ADDISABABA UNIVERSITY

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Effects of *Striga hermonthica*(Del.) Benth on early growth performances and yield of yellow sorghum [*Sorghum bicolor* (L.) Moench] in potted arenosols with or without compost at Mertulemariam town

BY

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Addis Ababa, Ethiopia

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GRADUATE PROGRAMME

DECLARATION

This is to certify that the thesis prepared by worku Agazhu Addisie, entitled "Effects of *Striga hermonthica (*Del.) Benth on early growth performance and yield of yellow sorghum [*sorghum bicolor* (L.) Moench] in potted arenosols with or without compost at Mertulemariam town, North-West Ethiopia" submitted in partial fulfilment of the requirements for the degree of Master of Science in Biology complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Addis Ababa University, 2019

ABSTRACT

Sorghum bicolor (L.)Moench, commonly known as yellow sorghum, belongs to the grass family of East African origin, which has spread to other parts of the world due to its drought resistance and heat tolerance traits. It is the most common staple cereal crop for poor farmers, but is adversely affected by *Striga hermonthica* (Del.) Benth weed that causes complete loss of most yellow sorghum land races. The weed causes considerable reduction of early growth and yield performances of yellow sorghum grown in semi-arid non- fertile areas of East Gojjam, Amhara Regional State. The present study was aimed at assessing the impact of *Striga* weed on growth development and yield of yellow sorghum grown in potted soils with or without compost. A total of 90 plastic bags (depth 28 cm, diameter 18 cm) were filled with 1 kg arenosols, of which 30 bags contained only *Striga* infected arenosols (SIS), 30 bags contained *Striga i*nfected arenosols mixed with comp (SIS+Comp) and the remaining 30 contained non-*Striga* infected arenosols mixed with comp(NSIS+ Comp).The present study found out that measurements on (NSIS+ Comp) treatment gave value of mean plant height (cm), internodal length (cm),leaf number, leaf area (mm^2),and root collar diameter (cm) of 129.8, 19.5, 14, 354.6, and 3.5, respectively. Similarly, number of seeds per plant, seeds weight (g), thousand seeds weight (g) and total dry weight (g) were, 3,820,131.6, 43.2 and 57, respectively. The corresponding values for plants grown in SIS + Compost were 127, 18, 13,327.6, 3.3, 3,624, 129, 41.5, and 53.5, respectively. control plants grown in SIS only resulted in87.3, 13.5, 8, 262.9, 2.3, 1,950, 76.3, 25.8, and30.1, respectively. Based on the results obtained, it is concluded that application of compost significantly ($p \leq 0.05$) improved almost all the early growth performances and yield components of *S.bicolor.*

KEYWORDS/PHRASES, Biomass**,** Biotic constraints, Germination, Leaf area, Root collar diameter.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANRSBA = Amhara National Regional State Bureau of Agriculture

Comp =Compost

DAG= Days After Germination

GP= Germination Percentage

GV = Germination Vigour

IL= Internodal Length

LN= Leaf Number

LA= Leaf Area

MGT = Mean Germination Time

NSIS+ Comp = Non-Striga Infected Soil plus Compost

RCD = Root Collar Diameter

SIS + Comp= Striga Infected Soil plus Compost

SIS=Striga Infected Soil

1. INTRODUCTION

1.1Background of the study

Ethiopia is one of the world's major centres for indigenous plant domestication. Indigenous plants are critical in providing clean water, fresh air, fertile soil, food, fibre, fuel, and drugs (Legesse Negash, 1995). Because of the little attention given to indigenous crop varieties in favour of improved seed varieties, Ethiopia's indigenous crops are facing serious threat of extinction (Yonas Abiye, 2015).

Food is an essential requirement of mankind, and plants provide up to 95% of world's food supply, directly or indirectly, but global population projections are a grim reminder that food production must continue to increase and must be doubled in next 35 years. The research output jointly conducted by the Ethiopian Biodiversity Institute (EBI) and International Biodiversity Institute (IBI) proved that the local varieties of crops have better yields and productivity. Local crops in Ethiopian farmland were seriously affected by *Striga hermonthica* weed include maize (*Zea Mays*), Teff (*Eragtrotis teff*), candle millet *(Eleusine Cor acana*) and yellow sorghum(African crops 2005).Among these crops *S.bicolor* was the most staple crop that serves as source of food for local people like to make porridges as a steam cooked product or as traditional beer and also important source of animal feed in mixed farming situation, therefore sorghum is being a potential food source to meet the increasing global food demand(Tove Danovich, 2016).

Yellow sorghum is an indigenous crop to Africa and though commeritial needs and uses may change over time.*Sorghum*belongs to the grass family Graminea will remain a basic staple food for many rural communities (Gebisa Ejeta, 2009). It can be grown as rain-fed with little or no external inputs by subsistence farmers that have been grown in arid and semi-arid tropics. The genetic diversity between sub-species of *sorghum* makes it more resistance to pests and pathogens than other less diverse food sources. In addition, it is highly efficient in converting solar energy to chemical energy and also use of water (Hooper *et al*.2009).All of these features makes it a promising candidate help to meet the increasing food demand. *Sorghum* plant has also other morphological and physiological characteristics that contributed to their adaptation to dry conditions and for instance waxy bloom on the leaves and stem reduces epidermal water loss (Lang and Hill, 1982). Conservation of moisture by reducing transpiration, it was the most photo synthetically efficient plant species characterized by highest dry mater production rates.

Striga hermonthica (witch weed)is a root parasitic flowering plant that adversely affected cereal crops in semi-arid non fertile areas of the farm land. It was classified in family Orobanchaceae (Joel, 2000).There are four major species of striga, such as *S.hermonthica, S. asiatica, S.aspera and S.gesnerioldes* (Joel, 2000).Among these species *S.hermonthica* was found and caused complete failure of Sorghum landrace, this indicated that the parasitic weed caused complete failure of the early growth performance and rapid reduction of the yield of yellow sorghum in arid and semi-arid non fertile area of Mertulemariam town. This study aimed to assess the impact of Striga on the early growth performance and yield of sorghum land race simultaneously to identify and create awareness of effective Striga management strategies to local farmers in order to implement on their farm land. The main reason why I initiated to study on this topic was the expansion of Striga weed aggravated hunger, malnutrition ,food in security ,as well as puberty and to achieve food sustainability of local farmers living in arid and semi-arid non fertile area of Mertulemariam town, Enebsie Wereda, Amhara Regional State more over their were urgently needed to replace completely disappeared yellow sorghum land races and to improve the early growth and yield of currently cultivated yellow sorghum by implementing effective Striga management strategies such as application of compost that local farmers first applied for the purpose of integrated soil conservation methods and other pest control mechanisms.

1.2Statement of the problem

Ethiopia's long history of agriculture has contributed to the diversification of the general agro-biodiversity for food and agriculture of the indigenous crops as well as those that reached the country long time ago (Zemedie Asfaw and Abebe Getahun,2001). Ethiopia is an important biodiversity centre in plants including domesticated species. It is the land of many unique endemic species of higher plants and other groups (Legesse Negash, 1995). The diversity in cultivated plants in terms of species varieties and genetic constitution is remarkable. Some important crops (e.g., teff, maize, sorghum, enset and many others) have their origins in Ethiopia while some others have their highest centre of diversity in Ethiopia There are factors that cause the reduction of crop plants.*Striga hermonthica* was a major biotic constraint for complete loss of yellow sorghum and also caused considerable rapid yield reduction that aggravated to hunger, malnutrition, food insecurity and results puberty across arid and semi-arid non fertile areas of Enebsie Wereda.

As I have interviewed the agricultural extension workers of Enebsie Wereda from the past 20 years the yields of yellow sorghum was cultivated on specific place around

Mertulemariam town is called Eneguzy estimated about 75 tons grains per hectare of land and the production of yellow sorghum that was cultivated on specific place called Chinquire estimated about 72 tons grain per hectare of land (source Enebsie Wereda Agricultural office). As a result of rapid infection level of Striga weed the yield of yellow sorghum in 1989 E.C 75 tons per hectare of land reduced to10 tons per hectare in2000 E.C. Yield reduction of yellow sorghum was the major cause that local farmers did not cultivate this species more, that was the reason they were partially disappeared from Enebsie wereda. Therefore, this study was conducted to evaluate the impact of *Striga* weed on growth performance and yield of yellow sorghum and the effect of compost against striga weed and in an effort to draw attention to this neglect ted and underutilized species, so it can contribute to food security and income of subsistence farmers.

1.3Significanceofthestudy

If the mechanism that could reduce the effect of striga weed on the growth and yield of *S.bicolor* derived, farmers could benefit from it and improve the growth and yields of yellow sorghum, in addition to maximize the yields of other crops that were seriously affected by striga weed. So this could enable the local farmers in food sustainability and reduce poverty. This study also serves as a bench mark for the researchers who want to conduct further investigation in semi-arid non fertile areas around Mertulemariam town.

1.4 Basic research questions

- Why local farmers are not managing the effect of striga weed on the growth performances and yield of yellow sorghum [*Sorghum bicolor* (L.) Moench]?
- What factors that increase the impact of striga weed on the growth and yield of yellow sorghum?
- Could fertilizing the soil reduce the impact of striga weed on the growth and yield of yellow sorghum?
- What are the effective strategies to manage the impact of striga weed on the growth and development of yellow sorghum?

2. OBJECTIVES

2.1 General objective.

The general objective of this study was to assess the impact of *S.hermonthica* on early growth performances and yield of *S.bicolor* grown in potted SIS, SIS + Compost and NSIS + Compost under open nursery bed conditions.

2.2 Specific objectives

Specifically this study was intended to achieve the following objectives:

- To study the effect of compost application on morphological and yield attributing parameters of yellow sorghum against *Striga* weed.
- Determine and compare yields of yellow sorghum plants grown in SIS, SIS+comp and those grown in NSIS + Compost treatments
- Determine and compare biomass of yellow sorghum plants grown in SIS only, SIS + Compost and those grown in NSIS + Compost treatments.
- To develop effective strategies to reduce the impact of striga weed on the productivity of yellow sorghum.

3. LITRATUREREVIEW

3.1 *Sorghum bicolor* (L.)Moench

S.bicolor commonly called sorghum and also known as great millet, dura, Jowari, or Milo, it is a grass species cultivated for human function, United States department of agriculture (USDA, 2012). The word sorghum was came from the Latin word sorgo, which means a cereal grass *Sorghum bicolor* (*Sorghum vulgare*) having broad corn like leaves and a tall, pithy stem bearing the grain in a dense terminal cluster. Any of an economically important genus *sorghum* or old world tropical grass similar to corn in habitat but a hairy rachis, especially any of various cultivars such as grain sorghum or sorgo derived from a wild form synonyms *S.vulgare.*

3.1.1Taxonomy and morphological features

The current formal taxonomic concept sorghum genus and species agrees with the one established by Moench. All the different given by various taxonomists are hence taken as synonyms for *S.bicolor* (L.) Moench (USDA, 2012).

Classification of *S.bicolor* has been controversial and challenging due to high variability within the species defined a complex with annual members of sorghum. Sub genus *Sorghum* comprisin7weedy, 13 wild and 28 cultivated species. All of these species in addition to perennial members were later grouped within the single species, S.bicolor (De Wet 1967).Currently *S.bicolor* has three recognized sub species: sub species bicolor, subspecies verticilliflorum, subspecies drummondii.The sub- species bicolor includes the domesticated sorghum used for grain. It is divided based on floral morphology in to five interfertile races (bicolor, kafir, caudatum, durrandguinea) that can produce 10 intermediate races (Wiersema and Dehlberg, 2007).

The wild type of *Sorghum bicolor* is included in the sub species verticilliflorum. Annual weedy derivatives arising from the hybridization of domesticated sorghum and sub species. Verticilliflorum make up the sub species drummondii.The inter grades of sub species drummondii are highly variable due to gene segregation and include shatter cane (a feral form) and Sudan grass. Domesticated sorghum however Sudan grass, sorghum cross with Sudan grass hybrids, and other cultivated sorghums are considered (De Wet, 1972).

3.1.2Origin, occurrence and geographical distribution

S.bicolor is originated in North Eastern Africa, where large variability in wild and cult- ivated forms remain (De Wet 1972).Archeological evidences from near the Egyptian-Sudanese border supports that *S.bicolor* was first cultivated 8,500 to 4,000 years during the early Holocene period S.bicolor cultivation likely spread from Ethiopia, where it is believed domestication occurred to Africa, the middle east, and India along trade and shi- pping routes over 3000 years ago(Dahlberg *et al*.2011). Cultivation then spread from India to China along the silk route and to Southeast Asia with seed moving through coastal shipping routes (Shewale and Pandit, 2011).

S.bicolor was introduced in to US from commeritial cultivation from North Africa and India through the slave-trade at the end of 19^{th}century.*S.bicolor* cultivation in South Africa and Australia became substantial beginning around 1950(House 1985;Shewale and Pandit, 2011).Currently *S.bicolor* is widely cultivated in dry areas of Africa including Ethiopia, Asia, America, Europe and Australia. Sorghum is cultivated between the latitudes of 50 degree north in North America and Russia and 40 degree south in Argentina (Smith and Frederickson 2000).

There is little information on the cultivation of *S bicolor* in Canada, because product- ion is minimal (Almaraz *et al*.2009).Canada field trials were conducted in 1970s and 1980s assessing g the suitability of domesticated sorghum as a crop. Interest in S. bicolor for forage, grain production and use for bio energy, has increased in the past decade, especially in south Western Ontario and Quebec, (AERC, 2008).Approximately 5,000 to 8,000 acres of S.bicolor are grown annually in Eastern Canada and production and domestication plots has also been planted in Western Canada's. *S.bicolor* is the world's fifth most important cereal crop after *Oryza* species(rice),*Triticum* species(wheat), *Zea Mays* L.(maize) and *Hordeum vulpare* L.(barley).*S. bicolor* is widely cultivated and distributed through Tropical, semi-tropical, arid and semi arid environments in over 120 countries throughout Africa, Asia, Australia and Europe(FAO, 2015).S.bicolor is one of the main staple crop for the world's poorest and most food in secure people(FAO, 2011).as Ethiopia is the center of origin and diversity for *Sorghum bicolor,* the crop has been cultivated for thousands of years and hence the heritage has not been done before(Dogget, 1988).

