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Sudan University of Science and Technology

College of graduate Studies

Effect of Bio- fertilizers on Growth and Yield of faba bean *(Vicia faba L)* infested by *Orobanche crenata Forsk* Parasite

تاثير اللآسمدة الحيوية علي نمو وانتاجية الفول المصري المصاب بطفيل الهالوك

A Thesis Submitted in partial Fulfillment for the Requirements of M.Sc. Degree in Agronomy

By

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الآيـــــة

قَالَ تَعَالَىٰ: ﴿ وَٱللَّهُ أَنزَلَ مِنَ ٱلسَّمَآءِ مَآءً فَأَحْيَا بِهِ ٱلْأَرْضَ بَعْدَ مَوْتِهَآ ۚ إِنَّ فِى ذَٰلِكَ لَءَايَةً لِّقَوْمٍ يَسْمَعُونَ ﴿٦٥﴾ ﴾

سورة النحل الاية (65)

Dedication

To My Mother,
My Fathers soul
My sisters and brother
My Teachers
And my Friends
To my Family …With love

Salma

Acknowledgments

Above all I render my thanks to the Merciful ALLAH who offers me all things to accomplish this study.

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Abstract

Field and laboratory experiments were conducted during the winter season 2018-2019 at Demonstration Farm of Weed Science Center (WSC), Sudan University of Science and Technology. The objective of this study was to determine the effect of bio- fertilizers (Rhizobium, Mycorrhizae, and Effective Micro-organism (EM) on growth and yield of different two verities Sulem and Hudeba on faba bean *(Vicia faba L.*) infested by *Orobanche.* The laboratory experiment was determined the germination %, growth and attached of *Orobanche crenata* in roots, Rhizotron Method was used. Evidenced study on laboratory obtained that % germination and growth of Orobanche was highly significant with 90% in control compared with less value in Mycorrhizae 25%.

Treatments in field experiment were designed in Randomized Complete Block Design (RCBD) with spilt plot, replicated three times. The main plot consisted of eight treatments; (1.Rhizobium (R), 2. Mycorrhizae (M), 3. Effective Micro-organism (EM) 4. Rhizobium and Mycorrhizea (R+M), 5. Rhizobium and Effective micro-organism,(R+EM) , 6. Mycorrhizea and effective micro-organism (M+ER), 7. Rhizobium, Mycorrhizea and Effective micro-organism (R+M+ER), and 8. control (C),) in doses of (5 ml / hole of Mycorrhizae and 5mg of Effective micro-organism /hole, and subplots consisted of two varieties faba bean; Hudeba and Sulem. (5mg of Orobanche seeds were added/hole).

The vegetative and reproductive growth parameters studied were plant height ,number of leaves , chlorophyll content, number of 50 % flowering, number of flowers/plant, number of Orobanche /plot , dry weight of *Orobanche*, fresh

weight, dry weight, number of pods/plant, weight of pods/plant, number of seeds/pod, weight of seeds/plant, number of seeds/plant hundred seed weight and yield (kg/ha) for faba bean.

The results revealed significant difference between cultivars in; chlorophyll content at 60 DAS, dry weight of plant and Sulem had the highest value also number of Orobanche appeared significantly in Sulem. Application of bio-fertilizers and their interaction as a general revealed good evidence in all treatments than control in vegetative and reproductive parameters Among treatments significant difference appear clearly in, number of leaves (at 54 DAS), number of flower after the 54 and 60 DAS, chlorophyll content at 45 and 60 DAS, dry weight, 50% flowering, number of seeds/pod and number of Orobanche appeared in field.

The field experiment displayed the same laboratory result in germination % and number of Orobanche attached to faba bean; control was 3.62 and Mycorrhizae was 1.1.In interaction of varieties and treatments highly significant difference was appeared at 60 DAS in plant height and number of leaves in Sulem (EM).

المستخلص

اجريت هذه التجربة خلال الموسم الشتوي 2018 -2019 م فى معمل مركزدراسات الحشائش وطبقت بحقل مركز دراسات الحشائش الموبوءه بالهالوك بكلية الدراسات الزراعية جامعة السودان للعلوم والتكنلوجيا. هدفت الدراسة لتحديد اثر الاسمدة الحيوية (الميكرايزا ،الرايزوبيوم والمخصب الحيوي) علي نمو وانتاجية صنفين مختلفين سليم وحديبة من الفول المصري المصاب بالهالوك.

التجربة المعملية كانت لتحديد نسبة النموء والتحام الهالوك في جذور فول المصري باستخدام الرايزوترون .الدراسة الحالية المعملية استنتج نسبة الانبات والنموء الهالوك كانت عالية نسبيا بنسبة 90% مقارنة بالشاهد اقلاه نسبة عند الميكورايزا35% .

المعاملات في التجربة الحقلية صممت بالتصميم العشوائي الكامل مع القطع المنشقة مكررة ثلاثة مرات . وشملت القطع الرئسية ثمانية معاملات (1-الرايزوبيوم (R)،2- الميكورايزا(M)، 3-المخصب الحيوي (EM)،4- الميكورايزا +الرايزوبيوم(R+M) ،5- الميكورايزا +المخصب الحيوي (M+ER)،6- الرايزوبيوم +المخصب الحيوي (R+ER)،7- الميكورايزا +الرايزوبيوم +المخصب الحيوي(R+M+ER) 8-الشاهد(C) ،الجرعة المستخدمة في الميكورايزا والمخصب الحيوي5ملجم في الحفرة و بنسة 5 ملجم للحفرة واضيفت 5 ملجم من بذور الهالوك للحفرة .

دراسة مقايس النمو الخضري والانتاج هي طول النبات ،عدد الاوراق ، محتوي الكلورفيل ،نسبة الازهار 50% ،وعدد الازهار في النبات ،عدد الهالوك بالحوض ،الوزن الرطب والجاف للفول المصري والوزن الجاف للهالوك ،عدد القرون للنبات، وزن المائة حبة والانتاج (كجم /للفدان) للفول المصري.

اثبتت الدراسة فرق معنوي بين الاصناف المختلفة ، محتوي الكلورفيل عند 60 يوم ،الوزن الجاف للنبات في صنف سليم اعلي قيمة وظهور الهالوك في صنف سليم اعلي نسبيا .

تطبيق الاسمدة الحيوية في تفاعلاتها بصورة عامة ظهرت بصورة جيدة في كل المعاملات مقارنة بالشاهد في مقايس النمو الخضري و الانتاج .

بين المعاملات نجد اختلافا واضحا نسبيا في عدد الاوراق (45 يوم) ،وعدد الازهار في (45 و60 يوم)، في محتوي الكلورفيل في (45 و60 يوم) ،الوزن الجاف وعدد الازهار50% وعددالبذور في القرن وعددظهور الهالوك في الحقل.التجربة الحقلية عرضت نفس النتيجة المعملية في نسبة النمو وعدد التحام الهالوك للفول المصري ، الشاهد كان 3.62و الميكورايزا كانت 1.1 .في التفاعلات مابين الاصناف والمعاملات أظهرت فرق معنوي عالي كانت ظهرة في 60 يوم في طول النبات وعدد الاوراق في سليم .

CHAPTER ONE

INTRODUCTION

Faba bean (*Vicia faba L.)* belongs to the family Fabaceae (Mohamed, and *Gomau et al.,* 2005). It is one of the most important legume crops used as food for human consumption in developing countries and as animal feed in advanced countries (Hauggaard *et al .,* 2011). Its value as food and feed crop lies in its high lysine –rich protein, vitamins, minerals and carbohydrates (Crepon *et al*, 2010). Which make it one of the best solutions to the malnutrition, particularly in developing countries in Africa and parts of Asia and Latin America (Nadal *et al.*, 2003).

Its global acreage declined from 3.7 to 2.1 million ha between 1980 and 2014, and yield is highly variable within specific countries (Haidar *et al.* 2015). Despite the decreasing acreage, however, productivity per area has tended to increase, due to a reduced susceptibility to a biotic and biotic stresses (Maalouf *et al*., 2011). The global production yield of faba bean grain in 2014 was 4.1 million ton ha, which is approximately 21% greater than in 1994. In Sudan, faba bean is one of the primary grown and consumed legume crops (Osman *et al*., 2014). It constitutes the primary human nutrition, supplying high-quality proteins essential for a balanced diet for the daily breakfast and dinner of the millions of people who cannot afford meat as a source of protein in both rural and urban area (Osman *et al*., 2014)). In these areas, faba bean yield is far below the potential (Gasim *et al*., 2013), mainly because of the biological limitations of the traditional cultivars and poor management practices as well as the effect of a biotic (especially temperature) and/or biotic (diseases and pests) stresses.

