

## Effect of *Arbuscular mycorrhizae* on the growth of *Cucumis sativus* under different soil amendments

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### Abstract

The effect of *Arbuscular mycorrhiza* in germination, plant growth, number of leaf, leaf area, nodular number, fresh and dry weight of *cucumis sativus* (L) in different soil sample. The increase in amount of *mycorrhiza* led the germination percentage and plant growth and has a positive effect. The development of symbiosis between soil fungi *Arbuscular mycorrhiza* (AM) and most terrestrial plants can be very beneficial to both partners and hence to the ecosystem. AM fungi are widely believed that the inoculation of AMF provides higher growth of the *Cucumis sativus* plants the symbiotic association of AMF is a classic example of mutualistic relationship, which can regulate the growth and development of plants. The mycelial network of fungi extends under the roots of the plant and promotes nutrient uptake that is otherwise not available.

**Keywords:** *Cucumis sativus*, *Arbuscular mycorrhiza*, soil sample, plant growth, dry weight and Germination etc

### Introduction

*Arbuscular mycorrhizal* fungi (AMF) facilitate host plants to grow vigorously under stressful conditions by mediating a series of complex communication events between the plant and the fungus leading to enhanced photosynthetic rate and other gas exchange-related traits, as well as increased water uptake. Numerous reports describe improved resistance to a variety of stresses including drought, salinity, herbivory, temperature, metals, and diseases due to fungal symbiosis. Nearly 90% of plant species including flowering plants, bryophytes, and ferns can develop interdependent connections with AMF. AMF form vesicles, arbuscules, and hyphae in roots, and also spores and hyphae in the rhizosphere. Formation of hyphal network by the AMF with plant roots significantly enhances the access of roots to a large soil surface area, causing improvement in plant growth. AMF improve plant nutrition by increasing the availability as well as translocation of various nutrients. AMF improve the quality of soil by influencing its structure and texture, and hence plant health. Fungal hyphae can expedite the decomposition process of soil organic matter. Furthermore, mycorrhizal fungi may affect atmospheric CO<sub>2</sub> fixation by host plants, by increasing “sink effect” and movement of photo-assimilates from the aerial parts to the roots. Keeping in view the importance of AMF and the research advancements related to their applications in agriculture, the present review focuses on the role of AMF as bio-fertilizers in the regulation of plant growth and development with improved nutrient uptake under stressful environments, and the level to which AMF can enhance plant growth under stressful environments.

The cucumber plant (*Cucumis sativus*) belongs to the Cucurbitaceae family, a part of the *Cucumis* genus. The *Cucumis* genus contains nearly 40 species, such as the cantaloupe (*C. melo*), and watermelon (*Citrullus vulgaris*). The cucumber has many common names including pepino, cetriolo, gherkin, gurke, krastavac, concomb, hunggua, kiukaba, khira, kiukamupa, and kukamba.

*Cucumis sativus* is a frost-sensitive annual with coarse (large, bold, and rough) leaves and a creeping vine that can reach upwards of six feet in length. The spiraling, hairy vine and tendrils that originate from the axil, allow the plant to

readily climb supporting structures. Hairy, three to five-lobed leaves, with a triangular shape that are 10 - 40 cm in size, are each supported on a petiole and provide a canopy to cover the flowers and fruit. The overall root system is generally shallow (usually penetrates top 30 cm of soil) with lateral roots extending further than the vine; however, a tap root can reach one meter deep. The cucumber plant produces three types of rough, yellow flowers, including a male or staminate flower, a female or pistillate flower, and a hermaphrodite flower with both male and female structures. The pistillate flower can be recognized by its thin pedicels; it also has a large ovary (immature fruit) at its base. The ovary has three chambers and is connected to short, thick stigma lobes. The staminate flower grows in clusters, and each flower is on a slender stem containing three stamens. Hermaphroditic flowers are able to produce round fruits. Regardless of the sex, the flowers are yellow with wrinkled petals.