3.1.3Cultivation and use as a crop

S.bicolor is grown for grain, forage, sugar, bio energy, brooms and as a cover crop (Smith and Frederickson, 2000). Globally 50% of domesticated sorghum is used for human consumption; in the U.S, 90% percent of domesticated sorghum is used for livestock feed(Hamman et al.2001).Desirable crop characteristics of *S.bicolor* include its ability to become dormant during drought conditions and resume growth under favourable conditions, and its tolerance of salinity and temporarily water logging(Heuze *et al*.2012)

S.bicolor has been for centuries, one of the most important staple food for millions poor rural people in semi-arid tropics of Asia and Africa (Gebisa Ejeta, 2009). For some impoverished regions of the world, sorghum remains a principal source of energy, protein, vitamins, and minerals. In Ethiopia sorghum is fermented to make injera flatbread and in Sudan, itis fermented to make kisra, in India, dosa is sometimes made with a sorghum grain mixture (Smith, Frederickson, Richard).Sorghum grows in harsh environment, where other crops do not grow well, just as other staple foods, such as cassava, that are common in impoverished regions of the world. It is usually grown without the application of fertilizers or other inputs by a multitude of small-holder farmers in many countries.

3.1.5Production trends

FAO reported that United States of America was the top producer of *S.bicolor* in 2009 with harvest of 9.7.million tons. The next four major producers of *S.bicolor* in decreasing quantities were India, Nigeria, Sudan and Ethiopia. The other *S.bicolor* producing region in the world by harvested quantities, were ,Australia, Brazil, China, Burkina Faso; Argentina, Mali; Cameroon, Egypt, Niger, Tanzania and Uganda. The leading producer of *S.bicolor* in 2011 were Nigeria (12.6%), India (11.2%), Mexico (16 %), US (10.2%) and 50% others. *S.bicolor* grows in a wide range of temperature, high altitudes and toxic soils and can recover growth after some drought (FAOUN, 2012). It has five adaptive features that make it one of the most drought resistant crops, like, it has very large roots-to-leave surface area ratio, in times of drought it rolls its leave lessen water lost by transpiration, if drought continues it goes in to dormancy, rather than dying, its leaves are protected by waxy cuticle and it usesC_4 carbon fixation thus using only a third the amount of water that C3 plants required. *S.bicolor* with curved and heavy peduncle will make the young soft peduncle bend, which then will lignifies in this position combined with awed inflorescence, the form of a two-told defence against the consumer birds.

In Ethiopia, sorghum production ranks fourth in area coverage after teff (*Eragrotis teff*), maize (*Zea Mays*), and wheat (*Triticum*).It is grown on 1, 253,620 hectare with a total prod-uctivity of 1, 715, 954 tones (House, 1992), and it counts 14.2% and 13.6% of the crop area and production respectively. As a result there are over 3, 674, 865 farmers' households dependant on sorghum production.

3.1.4 Mode of reproduction

Sorghum.bicolor is predominantly self pollinating, but under specific conditions wind mediated cross pollination can occur over 60% depending on the genotype and average about 6% (Ellstrad and Foster, 1983; house, 1985).As a result of self pollination and out crossing most sorghum land races grown by subsistence farmers are mixtures of inbred and partially inbred lines(Singh *et al*.1997).The level of out crossing varies and is influenced by the panicle type of the cultivar; typically out crossing is higher in loose panicle grassy sorghum and lower in compact panicled domesticated sorghum. The estimated out crossing rate in domesticated sorghum under field conditions ranges from 5% to 40% (Barnaud et al.2008; Doggett, 1988; Ellstrand and Foster 1983). Several pollinator species have been observed consecutively visiting domesticated sorghum flowers, up on insect collection sorghum pollen grains were found on all of the insects (House, 1985). However, it was not determined if insect movement resulted in cross pollination. More studies are needed to determine the extent of insect pollination in *S. bicolour*.

The flowering and pollination of S.bicolor is described in House (1985).Inflorescence development begins when a floral initial forms 30 to 40 days after germination. Domesticated *S.bicolour* normally flowers 55to 70 days after germination in warm climates. But depending up on the genotype and environmental conditions, flowering may occur 30 to 100 days after germination. Wet and cool weather can also delay flowering. Flowering begins to open to two days after the emergence of the inflorescence from the boot. Flowering starts in the sessile spikelet (multiflowered sub divisions of the inflorescence) at the tip of and progresses down wards over 4 to 5 days. A single panicle may have up to 6,000 florets (Quinby and Karber 1947).all heads do not flower at the same time in a field. Flowering time varies based on the genotype, and climatic conditions, usually occurring from midnight to mid-morning and peaking around sunrise.

3.1.5 Factors affecting seed germination

Seeds are central to crop production, human nutrition, and food security. They carry the full genetic complement of the crop and are therefore the delivery system for agricultural biotechnology and crop improvement. The vast majority of crops produced in world agriculture begin with the sowing of a seed to establish a new plant in the field. Successful seedling establishment is the first critical step for crop production, and determines the success or failure of the future harvest (Konging1994). Seed is composed of three generation of plant tissues including the saprophyte that produces an immature seed known as ovule and the gameentophyte that develop inside the ovule to produce ova. The third plant tissue of the seed is the new saprophyte embryo. Endosperm is the nutritive substance of the seed up on which the seed embryo feeds as its development (Konging, 1994). Despite these anatomical structures of seed in higher plants, seed morphology differs from one plant species to another, there are small and big seeds, thin, flat, light, papery, dehiscent and indehiscent, smooth and hard seed coat.

Germination is the process by which the embryo wakes up from the state of dormancy and takes to active life. This process, in fact, covers all the changes from the earliest sprouting of the seed till it established itself as an independent plant. The signs of seed germination are redemption essential process, including transcription, translation, and DNA repair followed by cell elongation, and eventually at the time of radicle protrusion, resumption of cell division (Barroco *et al*., 2005). Germination is a two process, where testa rupture is followed by endosperm rupture. Following rupture of micropylar endosperm by emerging radicle, germination is complete (Kroch*et al*., 2002; Liu *et al*., 2005). During seed germination various stored substrate are reactivated, repaired if damaged and transformed into new building materials necessary for initial growth of the embryo, its subsequence growth, and seedling establishment in its natural habitat (Koller and Hadas, 1982). External and internal factors are declared to affect seed germination. According to Legesse Negash ,1995, propagation of many indigenous tree species from seed had been difficult due to lack of precise knowledge on their seed biology and germination physiology, because many native plant species have developed survival strategies through evolutionary process for million years, understanding these strategies in the context of seed physiology for successful plant propagation.

3.1.5.1External factors

Environmental factors such as temperature, light, pH, and soil moisture are known to affect seed germination (Chachalis and Reddy, 2000). Burial depth of seed also affects seed germination and seedling emergence. Some of the most important external factors are water, oxygen and suitable temperature**. (I)** Water or moisture: A dormant seed is generally dehydrated and contains hardly 10 to15% water in its living cells. The active cells, however, require about 75-95% of water for carrying out their metabolism. Therefore, the dormant seeds must absorb external water to be active and show germination. Besides providing the necessary hydration for the vital activities of protoplasm, water softens the seed coats, causes their rupturing, increases permeability of seeds, and converts the insoluble food into soluble form for its translocation to the embryo (Raven *et al* 2005). Water also brings in the dissolved oxygen for use by the growing embryo. Entrance of oxygen is also facilitated, and as a result, the rate of transpiration is accelerated. Seed germination incorporate those events that commence with the uptake of water by quiescent dry seed, and terminate elongation of embryonic axis (Bewley and Black, 1994). Water uptake by a seed is tripe phase, phase I rapid initial uptake; phase II plateau phase, and phase III further increase of water uptake , however, when only germination occurs (Bewley, 1997). The amount of water taken into seed for germination depend anatomically, physiological nature, and plant species, most seeds critical water (moisture) content for seed germination occur i.e. corn *(Zea mays)* 30%, wheat *(Triticimae sativum)* 40%, and soybean (*Glycine max*) 50% (Wash and Nyomora, 2012). If the internal water (moisture) content decrease below or increase above the critical moisture content seed essentially decay. **(II)**Supply of oxygen: Oxygen is necessary for respiration which release the energy needed for growth. Germinating seeds respire very actively/feebly and need sufficient oxygen.

3.1.5.2Internal factors

Hormones contained in various developmental stages, the seed, and enzymes are some of internal factors which in one way or another can affect seed germination (Neff *et al*., 2009). Many researchers also agree that seed dormancy period, seed viability (power of germination), and thickness or thinness of the seed coat may affect seed germination and hence are factors for seed germination (Finch-Savage and Leubner-Metzger, 2006). In some plants the embryo is not fully mature at the time of seed shedding. Such seeds do not germinate till the embryo attains maturity. The seeds of almost all the plants remain viable or living for a specific period of time. This viability period ranges from a few weeks to many years. Seeds of Lotus have the maximum viability period of 1,000 years. Seeds germinate before the ending of their viability periods. In many plants, the freshly shed seeds become dormant due to various reasons like the presence of hard, tough and impermeable seed coats, presence of growth inhibitors and the deficiency of sufficient amount of food, minerals, and enzymes, etc. Dormancy is a simple operational a bloke to completion of germination of an intact viable seeds under favourable conditions (Bewley, 1997). The seeds of some species are prevented from completing germination because the embryo is constrained by its surrounding structures this phenomenon is known as seed coat dormancy (Legesse Negash, 1993) even though; embryos isolated from these seeds are not dormant. The other type of dormancy is found when the embryos of the seeds are dormant, known as embryo dormancy. The third type of dormancy regulates seed germination by the inner tissue of the seed, which is the embryo, the enclosing endosperm and inner integument layer or both (Hartmann and Kester, 1975). Thus, dormancy must be broken to induce germination and various methods are used for this depending on the plant species and type of dormancy. Dormancy is self-guard for some seeds and seedling for suffering damage of death and allow some seeds to germinate when competition from other plants for light and water. Seeds germinate only after the dormancy is overcome or broken either through natural means such as animal gut activities (Manzano *et al*., 2005), wild fire (Van Staden *et al*., 2000), rainfall (Hartmann *et al.*, 2004) or through artificial means such as scarification, seed coat cracking, removing chemical inhibitors through leaching by water (Legesse Negash, 1995).

3.2*Striga hermontica (*Del.) Benth and its effect on crops

S.hermonthica is an obligate root parasite and therefore modulates its development with its host life cycle (Eject and Goessel, 2007).Germination of the weed proceeds in response to chemicals exuded by the host plants for attachment of both germination and houstorial initiation needed to occur very near to the host plant roots. Striga seeds pass through a period of dormancy and cannot germinate in the season, in which they are produced. This is because after ripening which prevents newly matured striga seeds from germinating too late in season.

Striga seeds produce more seeds per fully matured plant, which remain dormant in the soil for up to 10 years; (AATF, 2006). These seeds are small and therefore have limited energy reserves. This condition will make a germinated striga to survive in a free living state for only a few days, because it must depend on its small seed reserves. Crop yields lose due to striga attacks can vary depending on striga seed density, soil fertility, rainfall distribution, cereal host species variety grown and total 25 African countries reported striga infection in 2005 (De Groote et al., 2008).

Striga affects the life of more than hundred million people in African and causes economic damage equivalent to approximately one billion $US per year (Labrador,2008; Warburg, 2013).Striga infects important cereal crops such as maize, sorghum, upland rice causing devastating losses of yields. Farmers have reported losses between 20% and 80% and are eventually forced to abandon highly infested fields (At era and Itch, 2011). Grain yield losses even can reach 100% in susceptible cultivars under a high infestation level and drought condition (Haussmann et al., 2004).

According to estimates by Goessel *et al.* (2004). 17.2 million hectares (64%) of the total areas of sorghum production in West Africa are infested with striga. The infestation area and levels are expected to increases in the future because of continued cereal monoculture in combination with low organic and mineral fertilizer input rates. *Striga hermonthica* (Del.) Benth. *S. Asiatic* (L.)Kountze are the major biotic constraints to crops production, spatially in the non-fertile semi-arid region of Africa, where as *Aspera* (Wild.) Bentham, S. firebase have benefits of lower economic importance (Haussmann *et al*., 2004).Therefore controlling striga has become a huge task considering the seed production rate of 10,000 to100,000 seeds per plant which remain viable in the soil up to 10 years(Icier *et al*.,2006).This can lead to seed shed rates of over 1,000000 seeds per square meter per year(Kroschel andMuller-Stover,2003).This can lead to a rapid build up of the seed bank in the soil once fields have been contaminated (Van Moore et al, 2008).

Research on striga control has been carried for along time and a wide range of technologies have been developed (At era, *et al*., 2011). Despite efforts made to control the striga problem, it has persisted. Although research on the parasitic weed has a long history adoption of the control options is limited (Emechebe *et al*., 2004).

3.2.1Description

Striga (witch weed) are characterized by bright-green stems and leaves and small brightly coloured and attractive flowers. They are obligate hemi-parasites of root and required a living host for germination and initial development, through they can then survive on their own. The genus is classified in the family Orbanchaceae, although older classifications place it, in the Scrophulariaceae (Joel, 2000).

3.2.2Origin, occurrence and distribution

Plants belonging to genus *striga* (*Orobanchaceae*) comprise obligate root parasites of cereal crops that inhabit normal host growth via three processes, competition for nutrients, impairment of photosynthesis (Joel, 2000) and a phototoxic effect within days of attachment to its hosts(Gurney *et al.,*2006).Generally striga is native to semi-arid tropical areas of Africa, but have recorded in more than40 countries(Eject,2007;Vesey *et al*.2005).Striga is possibly originated from a region between the semen mountains of Ethiopia and Nubian Hills of Sudan(At era and Itch,2011). This region is also the birth place of domesticated sorghum *(Sorghum bicolor* (L.) Moench.

Approximately 30 striga species have been described and most parasitize grass species *(Poacaea*).Striga gesneroids(wild).is the only striga species that is virulent to monocots (Mohamed and Mussel man, 2008).Among 23 species of striga prevalent in Africa S.hermonthica is the most socio-economically important weed in Eastern Africa(Goessel *et al*.2004;Goethe*etal*,2005*).Striga hermonthica* is particularly harmful to sorghum, maize and millet cereal crops ,but also increasingly being found in sugar cane and rice fields(At era and

Itch,20). Crops previously un affected by striga weed is now showing series infestation (At era and Itch, 2011).The enzyme system of the parasite thrive under low soil fertility and moisture stress conditions, where most soils have been depleted of fertility through the removal of organic matter and limited use of compost, low fertility of soil in combination with drought induced stress and susceptible host cropping that predisposes the area to striga(Fasil Asefa, 2002)

3.2.3 Hosts and Symptoms

Although most species of striga are not pathogens that affect human agriculture, some species have devastating effect up on crops, particularly those planted by subsistence farmers. Crops most commonly affected are maize,sorghum,rice and sugar cane(At era and Itch).These species causes the most damage like *Striga asiatc*, *Striga gesnerioldes* and *Striga hermonthica*. Witch weed is capable of significantly reducing yields, some causes wiping out the entire crop. Host plant symptoms such as stunting, wilting and clorosis, were similar to those features that have been seen from severe drought damage, nutrient deficiency and vascular disease (Icier *et al.* 2006).

