and harvest, respectively) was noted from T_0 treatment which was statistically similar with $T_{5;}$ $T_{3,}$ T_2, T_1 & T_5; T_5, T_1 and T_5, T_1 at 60, 80, 100 DAS and harvest, respectively. The variation in plant height of maize due to weed control practices could be attributed to varying degrees of weed competition period for available resources. These findings were in line with that of Tahir *et al.* (2009), who reported maximum plant height by using pendimethalin (statistically at par with control treatment) and minimum plat height from no weeding plots.

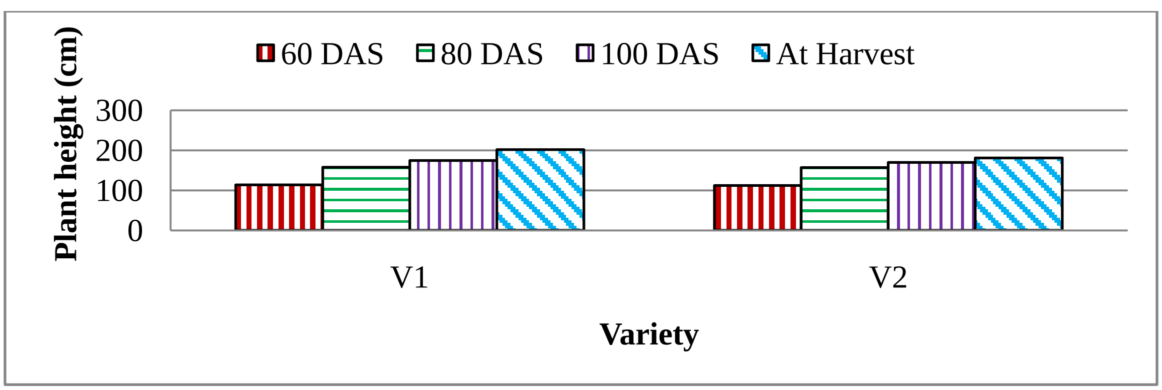
Effect of variety

Between two varieties the maximum plant height (113.53, 157.639, 174.572 and 201.667 cm at 60, 80, 100 DAS and harvest, respectively) was recorded in PSC-121as compared to that of Yangnuo-3000 which showed plant height of 112.222, 156.417, 169.594 and 180.506 cm at 60, 80, 100 and harvest, respectively as shown in the Figure 3. The plant height at 60 DAS and harvest was significantly higher than Yangnuo-3000. At 80 and 100 DAS, the plant height was not significant between two varieties. This finding was indirectly related with that of Akbar *et al.* (2016) who reported maximum plant height in PSC-121.



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 10.72, 15.16, 16.14 and 19.65 at 60, 80, 100 and harvest, respectively)

Fig. 2. Effect of weed control measures on the plant height (cm)



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 0.91, 11.19, 21.30 and 16.42 at 60, 80, 100 and harvest, respectively)

Fig. 3. Effect of variety on the plant height (cm)

Interaction effect of weed control measures and variety

Significant variation was observed on plant height influenced by combined effect of variety and weed control measures (Table 4). Results revealed that the tallest plant (126.8 cm, 169.70 cm, 189.80 cm, and 216.10 cm at 60, 80, 100 DAS and harvest, respectively) was achieved from the treatment combination of $V_2T_{4,}$ $V_1T_{1,}$ $V_1T_{4,}$ and $V_1T_{4,}$ at 60, 80, 100 DAS and harvest, respectively. On the other hand, the shortest plant was obtained from V2T0-97.33 cm, V1T0-142.00 cm, V1T0-159.30 cm and V2T1-170.70 cm at 60, 80, 100 DAS and at harvest respectively which were statistically similar with V_2T_5; V_1T_5, V_2T_1, & V_2T_5; V_1T_2, V_1T_5, V_2T_0, V_2T_1, V_2T_2, V_2T_3 & V_2T_5 and V_1T_5 & all the combinations of weed control measures with V_2 at 60, 80, 100 DAS and harvest respectively. The finding was in line with Khan *et al.* (2016), who reported that the interactive effect of variety and pendimethalin gives the taller plants over untreated no weeding plots.

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

Treatment combination	Plant height (cm)			
	60 DAS	80 DAS	100 DAS	At harvest
T_0V_1	108.2 cd	142.0 c	159.3 d	176.7 de
T_1V_1	115.1 b-d	169.7 a	176.8 a-c	203.7 a-c
T_2V_1	110.2 b-d	157.5 ab	174.9 a-d	210.1 ab
T_3V_1	119.0 ab	157.3 ab	182.5 ab	207.9 a-c
T_4V_1	118.3 a-c	166.2 ab	189.8 a	216.1 a
T_5V_1	110.3 b-d	153.2 bc	164.0 cd	195.5 b-d
T_0V_2	97.33 e	161.5 ab	170.5 b-d	174.8 e
T_1V_2	109.3 b-d	142.0 c	162.3 cd	170.7 e
T_2V_2	118.5 a-c	158.5 ab	168.9 b-d	180.7 de
T_3V_2	115.6 b-d	160.5 ab	171.7 b-d	189.1 c-e
T_4V_2	126.8 a	159.5 ab	176.2 a-c	189.6 c-e
T_5V_2	105.8 de	156.5 abc	167.9 b-d	178.2 de
$LSD_{(0.05)}$	**10.72**	**15.16**	**16.14**	**19.65**
CV (%)	**5.58**	**5.67**	**5.51**	**6.04**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

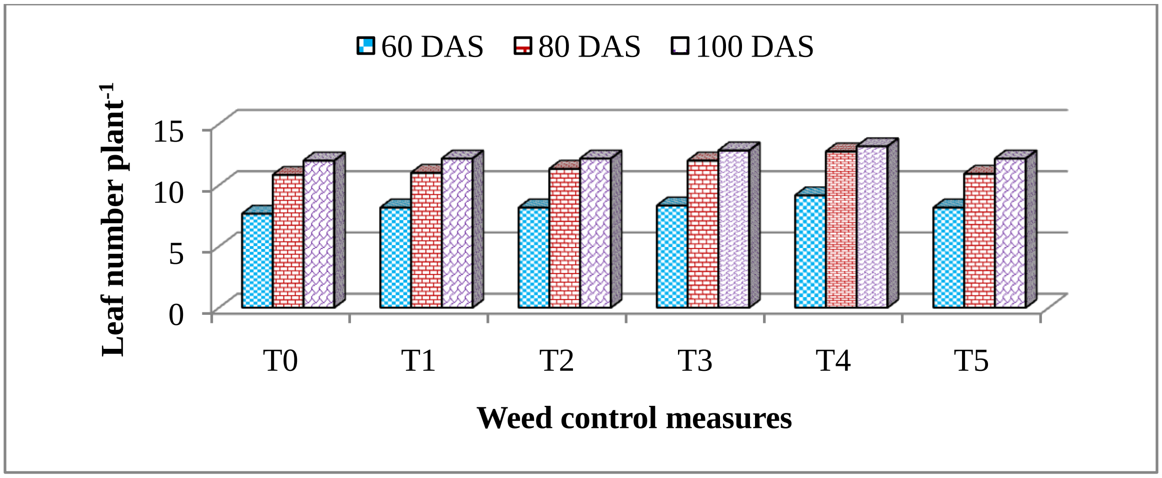
4.2.2. Leaf number palnt^{-1}

Effect of weed control measures

Figure 4 shows the leaf number per plant over time as influenced by different weed control measures. The highest number of leaf per plant (9.167, 12.75 and 13.17 at 60, 80 and 100 DAS, respectively) was obtained from T_4 which was significant singly at 60 DAS; statistically similar with T_3 at 80 DAS and having no significant difference among the measures at 100 DAS. The lowest number of leaf plant^{-1} (7.667, 10.83 and 12 at 60, 80 and 100 DAS respectively) was recorded from T_0. T_0 treatment was statistically identical with T_1, T_2 & T_5 treatment and similar with T_3 treatment at 60 days. At 80 DAS, T_0 was statistically at par with T_2, T_1 and T_5. There was no significant statistical difference among the weed control measures at 100 DAS. There might be some differences in the values but are not shown statistically. This finding was in line with that of Mienwipia (2013).

