INTRODUCTION
**Solanum** is one of the largest genera of the family Solanaceae and consists of over 1700 species (Willis, 1966) distributed all over the world. Some of the species of this genus have great commercial and medicinal importance as they contain alkaloids. Alkaloids function in the (a) protection of the plants by herbivorous animals and insects, (b) detoxification reactions and (c) regulation of plant growth (James, 1950). The application of steroid hormones on germination, growth, flowering and sex expression of plants also exists in the literature (Helfmann, 1975). The plant *Solanum khasianum* Clarke has acquired an added importance in recent years as its berries contain much needed glyco-alkaloid solasodine (Sato et al. 1951). Solasodine was first reported in the berries of *Solanum sodomaeum* by Oddo (1929) since then a survey of the occurrence of the glyco-alkaloids in 264 species of this group identified nearly 100 species containing solasodine as aglycone (Schreiber, 1968; Mann, 1978). Solasodine is an important basic raw material for the synthesis of cortisones and other steroidal drugs. The increasing application of these drugs in the treatment of patients with Addison's disease, rheumatic arthritis, chronic cases of asthma, leukaemia, obesity, palsy psoriasis and as an
anabolic agent have motivated research in the synthesis of these hormonal steroids. The solasodine is also used for the production of oral contraceptive pills, and hence it has an immense value in family planning programmes. Solasodine is not manufactured in India in an adequate quantity due to want of a commercially profitable source. The imported solasodine costs about Rs.250/- per gram in the Indian market. An acute shortage of the raw material and enhanced demand for berries by a number of pharmaceutical industries have become very important incentives to increase the present production. Since 1947, (Marker et al.), diosgenin was used commercially for the production of cortico-steroid hormones and it still exists (Fleming, 1970; Sharma et al. 1971) but the commercial cultivation of Dioscorea plant is not encouraging due to the stringent climatic conditions (Abrol and Kapoor, 1962) and large investment involved in staking the plants with no profit even in three years because of slow growth and delayed maturity of the tubers. This deficiency has further added to the existing shortage of the raw material. As solasodine is a nitrogen analogue of diosgenin, it can be converted into a key intermediate compound 3 \( \beta \) acetoxy pregnane-5,16-diene 20 one (Sato et al. 1959; Fakih and Ramied, 1964) whose hormonal derivatives form the active
ingredients of the contraceptive pills. In addition, steps required for chemical modification of solasodine and diosgenin to prepare various hormonal steroids are also same. Therefore, the solasodine can be a good replacement for diminishing supplies of diosgenin under existing critical conditions. Among the 50 different species of *Solanum* growing in India, *Solanum khasianum* Clarke is amenable to successful cultivation over a wide range of soils and being rich source of solasodine (Sengupta, 1961; Maiti et al. 1964; Saini, 1966; Bahadur and Dayal, 1968; Kaul and Atal, 1978; Chaudhuri and Rao, 1964), this has encouraged the investigations to obtain improved varieties of this plant in recent years (Kaul and Zutshi, 1976; Ram, 1978; Hazarika et al. 1978) in terms of yield of berries as well as solasodine content. Crop productivity is the function of fully integrated system involving the processes of growth and development. For normal growth and development, certain regulatory mechanisms are necessary. The use of vitamins to regulate plant growth has yielded positive results (Ovcharov, 1958; Murty et al. 1967; Mehta, 1976; Chinooy et al. 1979). Ascorbic acid is an important and universal constituent of the plant redox system. It has been found that ascorbic acid turnover plays an important role during the life cycle of a plant and has a great
bearing on the growth, development, metabolic state and finally the productivity (Chinoy, 1962; Chinoy et al. 1970; Abraham et al. 1969; Saxena et al. 1969; Chinoy and Saxena, 1978). The physiological variations of the solasodine content during plant development is a subject of great interest. The amount of solasodine varies during berry development depending on the climatic and edaphic conditions and maturity of fruits. The amount is generally reported to be maximum in the fully grown mature berries (Chaudhuri and Hazarika, 1966; Bakshi and Hamied, 1971; Chandra et al. 1970). The content of solasodine disappears on fruit ripening (Saini et al. 1965; Kaul, 1976). The observations on the growth and glyco alkaloid content of Solanum khasianum have been described by Saini et al. (1965) and reported that fruits accumulate as much as 7.6% glyco-alkaloid content of their dry weight after about 50-55 days of their development. Khanna and Murty (1972) have observed that alkaloid production in S. khasianum during different stages of maturity strongly depends on the effects of the environmental interaction and its high alkaloid content is normally associated with low yield (Khanna and Murty, 1974). Chaudhuri and Chatterjee (1979a) have studied the influence of altitude and sucrose feeding on solasodine content and found an increase on sucrose feeding which was plant age dependent. The