Improving seed yield and quality of faba bean under stress conditions are important priorities to meet the increasing demand and feed of growing population .Thus, the breeding objectives for this crop have always been and still are to improve the resistances to drought, heat, diseases, and pests, as well as to enhance the grain yield and quality. However, evidence on the yield and nutritional quality of newly developed faba bean inbred lines under marginal environment of Sudan is scarce (Gasim *et al.*, 2013) .

Weed infestation is a major constraint in faba bean production, and can reduce yield by up to 50% (Fernanda *et al.*, 2013). Thus, early weed removal during the period between 25 and 75 days after sowing is necessary if a high yield is to be obtained (Amanuel, *et al.*, 2000). *Orobanche crenata Forsk* is a major constraint for grain and forage legume in the Mediterranean area (Parker *et al.*, 2009). Many of the broomrape traits such as achlorophyllous nature, underground parasitism, the physical and metabolic overlap with the crop, or lack of functional roots, reduce the efficiency of conventional programs in weed management aimed to their control (Fernández-Aparicio *et al.*, 2016). Most of the seeds in the soil will not be affected by the stimulant, forming a seed bank for the next cropping seasons. They can remain viable in the soil for more than 10 years, thus, if host crops are frequently cultivated, the seed bank in the soil increases tremendously leading to the failure of cultivating host crops (Mohamed *et al.*,2016),these characteristics limit the development of successful control measures which can be accepted and applied. However, several methods of control were developed in different countries in the Mediterranean region including cultural, mechanical, physical, chemical, biological, germination stimulants resistant varieties, and other in innovative techniques were suggested (Abbes *et al*.,2014; Bouraoui *et al*., 2012, 2016;

Fernndez-Aparicio *et al*.,2011, 2016). A management or eradication program must aim to reduce this seed bank, to minimizing the production of new seeds and their dispersal to new sites (Fernndez-Aparicio *et al*., 2011). The improvement of bio-fertility and quality of soil, especially under low input of agricultural systems, requires the input of organic materials. Bio-fertilizers conain different types of microorganisms, (Naureen *et al*., 2005). Arbuscular mycorrhizal fungi (AMF) promoted biomass production and photosynthetic rates by increasing the ratio of phosphorus (P) to nitrogen (N) accumulation. An increase in P was consistently associated with an increase in N accumulation and N productivity, expressed in terms of biomass and leaf area. Photosynthetic N use efficiency, irrespective of the inorganic source of N (e.g. NO_3^- or N_2), was enhanced by increased P supply due to Arbuscular mychorrhizal fungi (AMF), nitrogen, phosphorus, *Rhizobium* (Ann *et al* .,2004). Under low N fertilizer inputs, soil P availability is usually the major factor limiting the rate of N_2-fixation in legumes (Kebreab *et al.,* 2001).This work aimed to study the effects of different bio-fertilizers (Rhizoubium, Mycorrhizae and Microorganism) and their interaction on *Orobanche crenata* incident and growth and yield of faba bean (*Vicia faba L.)*.

CHAPTER TWO

LITERATURE REVIEW

2-1General:

Faba bean *(Vicia faba L.*) is an important grain legume crop in many countries and is severely constrained by infection of the weedy root parasite broomrape (*Orobanche crenata* Forsk), *(*Díaz-Ruiz *et al* ., 2009). The crop is also used as an excellent component of crop rotations, something that has been very much neglected in modern cropping, at a time when there is an urgent need to minimize the impact of chemical fertilizers on the environment, reduce emissions of undesirable grasses (Kopke and Nemecek, 2010).The inclusion of faba bean in cropping systems improves soil fertility. Its high efficiency in establishing symbiosis with specific Rhizobium bacteria, and the concomitant biological nitrogen fixation (BNF), is associated with a reduced need for fertilizer input in arable lands and increased soil biological activity, the two main agricultural practices that benefit from BNF are crop rotation cycles that include legumes, and the intercropping of yield legumes with crops that are incapable of fixing N, such as cereals or horticultural crops (Kumari *et al*., 2011). However, only a small proportion of other faba bean genetic resources have so far been evaluated, thus, efforts to characterize the available resources should be intensified and the collection of new local resources is crucial, because of the genetic erosion that is currently identified (Díaz-Ruiz *et al.*, 2009). Furthermore, breeding programs need to incorporate a more complex evaluation and integrated use of traits (Hassan *et al.,* 2009). Detailed information about the productivity and seeds quality of faba bean inbred lines grown in nontraditional areas of Sudan will enhance our knowledge and contribute to the food security and income of the growing population (Mokhtar *et al*., 2009).The provident of fertility and quality of soil, especially under low input agricultural systems, requires the input of organic materials (Naureen *et al*. 2005).

Faba bean usually grows without irrigation, with the exception of crops cultivated in very dry and hot climatic zones. Thus, production is highly dependent on the amount and variation in rainfall during the growing season (Oweis *et al*., 2005). Several insects have the potential to infest faba bean plants. The common pest was aphids infest new leaves of faba bean (Hansen *et al*., 2008). Crop rotation with spring crops can significantly reduce weed pressure (Karkanis *et al*., 2016).

2.2 Origin:

faba bean was domesticated around 8000BP in the Near East; the oldest remains were found in Jericó and dated 6000 BC, but no wild relative have yet been found(Hauggaarg, *et al* ., 2011). As a landrace (CV. paucijuga) collected in NW Pakistan shows a primitive set of characters has lead some authors to speculate with an origin in that region, but the existence of primitive landraces out of their true center foreign, and not merely of diversity, is not a proof for that conclusion (Ethiopia is very rich in primitive endemic landraces of wheat, barley, lentil, etc., and is not the Center of origin (Hauggaarg, *et al* ., 2011). The genus *Vicia faba* belong to the family Fabaceae. Knowledge of the wild progenitor and area of origin of the genus, and subsequent steps in the domestication of its most important member species, it is scarce and disputed (Shiran *et al*., 2014).

2-3 Adaptation:

Faba bean is a cool season annual legume (Bilalis *et al*., 2003). Drought and heat are considered as major constraints in faba bean growth and production in Europe. The most drought-sensitive growth stages are flowering, early podding, and grain;(Katerji *et al*., 2011).

2-4 crop Description:

Faba bean is upright hollow and un branched stem (s) from the base, and grows between 0.1 and 2m tall and the flowers have a typically papilionaceous structure and are grouped in inflorescences; they are either pure white in color or with diffuse anthocyanin pigmentation on all petals, while black spots are often present on the wing petals Stem growth is indeterminate, and some cultivars are prone to lodging. (Bond *et al.,* 1985, Duc *et al* ., 2015, Heuze *et al* ., 2016).

2-5 Crop Utilization:

Faba bean utilized in the worldwide food and feed with livestock. Green pod is mainly used as vegetables and dry cotyledons as a source of protein .it is one of the best crops that can be used as green manure and one of the best bio fertilizers of Nitrogen by fixing 130-160Kg N ha, It constitutes to the primary human nutrition, supplying high-quality proteins essential for a balanced diet for the daily breakfast and dinner of the millions of people who cannot afford meat as a source of protein in both rural and urban area (Osman *et al*., 2014).