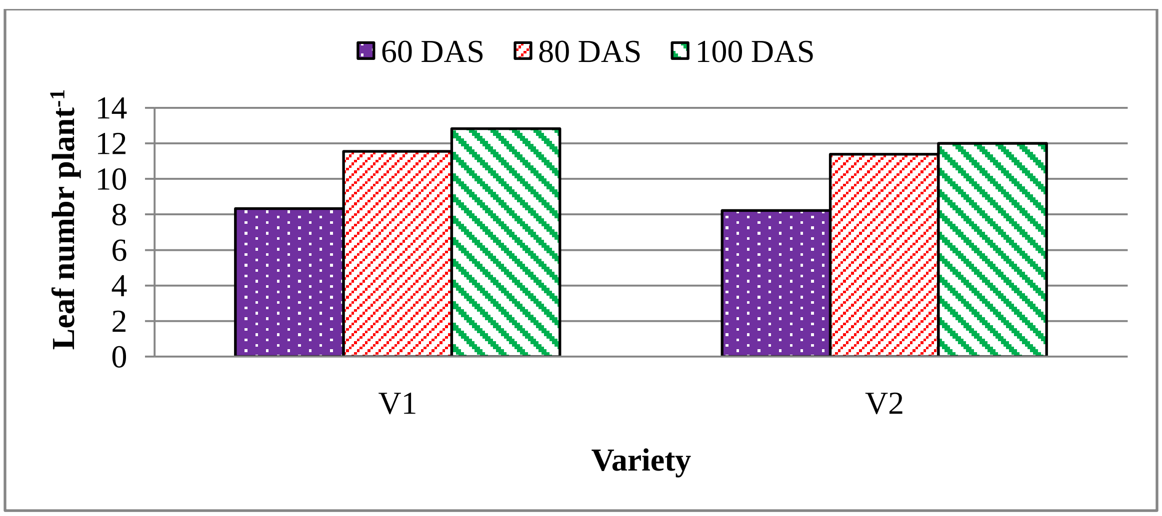
Effect of variety

Figure 5 shows the performance of varieties regarding leaf number per plant. Leaf number per plant was not significant between the varieties. V_1 gave the maximum leaf number per plant (8.33, 11.56 and 12.83 at 60, 80 and 100 DAS, respectively) while leaf number per plant for V_2 was 8.22, 11.38 and 12.00 at 60, 80 and 100 DAS, respectively. Although there was differences in values in leaf number per plant but were not shown statistically. This result was at par with that of Ullah *et al.* (2017) who reported the maximum number of leaf per plant from the hybrid white maize variety Suvra, more closely related to variety V_1 (PSC-121).



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 1.178, 1.320 and 2.285 at 60, 80 and 100 DAS, respectively)

Fig. 4. Effect of weed control measures on leaf number plant^{-1}



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 1.26, 0.62 and 0.82 at 60, 80 and 100 DAS respectively)

Fig. 5. Effect of variety on leaf number plant^{-1}

Interaction effect of weed control measures and variety

Data placed on Table 5 shows the interactive influence of variety and weed control measures on leaf number per plant. From the findings, the maximum number of leaf per plant was noted from V_1T_4 and the lowest value was recorded from V_1T_0 and V_2T_0 simultaneously which was statistically similar with all other measures except V_1T_4 & V_2T_4 at 60 DAS. At 80 DAS, the highest number of leaf per plant was reported from V_2T_4 that was statistically at par with V_1T_3, V_1T_4 and V_2T_2 while the minimum number of leaf per plant was noted from V_2T_5 which was statistically similar with all other measures except the measures that were statistically significant with $V_2T_{4.}$ The maximum number of leaf per plant at 100 DAS was obtained from V_2T_3 which was statistically significant with all of the measures excluding V_1T_5 which showed the lowest number of leaf per plant. These findings can be thrust to the findings of Ullah *et al.* (2017), who noted maximum number of leaf per plant when white grained maize variety was combined with sowing methods.

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

Treatment Combination	Leaf Number plant^{-1}		
	60 DAS	**80 DAS**	**110 DAS**
T_0V_1	7.667 c	11.17 cd	11.33 b
T_1V_1	8.333 a-c	10.50 cd	12.00 ab
T_2V_1	8.000 bc	11.00 cd	11.67 ab
T_3V_1	8.667 a-c	12.50 ab	12.00 ab
T_4V_1	9.333 a	12.67 ab	13.33 ab
T_5V_1	8.000 bc	11.50 b-d	11.67 ab
T_0V_2	7.667 c	10.50 cd	12.33 ab
T_1V_2	8.000 bc	11.50 b-d	12.33 ab
T_2V_2	8.333 a-c	11.67 a-c	12.67 ab
T_3V_2	8.000 bc	11.50 b-d	13.67 a
T_4V_2	9.000 ab	12.83 a	13.00 ab
T_5V_2	8.333 a-c	10.33 d	13.00 ab
$LSD_{(0.05)}$	**1.178**	**1.320**	**2.285**
CV (%)	**8.35%**	**6.76%**	**10.81%**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.2.3. Leaf area index

Effect of weed control measures

Leaf area index is an important parameter in determining the photosynthetic capability in plant thereby growth and yield. Leaf area index is indirectly become affected by supplied inputs like herbicides. Figure 6 represents the effect of weed control measures on leaf area index. The maximum leaf area index (1.54, 3.653 and 4.62 at 60, 80 and 100 DAS respectively) was recorded from T_4 treatment which was statistically at par with T_3 at 60 & 80 Das and T_2 & T_1 at 100 DAS. The minimum leaf area index (1.11, 2.518 and 3.603) was noted from T_0. In most of the cases T_0 was statistically at par with T_2, T_1 and T_5 measures. Closer findings were reported by Kandasamy (2018) who reported significant increase in leaf area index in the herbicide treated plots over the untreated plots.

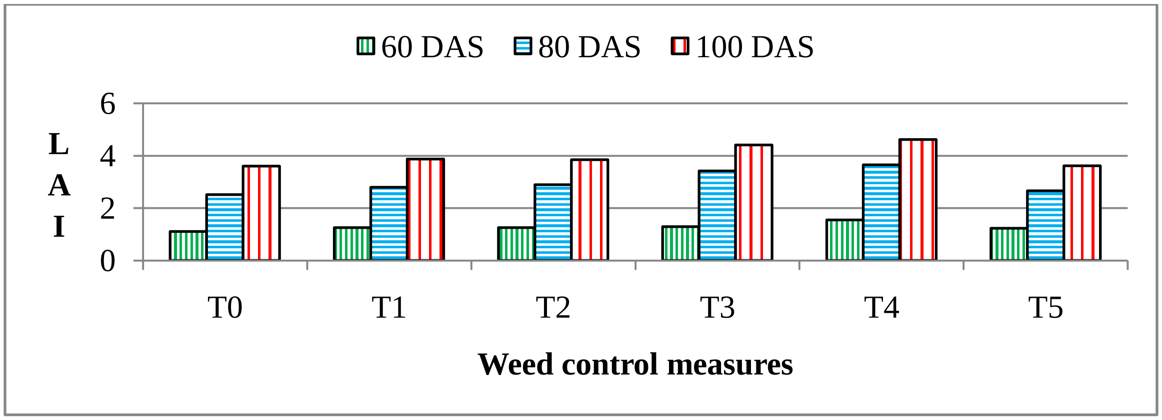
Effect of variety

Figure 7 shows the varietal performances of white maize variety in respect of leaf area index. PSC-121 performed the best giving leaf area index of 1.296, 3.036 & 4.09 as compared to that of Yangnuo-3000 which gave the values of 1.262, 2.94 & 3.897 at 60, 80 and 100 DAS respectively. Although there was difference in values between PSC-121 and Yangnuo-3000 regarding leaf area index, no statistically significant difference was not recorded between varieties. Robertson *et al.* (2012) reported the maximum maize leaf area index of 6.5 in the variety Pioneer 3IN30 that is very closer to the finding of this experiment.

Interaction effect of weed control measures and variety

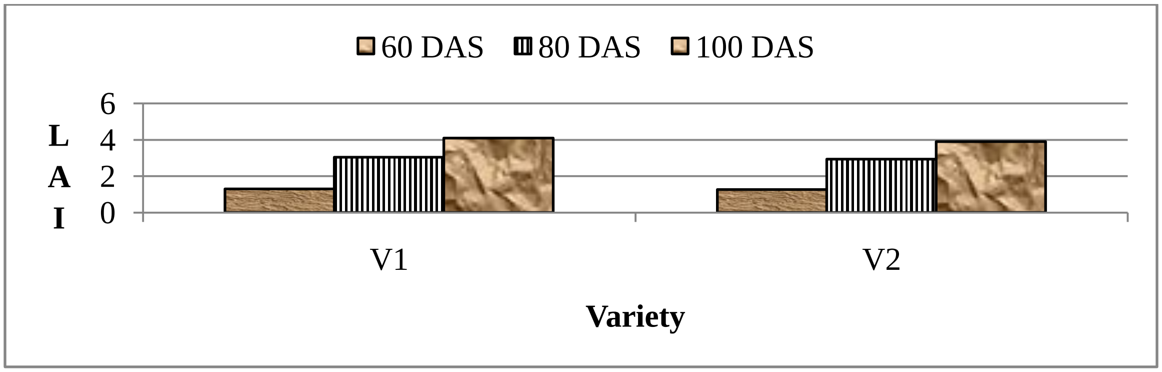
In Table 6, the leaf area index was influenced by different weed control measures and variety is shown. From the experiment it was observed that V_1T_4 showed the highest leaf area index (1.530, 3.913, and 4.770 at 60, 80 and 100 DAS, respectively). The lowest leaf area index was noted from V_2T_0 (1.077), V_1T_0

(2.380) and V_1T_5 (3.230) at 60, 80 and 100 DAS, respectively. Notwithstanding, leaf area index values varied numerically, there was no significant differences among the combinations statistically. This finding was closer to the finding of Robertson *et al.* (2012).



