**International Journal of Botany Studies**
**ISSN: 2455-541X; Impact Factor: RJIF 5.12**
**Received: 16-02-2021; Accepted: 08-03-2021: Published: 13-03-2021**
**www.botanyjournals.com**
**Volume 6; Issue 2; 2021; Page No. 141-146**

# Study of vesicular arbuscular mycorrhizal status of different types of plantation and the effect of indigenous vam on the growth of *Sorghum bicolor*

**Sudhansu Samanta**
Post Graduate, Department of Botany, Sabang Sajanikanta Mahavidyalaya, Lutunia, Affiliated to Vidyasagar University, Midnapore, West Bengal, India

**Abstract**
Plants grown in *Casuarina equisitifolia* field mycorrhizal soil was proved more efficient in promoting plant height, leaf number as well as leaf area index and highest VAM infection potential, which could provide more VAM infectionpotentiality in the early age of seedling establishment. In this treatment VAM infection percentage was found correlated with plant growth. All the observation suggested that higher mycorrhizal soil inoculum helped to produce plant growth in early stage which continued to be same at latter stage of plant growth also. Soil inoculums of Grasses also proved as efficient as *Casuarina equisetifolia* soil inoculums for the growth of the plant height, dry weight in relation to highest VAM infection % and low VAM spore inoculum in rhizospheric soils.

**Keywords:** vesicular arbuscular mycorrhizal (Vam), *Sorghum bicolor*, field soil, mixed plantation, promoting plant growth etc

## Introduction
Vesicular arbuscular Mycorrhizae are an integral part of most plants in nature (Giazninazzi *et al*., 1982) and occur on 83% of dicotyledonous and 79% of monocotyledonous plants investigated (Wilcox, 96). Infection of the root system of the plant by the mycorrhizal fungi creates a symbiotic relationship between the plant and fungus. In this relationship, the fungi obtain carbon compounds and other nutritional requirements from the symbiotic plant roots, and in return, supply the plant with most of the immobile mineral elements such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Copper (Cu) and Zinc (Zn) from the soil solution, thus, becoming a significant component in low-input agricultural systems (Barea and Jeffries, 1995) [12].
Mycorrhizal benefits have been reported for many cereals, including pearl millet, wheat, and maize (Rao *et al*. 1983; Lu and Miller, 1989) [2, 1]. Suri *et al.* (2006) [3] screened out efficient local VAM strains out of 600 soil samples collected from various crop rhizospheres in wet temperate zone of Himachal Pradesh (India), located in North-Western Himalayas. The crops covered were maize, wheat, oats, berseem, soybean, French bean, onion, potato, garlic, chilies, citrus, apple, pear, peach etc. Maximum spore count (110-185 spores/250 g soil) was recorded under vegetable field soils. In VAM root infectivity studies conducted in green house with selected soils as VAM inoculants, highest infectivity in maize (38%) and soybean (40%) was noticed with use of VAM inoculant from vegetable fields. In most soils/crops, *Glomus* spp. of VAM was found to be predominant. It is inferred from above study that VAM as biofertilizer has the potential to improve crop productivity and soil fertility in P-deficient acid soils.
Current reports on VAM association and mineral elements availability have constantly concentrated on P uptake (Thompson, 1987; Smith and Read, 1997; Graham, 2000; Plenchette *et al*., 2005) [15, 14, 16, 17]. However, there is evidence that VAM association can also lead to acquisition of other mineral elements for their own uses as well as the growth and development of their hosts in mixed culture systems cereals gain more N from the associated N-fixing legume partner under conditions of limiting soil nitrogen (N) (Vest, 1971; Eaglesham *et al*., 1981; Ndakidemi, 2005; Munkvold L. *et al*., 2004) [18, 19, 20] and Joachim H. J. R. Makoi and Patrick A. Ndakidemi.2009) [22].
In the presence of VAM, *Sorghum bicolor* fertilized with any of the rock phosphates, produced yields comparable to plants fertilized with chemical fertilizer, at soil pH 5.5 to 7.5 and at 25°C soil temperature. As the soil pH increased from 5.5 to 7.5 the yield declined. Likewise, yields decreased with increasing soil temperature and at 35°C VAM showed no effect in any treatments. VAM effectiveness depends on carbon supply of host. Sylvia *et al*. (1998) [4] estimated that as much as 20% of the total carbon assimilated by the plant allocated to mycorrhizal fungi
Mycorrhizal advantage to the crops as highlighted above are not available to the crops grown by farmers because cheap and effective source of mycorrhizal inoculums is not in normal chain of supply. This is the major bottleneck towards the application of mycorrhizal inoculums at field level.
Present study was undertaken to access the VAM status of different field soil and the effect of the indigenous VAM propagules on the growth of the test plant *Sorgham bicolor*.