2-6 *Orobanche crenata Forsk*:

Orobanche crenata Forsk is a major constraint for grain and forage legume on over 4 Mha of the Mediterranean area (Parker e*t al* ., 2009). Broomrapes (*Orobanche* spp.) are parasitic angiosperms, which attach the roots hosts to take water and nutrients from them and are a root holophrastic plant devoid of chlorophyll and entirely depending on the host for nutritional the host tissues until they reach the vascular system for uptake of water, nutrients, assimilates, and grow at the expense of the host plant's resources (Kharrat *et al*., 2004). Orobanche seeds germination occurs after a preconditioning period (moist and suitable temperatures for several days and exposure to germination stimulants exuded by host roots. After several weeks of underground development, the parasite emerges above the soil surface and develops flowering stems which produce seeds within a short period of time; most of the seeds in the soil will not be affected by the stimulant, forming a seedbank for the next cropping seasons (Rezene *and Gebra*, 2003). Pre-plant composting fresh manure under plastic mulch in the planting rows causes *Orobanche* seeds to lose viability within six weeks, and reduces *Phelipanche ramosa* infestation on many vegetables *(*Rispail *et al.*, 2007; Pérez-de-Luque *et al.*, 2009). Orobanche species (broomrapes) are chlorophyll-lacking root parasites of many cultivated crops such as legumes, sunflower and tobacco (Parker *et al.*, 2012). It is not likely to show any yield increase in the short term. Fermenting manure in the farm can be easily practiced by subsistent farmer without much input and can aid sustainable farming strategy (FAO, 2008).By definition, host plants are resistant to broomrape when they do not support the entire life cycle of the parasite. Such complete resistance is rare, but degrees in resistance are common. The genetic and molecular components of resistance are now being studied, mainly in legumes challenged with *O. crenate* and in sunflower challenged with *O. Cumana (*Rispail *et al.*, 2007; Pérez-de-Luque *et al.*, 2009).

2-7 Effect of Rhizobium and Mycorrhizae on *Orobanche*:

Orobanche infestation was influenced by the bacteria and Arbuscular Mycorrhizal fungi (AMF) and the time (Mohammed and Rania, 2013). faba been with combination between bacterial strains (B2) {TAL1399 plus A. brasilense},B3(TAL1399plus BMP{Bacillus megathirium vary phosphaticum }) alone or in combination with Arbuscular Mycorrhizae fungi(AMF) were completely inhibited Orobanche plant emergence .Time at which highest rate of Orobanche emergence occurred on faba bean was significantly delayed with AM fungi incorporated with each of the bacterial strains, Bacillus (B1,B2and B3) the highest increment of faba bean shoot was obtained when AM fungi incorporated with bacterial strains B3 as compared to control (Mohammed and Rania, 2013). Arbuscular Mycorrhizal (AM) fungi plus bacterial B2 root colonization were positively correlated with total dry matter of faba bean. Mycorrhizae root colonization was positively correlated with total dry matter of faba bean. Similarly, some Rhizobium leguminosarum strains have been reported to induce define against *O.crenata* in pea through activation of the oxidative process, and production of possible toxic compounds including N (Makkouk *et al.*, 2002). Mycorrhizae are permits the plant to obtain additional moisture and nutrients, this is particularly important in uptake of phosphorus and major nutrients required by *Orobanche* (Haidar *et al* ., 2015). With respect to nodule numbers results displayed that faba been inoculated with bacterial B2 alone or in combination with AM fungi sustained the highest nodule numbers as

2-8 Effect of Rhizobium on *Orobanche*:

The symbiotic relationship formed between legumes and Rhizobia plays an integral role in agriculture as bacteria fix atmospheric nitrogen (N2). Rhizobia symbiosis with legumes produces 50% of 175 million tons of total biological N2 fixation annually worldwide (Esraa *et al* .., 2019). Fungal isolation was made on Potato Dextrose Agar (Rhizobium) And Slight Nutrient Poor Agriculture, Legumes can introduce N into the agro-ecosystem due to their symbiosis with a gram-negative Proteobacteria (*Rhizobium leguminosarum)* of faba bean. The Rhizobia fixes atmospheric nitrogen (N2) into ammonia (NH3) which is available for the plant, in return for carbohydrates such as glucose and sucrose (Vilariño *et al.*, 2009). Biological nitrogen fixation has high potential for low-input systems. In system, mostly more N is removed from the soil than replenished causing depletion of soil nutrients (Cocking *et al* ,. 2009). Additionally, smallholder farmers in developing countries don't have easy access to the high priced mineral fertilizers (Abbas *et al.*, 2004). The manipulation of Rhizosphere ecosystem, These Rhizosphere microorganisms colonize the root surfaces of weed seedlings and suppress the growth of weed plant by reducing weed density, biomass and its seed production(Sindhu *et al* ., 2018).

2-9 Effect of Effective Microorganism (EM) on Orobanche:

A microorganism or microbe is an organism which is microscopic, making it too small to be seen by the human eye, the study of microorganisms is called microbiology. Microorganisms include bacteria, fungi, archaea, protests and viruses, and are among the earliest known life forms (Sillero *et al*.., 2010).Soil microorganisms interfering with early developmental stages of parasitic weeds were thought of as possible alternatives and/or viable supplements to other control methods (Esraa *et al*,. 2019). Free-living nitrogen fixing microorganism, belonging to the genera Azospirilium, symbiotic nitrogen fixing microorganism, belonging to the genera Rhizobium in addition to phosphorus solubilizing micro-organism belong to genera Bacillus, were assayed. Fungi (mushroom, molds, and yeasts) are eukaryotic cells (with a true nucleus), most fungi are multi-cellular and their cell wall is composed of chitin (Duc *et al.,* 2015). They obtain nutrients by absorbing organic material from their environment (decomposers), through symbiotic relationships with plants (symbionts), or harmful relationships with a host (parasites). They form characteristic filamentous tubes called hyphae that help absorb material. The collection of hyphae is called mycelium. Fungi reproduce by releasing spores (Duc *et al.,* 2015). Organic materials hold great promise due to their local availability as a source of multiple nutrients and ability to improve soil characteristics is characterized by a lawn number of underground and emerged *Orobanche* with no parasite necrosis (Kharrat *et al.*, 2010).

CHAPTER THREE

MATERIALS AND METHODS

3.1 The site of experiment:

The experiment was carried out during winter season (2018-2019) in Weed Science Center (WSC) Farm, at the College of Agricultural Studies, Sudan University of Science and Technology, Shambat. Shambat is Located in 23o 35, longitude 15º 31', and altitude 288m sea leaves, within the semi-desert region (Adam, 2002) the soil of the site is described by Abdulla, (2008), as loam clay it is characterized by a deep cracking, moderately alkaline clays, and low permeability, low nitrogen content and pH (7.5-8) content (50-60%) and high exchangeable sodium percentage (ESP), in subsoil. Experiment aimed to study the effect of bio- fertilizers on growth and yield of faba bean *(Vicia faba L)* infested by broomrapes (*Orobanche crenata Forsk)* parasite.

3-2 Source of seeds:

Two cultivars of faba bean (Hudeba, and Sulem), and *Orobanche crenata* seeds, were obtained from Shambat, College of Agricultural Studies, Sudan University of Science and Technology.

3-3 Source of biofertilizers:

Bio-fertilizers (Mycorrhizea, rhizobium and effective micro-organism) were brought from Moroug Corporation in Bahrim Khartoum North, Sudan.

3-3 Experimental design:

The experimental design is a Randomized Complete Block Design (RCBD) arranged in split plots, replicated three times. Varieties in main plots and bio-fertilizers in sub plots.

3-3-1 Experimental treatments:

Treatments were; two faba bean varieties, V1, (Hudeba), V2, (Sulem), and eight bio-fertilizers; 1-Control (without any fertilizer), 2-Mycorrhizae (M), 3-Rhizobium(R),4-Effective Microorganism (EM),5-Mycorrhizae +Rhizobium(M+R),6- Mycorrhizae + Effective micro-organism (M+EM), 7-Rhizobium + Effective microorganism (R+EM),8- Mycorrhizae +Rhizobium + Effective microorganism (M+R+EM).

3-4 Land preparation:

The experimental area was tilled adequately to prepare a suitable seed bed. the implemental used included a chisel(cross plough) to break and loosen the clay soil and leveler (scraper) to level the experimental area for the easy movement and uniform distribution of bio-fertilize .The field was then divided into three blocks(replication),the plot size was 2*3 M. The density was each plant equal 288(cm). Sowing was done on mid November; the seeds were sown manually at the rate of two seeds/hole. Time added fertilizers with field in rows Mycorrhizae and Rhizobium at 5g/field, and Effective microorganism used after compared leaves in plant 3-5ml/field after growth plant. Five gram/ hole of *Orobanche* were added 5g/field for all experiment. The plants were sprayed immediately when aphids appeared in the field and controlled by FASTAC 100 EC (liter/fed).