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 0.38, 0.88 and 1.23 at 60, 80 and 100 DAS, respectively)

Fig. 6. Effect of weed control measures on the leaf area index (LAI)



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 0.13, 0.90 and 0.30 at 60, 80 and 100 DAS, respectively)

Fig. 7. Effect of variety on the leaf area index (LAI)

Table 6. Interaction effect of weed control measures and variety on the leaf area index (LAI)

Treatment Combination	Leaf area index		
	60 DAS	80 DAS	100 DAS
T_0V_1	1.113 b	2.380 d	3.630 a-c
T_1V_1	1.377 ab	2.960 b-d	3.877 a-c
T_2V_1	1.143 b	2.720 cd	3.453 bc
T_3V_1	1.353 ab	3.830 ab	4.420 a-c
T_4V_1	1.530 a	3.913 a	4.770 a
T_5V_1	1.260 ab	2.410 d	3.230 c
T_0V_2	1.077 b	2.657 cd	3.577 a-c
T_1V_2	1.127 b	2.627 cd	3.860 a-c
T_2V_2	1.383 ab	3.057 a-d	4.247 a-c
T_3V_2	1.233 ab	2.997 b-d	4.383 a-c
T_4V_2	1.563 a	3.393 a-c	4.470 ab
T_5V_2	1.187 ab	2.910 cd	4.003 a-c
$LSD_{(0.05)}$	**0.3846**	**0.8817**	**1.228**
CV (%)	**17.58%**	**17.34%**	**18.06%**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.2.4. Crop growth rate (g m^{-2} day^{-1})

Effect of weed control measures

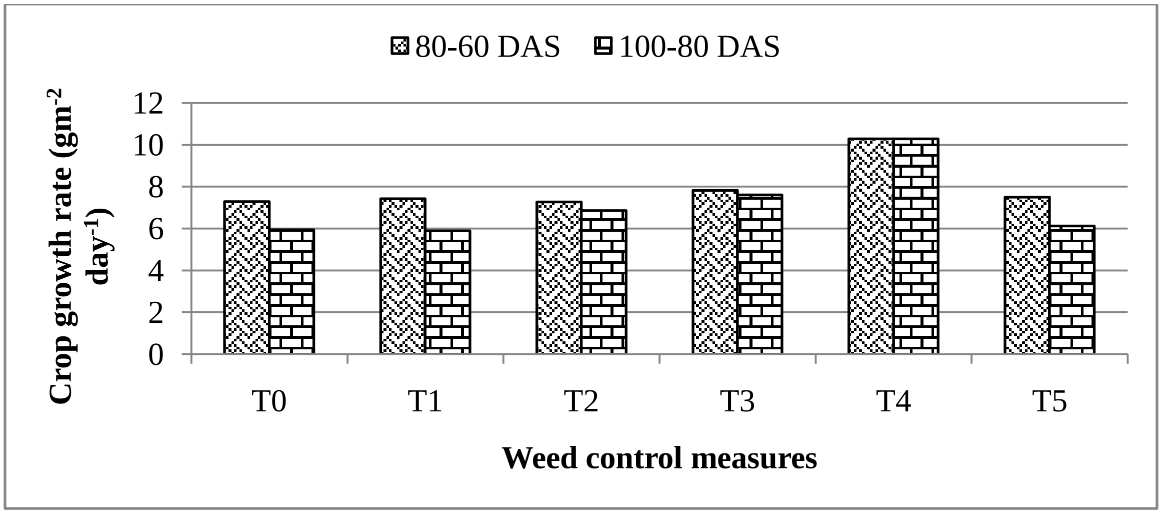
Figure 8 represents the effect of weed control measures on crop growth rate. Between two growth stages the maximum crop growth rate was recorded in 80-60 DAS stage. On the other hand, in both stages T_4 showed the highest crop growth rate (80-60 DAS: 10.28 $gm^{-2}day^{-1}$ and 100-80 DAS: 10.29 $gm^{-2}day^{-1}$) while the lowest growth rate was recorded from T_2 (80-60 DAS stage) and T_1 (100-80 DAS). The treatment T_4 was singly significant over other measures at 80-60 DAS stage and statistically similar with T_3 at 100-80 DAS stage. However, a decreasing trend of crop growth was followed from first stage to the second stage. This result was in line that of Bharati (2016) who also found the maximum crop growth rate from Pendimethalin + Oxyflurofen @ (1 + 0.03) kg/ha treated plots and also a decreasing trend of CGR was observed.

Effect of variety

Effect of variety on crop growth rate is graphed in the Figure 9**.** Maximum crop growth rate (8.791 $gm^{-2}day^{-1}$ and 7.766 $gm^{-2}day^{-1}$ at 80-60 and 100-80 DAS respectively) was shown by V_1. Though there was numerical variation between varieties but was not enough to create statistically significant difference. This finding can be thrust to the finding of Nwogboduhu (2016).

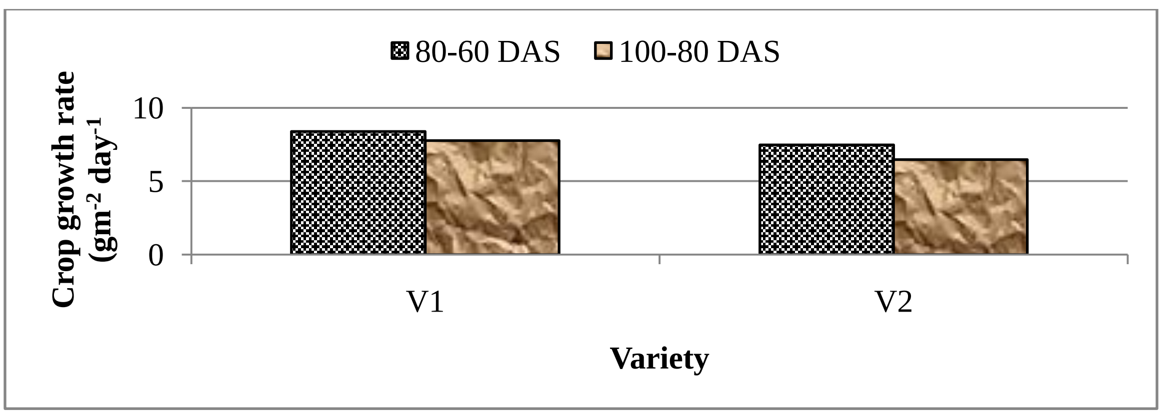
Interaction effect of weed control measures and variety

Variety and weed control interaction effect on the crop growth rate is given in the Table 7**.** From the experimental finding, it can be reported that V_2T_4 gave the highest crop growth rate (10.74 $gm^{-2}day^{-1}$ and 10.68 $gm^{-2}day^{-1}$ at 80-60 DAS and 100-80 DAS, respectively). The lowest crop growth rate (6.437 $gm^{-2}day^{-1}$) was recorded from V_2T_5 at 80-60 DAS and 4.513 $gm^{-2}day^{-1}$ V_2T_2 at 100-80 DAS. This result can be thrust to that of Hokmalipour *et al.* (2011).



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 2.06 and 4.19 at 80-60 DAS and 100-80 DAS, respectively)

Fig. 8. Effect of weed control measures on the crop growth rate (g m^{-2} day^{-1})



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 4.16 and 5.98 at 80-60 DAS and 100-80 DAS, respectively)

Fig. 9. Effect of variety on crop growth rate (g m^{-2} day^{-1})

Table 7. Interaction effect of weed control measures and variety on the crop growth rate (g m^{-2} day^{-1})

Treatment Combinations	Crop Growth Rate ($gm^{-2}day^{-1}$)	
	80-60 DAS	**100-80 DAS**
T_0V_1	7.640cd	6.333b-d
T_1V_1	8.140b-d	6.723a-d
T_2V_1	7.660cd	9.213a-c
T_3V_1	8.530bc	7.903a-d
T_4V_1	9.827ab	9.907ab
T_5V_1	8.550bc	6.513 a-d
T_0V_2	6.437d	4.513d
T_1V_2	6.697cd	5.063cd
T_2V_2	6.880cd	5.360 cd
T_3V_2	7.123cd	7.300a-d
T_4V_2	10.74a	10.68a
T_5V_2	6.947 cd	5.907b-d
$LSD_{(0.05)}$	**2.069**	**4.191**
CV (%)	**15.32**	**34.57**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.2.5. Leaf area duration (Day)

