INTRODUCTION
I. INTRODUCTION

Cotton (Gossypium spp.) is the greatest industrial and chief fibre crop of the world. It ranks second to food plants in its usefulness to mankind. The utilization of cotton is directly related to the advancement of human civilization. As the needs of man, over the centuries multiplied several fold, the use of cotton also increased greatly. The lint fibre is used for clothing and in the manufacture of household and industrial articles. The cotton seed oil is edible and is used in the preparation of vanaspati. Cotton seed cake is a very good organic manure and is also used as cattle feed. In USA, the cotton seed flour is used in bread and biscuits making.

Gossypium hirsutum L. is the widely cultivated species of cotton in most of the cotton growing countries except a few countries like Egypt where G. barbadense L. is cultivated. There are a large number of hybrid varieties of G. hirsutum which are highly sought after by the farmers world over for their wide adaptability, variability of counts (6-60) and high yield. India has the largest area (8.9 million ha) under the cultivation of cotton (SICA, 1996) but its yield (224 kg/ha⁻¹) is the lowest in the world. During 1990-91, India produced 9.75 million bales of cotton but the consumption of the textile mills has gone up to 1.83 million tonnes. Though cotton crop responds well to nitrogen, phosphorus and potassium (N,P,K), inadequate fertilization is one of the main reasons for low cotton yields, especially in developing countries like India (Fageria et al., 1990). A sample survey of fertilizer practices in selected districts of various states in India showed that only seven to twenty per cent of irrigated area received fertilizers (Seshadri and Prasad, 1979). Though there is considerable scope of increasing cotton yield by improving fertilization, shortage and increasing costs of chemical fertilizers make the farmers very difficult to apply them even at the average rate.
This necessitated many farm scientists to find out an alternative to conventional farming to minimize the fertilizer requirements of a crop without any adverse effect on the promotion of plant growth. Organic farming is the alternative which relies heavily on the use of natural resources, biological processes and crop rotations. In organic farming, functioning of microorganisms, especially vesicular-arbuscular mycorrhizal (VAM) fungi, symbiotic and non-symbiotic nitrogen fixing bacteria, becomes a major component of nutrient cycling and plant growth (Wani et al., 1991) in contrast to conventional agriculture which bypass many of the beneficial activities of microorganisms.

Ninety per cent of the land plants form endomycorrhizal type of association with members of the family of Glomaceae of Zygomycetes (Morton, 1988). They are characterised by the production of vesicles and arbuscules within or outside the root cortical cells and thus, referred to as vesicular-arbuscular mycorrhizas (VAM) (Dangeard, 1900). The VAM association is particularly common in tropical trees, herbs and especially in crop plants. It is well known fact that N and P are two major plant nutrients and their deficiency causes limitations in plant growth (Dwivedi and Leela, 1993). Most of the P fertilizer is quickly converted into forms which are not available to plants. Thus, only 25 per cent of the P fertilizer is utilized by crops in the year of its application (Hayman et al., 1975a).

VAM fungi play a prominent part in P cycling and the uptake of P and also other mineral nutrients by the plants, from less fertile soil (Gianinazzi-Pearson and Gianinazzi, 1981). The rate of uptake of mycorrhizal roots is faster than non-mycorrhizal roots. The increase in absorption by mycorrhizal roots has been attributed to the increase in surface area for absorption. VAM fungi enhance water transport in plants (Safir et al., 1971, 1972), develop resistance in plants against drought and salinity (Safir et al., 1972), mineralize organic P (Jayachandran et al., 1992), increase level of cytokinins (Barea and
AzconAguilar, 1982) and reduce soil erosion and increase water holding capacity of the soil by increasing soil aggregation (Sutton and Sheppard, 1976).

Of all the non-symbiotic (free living) nitrogen fixating bacteria, *Azospirillum* is extensively studied for its plant growth promoting effect following inoculation. N fixation is naturally the first major property for the enhancement of plant growth by *Azospirillum* (Van Berkum and Bohlool, 1980). *A. brasilense* enhances the uptake of ammonium, P, iron etc. (Sarig et al., 1988). In *Azospirillum* inoculated plants, the extraction of soil moisture is greater and water is absorbed from deeper layers of the soil profile (Bashan, and Levanony, 1990). It produces several plant hormones, the major being indole-3-acetic acid (IAA) (Fallik et al., 1989).

Protection of the plants is of tremendous importance for a successful harvest of cotton which is attacked by viral, bacterial and fungal pathogens. Apart from these, insect pests and nematodes also cause great damage to the crop. Of all the fungal diseases, verticillium wilt, caused by *Verticillium dahliae*, is a major disease of cotton in many countries, including India, particularly in Tamil Nadu and Karnataka.

During 1991-92 the annual global losses of cotton yield were about 1.5 million bales worth more than 1 US $ billion. The disease becomes severe during the months of winter when the soil temperature gets reduced between 20 and 30°C. There are no chemical controls for verticillium wilt disease except for broad-spectrum biocides such as methan sodium and methyl bromide (Fravel and Roberts, 1991). Broad-spectrum biocides are expensive and sometimes create additional problems, since the pathogens easily invade areas of low biological diversity (Fravel and Roberts, 1991). Moreover the frequent use of chemical biocides not only pollutes the soil, but adversely affects the soil microflora.
VAM fungi are widely studied for suppressing the detrimental effects of root pathogens (Liu, 1995). Likewise several *Azospirillum* strains have the potential to produce bacteriocins that inhibit the entry of the pathogens (Negi et al., 1990) and by hastening the formation of lateral roots greatly help in controlling pathogens (Marimuthu, 1994).

Though VAM fungi and *Azospirillum* are reported to promote plant growth and increase disease resistance against root pathogens in various plant species, the study on their role on plant growth and development of disease resistance against verticillium wilt in cotton is very scanty. The present investigation was taken up with the following two main objectives.

1. To study the effect of *Glomus geosporum* (Nicol. and Gerd.) Walker and *Azospirillum brasiliense* Tarrand, Krieg and Dobereiner, individually and in combination on the growth and nutrient status of cotton.

2. To elucidate the potential of *G. geosporum* and *A. brasiliense* as biocontrol agents against verticillium wilt of cotton, caused by *Verticillium dahliae* Kleb.