3-5 Laboratory experiment:

Orobanche seeds treated with water displayed negligible germination GR24 applied to Orobanche seeds conditioned in water induced the highest germination, Results revealed that conditioning in the growth rhizotron had germination in response to GR24 at the lower concentration. That previously conditioned in presence of bacterial strains, were comparable to that of the corresponding, irrespective to germination stimulant. The combinations of the bacterial significantly inhibited haustorium induction compared to the corresponding water control.

3-5-1Conditioning:

Condition test for tolerance and resistant of faba bean (Sulem and Hudeba) to Orobanche in Incubator used rhizotron. Mycorrhizae and Rhizobium and Micro-organism (EM) to incident by Orobanche. , Petri rhizotron size (25-25 cm), added Mycorrhizae and Rhizobium at 5g, and Effective micro-organism 5 ml during in three weeks reading after 48 hours used after compared level in after growth radical Orobanche.

3-5-2 Rhizotron:

This experiment was undertaken to compared used condition in radical growth of *Orobanche crenata* and faba bean together in laboratory using after conditioning 14 DAS in incubator on temperate 30C^{o}, first that cleaned faba bean seeds and germinated in normal test tubers on light incubator for cumbered roots, then prepared the petrie rhizotron contended Rocoul , after that pleased faba bean germinated in petrie rhizotron after 3DAS for adaptation Varity faba bean , Distributed the Orobanche seeds around faba bean roots. Used long Ashton (LA) Solution and bio-fertilizer Solution for mortised and nutrition plant faba bean and seeds Orobanche every 3 DAS used treatment does 3ml on number (3-5) example Mycorrhizae , Rhizobum and Microorganism directly after dieted of or , than used readings Orobanche seeds germination rat after stimulated by faba bean ,so that used germination ret as taken reading radical Orobanche attached went in faba bean roots after every 4DAS to 3 reading.

3-6 Data collected:

3-6-1 Vegetative growth parameters:

3-6-1-1Plant height (cm):

Three plants randomly selected from each plot and height of plant was determined in centimeter (cm) from the soil surface to the plant tip. Reading was taken three times (30, 45 and 60 DAS after sowing).

3-6-1-2 Number of leaves:

Three plants randomly selected from each plot, number of leaves was account and reading was taken three times (30, 45 and 60 DAS after sowing DAS).

3-6-1-3 Plant chlorophyll:

Three plants randomly selected from each plot and the mean plant chlorophyll content was determined using SPAD value instrument. Reading was taken three times (30, 45 and 60 DAS after sowing).

.3-6-1-4 Number of 50% flowering:

Three plants randomly selected flowered number were calculated, (reached 50%).

3-6-1-5 Number of flowering plants /plot:

Three randomly selected plants from the each plot, flowering number from the each plant were counted for three times (45, 50 and 55 DAS after sowing DAS).

3-6-1-6 Number of Orobanche/plot:

Emergence plant numbers of Orobanche from the each plot were counted after appeared for three times (30, 45 and 60 days after sowing DAS).

3-6-1-7 Fresh weight of plant (g):

Five plants were randomly selected from the each plot, and then weighted by sensitive balance.

3-6-1-8 Dry weight of plant (g):

The same plant which taken for the fresh weight, was dry by oven for 48 hour at 150°C degree then weighted used sensitive balance.

3-6-2 Yield components:

3-6-2-1 Weight of seeds/plant (gm):

Seeds from the plants were dried on room temperature at three days weighted using sensitive balance.

3-6-2-2 Number of seeds/pods:

Seeds from the plants were counted by hand to the seeds number/pod.

3-6-2-3 Number of pods/plant:

Number of pods from the plants seed was counted by hand /plant.

3-6-2-4Weight of pods/plant:

The Pods /plant were dried in room temperature then weighted used sensitive balance.

3-6-2- 5Hundred seed weight (g):

Hundred seed were randomly selected, seed weighted in grams using sensitive balance.

3-6- 2- 6Yield (kg/ha):

When signs of maturity were clear on the plant (complete yellowing of or leaves and seeds),one meter longitudinal in each plot harvested for yield, weighted and then seed yield per plot was converted to seed yield in ton/hectare(t/ha).

3-7 Statistical analysis:

Data on faba bean growth and yield attributes and *Orobanche crenata* were subjected to analysis of variance (ANOVA) and means were separated for significance by the least significance difference (LSD) at 5% and 1% level using statically 8.0 software, version to 2.O (UK).

CHAPTER FOUR

RESULTS

4.1. Germination 100 % and attachment of Orobanche:

The analysis of variance of *Orobanche* germination % and *Orobanche* attached to *faba bean* as affected by bio-fertilizers in faba been subjected to *Orobanche* were presented in (Table 4.1)**.** Varieties were not affected significantly but there was significant different in Germination % of *Orobanche* and attached Orobanche on faba bean in treatments and their interaction .The highest value in Hudeba was (20.88%) when treated by M and the height value in Sulem was (6.61%), M+R+EM, in interaction between two variety The highest value is M+R+EM (4.93%) and the lowest values were (M+R) = (1.86%). In interaction Hudeba (M) showed the greatest infection by *Orobanche* the value was (20.88%) and Sulem (M+R) obtained the lowest infection value (1.72%). Between verities Hudeba infected by Orobanche was greater than Sulem. The significant different in interaction was observed in attachment number *Orobanche* attached growth highest value treatment was control (3.62 %) and the lowest value M (1.10%) , highest attach in Varity the lowest velum , in Sulem (1.85%), and the interaction in highest was Hudeba in control (5.16%) and Hudeba Rhizobium had the highest condition growth (4.55%) and the lowest Sulem (M) was (0.66%).

Table 4.1.1. Effects of bio-fertilizers on growth of faba bean *(Vicia faba L) infested by Orobanche crenata Forsk* germination and number of attachment in*).*

Treatment	germination % *Orobanche*			*Orobanche* attachment		
	V1	V2	X	V1	V2	X
M	20.88de	2.05e	2.47b	1.53def	0.66f	1.10d
R	6.08ab	2.43de	4.26a	4.55ab	1.82def	3.18ad
EM	2.56de	2.05e	2.44b	2.26cde	2.38cde	2.32dc
M+R	2.00e	1.72e	1.86b	1.06ef	1.43def	1.25d
M+EM	2.88de	1.99e	2.44b	2.43cd	1.21def	1.82cd
R+EM	3.38cd	4.72bc	4.30a	1.66def	1.95cdef	1.80cd
M+R+Em	3.88cd	6.61a	4.93a	2.34cde	3.33bc	2.82ad
Control	3.41cde	2.33de	2.87b	5.16a	2.08cde	3.62a
X	3.37a	3.02a		2.62a	1.85b	
LSD V		0.3114			0.2339	
LSD T		0.6227			0.4679	
LSD V*T		0.8807			0.6617	
CV%		25.49			36.33	

V1 (Hudeba variety), V2 (Sulem variety),M (Mycorrhizae), R(Rhizobium), EM(effective Micro-organism).

Means within column by the same letters were not significantly different according to Duncan Multiple Range test at 5%.

4.1.2 100% growth *Orobanche*:

The analysis of variance 100% growth faba bean infested by*Orobanche crenata* as on affected by bio- fertilizers (Rhizobium, Mycorrhizae and Effect of microorganism) revealed significant different among treatments Control% growth was height 90% and low number of M and M+R was 25% (Table 4.2)**.**

Table4.1.2. Effect of bio-fertilizers on growth on *faba bean (Vicia faba L*) 100%growth mean infested by Orobanche *crenata Forsk*.

Treatment	**% growth *Orobanche* X**	
M	25.00d	
R	85.00ab	
EM	70.00ab	
M+R	25.00d	
M+EM	40.00cd	
R+EM	60.00bc	
M+R+Em	70.00ab	
Control	90.00a	
X	v1,61.9a	V2,54.3a
LSD V	6.1962	
LSD T	12.392	
LSD V*T	2.365	
CV%	21.32	

V1 (Hudeba variety), V2(Sulem variety),M (Mycorrhizae), R(Rhizobium), EM(effective Micro-organism).

