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Research Article

Effect of AM Fungi and *Streptomyces* isolate *S. remosus* on plant growth, biomass yield, and nutrients uptake in *Sorghum* Var. Maladandi (*Sorghum Vulgare* Pers.)

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Abstract

Over the recent decades, laboratory and field experiments have generated, a considerable data regarding the promising use of beneficial micro organisms..In this study, special attention has been paid on Arbuscular Mycorrhizal Fungi (AMF) and *Actinomycetes*, (*Streptomyces)* are rhizospheric microorganisms play an important role in promoting plant growth and protection against plant pathogen. These two microorganisms could participate directly or indirectly in the enhancement of root hair production and root colonization understanding this two microorganisms,. Interaction studies were carried at laboratory conditions on *Sorghum* (*Sorghum valgare* pers.). Six AM Fungi *Glomus byaggarajii* G. macro carpum, *G. rosseae*, *Rhizophagus fasciculatus*, *Selecystis dussii* and *Scutellosphora nigra* combined with *Streptomyces remosus* was inoculated on *Sorghum*.The results showed that the inoculation of *Rhizophaus fasciculatus* with streptomyces remoses significantly influenced on Sorghum plant with increased plants growth, biomass yield per cent root colonization, spore number and an increased chlorophyll contents and nutrients N.P. and Zn and Cu, compared to (Control) non-inoculated plants. *Selerocystis dussii* with *Streptomyces remosus* and *Glomus macrocarpum* with *s. remosus* were the second and third suitable strains for *Sorghum vulgare*. There was an increased root hairs with reduced root length was documented on Sorghum plants when plants received *Steptomyces remosus.* Similarly, the copper content was higher among the (Control) non-inoculated *Sorghum* plants. However, other AM fungi *G. mosseae*, *Scutellospora nigra* with *Streptomyces remosus* have influenced moderately on *sorghum* improvement compared to *G. bagyarajii* considered to be least influenced with *S. remosus.* And therefore, the results of the present study confirm that *Sorghum vulgare* have been proved for the positive growth response to mycorrhiza and Streptomyces inoculation.

INTRODUCTION

Agriculture and natural resource-based enterprises are the foundation for economic growth all over the world. Sustainable agriculture integrate environmental health, economic viability and social equity to ensure long term productivity of natural resources and improved livelihoods. It helps to reduce the risks of complex problems like climate variability and climate change in developing countries. In the last century, chemical fertilizers were introduced and this made farmers to be happy of getting increased yield in agriculture in the beginning. But slowly chemical fertilizer started displaying their negative effects such as leaching, polluting water basins, destroying microorganisms and insect pollinators, making the crop more susceptible to the attack of diseases, reducing the soil fertility and thus causing irreparable damage to the overall system.

Of all the variables that imact upon plant growth, soil microbial activity is arguably very complex but plays a very important role in precisions agricultural practices. The importance of the microbiota to bio-geochemistry has long been appreciated. Interactions between plants and microbes have been well documented. (Lakshman, 2010;Krisana *et al*., 2018).

The point that the microorganisms are an intimate part of the plant ecosystem and that understanding their roles will lead to new management opportunities. (Marschner and Timonen, 2015). Soil microbiologists aim to develop new management tools for agricultural systems. Similarl,y response of rice crop inoculate with AM fungi and plant growth promoting rhizobacteria to different soil nitrogen concentration, (Barea *et al*., 2005; Ahanthaum, *et al.,* 2007). One of the most important input for increasing agricultural productivity (Meyer and Linderman, 1986).The use of eco-friendly technology such as biofertilizers and biopesticides (Lakshman and Channabasava, 2014). Bio-fertilizers such as plant growth promoting rhizobacteraia (PGPR) and beneficial fungi associated with rhizosphere of the plants have gained more importance. Among the beneficial microbes, the soil fungi which form mutualistic associations are referred as "Mycorrhizal fungi". Along with the bacteria and fungi, actionomycetes were also supported the plant growth and nutrient uptake (Azcon, 1989; Jariwala and Ravirajan, 2013; Gangwar *et al*., 2014).