## Materials and Methods
### Geographical location
Pot experiment was conducted at the experimental cum botanical garden of post graduate department of Botany, Sabang Sajanikanta Mahvidyalaya under Vidyasagar University, West Bengal, India during 2019. It is situated in the Southern region of west Bengal, India, located at $22{\cdot}2262^0$ N latitude and $87.5630^0$E longitudes at a distance of 86 km from the Bay of Bengal, at elevation of 12m above mean Sea level.

**Climate:** The climate of this region is warm and humid, the average annual rainfall ranges from 1300mm to 1500mm, 80% of which is received during June to October from southwest monsoons.

**Soil:** The Soils of the different fields were lateritic and sandy loam in texture; it is low in organic carbon, nitrogen (N) content and acidic to alkaline after harvesting the crops. The agriculture field soil was collected in post-harvest condition. The details of physico-chemical characteristic and VAM status of the soil have been given in a table: 1:

**VAM inoculum:** Indigenous VAM spores of rhizospheric soil and roots of different fields acted as mycorrhizal inoculum. Name of the plantations and crops from which soil was collected are given below.

**Site I (mixed plantation)**
Mixed plantation. *Acacia auriculiformis, Shorea robusta, Tectona grandis, Alstonia scholaris, Switenia Mehogoni* and *Eucalyptus* sp. The ground vegetation was not significant.

**Site II**
This was a fenced area under protection. This site was planted as such with *Casuarina equisitifolia* but some other tree species also grew like *Citrus aurantifilia*, *Psidium guajava*, and *Anacardium occidentale* etc., here and there. The ground vegetation comprised *Sida cordifolia, Eupatorium sp, Tephrosia sp, Evolvulus sp.* etc.

**Site III**
This was the site where *Anacardium occidentale*. Ground vegetation was almost nil with few grass species.

**Site IV**
This was the area where *Eucalyptus* sp planted. The ground vegetation was almost nil with few grasses.

**Site V (mixed plantation)**
Mixed forest of many species. Species composition was *Tectona grandis, Dalbergia sissoo, Syzygium cumini Casuarina Equisetifolia; Azadirachta indica, Acacia Auriculiformis, Cassia fistula, Albizia Lebbek.* As canopy was not closed ground vegetation comprises many herbaceous Species.

**Site VI**
This was protected land where various wild vegetation of grasses, *Clerodendron* sp, *Eupatorium sp, Lantana* sp. *Mimosa Pudica, Sida Cordifolia, Tephrosia sp, Evolvulus sp, Eragrostis sp.* we're growing.

**Site VII**
This was agricultural land used for farming traditionally. Food crops, vegetables and oilseeds were cultured as usual. Inoculum included soil spore root fragments and mycelia associated with soil.

**Enumeration of VAM spore population**
100gm of air-dried rhizospheric soil was dispersed in 500ml water in a beaker, stirred rigorously and allowed to stand for 30-45 seconds, when the soil settled down. The supernatant was poured through sieves of 200µ, 150µ, 100µ & 50µ mesh. The entire process was repeated thrice. The residues on the sieves were washed with water jet and collected in beaker. The content of the beaker was filtered on Whatman No 1 filter paper and the spores on the filter paper were observed under stereo microscope and the number counted. (Gerdemann & Nicolson, 1963) [5].

**VAM infection of root:** The root samples were boiled in 10% KOH in an autoclave at 15lb/$m^2$ pressure for 10 minutes, washed with distilled water, acidified with dilute HCl, washed with distilled water and stained with 1% cotton blue for 2-3 hours (Phillips and Hayman 1970) [6]. The stained root samples were mounted in lacto phenol and observed under compound microscope for VAM infection. The infection percentage ranged between 75% to 100%.