Effect of weed control measures

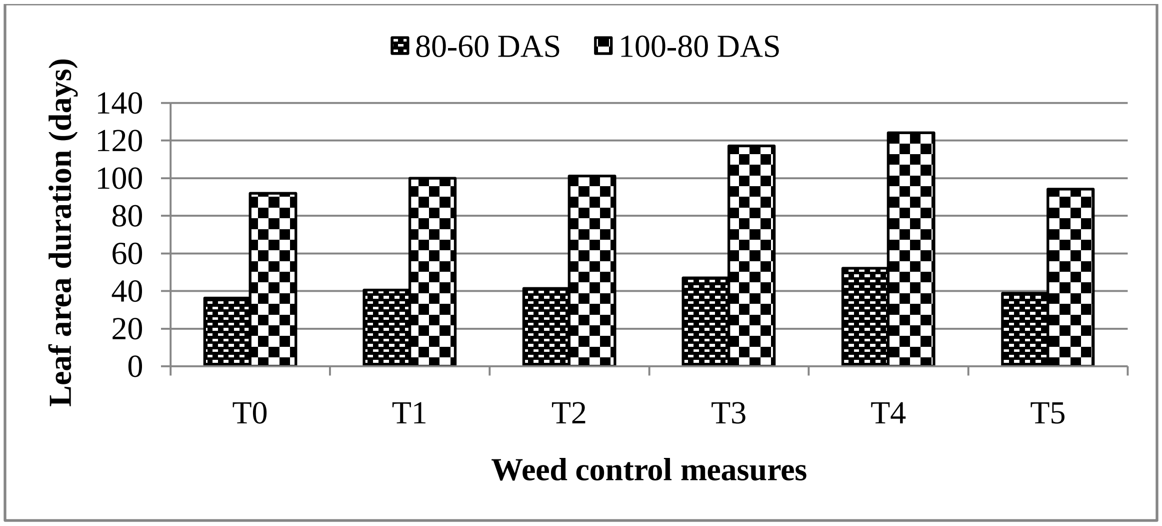
Leaf area duration is an important parameter for determining the growth of a crop. Figure 10 represents the effect of weed control measures on leaf area duration. T_4 showed the maximum leaf area duration in both 80-60 DAS and 100-80 DAS stages (52.0 day and 124.1 day respectively) and was statiscally at par with T_3. The lowest leaf area duration was recorded from T_0 in both 80-60 and 100-80 stages (36.29 days and 91.85 days, respectively). This finding can be thrust to the finding of Hammad *et al*. (2011) who reported the maximum leaf area duration of 258.4 day at harvest.

Effect of variety

Effect of variety on the leaf area duration is portrayed in the Figure 11. However, the maximum leaf area duration (43.31 and 103.96 days) was reported from V_1 at both stages of 80-60 and 100-80 DAS over V_2. There was no statistical difference between V_1 and V_2 regarding leaf area duration. The result greatly varied from that of Mienwipia (2013).

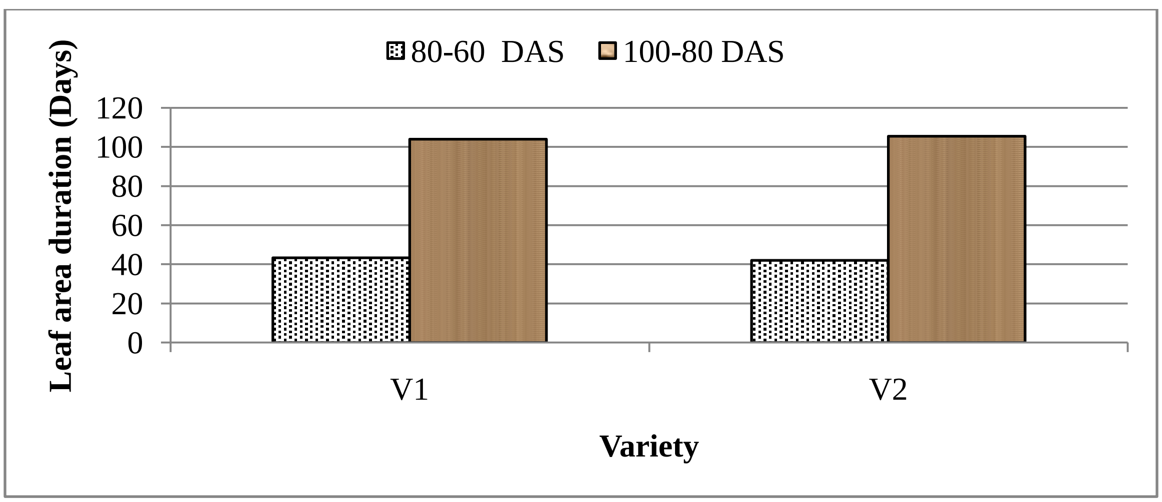
Interaction effect of weed control measures and variety

Combined effect of variety and weed control measures are given in the Table 8. In both 80-60 and 100-80 DAS, V_1T_4 performed the best giving leaf area duration of 54.43 and 130.2 days respectively followed by V_1T_3 which is statistically similar with V_1T_4 at both stages. The treatment combination of worst performance was showed by V_1T_0 (35.22 and 100-80 days) at both stages (80-60 and 100-80 DAS). This result can be thrust to the finding of Iqbal *et al.* (2006).



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 10.48 and 26.98 at 80-60 DAS and 100-80 DAS, respectively)

Fig. 10. Effect of weed control measures on the leaf area duration (day)



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 5.82 and 11.24 at 80-60 DAS and 100-80 DAS, respectively)

Fig. 11. Effect of variety on leaf area duration (day)

Table 8. Interaction effect of weed control measures and variety on the leaf area duration (Day)

Treatment Combination	Leaf Area Duration (Day)	
	80-60 DAS	**110-80 DAS**
T_0V_1	35.22 d	84.57 d
T_1V_1	43.38 b-d	102.5 b-d
T_2V_1	38.29 d	92.55 cd
T_3V_1	51.80 ab	123.7 ab
T_4V_1	54.43 a	130.2 a
T_5V_1	37.36 d	93.54 cd
T_0V_2	36.71	90.16 d
T_1V_2	37.53 d	97.31 b-d
T_2V_2	44.44 a-d	109.6 a-d
T_3V_2	42.28 b-d	110.7 a-d
T_4V_2	49.58 a-c	118.0 a-c
T_5V_2	40.98 cd	103.7 a-d
$LSD_{(0.05)}$	**10.48**	**26.98**
CV (%)	**14.43%**	**15.13%**

V_1 = PSC-121, V_2 = Yangnuo-3000, 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), T_5= One hand weeding at 45 DAS.

4.3 Yield parameters

4.3.1. 100-seed weight (g)

Effect of weed control measures

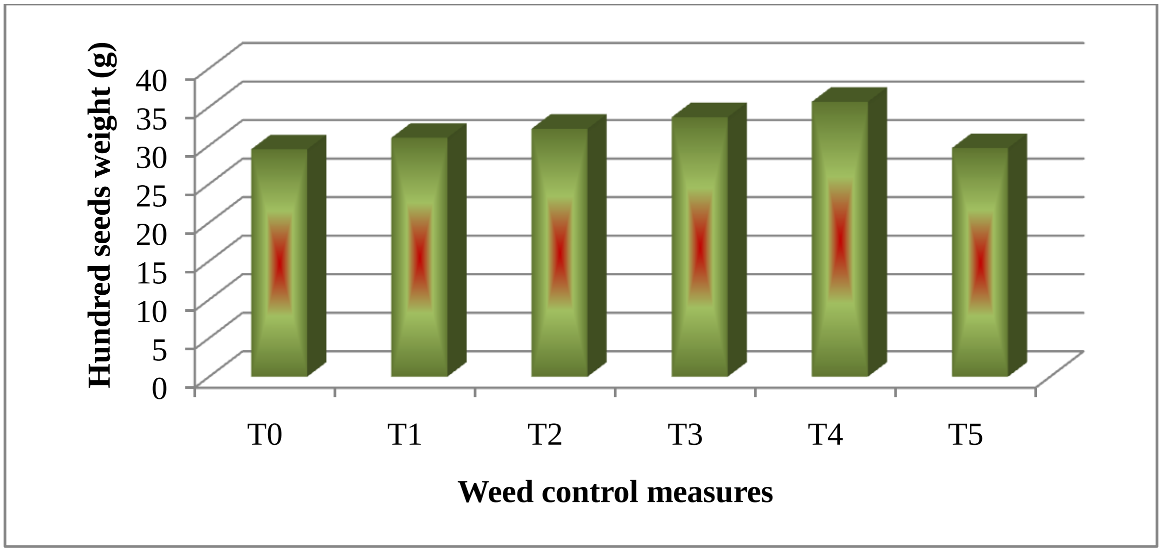
100-seed weight is a very important parameter which ultimately influences the final yield in the grain crops. Figure 12 shows the effect of different weed control measures on the 100-seed weight of maize. The result indicated that the maximum 100-seed weight (35.67 g) was obtained from T_4 treatment which was followed by T_3 treatment giving 100 seed weight of 33.67g. However, T_4 was statistically at par with T_3 and T_2. The minimum 100-seed weight (29.5g) was recorded from T_0 which was statistically similar with T_5 and T_0. This finding was very close to that of Ali *et al* (2014) and Tahir *et al.* (2009) who reported the maximum 100 seed weight from the pendimethalin herbicide treated plots.