4 2.Vegetative growth:

4.2.1 Plant height (cm):

The analysis of variance of plant height of faba bean cultivars infested by *Orobanche crenata* as affected by bio-fertilizers (Table4.1) revealed no significant different at 30 and 45 DAS, among all treatments. At 60 DAS there was a significant difference among interaction of variety and micro-organisms only. Application of EM on Sulem obtained the longest plant height (55.01 cm) , meanwhile, Hudeba with EM and R showed the lowest plant height (39.87 cm).

Table4.2.1. Effect of bio-fertilize on faba *bean (Vicia faba L.)* plant height in infested by *Orobanche crenata Forsk*.

Treatment	(30 DAs after sowing)			(45 DAs after sowing)			(60 DAs after sowing)		
	V1	V2	X	V1	V2	X	V1	V2	X
M	27.68a	27.84a	27.76a	41.07a	39.06a	40.06a	44.88ab	47.51ab	46.19a
R	24.31a	25.81a	25.06a	32.56a	34.27a	33.39a	39.26b	39.87b	39.57a
EM	24.27a	29.08a	26.68a	33.44a	34.71a	38.57a	39.20b	55.01a	47.10a
M+R	29.23a	30.11a	29.67a	39.92a	40.56a	40.24a	46.21ab	51.05ab	48.63a
M+EM	25.14a	26.53a	25.84a	35.30a	37.41a	36.35a	41.75ab	51.07ab	46.41a
R+EM	24.35a	29.57a	26.96a	33.85a	41.75a	37.80a	42.26ab	50.84ab	46.55a
M+R+Em	26.55a	24.29a	25.42a	36.55a	35.43a	35.99a	44.94ab	43.06ab	44.00a
Control	26.88a	27.44a	27.16a	39.74a	35.91a	37.82a	44.46ab	46.88ab	45.67a
X	26.05a	27.58a		36.55a	38.50a		42.87a	48.16a	
LSDV		1.3308			2.0769			2.6076	
LSD T		2.6616			4.1538			5.2152	
LSD T*V		3.7641			5.8744			7.3754	
CV%		17.78			19.72			20.32	

V1 (Hudeba), V2 (Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism Means within column followed by the same letters were not significantly different according to Duncants Multiple Range test (DMRT) at 5%.

4.2.2 Number of leaves /plant:

The analysis of variance of number of leaves presented in Table 2. The results revealed no significant difference between cultivars in 30, 45 and 60DAS, also among bio-fertilizers in 30 and 60 DAS. At 45DAS the application of M (Mycorrhizea) gave the highest leaves number, as compared to others treatments ,but the differences was not significant (Table4.2).At 45 DAS , Hudeba and Sulem with M+R obtained the highest number of leaves and ranged between 18.89-18.5(table 4.2)

Table4.2.2. Effect of bio-fertilize on leaves/plant of faba *bean (Vicia faba L.)* incident by *Orobanche crenata Forsk.*

Treatment	(30 DAs after sowing)			(45 DAs after sowing)			(60 DAs after sowing)		
	V1	V2	X	V1	V2	X	V1	V2	X
M	8.88ab	9.44a	9.16a	14.88a	14.22ab	14.55a	12.55b	18.44ab	17.1a
R	8.44ab	8.11ab	8.27a	12.33ab	12.44ab	12.03b	18.00ab	17.44ab	17.7a
EM	7.33ba	8.88ab	8.10a	13.00ab	13.22ab	13.11b	18.77a	18.66a	18.7a
M+R	8.88ab	8.89ab	8.88a	14.22ab	14.66ab	14.44ab	18.89a	18.55a	18.7a
M+EM	8.66ab	8.44ab	8.55a	11.66b	13.11ab	12.38b	15.89ab	17.44ab	16.6a
R+EM	8.11ab	8.33ab	8.22a	13.55ab	15.22a	14.39ab	16.55ab	17.22ab	16.8a
M+R+EM	8.11ab	9.77a	8.16a	13.55ab	11.67b	12.61ab	17.89ab	16.66ab	17.2a
Control	8.33ab	8.55ab	8.44a	13.55ab	13.88ab	13.72ab	17.11ab	17.22ab	15.5a
X	8.34a	8.80a		13.34a	13.55a		16.95a	17.70a	
LSD V	0.3196			0.5246			1.0352		
LSD T	0.6392			1.0491			2.0705		
LSD T*V	0.9039			1.4837			2.9281		
Cv%	13.26			13.91			20.78		

V1 (Hudeba variety), V2 (Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism).
Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%

4.2.3 Chlorophyll Contents:

Chlorophyll content in faba bean infested by *O.crenata* (Table 4.3). The results of analysis of variance showed at 45 DAS , faba bean irrespective of cultivars applied with M, R and EM displayed highest values of chlorophyll content(49.87-50.32), as compared to the control (Table 4.3). However, at 45DAS, untreated control sustained the highest value (49.6).

Analysis of variance showed significant differences in interaction between faba bean cultivars and treatment. At 30DAS, R added to Hudeba displayed the highest chlorophyll content, as compared to other treatments. M, M+R and M+EM increased Sulem chlorophylls content by 10.1, 15.3 and 6.5%, respectively ,as compared to the control (Table 4.3).

At 60 DAS, M, R and EM alone or combination increased chlorophyll content significantly in Hudabe and Sulem by 11.2-19.9 and 8.6-14.4 respectively as compared to individual control (Table 4.3).

At 45 Das, Hudabe control revealed the highest value of chlorophyll content (51.87), while combination between M +R displayed the lowest (41.72).Application Sulem by R+EM increased chlorophyll content, but not significantly.

Table4.2.3Effect of bio-fertilize on chlorophyll content (SPAD value) of faba bean *(Vicia faba L.)* infested by *Orobanche crenata.*

Treatment	(30 DAs after sowing			(45 DAs after sowing)			(60DAs after sowing)		
	V1	V2	X	V1	V2	X	V1	V2	X
M	43.47b	53.05ab	48.26a	50.84ab	49.44ab	50.14a	43.44cd	43.89bcd	43.66b
R	56.92a	49.48ab	53.20a	51.07ab	49.56ab	50.32a	49.58ab	41.76cd	45.67ab
Em	46.90ab	48.56ab	47.7a	52.21a	47.54ab	49.87a	46.47abc	42.65cd	44.56ab
M+R	48.54ab	55.53a	52.03a	48.42ab	48.60ab	48.51ab	41.72cd	46.42abc	44.07 b
M+EM	50.66ab	51.31ab	50.98a	48.60ab	49.17ab	48.89ab	44.12bcd	44.87bc	44.49ab
R+EM	47.87ab	46.80ab	47.33a	45.93ab	50.05ab	47.99abc	46.77abc	47.20ac	46.78ab
M+R+Em	49.98ab	46.90ab	48.44a	48.49ab	50.08ab	49.28ab	51.53a	38.18d	44.86ab
Control	53.58ab	48.18ab	50.88a	43.55b	43.76b	43.66b	51.87a	45.40bc	48.63 a
X	49.74a	49.89a		48.64a	48.53a		46.89a	43.79b	
LSD V		1.8088			1.4472			1.0560	
LSD T		3.6176			2.8943			2.1121	
LSD V*T		5.1161			4.0932			2.9869	
CV%		12.65			10.47			7.80	

V1 (Hudeba variety), V2 (Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism).

Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

4.2.4Number of flowers/plot:

Number of faba bean flowers was presented in (Table 4.4). The analysis of variance revealed no significant different between verities and treatments at 45 DAs. However, Significance difference was clear 50 and 55 DAS of treatments and their interaction between verities and treatments. At 50 DAS numbers of flower were greater height M (17.61) and lower in (13.44), when added M +R (21.05) and lower in R alone (15.55). In interaction the highest value was obtained Hudeba (M), Sulem (M+EM) was (9.89) at 45 and 50 DAS, Hudeba (R+EM) was (16.33) at 55 DAS. However, at 55 DAs, all treatment with few expectations gave similar number of flowers ((Table 4.4).