3.2.4 Life Cycle

Each striga plant seeds germinate in the presence of host plant root, and capable of pro-ducing several seeds, which may remain viable in the soil for over 10 years (Icier *et al*. 2oo6).Striga seeds germinate in the presence of host root that exudates and develop historian which penetrates host root cells. Host root exudates contain stfingo lactones, signalling molecules that promote striga seed germination. A bell like swelling forms where the parasitic roots attaches to the roots of the host plant (Icier *et al*. 2006).

The pathogen develops underground, where it may spend the next four to seven weeks before emergency when rapidly flowers and produce seeds. Witch weed seeds spread readily via wind and water and in soil via animal vectors. The chief means of dispersal is through human activity by means of machinery tools.

3.3 *S. hermontica* control methods.

The control method of striga is cultural and mechanical methods. The number of cultural practices have been recommended for striga, such as crop rotation (Oswald and Ransom, 2001) intercropping (Odom et al. 2007).And water management (Fasil and Verkleij, 2007); and hand weeding(Ransom, 2000), reduces the production. These methods should also reduce the density of striga seeds already in soil seed bank (Fasil and Verkleij, 2007). Some of these practises improve soil fertility, which will stimulate the growth of the host plant but also adversely affects germination, attachment and subsequent attachment development of the juvenile striga plant (Fasil and Verkleij, 2007). However this approach has only limited success for small scale farmers largely due to Scio-economic and the finical constraints.

3.3.1 Hand weeding and sanitation

Today the most weed control method in against striga is hand weeding practise of farmers. It is recommended to prevent seed set and seed dispersal. Weeding the striga plant is a tedious task and may not help to prevent striga on already infected plants, it is necessary to prevent seed production and re-infection of the soil. Due to high costs in repeated hand-pulling of striga, it is recommended that hand pulling should not begin until 2-3 weeks after *S. hermonthica* begins to flower to prevent seeding (Parker and Riches 1965). Crop stubble should also be uprooted or burned to prevent the continued growth and seeding of the parasite (Ramallah *et al.*1983). This weed competes for water and nutrients as a root parasite. In so doing, crop growth is stunted and yields are generally reduced (Ayongwa *et al; 2010*) it is not practical to hand weed dense infestations, and weeding is often ineffective, particularly since it is time consuming and labour-intensive (Parker and Riches, 1993). It is practical, at a low level of infestation before striga flower and in combination with herbicides or fertilizers.

3.3.2 Crop rotation

Rotating the infested maize or sorghum areas to barley or wheat, groundnuts or pulses are viable and effective options in Ethiopia. In Ethiopia two years of cropping to a non-host was reported to reduce striga infestation by 50% (Shankar, 2002). In the results of a fou**r** year experiment in bush fields indicated that one season cow pea in 1998, had a positive effect on subsequent millet grain yields, soil organic carbon and nitrogen and reduced striga infestation. The increases yields due to millet-cow pea rotation were 37% in 1999 compared to three to five year’s continuous millet cropping (Smack, 2003). However, small-holder farmers desiring to maximize the grain production potential of the land may be difficult to be persuaded to grow other crops. Practical control measures are effective when a combined program of crop rotation, weeding sanitation and resistant varieties.

3.3.3 Trap crops and catch crops

Trap crops cause suicidal germination of the weed which reduces the seed bank in the soil. Some varieties of cow pea, groundnut and soybean have potential to cause suicidal germination of *S.hermonthica* and improve soil fertility (Carsky *et al.*, 2000; Schulz *et al.*, *2003*). The use of trap crops such as soybean causes suicidal germination of the striga seedlings which do not attack the soybean consequently, the striga is ploughed off before flowering there by reducing the seed density of striga in the soil (Umbra *et al*., 1999)..

Catch crops are planted to stimulate a high percentage of the parasite seeds to germinate, but they are destroyed or harvested before the parasite can reproduce. A thick planting of Sudan grass at 20-25 kg seed per hectare should be sown and either ploughed in or harvested for forage at 6-8 weeks before striga give seeds. The main crop could then be planted during the main rains (Parker and Riches, 1993).

3.3.4 Intercropping

Intercropping cereals with legumes and other crops is a common practice in most area of Africa. Intercropping is a potentially viable, low cost of Africa and has been reported as influencing striga infestation (Odem *et al*.,2007). Intercropping is a potentially viable, low cost practice, which would enable to address the two important and interrelated problems of low soil fertility and striga (Fasil Asefa, 2002).

Intercropping different legumes with maize and sorghum helps to reduce striga, but does not eliminate the weed (Khan, 2007). This explains why in spite of most farmers intercropping cereals with legumes as dominant cropping system in western Kenya, Striga infestation is still high in most fields. A variant intercropping system dubbed “push-pull” where *Desmodium* species is intercropped with cereals with an age of fodder crops are effective in striga management. Therefore, there is need to combine more than one strategies to improve the effectiveness of existing control strategies (Eject and Goessel, 2007).

3.3.5 Soil fertility

Nitrogen and phosphorus deficiency as well as water stress accelerates the severity of striga damage to the hosts. Striga is particularly a pest of low fertile soil and usually the infestation decreases if mineral nutrients, especially nitrogen and phosphorus are applied insufficient quantities(Adagba *et al.,* 2002).Nitrogen is a chlorophyll component, and it promotes vegetative growth and green foliage (Jones, 1983). Consequently, nitrogen is the element without which plants are unable to complete their life cycle, germination, growth and development, flowering and production of seeds that would again start the plant’s life cycle (Marschner, 1995; Legesse Negash, 2010).

Phosphorus is one of the essential nutrient elements used for plant growth and development. It plays a major role in photosynthesis, respiration, energy storage, cell division, and maturation. It also constitutes and participates in the synthesis of diverse biologically active molecules (Heldt, 2005; Marschner, 1995; Tiessen, 1993). Phosphorus plays a critical role in the life cycle of plants and in most essential element in influencing plant growth and seed production (Wilde et al. 1979; Brady, 1990).Fertilizer application had significant effect on height. Vigour score, reaction score of sorghum as well as shoot count, days to emergence, dry matter production and dry weight of striga , that means application of high nitrogen increases the performance of cereal crops under striga infestation, this is due to the fact that nitrogen reduced the severity of striga attack while simultaneously increases the host performance

Potassium is another major substance that plants get from the soil, it is used in protein synthesis and other key plant processes, in plant metabolism and chlorophyll development (Remison, 2005). Yellowing, spots of dead tissue, and weak stems and roots are all indicative of plants that lack enough potassium.

Results of an experiment designed to develop integrated nutrient management strategy, confirmed that the combined use of compost could lead to significant reduction in infestation and considerable increase in sorghum yield (Silica *et al*., 2000), also found that increasing soil fertility not only stimulates the growth of the host also adversely affects longevity of the striga seeds in the soil, germination and attachment, has noted in western countries that host plant shading can restrict striga growth when soil fertilizer is applied. Application of high dosage of nitrogen low fertilizer is generally beneficial in delaying striga emergency and obtaining stronger crop growth (Doge *et al*., 2008).

3.3.6‘Push-pull’ technology

The ‘push-pull' technology is an intercropping strategy where fodder legumes *(D.Uncinatum* and *D.intortum* and intercropped and first conceived by Pyke, 2007, and later formulized by Miller and Cowls (1990). Involves the use of behaviour-modifying stimuli to manipulate the distribution and abundance of a pest and beneficial insects for management of the pest(Cook *et al* .,2007).This technology was first developed to control stem borers bull was later found to also suppress striga weed in the field depending on which push component the main crop has been intercropped.

In push-pull strategy, pests are repelled away from the target crop by stimuli that make host appearance. The pests are simultaneously attracted (Pull) to a trap crop where they are concentrated, leaving the target crop protected. Disodium is extremely effective in controlling striga (Khan *et al.*,2008) where resulting in significant yield increase in maize from 1to 3.5 tons per hectare per cropping season and improving farm productivity.

The technology so far most effective and in needed the only push-pull strategy in practice by farmer (Cook *et al*., 2007; Hssannali *etal*.2008). Also enhances productivity of maize-based farming systems through in-situ suppression elimination of striga weed (Khan *.et al* .2000,2001,2002).According to the study done by Khan(2010), push-pull technology helps for controlling both striga and stem borers with at least 2 tons per hectares higher grain yield. The technology is currently being disseminated among small holder farmers in eastern Africa.

3.4 Soil

Soil is a loose material made up of different materials and elements. Major components of soil include **(I)** Inorganic matter**:** -this is the non-living thing found in the soil, 45% of the total soil volume**. (II)**Organic matter: - this is the dead bodies of animals and plants in the soil. Microorganisms like bacteria and fungi in the soil are also organic matters. About 5% of the soil is organic matter, improves soil structure and increases the nutrient and water holding capacity of the soil, stability of soil aggregates(Brady,1990).Organic matter provides a food supply for soil biology and reduce nutrient leaching. Organic matter is fully broken down one of the things that is left is humus. Humus has some useful qualities in that it adsorbs nutrients, adsorbs much higher quantities of water than clay can, and improves soil structure due to its low plasticity and good cohesion. **(III)**Water, water accounts about 25% of the volume of the soil. **(IV)**Air**:** - different gases may enter and fill the open space in the soil; a good soil has 25% of its volume composed of air

3.4.1 Soil formation

The process by which rocks are broken down into pieces called weathering, physical (mechanical) and chemical weathering. In physical weathering rocks are broken into small particles of soil and are affected by climate, type of rock, plant and animal action. Because of variation of temperature during day time and at night rocks contract and expand. The contraction and expansion make the rock layer peel-off and fall to the ground. This process is called exfoliation (onion-skin weathering). Roots of trees entering into cracks of rocks force the rocks to break down into pieces. Small creatures, such as rabbits, worms, moles etc. making holes in the soil in search of food and shelter, while doing this they break down rocks. Young rocks are softer so they can easily break down. Ex. sedimentary and igneous breaks down easily than metamorphic rocks which are old and hard. In chemical weathering there is chemical change (reaction) in soluble minerals. Such factors as heat, cold, air, water, and certain plants, acting over a long period of time, break rocks into small particles; the tiny rock particles, when mixed with water, air, and organic material, form soil, humus and the uppermost layer called topsoil normally supports plant life (Hall and Lesser, 1966).

3.4.2Soil types

Different methods are used to identify soils**. (A)**Texture**:** - it is the size of soil particles. Soil texture is determined by the proportions of sand, (large size) silt, (medium size) and clay (small size) in the soil. When they are wet, sandy soils feel gritty, silt soils feel smooth and silky, and clay soils feel sticky and plastic, or capable of being moulded. Soil texture influences many soil physical properties, such as water-holding capacity and drainage. Coarse-textured sandy soils generally have high infiltration rates but poor water holding capacity. Because of its porous, readily admits air and water, which are essential to plant growth (Hall and Lesser, 1966). Silt particles are much smaller than sand, have a greater surface area, and are generally quite fertile. They do not hold as much moisture as clay soils; however more of the moisture is plant available. Fine-textured clay soil generally has a lower infiltration rate but a good water holding capacity (Brand and Weil, 1999).

The tiny, firm-packing clay particles form a non-porous soil that is difficult to till and likely to cake. Being non-porous, the soil can absorb very little water**. (B)**Structure: - it shows the arrangement of soil particles (sand, silt and clay) and pores in the soil and to the ability of the particles to form aggregates (Braunack and Dexter, 1989). Macro-pores allows good aeration, rapid infiltration of water, easy plant root penetration, good water drainage, as well as providing good conditions for soil micro-organisms to thrive. Micro-pores hold water against gravity (capillary action) but not necessarily so tightly that plant cannot extract the water (Brand and Weil, 1999). (**C)**Colour**:** -it indicates the type of materials in the soil- Ex: red soil is rich in iron. Black soil is rich in humus**. (D)**Fertility: - Soils with high nutrient content are fertile soils, if not they are infertile(Thompson and Throch, 1978**).(E)**Soil profile**:** - Soils have three layers from top to bottom**. (F)**Location: - different soils are found in different parts of the world. In equatorial rain forest region soils are red and called laterites. In the temperate zone soils are black and known as chernozems. In the cold zone soils are grey and called podosols.

There are about 19 soil types identified throughout the country,Ethiopia.The big proportion of the country's landmass is covered by litho sols/liptosols (14.7%), nitosols (13.5%), cambisols (11.1%) and regosols (12%) in order of their importance, the rest includes vertisols (10.5%), fluvisols (7.9%), luvisols (5.8%), arenosols (5%), xnarosols (4.8%), solonchaks (4.2%), yermosols (3.1%) cresols(2.9%), rendzinas (1.5%), andosols (1.2%),(0.81%gleysols (0.47%), histosols (0.42%), solonetz (0.04%) and chernozems

(0.07%). Complexes of soil forming factors have primarily the distribution of the soil types, (MOA, 2000).

According to Ashenafi Gedamu (2008) the dominant soil types of the Amhara Region include black vertisols (47%). The soil of the study area comprises 45% arenosols,28% black vertisols,11%brownnitosols nd16% other soil types.

3.4.2.1 Arenosols and its key characteristics

Arenosols is one of the 19 soil groups in the classification system of the (MOA, 2000). Arenosols is sandy texture that lacks any significant soil profile development. They exhibit only a partially formed surface horizon (uppermost layer), that is low in humus accumulation. Given their excessive permeability and low nutrient content, agricultural use of these soils requires careful management (FAO, 2001). They occupy about 7% of the continental surface area of the earth, and they are found in arid and semi-arid regions, such as the Sahel of western Africa and the desert of Western Australia as well as in the tropical regions of Brazil. They are dry for most of the growing season. Rain is not sufficient to leach through the soil, so lime and salts accumulate in the lower sub-soil. Nutrient levels are relatively high but the soils must be irrigated to produce crops. Arenosols are most commonly formed in warm, humid or semi-arid and arid climates, where the natural vegetation is predominantly open forest, or desert shrub (Ahmed, 1996). The basic property of arenosols, that endows them low water holding capacity in their sandy content, which commonly lies between 10-25% and it, may be as high as 35% (Ahmad and Marmut, 1996).

