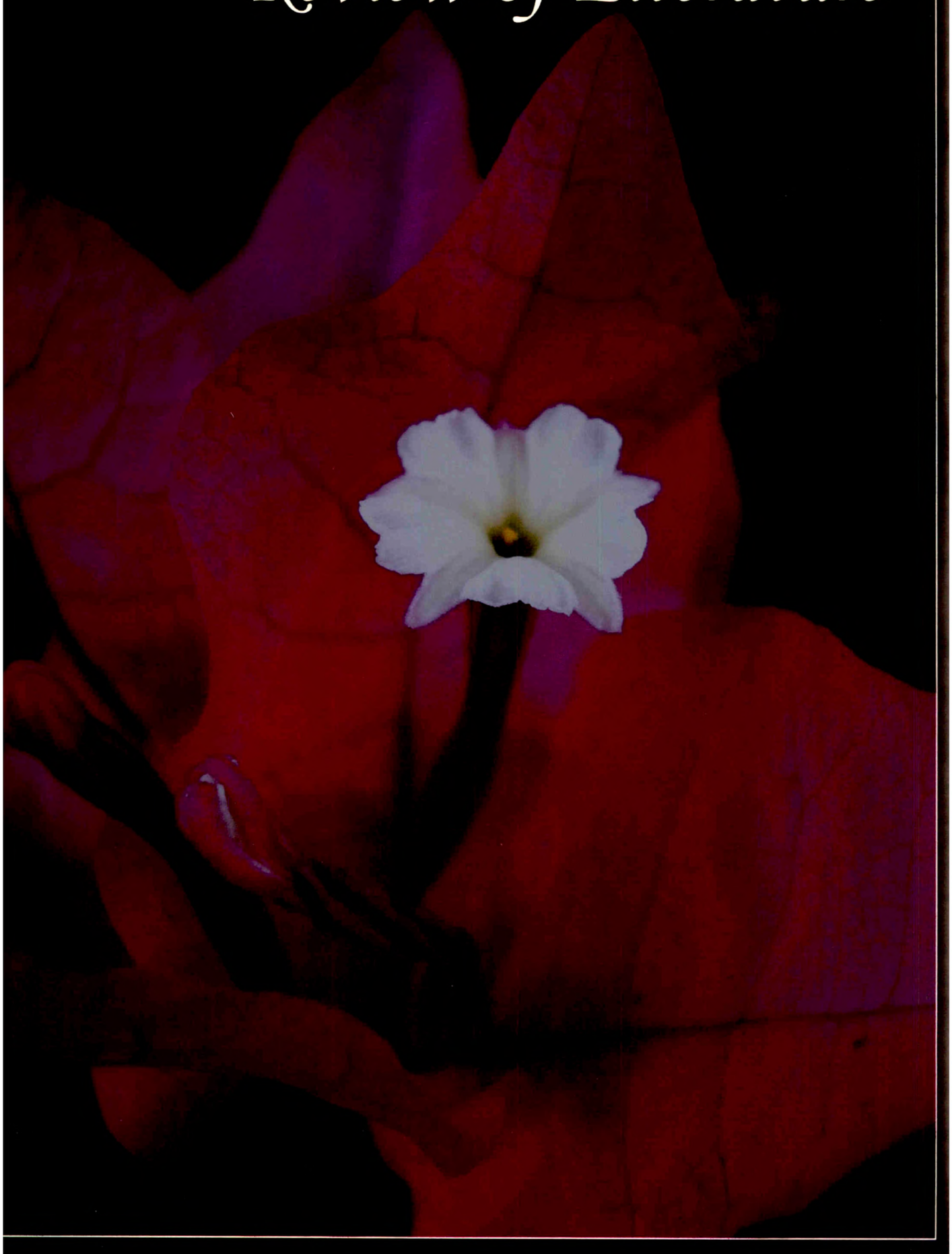
Review of Literature



I. Brief review of literature

A) About the genus

The plant *Bougainvillea spectabilis* is native of South America and Brazil. It grows on waste land and as a hedge plant. It is grown in gardens as ornamental plants. According to Gilman (1999) *Bougainvillea* plant has outstanding ornamental value; it can also be used as an espalier or in containers of poolside, hedge specimen, container or above-ground planter, mass planting, ground cover trend as standard, hanging basket, cascading down a wall. Dai Bisheng (2007) studied the effect of Carbendazim plus Thiram and Triamedimefon plus Ethylicin on the survival rate of softwood cuttings of *Bougainvillea spectabilis.* A simple and efficient *in vitro* regeneration protocol for *Bougainvillea spectabilis* Willd., was developed by Shah *et al.,* (2006). However the ethanolic extract of leaves of *Bougainvillea spectabilis* was screened for the hypoglycemic activity and anti-infammatory activity, (Senapati *et al.*, 2006). About 75% inhibition of Cucumber mosaic Virus (CMV) of Brinjal by plant extract of *Bougainvillea spectabilis* were studied (Bharati, 1999). Tan *et al.* (1999) studied physiological response of *Bougainvillea spectabilis* to sludge and artificial topsoils derived from flyash, sludge and rengam series subsoil. Further they noticed that *Bougainvillea spectabilis* is capable of tolerating the heavy metals present in the artificial topsoil.

