CHAPTER I

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L) Lam.) is a versatile crop grown throughout the tropics and in warmer temperate countries for its edible tubers. It can be grown on a wide range of soils, but sandy loams reasonably high in organic matter with permeable subsoil are ideal. The crop is grown from 40^0 N to 32^0 S latitude and from sea level up to 2100 m altitude under a wide range of temperature, the optimum being 24^0 C. It requires a minimum of 500 mm rain and an annual rainfall of 750 to 1000 mm would be quite appropriate for the crop (Nair, 1997).

Sweet potato has the capability to produce the highest amount of calories per unit area and time in comparison to cereals and other root and tuber crops (Ilangantileke, 1997). It is the world's seventh most important food crop after wheat, rice, maize, potato, barley and cassava. It has manifold uses, ranging from consumption of fresh roots or leaves to processing into animal feed, starch, flour, candy, and alcohol. In the global scenario, greater than 80 per cent of area under sweet potato cultivation and production is occupied by the Asian countries. In India, sweet potato is grown in an area of 0.14 million hectares and has an annual production of 1.13 million tons and productivity of 8.07 t ha^{-1} (FAI, 1997).

Viewed at the global level, the productivity of sweet potato in India is only about 50 per cent that of world average and about 35 to 40 per cent that of China and Japan. In India major sweet potato producing states are Orissa, Uttar Pradesh and Bihar. In West Bengal, it is grown only to a limited extent in certain areas and does not find a place in the prevailing cropping system of the state. In the South Gangetic plains, rice in 'Kharif' (rainy) season followed by potato in 'Rabi' (winter) season is the existing cropping system. However, lack of storage facilities for potato tubers and high cost of cultivation has made this system often economically non-viable. Sweet potato has the potential to replace potato in such a case. It is, however, pertinent to identify the ideal time of planting of the crop in a new area prior to its introduction. The crop in India is grown utilizing the monsoon rains during Kharif and with supplemental irrigation during Rabi. Investigations carried out in different parts of the country on optimum time of planting revealed that planting of sweet potato in late September or early October would be ideal (Shanmugavelu *et al.*, 1972). However, when grown during the above said period, which gets few rains, irrigation to the crop becomes quite essential. It has been reported that irrigation would generally increase yields and improve the grade and quality of tubers.

It is expected that with proper nutritional management and adoption of improved agro-techniques, the production could be substantially augmented (Ravindran, 1997). However, in the pursuit of enhancing the production, indiscriminate use of chemical fertilizers may lead to the depletion of bio-essential nutrients from the soil. Intensive cropping systems with high yielding and fertilizer responsive crop varieties require high amount of nutrients which are removed in large amounts from the soil pool. A judicious, combined application of organic and inorganic sources (chemical fertilizers) is therefore essential for increasing tuber yields as well as for sustaining the productivity of the soil. Such organic materials improve the physical condition and may regulate the release of nutrients for plant growth, thus, increasing fertilizer use efficiency (Tisdale *et al.*, 1990).

Organic source of soil fertilization in the form of farm yard manure (FYM) is a well documented and widely accepted practice. However, its unavailability and increasing cost warrants the use of alternative and cheap organic materials for soil remediation. Some such materials, if used as soil conditioners (amendments and enrichment), may prove to be advantageous from both agricultural and environmental points of view. Paper factory sludge (PFS), an organic waste from paper factory is usually dumped as wastes in lagoons near the vicinity of the factory in large quantities, which often leads to environmental problems. Due to the high content of organic matter (cellulose) in paper sludge, composting and land application are viable alternatives to disposal (Bellamy *et al.*, 1995). Further, this sludge is rich in calcium and organic constituents and hence is potential soil conditioner. The paper mills located in the acid soil region of Assam, Nagaland, West Bengal, Orissa, Madhya Pradesh and Andhra Pradesh produce 182 thousand tons of PFS annually which could be used for amending acid soils around the paper mills (Panda, 1998). Besides enriching the soil with organic matter, it has the capability to enhance water holding capacity and improve soil structure and bulk density, as observed by Zhang *et al.*, (1993). The potential of PFS as a viable alternative to FYM is thus quite a feasible proposition worthy to be explored.