3.4.2.2 Management related properties of arenosols

Soil management is the basis of all scientific agriculture, which involves six essential practices: proper tillage; maintenance of a proper supply of organic matter in the soil; maintenance of a proper nutrient supply; control of soil pollution; maintenance of the correct soil acidity; and control of erosion. It is important that for optimum sustainable benefits from the use of the soils, their particular properties and behaviour must be understood and incorporated in management strategies. Proper use of the soil, therefore, starts with appropriate selection of crops to be grown and the adoption of practices suitable for the soils. The use of the soils is considered in three broad categories, that is, for crop production, for pasture both native and improved, and for agro forestry for crop production on a worldwide basis (Maxton, 1926).

Arenosols are presently used for a range of crops including cereals, small root crops, fibre crops , maize, sorghum and sugarcane (Ahmed, 1996).Arenosols as a class of soils, are easily recognized because of their sandy textures, grey colours, and special attributes. These soils are very productive if well managed as like to all other soil types, but present constraints to low input agriculture. Although positive response to management make these soils attractive for agriculture. Some other properties of arenosols have high slaking and dispersion potential, and moderate to high bulk densities(Maxton, 1926)..

3.5The effects of fertilizers on growth performances and yieldof *S.biolor* under nursery bed conditions.

Fertilizer is a substance added to soil to improve plants' growth and yield. First used by ancient farmers, fertilizer technology developed significantly as the chemical needs of growing plants were discovered. Like all living organisms, plants are made up of cells. Within these cells occur numerous metabolic chemical reactions that are responsible for growth and reproduction. Since plants do not eat food like animals, they depend on nutrients in the soil to provide the basic chemicals for these metabolic reactions. The supply of these components in soil is limited, however, and as plants are harvested, it dwindles, causing a reduction in the quality and yield of plants (Maxton, 1926).

Fertilizers replace the chemical components that are taken from the soil by growing plants. However, they are also designed to improve the growing potential of soil, and fertilizers can create a better growing environment than natural soil. They can also be tailored to suit the type of crop that is being grown. Typically, fertilizers are composed of nitrogen, phosphorus, and potassium compounds. They also contain trace elements that improve the growth of plants. The use of chemical fertilizers and organic compost has both positive and negative effects on plant growth and the soil. Fertilizers affect plant growth by supplementing plant nutrients which allow plants grow faster and thicker. However, this applies only if the soil is deficient in nutrients.

Fertilizers do not compensate for other growth inhibiting factors such as lack of water, poor soil preparation and weeds (Maxton, 1926). Incorporating inorganic and organic fertilizers to soil would provide multiple benefits for improving the chemical and physical status of the soil to which results in improved crop yield (Basso and Ritchie, 2005). Fertilizers enhance the growth of plants. This goal is met in two ways, the traditional one being additives that provide nutrients. The second mode by which some fertilizers act is to enhance the effectiveness of the soil by modifying its water retention and aeration.

4. MATERIALSANDMETHOD

4.1 Description of the study area

The present study was conducted at Mertulemariam town between December 2019 and Jun2019. Mertulemariam is found in North Western Ethiopia, located in East Gojjam Administrative Zone, Amhara Regional State, Ethiopia. Mertulemariam is located at 180 km from Bahir Dar and 365 km north of Addis Ababa. It is the administrative centre of Enebsie Wereda. The total area of the Wereda is 106,533.63 hectares and has a population of 146,192 of which 72,223 are males and 73,969 are females in 2018(information obtained from Enebsie wereda finance office). Enebsie Wereda is composed of 35 K*ebeles* that have three agro-ecological zones, namely kola (57.86%), woynadega (37.14%) and dega (14%). (Information obtained from Enebsie wereda agricultural office). The altitude of the study area ranges from 500-2,300m above sea level; the annual temperature and rainfall ranges fall between26-30^{O}Cand 600 -900mm respectively.

From the total area of the Wereda 98,460.52 hectares of farm land were covered by the common cereal crops such as yellow sorghum [*Sorghum bicolour* (L.) Moench], Maize *(Zea Mays*), navy bean (*Phaseolus vulgaris*), Teff (*Eragrotis Teff),* pea *(Pisum Sativum*) and wheat *(Triticum*) (Information obtained from Enebsie Wereda agricultural office).

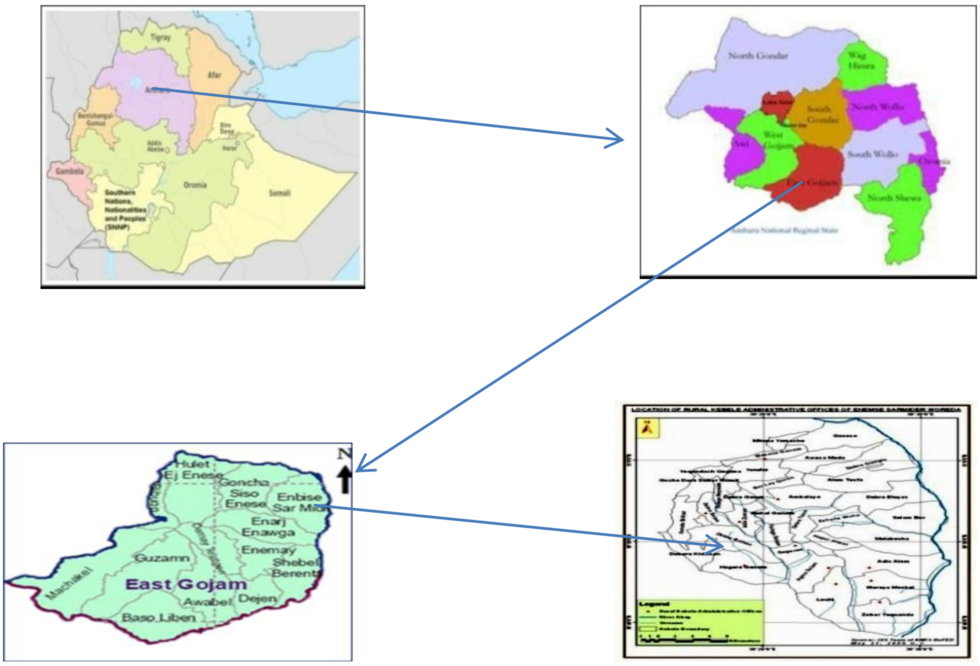

Figure1: Map showing location of the present study area Mertulemariam town, East Gojjam Administrative Zone.

4.2 Field observation

Field observation was one of the data collection methods that helped to collect data by observing and recording the real events about yellow sorghum. I observed the effect of striga weed on yellow sorghum land race and the soil type that was suitable for the spread and growth of striga weed and finally what would be the final effect of striga weed on early growth performances of yellow sorghum.

A **B**

Figure 2:(A) Yellow sorghum farm infested with striga in Eneguzy *Kebele*;**(B)** Similarly yellow Sorghum farm in Chinkuir *Kebele,* East Gojjam Administrative Zone.

4.3 Nursery bed preparation

Before starting the actual plastic bag experiment, a rectangular nursery bed of 120 cm x 400 cm was prepared, which was enough to accommodate the 90 plastic bags. The nursery was fenced with wooden materials such that the yellow sorghum plants were protected from wind and domestic animals. Insecticide net stalks were used to cover the bags for conserving moisture, and to prevent birds and certain flying insects from entering in to the nursery bed.

4.4 Seed preparation

Seeds of yellow sorghum were obtained from Eneguzy Kebele during the 3rdweek of October 2019. Seeds were sieved to remove any debris materials and were stored at room temperature in paper bags until required.

Figure 3: Seeds of yellow sorghum used for planting in plastic sleeves. Seeds were obtained from Enguzy *Kebele*.

4.5 Soil sampling and analysis

Soil samples were collected from the non fertile semi-arid area around Mertulemariam town particularly from Eneguzy *Kebele*. Sixty kg of striga infected arenosols were taken from farmland which was previously striga weeds were grown and 30 kg of arenosols were taken from the mountain site that was previously free from striga weed. A large composite soil sample was then prepared by drying non fertile arenosols in sun, powdering this thoroughly so as to ensure sample homogeneity as much as possible.

Figure 4:A large composite soil samples were prepared by drying arenosols in sun, powdering this thoroughly so as to ensure sample homogeneity.

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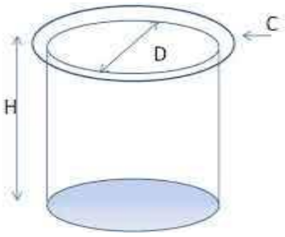
Composite soil sample was made from the powdered soil and was then subjected to various analyses in the Debre Markos Soil Testing and Fertility Improvement Centre Laboratory. Ninety cylindrical plastic bags were bought from the local market of Mertulemariam town on October 4/2019 were used for the present study (depth 28 cm, diameter 18 cm). Areas of each plastic bag could be calculated before starting the actual experiment.



$\boldsymbol{A = 2\pi r(r + H)}$, Where, r is the radius of a cylinder(r =diameter (D)/2),H is height of cylinder, Pi(π)=3.14$A = 2 \times 3.14 \times 9(9+28\text{cm}) = 23.14 \times 9 \times 2091.24\ \text{cm}^{2}$,1m 100 cm ($1\text{m}^2 = 10{,}000\ \text{cm}^2$) ⇒ $2091.24\text{cm}^2 = 0.2091\text{m}^2$

1 hectare = 100 m × 100 m = 10,000 m^2

4.6 Compost application and amount

The inorganic sources of nitrogen, phosphorous and potassium were artificial fertilizers (DAP and urea), while. Organic sources of N, P and K nutrients were compost. According to ANRSBA, 12 tons/ha of compost is recommended for crops like maize, sorghum and other related species that grown in arid and semi-arid areas. For the present study compost was obtained from Sholla *Kebele*Rural Development of Agricultural Office and Tree Planting Centre, EnebsieWereda.The mount and application of compost could be calculated as follows.

10,000 m^2= 120 quintal, 120 quintal = 12000kg (1 quintal = 100kg)

10,000 m^2= 12000kg

0.209 m^2= ?⇒ 0.25 kg

The required quantities of compost were weighed as per treatment using IS-8 made in India, ES-8 model. The prepared amount of compost was mixed in to soil sample before the time of planting (0.25 kg of compost per bagwas applied in to each 60 bag that contain 1kg of soil sample).

A.  B

Figure 5: (A) Compost taken from Sholla kebele Rural Development Agricultural Office and Tree Planting Centre; (B) sundried compost sample.

4.6.1 Raw materials used for composting and the manufacturing processes.

Technically, compost may be made from any organic materials, from any parts of an organism, plant or animal that contains carbon. Compost also requires a source of nitrogen, oxygen, and water, plus small amounts of a variety of elements usually found in organic material, including phosphorus, copper, potassium, calcium, and others. In order for the organic materials to combine with the other materials and decompose into compost, several living organisms and microorganisms are needed(Wang, *et al*, 2005).

4.7 Planting seeds of *Sorghum bicolor*and planting method under nursery bed condition

Ninety plastic bagsat depth of 28 cm and diameter of 18 cm were filled with 1kg of non-fertile arenosols measured by the aid of IS-8 made in India model, among these 30 bags contained only striga infected arenosols, 30bags contained striga infected arenosols mixed with comp and the rest 30 contained NSIS+Comp. Thebagswere labelled and randomly arranged on the prepared nursery bed. Lottery methods are used to randomize the placement of plastic bags.

Four hundred fifty (450) seeds were planted on 1/5/2019 by hand in planting plastic bagsand tried to finish planting in a day. Before planting the seeds water the soil was watered so as to ensure enough moisture for the seeds. Five healthy looking and big seeds of yellow sorghum were planted in the middle of each of the 90 moisten bags at the depth of 3 cm. This was because correct planting depth gives good germination. Just after the planting, the seeds were well covered in the soil. Each bag containing the planted seeds was watered the same amount of pure water twice a day (6,000ml morning, 6,000ml late evening) and was provided with a daily dose of 12,000 ml using a watering can and were allowed to grow for five months under nursery bed conditions, where the mean minimum and maximum temperature during the study period were 27± 29^{o}C noon, and24 ±26.5^{o}C respectively.

A B

Figure 6: (A) Measuring 1 kg thoroughly mixed sun dried arenosols for the present study; **(B)** Labelling and arranging plastic bags that filled with sample soil mixed with or without compost

A **B**

Figure 7:(A) Labeled and randomly arranged plastic bags filled with SIS, SIS + Comp and NSIS + Comp; **(B)**Plastic bags were watered with equal amount of water twice a day.

4.8 Data collection and statistical analysis

Data on seed germination response were collected every two days after the first day of germination for about 14 consecutive counts. Seeds were considered germinated at the time when protrusion of radicle.

Figure 8: Data were collected by counting all germinated seeds in each plastic bag every two days after the first day of germination.

The final germination was recorded and expressed in terms of germination parameters such as germination percentage (GP), mean germination time (MGT) and germination vigor (GV) were calculated according to Lbourian and Agudo (1987).

- Determination of germination days: The duration of seed germination was recorded.
- Germination Percentage $\boldsymbol{GP = (n/N)\times 100;}$ **where** $\boldsymbol{n}$ = total number of Germinated seeds in plastic bag$N$ = Total number of seeds.used.
- Mean germination time: $\boldsymbol{MGT = (\sum niti)\ /\ n,}$ where: ni = percentage of seeds germinated between consecutive counts.

  ti = Time (in day) taken since germination experiment started.

  n = Total number of seed germinated.
- Germination vigor: $\boldsymbol{GV = \sum (Gi/ti) \times 100/N}$ Where:

  Gi =Number of seeds germinated up to the day under consideration

, ti =Time taken for all germination

  N = Total seeds used.

After germination had occurred and the seedlings had grown to a height of 15 to 20cm, only 27 seedlings were selected as judged by eye and removed the others. From each treatment

9 plastic sleeves were selected by simple random sampling technique. Plant height, intermodal length, number of leaves per plant, surface area of the leaf and root collar diameter were considered as an important growth parameters of the present study. Similarly, number of seeds/plant, seeds weight per plant, and seeds weight, chaff dry weight and total dry weight were also considered as yield parameters. To compare growth responses of seedlings under nursery bed conditions, take height (cm) increment measurements every 7 days until anthesis each from the ground to the tip of the apex. Likewise, number of leaves and leaf surface area (mm^2) were measured periodically at 33,40,47,54,61,68,75,82, 89,96,103,110,117,124 and 60,67,74,81,88,95,102,109,116,123days, respectively after germination. Total dry weight (g), chaff dry weight (g), and seed weight (g) were recorded at harvest. Leaf area has an irregular shape;its area cannot be directly calculated by using mathematical formula, therefore to found the area of the leaves (one leaf from each sampled plant) was spread over millimetre graph paper, a uniform interval 1mm and the outline of leaf were drawn while still attached to the plant. Then count the number of grid squares within the leaf (number of full squares, ¾, ½ and ¼ squares) and add the number of grid squares within the leaf to get the total number of squares. The approximate areas of the leaf were calculated using area $= S^2$.