Table4.2.4. 3Effect of bio-fertilize on number of flowers on growth faba *bean (Vicia faba L.)* infested by *Orobanche crenata.*

Treatment	(45 DAs after sowing)			(50 DAs after sowing)			(55 DAs after sowing)		
	V1	**V2**	**X**	**V1**	**V2**	**X**	**V1**	**V2**	**X**
M	19.77a	15.44abc	17.61a	19.77ab	20.44a	20.94ab	23.77ab	26.66a	25.22ab
R	12.44abc	12.11abc	12.27a	12.44ab	15.44ab	15.55c	19.55ab	19.88ab	19.72b
EM	15.11abc	17.22abc	16.61a	15.11ab	20.99a	19.50abc	19.22ab	26.44a	22.83ab
M+R	18.66ab	16.22abc	17.44a	18.66ab	20.99a	21.05a	26.44a	25.77a	26.11a
M+EM	11.44bc	19.22ab	15.33a	11.44ab	18.55ab	16.77abc	19.44ab	24.00ab	21.72ab
R+EM	9.89c	17.11abc	13.44a	9.78b	19.00ab	15.94bc	16.33b	23.11ab	19.72b
M+R+Em	17.66abc	12.33abc	15.00a	17.66ab	15.44ab	17.61abc	24.89a	19.22ab	22.05ab
Control	17.22abc	12.78abc	15.00a	17.22a	15.00ab	16.94abc	22.55ab	18.44ab	20.50ab
X	15.26a	15.30a		17.79a	18.29a		21.52a	22.94a	
LSD V		1.4070			1.3204			1.4449	
LSD T		2.8141			2.4607			2.8898	
LSD V*T		3.9797			3.4800			4.0868	
Cv%		32.94			24.41			23.23	

V1 (Hudeba variety), V2 (Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism).Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

4.2.5 Fresh weight faba bean:

The result of statistical analysis showed no significant differences between varieties and treatments (Table 4.5). Interaction showed significant difference V2(R+EM) the highest values was (456.09 g) and the lowest in V1(R) was (262.1 g).

4.2.6. Dry weight faba bean*:*

The result of statistic analysis Showed significant difference between treatments and interaction, and between varieties and treatments in interaction the highest values in Sulem (R+EM) was (159.7 g) and less values in Hudeba (EM) was (79.67 g). Both cultivars obtained comparable shoot dry weight (Table 4.5).

Table4.2.5. Effect of bio-fertilize on fresh/ dry weight of faba *bean (Vicia faba L.)* infested by *Orobanche crenata.*

Treatment	Fresh weight *faba bean*			Dry weight *faba bean*		
	V1	**V2**	**X**	**V1**	**V2**	**X**
M	383.oab	437.0ab	383.0a	132.6abcd	135.5abcd	134.0ab
R	262.1b	330.6ab	262.2a	89.73bcd	150.3abcd	97.52b
EM	312.8ab	406.6ab	312.8a	79.67d	151.8ab	115.7ab
M+R	353.1ab	325.3ab	353.2a	149.5abc	113.3abcd	131.4ab
M+EM	259.6ab	306.6ab	259.7a	84.3cd	119.3abcd	101.8ab
R+EM	410.5ab	456.09a	412.5a	127.47abcd	159.7a	143.0ab
M+R+Em	409.5ab	396.6ab	409.5a	155.9a	121.9abcd	138.9ab
Control	368.3a	295.0ab	368.3a	156.4a	135.0abcd	145.7a
X	121.9a	130.1a		15.26a	15.30a	
LSD V		42,458			11.411	
LSD T		84.916			22.821	
LSD V*T		120.09			32.274	
Cv%		43.24			31.82	

V1 (Hudeba, variety), V2 ((Sulem, variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism).Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

4.2.7 Number *Orobanche*/plot:

The analysis of variance revealed significant different among treatments and interactions, but no variation between varieties (Table4. 6). In treatments, R was (3.80) and M+ R+EM were (0.66) due to the highest and the lowest number of *Orobanche* appearance at 53 DAs at 60 DAs the R was (6.16) and M+R+EM was (2.0) as the highest and the lowest values respectively. In interaction Sulem (EM) was (7.33) and Hudeba (control) was (1.0), (Table 4. 6).

4.2.8 Orobanche Dry weight:

The analysis of variance revealed significant different among treatments and interaction, but no significant differences between varieties (Table4.6).In treatments R was (19.43g), and control was the lowest (7.36g). Interaction V1(R) was (26.23g), and V2(R+EM) was (2.43g), untreated control displayed highest shoot dry weight (145.7g) followed by descending order by application by R+EM , M+R +EM and M and obtained 143.0-138.9 and 134.0 respectably(Table 4.6).

Table 4.2.6. Effect of bio-fertilize on number and dry weight *Orobanche* of faba *bean (Vicia faba L.)* Infested by *Orobanche crenata.*

Treatment	(53 DAs after sowing)			(60 DAs after sowing)			Dry weight of *Orobanche*		
	V1	V2	X	V1	V2	X	V1	V2	X
M	1.66ab	4.33a	3.00ab	5.00abcd	5.00abcd	5.00ab	11.13b	11.83b	11.48ab
R	3.33ab	4.33a	3.80a	6.33ab	6.00abc	6.16a	26.23a	12.63ab	19.43a
EM	1.00bc	4.33a	2.66abc	2.33cde	7.33a	4.83ab	5.50b	11.40b	8.45b
M+R	1.66ab	3.00ab	2.33abc	3.00bcde	4.00abcde	3.50bc	9.96b	10.70b	10.33ab
M+EM	3.00ab	2.00abc	2.50abc	3.00bcde	3.00bcde	3.00bc	10.63b	8.30b	9.46b
R+EM	0.00c	2.00abc	1.00bc	3.33bcde	1.66de	2.50bc	4.93b	2.43b	3.68b
M+R+m	0.00c	1.33bc	0.66c	2.00de	2.00de	2.00c	11.56b	3.46b	7.51b
Control	2.00c	2.66abc	1.33bc	1.00e	3.33bcde	2.16c	6.93b	7.80b	7.36b
X	1.33a	3.00a		3.25a	4.041a		10.86a	8.57a	
LSD V		0.5114			0.6516			2.3874	
LSD T		1.0229			1.3031			4.7748	
LSD T*V		1.4466			1.8429			6.7526	
CV%		74.78			57.64			84.53	

V1 (Hudeba variety), V2(Sulem variety), (Mycorrhizae), R(Rhizobium), EM(effective Micro-organism).Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%

4.2.9 Days to 50%flowering:

The analysis of variance revealed significant different among treatments and no significant different between varieties and the interaction between varieties and treatments in number of days to 50% flowering, (Table 4.7).

Table4.2.7. Effect of bio-fertilize on 50% flowering and Number of seeds/pod of faba *bean (Vicia faba L.)* infested by *Orobanche crenata.*

Treatment	50 % flowering			Weight of seeds/pod		
	V1	V2	X	V1	V2	X
M	46.00a	47.00a	46.50ab	2.71a	2.08a	2.39ab
R	47.66a	46.33a	47.00ab	2.61a	2.08a	2.35ab
EM	47.00a	46.67a	45.67ab	2.13a	2.41a	2.27ab
M+R	45.67a	45.67a	45.67ab	2.11a	2.47a	2.29ab
M+EM	47.66a	47.33a	46.50a	2.10a	2.80a	2.45ab
R+EM	47.00a	45.67a	46.33ab	4.41a	2.07a	3.24a
M+R+Em	47.00a	47.00a	47.00ab	2.54a	2.17a	2.35ab
Control	45.00a	46.00a	45.16b	2.03a	2.16a	2.09b
X	46.62a	46.37a		2.58a	2.28a	
LSDV		0.4747			0.2677	
LSD T		0.9494			0.5335	
LSDV*T		1.3427			0.7571	
CV%		3.59			37.98	

V1 (Hudeba variety), V2 ((Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism). Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

4.3 Yield and yield components:

4-3-7 Weight of seeds/pod:

The analysis of variance revealed no significant different in varieties and interaction between verities and treatments, but there significant different among treatments on number of seeds/pod in (Table 4.7). In treatments variation were observed in the R+EM with the highest number of seeds/pods of (3.24) and control had the less number of seeds/pods which was (2.09).

4-3-8Number of seeds/pod:

The results of statistical analysis of variance revealed no significant different for all varieties, treatments and 60DAs (Table4.8). But the best value there is in Sulem in all analysis in treatment was EM (72.00) and R had the less number of seeds/pods which was (53.66), in interaction Sulem was M+EM (86.66) and variety was Sulem (69.66).