Most of the terrestrial plants maximum of 90% have associated with the formation of mycorrhizal association (Parniske, 2008; Garcia *et al.,* 2016). Arbuscular mycorrhizal (AM) fungal association plays an important role in the agricultural and horticultural plants (Bagyaraj, 1984, Jeffries, 1987; Richardson, 2001). Among important agricultural and horticultural plants that associated with mycorrhizal fungi are corn, carrots, leek, potatoes, beans, soybeans, other legumes, tomatoes, peppers, onions, garlic, sunflower, strawberries, citrus, apples, peaches, grapes, cotton, coffee, tea, cocoa, sugarcane, forest species, wild plants, and even weeds. Mycorrhiza plays a very important role on enhancing the plant growth and yield due to an increase P supply of phosphorus to the host plant. (Lakshman, 1999, and 2009, Merrild *et al.,* 2013). Plants can absorb and accumulate several times more phosphate from the soil or solution than non-mycorrhizal plants (Lakshman and Raghavendra, 1995). Plants inoculated with endomycorrhiza have been shown to be more resistant to some root diseases (Mohammadi *et al.,* 2011; Jung *et al.,* 2013.) Mycorrhiza increase root surface area for water and other nutrients uptake (Auge, 2004).Therefore, plants with mycorrhizal association will have higher efficiency for nutrients absorption, such as phosphorus, potassium, calcium, magnesium, zinc and copper, and also increase about resistance to drought.

Actinomyces are basically soil inhabitating bacteria.The Streptomyces are members of the bacterial order. *Actinomyces,* bacteria which resemble fungi in their branching filamentous structure. Streptomyces is the largest genus of Actino-bacteria and the type genus of the family Streptomycetaceae (Kamal and Sharma, 2014; Sharma, 2014).Streptomycetes are characterized by a complex secondary metabolism (Tahvonen, 1988; Loria *et al.,* 1997). They produce over two-thirds of the clinically useful antibiotics of natural origin, including sugars, alcohols, amino acids, organic acids, and aromatic compounds.This is achieved by producing extracellular hydrolytic enzymes. Streptomyces are widely used in industries due to their ability to produce numerous chemical compounds including antibiotics, enzymes and anti-tumor agents.

The name *"Sorghum"* comes from Italian "Sorgo" in turn from latin "Syricum" (granum) meaning "grain of Syria" Sor*ghum,* currently classified as *S. bicolor,* was formerly known as S. *vulgare* Pers. Jowar/*Sorghum* is the third most important food crop of the country after rice and wheat. The plant has a tendency to be grown in adverse climatic conditions. Its grains are rich in carbohydrate, minerals and vitamin and hence provide cheap food to a large section of the poor population. It is used as a source of sugar, syrup, fiber, and feed grain. It is also used as fodder crop in many parts of the country. In view of its importance, to understand the effect of different AM fungi with *Streptomyces* isolate *Sermosus,* this study was carried out under greenhouse condition.

MATERIAL AND METHODS

Sorghum vulgare Pers. Maladandi variety seeds were obtained on request from seed technology unit, University of Agricuslture Sciences (UAS), Dharwad - 580005, Karnataka, India. Seeds were brought to the laboratory and stored in the polyethylene bags kept in refrigerator at 4°C under aseptic conditions until used.

These seeds were subjected for viability test by using moist chamber method. Prior to sowing seeds were thoroughly surface sterilized by keeping them in 0.1N $Hgcl_2$ for about 2-3 min and then washed with sterile distilled water for removal of traces of $Hgcl_2$

