CHAPTER - I
INTRODUCTION
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Functionally the seed can be regarded as an embryonic plant in an inactive state, enclosed along with a food store in a protective coat which may be a series of membranes and sometimes may be stony shells.

Germination, is the beginning of growth of the inactive or dormant embryo within the seed, which consists of a series of morphological, biochemical and physiological changes leading to the rupture of the seed-coat and emergence of the seedling.

As the seeds develop from the fertilised ovule there is a progressive decrease in water content, and it is this state of near desiccation which gives the seed its longevity and its resistance to many environmental variations. Normally seeds germinate immediately the appropriate conditions are being available which are recognised to be - (1) a supply of oxygen (which permits respiration to proceed), (2) a supply of water (which will dissolve or put into suspension the cell contents so that chemical and specially enzymic reactions can occur), and (3) a suitable temperature (to allow the chemical reactions to go on at an adequate rate.) Thus, when these requirements are met seeds are reactivated for growth (i.e. germination). It is not difficult, however, to show that even under seemingly ideal conditions of temperature, water and oxygen supply, seeds of many species fail to germinate i.e., they exhibit seed dormancy, until some additional requirements (like light, darkness, etc.) are met with. Thus, the final
process in germination is embryo growth with the generation of sufficient force to rupture whatever embryo-covers are included in the dispersal unit (Crocker et al., 1946). The starting process is commonly considered to be imbibition, but the germination behaviour of a seed may be considered as far back as fertilisation. 'Germination', thus, can be defined as a process starting with the imbibition of the dispersal unit and ending with the protrusion of the embryonic root which takes place inside the dispersal unit and prepare the embryo for normal growth (Evenari, 1957a, b). Certain partial, processes must therefore occur long before imbibition or the hydration of the embryo. In germinating process, changes must be looked for on the sub-cellular, or even sub-microscopic level, as well as in enzyme-substrate hormone relationships. Besides, in order to bring about renewal of development the dispersal unit of which the embryo is a part has to be given a certain constellation of external conditions which cause removal or bypassing of the block and initiate germination. In many cases one of these "Conditions sine qua non" is 'light' or the absence of light. Evenari (1956) used the term 'photoblastism' to indicate the effect of light or dark on germination. A large number of types of seeds show a form of dormancy which is overcome by exposure to light, and which are termed as positively photoblastic. Lactuca sativa L. (lettuce), Juncus spp., Nicotiana tabacum (tobacco), Betula spp., Lensium virginicum Lyconersicus esculentus (tomato) Amaranthus retroflexus etc. are the common examples of positively photoblastic seeds. Again
a smaller number have their germination inhibited by light. They require darkness for germination and are called as **negatively photoblastic**, e.g., *Phacelia tanacetifolia*, *Amaranthus caudatus*, *Helieborus niger*, *Nemophila insana*, etc. Now, it has become sufficiently clear that seeds which under normal conditions are photoblastic can be made photoblastic and vice versa by certain treatments.

Recent workers such as Crocker (1936 and 1948), Evenari (1966), Toole, Hendricks, Borthwick and Toole (1956), and Toole (1958) describe the discovery of light sensitivity in seeds and enable us to trace the development of knowledge on the subject.

Tobacco (*Nicotiana tabacum* L.) seeds show a marked difference in germination behaviour when allowed to germinate in light and dark. The percentage of germination being higher in light than in dark shows a direct relationship or co-relationship between light and germination. The work done at the Central Tobacco Research Institute, Rajahmundry, indicates that while the variety Chatham germinates to the extent of about 94.5% in the dark as compared to about 99% under diffused light at room temperature (30-31°C), other varieties, such as Motihari Havana and X-49, show a fair improvement (11-48 per cent) in germination in diffused light. This has also been substantiated by the findings of Sarma and Chakraborty (1975) in Motihari variety.

Modern techniques have tended to be confined to study of promotion and inhibition of germination by the application of
germination stimulators and growth retardants by exposing the seeds to light or dark. Some inorganic nitrogen compounds and sulphur nitrogen compounds are also known to stimulate germination of photoblastic seeds in darkness by replacing the requirements for light. Since the investigations of Lehman (1919) and Gassner (1915a) KNO$_3$ is known to bring about germination of photoblastic seeds. — (e.g. Ranunculus aceratus) in dark.