Effect of variety

Influence of varieties on 100-seed weight is given in the Figure 13. Between two variety (PSC-121 and YANGNUO-3000), PSC-121 showed the maximum 100-seed weight (33.898g). This finding was in line with that of Akbar *et al*. (2016) who reported the maximum 100 seed weight from PSC-121.

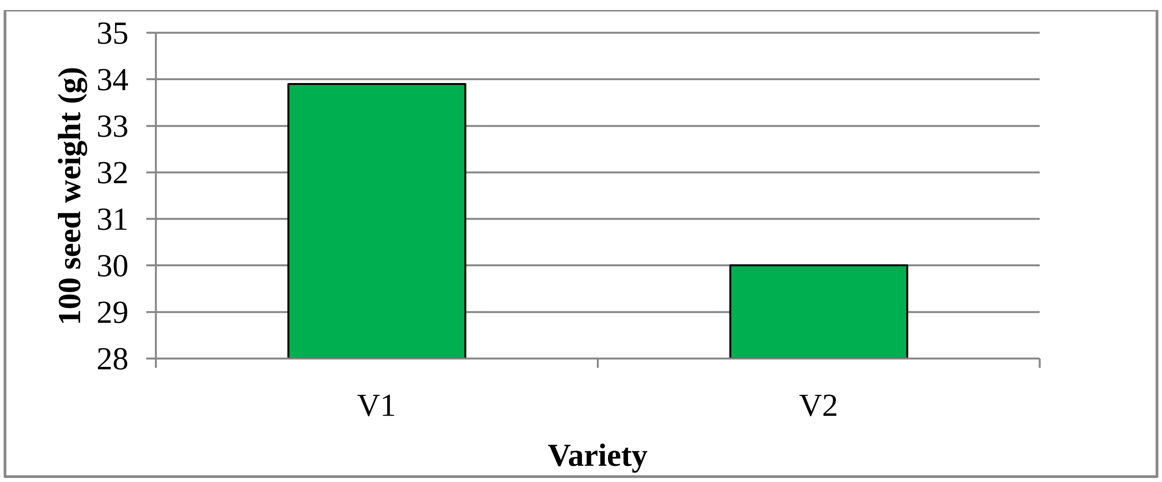
Interaction effect of variety and weed control measures

Table 9 represents the combined effect of variety and weed control measures on 100-seed weight. From the table, it can be referred that the treatment combination V_1T_4 showed the highest 100-seed weight (40.33 g) which was statistically similar with V_1T_3. The lowest 100-seed weight was recorded from V_2T_5. This finding was in line with that of Akbar *et al.* (2016) who indicated maximum 100-seed weight from the combined effect of PSC-121 and fertilizer rate.



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 5.715)

Fig. 12. Effect of weed control measures on the 100-seed weight (g)



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 4.75)

Fig. 13. Effect of variety on the 100-seed weight (g)

Table 9. Interaction effect of weed control measures and variety on the 100-seed (g)

Treatment Combination	**100-seed weight (g)**
T_0V_1	29.67 cd
T_1V_1	31.67 b-d
T_2V_1	33.00 bc
T_3V_1	36.00 ab
T_4V_1	40.33 a
T_5V_1	32.67 bc
T_0V_2	26.67 d
T_1V_2	30.33 b-d
T_2V_2	31.33 b-d
T_3V_2	31.33 b-d
T_4V_2	31.00 b-d
T_5V_2	29.33 cd
$LSD_{(0.05)}$	**5.715**
CV (%)	**10.50**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.3.2. Number of grains cob^{-1}

Effect of weed control measures

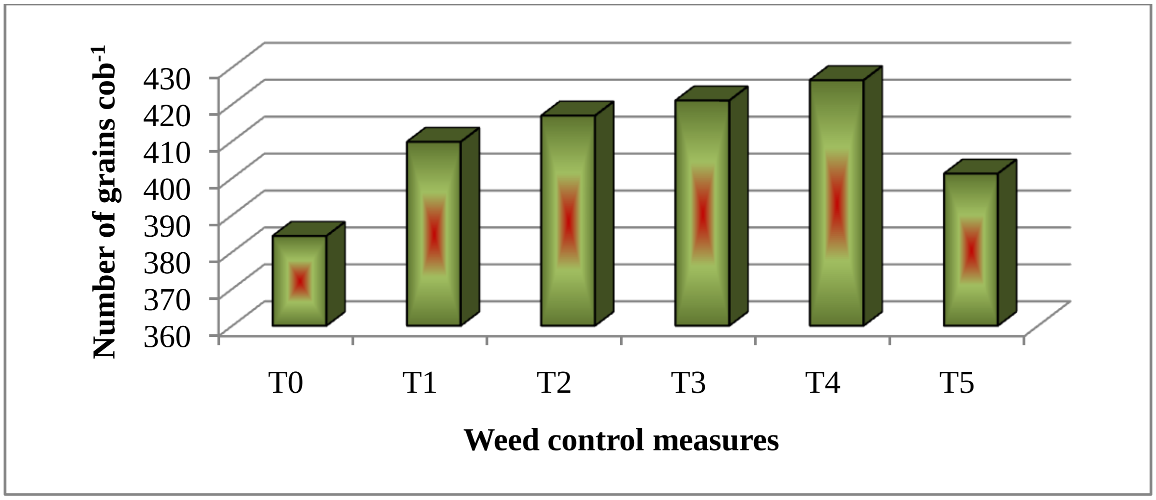
Number of grains per cob is a very important yield parameter that can be thrust to predict grain yield in maize. Figure 14 shows the effect of weed control measures on number of grains cob^{-1}. All of the herbicidal measures showed prime performance over the manual hand weeding at 45 days and weedy check. The maximum number of grains cob^{-1} (426.5) was obtained from T_4 and it was statistically similar with all the measures except T_0. The result was in line with that of Ali *et al.* (2014) who also reported the maximum number of grains per cob from pendimethalin herbicide treated plots.

Effect of variety

Effect of variety on number of grains per cob is graphed in the Figure 15. It was revealed from the experiment that variety PSC-121 (V_1) have the supreme potentiality to produce maximum number of grains cob^{-1} (412.0) over Yangnuo-3000 (V_2) due to genetic and environmental make up. Though grain cob^{-1} was numerically higher in V_1, it was not statistically significant over V_2. Similar result was found by Akbar *et al.* (2016).

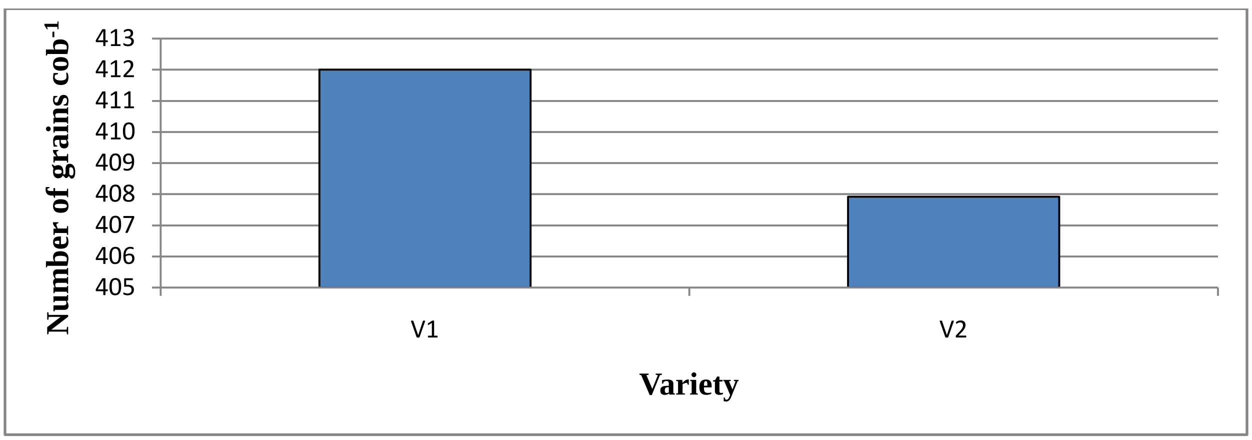
Interaction effect of weed control measures and variety

Variety and weed control interaction effects on number of grains per cob are placed in the Table 10**.** The maximum number of grains per cob (445.6) was reported from V_1T_4 and the lowest grain number cob^{-1} was recorded from V_1T_0. V_1T_4 was statistically similar with all the measures except $V_1T_{0,}$ $V_1T_{1,}$ V_2T_0 and V_2T_5. This finding can be thrust to the finding of Akbar *et al.* (2016) who reported maximum grain number cob^{-1} from the interaction of PSC-121 (V_1) and fertilizer dose interaction.