Arbuscular Mycorrhizal fungal species namely;*Rhizophagus fasciculatus, Glomus bagyarajii, Glomus macroparpum, Glomus mosseae, Sclerocystis dussii and Scutellospora nigra* were selected as inoculants. These were selected based on their relative abundance in the rhizosphere of experimental plant from different location of Dharwad district in Karnataka. These AM fungal species were mass multiplied by using Johnson grass *Chloris gayana* Kunch. As host plant under green house conditions. Pure fungal inoculum was maintained in separate culture pots aseptically in the Micro-biology Laboratory, P.G. Department of Studies in Botany, Karnatak University, Dharwad – 580003, India. The *streptomyces* spp. was isolated from the soils samples collected from the rhizosphere of the Jowar plants for the isolation of *streptomyces* spp. 10g. rhizzosphere soil from *Sorghum* plants have been collected and suspended in 100 ml of distilled water. An aliquot was inoculated on Soybean casein digested agarmedia. Then the isolation was carried out under the aseptic conditions by using Soybean casein agar digested media. The *streptomyces* isolate was subcultured on Soybean casein digested agar media with incubation period of 2 weeks at 28°C. Later suspension culture was prepared for the further analysis was carried after the estimation of Indole 3-acetic acid (IAA) production by *Streptomyces* isolate was determined under in vitro conditions Soybean casein broth, which was kept in continuous rotary shaker for 7 days at 28°C.following the method described by (Pandey *et al*., 2011; Stephen, 2014). *Streptomyces* cellular extracts were carried out by using Soyabean casein digested agar media (SCDA). Results showed that, cellular extracts of *Streptopmyces* were found to be more effective against bacterial pathogens such as *Bacillus subtillis*, and *Pseudomonas aeruginosa*, the maximum zone of inhibition was observed for the *Bacuillus subtillis*, compared to *Pseudomonas aeruginosa*, under in vitro laboratory conditions. Finally, the species of *Streptomyces remosus* was identified accordingly the procedure of (Manulis *et al.*, 1994).

Greenhouse experiments were conducted by using earthen pots measuring (10x12) cm diameter earthen pots and they were filled with 8 kg soil potting mixture consists of soil, sand and farmyard manure (2:1:1) ratio. The used soil was sandy loamy. Then AM fungal mixed inoculums (10 g. rhizosphere soil Johnson grass *Chloris gayana* Kunch.contain spores (100-180/10g plus highly colonized root bits 5g.) inoculum (15g.pot) was layered just 3-5 cm below the surface of the potting mixture. Surface sterilized seeds were sown before sowing the seeds gum arabic plus Jaggery mixed agarmedia was pasted on each *Sorghum* seed ($5x10^{10}$) cells per seed). Experimental pots were also treated with 10 ml Hoagland's solution without Phosphorus once in a fifteen days. All the experimental pots were maintained with triplicate of random black design (RBD). The experiments were undertaken according to the following steps as follows: AM fungi was the identified based on the manuals of identification of mycorrhiza proposed by (Schenck and Perez, 1990; Prasad *et al.*,1999).

Control (N-I) Non-inoculated.

Streptomyces (*S.remosus*).alone.

AM fungus *Glomus bagyraii* with *streptomyces* (*S.remosus*).

AM funguis *Rhizophagus fasciculatus* with *streptomyces.(S. remosus).*

AM fungus *Glomus macrocarpum* with *Streptomyces (S. remosus).*

AM fungus *Glomus mosseae* and *Streptomyces (S. remosus).*

AM fungus *Streptomystis dusii* and *streptomyces (S. remosus).*

AM fungus *scutellospora nigra* and *Sclerocystis (S. remosus).*

After completion of 45 and 90 days plants were harvested during that time plants were uprooted from the pots manually. Uprooted plants were washed thoroughly and then root and shoot were separated. Immediately shoot and root fresh weight were recorded by using a NAMED electric balance. Simultaneously, shoot and root length was measured with help of measuring tape manually. Then shoot and root samples were subjected for drying under airtight oven for about 48 hours at about 72°c. Before drying, half of the root samples were taken and stored in F.A.A. (Formalin Acitic Acid; etnyl alcohol) (5:5:90) for further analysis and the rhizopshere soil samples were collected from each experimental pot to analyze the AM fungal spore density. To etermine the AM fungal spore population in the rhizosphere 25g of soil was subjected for wet-sieving and decanting technique

following the procedure of (Gerdemann and Nicolson, 1963). Stored root samples were thoroughly washed under running water to determine the mycorrhizal root colonization by using rapid clearing and staining technique as described by Phillip and Hayman (1970). Root samples were washed under tap water, and then they were cut into 1cm long bits and mixed in 10% KOH solution and autoclaved for 60 minutes, then KOH solution was decanted and roots segments were washedin distilled water to remove brown colour. Then, roots were acidified with 2% N HCL for 3-5 min. Then root segments were stained with 0.05% Tryphan blue for 10-15 min. Then root segments were mounted in Lactophenolon on micro-slide. The per cent root colonization was determined by the root slide technique, as described by Giovannetti and Mosse (1980). The following formula was used to calculate the percent root colonization:

$$\text{Per cent root colonization} = \frac{\text{No. of root segments colonized}}{\text{Total number of root segments examined}} \times 100$$

Phosphorus content of shoots were determined colorimetrically by the vanadomlybdate phosphateric yellow colour method of Jackson (1973). Nitrogen content of shoots were analysed by the microkjeldahl method (Bremner, 1960). For the root samples Zn and Cu was analysed by using 50311 USA made automatic absorption spectrometer.