**Experiments**
**Pot experiments:** Polythene bags of 20cm height and 20cm diameter were used. Hundred and five pots were used for experiments. Pots were arranged in seventh rows. The design followed was Random Block Design with7 replications.

**Soil preparation:** Soil was collected from the field from top 20cm depth after passing through 2mm size of sieve. Each pot was surface sterilized with formalin and thereafter was filled up with 2kg soil collected from the various agricultural fields as stated above.
*Sorghum* seeds were germinated in natural condition at $35^0$c and 95% humidity for 3 days before plantation. Watering was done to maintain uniform moisture content in soil in all the pots as and when required.

**Observation records**
**Sampling procedure:** During growing period, root samples were collected at 7 days, 15days, 30 days, 45 days after sowing (d.a.s). Measurements were done at 7, 15, 30 and 45 (d.a.s). Leaf and whole plants were collected at 45 days for chlorophyll and plant dry weight estimation at 45 days.

**Growth:** The data on plant height, leaf number and leaf area were recorded at7days 15days, 30 days and 45 days after sowing. Plants height was considered from ground level to apex of the fully opened apical vegetative bud.

**Measurements**
The plants height was measured by plain scales. The dry weight was obtained after drying the plants in oven at $80^0$c for 48 hours, VAM infection percentage was determined following Phillips and Hayman (1970) [6] Spore were extracted following Gardemann and Nicolson (1963) and counted under stereomicroscope.

**Recorded morphological parameter:** For observing and recording different morphological parameters five plants were randomly selected from all treatments. All under mentioned parameters were recorded at at 7days, 15days, 30 days and 45 days after sowing except the chlorophyll and plant dry weight. Plant dry weight was recorded after 45 d.a.s. VAM infection percentage was also observed after 45 days.

1. Plant height
2. No of leaf
3. Leaf area.
4. Leaf chlorophyll content.
5. Plant dry weight
6. VAM infection percentage
7. VAM spore number

## Result

### Physico-chemical properties of different types of soils.

The Rhizospheric soil of the sites characterized as acid lateritic but our experiments showed that plantation increased the pH level and pH gradually converted to normal. Lowest soil pH 5.9 was recorded in *Casuarina Equisitifolia* mixed plantation. Highest pH was recorded in mixed plantation with *Tectona grandis* and protected wild vegetation of grass followed by agriculture land, *Acacia auriculiformis* mixed plantation, *Anacardium* plantations and *Eucalyptus* coppices. The moisture content varied within 1.10% to 9.26%. Soil organic carbon improved mixed plantation with *Tectona grandis* and decreased in following order protected grass land that is Acacia mixed plantations *A. occidentale, Eucalyptus, and C. Equisitofolia* agriculture land.

### VAM spore numbers in the Rhizospheric soil of different plantation sites and its species composition.

Lowest VAM spore number 431 per $100^{-g}$ soil was observed in agricultural land and highest VAM spore number 2195 per $100^{-g}$ soil was recorded in protected wild vegetation with grass sp. *Acacia* mixed plantation recorded 1649 VAM spore per 100g soil and followed by *Tectona grandis* mixed plantation (1449), *A. occidentale* (1430), *Eucalyptus* (1142) and *C. Equisitifolia* (764).

### Growth

**Plant height:** At 7 days all the rhizospheric soil with VAM spores produced higher plants than control. *Casuarina* field soil produced maximum plant height, which was 4.92 times more than control. VAM spore with *Anacardium* field soil and grass field soil increased plant height by 4. 78, 6.07 times more than control. At 15, 30 and 45 days also the trend was similar. *Casuarina* field soil with VAM inoculum produced higher plant by 43% more than control. However, field soil of grasses increased 31% plant height compared to control. The plant height improved in following order agricultural field soil>Acacia plantation>Tectona grandis >Anacardium field soil>Eucalyptus field soil. (Table -3)