The data of plant parameters were analysed and their means were computed. The analysis of variance (ANOVA) single factor was carried out for germination, growth and yield parameters of the study ($p \leq 0.05$) was used to determine the homogeneity subsets whenever significant differences existed among mean values presented in the appendices.

4.9Harvesting

Crop was harvested when majority of leaves (nearly 85%) in plants senescened and the panicle is turned into yellow in colour. Harvesting was done on 160,150 and145days in SIS,SIS+ Comp and NSIS + Comp, respectively after germination for biomass determination. The roots of harvested seedling were watered too much to minimize the detachment of fine roots, the detached parts were tied on the corresponding part. The shoot and root of the fresh seedlings were carefully separated by cutting with dissecting sickle. The respective shoot and root of seedlings were labelled and arranged. Dry matter data has been recorded after drying the seedling in the sun for six days so as to attain constant dry weight. The dried shoot and root of each seedling were measured separately to determine shoot and root dry weight and to get total dry weight usingTriple Beam Balance; OHAUS model.

A **B**

Figure 9:(**A**)Harvested panicles of yellow sorghum;(**B**)Roots and shoots of yellow sorghum seedlings.

The ripen panicles of each treatment were collected using dissecting sickle and stored in plastic separately. The collected panicles were sun dried separately for the determination of seed yields per plant. Threshing was done and the chaffs were separated so as to keep seeds clean. The seeds were counted to determine total number of seeds per plant and weighted on using a digital balance SF-400 model that was obtained from Mertulemariam agricultural college to measure the weight of seeds per plant and thousand seeds weight from each treatment.

A **B**

C **D**

Figure10: (A) Sun dried harvested panicle of yellow sorghum obtained from NSIS + Comp; (B) SIS + Comp; (C) SIS treatments and (D) Threshing was done to separate seeds from the chaff for the determination of seed yields.

5. RESULTS

5.1 Germination parameters of yellow sorghum as influenced by *Striga* and compost under nursery bed conditions.

5.1.1 Germination percentage

Result on germination percentage of yellow sorghum obtained from NSIS treated with compost, SIS treated with compost and SIS only as control group. Seed germination began within 9 days in all treatments after planting under nursery bed conditions. Maximum germination percentage was observed in NSIS + Comp (90%)compared to SIS + Comp (88.2%) and SIS (79.6%). Seeds planted in SIS+ Comp germinated better over the control. However there was no significant difference among various treatments at $p \leq 0.05$

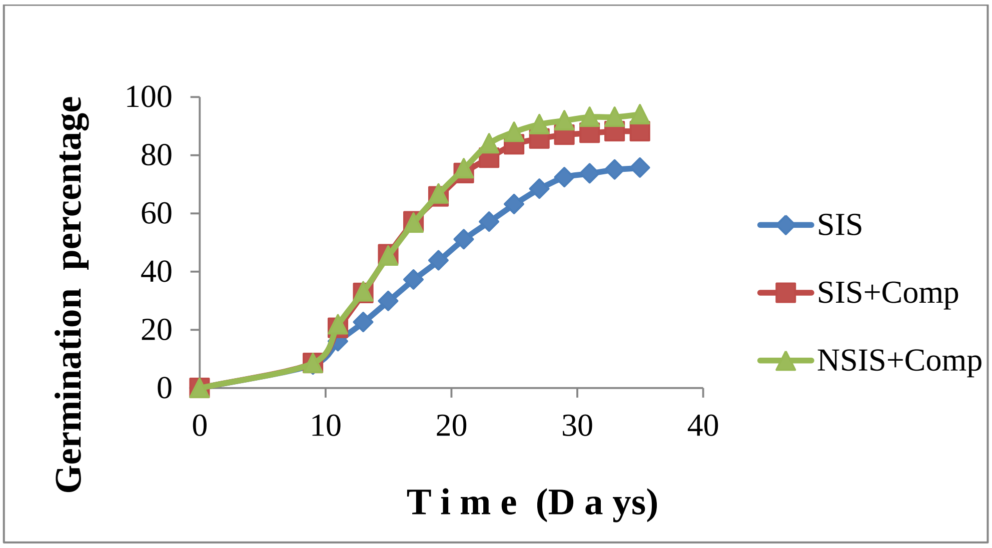


Figure 11: Germination percentage of yellow sorghum seeds planted in plastic bags filled with SIS, SIS + Compost and NSIS + Compost. Data points represent the mean germination percentage on the respective days.

5.1.2 Mean germination time

The effects of compost application on mean germination time have been shown in Figure13.Maximum mean germination time was obtained from seeds planted in control SIS (11.7%)over seeds planted in SIS+ compost(9.5%) andNSIS+Comp(9.8%). Minimum value was obtained in NSIS+ Comp. There was no significant difference in mean germination time between various treatments at $p \leq 0.05$.

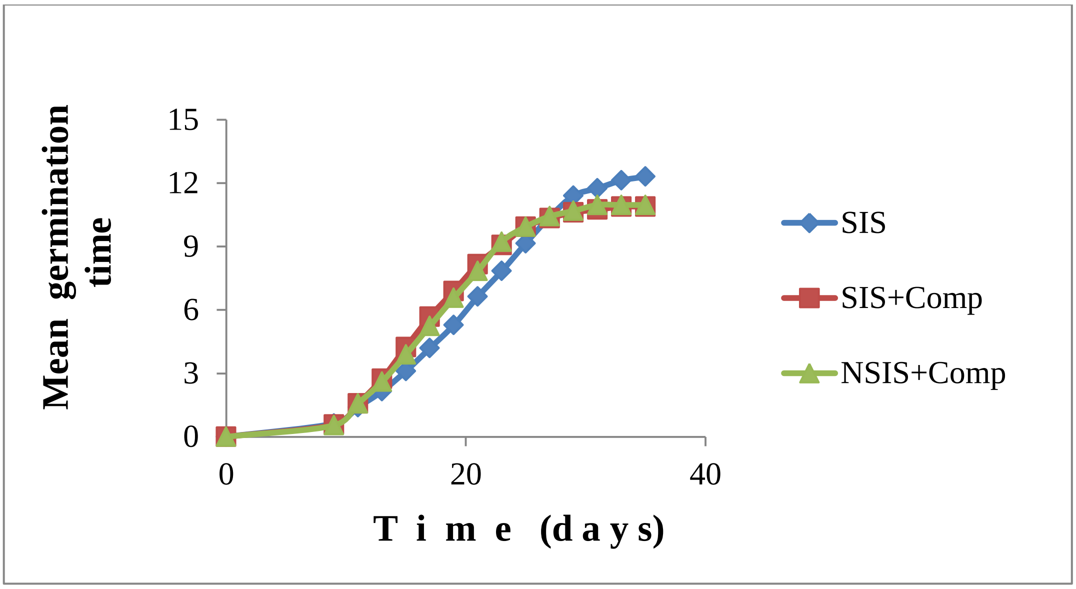


Figure 12: Mean germination time of yellow sorghum seeds planted in plastic bags filled with SIS, SIS + Comp and NSIS + Comp. Data points represent mean germination time on the respective days.

5.1.3 Germination vigour

Germination vigour percentage seeds planted in SIS, SIS+ Compost and NSIS+ Compost under nursery conditions were calculated. The germination vigour percentage of these different treatments showed no significant difference at $p \leq 0.05$. Maximum germination vigour percentage was obtained in NSIS + Comp (5.3%) compared to SIS + Comp (5.1%) and control SIS (4.6%).Seeds planted SIS + Comp was higher germination vigour percentage over the control.

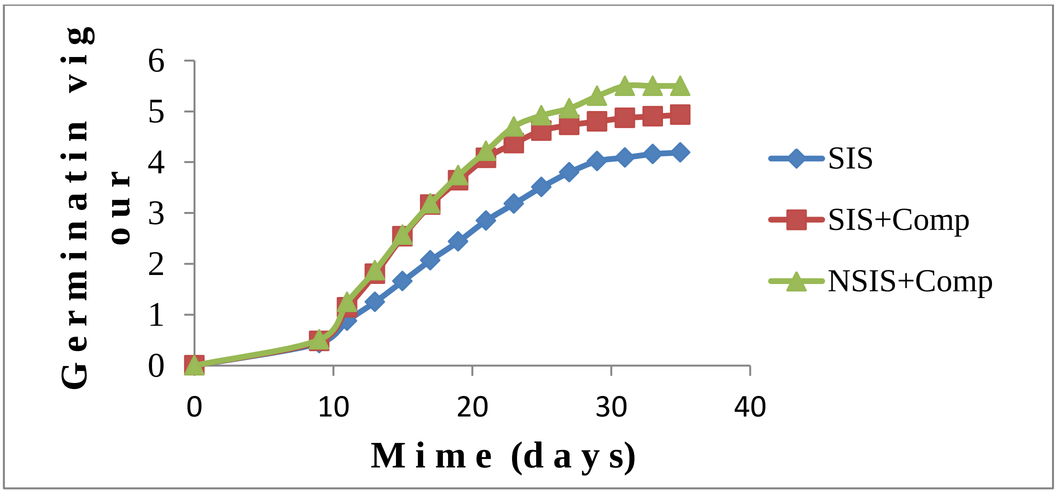


Figure 13: Germination vigor of yellow sorghum seeds planted in plastic sleeves filled with SIS, SIS+ Compost and NSIS + Compost. Data points represent germination vigor on the respective days.

5.2 Flowering and maturity of yellow sorghum as influenced by Striga weed and compost under nursery bed conditions.

Applications of compost in seedlings grown in NSIS fasten flowering and maturity by 11 and 13 days respectively compared to the control SIS. On the other hand application of compost in SIS fastens flowering and maturity by 7 and10 days, respectively compared to the control with no compost.

Table1: Treatments employed start of germination, start of flowering, 50% flowering, complete flowering and maturation of seedlings grown in NSIS + Compost, SIS+ Compost and SIS treatments.

Treatments	**Start of germination days**	**Start of flowering**	**50% flowering**	**Complete flowering**	**Days of maturation**
SIS	9/5/2019	81	89	101	160
NSIS + Comp	9/5/2019	70	82	89	147
SIS + Comp.	9/5/2019	74	86	93	150

5.3Growth parameters of yellow sorghum as influenced by Striga weed and compost under nursery bed conditions

5.3.1 Plant height increment

Seedlings grown in SIS, SIS + Comp and NSIS + Comp have shown significant differences in their mean height. However from the1st, up to 8thweeks $i.e.$ 7 up to56days after germination there were no so much height differences.

After germination from 63 up to126 days seedlings grown in NSIS + Comp showed maximum height compared to seedlings in SIS + Comp and SIS only. Therefore there were significant differences at $p \leq 0.05$ as shown in table 2.

Table2: Height of seedlings (cm) grown in SIS, SIS+Comp and NSIS + Comp treatments.

Treatments	Days of measurement									
	63	70	77	84	91	98	105	112	119	126
SIS	30.6	38.8	42.3	47.4	55.6	63.3	72.02	79.4	85	87.9
SIS+Comp	33.5	45.1	54.5	65.06	75.1	86	97.5	106.4	121.2	127
NSIS+Comp	35.7	47.6	54.06	68.06	79.6	89	105.5	110.3	122.4	129.9

5.3.2 Intermodal length (IL)

. The highest IL difference was observed in the 18th and 19th weeks i.e. 126 and 133 days with mean IL of seedlings grown in SIS were 13.2 &13.5 cm where as the corresponding values in NSIS + Comp (17.6 & 19.5cm)and in SIS + Comp (16.3& 18cm), respectively. There was significant difference at $p \leq 0.05$ in mean IL of NSIS + Comp and SIS + Comp over the control.

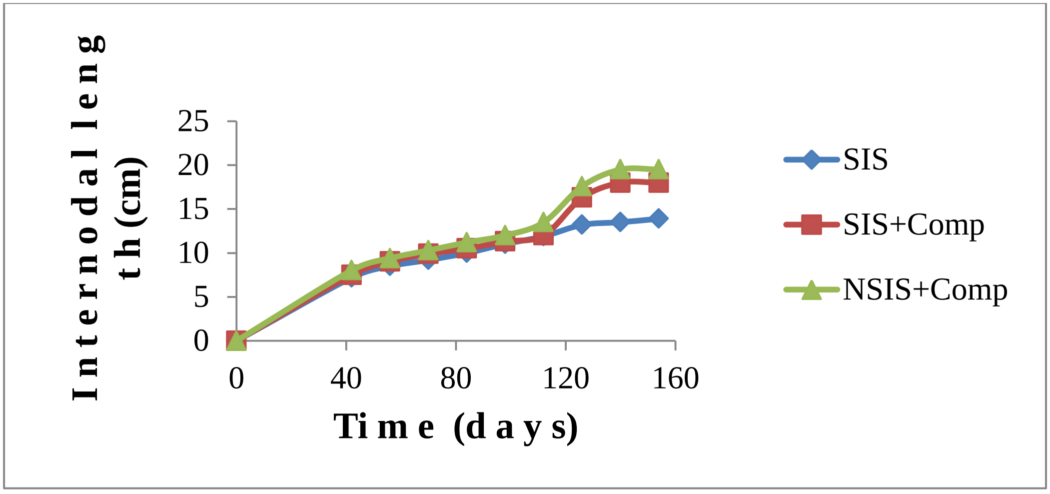


Figure 15: Mean intermodal length (cm) of yellow sorghum seedlings grown in SIS, SIS + Comp and NSIS+Comp.

5.3.3Leaf number (LN)

The mean LN produced per plant was significant at $p \leq 0.05$ for seedlings grown in NSIS + Comp (14) and those grown in SIS + Comp (13) over the control SIS only (8)as provided in Figure 17.