Cucumber plants are naturally monoecious, meaning there are separate male and female flowers on the same plant. Gynoecious predominately produce female flowers, however, they will produce male flowers under conditions that include longer days, high temperatures, and light intense days. The seeds of both monoecious and gynoecious may be mixed for planting in the same area. Pollen is transferred by bees and other insects from the male to female flower. On commercial farms, gynoecious hybrids are more frequently used as they are more productive and develop earlier. The cucumber fruit is known as a “false berry.” It grows in either a round or triangular shape and is covered in a hard, thick outer rind. The fruit goes through two stages, immature and mature. During the immature stage, chlorophyll in the cells located under the fruit’s epidermis makes the rind green in color. In the mature stage, the rind changes to a yellow-white color and the epidermal layer may develop warty areas that form a trichomes (spiky hair). The fruit has three locules of soft tissue where the seeds are embedded. The cucumber fruit ranges in color from yellow, orange, white, and green. A regular cucumber contains seeds and can also be referred to as a seeded cucumber. Regular cucumbers have green stripes on a dark green skin with a rough surface and strong trichomes. They




are about 15-25 cm in length and uniformly cylindrical. English cucumbers are evenly green throughout and long in length (about 25-50 cm). The English cucumber is cylindrical in shape, with a short, narrow neck at the end of the stem, and contains either atrophic seeds that are barely identifiable or no seeds.



The cucumber plant is native to India and has been cultivated for more than 3000 years. In the United States, the



volume of cucumbers pickled is higher than any other vegetable; with 550,000 metric tons being produced each year. The 2012, United States Department of Agriculture data, showed the state of Georgia producing more cucumbers than any other state in the United States with 283.5 million pounds of cucumbers. Florida followed, producing 280.8 million pounds of cucumbers.

**Materials and Methods**

**Soil analysis:** I already collected five types of different soil

1) Type A: Soil of barren land	2) Type B: Road side area soil	3) Type C: Agricultural field soil of <i>Oryza sativa</i>
<p><b>Collected location:</b> Chandipur  <b>Latitude:</b> 22.45 <b>Longitude:</b> 86.98  <b>Common plants on that area</b>  <i>Eucalyptus sp</i>  <i>Alternanthera philoxcroides</i></p> 	<p><b>Collected location:</b> Chandipur  <b>Latitude:</b> 22.45 <b>Longitude:</b> 86.96  <b>Common plants on that area</b>  <i>Cynodon dactylon</i>  <i>Coccinia cordifolia</i>  <i>Tabernaemontana divaricata</i>  <i>Cyperus killyinga</i></p> 	<p><b>Collected location:</b> Chandipur  <b>Latitude:</b> 22.45  <b>Longitude:</b> 86.98  <b>Common plants on that area</b>  <i>Oryza sativa</i></p> 

4) Type D: Soil from edge of agricultural field	5) Type E: Rhizospheric soil of medicinal plant
<p><b>Collected location:</b> Chandipur  <b>Latitude:</b> 22.45 <b>Longitude:</b> 86.96  <b>Common plants on that area</b>  <i>Cynodon dactylon</i> <i>Alternanthera philoxcroides</i> <i>cyperus rotundus</i></p> 	<p><b>Collected location:</b> Chandipur  <b>Latitude:</b> 22.45 <b>Longitude:</b> 86.96  <b>Common plants on that area</b>  <i>Azadiracta Indica</i></p> 

Type F: Mixed soil	Type G: Mixed sterilization soil
 <p>After collecting 5 types of soil, 2kg of soil from each type has been mixed together to make 10kg mixed soil and then filled 1 kg of soil in 5 packets.</p>	 <p>After packing 5kg of mixed soil Additional 5kg of that soil is treated with formaldehyde (10% sol), Then after 72 hours it also repacked in 5 different packets. Sterilization Soil</p>

**Step 7:** Now, from those 7 types of soil 100gm of soil sample are taken from each type of soil and then each type of soil sample are examined in college laboratory for study of micorrhiza spore number. Again 2 times doing this work following this process. And then mean result micorrhiza spore calculated from each type of soil sample.

