Introduction

Remote Sensing of crops from space borne platforms has a significant role in the assessment of crop condition and productivity, because remote sensing techniques offer the advantage of integrating large samples of crop in a short time. Hence spectral sensing of crop plants has been attempted by many investigators (Baret et al., 1988; Carter, 1993). But such radiometric investigations have not so far been conducted on jojoba (Simmondsia chinensis (Link) Schneid.). It is a Mexican woody desert dioecious shrub of Buxaceae with remarkable energy conversion efficiency (ECE) in building up, in seeds, a unique non-triglyceride liquid wax of high energy content. It was introduced in India in early seventies on sandy soils in arid zone of Rajasthan, semi-arid zone in Bhavnagar district in Gujarat and in late eighties in coastal sandy soils in partially semi-arid zone of Visakhapatnam district in Andhra Pradesh. Also the knowledge on the effect of salinity stress on spectral responses of plants will be useful in non-destructive assessment of the performance of the crop. Therefore, an attempt is made in the present investigation to relate spectral reflectance, leaf Area Index (LAI), chlorophyll content and age, as effected by salinity stress in jojoba.

Material and Methods

Nine months old seedlings of jojoba, raised in polyplots with fresh water, were transplanted into the coastal dune sand in Visakhapatnam...
district in East Coast of India at a spacing of 2.0 x 2.0 m. Eighteen plants, in three rows of six each, were subjected to sea water treatment of three different concentrations of salinity at 5, 7.5 and 10 PSU. As the experimental plots were contiguous to sea shore, the sea water was brought and was diluted to required concentrations just before treatment. Control plants, irrigated with non-saline water were also maintained. Two litres of water of required salinity were applied to each plant once in a week during monsoon and twice in a week during non-monsoon months.

Spectral reflectance in the visible bands 1 and 2 (450-520 nm and 520-590 nm) and near infrared bands 3 and 4 (620-680 nm and 770-860 nm) was measured using portable field radiometer operating in bands similar to those of Indian Remote Sensing Satellite LISS cameras. Radiance data were collected at three different growth stages of jojoba, (a) One and half years after transplantation or 27 months old plants, (b) Two years after transplantation or 33 months old plants and (c) Two and half years after transplantation or 39 months old plants.

Measurements were taken from eight plants for each treatment between 0930 and 1100 hours, and 1330 and 1500 hours IST in direct sunlight under cloudless sky keeping the radiometer at two metres height from the plant canopies normal to the ground surface. Percentage of reflectance value from barium sulphate panel was taken after each measurement. Correlation coefficient between reflectance values of chlorophyll absorptance and reflectance bands was arrived at. LAI was measured following the procedure of Weigand et al. (1979) and correlated with reflectance.

To minimize the effect of soil background and to increase the contrast between soil and vegetation, red and infrared reflectances were correlated using the vegetation indices (VIs). Chlorophyll a and b were estimated in the leaves spectrophotometrically in the laboratory using Holden's formula (Holden, 1974).

**Result and Discussion**

**Reflectance and Wave Length Interval (WLI)**

A minimum reflectance of less than 25 per cent was obtained from jojoba canopy at bands 1 and 2 corresponding to 450 nm and 590 nm (Fig. 1), due to the absorbance of 70 to 90 per cent of electromagnetic spectrum in blue and red bands. The visible light absorbance region is dominated by plant pigments chlorophyll a at 430 nm, Chlorophyll b at 450 and 650 nm and also by carotenes and xanthophylls (Myers, 1974). Nevertheless, once a chlorophyll molecule is excited by energy of a specific wavelength, about 30% of absorbed radiation is emitted as fluorescence in red and infrared regions (Myers, 1974). The present investigation shows that increased reflectance occurs in infrared with increasing chlorophyll concentration as also reported by Baret et al. (1988) and Clevers (1991). In both male and female plants of jojoba, reflectance increased from 20 to 25% at 550 nm (band 2) to more or less 50% at 860 nm (band 4) (Figs. 1 & 2).

Spectral responses are found to have crop specific relationship which changes with age (Ajai et al., 1984; Baret et al., 1988 and Clevers, 1991). Moreover reflectance characteristics of a crop indicate its growth and condition. The present results reveal that reflectance values at different ages of jojoba follow a similar pattern. At all WLIs male plants have greater reflectance than females (Figs. 1 & 2). The reflectance at band 1 dominated by blue is less than that band 2 dominated by green at 27 months. A reverse trend was observed at 33 and 39 months especially in male plants. As the plant becomes older, IR (band 4) reflectance decreases in both male and females, whereas a reverse trend was observed at band 3. A similar trend was recorded in cereals (Ajai et al., 1984; Clevers, 1991), due to yellowing and senscence. In the evergreen shrub jojoba, it is probably due to widening of canopy resulting in more soil reflectance through inter foliar spaces. Jojoba shows high sensitiveness at WLIs 620-680 and 770-860 nm.