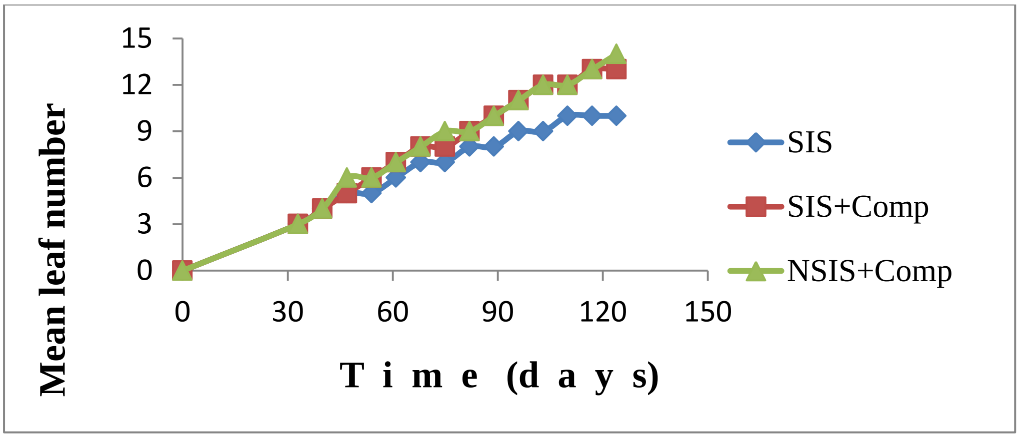


Figure 16: Mean LN of yellow sorghum seedlings grown in SIS, SIS + Comp and NSIS + Comp

5.3.4 Leaf area (LA).

Seedlings grown in NSIS + Comp showed significant at $p \leq 0.05$, maximum mean LA value (354.6 mm^2) compared to seedlings grown in SIS + Comp (327.6$mm^{2)}$ and to those grown in control SIS (262.9mm^2). On the other hand seedlings grown in SIS+Comp showed higher LA compared to those in SIS as shown in Figure 18.

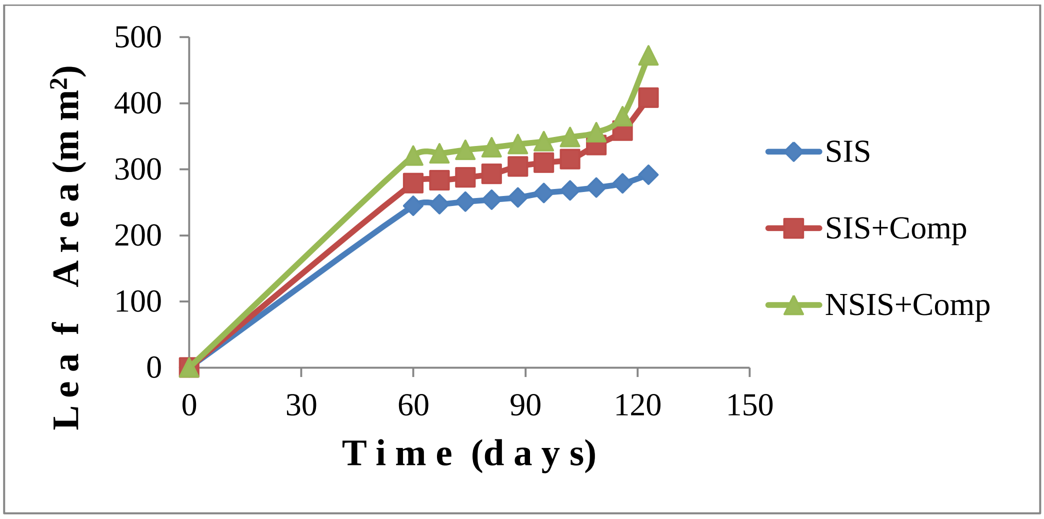


Figure 17: Mean leaf area (mm^2) of yellow sorghum seedlings grown in SIS, NSIS + Comp and SIS + Comp

5.3.5 Root collar diameter (RCD)

Significantly maximum mean RCD at $p \leq 0.05$w obtained in NSIS+Comp (3.5cm) and in SIS+ Comp (3.3 cm)treatments, respectively over the control SIS(2.3cm

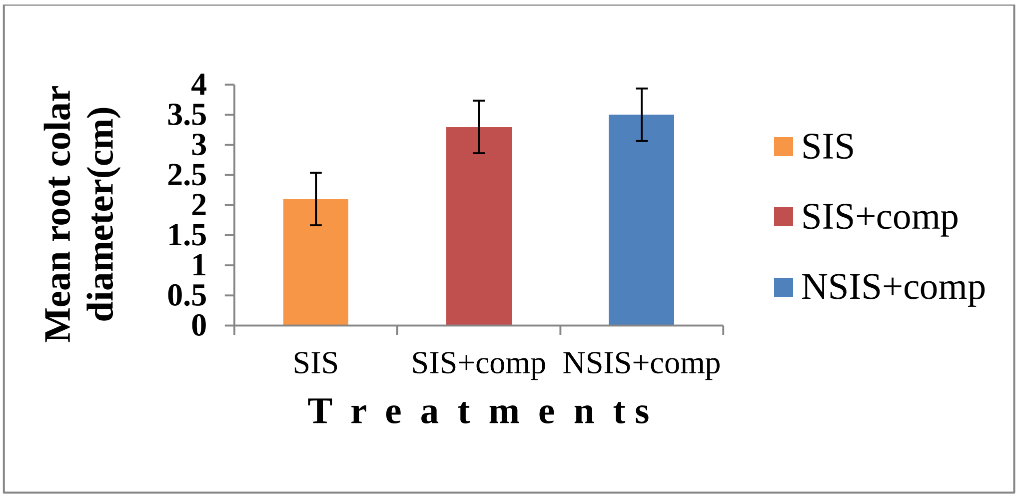


Figure 18: Mean RCD (cm) of yellow sorghum seedlings grown in SIS, SIS + Comp and NSIS+ Comp. Vertical bars indicate ± SE.

5.4 Yield parameters of yellow sorghum as influenced by *Striga* and comp under nursery bed conditions.

5.4.1 Number of seeds per plant

Plants grown in NSIS + Comp and SIS+Comp had significantly ($p \leq 0.05$) maximum value of mean number of seeds/plant (3820) and(3624), respectively over the control SIS (1950).As a result application of comp in NSIS and SIS increased yield by 95% and 85.8%, respectively compared to the control.

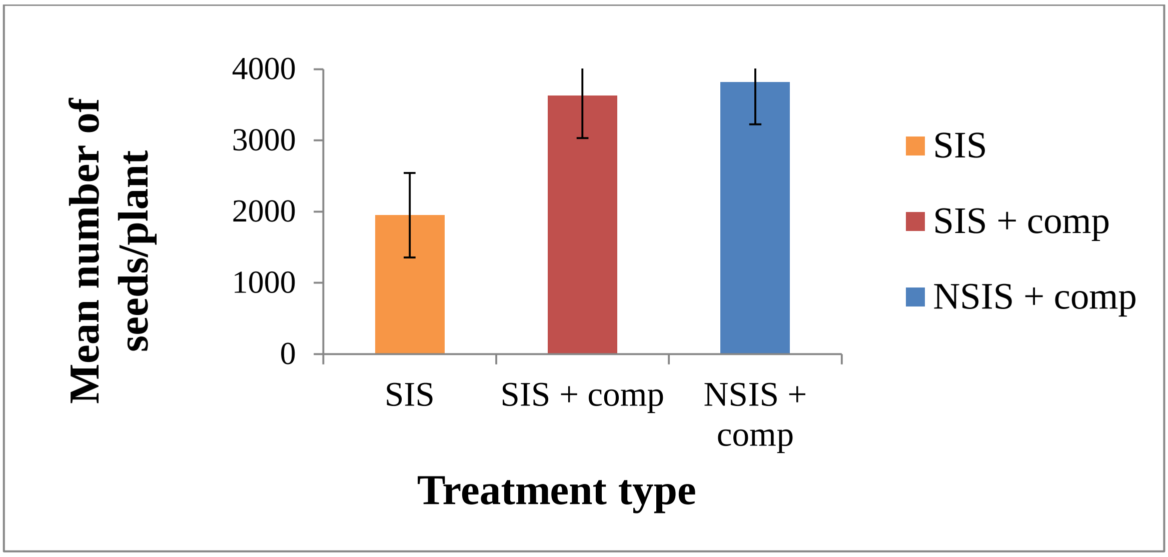


Figure19: Mean number of seeds /plant of yellow sorghum seedlings grown in SIS, NSIS+Comp and SIS + Comp. Vertical bars indicate E±S

5.4.2 Seeds weight per plant (g)

Mean seeds weight had significantly ($p \leq 0.05$) maximum in NSIS + Comp and SIS + Comp with the value of(131.6 g) and (129.3g),respectively over the control SIS only (76.3g). But there was no big difference between NSIS+Comp and SIS+Comp.

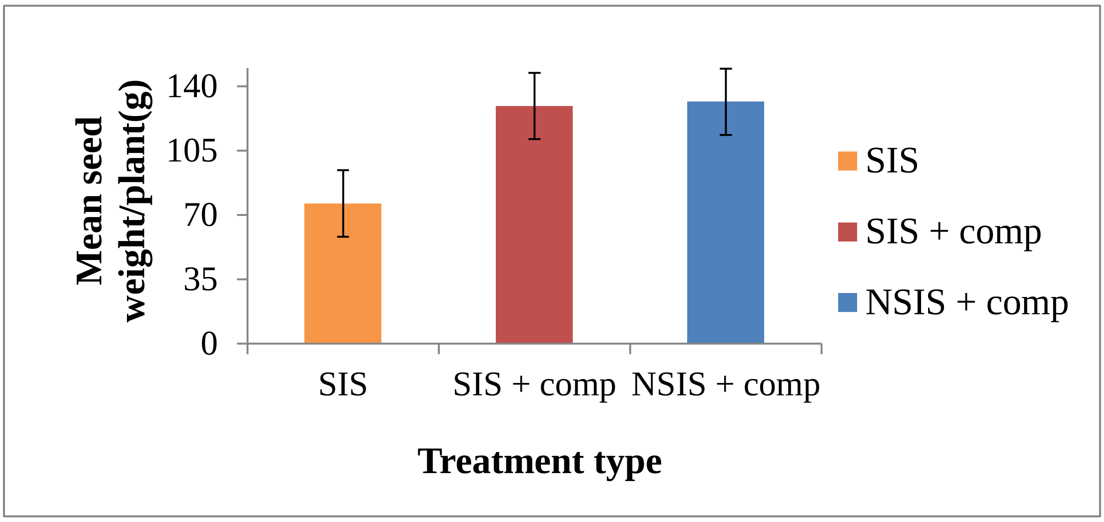


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Figure 20: Mean seeds weight (g) of yellow sorghum seedlings grown in SIS, NSIS + Comp and SIS + Comp treatments. Vertical bars indicate ± SE.

5.4.3 Thousand seeds weight (g)

Thousand Seeds were taken randomly from the sampled plants of each treatments then weighed in digital balance SF-400 model to determine 1000 seeds weight from each treatment. Though slight differences of 1000 seeds weight was recorded between NSIS+Comp and SIS + Comp treatments. Mean seeds weight had significantly ($p \leq 0.05$) maximum in NSIS + Compost and SIS + Comp with the value of (43.2 g)and(41.5 g), respectively compared to the control SIS only (25.8 g)as shown in figure 22.

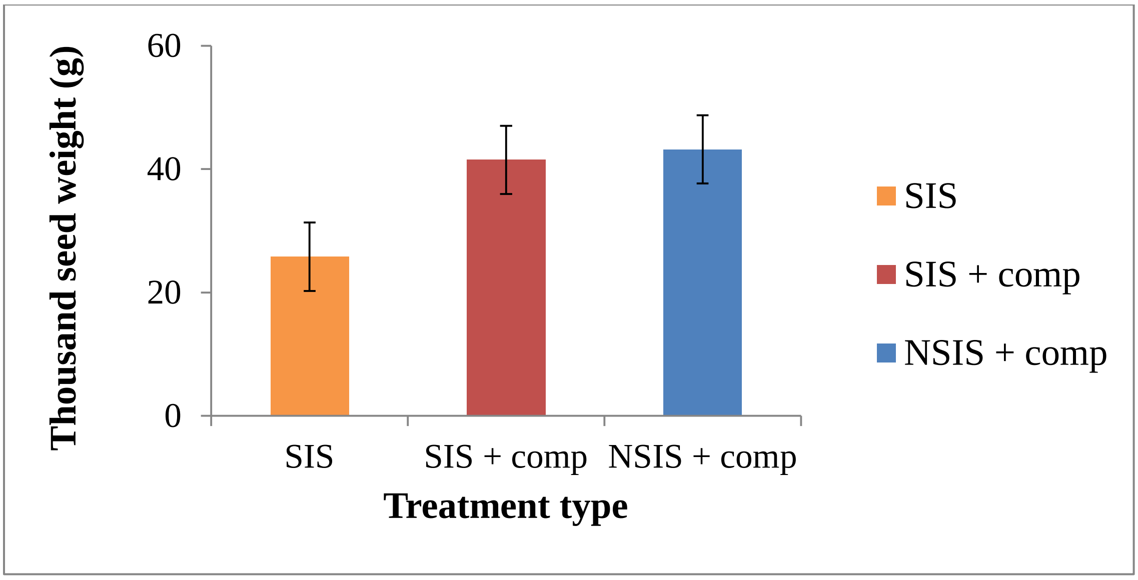

Figure 21: Mean thousand seeds weight (g) of yellow sorghum seedlings grown in SIS, NSIS+Compost and SIS + Comp Vertical bars indicate ± SE.

5.4.4 Biomass production

The NSIS+ Comp treatments had highest mean shoot (52.5g), root(5g) and total dry weight(57g), respectively compared to SIS + Comp (48.7, 4.8 and 53g) and control SIS (27.2, 2.9, 30.1g).There was significant difference at $p \leq 0.05$of biomass production between NSIS+ Comp and SIS + Comp over the control group as shown in Figure23, 24 and 25.Similarly plants grown in NSIS + Comp and SIS + Comp also exhibited maximum chaff dry weight (3.5g)and (3 g), respectively compared to those grown in control treatment (1.7 g) as shown in Figure 26.