An antiviral protein active against mechanical transmission of tomato spotted wilt virus was identified in the root tissues of *Bougainvillea spectabilis*.It is purified and characterized (Balsarswati *et al*, 1998). Esculetin, a phenolic compound found in *Bougainvillea spectabilis* was investigated for its possible protective effect against liver damage caused by paracetamol and CCL4 (Gillani *et al* 1998).Srivastava and Krishnan (1962) have studied the enzymes oxalic acid oxidase and catalase in the leaves of *Bougainvillea spectabilis* Willd. The activity of Fe–Porphyrin enzymes, catalase and peroxidase in comparable young, green, chlorotic and Fe-EDTA sprayed chlorotic leaves of *Bougainvillea spectabilis* were studied by Agarwala and Mehrotra (1977). According to Naik *et al* (1976) the polyamine levels in the stem and leaves of *Bougainvillea spectabilis* were significantly decreased on the infection by *Cuscuta reflexa* .Chlorophyll and anthocyanin ,anthocyanidin or betacyanin amounts and hill activity of red bracts of *Bougainvillea spectabilis* were also studied by Sharma (1980).

B) Physiology of senescence

Tollenar and Daynard (1982) defined leaf senescence as a series of events of deterioration and changes which leads to the death of leaf while according to Leopold (1961) the deteriorative process which naturally terminate the functional life of an organ or an organism are collectively called senescence. The chlorophyll is decreased due to decreased synthetic activity

than degradative process, (Goldwaite and Leatsch, 1967). Along with chlorophyll the accessory pigments (carotenoides) also decreased during leaf senescence although this aspect is not paid much attension (Sestak, 1985). During senescence there is increased rate of protein breakdown and mainly correlated with rapid protein loss, (Lorenzo et al, 1985). The amino acids accumulate in detached leaves and with time there is an increased utilization of these amino acids as respiratory substances. The nitrogenous components appear to be accumulated as the amino residues of glutamine and asparagine. Decline in photosynthesis is associated with senescence and decline RuBPcase activity and chlorophyll associated with onset of senescence. The activities of other enzymes malate dehydrogenase, malic enzymes, phosphoglycerate kinase, NADH linked Glyceraldehyde-3-phosphate dehydrogenase, ribose 5 phosphate isomerases and fructose 1, 6 diphosphatase also decrease along with senescence, (Woolhouse and Batt, 1976). There are also reports of changes in activities of enzymes such as pyruvate kinase and aldolase during senescence and aging, (Sacher *et al*, 1972; Murumkar, 1986). The other oxidative enzymes such as catalase and peroxidase have been reported to exhibit opposite behaviour during the leaf senescence. The activity of enzyme peroxidase showed considerable increase during senescence in leaves of monocot and dicot species (Datta and Mishra ,1976) .On the other hand a decline in catalase activity has been noticed during leaf senescence. Deszi (1975) observed a decrease in glycolate oxidase activity with age in barely leaves .In case of

senescence of chickpea leaves a decline in activities of other key enzymes of photorespiration, phosphoglycolate, phosphatase has been reported by Murumkar and Chavan (1986).The functional life span on the leaf cells can be curtailed by hormone treatment .According to Stoddart and Thomas (1982) plant growth regulators exert a controlling influence over leaf senescence .All cytokinin are playing a role in delaying senescence. They delay proteolysis and chlorophylls loss in the dark. Cytokinins delay leaf senescence in many species and may cause regreening of yellow leaves in some species (Dyer and Osborne, 1971; Venkatarayappa et al, 1984). Singh et al (1992) noticed that young tobacco leaves can synthesize their own cytokinins while mature and senescent leaves not to do so.

The effect of exogenous applications of cytokinins on attached leaves with a normal connection to a root system is generally less pronounced but the retardation of senescence is still observed, (Fletcher, 1969; Adedipe and fletcher, 1971).Richmond and Lang (1957) noted that kinetin delayed the loss of both chlorophyll and protein from leaves while Dyer and Osborne (1971) observed that kinetin also showed the decline in nucleic acids. Osborne (1962) demonstrated the stimulation of protein and RNA synthesis by cytokinins.

Gibberlic acid (GA) seems to be the most effective when endigenous GA is low, (Fletcher and Osborne, 1966). Elkinaway (1984) studied the hormonal changes with leaf senescence in cotton and observed that the definite

drop in free Indole Acetic Acid (IAA) below its initial level secured on 20th day when most of leaf protein and chlorophylls were already broken down.

