INTRODUCTION
Paddy is one of the important crops in the world. More than half of the four billion people on the earth depend on rice as their staple food. It is widely dispersed over the world in a broad range of 15° N to 40°S and in areas from sea level to altitudes of more than 2,500 m above mean sea level. Paddy evolved in the humid tropics as a semi aquatic plant. Paddy is the major food crop in south and south-east Asia, and Asia has the unique feature of producing nearly 90% of the world's rice crop. Cultivation of rice has been known in India from about 2000 BC. Among Asian paddy growing countries, India stands first in rice crop area. In India, rice is cultivated in an area of about 36 million hectares. Owing to scientific developments and modern agricultural practices, rice yield in India has increased several folds in recent years.

Paddy is successfully grown in lands which provide sufficient water for 3 to 6 months during the cultivation period. The principal biological consequences of waterlogging are the suppression of changes of mesophytic vegetation in soil microflora and the growth of several forms of algae (Venkataraman, 1972). It is known that rice field provides all necessary requirements like light, water and nutrients for the growth of algae. The growth and
activity of algae in submerged soil is of great importance, specially of blue green algae which are favoured by rice field ecosystems. Blue green algae are known for their world wide distribution. The earliest known record of algae on soil was that of Paracelices, an ancient Greek, who described an alga, probably a species of Nostoc (Metting, 1981). Briscoe & Roach (1927) carried out the earliest detailed studies on soil algae. According to him, the blue green algal flora varies from habitat to habitat and even within different areas of the same habitat with marked seasonal fluctuations in the flora. Paddy field ecology has been studied less than that of heterotrophic micro-organisms (bacteria) and that is why in the recent years interest is focused predominantly on rice fields (Parkinson et al., 1972).

Certain rice field algae serve as soil conditioners (Griffin and Kees, 1956) and supply growth substances which are beneficial to rice plants (Whitton, 1965; Venkataraman and Neelakantan, 1967; Mistustin and Shitnikova, 1971; Watanabe and Roger, 1984; Kotle and Goyal, 1986). The biological properties of nitrogen fixing blue green algae is of considerable importance in tropical soils such as India (Venkataraman, 1972). Based on the extended study De (1939) and Singh (1942) have recommended certain nitrogen fixing blue green algae as biofertilizers. The potentiality of these

Paddy field algal studies have been made from various parts of the globe. Lee (1939) and Singh (1942) have given an account of distribution of nitrogen fixing blue green algae from different parts of the world. A number of studies have been made since then. Few important ones are those of Watanabe (1959) and Kobayashi et al. (1967) in Japan; Bunt (1961) in North Australia; Prikhodkova (1971) in Russia; Junoto (1973) in Indonesia; Yoshida et al. (1973) in Philippines and Reynaud and Roger (1978) who recorded the distribution of nitrogen fixing blue green algae in Senegal.

In India, first report on paddy field algae was made by Banerji (1935) on paddy field soil algal flora of Bengal. This was followed by Singh (1939) who studied algal flora of rice fields of four districts of Uttar Pradesh; Gonzalves and Gangla (1949) on the paddy field algae of suburbs of Bombay; Khan (1957) on soil algae from paddy fields of Kashmir; Pandey (1965a and b) on the paddy field soils of

Blue green algae are abundantly found in tropical paddy fields. De (1939) attributed high fertility of paddy field soils for the abundant growth of blue green algae in them. By 1985, a total of 330 species of heterocystous members were recorded, out of 800 taxa of blue green algae belonging to 70 genera, from Indian soils and paddy field soils (Bongale and Bharati, 1985). After mass cultivation and inoculation in paddy fields, blue green algae have been successfully used as biofertilizers by many workers like Watanabe (1959), Subramanyan (1972), Fay and Kulasoooriya (1973), Venkataraman (1972, 1975 and 1979), Thomas (1973) and Kannaiyan et al. (1980). Several reviews regarding the blue green algal biomass have been made by Fogg (1959), Singh (1961), Shields and Durrell (1964), Lund (1962 and 1969), Venkataraman (1972), Stewart (1973), Roger and Kulasoooriya (1980), Metting (1981), Roger et al. (1986) and Singh and Bisoyi (1989). It has been estimated that artificially produced blue green algal blooms contribute over 48 Kg N/ha/crop in Uttar Pradesh (Singh, 1982; Bisoyi and Singh, 1988). When inoculated with indigenous strains, Bisoyi and Singh (1988), observed increased inoculum production by more than 10 times as compared to uninoculated plot. Reynaud and Metting (1988), who studied establishment of 23 strains, found that the strain
that significantly developed was a local isolate of Nostoc. For successful algalization, fresh forms of blue green algal inoculum is important. In a field study fresh form of inoculum (100 Kg/ha) was compared with dry form of inoculum (10 Kg/ha) and it was observed that the fresh form produced higher biomass (Singh and Singh, 1987).