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 45.61)

Fig. 14. Effect of weed control measures on the number of grains cob^{-1}



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 7.88)

Fig. 15. Effect of variety on the grain number cob^{-1}

Table 10. Interaction effect of weed control measures and variety on the Number of grains cob^{-1}

Treatment Combination	No. of grains cob^{-1}
T_0V_1	383.9 b
T_1V_1	399.6 b
T_2V_1	411.2 ab
T_3V_1	427.7 ab
T_4V_1	445.6 a
T_5V_1	404.0 ab
T_0V_2	384.8 b
T_1V_2	420.1 ab
T_2V_2	422.7 ab
T_3V_2	414.3 ab
T_4V_2	407.3 ab
T_5V_2	398.4 b
$LSD_{(0.05)}$	**45.61**
CV (%)	**6.53**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One hand weeding at 45 DAS.

4.3.3. Grain yield (t ha^{-1}), Stover yield (t ha^{-1}) and Biological yield (t ha^{-1})

Effect of weed control measures

Grain, stover and biological yields are significantly affected by weed control measures. Figure 16 represents the effect of weed control measures on grain yield, stover yield and biological yield (tha^{-1}).

From the experiment it was observed that T_4 gave significantly higher grain yield (8.817 t ha^{-1}) than other measures and was statistically similar with T_3. The treatment T_0 performed the least (5.645 t ha^{-1}) and was statistically similar with T_1 and T_5. This finding was in line with that of Tahir *et al.* (2009) who also found the maximum grain yield from pendimethalin treated plot.

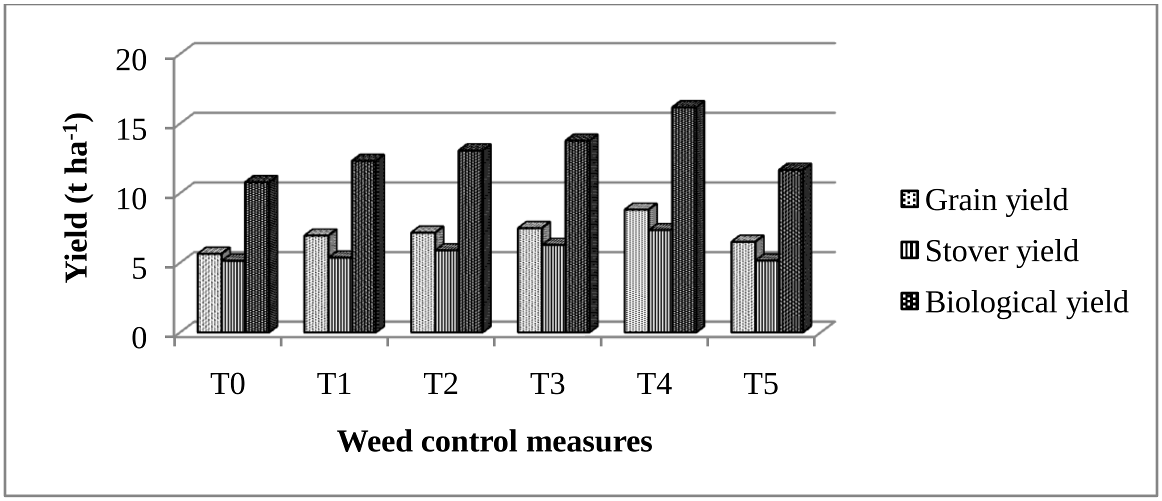
In case of stover yield and biological yield T_4 performed the best (7.35 t ha^{-1}and 16.17 t ha^{-1}, respectively) and was statistically significant with T_3 for stover yield. This result was at par with those of Bharati (2016) who recorded the highest stover and biological yield from pendimethali and Oxyflurofen treated plots.

Effect of variety

Figure 17 shows the effect of variety on grain, stover and biological yield (t ha^{-1}). The variety V_1 produced the higher number of grain, stover and biological yields (7.758, 6.121 and 13.878 t ha^{-1}, respectively) over V_2. Although there was numerical difference between the varieties regarding grain, stover and biological yield but it was not different significantly. Very closer findings were reported by Akbar *et al.* (2016) and Khan *et al*. (2016).

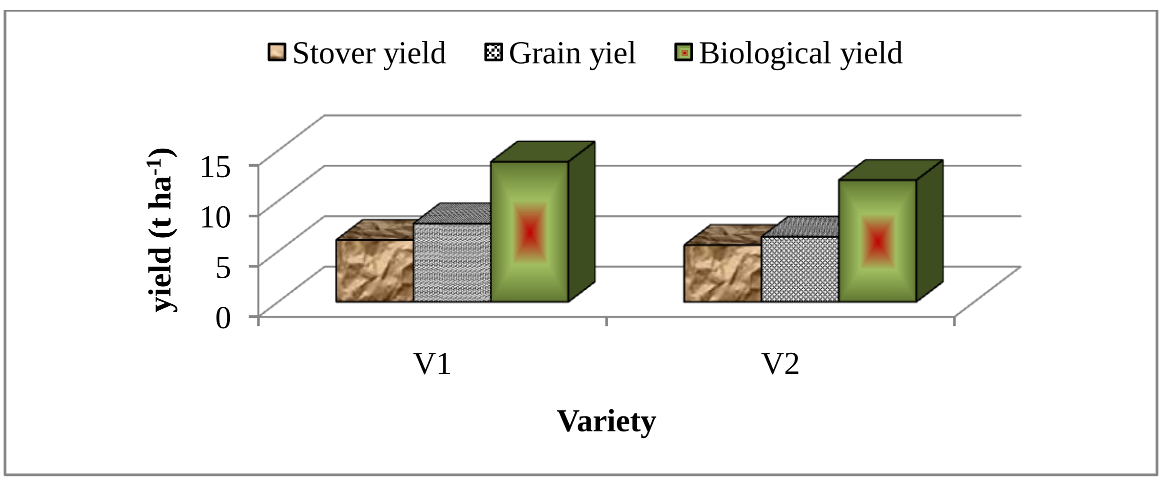
Interaction effect of weed control measures and variety

Combined effect of variety and weed control measures are given in the Table 11**.** Grain yield, stover yield and biological yield became significantly affected by variety and weed control measures interaction. The highest grain yield (9.633 t ha^{-1}) was recorded from V_1T_4 interaction and was statistically similar with V_1T_3, V_1T_1 and V_2T_4. The least performer was V_1T_0 giving 5.51 t ha^{-1}grain yield. In case of stover yield, V_2T_4 showed the maximum stover yield (7.617 t ha^{-1}). The treatment combinations of V_1T_1, $V_1T_{2,}$ V_1T_3 and V_1T_4 were statistically at par with V_2T_1. V_2T_1 performed the least (4.513 t ha^{-1}). However, in case of biological yield V_1T_4 (16.72 t ha^{-1}) and V_2T_1 (9.830 t ha^{-1}) were the best and worst interaction respectively. V_1T_4 was statistically similar with V_1T_3, V_1T_1 and V_2T_4 interactions. Akbar *et al.* (2016) and Khan *et al.* (2016) reported closer findings to the findings of this experiment.



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 1.995, 1.57 and 2.49 for grain yield, stover yield and biological yield tha^{-1}, respectively)

Fig. 16. Effect of weed control measures on the grain, stover and biological yield (t ha^{-1})



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 6.435, 5.618 and 12.053 for grain yield, stover yield and biological yield tha^{-1}, respectively)

Fig. 17. Effect of variety on the grain, stover and biological yield (t ha^{-1})

Table 11. Interaction effect of weed control measures and variety on the grain, stover and biological yield (t ha^{-1})

Treatment Combination	Grain Yield (t ha^{-1})	Stover Yield (t ha^{-1})	Biological Yield (t ha^{-1})
T_0V_1	5.320 d	4.820 ef	10.33 ef
T_1V_1	8.580 ab	6.237 a-e	14.81 a-c
T_2V_1	7.270 b-d	6.420 a-d	13.69 b-d
T_3V_1	8.593 ab	6.960 a-c	15.55 ab
T_4V_1	9.633 a	7.083 ab	16.72 a
T_5V_1	6.960 b-d	5.203 d-f	12.16 d-f
T_0V_2	5.510 d	4.513 f	9.830 f
T_1V_2	5.780 d	5.470 c-f	11.25 d-f
T_2V_2	7.060 b-d	5.380 d-f	12.44 c-e
T_3V_2	6.390 cd	5.600 b-f	11.99 d-f
T_4V_2	8.000 a-c	7.617 a	15.62 ab
T_5V_2	6.060 cd	5.127 d-f	11.18 ef
$LSD_{(0.05)}$	**1.995**	**1.569**	**2.486**
CV (%)	**16.50%**	**15.70%**	**11.26%**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One Hand Weeding at 45 DAS.