Some sort of external factors also cause senescence. According to Smart (1994) daylength and light flux appear to influence the onset of senescence. Titus (1989) reported that the first sign of leaf senescence in apple was a decline in protein as a daylength become less than 14 hours and when daylength is less than 12 hours; the level of chlorophyll, DNA and RNA began to fall while RNAase, polyphenol oxidase and malate dehydrogenase activities increased dramatically. According to Lyons (1973) and Cares *et al* (1985) exposure to either high or low extremes of temperatures can trigger leaf yellowing.

According to Shanner and Boyer (1976) water stress cause induction of senescence through reduction of incorporation of amino acids into RUBP carboxylase protein relative to other protein and depression of leaf nitrate reductase activity by reducing nitrate flux. Makino *et al* (1984) shown that nitrogen nutrition during leaf development greatly influences not only lifespan but the rate of senescence. A low level of nitrogen is correlated with a reduced cytokinin level in the shoots or xylem sap of several species, (Goodwin *et al*, 1978). There is evidence that inhibited nutrient uptake and nutrient deficiency are directly responsible for enhanced leaf senescence and cessation of shoot growth in plants subjected to water logging (Trought and Drew, 1980).

According to Levitt (1972) salinity may also cause changes resembling senescence in particular high salt levels around the roots may cause leaf yellowing. Invasion by pathogen may retard or accelerate senescence (Smart, 1994). Rust and mildew infections of cereals typically caused formation of 'green islands' around the infection sites (Shaw, 1963; Mothes, 1970; Scholes and Farrar, 1987). In contrast, localized mosaic or general yellowing is the common symptoms of viral infections in leaves (Mathews, 1991).

C) Hormonal Regulation

The plant growth regulators exert a controlling influence over leaf senescence.

1. Gibberellic Acid

Gibberellins are discovered in the fungus *Gibberella fujikuroi.* The basic structure is the Gibbane carbon skeleton. The acid is terpenoid with a simple variation with gibbane ring. GA3 is termed as gibberlic acid and different gibberellins are named as GA1, GA2, GA3,.....

GA3 is tertracyclic dihydroxylactonic acid having the formula $C_{19}H_{22}O_6$.

The actively growing tissues produces maximum amount of gibberellins and is most effective at stages when endogenous GA is low (Fletcher and Osborne, 1965). Senescing tissue metabolizes GA more rapidly. GA inhibits photorespiration and can delay senescence. However foliar sprays of GA do not alter monocarpic senescence or pod development in Soyabean (Nooden, 1980).

2. Auxins: Indole Acetic Acid (IAA)

Indole acetic acid is synthesized in meristem of young part of plant e.g. shoot apex or embryos. Several of the synthetic auxins have been reported and some of them includes Indole Butyric Acid (IBA), Napthalacetic acid (NAA), 2-4-D, etc. auxin cause inhibition of lateral bud development through the apical dominance. Elkinaway (1984) studied the hormonal changes with leaf senescence in cotton and observed that the definite drop in free IAA below its initial level on 20^{th} day. When the most of the leaf protein and chlorophylls already brokendown. In oat leaf the auxin retarded senescence only at concentration about 500 time that of kinetin (Shibaoka and Thimann, 1970).

3. Kinetin

All cytokinins are playing a role in preventive or at least greatly delaying senescence. They delay proteolysis and chlorophyll loss in dark. Neumann and Nooden (1980) reported that cytokinin delayed development of visible leaf senescence in soybean. Kinetin exist a striking effect on respiration by keeping low rate. Lamattina *et al.*, (1987) observed that kinetin action on preventing protein breakdown was found higher than action of promoting protein synthesis. Kinetin promoted the transpirations of leaf discs of *Brassica* and *Nicotiana* whose stomata occurs on both sides (Thimann and Satler, 1979).

II. MATERIALS AND METHODS

A) PLANT MATERIAL

Bougainvillea spectabilis (Willd.) has been selected for the present investigation. It is an ornamental plant. It is also used as hedge in formal and informal gardens. The plant material near by the college campus of Krishna Mahavidyalaya Rethre (Bk.) is selected for the present study. In the present investigation foliar spray of three well known phytohormones i.e., GA, IAA and kinetin are given to *Bougainvillea spectabilis* (Willd.). After screening of various concentrations, 50ppm concentration of each phytohormone is selected for the present study. Foliar spray of phytohormones was given three times after four days of interval. After 20 days of foliar spray the plant material was harvested randomly for the analysis of various organic and inorganic constituents. For the present investigation, various stages of leaf development were used such as

1. Premature (PM)
2. Mature (M)
3. Onset of senescence (O)
4. Senescent stage (S).