**Step 8:** Then 5 to 6 germinated seeds should be planted in all the potted packets.

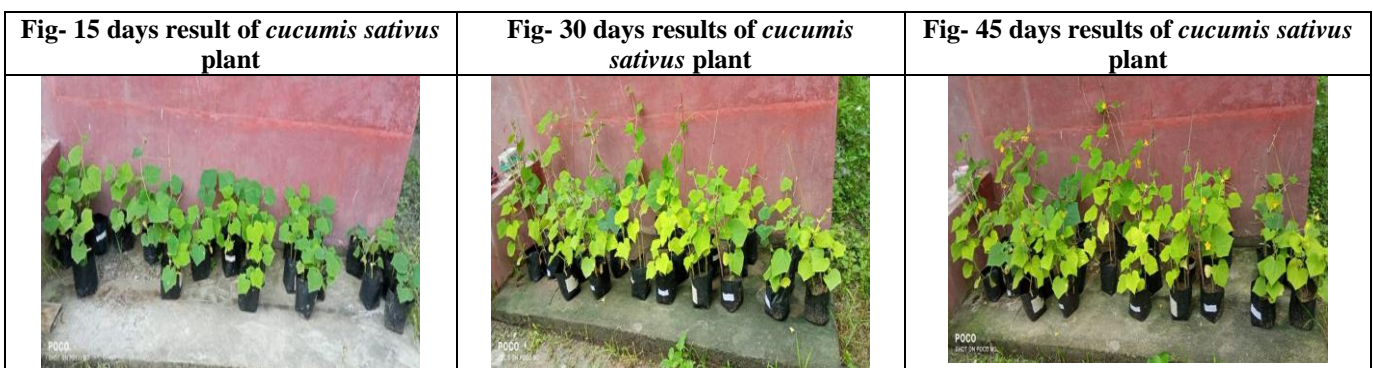


**Step 9:** After the seedlings, 2 or 3 relatively healthy tree should be left and the rest of the tree should be uprooted.



**Step 10:** After 15 days we have to determine the number of leaves, flowering, hight of each plants, leave area, and prepared date chart and result table from collected data. After 15 days we have to notice about physical aching of the plants and note down changed data respectively.

**Observation and Result**



**Table 1:** Observation record of cucumis sativus under different types of soil sample after 15 days collected date -15/6/17

Types of soil sample	Time	Pot number	Plant Hight (cm)	Number of leaves	Leaf area measurement
Agricultural field soil of Oryza sativa	0-15 days	1	10	3	31.44 cm
		2	13	4	38.77
		3	12	4	38.98
		4	12	4	45.99
		5	10	3	31.08
Soil of barren land	0-15 days	1	14	4	56.36

		2	13	4	57.17
		3	11	4	59.35
		4	10	3	49.05
		5	13	4	61.31
Rhizospheric soil of medicinal plant	0-15 days	1	11	4	28.62
		2	13	4	47.58
		3	11	4	47.42
		4	12	3	70.78
		5	12	4	51.75
Edge of agricultural field soil	0-15 days	1	15	4	50.05
		2	15	4	35.74
		3	17	5	51.25
		4	16	4	67.25
		5	17	5	30.25
Road side area soil	0-15 Days	1	17	5	56.06
		2	14	4	56.75
		3	16	4	63.00
		4	19	5	62.00
		5	17	4	46.04
Mixed soil	0-15 Days	1	10	3	43.65
		2	11	3	40.01
		3	10	3	32.45
		4	12	3	45.03
		5	13	4	34.54
Mixed sterilized soil	0-15 Days	1	10	3	39.12
		2	10	3	32.05
		3	12	4	30.55
		4	11	4	28.82
		5	11	3	31.75

**Table 2:** Observation record of Cucumis sativus under different types of soil sample after 30 days Collected Date -30/6/17