4.3.4. Harvest index (%)

Effect of weed control measures

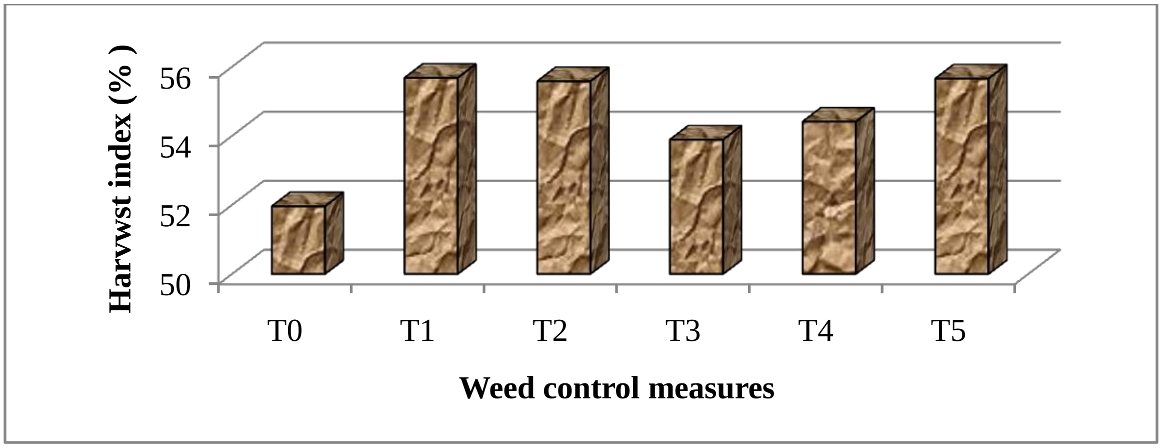
Figure 18 shows the effect of different weed control measures on harvest index. T_1 (55.68%) showed the highest harvest index following T_2 (55.66%) and T_5 (55.58%) due to high stover yield. The lowest harvest index was obtained from T_0 (51.96%). There was numerical variation among the measures but were not statistically significant. This finding was in line with that of Rasool and Khan (2016) and Dennis Pennington (2013).

Effect of variety

Performance of the white maize varieties regarding harvest index are shown in the Figure 19. V_1 showed the maximum harvest index of 55.651% whereas 53.412% was recorded from V_2. V_1 was numerically higher than V_2 but were not significant statistically. This finding can be thrust to that of Geleti *et al.* (2011), who reported 51.96% and 52.74% harvest index in BH-660 and BH-540 maize hybrid varieties respectively having no statistical difference between them.

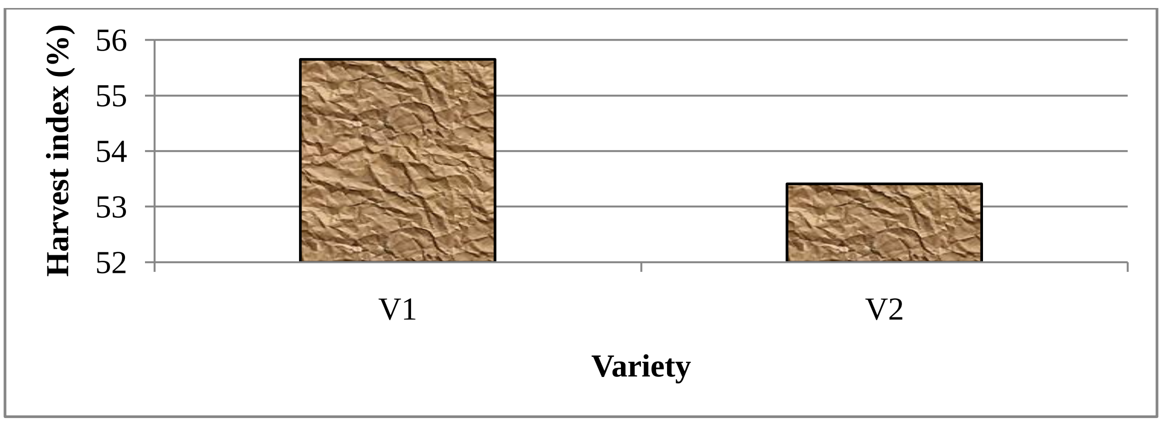
Interaction effect of weed control measures and variety

Table 12 represents the combine defect of herbicides and variety on harvest index. The result revealed that the maximum harvest index of 58.08% was recorded from V_2T_2 following V_1T_1 (58.02%) and V_1T_4 (57.81%). All the combinations were statistically similar. This finding was nearly similar with that of Khan *et al.* (2016), Rasool and Khan (2016) and Dennis Pennington (2013).



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), T_5= One hand weeding at 45 DAS. ($LSD_{0.05}$ = 11.05)

Fig. 18. Effect of weed control measures on the harvest index (%)



V_1 = PSC-121, V_2 = Yangnuo-3000 ($LSD_{0.05}$ = 2.55)

Fig. 19. Effect of variety on the harvest index (%)

Table 12. Interaction effect of weed control measures and variety on the harvest index (%)

Treatment Combination	Harvest Index (%)
T_0V_1	52.60
T_1V_1	58.02
T_2V_1	53.09
T_3V_1	55.22
T_4V_1	57.81
T_5V_1	57.18
T_0V_2	51.32
T_1V_2	53.35
T_2V_2	58.08
T_3V_2	52.56
T_4V_2	51.02
T_5V_2	54.14
$LSD_{(0.05)}$	**NS**
CV (%)	**11.90**

V_1 = PSC-121, V_2 = Yangnuo-3000; 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), T_5= One Hand Weeding at 45 DAS.

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at the agronomy farm of Sher-e-Bangla Agricultural University, Dhaka during November 2017 to April 2018 to examine the varietal performances of white maize as influenced by different weed management practices. The experiment was set up by taking two treatment factors. The treatment factors are: (1) Variety; having two levels, viz. PSC-121 & Yangnuo-3000; (2) Weed control measures having six levels, 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. The experiment was conducted in Split Plot Design with three replications. Data on different parameters were recorded and analyzed statistically.

Results revealed that weed control measures, variety 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 pant height (122.6, 162.8, 183.0 and 202.9 cm at 60, 80, 100 DAS and harvest, respectively), number of leaf per plant (9.167, 12.75 and 13.17 at 60, 80 and 100 DAS, respectively), leaf area index (1.54, 3.653 and 4.62 at 60, 80 and 100 DAS, respectively), crop growth rate (80-60 DAS: 10.28 $gm^{-2}day^{-1}$ and 100-80 DAS: 10.29 $gm^{-2}day^{-1}$, respectively), leaf area duration (80-60 DAS: 52.0 days and 100-80 DAS: 124.1 days, respectively), 100 seed weight (35.67 g), grains cob^{-1} (426.5), grain yield (8.817 t ha^{-1}), stover yield (7.35 t ha^{-1}) and biological yield (16.17 t ha^{-1}), WCE (74.24%) were reported from T_4 and the highest harvest index (55.68%) was recorded from T_1. Weedy check treatment T_0 showed the least performance in respect of all parameters studied in the experiment.

In terms of varietal performance, higher pant height (113.53, 157.639, 174.572 and 201.667 cm at 60, 80, 100 DAS and harvest, respectively), number of leaf plant^{-1} (8.33, 11.56 and 12.83 at 60, 80 and 100 DAS, respectively), leaf area index (1.296, 3.036 & 4.09 at 60, 80 and 100 DAS, respectively), crop growth rate (80-60 DAS: 8.391 gm^{-2}day^{-1} and 100-80 DAS: 7.766 gm^{-2}day^{-1}), leaf area duration (80-60 DAS: 43.307 day; 100-80 DAS: 103.959 day), 100-seed weight (33.898g), grains cob^{-1} (412.0), grain yield (7.758 t ha^{-1}), stover yield (6.121 t ha^{-1}), biological yield (13.878 t ha^{-1}) and harvest index (55.651%) were recorded from V_1 as compared to that of V_2.

In case of the interaction of weed control measures with variety, the tallest plants (126.8, 169.70, 189.80, and 216.10 cm at 60, 80, 100 DAS and at harvest, respectively) were achieved from the treatment combination of $T_4V_{2,}$ $T_1V_{1,}$ $T_4V_{1,}$ and $T_4V_{1,}$ at 60, 80, 100 DAS and harvest, respectively; The maximum number of leaf plant^{-1} was recorded from T_4V_1 (9.33), T_4V_2 (12.83) and T_3V_2 (13.67) at 60 DAS, 80 DAS and 100 DAS, respectively; The maximum leaf area index (1.530, 3.913, and 4.770 at 60, 80 and 100 DAS respectively), leaf area duration (80-60 DAS: 54.43 day and 100-80 DAS: 130.2 day), 100 seed weight (40.33 g), grains per cob (445.6), grain yield (9.633 t ha^{-1}), biological yield (16.72 t ha^{-1}) were recorded from T_4V_1; The highest crop growth rate (10.74 gm^{-2}day^{-1} and 10.68 gm^{-2}day^{-1} at 80-60 DAS and 100-80 DAS, respectively), stover yield (7.617 t ha^{-1}) were reported from T_4V_2 and the highest harvest index (58.08%) was recorded from T_2V_2. On the other hand, the shortest plant (97.33, 142.00, 159.30 and 170.70 cm at 60 DAS, 80 DAS, 100DAS and harvest, respectively) was recorded from T_0V_1 and T_0V_2, respectively. The lowest number of leaf plant^{-1} (7.66, 10.33 and 11.33 at 60 DAS, 80 DAS and 100 DAS, respectively) was recorded from T_o V_1, T_5V_2 and T_0V_1, respectively. However, the lowest leaf area index was noted from T_0V_2 (1.077), T_0V_1 (2.380) and T_5V_1 (3.230) at 60, 80 and 100 DAS, respectively. In case of crop growth rate, the lowest crop growth rate (6.437 gm^{-2}

day^{-1}) was recorded from T_0V_2 at both 80-60 DAS (6.437 gm^{-2}day^{-1}) and 100-80 DAS (4.513 gm^{-2}day^{-1}). The lowest leaf area duration (at both 80-60 DAS: 35.22 day and 100-80 DAS: 90.16 day), number of grains cob^{-1} (283.9), grain yield (5.51 t ha^{-1}) were recorded from T_0V_1. T_0V_2 showed the minimum 100-seed weight (26.67 g). T_0V_2 was the worst combination for stover yield (4.513 t ha^{-1}) and biological yield (9.830 t ha^{-1}). Finally, the minimum harvest index (51.09%) was recorded from T_4V_2 due to lower stover yield.