**Leaf number:** All the treatments produced higher leaf number than control at all through the growth periods. Rhizospheric soil with VAM spores did not affect the leaf number among treatment at 7 to 30 days. However, at 45 days *Tectona grandis* produced lowest leaf number compared to all other treatments. (Table -4)

**Leaf area:** At 7 days VAM spores with *Acacia* plantation, *Tectona grandis* mixed plantation, grass field and agriculture field recorded decreased LAI than control. However, Casuarina, Anacardium and Eucalyptus plantations produced higher plant LAI than control. At 15 days all treatments showed decreased LAI compared to control. At 30 days grass field soil, *Tectona grandis* plantation, *Eucalyptus* and *Anacardium* plantations promoted more LAI than control. Only casuarinas field soil with VAM soil produced mote LAI than control. All other treatments failed to Promoted positive LAI**.** (Table -5)

**VAM infection %:** There was only hyphal infection was observed at 7 to 30 days. Vesicular and arbuscular infection was observed at 45 days. Highest 77.5% VAM infection was observed in *Casuarina* field soil followed by the rhizospheric soil of *Acacia (75%),* grass (75%), agricultural field (42.5%), *Eucalyptus (37.5%), Tectona grandis* (32.5%) and Anacardium (25%) plantation**.** (Table -6 & Table-7)

**Leaf Chlorophyll content:** All the VAM inoculated plants produced higher leaf chlorophyll than control. Highest chlorophyll content was recorded in agricultural soil treatments where the increased being 45% over control. *Acacia, Eucalyptus, and Casuarina* field soil with VAM inoculums produced 181%, 64% and 21% more chlorophyll content respectively compared to control. (Table -8)

**Plant Biomass:** All the VAM inoculated plants produced increased plant biomass over control. Highest plant biomass was recorded in agricultural VAM soil and the increased being (0.95gm) followed by grass (0.83gm), *Casuarina* (0.65gm), *Anacardium* (0.45gm), *Acacia* (0.34gm) *Tectona grandis* (0.33gm) and Eucalyptus (0.23gm). (Table-8).

**Table 1:** Physico-chemical properties of different types of soils.

| Name of the plantations | Name of the plant Species | $P^H$ | Moisture content % | Organic Carbon (%) |
|---|---|---|---|---|
| Site I | Acacia auriculiformis, Shorea robusta, Tectona grandis, Alstonia scholaris, Switenia Mehogoni and Eucalyptus sp. | 6.5 | 1.1 | 1.18 |
| Site II | Casuarina equisitifolia, Citrus aurantifilia, Psidium guajava, Anacardium occidentale Sida cordifolia, Eupatorium sp, Tephrosia sp, Evolvulus sp | 5.9 | 1.43 | 0.79 |
| Site III | Anacardium occidentale | 6.3 | 4.33 | 0.90 |
| Site IV | Eucalyptus. | 6.1 | 1.56 | 0.86 |
| Site V | Tectona grandis, Dalbergia sissoo, Syzygium cumini Casuarina equisetifolia; Azadirachta indica, Acacia auriculiformis, Cassia fistula, Albizia lebbek. | 6.8 | 9.26 | 1.65 |
| SiteV I | Clerodendron sp, Eupatorium sp, Lantana sp. Mimosa pudica, Sida cordifolia, Tephrosia sp, Evolvulus sp, Eragrostis sp. were growing. | 6.8 | 2.66 | 1.57 |
| Site VII | Oryza sativa, Solanum tuberosum, Linum uitassimum, Brassica nigra. | 6.7 | 4.76 | 0.71 |

**Table 2:** Table showing different sites with the year of plantation, plant species and VAM spore numbers.

| Name of the plantations | Name of the plant Species | VAM spore numbers in $100^{-g}$ soil |
|---|---|---|
| Site I | Acacia auriculiformis, Shorea robusta, Tectona grandis, Alstonia scholaris, Switenia Mehogoni and Eucalyptus sp. | 1641 |
| Site II | Casuarina equisitifolia, Citrus aurantifilia, Psidium guajava, Anacardium occidentale Sida cordifolia, Eupatorium sp, Tephrosia sp, Evolvulus sp | 764 |
| Site III | Anacardium occidentale | 1430 |
| Site IV | Eucalyptus. | 1142 |
| Site V | Tectona grandis, Dalbergia sissoo, Syzygium cumini Casuarina equisetifolia; Azadirachta indica, Acacia auriculiformis, Cassia fistula, Albizia lebbek. | 1449 |
| SiteV I | Clerodendron sp, Eupatorium sp, Lantana sp. Mimosa pudica, Sida cordifolia, Tephrosia sp, Evolvulus sp, Eragrostis SP. were growing. | 2195 |
| Site VII | Oryza sativa, Solanum tuberosum, Linum uitassimum, Brassica nigra. | 431 |