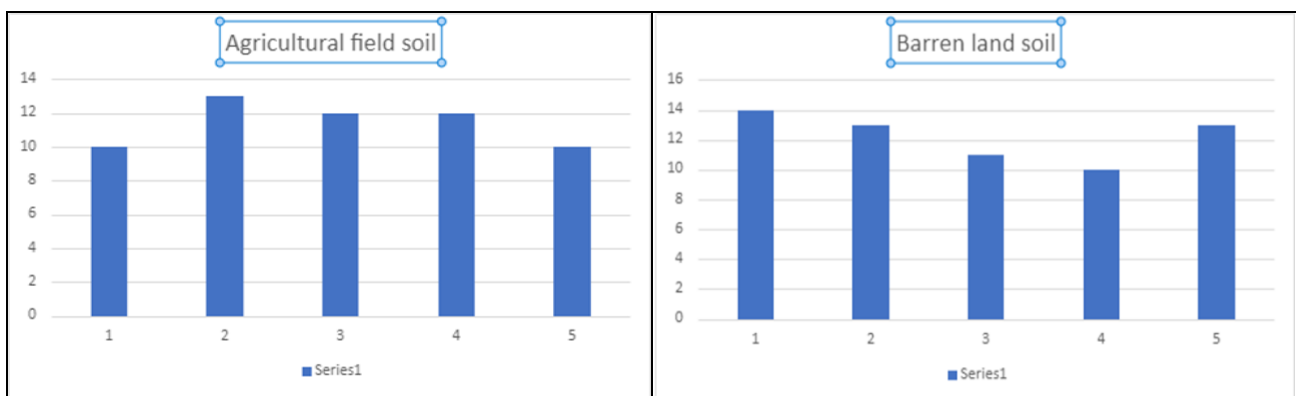
Type of soil sample	Time	Pot number	Plant height(cm)	Number of leaves	Flower	Measurement of leaf area
Agricultural field soil of Oryza sativa	15-30 days	1	20	5	1	55.6
		2	36	9	3	63.32
		3	33	7	0	64.8
		4	33	7	2	70
		5	30	8	0	64.1
Soil of barren land	15-30 days	1	45	8	4	67.85
		2	36	8	4	76.5
		3	36	6	2	83.75
		4	31	6	3	59.5
		5	37	8	3	82
Rhizospheric soil of medicinal plant	15-30 days	1	30	7	1	48.32
		2	39	7	3	71.82
		3	45	8	2	64.25
		4	68	10	4	82.25
		5	67	10	4	79.9
Edge of agricultural field soil	15-30 days	1	41	8	2	73.1
		2	43	8	3	67.3
		3	70	11	2	78
		4	40	8	4	82
		5	65	9	6	55
Road side area soil	15-30 days	1	47	10	3	73.5
		2	45	9	3	101.25
		3	42	9	1	101
		4	72	11	7	99
		5	43	8	2	67.5
Mixed soil	15-30 days	1	38	7	2	59.42
		2	20	6	0	54.61
		3	19	6	0	54.2
		4	39	7	2	64.57

		5	38	7	0	52.6
Mixed sterilized soil	15-30 days	1	20	7	0	74.5
		2	32	6	0	46.13
		3	38	8	0	74.7
		4	38	8	0	47.2
		5	36	8	0	55