4-3-8 Number of pods/plant:

The results of statistical analysis of variance revealed no significant different for all varieties, treatments and interaction 60 DAS in Hudeba (M) alone and combination between (EM) increased height number of pods by (10.8) and (17.84) of respectively as compared to the control, but not significantly. Treatment Sulem with (EM), (M+EM) and (R+EM) increased number of pods by 17.7, 39.1 and 28.4% respectively (Table4. 8).

Table 4.3.8 Effects of bio-fertilize and Number of Number seeds/pod and Number of pods/plant of faba *bean (Vicia faba L.)* incident by *Orobanche crenata.*

Treatment	Number seeds/pod			Number of pods/plant		
	V1	**V2**	**X**	**V1**	**V2**	**X**
M	66.66a	51.66a	59.16a	13.33a	10.33a	11.83a
R	40.66a	66.66a	53.66a	8.13a	13.33a	10.73a
EM	70.66a	73.33a	72.00a	14.13a	14.66a	14.40a
M+R	55.00a	63.33a	59.16a	11.00a	12.66a	11.83a
M+EM	53.33a	86.66a	70.00a	10.66a	17.33a	14.00a
R+EM	43.33a	80.00a	61.66a	8.66a	16.00a	12.33a
M+R+Em	51.66a	73.33a	62.50a	10.33a	14.66a	12.50a
Control	60.00a	62.33a	61.16a	12.00a	12.46a	12.23a
X	55.16a	69.66a		11.03a	13.93a	12.50
LSD V		8.9024			1.7805	
LSD T		17.805			3.5610	
LSD V*T		25.180			5.0359	
CV%		49.47			49.47	

V1 (Hudeba variety), V2 ((Sulem variety), M (Mycorrhizae), R (Rhizobium), EM (effective Micro-organism).

Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

4-3-9 hundred seed weight (gm):

The statistical analysis of variance of hundred seed weight was presented in (Table 4.9). The results showed the height value in treatment M+EM in hudabe (76.44g) and lowest value was M (40.4g) the height value in Sulem was R (85.35g) and lowest in control was (38.36g) combination between M+EM increased hundred seed weight of significantly by 65.7%, as compared to the control Treatment M and combination M+R increased hundred seed weight , but not significantly .However the observed increment was considerable (47.4-50.6%) ,(Table 4.9).

4-3-9 Dry weight (gm):

The results of statistical analysis, showed significant different between Sulem displayed highest varieties dry weight Sulem highest (88.69 kg/fed) with Hudeba sustained the lowest (74.34).Treatments EM and M+EM increased faba bean dry weight by 19.2 kg/fed and 70.0% as comparison to control (Table 4.9).

4-3-9 Yield Kg/fed:

The statistical analysis of variance revealed no significant different for all treatments, varieties and their interaction (Table 4.9). Mean while, showed Sulem slight increase in yield than Hudeba height value was M+R+EM (544.1),was low value in R(350.7) and also application of Sulem heighted was (M+EM) (725.7) led to great yield but not significantly difference.

Table4.3. 9Effect of bio-fertilize on100 seed weight (gm), Dry weight kg/fed and Yield kg/fed of faba *bean (Vicia faba L.)* infested by *Orobanche crenata Forsk.*

Treatment	100 seed weight (gm)			Dry weight kg/fed			Yield kg/fed		
	V1	**V2**	**X**	**V1**	**V2**	**X**	**V1**	**V2**	**X**
M	53.16ab	49.63ab	46.30b	89.20a	65.93a	77.56a	516.6a	389.4a	453.0a
R	49.59ab	85.35a	67.47ab	60.00a	93.00a	76.50a	350.7a	400.8a	375.8a
EM	40.46b	60.00a	50.23ab	92.60a	94.90a	93.75a	491.2a	573.1a	532.1a
M+R	51.60ab	86.25a	68.92ab	73.93a	84.87a	79.40a	455.2a	553.9a	504.5a
M+EM	76.44ab	75.14ab	75.79a	64.70a	124.0a	94.35a	393.6a	725.7a	559.6a
R+EM	53.00ab	49.50ab	51.25ab	87.73a	85.50a	86.61a	468.5a	526.9a	497.7a
M+R+Em	51.53ab	47.70ab	49.61ab	68.13a	78.53a	73.33a	544.1a	473.2a	508.7a
Control	53.16ab	38.36b	45.76b	74.47a	82.83a	78.65a	437.3a	483.2a	460.3a
X	52.34a	61.49a		76.34a	88.69b		457.2a	515.8a	
LSD V		7.1388			11.182			66.236	
LSD T		14.278			22.364			132.47	
LSD V*T		20.191			17.805			79.408	
Cv%		44.51			48.02			48.36	

V1(Hudeba variety), V2((Sulem variety) ,m (Mycorrhizae), R (Rhizobium), EM(effective Micro-organism).Means within column followed by the same letters were not significantly different according to Dun cants Multiple Range test (DMRT) at 5%.

CHAPTER FIVE

DISCUSSION

Broomrapes (*Orobanche crenata Frorsk*.) are a root holophrastic plant devoid of chlorophyll and entirely depending on the host for nutritional requirements. They cause considerable yield losses (5-100 %) in the crops, especially in the drier and warmer areas of Europe, Africa and Asia where it is reported to mainly parasitize species of leguminous, oilseeds, solanaceous, cruciferous and medicinal plants (Habimana *et al.,* 2014) .The long-term impact of the broomrapes is even more serious: their seeds may easily spread to other fields, and can persist in soil up to 20 years, leading to an accelerated increase in the infested areas in which susceptible crops are under danger. Orobanche seed dispersal is facilitated by man, agricultural tools, crop seeds, prop gules and also by animals through their excreta (Habimana *et al.,* 2014). Although several potential control measures were developed over the past few decades for some crops, any approach applied alone is often only partially effective and the results are sometimes inconsistent due to variable environmental conditions. Therefore, the only effective way to combat weedy root parasite like Orobanche to date is through an integrated approach, combining a variety of measures in a concerted manner. Orobanche tends to be associated with less fertile soil conditions (Perez-de-Luque *et al*., 2010, Goldwasser *et al.* 2008, (Hassan Elrashed *et al*., 2013). The result in laboratory control compared with less value in Mycorrhizae 25%. The same result was in condition germination, R, (M+R+EM) and number of Orobanche connected to faba bean; control was 3.62 and Mycorrhizae was 1.1, reported that with increasing of nitrogen fertilizers concentration, studied indices (bush height of sunflower, fresh weight of stem, leaf and crop of sunflower) were increased(Ibrahim *et al*. 2012). Estimated average faba bean yield losses a result of *O. crenata* infestation ranged from 2 to 28 % at the district level while average yield loss was estimated to reach 99% at the field level(Hawassa *et al* ., 2017).

The present work was carried out to evaluate the potential of arbuscular Mycorrhizae fungi (AMF), Rhizobium and effective microorganism to suppress *O.crenata* on faba bea*n* (Rania *et al.,* 2013). The results revealed significant difference between cultivars in; chlorophyll content at 60 DAS, dry weight of plant and Sulem had the highest value also number of Orobanch*e* appeared significantly in Sulem in laboratory experiment, Application of bio-fertilizers and their interaction as a general revealed good evidence in all treatments than control in vegetative and reproductive parameters. This finding was in the same line with (Abbes, *et al*., 2016). Who stated that Orobanche infestation was influenced by the bacteria, AM fungi and the time the observation was made. Mycorrhizae root colonization was positively correlated with total dry matter of faba bean. Similarly, some Rhizobium legume in osarum strains have been reported to induce define against *O. crenata* in pea through activation of the oxidative process, and production of possible toxic compounds, including N (Rubiales , 2003). Mycorrhizae are permits the plant to obtain additional moisture and nutrients. This is particularly important in uptake of phosphorus. One of the major nutrients required by plants (Jordanm *et al.*, 2000). Among treatments significant difference appear clearly in, number of leaves at 45 DAS, number of flower after 45 and 60 DAS, chlorophyll content in second and third reading, dry weight, 50% flowering, number of seeds/pod number of Orobanche appeared in field. In laboratory % of germination growth of

Orobanche were highly significant with 90% in. In the other side, with increasing of nitrogenous fertilizer, the amount of broomrape germination was decreased. In interaction of varieties and treatments highly significant difference was appeared at 60 DAS, of plant height Sulem (M+R), number of leaves Sulem (EM), V1 (EM) , to 30DAS Sulem with(M +R+EM) , or 45 DAS Sulem (R+EM) is high. number of flowers/plot Hudabe (M), Sulem (EM), Sulem (M), Sulem (M+R), chlorophyll content in first reading Hudabe (R) , in second reading Hudabe EM and at 60 DAS Sulem (M+R) ,(R+M) fresh weight of plant Hudabe (Control), Dry weight Sulem (R+EM), Hudabe (M+R+EM) they are highest than interaction. Number of Orobanche/filed Sulem (M+R+EM), and dry weight of Orobanche/filed). Several reports showed that fertilizers, mainly phosphorus and nitrogen, lead to significant reductions in infestation of host crops by Striga, Orobanche and Phelipanche and the reduced infestation appears to be linked with alteration in strigolactone production .The highest increment of faba bean shoot was obtained when AM fungi were incorporated with bacterial strains B3 as compared to control (Hassan *et al.*, 2013).