Modern agriculture requires enormous input of nitrogenous fertilizers. As the blue green algae probably account for about one-half of the total amount of nitrogen fixed annually, much attention is now being given to micro organisms. The blue green algae are particularly of great importance because of their unique combination of an oxygenic photosynthesis and the fundamentally anaerobic process of nitrogen fixation and, therefore, could be used as a source of nitrogenous biofertilizer.

Venkataraman (1975) emphasized the importance of native algal strains in a successful algalization program. Accordingly in the present study, three strains of BCA viz., Nostoc ellipsosporum Rabenh, Anabaena iyengarii Bharadwaj v. unispora Singh, and Hapalosiphon welwitschii West & West were isolated from the soils of Dharwad.
Certain agricultural chemicals such as herbicides, pesticides and fungicides are being used to protect the crop from pests and diseases. To certain extent these chemicals affect the existence of soil microorganisms. Therefore tolerance of nitrogen fixing blue green algae to such compounds is of great practical value for their survival in soil. Effect of pesticides and herbicides on nitrogen fixing blue green algae has been studied by many workers like Inger (1970), Hamdi et al. (1970), Venkataraman and Rajyalakshmi (1971 a and b), Ahmed and Venkataraman (1973), Feung et al. (1974), Mamma and Hamilton (1974), De Silva et al. (1975), Das and Singh (1977, 1978 and 1979), Kar and Singh (1978 and 1979), Sharma and Gaur (1980), Khalil et al. (1980), Subramanian and Shanmugasundaram (1986) and Singh (1990). Similarly effect of fungicide on nitrogen fixing blue green algae has been studied by Gangawane (1980), Gangawane and Saler (1979), Angadi (1982) and Giriyappanavar (1988). Depending upon the nature and concentration of the chemicals, their effect may be stimulatory (Ahmed and Venkataraman, 1973) or inhibitory (Venkataraman and Rajyalakshmi, 1971) to BGA. Detailed experiments conducted at Central Rice Research Institute (Singh and Bisoyi, 1989) indicated that Cytrolane (an organophosphate pesticide) at 2.5 Kg a i /ha encouraged the growth and nitrogen yield of Aulosira sp.
In a laboratory study, Furadon even at 25 ppm concentration stimulated the growth and nitrogen fixation by *Nostoc muscorum* (Kar and Singh, 1978). The toxicity of insecticide decreased with the incubation period which suggests detoxication of the insecticide by blue green algae (Das and Singh, 1977; Kar and Singh, 1979). However, Diabinon at 1 Kg a.i/ha decreased the growth of *Aulosira* sp. Gamaxena and BHC were found to be algicidal to various bloom forming blue green algae at 10 ppm (Das and Singh, 1978 and 1979).

In the present study, it was felt necessary to find the effect of certain commonly used insecticides and pesticides on the growth, heterocyst frequency and nitrogen fixation of *Nostoc ellipsosporum*, *Anabaena iyengarii* var. *unispora* and *Hapalosiphon welwitschii*.

These studies are presented as follows:

1. Selection of medium

2. Nitrogen fixation by *N. ellipsosporum*, *A. iyengarii*, *v. unispora* and *H. welwitschii*.

3. Effect of pH on the growth, heterocyst frequency and nitrogen fixation by *N. ellipsosporum*, *A. iyengarii* *v. unispora* and *H. welwitschii*.

4. Effect of fungicide on the growth, heterocyst frequency and nitrogen fixation by *N. ellipsosporum*, *A. iyengarii* *v. unispora* and *H. welwitschii*. 
5. Effect of pesticide on the growth, heterocyst frequency and nitrogen fixation by *N. ellipsosporum*, *A. syngarri* v. *unispore* and *H. welwitschi*.

Although reports on soil algae of Karnataka State have been made by Bongale (1975 and 1988), Angadi (1982) and Yashovarma (1985), studies on paddy field algae of Dharwad appears to be scanty. Earlier studies were restricted only to Dharwad proper and Hangal Taluka of Dharwad district. In view of this, a detailed exploratory study of soil algae of the paddy fields in the wet zone of Dharwad district was undertaken. Further, since studies on the natural algal flora of paddy fields during growth of paddy are comparatively few (Singh, 1961; Pandey, 1965 a and b; Tiwari, 1972; Watanabe and Lee 1977; Whitton, 1984; Singh, 1985; Begum et al., 1988), a detailed ecological study of algae occurring in four rice fields of two villages of Dharwad has been carried out.