RESULTS AND DISCUSSION

Sandy loamy soil, which was uised for earthern pot experiments and its physic-chemical characteristics (Table 1). It is clearly showed the lower content of phosphorus compared to other two major elements nitrogen and potassium, Clay percent is lower than Sand and the slit soil p^H is acidic with moisture 28.03 per cent.

Sorghum vulgare Pers. var. Maladandi showed a significantly positive res-ponse to all the treatments compared to control. Experimental result showed increased growth in plants after the inoculated with AM fungi and *Streptomyces* compared to (control) non inoculated plants. But the rate of extent of increased growth with varied with each AM fungus and *Streptomyces* isolate *S. remosus* inoculation.

The inoculations of *Rhizophagus fasciculatus, Sclerocystis dussii* and Glomus *macrocarpum* with *Streptomyces remosus* had influenced maximum growth, biomass yield and nutrients uptake as first, second and third effective strains compared to other threeAM fungi; *Glomus mosseae, Scutellospora nigra and Glomus bagyarajii*. But those inoculated with *Strptomyces plus Glomus mosseae plus, streptomyces,Scutellospara nigra plus* and *Streptomyces plus Glomus bagyarajii* plants showed favourably increased plant height, root length over the non-inoculated plants. The second best bioinoculant inoculation was *Sclerocyst dussii* with *Streptomyces* and it was followed by *Glomus macrocarpum,* with *Streptomyces Glomus mosseae Scutello spora nigra* with *Streptomyces.* The least increased value for shoot and root length was observed inoculation of AM fungus *Glomus bagyarajii* and *Streptomyces,* but it was significantly higher than that of the non-inoculated plants. Experimental results also revealed that, almost 75% increased in plant growth response at 90 DAE (days after examination) over the results that was recorded at 45 DAE. Number of root hairs were increased those plants inoculated only *streptomyces* plants shown in (Table 2).

Sorghum vulgare Pers. Var. Maladandi shoot and root fresh weight as well as dry weight. Fresh and dry weight of AM fungi and *Streptomyces* inoculated plants showed increased biomass production over control plants. But the rate of extent of increased biomass was varied with each AM fungi and *Streptomyces* isolate. Maxi-mum value for biomass production was recorded with inoculation of AM fungus *Rhizophagus fascuiculatus* with *Streptomyces* compared to otherfive AM fungi and *Streoptomyces* isolate (S. remosus).

Sorghum vulgare Pers. var. Maladandi was inoculated with six different AM fungi with *Streptomyces* isolate, results were found to be significantly proved improved over the non-inoculated plants. Results showed that the maximum per cent mycorrhizal colonization was recorded in roots of *Sorghum vulgare* Pers var. Maladandi plants with inoculation with *Rhizophagus fasciculatus* with *Streptomyce,* when compared to other five AM fungi and *Streptomyces,* but the results were favourably good over the non-inoculated plants. It was found that the lower per cent of mycorrhizal colonization was served on the

inoculation AM fungus *Glomus bagyarajii* with Streptomyces. But it was moderately inmfluenced over the non-inoculated plants. Results clearly revealed that increase number of AM fungal spore in the rhi-zosphere of Jowar plants in all the six AM fungi with Streptonmyces inoculated plants. And inoculated plants showed higher biomass yield over the control plants.