**Table 3:** Table showing Plant height of Sorghum plants (*Sorghum vulgare L.*) grow in different soils on 7, 15, 30, 45, days after sowing (d.a.s).

| Treatment ed Soil | Height(cm) | Height(cm) | Height(cm) | Height (cm) |
|---|---|---|---|---|
| | 7 days | 15 days | 30 days | 45 days |
| SITE I | 14.8 | 16.63 | 26.00 | 34.60 |
| SITE I control | 3.5 | 12.97 | 21.03 | 26.73 |
| SITE II | 16.4 | 23.03 | 28.80 | 40.93 |
| SITE II control | 2.77 | 15.73 | 21.37 | 28.60 |
| SITE III | 16.03 | 18.33 | 25.50 | 34.33 |
| SITE III control | 2.77 | 13.20 | 20.27 | 28.10 |
| SITE IV | 11.93 | 15.37 | 24.23 | 30.80 |
| SITE IV control | 2.13 | 12.63 | 19.37 | 24.63 |
| SITE V. | 12.66 | 17.13 | 29.60 | 32.40 |
| SITE V. control | 1.33 | 13.30 | 17.53 | 23.83 |
| SITE VI | 15.77 | 18.10 | 28.10 | 35.73 |
| SITE VI control | 2.23 | 14.40 | 20.17 | 27.13 |
| SITE VII | 14.40 | 19.93 | 27.30 | 35.67 |
| SITE VII Control | 1.03 | 13.23 | 18.90 | 30.97 |

**Table 4:** Table showing Leaf number of Sorghum plants (*Sorghum Vulgare L.*) grow in different soils on 7, 15, 30, 45, days after sowing (d.a.s).

| Treatmented Soil | leaf | Leaf | Leaf | Leaf |
|---|---|---|---|---|
| | 7 days | 15 days | 30 days | 45 days |
| SITE I | 3 | 3 | 4 | 6 |
| SITE I control | 2 | 3 | 4 | 5 |
| SITE II | 3 | 3 | 4 | 6 |
| SITE II control | 2 | 3 | 4 | 5 |
| SITE III | 3 | 3 | 4 | 6 |
| SITE III control | 2 | 3 | 4 | 6 |
| SITE IV | 3 | 3 | 4 | 6 |
| SITE IV control | 2 | 3 | 4 | 6 |
| SITE V. | 3 | 3 | 4 | 5 |
| SITE V. control | 2 | 3 | 4 | 5 |
| SITE VI | 3 | 3 | 4 | 6 |
| SITE VI control | 2 | 3 | 4 | 6 |
| SITE VII | 3 | 3 | 4 | 6 |
| SITE VII Control | 2 | 3 | 4 | 5 |

**Table 5:** Table showing Leaf area index (LAI) of Sorghum plants (*Sorghum vulgare L.*) grow in different soils on 7, 15, 30, 45, days after sowing (d.a.s).