Acid soils in India occupy about 30 per cent of the cultivated area, which have been formed due to drastic weathering associated with hot humid climate and heavy precipitation. Laterization, podzolization, intense leaching of bases and accumulation of undecomposed organic matter under marshy condition contribute to acidity. Nutrient imbalance caused by the low pH of acid soils is the main reason for its low productivity. Availability of most of the essential major and micronutrients are inherently low under such soil condition. Management of acid soils should aim at realization of production potential either by addition of amendments or to manipulate agricultural practices to obtain optimum crop yield under acidic condition. Application of lime as amendment to neutralize the soil acidity is the common and traditional practice. Liming improves the base status, inactivates Fe, Mn and Al in soil solution reduces phosphorous fixation and stimulates microbial activity in soil. However, lime requirement of acid soils in India is very high and the effect of liming does not last long due to leaching losses and its use becomes cost prohibitive.

Alternative measures, therefore, have to be found and reports in the recent past on this aspect suggest the potential of fly ash as a soil amendment for correcting soil acidity. Fly ash (FA) is a waste material generated during the combustion of coal in thermal power plants. It is chemically a ferroaluminosilicate and a major solid waste of the industrial area, particularly of thermal power plants. It is finely divided residue resulting from the combustion of pulverized bituminous coal or sub-bituminous coal (lignite) in the coal furnaces and consists of organic mineral constituents of coal and organic matter, which is not fully burnt (Vimalkumar, 1995). At present, there are 70 thermal power plants in India, producing about 60 million tones of FA annually. This figure is likely to touch 100 million tones by 2000 AD if a 10 per cent annual growth in thermal power generation is considered. However, hardly 5 per cent of FA generated in the country are used for gainful applications like manufacture of bricks, road embankments, mine fills etc. Of late, use of FA in agriculture is gaining popularity due to its manifold beneficial effects. Fly ash is a rich source of plant nutrients. The major elements in order of decreasing abundance are Si, Al, Fe, Ca, C, Mg, K, Na, S, Ti and P. Some of the trace elements present in FA are As, B, Cd, Pb, Mo, Ni, Se and Zn. Several reports indicate that soil-fly ash mixtures tend to have lower bulk density, higher water holding capacity, lower hydraulic conductivity and lower moduli of rupture than soil alone. A high pH range of 8.0 to 12.8 in FA was reported by Aitken *et al.*, (1984) and its effectiveness in increasing crop yields has been reported by several workers. These physico-chemical properties of FA indicates its richness in nutrient resources and potential as a soil amendment that could be an alternative to lime.

Another possible alternative to lime is rice husk ash (RHA) which is a waste product from rice mills. Use of this ash in agriculture is an old practice but scientific information on its use as a soil amendment in acid lateritic soil is limited. Being an ash derived directly from plant source, it has all naturally occurring elements that are present in the plants. Rice husk ash is alkaline in nature (pH>7.5) and with its adequate content of essential and trace elements, it could be used in acid lateritic soil as a soil amendment/conditioner.

Taking into account the potential of these industrial wastes in correcting and maintaining the soil health, an integrated approach in nutrient management has been envisaged to increase the production of sweet potato in the acid lateritic belt of Southern Gangetic plains of West Bengal, which is a non-traditional area for the crop. Following were the major objectives of the study.

- To identify the proper time of planting of sweet potato under different soil fertilization

- To study the soil-crop-water interactions and the influence of major and micronutrients on sweet potato
- To investigate the efficacy of industrial wastes like fly ash, rice husk ash and paper factory sludge as soil amendments and their influence on heavy metal uptake by plants and accumulation in soil
- To study the growth pattern, development, yield and quality of sweet potato in fly ash treated soil