Most soil *actinomycetes* show their optimum growth in neutral and slightly alkaline conditions. (Bhavdish *et al.,* 2003) have reported that approximately 80% of rhizosphere bacteria can secrete IAA. Similar function might have occur in *rhizosphere Sorghum* plants *rhizosphere*. But there was varied with each AM fungal species. More number of AM spores was recorded when AM fungus *Rhizophagus fasciculatus* with *Sreptomyces* inoculation and least number of AM spores were recorded with the inoculation of *Glomus bagyarajii* with *Streptomyces*. In beginning at 45 DAH lower number of AM fungal spores was observed in the rhizopshere of all the AM fungi inoculated plants. Similarly, inoculated plant leaves showed an increased chlorophyll a, b and total chlorophyll. Similar results were obtained on other plants by (Charita Devi and Reddy, 2004; Khamna *et al.* 2011). There was an increased uptake of Nitrogen Phosphors in shoots and the micronutrients Zn and Cu in roots also increased. However, cu content was higher in non- inoculated *Sorghum plants* than that of inoculated plants (Table 3). After, the inoculation of AM fungis *Rhizophagus fascicyulatus* with *streptomyces* remosus *Sclerocystis dussii* with *Streptomyces, Glomus* m*acrocarpum* with *Streptomyces* as best, good and better or first, second and third selective bioinoculants for *Sorghum*..plants.

The response of AM Fungal inoculation also varied among them different cultivars of crops (Friesen *et al.,* 2011), Most of the AM fungi with *Streptomycs* resulted in increased growth and biomass of the Jowar plants inoculated with six different AM fungi and *Streptomyces* compared to non-mycorrhizal plants..These findings are consistent with earlier findings of (Lombert *et al.,* 1979; Khanna *et al.,* 2010; Meenakshi Sundaram and Santhguru, 2011; Kamal and Sharma, 2014).

The mycorrhizal fungi with *Streptomyces remosus* play an important role in uptake of N P, Zn and Cu, when as compared to non-mycorrhizal plants. The my-corrhizal plants frequently contain higher concentrations of Nitrogen, Phosphorus and Zinc. (Krishna *et al.,* 1982; Meyer and Linderman, 1986; Richardson, 2001; Lakshman, 2009 and 2010; Battini *et al*., 2011). It is usually assumed that root colonization by introduced bacteria is important for the biocontrol. Mycorhiza and *Streptomysis remosus* of two microorganism that colonizes root is ideal to be used as a control agent against soil borne pathogen disease. (Artursson *et al.,* 2006; Pandey *et al*., 2011).

There was a variation in degree of functional compatibility and growth curve, between untreated and inoculated plants, the results shows that plants inoculated with *Streptomyces* has a great significant to plants with increased endophytic root hairsm than root length. (Dhurba Das *et al.,* 2014 Alesandra, *et al.,* 2018). Endophytic actinomycetes is colonizing inside the plant, it get nutrition and protection from the host plant.(Doumbou *et al.*,2001). In turn, it acts as a biocontrol of pathogen through then production of phytoharmones and induction of systematic disease resistance. There was an increased copper uptake in root hairs of non-inoculated plants over the inoculated ones. Similar finding was reported by early workers on different plants. (Azcon, 1989; Filion *et al.,* 1999; Lakshman, 2010; Jariwala and Ravirajan, 2013).The association of AM fungi and *Streptomyces* has contribute great advantage to the plants, results indictates that more efficient fungi formed a more effective association with host plant (Sujan Singh, 2000; Brundrett, 2004; Freesen *et al.,* 2011; Andress, 2015).The results showed that AM fungi plus *Streptomyces remosus* inoculation plant shoot showed increase of P and nitrogen. Our results also showed that increased Zn concentration in roots of inoculated plants in contrast to copper uptake was observed that was higher higher concentration in non-inoculated (control) plant roots. An increased AM fungal colonization was recorded from 45 to 90 Days harvest with inoculation *streptomyces* remosus with *Rhizophagus Fasciculatus, Scerocystis dussii* and *Glomus macrocarpum with Streptomyces* on the pre scence of extraradical hyphae and AM fungal spores and consequently there was highest number of root hairs were observed among the plant roots, they were treated only with *Streptomyces remosus.* This is mainly AM fungi influenced the growth of plants, by improving mycorrhizal root colonization and stimulating extraradical hyphal growth in the facilitating AM spore germination. The later on the imp-rovement root hairs production, were documented by (Kravehenko *et al.,* 1991; Crowley

and Rengel, 1999; Johnsson *et al.*, 2004;Arthuronnet al,m*et al.*, 2006; Lakshman, 2010; Zamioudis *et al*, 2012; Ranveeer Kamal *et al.*, 2014). Stimulation of root development influenced *Stretomycis remosus*inoculation alone. Similar results were observed in the present study.