Yield showed no significant difference due to addition of bio-fertilizers for two infected faba bean cultivars, no clear infestation by Orobanche in spite of addition of 5 g of Orobanche/hole, this may be due to treatments or soil or environmental condition. This may agree with (Mariam and Rungsit. 2004). In many regions, Faba bean crops are subject to different conditions of biotic and a biotic stress and, consequently, yield is ultimately dependent on cultivar resilience to multiple stress conditions and Hence, breeding new cultivars with increased resilience to a biotic stresses, (Siddique *et al*., 2013 ,Nebiyu *et al*., 2016). Found that broomrape infestation of tomato decreased with increases of soil nitrogen Also. (Hassan *et al.*, 2013) reported that a considerable delay in Orobanche infestation could be displayed on inoculation of faba bean with bacteria and AM fungi. Various cultural and chemical strategies have been used to control *O. foetida* (Kharrat *et al.,* 2004; Abbes *et al*., 2010a) and *O.crenata* on faba bean (El-Shirbini and Mamdouh, 2004; Pérez-de-Luque *et al*., 2004). Unfortunately, most of them alone are not effective or have insufficient success due to the longevity in soil, small size, and high fecundity of Orobanch*e* seed (Díaz- Ruiz et al., 2009). An integrated control strategy based on the use of resistant varieties remains the most likely economical and feasible control method (Pérez-de-Luque *et al*., 2010; Mohammed *et al.,* 2012). Adoption of an integrated approach encompassing AM fungi and bacteria inoculation may provide a novel, cheap and easy method to apply for *O.crenata* control under subsistence low-input farming systems ,This provides the parasite with a great genetic adaptability to environmental changes, including host resistance, agronomical practices and herbicide treatments (parker *et al*., 2009).

Recommendation

-From the study application of bio- fertilizer (Rhizobium, Mycorrhizae and effective Microorganism) during flowering and pods stage of faba bean cultivar in weather of Khartoum North maintain good growth and yield.

-I recommended Faba bean Sulem cultivar gave better growth and yield than Varity Hudeba with using of boi-fertilizer (Mycorrhizae ,effective Microorganism, and mixed Mycorrhizae and effective Microorganism (EM)),in the field.

APPENDICES

ANOVA Table

Analyses of variance (ANOVA) table 1 Effect of bio-fertilize on number of Germination% and attached Orobanche of faba bean *(Vicia faba L.)* infested by *Orobanche crenata Frorsk.*

Source of Variation	Df	Germination % *Orobanche*	Attached *Orobanche*
Replication	2	16.41 **	2.58 NS
Varity	1	1.44 NS	7.13**
Error A	2	7.81	056
Treatment	7	7.6 4*	4.97*
V*T	7	5.82*	3.34NS
Error B	28	0.69	0.66

* Significant

** Highly significant

NS not significant

APPENDICES

Analyses of variance (ANOVA) Table 2.Effect of bio-fertilize on number of growth100% Orobanche of faba bean *(Vicia faba L.)* infested by *Orobanche crenata Frorsk*.

Source of Variation	DF	Grow with %Orobanche
Varity	1	225.00**
Error	7	153.6NS

NS= not significant

* Significant

**=Highly significant

APPENDICES

Analyses of variance (ANOVA) table 3. Effect of bio-fertilize on number of plant during growth faba bean (*Vicia faba L*) infested by *Orobanche crenata Frorsk*.

Source of Variation	Df	Plant Height 30DAS	Plant Height 45DAS	Plant Heigh60DAS	Leaves Number 30DAS	Leaves Number 45DAS	Leaves Number60 DAS	Chlorophyll Content30DAS	Chlorophyll Content45DAS
Replication	2	10.77 *	117.78 **	139.99 **	0.03 NS	5.54 **	30.26 **	158.12 **	18.85 *
Varity	1	28.17 **	45.71 *	336.02 **	2.54 **	0.52 NS	6.73 NS	0.67 NS	0.15 NS
Error A	2	0.55	9.86	25.89	0.27	0.51	11.31	32.22	14.35
Treatment	7	13.01 *	30.81NS	44.77NS	0.89 *	5.34 **	6.88NS	28.86*	27.68 **
V*T	7	9.00 NS	35.33 *	48.56 *	0.87 *	1.91 *	7.50 *	51.10 *	9.82 *
Error B	28	22.73	54.76	85.57	1.29	3.50	12.97	39.77	25.90

* Significant

** Highly significant

NS not significant

APPENDICES

Analyses of variance (ANOVA) table 4. Effect of bio-fertilize on number of plant during growth faba bean (*Vicia faba L*) infested by *Orobanche crenata Frorsk*.

Source of Variation	Df	Chlorophyll Content60 DAS	Day50 % Flowers	Flowers Number 48DAS	Flowers Number51 DAS	Flowers Number54 DAS
Replication	2	13.28 NS	2.44 **	178.44 **	172.96 **	316.09 **
Varity	1	114.73 **	0.75 NS	0.02 NS	2.99 NS	24.11 NS
Error A	2	25.38	1.56	1.38	0.93	2.10
Treatment	7	16.32 NS	3.52 **	20.09 *	28.46 *	34.49 *
V*T	7	52.03 *	0.94 NS	41.09 *	21.o3 *	34.45 *
Error B	28	12.53	2.79	25.36	19.40	26.69

* Significant

**=Highly significant

NS= not significant

APPENDICES

Analyses of variance (ANOVA) table 5. Effect of bio-fertilize on number and dry weight/ plant Orobanch during growth behest faba bean (*Vicia faba L*).infested by *Orobanche crenata Frorsk*,

Source of Variation	Df	*Orobanche* Number 53DAS	*Orobanche* Number 60DAS	*Orobanche* Dry Weight
Replication	2	6.58 *	22.58 **	198.44 **
Varity	1	33.33 **	7.52 NS	63.02 NS
Error A	2	10.33	14.58	81.38
Treatment	7	7.00 *	13.93 *	125.44 **
V*T	7	2.71 NS	6.28 NS	55.04 NS
Error B	28	2.63	4.42	67.47

***** Significant

** Highly significant

NS not significant

APPENDICES

Analyses of variance (ANOVA) table 6 .Effect of bio-fertilize during on yield component /plant faba bean (*Vicia faba L*) infested by *Orobanche crenata Frorsk*.

Source of Variation	Df	Shoot Fresh Weight/faba bean	Shoot Dry Weight/faba bean	Weight seeds/plant(g)	Number of seeds/bods	Number seeds/plant	Hundred seed weight (g)	Dry weight kg/fed	Yield kg/fed
Replication	2	25572.4**	139000.5**	217.88 **	5446.90 **	1.01521 *	531.29 *	12453.2 **	43601 **
Varity	1	27888.5**	799.5NS	100.92 *	2523.00 **	1.09505 *	1004.2 **	1830.3 **	41243**
Error A	2	13160.9	919.7	36.61	915.19	0.94276	186.37	522.4	1490
Treatment	7	22014.7**	2090.8*	8.54 NS	213.57 NS	0.71217 NS	839.22 *	388.1 NS	19238NS
V*T	7	19421.7NS	2151.1*	19.08 NS	477.00 NS	1.34163 **	532.30 NS	907.4 *	27522 *
Error B	28	22237.3	1608.3	38.14	953.59	0.85382	641.91	1570.4	55342

***** Significant

** Highly significant

NS not significant

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