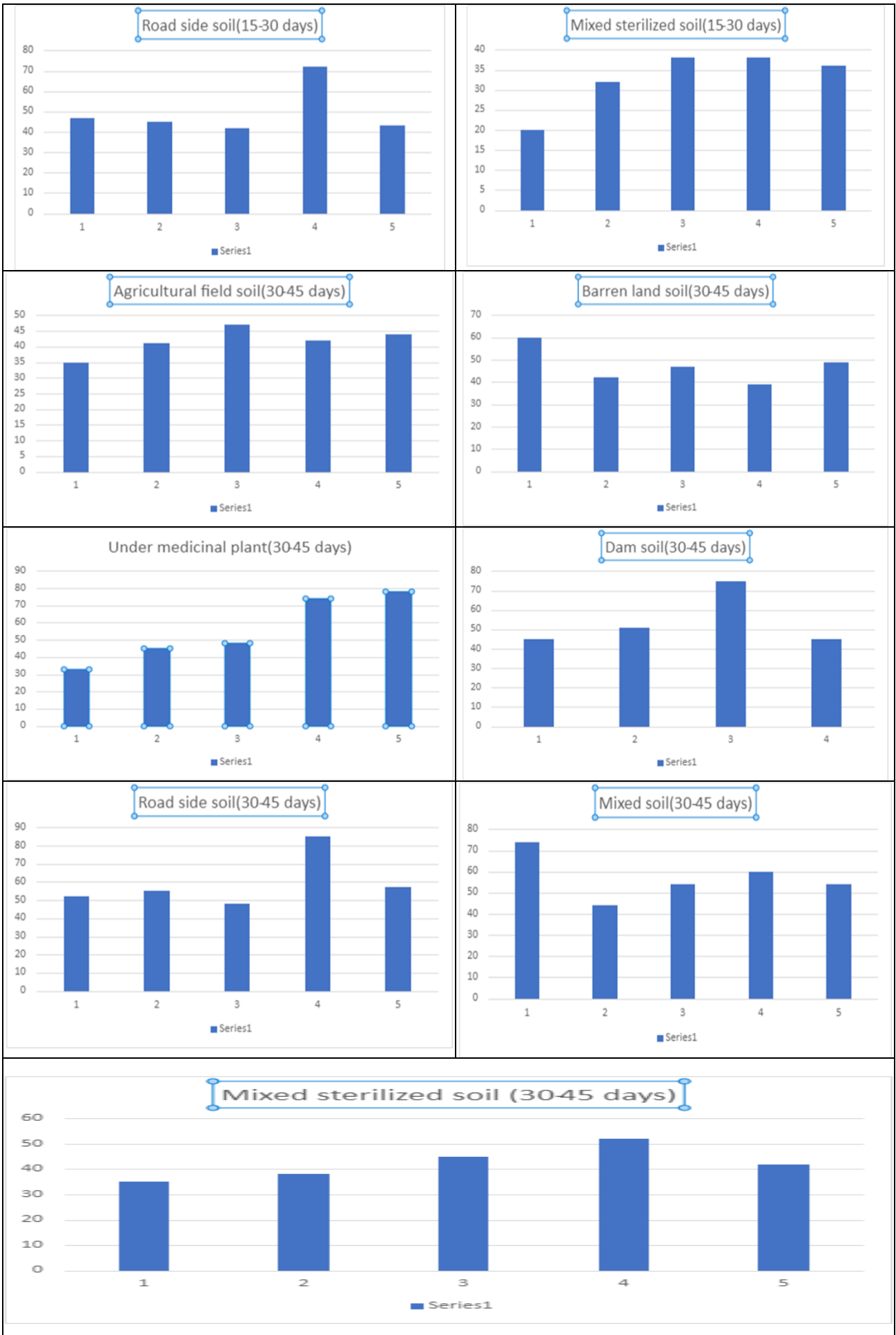
**Table 3:** Observation record of Cucumis sativus under different types of soil sample after 45 days Collected Date -15/7/17

Types of soil sample	Time	Pot number	Plant height (cm)	Number of leaves	Number of Flower	Number of Fruit	Measurement of leaf area
Agricultural field soil of Oryza sativa	30-45 days	1	35	9	9	2	59.5
		2	41	10	4	1	67.32
		3	47	10	6	1	75.4
		4	42	10	4	1	83
		5	44	10	4	2	75.1
Soil of barren land	30-45 days	1	60	10	5	2	72
		2	42	9	4	1	78
		3	47	8	4	0	90.5
		4	39	8	3	0	64.25
		5	49	9	7	2	86
Rhizospheric soil of medicinal plant	30-45 days	1	33	9	5	2	56.5
		2	45	8	4	2	76
		3	48	10	5	1	67.3
		4	74	11	3	1	92
		5	78	11	6	1	83.75
Edge of agricultural field soil	30-45 days	1	45	7	2	0	77
		2	51	9	6	1	71.82
		3	75	12	7	2	87
		4	45	8	6	2	92.25
		5	70	12	3	1	63
Road side area soil	30-45 days	1	52	11	8	3	92.5
		2	55	10	5	2	125
		3	48	10	5	1	115
		4	85	13	4	1	109.5
		5	57	11	10	4	93.9
Mixed soil	30-45 days	1	70	9	4	0	77
		2	44	8	6	4	65.02
		3	54	9	5	1	67
		4	60	10	5	1	74.5
		5	54	8	6	0	67.5
Mixed sterilized soil	30-45 days	1	35	8	6	2	94.5
		2	38	7	2	0	56.25
		3	45	10	0	0	86
		4	52	9	0	0	59.5
		5	42	8	2	0	67