| Treatmented Soil | Leaf area index | Leaf area index | Leaf area index | Leaf area index |
|---|---|---|---|---|
| | 7 days | 15 days | 30 days | 45 days |
| SITE I | 0.025 | 0.015 | 0.025 | 0.061 |
| SITE I control | 0.038 | 0.024 | 0.040 | 0.093 |
| SITE II | 0.043 | 0.029 | 0.036 | 0.071 |
| SITE II control | 0.023 | 0.065 | 0.044 | 0.065 |
| SITE III | 0.040 | 0.021 | 0.045 | 0.057 |
| SITE III control | 0.019 | 0.033 | 0.037 | 0.149 |
| SITE IV | 0.025 | 0.014 | 0.059 | 0.039 |
| SITE IV control | 0.015 | 0.059 | 0.032 | 0.057 |
| SITE V. | 0.026 | 0.027 | 0.053 | 0.055 |
| SITE V. control | 0.028 | 0.054 | 0.035 | 0.058 |
| SITE VI | 0.028 | 0.042 | 0.058 | 0.074 |
| SITE VI control | 0.065 | 0.057 | 0.046 | 0.085 |
| SITE VII | 0.031 | 0.029 | 0.04 | 0.053 |
| SITE VII Control | 0.015 | 0.062 | 0.044 | 0.056 |

**Table 6:** Table showing VAM infection percentage of Sorghum plants (*Sorghum Vulgare L.*) grow in different soils on 7, 15, days after sowing (d. a. s).

| Treatmented Soil | Hyphal infection % | Vesicular infection % | Arbuscular infection % | VAM infection % | Hyphal infection % | Vesicular infection % | Arbuscular infection % | VAM infection % |
|---|---|---|---|---|---|---|---|---|
| | 7 days | 7 days | 7 days | 7 days | 15days | 15days | 15days | 15 days |
| SITE I | 32.5 | 0 | 0 | 0 | 7.5 | 0 | 0 | 0 |
| SITE I control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE II | 45 | 0 | 0 | 0 | 15 | 0 | 0 | 0 |
| SITE II control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE III | 10 | 0 | 0 | 0 | 7.5 | 0 | 0 | 0 |
| SITE III control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SITE IV | 12 | 0 | 0 | 0 | 12 | 0 | 0 | 0 |
| SITE IV control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE V. | 6.66 | 0 | 0 | 0 | 12.5 | 0 | 0 | 0 |
| SITE V. control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE VI | 5 | 0 | 0 | 0 | 6.66 | 0 | 0 | 0 |
| SITE VI control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE VII | 15 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| SITE VII Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

H=Hyphae, V=Vescicle, A=Arbuscule.

**Table 7:** Table showing VAM infection percentage of Sorghum plants (*Sorghum vulgare L.*) grow in different soils on 30, 45, days after sowing (d.a.s).

| Treatmented Soil | Hyphal infection % | Vesicular infection % | Arbuscular infection % | VAM infection % | Hyphal infection % | Vesicular infection % | Arbuscular infection % | VAM infection % |
|---|---|---|---|---|---|---|---|---|
| | 30 days | 30 days | 30 days | 30 days | 45days | 45days | 45days | 45 days |
| SITE I | 40 | 0 | 0 | 0 | 100 | 75 | 2.5 | 75 |
| SITE I control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE II | 42.5 | 0 | 0 | 0 | 100 | 60 | 70 | 77.5 |
| SITE II control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE III | 22.5 | 0 | 0 | 0 | 100 | 25 | 25 | 25 |
| SITE III control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE IV | 22.5 | 0 | 0 | 0 | 100 | 2.5 | 37.5 | 37.5 |
| SITE IV control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE V. | 2.5 | 0 | 0 | 0 | 100 | 20 | 30 | 32.5 |
| SITE V. control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE VI | 60 | 0 | 0 | 0 | 100 | 42.5 | 70 | 75 |
| SITE VI control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SITE VII | 12.5 | 0 | 0 | 0 | 100 | 0 | 42.5 | 42.5 |
| SITE VII Control | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 8:** Table showing leaf chlorophyll content and Plant biomass of Sorghum plants (*Sorghum vulgare L.*) grow in different soils on 45 days after sowing (d.a.s).

| Treatmented Soil | Chlorophyll (mg/g) | Biomass(gm) |
|---|---|---|
| SITE I | 3.1 | 0.34 |
| SITE I control | 1.1 | 0.24 |
| SITE II | 2.8 | 0.65 |
| SITE II control | 2.3 | 0.37 |
| SITE III | 2.7 | 0.45 |
| SITE III control | 2.2 | 0.23 |
| SITE IV | 2.8 | 0.23 |
| SITE IV control | 1.7 | 0.13 |
| SITE V. | 3.7 | 0.33 |
| SITE V. control | 2.1 | 0.22 |
| SITE VI | 1.8 | 0.83 |
| SITE VI control | 1.6 | 0.32 |
| SITE VII | 3.2 | 0.95 |
| SITE VII Control | 2.2 | 0.53 |