In conclusion; Arbuscular mycorrhizal fungi (AMF) can provide numerous benefits to their host plants, including improved nutrient uptake, drought resistance, and disease resistance. Similarly, actinomyces are one of the major components of the microbial populations present in the soil. These actinomyces are known for their economic importance as they are producers of biologically active substance, such as antibiotics, vitamins, IAA and enzymes (Linderman, 1988, Lakshman and Geeta Patil, 2004; Krishna *et al.*, 2018). These, two beneficial microorganisms i.e., combined inoculation of AM fungi with actinomycetes has been found to exert a synergestic effect which influenced optimal root colonization, and enhance in the plant biomaa by one or more mechanisms mainly of improved mineral nutrition, disease suppression or phytoharmone production. And thus, in the present study clearly experimented that *Streptomyces remosus* helps in the production highest number of root hairs than AM Fungi inoculated Sorghum. The inoculation of AM fungus *Rhizophagus fasciculatus* plus *Streptomyces* considered to be best strains for Sorghum. The comined inoculation for Jowar significantly improved growth, biomass yield, chlorrphyll content in leaves, N. P and zn and cu uptake in shoot and roots. The cu content in roots of non inoculated improved significantly over the inoculated *Sorghum* var. Maladandi (*Sorghum vulgare*) plants. It is therefore, an increasing demand for low-input agriculture has resulted in a greater interest in soil microorganisms. Among the nutria groups arbuscular mycorrhizal fungi and actinomyctus bacteria are able to enhance plant nutrition and health, and to improve soil quality. In recent days, these organisms appear as a research target for the agricultural crops as promising candidates.

Table 1. Physico-chemical characteristics of Soil used for the pot experiment.

Characteristics	Value
Texture	Sandy Loamy
p^H	6.8
Soil moisture (%)	28.03
Sand (%).	49.2
Slit (%).	53.1
Clay (%).	22.0
Organic matter (%).	0.82
E.C. Mmhos Cm^2	0.97
Nitrogen (%).	1.56
Phosphorus (%).	0.29
Potassium (%).	2.43
Zinc (%).	2.04
Copper (%).	1.10
Manganese (%).	1.31
Lead (%).	0.31

Elemental concentration is in mg/kg soil. Each value is the mean of 12 samples.

Table 2. Showing the effect of different AM fungi and *Stretomyces* (*S. remosus*) isolate on plant growth, fresh and dry weight of *Sorghum* var. Maladandi *Sorghum* vurgare pers. At two harvests 45 and 90 days.

Treatments	Shoot Length (cm)	Shoot F.W. (g.)	Shoot D.W. (g.)	Root length (cm)	Root F.W. (g.)	Root hairs/Plant	Root D.W. (g.)	Percent root colonizat-ion	AMF Sores/ 25 g.soil
45 DAYS									
Control (NI) Non Inoculated	24.31a	20.20b	0.98a	8.51c	1.19b	6.3c	0.77a	0.00	0.00.
Streptomyces (Sorwemosus)	39.42c	5.13a	2.41b	11.22d	2.17c	51.2d	0.94c	0.00	3.10b
Stept.+ G. *bagyarajii*	48.22d	6.20c	2.54ab	14.03ac	2.34b	29.5b	1.00d	47.11d	77.0c
Strept.+ R. *fasciculatus*	57.12a	11.10d	5.12d	18.32b	3.71c	34.1c	2.13a	72.12b	93.00a
Strept.+ G. *macrocarpum*	53.10c	7.10ac	4.30b	15.14a	3.63d	31.0d	2.10b	54.10c	68.0d
Strept.+ G. *mosseae*	51.41ab	6.15c	2.11a	14.53a	3.15c	33.4c	1.24ab	51.12d	71.0c
Strept.+ Sl. *dussii.*	55.24c	7.13c	4.10c	15.22d	3.22c	32.1a	1.41a	56.00b	82.0d
Strept.+ Sc. *nigra*	49.50b	6.41b	2.70ab	14.12b	3.12c	28.4d	1.17c	49.15d	74.0c
90 Days									
Control + NI Non Inoculated	31.11b	3.11b	1.30a	12.10c	1.10a	13.0a	0.84d	0.00	0.00
Strept.+ omyces (S. remosus).	47.02a	5.15a	2.12b	17.23a	1.33d	92.2c	0.97b	0.00	2.11c
Step.+ G. *bagyarjii*	58.13c	12.13d	5.10a	15.30c	1.62b	51.3d	1.17c	48.13d	71.0b
Strept+R. fasciculatus	78.21b	17.50c	9.50b	22.40b	2.14c	64.3b	1.25d	76.00b	97.0c
Strept + G. *macrocarpum*	69.52d	14.20b	6.00c	20.00ac	1.97a	61.2d	1.16c	63.13a	78.0ab
Strept + G. mosseae	64.31a	13.43e	5.72ab	19.17ab	1.72ab	50.0c	1.14d	61.22 ab	74.0a
Strept.+ Sl. *dussii.*	73.11c	15.14d	7.51c	21.11c	2.11b	52.0b	1.21b	64.23c	83.0d
Strept.+ Sc. *nigra*	61.00b	13.22a	6.11a	19.14d	1.64d	43.3a	1.10a	57.12a	76.0c