**Graphical representation of plant growth based on recorded data base (height)**







**Table 1:** showing VAM spore number in 100 gm soil sample from different places

Soil sample	Plants present in the soil	VEM Spore no./100GM	Mean
1.Agricultural field soil of Oryza sativa	1)Oryza sativa	75	79
		78	
		85	
2)Barren land soil	1)Eucalyptus sp 2)Alternanthera philoxcroides	480	513
		520	
		540	
3. Rhizospheric soil of medicinal plant	1)Azadircta indica	170	182
		185	
		192	
4)Dam soil	1)Cynodon dactylon 2)Alternanthera philoxcroides	425	450
		455	
		472	
5)Road side soil	1)Cynodon dactylon 2)Coccinia cordifolia 3) Tabernaemontana divaricata 4)Cyperus killyinga	565	574
		574	
		585	
6)Mixed soil		79	359
		513	
		182	
		450	
		574	
7)Mixed sterilized soil		0	0
		0	
		0	

**Table 2:** Effect of VAM on the growth of *Cucumis sativus* under different types of soil sample

Soil types	Mean vam spore number	Mean plant height			Mean leaf number			Mean of avg. leaf area		
		15 days	30 days	45 days	15 days	30 days	45 days	15 days	30 days	45 days
1) Cultivating field soil	79	11.5	30.4	41.8	4	7	10	37.39	63.56	72.06
2) Barren land soil	513	12.2	37	47.4	4	7	9	56.73	73.92	78.15
3)Under medicinal plant soil	182	11.8	49.8	55.6	4	8	10	49.23	69.30	75.15
4)Dam soil	450	16	51.8	57.2	4	9	10	46.90	71.08	78.21
5)Road side soil	574	16.6	49.8	59.4	4	9	11	56.95	88.45	107.18
6)Mixed soil	359	11.2	28.8	57.2	3	6	9	39.20	57.08	70.20
7)Mixed sterilized soil	0	10.8	32.8	42.4	3	7	8	32.54	59.50	72.65

**Discussion**

Cucumber is the common name for a widely cultivated creeping vine, *cucumis sativus*, in the gourd family *cucurbitaceae*. The cucumber is a creeping vine that roots in the ground and grows up trellises or other supporting frames, wrapping around supports with thin, spiralling tendrils. The vine has large leaves that form a canopy over the fruits. The fruit of typical cultivars of cucumber is roughly cylindrical, but elongated with tapered ends and may be as large as 62 centimeters long and 10 centimeter in diameter. These fruits are rich in vitamin, calcium, Iron, Magnesium, Potassium, Phosphorus, Zine, Sodium and other mineral matter.

An *arbuscular mycorrhiza* is a type of mycorrhiza in which the symbiont fungus (AM fungi or AMF) penetrates the cortical cells of the roots of a vascular plant forming arbuscule mycorrhiza plays a significant role in sustainable agriculture has mutualistic symbiotic association with plant root. It increased nutrient (N,P,K,Fe and Zn) uptake was recorded with the inoculated plants.

We collected 5 types of soil from different place above mentioned by taking 7kg from each places. After collecting we remove 2kg from each soil sample and remain giving

5kg, we share 5 different polythene by giving 1kg to each. In this way we got 5\* 5=25 polythene. After that previous collected 2 kg soil from each sample we taking 1 kg from each and making 5 other sample, remaining 5kg we sterilized by 10% formaldehyde for 72 hours on covered by sack. After 72 hours we opened the sack and dry soil on sunlight. After that we get another 5 slide by 1 kg each polythene in this way we get total 35 slide.

After soil sample distribution in polythene. We germinate the selected seed. After germination we throw down 2-4 seeds in the each polythene and give proper water to each sample polythene.