However, from the above core discussion it can be concluded by inferring that

1. Among the six different weed control measures, Pendimethalin @ 3.0 l/ha (Panida 50EC) (T_4) is the most efficient one to control weeds in white maize field.
2. Between PSC-121 (V_1) and Yangnuo-3000 (V_2), PSC-121 is the best performer regarding growth and yield attributes of white maze.
3. Among twelve different weed control measures and variety interaction, T_4V_1 and T_4V_2 are the most effective combination offering the maximum growth and yield in white maize.

No analysis was carried out to determine the level of herbicide residue and individual population of microbes in the soil. Further studies are therefore suggested to conclusively determine the residual quantity of each herbicide and the population of each microbe in the soil in order to predict the ultimate effect of any detected level on flora and fauna on the soil.

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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)			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 (AEZ 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

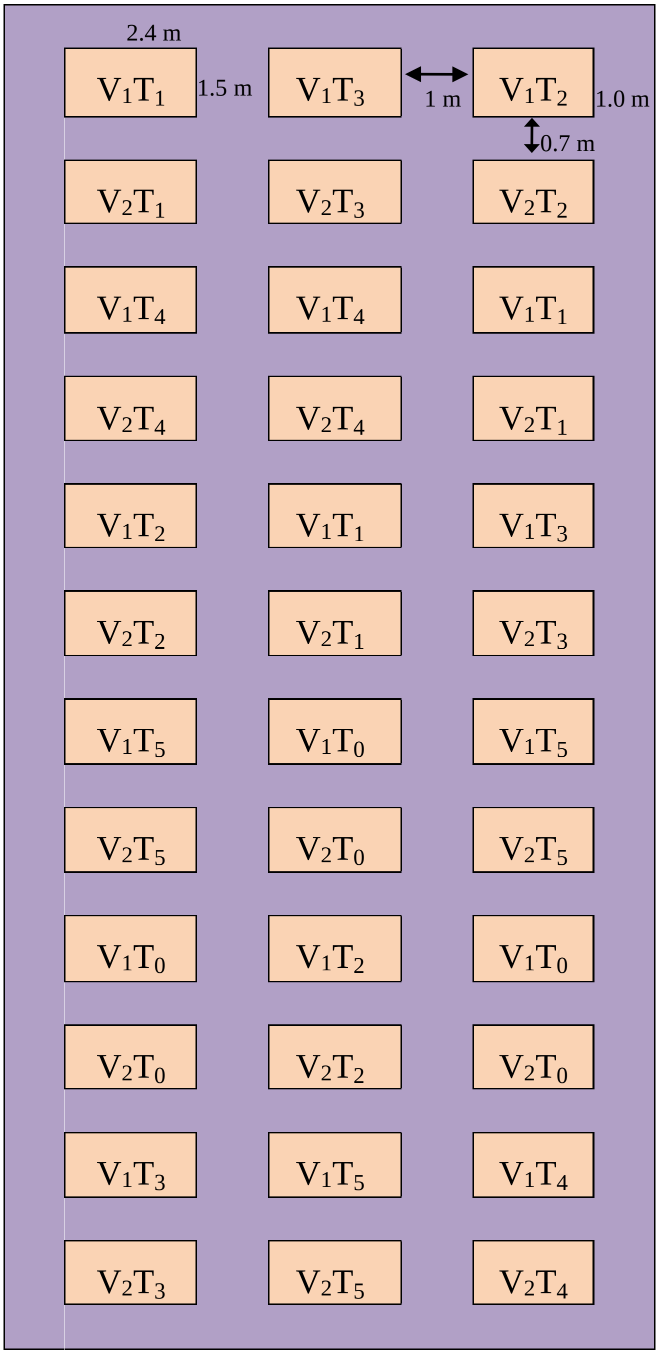
Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

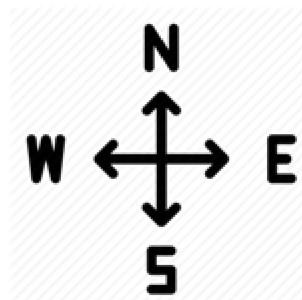
Characteristics	Value
Partical size analysis % Sand	27.00
%Silt	43.00
% Clay	30.00
Textural class	Silty Clay Loam
pH	5.60
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45.00

Source: Soil Resource Development Institute (SRDI)

Appendix III: Layout of experimental field



V_1= PSC-121,
V_2= Yangnuo-3000
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)
T_5= One hand weeding at 45 DAS.



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

source	df	Mean Square Values						
		Weed density	Weed biomass	WCE	Chapra	Mutha	Durba	Helencha
Replication	2	21.806	37.13	34.93	2.346	23.794	2.771	11.570
Factor A	1	93.965	5.44	82.20	4.767	0.871	0.003	0.046
Error	2	315.06	142.21	31.71	41.607	5.380	7.212	1.350
Factor B	5	425.43	14490.6	4454.6	472.617	119.61	49.930	89.077
AB	5	49556.9	70.061	21.415	86.870	11.626	4.659	0.835
Error	20	303.19	134.44	56.198	32.365	6.311	4.034	5.387

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

source	Degrees of Freedom	Mean Square Values			
		60 DAS	80 DAS	100 DAS	At Harverst
Replication	2	21.806	66.299	43.941	332.735
Factor A	1	15.563	13.444	223.004	4030.133
Error	2	0.409	60.924	220.560	131.069
Factor B	5	288.807	86.778	287.502	574.531
AB	5	94.100	360.994	162.292	188.206
Error	20	39.618	79.211	89.767	133.130

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

source	Degrees of Freedom	Mean Square Values		
		60 DAS	80 DAS	100 DAS
Replication	2	0.778	0.715	4.333
Factor A	1	0.111	0.250	6.250
Error	2	0.778	0.188	0.333
Factor B	5	1.444	3.444	1.317
AB	5	0.244	1.233	0.917
Error	20	0.478	0.601	1.800

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

source	Degrees of Freedom	Mean Square Values		
		60 DAS	80 DAS	100 DAS
Replication	2	0.046	0.153	0.986
Factor A	1	0.011	0.082	0.336
Error	2	0.008	0.401	0.044
Factor B	5	0.126	1.199	1.068
AB	5	0.046	0.438	0.329
Error	20	0.051	0.268	.520

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

source	Degrees of Freedom	Mean Square Values	
		LAD1	LAD2
Replication	2	12.491	606.372
Factor A	1	58.906	82.235
Error	2	142.972	533.831
Factor B	5	807.149	4055.257
AB	5	238.918	1202.499
Error	20	151.478	1003.845

Appendix IX: Analysis of variance of the data on crop growth rate of white maize

source	Degrees of Freedom	Mean Square Values	
		CGR1	CGR2
Replication	2	0.280	23.717
Factor A	1	7.636	15.093
Error	2	1.610	6.424
Factor B	5	8.201	17.127
AB	5	1.606	5.177
Error	20	1.475	6.055

Appendix X: Analysis of variance of the data on grains per cob and 100 seed weight of white maize

source	Degrees of Freedom	Mean square value for grains per cob	Mean square value for 100 seed weight
Replication	2	3769.313	2.528
Factor A	1	149.654	136.111
Error	2	98.248	23.861
Factor B	5	1411.750	34.711
AB	5	638.556	17.644
Error	20	717.264	11.261

Appendix XI: Analysis of variance of the data on grain, stover and biological yield and harvest index of white maize

source	Degrees of Freedom	Mean Square Values			
		Grain yield	Stover yield	Biological yield	Harvest index
Replication	2	0.503	0.362	1.636	1.092
Factor A	1	15.748	2.275	29.976	45.114
Error	2	1.320	2.235	6.883	5.531
Factor B	5	6.711	4.352	21.288	12.901
AB	5	2.574	1.529	6.621	24.159
Error	20	1.372	0.849	2.130	42.128