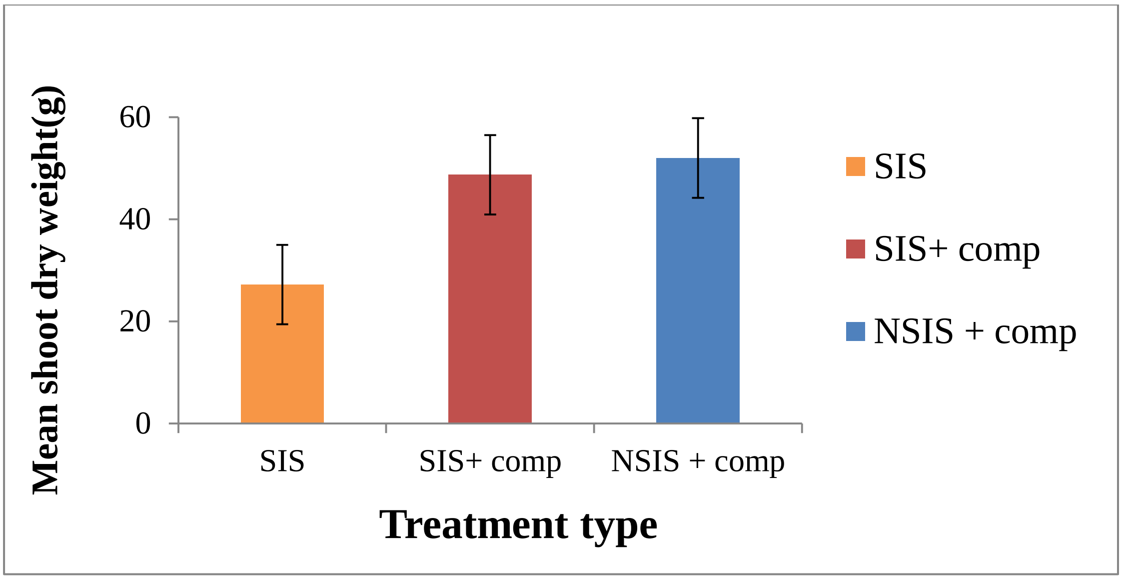

Figure 22: Mean shoot dry weight (g) of yellow sorghum seedlings grown in SIS, SIS + Compost and NSIS + Comp. Vertical bars represent ± S.E.

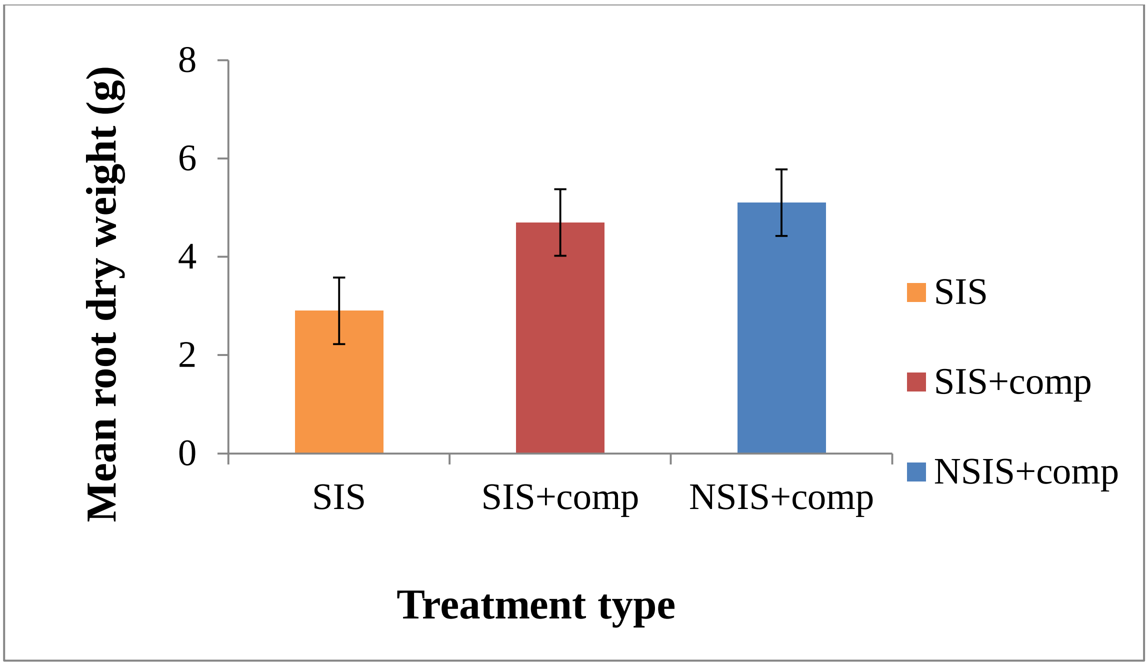

Figure 23: Mean root dry weight (g) of yellow sorghum grown in SIS + Compost showed the maximum value next to NSIS+ Comp over the control SIS. Vertical bars represent ± S.E.

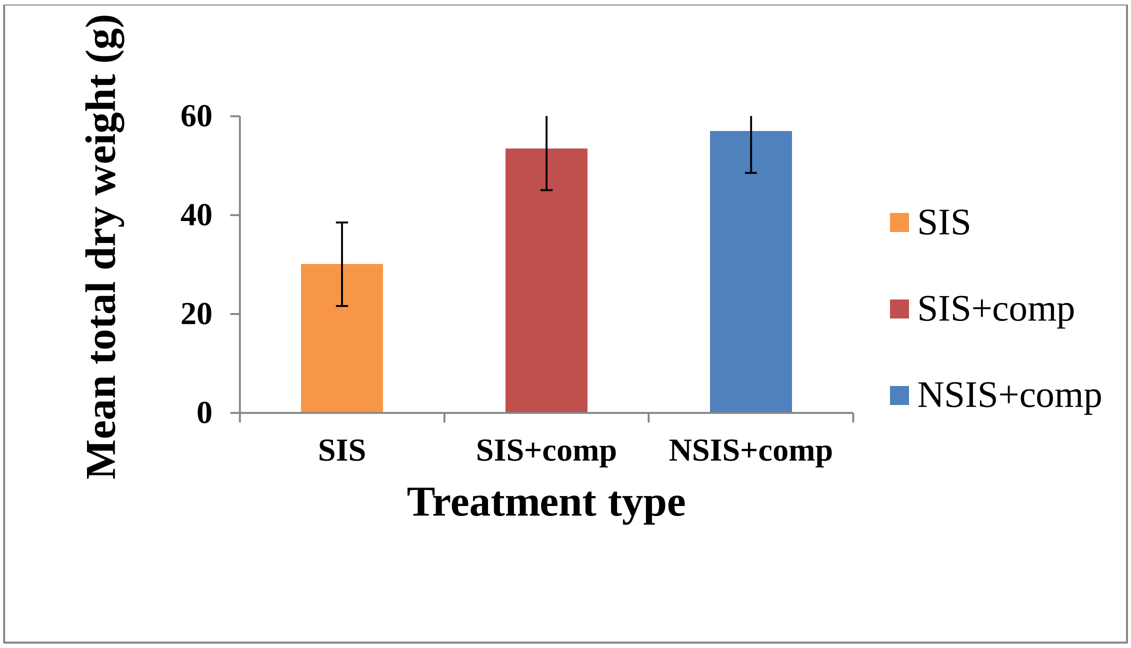

Figure 24: Mean total dry weight (g) of yellow sorghum grown in three treatments. Seedlings grown in NSIS + Comp and SIS + Comp showed the maximum value, respectively over the control SIS. Error bars represent ± S.E.

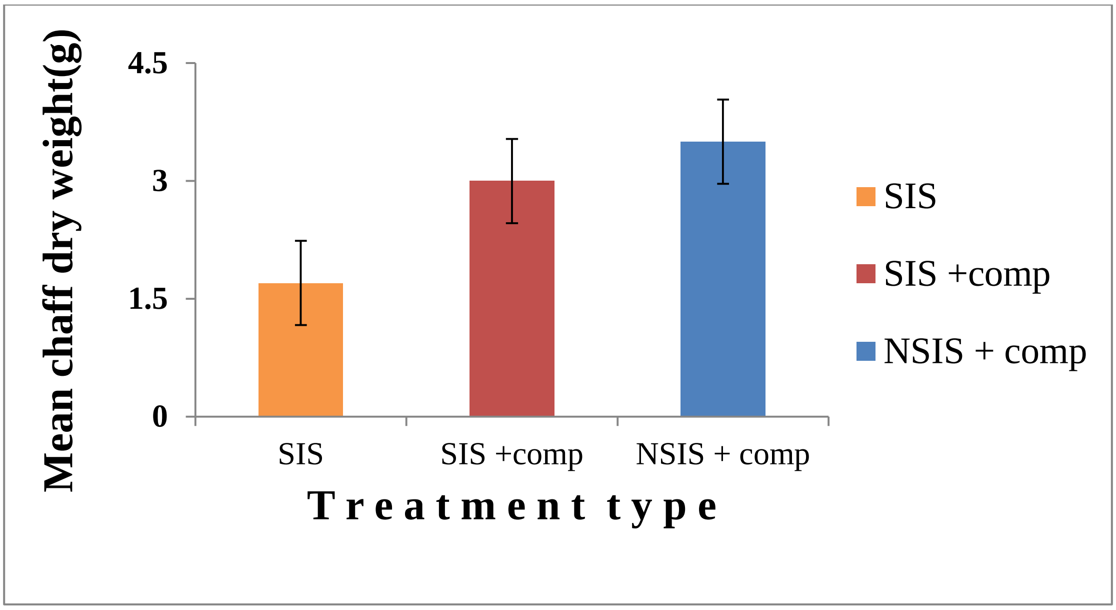

Figure 25: Mean chaff dry weight (g) of yellow sorghum seedlings grown in NSIS + Comp showed maximum chaff dry weight over SIS + Comp and the controlSIS.SIS + Comp also better than the control. Error bars represent ± S.E.

5.5 Results of soil analysis

The results of arenosols analysed for texture, pH, OC, TN, Av. P, and Av. K were presented in table 2.The results indicated that the arenosols used for the present study was below the standard. The standard average values of OC, TN, Av. P, and Av. K were 4-10%, 0.125- 0.225%, 8-12 ppm and 100-250 kg/ha, respectively (Frank, 1990).

Table 3: The results of physico-chemical properties of arenosols analyzed in Debre Markos Soil Testing and Fertility Improvement Centre Laboratory used for the present study

S. No.	**Constituent**	**Analytical value**	***Interpretation***	**Method of determination**
(A) Physical properties				
	Texture		Clay soil class	Hydrometer method
1	Sand (%)	55		
2	Silt (%)	27		
3	Clay (%)	18		
(B) Chemical properties				
1	Soil pH	6.5	Slightly acidic	Water method
2	Organic Carbon(OC %)	2.5	Low	Walkely & Black method
3	Total Nitrogen (TN %)	0.05	Very low	Kjieldhal method
4	Av.P (ppm)	5	Low	Olsen method
5	Av..K (kg/ha)	83.5	Low	Ammonium acetate method

5.6 Plant materials used for compost preparation

The compost used for the present study was manufactured from dung, nitosols, ash and different plant materials. The plant materials were used in their vegetative stages (Data obtained from Rural Development of Agricultural office and Tree Planting Centre, Enebsie Wereda, East Gojjam administrative Zone). Those plants used for compost manufacture were presented in Appendix 16.

Table 4: List of plants used for compost preparation manufacture for the present study obtained from Rural Development of Agricultural office and Tree Planting Centre.

S. No.	Local Amharic name	English name	Scientific name
1	Sensel/Semiza	Poison arrow tree	*Justica shimperiana*
2	Gerawa	Bitter leaf	*Vernonia amygdalina*
3	Yekura hareg	Corton	*Cucumis dipsaceus*
4	Astenager	Jimsonweed	*Datura stramonium*
5	Sesbania	Sesbania	*Sesbania sesban*
6	Yeferenge tid	Mexican cypress	*Cupress lusitanica*
7	Serdo	Bermuda grass	*Cynodon dactylon*
8	Muja	Snowdenia	*Snowdenia polystachya*
9	Telenje	Chaff flower	*Achyranthes aspera*
10	Chakema/Gullo	Caster bean	*Ricinus communis*
11	Lite	Cheese weed	*Malva parviflora*
12	Bisana	Corton	*Corton macrostachyus*

6. DISCUSSION

6.1 Germination parameters of yellow sorghum as influenced by striga weed and compost under nursery bed conditions.

6.1.1Seedgermination

Not all seeds planted in the plastic sleeves germinated, however greater than 50% seed germination was achieved in this study. Some of the seeds did not germinate; this may be due to seed dormancy mechanisms that are specific to the species that plants develop diverse dormancy mechanisms so as to avoid unfavourable environmental conditions (Bewley and Black, 1994; Bradbeer, 1988; Legesse Negash, 1995; 2010).Maximum germination percentage was recorded in NSIS + Comp (90%) and in SIS+ Comp (88.2%), respectively compared to the control SIS only (79.6%). This may be due to nitrogen, the most effective in breaking dormancy and stimulating germination and emergence (Agenbag and Villiers, 1989). The potential role of nitrogen especially nitrate, as a stimulator of seed germination is known (Bewley and Black, 1982; Hilhorst and Karssen, 1992 and Baskin, 1998).

6.2 Growth parameters of yellow sorghum as influenced by *Striga* weed and compost under nursery bed conditions.

6.2.1 Height increment

Plant height is a simple measurement of plant growth and it depends on number of nodes and length of effective nodes. In these study significant effects of compost on plant height was measured. Maximum plant height was noted in non- striga infected soil mixed with compost (NSIS + Comp) and in *Striga* infected soil mixed with compost (SIS + Compost), respectively. Plants were longer in the experimental groups (NSIS + Comp and SIS + Comp), probably because compost was applied while minimum plant height was in the control group (SIS). Plants were shorter in the control group probably because no compost was applied and due to the parasitic striga weed. An increase of plant height in NSIS + Compost and SIS + Compost would likely to be associated with nitrogen, phosphorus and potassium vegetative growth promoting effect, which increase the seedling height by 21% (Taiz and Zeiger, 2006).

6.2.2 Leaf number (LN)

There was significant difference of the total number of green leaves between treatments at $P \leq 0.05$levels. This indicate that compost containing soil could improve the total number of green leaves where as non compost containing but striga infected soil decrease the number of green leaves. This is because compost application had effect on shoot count and reduces the emergence and reproduction of striga weed (Lanoka 2010). Maximum number of leaves was registered in non-striga infected soil mixed with compost (NSIS + comp) and in striga infected soil mixed with compost (SIS+ Comp), respectively over the control SIS only. This might be due to favourable effect of high nutrient availability. Nitrogen is a chlorophyll component and it promotes vegetative growth and green foliage (Jones, 1983).

6.2.3 Leaf area (LA)

LA fairly gives a good idea of photosynthetic capacity of the plant. It is an important variable for most eco-physiological studies in terrestrial ecosystem concerning, evapotran spiration, photosynthetic efficiency, fertilizers, irrigation response and plant growth (Blanco and Folegatti, 2005). It is also valuable in studies of plant nutrition, plant competition, plant-soil-water relations, plant protection measurement and heat transfer in plants (Mohsenin, 1986) and thus it is an important parameter in understanding photosynthesis, light interception, water and nutrient use and crop growth and yield potential (Smart, 1974; William, 1987). It has been observed in the present study that the effect of compost had profound influence on LA of sorghum at different crop growth stages.