After some days when the plants grow we remove extra plant we are given to grow. Now the sample are ready to be observed. The observed period should be 45 days. After 45 days later observed the plant of Road side soil and under medicinal plant soil growth very well. But the plant of agricultural soil and barren land soil and mixed sterilized soil not go properly. So, conclusion is that the amount of mycorrhiza is rich in soil of road side soil, under medicinal plant soil and dam soil so nutrient uptake are properly. The amount of mycorrhiza is low in agricultural plant soil, barren

land soil and mixed sterilized soil. So nutrient uptake are not so properly.

**Agricultural field soil of *Oryza sativa*:** Species found in the cultivating field where collecting the soil plant name are *Oryza sativa*. 79 spore are counted in the laboratory in this type of soil. And growth result of this type of soil, plant mean height 41.8, mean of leaf number 10, mean of avg. Leaf area 72.06.

**Barren land soil:** Species found in the barren land where collecting the soil plant name are *Eucalyptus* sp, *Alternanthera philoxroides*. 513 spore are counted in the laboratory in this type of soil. And growth result of this type of soil, plant mean height 47.4, mean of leaf number 9, mean of avg. leaf area 78.15.

**Rhizospheric soil of medicinal plant:** Species found in the under medicinal plant area where collecting the plant soil name is *Azadircta indica*. 182 spore are counted in laboratory in this type of soil. And growth result of this type of soil, plant mean height 55.6, mean of leaf number 10, mean of avg. Leaf number 75.15.

**Soil from edge of agricultural field:** Species found in the dam area where collecting the soil plant name are *Cynodon dactylon*, *Alternanthera philoxcroydes*. 450 spore are counted in laboratory in this type of soil. And growth result of this type of soil, plant mean height 57.2, mean leaf number 10, mean of avg. Leaf area 78.21.

**Road side area soil:** species found in the road side area where collecting the plant name is *Cynodon dactylon*, *coccinia cordifolia*, *Tabernaemontana divaecaata*, *Cyperus killyinga*. 574 spore are counted in laboratory in this type of soil. And growth result of this type of soil, plant mean height 59.4, mean of leaf number 11, mean of avg. Leaf area 107.18.

Mixed soil - 359 spore are counted in laboratory in this type of soil. And growth result of this type of soil, plant mean height 57.2 mean leaf number 9, mean of avg. leaf number 70.20.

**Mixed sterilized soil:** 0 spore are counted in laboratory in this type of soil. And growth result of this type of soil, plant mean height 42.4, mean leaf number 8, mean avg. Leaf area 72.65.

According to the upper showing table it is observed that growth of plant from various type of soil are not same. It is observed that some type of soil those contain low ammount of mycorrhiza spore but growth rate is higher then those soil which have more micorrhiza spore. Because of more nutrient present in those soil because of more nutrient present in those soil than those soil which contain more mycorrhiza spore.

### Conclusion

From the present study, it can be conclude that the effect of *arbuscular mycorrhiza* in germination, plant growth, number of leaf, leaf area, nodular number, fresh and dry weight of *cucumis sativus* (L) in different soil sample. The increase in amount of mycorrhiza led the germination percentage and plant growth and has a positive effect. The development of symbiosis between soil fungi Arbuscular

mycorrhiza (AM) and most terrestrial plants can be very beneficial to both partners and hence to the ecosystem. AM fungi are widely believed that the inoculation of AMF provides higher growth of the *Cucumis sativus* plants The symbiotic association of AMF is a classic example of mutualistic relationship, which can regulate the growth and development of plants. The mycelial network of fungi extends under the roots of the plant and promotes nutrient uptake that is otherwise not available. Presence of higher number of *mycorrhiza mycorrhizal* spore led to increased growth of the plants. Road side soil contained maximum number of mycorrhizal spore helps to attained higher height of the plants, leaf number and leaf area compared to others soil contained less number of mycorrhizal spores in soil. The increase of plant growth of cucumber gives a conclude to use AMF fungi as a tool to enhance plant biomass and growth of crops. Thus, it might be possible to use the mycorrhiza as a biofertilizer has a potential role in plant growth and development.

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