## Discussion

The agricultural soil of Midnapore has is neutral to slightly acidic $p^H$. With intermediate in soil moisture. However, published reports indicate it is deficient in available phosphate and other nutrients and to a certain extent in nitrogen and organic carbon as well. (Jana and Das, 1987; Sharma et al 1990) [7]. Actually, the soil is slightly acidic and this acidity factor and low moisture level tend to immobilize the phosphorus as bound iron and aluminum phosphates and thus reduce its availability (Mondal and Mondal, 1990) [8]. Besides this, leaching of nutrient is a natural process due to high porosity and light weight of the soil. All these factors reduce the availability of nitrogen, phosphate, zinc and other micro and macro nutrients. (Jana and Das, 1987, Dutta *et al*., 1989) [7]. in such a soil, addition of chemical phosphate fertilizer is also of little use, since they too are fixed, become immobile and unavailable. The red lateritic soil creates nutrient and moisture stress to the plant growth. Excessive use of chemical fertilizer promotes to increase soil $P^H$.

VAM facilitate better survival of plants under stress condition through a boost in uptake of nutrients particularly P, Zn, Cu & water (Auge *et al*, 1986) [9]. Nelson and Safir (1982) [10] observed the increased drought tolerance of mycorrhizal onion plants caused by improved phosphorus nutrition. Plants grown in *Casuarina equisitifolia* field mycorrhizal soil was proved more efficient in promoting plant height, leaf number as well as leaf area index and highest VAM infection potential, which could provide more VAM infection potentiality in the early age of seedling establishment. In this treatment VAM infection percentage was found correlated with plant growth. All the observation suggested that higher mycorrhizal soil inoculum helped to produce plant growth in early stage which continued to be same at latter stage of plant growth also. Soil inoculums of Grasses also proved as efficient as *Casuarina equisetifolia* soil inoculums for the growth of the plant height, dry weight in relation to highest VAM infection % and low VAM spore inoculum in rhizospheric soils. In case of *Anacardium occidentale* and *Tectona grandis* inhabited soil showed low VAM infection % (25% and 32.5% respectively) although there were good number of VAM spore recorded in both the soils. (Table- 2). Higher VAM infection percentage 77.50 was observed in *Casuarina equisetifolia* where VAM spore number was very low as much as 764 per 100g soil. *A. auriculiformis* soil treatment recorded 75% VAM infection, however VAM spore number was 1649 per 100g soil. Simply 25% and 32.5% VAM infection was observed in *Anacardium occidentale* and *Eucalyptus* plantations. Highest 950mg plant biomass was recorded in the treatment of agricultural soil with VAM inoculums which produced 79% more dry weight than control. However, it was clear

that grass soil inoculums had maximum potential for plant growth enhancement factors and higher VAM inoculation potential, the increased being 32 % in plant height,159% in plant dry weight and 75% VAM infection percentage. After 45 days of sowing of *Sorghum* plants, there were least amount of root infection in *Anacardium occidentale* soil treatment and *Eucalyptus* soil which resulted lower plant height and plant dry weight in *Sorghum* plants and but all other soil treatments promoted higher growth clearly suggesting that mycorrhizal infection are very essential for plant height and for increasing higher plant dry weight.

Excessive use of chemical fertilizer is considered a major ecological problem because it inhibits the natural mycorrhizal population and other microbial flora of soils. In our experiment it has been seen that even though mycorrhizal spore were lower in rhizospheric soil but because of the higher level of residual nutrient promoted plant growth in respect of chlorophyll content and plant dry weight. However, VAM inoculum present in *Casuarina equisitifolia* promoted maximum77.5% VAM infection percentage, 43% plant height and 76% increase in plant dry mass over control.

This research works an inspiration to cultivate agricultural plants with natural VAM inoculums present in the rhizospheric soil of grasses and *Casuarina equisitifolia* plantations may promote good plant growth without further application of chemical fertilizer.

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