For the present study maximum mean leaf area was noted in SIS + Compost next to NSIS + Comp over the control SIS only as shown in Figure18.This might be due to the fact that the application of compost provide better nutritional environment for better growth of seedlings against striga weed (Folegatti, 2005).

6.2.4 Root collar diameter (RCD)

RCD is defined as the diameter of the main stem measured at or within a specified distance from the root collar. The highest mean RCD was obtained in NSIS + Comp and SIS + Comp groups, respectively compared to the control group. Fertilization treatments increased the seedling root collar diameter by 29% (Taiz and Zeiger, 2006). Nitrogen and phosphorus are critical determinants of plant growth, productivity and both plant growth and root morphology are important parameters for evaluating the effects of supplied nutrient (Razaq *et al*., 2017).

6.3 Flowering and maturity of yellow sorghum as influenced by striga weed and compost under nursery bed conditions.

A significant variation was noted among the treatments in relation to days for flowering and maturity. The minimum days for start of flowering, 50% flowering, complete flowering and maturity were recorded in NSIS + Comp Maximum number of flowers producedmaximum yield. Similarly, Salim and Saena (1993) noted that early flowering was associated with high harvest index and high seed mass.

6.4 Yield parameters ofyellow sorghum as influenced by*striga* weedand compunder nursery bed conditions.

6.4.1 Number of seeds/plant

Application of compost at rates of 12 tons/ha had a marked effect on seed of yellow sorghum under nurserybed conditions. Because of superiority in growth parameters due to efficient accumulation of desired food materials and the absence of striga weed in NSIS + Comp treatments the number of seeds/plant increased over other treatments. Plant height possessed the positive association with grain yield (Lic and Chin, 1980). The decreased seed yield of sorghum in the control group(SIS only) might be due to a decreased in plant height and there by leading to reduced the size of panicle and number of seeds/panicle, this is as aresult ofparasitic effect of *Striga*weed. Moreover, the lower organic matter, lower total nitrogen and phosphorus contents observed on the arenosolsanalysed had also positively influenced crop yield and increased sorghum seed yield at arenosols+ comp.

6.4.2 Seed weight

The maximum seeds weight and 1000 seeds weight were recorded in NSIS + Comp group while the minimum value was registered in control SIS group. Such significance productivity of yellowsorghum was very low which may be enhanced by adequate supply of nutrients especially phosphorous, because being sorghum crop respond well to phosphorus (Nambaiar and Abrol, 1989).

6.4.3 Biomass production

The NSIS + Compgroups andSIS + Comptreatments had highest biomass(g) production over the control SIS. This was due tomore supply of N and P resulted into more utilization of food nutrients as well as more accumulation of photosynthesis than others. Fertilization treatments increased the seedling mean dry weight of the stems and leaves by 82%(Taiz and Zeiger, 2006),Mondale*et al*. (1992) and Ramamurthy and Shivshankar (1996) have reported higher dry matter accumulation by plants due to balanced supply of essential elements to the crop.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1Conclusions

Striga hermonthica (Del.) Benth was the only species of striga weed common in semiarid tropics and which causes complete loss of yellow sorghumand also consequentlycaused considerable reduction ofyield. Yellow sorghum was the most sensitive cereal crop to *Striga* weed as compared to other crops affected by the weed.The present study revealed that addition ofcompost on to non-fertile arenosols was the best for the growth ofyellowsorghum [*Sorghum bicolor*(L.)Moench]against*striga* weed.Application of compost in yellow sorghum grown on Striga infected soil(SIS) treatment atrates of 12 tons /ha improved the vegetative growthby44.5% ,similarly increased yield by 85.8%compared to the control SISgroup without compost. This was because compostis sources of mineral elements, on which plants require for effective growth anddevelopment. The most important crop nutrients in agricultural systems are nitrogen, phosphorus, and potassium (Chude *et al*., 2004).Their deficiencies or excesses result in marked effects on the growth and yield of crops. Yellow sorghum seedlings grown instriga infected soil mixed with compost(SIS + Comp) treatment showed better growth performances, yield and biomass production nearly like to yellow sorghum grown in non-striga infected soil mixed with compost (NSIS + Comp) over the control SISonly. Thereforewith the application of compost the growth performances of yellow Sorghum could compute and dominate the growth and impact of striga weed.

7.2 Recommendations

Application of compost at rates of 12 tons /ha should be recommended in yellow sorghum seed production of similar climatic and soil conditions. Moreover, compostapplications on yellow sorghum seed production should consider soil related factors that affect the availabilityand evolution of nutrients in soils as integral parts of efforts to improve seed production and soil fertility. Thus, further research work should be undertaken to determine integrated use of nutrients from compost.

Local farmers should prevent and control the impact of striga weed on crops through merging of two or more soil conservation methods like adding compost and the other methods listed under the conclusion part and they should cultivate yellow sorghum on compost containing soil to minimize the impact of striga weed.To achieve the continuous fertility of soil; moreover to manage striga effectively local farmers should require organic fertilizer (compost) rather than adding inorganic(chemical fertilizers).

Lower administrative agricultural extension workers should provide training for local farmers about effective prevention method of striga by creating awareness how to prepare compost and merging of two or more soil conservation methods. Wereda agricultural experts should search and fairly distribute well adaptive seeds of yellow sorghum for each *kebel*e to replace thesecompletely disappeared species and to improve yield performance of yellow sorghum as well as they should facilitate and follow up the *Kebele* agricultural extension workers to create awareness about effective Striga management strategies through training and also they should allocate better tolerant species of sorghum to each *Kebele* that were benefitable for poor resource farmers, and also should support them by developed crediting money in association rather supporting them by providing food crops coming from developed countries .

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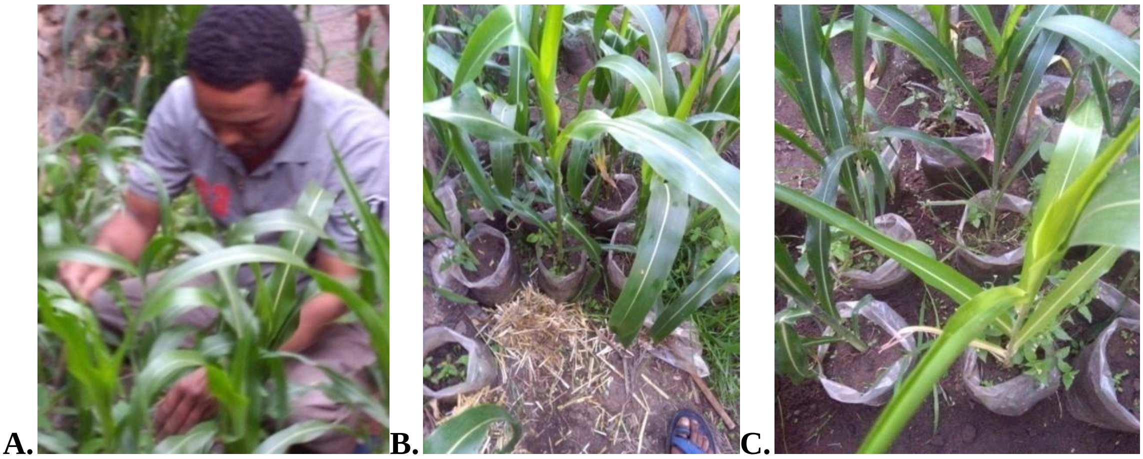
APPENDICES

A.  **B.**  **C.** 

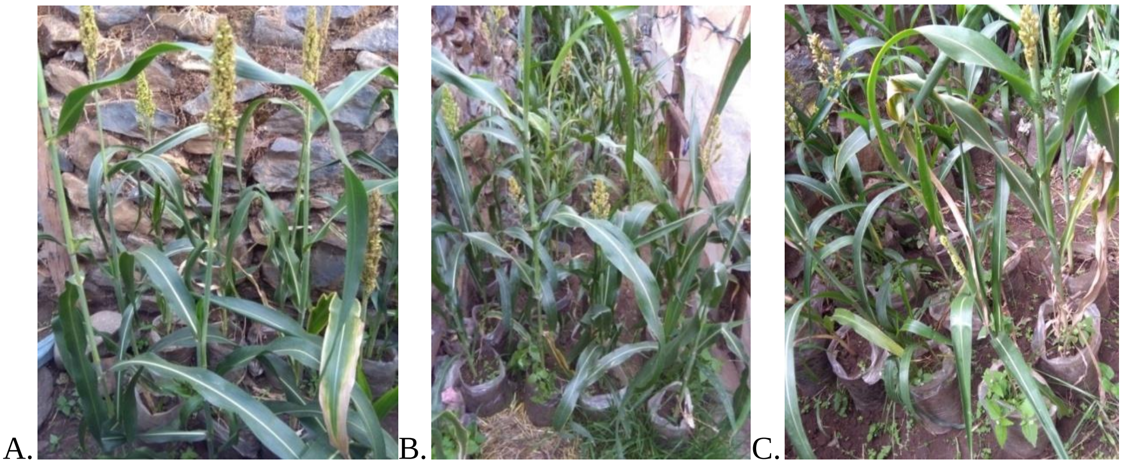
Appendices1:(A**)** 20 Days old yellow sorghum seedlings grown in NSIS+comp; (B) SIS + comp and (C) SIS only under nursery bed conditions at Mertulemariam town.

A.  **B**.  **C**. 

Appendices2:(**A**)40 Days old yellow sorghum seedlings grown in NSIS+comp**; (B)** SIS + comp and **(C)** SIS only with watering practice under nursery bed conditions.



Appendices 3: (A) 60 Days old yellow Sorghum seedlings grown in NSIS+Compost with hand weeding practice; **(B**) SIS + Compost**.**And**(C**) SIS only under nursery bed conditions.



Appendices4: (**A**) 90 Days old yellow sorghum seedlings grown in NSIS+comp;**(B)** SIS + comp and **(C)** SIS only under nursery bed conditions.

A.  B.  C. 

Appendices 5: (A) 130 Days old yellow sorghum seedlings grown in SIS only; (B) SIS + Compand(C) NSIS+Compunder nursery bed conditions.

A.  B. 

Appendices 6:(A) Measurement of mean surface area of a leaf using graph paper with 1mm division; (B) Measurement of height increments using cm ruler in soil sampled.

ሰንሰል/ስሚዛ/*Juusticia* ግራዋ/*Vernonia amygdalina* የቁራሐረግ/*Cucumis dipsaceusschimperiana*

አስተናግር/*Datura stramonium* ሳስባንያ/*Sesbania sesban* የፈረንጅፅድ/*Cupressus lusitanica*

ብሳና/*Corton macrostachyus*

Appendices 7: List of plant samples photo used for compost manufactu**re(**obtained from Sholla *kebele* Rural Development Agricultural office and Tree Planting Centre, East Gojjam Administrative Zone.

Appendices 8 Statistical analyses of germination percentage, germination time, early growth parameters and yield of *Sorghum bicolor* (L.) Moench using ANOVA single factor

Germination parameters

Germination (%)

Days	SIS	SIS +comp	NSIS +comp
0	0	0	0
9	8	8.6	8.6
11	16	20.6	21.9
13	22.6	32.6	33.2
15	29.9	45.9	45.5
17	37.2	57.2	56.8
19	43.8	65.8	66.8
21	51.1	73.8	75.4
23	57.1	79.1	84
25	63.1	83.7	88
27	68.4	85.7	90.6
29	72.4	87	91.9
31	73.7	87.6	93.1
33	75	88.2	93.1
35	75.6	88.2	94

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	15	693.9	46.26	676.6311
Column 2	15	904	60.26667	974.4981
Column 3	15	942.9	62.86	1103.871

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	2392.36	2	1196.18	1.302555	0.282591	3.219942
Within Groups	38570.01	42	918.3335			
Total	40962.37	44				

Germination mean time

Days	SIS	SIS + comp	NSIS + comp
0	0	0	0
9	0.63	0.58	0.54
11	1.4	1.57	1.57
13	2.15	2.74	2.6
15	3.11	4.24	3.89
17	4.19	5.68	5.24
19	5.29	6.9	6.57
21	6.63	8.16	7.84
23	7.84	9.07	9.23
25	9.15	9.93	9.94
27	10.4	*10.34*	10.43
29	11.41	10.62	10.69
31	11.76	10.75	10.97
33	12.13	10.89	10.97
35	12.31	10.89	10.97

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	15	98.4	6.56	20.08224
Column 2	15	102.36	6.824	16.39688
Column 3	15	101.45	6.763333	17.04834

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.573604	2	0.286802	0.016074	0.98406	3.219942
Within Groups	749.3845	42	17.84249			
Total	749.9581	44				

Seed number/plant

SIS	SIS+comp
1890	3590
1972	3612
1988	3670

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	5850	1950	2764
Column 2	3	10872	3624	1708

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	4E+06	1	4E+06	1879.88	2E-06	7.708647421
Within Groups	8944	4	2236			
Total	4E+06	5				

SIS	NSIS+Comp
1890	3830
1972	3815
1988	3815

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	5850	1950	2764
Column 2	3	11460	3820	75

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	5E+06	1	5E+06	3695.21	4E-07	7.708647421
Within Groups	5678	4	1419.5			
Total	5E+06	5				

Seed weight/plant

SIS	SIS+comp
75	128.1
76.8	130
77.1	129.8

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	228.9	76.3	1.29
Column 2	3	387.9	129.3	1.09

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	4213.5	1	4213.5	3540.756303	5E-07
Within Groups	4.76	4	1.19		
Total	4218.3	5			

SIS	NSIS+ comp
75	130
76.8	132.2
77.1	132.6

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	228.9	76.3	1.29
Column 2	3	394.8	131.6	1.96

ANOVA

21.6	55.7

Groups	*Count*	*Sum*	*Average*	*Variance*

Column 1	3	81.6	27.2	24.52
Column 2	3	156	52	10.99

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	922.56	1	922.56	51.961	0.00196354	7.7086
Within Groups	71.02	4	17.755			
Total	993.58	5				

.Root dry weight

SIS	SIS+comp
2.7	4.5
3.1	4.9
2.9	5

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	8.7	2.9	0.04
Column 2	3	14.4	4.8	0.07

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5.415	1	5.415	98.455	0.000579202	7.7086
Within Groups	0.22	4	0.055			
Total	5.635	5				

SIS	NSIS+comp
2.7	5.3
3.1	4.9
2.9	4.8

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	3	8.7	2.9	0.04
Column 2	3	15	5	0.07

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Between Groups	6.615	1	6.615	120.2727273	0.0004
Within Groups	0.22	4	0.055		
Total	6.835	5			