flowering, fruiting and solasodine content increased when gibberellic acid was fed to the plants (Chaudhuri and Chatterjee, 1979 b). The effect of temperature (Saini and Biswas, 1967; Kaul and Zutshi, 1976), different sowing dates (Saini and Biswas, 1967), locality and other factors (Saini et al. 1965) on the solasodine content have also been studied. Much variation in the concentrations of solasodine in the fruit also exists (Maity et al. 1964, 1965; Saini, 1966; Bakshi and Ramied, 1964, 1971; Telek, 1977). The glyco-alkaloid is localized in the gelatinous mass covering the seed surface in the fruit and a direct correlation has been reported between the number of seeds in a fruit and the solasodine content (Saini, 1965, 1966). Mukherjee et al. (1968) have studied the increase in flowers and fruits by gibberellic acid treatment. According to Datta et al. (1973) the increase in solasodine content is due to the use of lower concentrations of phloridzin (1 mg/l) as foliar spray while higher concentrations (1000 mg/l) stimulate the plant height, leaf number and yield of berries. Intensive work has been done on cultivation (Koy, 1977; Kaul and Atal, 1978; Chandra and Srivastava, 1978; Singh and Rawat, 1978); genetics (Bhatt, 1972; Kaul and Zutshi, 1974; Pingle and Nynansagar, 1976; Heble and Bhatt, 1976; Chauhan et al. 1975, 1976; Janski
Ammal and Bhatt, 1970; Khanna and Murty, 1972; Singh et al., 1978), agronomy (Ram, 1978; Hazarika et al., 1978), tissue culture (Khanna et al., 1976; Kokate and Radwan, 1978; Aminuddin, 1978; Chaturvedi and Sinha, 1979) and pathology (Bordoloi et al., 1971; Verma et al., 1972; Upadhyay and Bordoloi, 1977; Majumdar et al., 1977; Zaidi et al., 1978; Waseem et al., 1979; Gupta et al., 1979) but no information is available to understand the systematic fluctuations in the solasodine content during floral and berry development and its interrelationship to other metabolic reactions. However, it demands a great physiological attention. Enzymes catalyse a number of chemical reactions and their actions are expressed during the growth, development and maturity of the organism. Improved growth and development are due to pivotal functioning of the important enzymes involved directly or indirectly in energy transfer, mobilization of food reserves and other metabolic activities. Peroxidase enzyme plays a key role in growth and differentiation by its involvement in a large number of biochemical reactions (Kenton and Mann, 1950; McCune, 1961; Fruton and Simmonds, 1963; Alexander, 1964; Yip, 1964; Galston et al., 1968). Altman et al. (1966) pointed out a positive correlation between the rate of respiration and the activities of catalase and peroxidase. Many workers have demonstrated the formation of free radical of ascorbic
acid (Piette et al. 1961; Yamazaki, 1962; Chinoy et al. 1969; Chinoy et al. 1974) and also as catalyzed by a specific enzyme ascorbic acid free radical peroxidase (Gurevich, 1963; Chinoy, 1969; Guruurthi, 1971; Ghesani, 1972; Shah, 1973). An enhanced activity of hydrolytic enzymes viz. protease, invertase, amylase etc. at the same time results in early germination, better growth and productivity (Saxena et al. 1969; Black, 1970; Chng, 1972; Chinoy and Saxena, 1972; Mehta, 1978). The maximum rate of hydrolysis of the stored proteins coincides with the maximum growth. An increase in the protein content takes place during certain stages of growth e.g. at the time of flowering (Kursanov and Gryshkova, 1940; Chinoy, 1967). Mitra and Sen (1966) observed retardation in flowering by using inhibitors of protein synthesis. Increased protein content is correlated with the increased metabolic activity of cells (Brown et al. 1952). Josef et al. (1966) have shown an increased protein synthesis towards maturity in Phaseolus vulgaris. Carbohydrates are the principal substrates utilized during plant growth and development. The rate of carbohydrate metabolism is mainly determined by the developmental stages of plant and its flow also depends on the velocities of the hydrolytic enzymes such as amylase and invertase (El Fouly and Garas, 1974; Hofmann
et al. 1963; Wunsch, 1974). During flowering the content of sugar increases significantly (Sadik and Ozbun, 1967; Gurumurti et al. 1968) and floral differentiation is closely connected with the changes in the concentrations of polysaccharides (Gzheshyuk and Izevski, 1958). Martin (1966) has discussed the interlocking chemical reaction by which plants utilize carbohydrates to furnish carbon substrates for their metabolism and for mobilization of organic nutrient for growth. Singh and Juliano (1973) observed a close association between sucrose metabolism and rate of starch accumulation. Seasonal variations in the carbohydrate content of fruit trees have been also investigated by number of workers (Hooker, 1920; Shukla et al. 1973; Kandiah, 1979 a). Parskaya and Okhina (1959) have assigned an important role to nucleic acids in growth and organ forming processes. Similar role has also been reported by many researchers (Sen, 1964; Laloraya, 1965; Mitra and Sen, 1966; Phillips et al. 1969; Saxena, 1969; Chrinivesan and Rao, 1971). Millikan and Ghosh (1971) reported significant changes in nucleic acid content with maturation and senescence. An extreme sensitivity of ascorbic acid to physiological changes has a great impress on the metabolic state and productivity. The beneficial effects of the external application of ascorbic acid on
growth characters, metabolic activities and productivity of plants are suggested by many workers (Saxena et al. 1969; Chinoy et al. 1970; Sinha and Nandi, 1972; Patil and Lall, 1973; Mehta et al. 1976; Mehta, 1977). A parallelism has been also established between higher ascorbic acid content and higher DNA/RNA ratio in leaves during flowering. In our laboratory, invitro studies (Chinoy et al. 1974) revealed a direct interaction of AA with nucleic acids. The properties of AA = DNA system in relation to crop production has also been reviewed (Chinoy, 1967; Chinoy and Saxena, 1978). Nandi and Chatterjee (1975) have recently reported the role of nitrogen during the alkaloid formation with the progress of developmental growth. Positive correlations between grain nitrogen content and plant growth and even yield have also been reported (Peacock and Hawkins, 1970; Ries, 1971; Lowe and Ries, 1973). The pattern of fruit development as associated with the changes in the distribution of dry weight and nitrogen has been described by Farrington (1967) in Lupinus.