Mean value followed by the same letter Unitex aedummdexct significantly at P = 0.05 according to DMRT G. *Glomus*, R. *Rhizophagus*, Sl. *Sclerocystis*, Sc. *Scutellospora.*

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Table 3. ShowTng the effect of different AM fungi and *Streptomyces S. rimosus* isolate on chlorophyll content in leaves nityrogen and phosphorus content in shoots of *Sorghum* var. Maladandi *Sorghum Valgare* pers at two harvests 45and 90 Days.

	45 Days						
Treatments	Chlorophyll A	Chlorophyll B	Total Chlorophyll	Nitrogen mg/Plant	Phosphorus mg/Plant	Znmg/root	Cu mg/root
Control (NI) Non Inoculated	0.021a	0.0132c	0.053b	0.82b	0.144d	0.13c	0.31a
Streptomyces	0.054cd	0.0140b	0.068ac	2.17ab	0.212b	0.44d	0.19d
Step.+G. bagyarajii	0.0105c	0.0101c	0.0206b	3.44c	0.317b	0.48c	0.21b
Strept+R. fasciculatus	0.0217b	0.0210c	0.0427d	5.14c	0.532c	0.49a	0.20c
Strept+G. macrocarpum	0.0169ac	0.0171d	0.0340c	4.21c	0.157d	0.57ab	0.16a
Strept+G. Mosseae	0.0153b	0.0160c	0.0313ab	4.15b	0.452	0.50c	0.18b
Strept+Sl. Dussii.	0.0196d	0.0211b	0.0407ac	4.72c	0.503b	0.51d	0.15d
Strept+Sc.nigra	0.0145ab	0.0134c	0.279d	3.48d	0.437a	0.37a	0.19c
		90 Days					
Control (NI) Non-Inoculated	0.033b	0.041a	0.074a	0.93b	0.153c	0.47b	0.33b
Streptomyces	0.046c	0.083d	0.0129b	2.39ab	0.239d	0.53c	0.18d
Step.+G. bagyarjii	0.0132bc	0.014ac	0.0246b	3.47a	0.314b	0.49b	0.21a
Strept+R. fasciculatus0.02a	0.0233b	0.027b	0.0509d	5.9c	1.701d	0.54c	0.29b
Strept+G. macrocarpum	0.0183c	0.0170ab	0.0353ab	4.41b	0.672c	0.51b	0.16d
Strept+G. mosseae	0.0178d	0.0156d	0.0334c	4.81a	0.660b	0.45ac	0.17b
Strept+Sl. dussii.	0.0203	0.0212b	0.0415d	4.86a	0.813a	0.44a	0.19d
Strept+Sc.nigra	0.0146c	0.016a	0.0307	3.82c	0.671c	0.46d	0.18c

Values are not followed b y identical letters in each veritical column are significantly different but significant at p=0.05 according to DMRT.

G. *Glomus*, R. *Rhizophagus*, Sl. *Sclerocystis*, Sc. *Scutellospora.*

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