The review of literature cited above indicates that enzymes and metabolites occupy key positions in plant growth and development. The well-knit operation of enzymic reactions, with metabolic drifts results in better productivity. The studies regarding the plant growth
behaviour, systemic fluctuations in the solasodine content during floral and berry development, site of solasodine biosynthesis and accumulation, participation of accessory organs, right period of berry maturity for harvest, yield improvement by physiological means and interaction with other metabolic reactions are completely lacking in *Solanum khasianum* plant. Before it could be recognized as a potential commercial field crop, it requires in its entirely, a detailed physiological investigation to explore the avenues of increased effective material output. Therefore, the present study, in a part, envisages to explore the possibilities of increased solasodine production by employing physiological means such as foliar application of chemicals particularly ascorbic acid and hydrogen peroxide which are well known for their action of promoting growth as well as the yield. Secondly, what could be the possible metabolic interactions in relation to solasodine production and possible ways if any to increase its content by altering biochemical reactions.

Seeds of *Solanum khasianum* Clarke (var. RKL-20-2) were obtained from the Regional Research Laboratory, Jammu-Tawi, India. The crop was initially raised in the earthen pots keeping uniformity of soil composition. When the seedlings attained certain growth, they were transplanted in
the sufficiently ploughed and irrigated experimental field. The spacing of a plant within a row and row to row was maintained at 1.5 meters.

Following are the treatments employed for foliar spray after selection on preliminary laboratory trials.

1. Control (unsprayed plants)
2. Distilled water (DW)
3. Hydrogenperoxide (H₂O₂) - 0.2 v/v
4. Ascorbic acid (AA) - 10 ppm
5. Ascorbic acid + hydrogen peroxide (AA + H₂O₂) - 10 ppm + 0.2 v/v

The foliar spray was carried out twice a month after 20th day of transplantation and continued up to the maturity of crop. Other agricultural operations like manuring, irrigation, weeding and application of pesticides were practised time to time to raise the crop successfully.

The following was the preamble of the experiments designed and consequent analyses of the data -

Experiment - I. Study of growth and yield contributing characters.

(A) Growth criteria
(B) Fresh weight and Dry weight
(C) Flowering data
(D) Meteorological data
Experiment - II. Biochemical analysis during floral and berry development.

From the 6 different stages of flower, corresponding leaf and 8 different stages of berry and in both the organs of berry i.e. berry wall and fruit-pulp, the following biochemical analyses were performed.

(A) Ascorbic acid turnover (AA, AAU, ASG)
(B) Peroxidase activity
(C) Catalase activity
(D) AA-FR-peroxidase activity
(E) Nucleic acid contents (RNA, DNA)
(F) RNase activity
(G) Protein content
(H) Protease activity
(I) Sugar content (Reducing, Total)
(J) Invertase activity
(K) Solasodine content and
(L) Nitrogen content