Interactions between photoblastism and KNO$_3$ have also been reported by several investigators (Toole et al., 1958a, b; Mayer and Poljakoff-Mayber, 1963). Other inorganic nitrogen compounds such as Ammonium Nitrate (NH$_4$NO$_3$), Ammonium Chloride (NH$_4$Cl) are also reported to be equally effective in inducing germination in light-requiring seeds (Hasimoto, 1961). Similarly, thiourea, a sulphur-nitrogen compound, is reported to be a potent germination stimulator which completely eliminates the requirement of light for lettuce seed germination (Thompson and Kesar, 1938, 1939; Mayer, 1956; Poljakoff-Mayber et al., 1958; Haber and Luippold, 1960a; Sarma and Gohain, 1972; Sarma and Chakraborty, 1975). Although reports are pouring in corroborating the stimulatory effects of KNO$_3$, NH$_4$NO$_3$ or thiourea, there are also reports indicating that these compounds might not be always equally effective in promoting germination of positively photoblastic seeds, e.g. Nicotiana tabacum (Hashimoto, 1958) and Juncus maritimus (Tadmor et al., 1958). Pal, Gopalachari and Bhat (1958) found improved germination of tobacco seeds (cv. Chathama) when treated with KNO$_3$ (0.2 p.c.) but reduced germination with thiourea (0.4 p.c.).
Gibberellins, chemically different from auxins, are naturally occurring substances which received attention only in 1960's as potent germination stimulators. Gibberellins are found to have profound effect on plant growth at fantastically low concentrations. It was not long after the physiological activities of gibberellins were recognised that Khan et al. (1966, 1967) and Lena (1966) found that several types of light requiring seeds germinated well in the solution of gibberellins in darkness. Stimulation of germination by gibberellins is enhanced by light exhibiting an additive effect (Evenari et al., 1968; Kahn, 1960b). Ogawara and Ono (1961) reported a clear synergism between KNO₃ and GA₃ in stimulation of germination of positively photoblastic tobacco seeds. The present investigation was designed to have a deeper insight into the stimulation of germination by GA₃ in dark and enhanced stimulation in light.

Kinetin has long been recognised as a potent germination stimulator. Application of Kinetin can stimulate germination (Miller, 1966) and even break dormancy (Khan, 1966, 1971). Even the dormancy induced by ABA is relieved by cytokinins (Khan 1968) in certain seeds. The ability of applied cytokinins to break dormancy is probably a consequence of their impressive ability to stimulate the enlargement of the cotyledons (Ikuma and Thimann, 1963; Esaahi and Leopold, 1969a). The inhibition of germination by Coumarin has been thoroughly documented by many investigators (Mutile, 1945; Mayer and Evenari, 1953; Khan and Tolbert, 1966; Berrie et al., 1967 and many others).
Almost in all cases coumarin as well as a number of unsaturated lactones were reported to inhibit germination of light-sensitive seeds. The 'blastocholine' (germination-inhibitor) properties of coumarin have been demonstrated in a number of seeds by several other investigators, (Schreiner et al., 1907; Veldstra and Havinga, 1947; Nutille, 1943-44, 1945; Mayer and Evenari, 1953; Misra and Patnaik, 1959). However, Neumann (1959) and Mayer and Poljakoff-Mayber (1961) and Thimann and Bonner (1949) reported that at lower concentration coumarin has stimulatory effect. It has also been reported that coumarin induces dormancy in non-dormant lettuce seeds and this can again be reversed by exposing the seeds to high humidity, light and to treatment with GA3 and Kinetin.

Besides coumarin another series of chemical compounds have emerged in recent years which have been termed as "dwarfing compounds" or growth retardants. These compounds are (2-chloroethyl) trimethyl ammonium chloride (CCC), B-995 and AMO 1618. CCC is reported to induce inhibition of gibberellin biosynthesis (Lang, 1970; Baldev et al., 1965; Ross and Bradbeer, 1971a,b). On the other hand, some claimed to have increased the gibberellin content in tissues treated with CCC (Reid and Cresier, 1970). Inhibition of the germination of seeds of lettuce and Kale (Berrie and Robertson, 1973; Wittwer and Tolbert, 1960; Knypl, 1967a) had also been reported. This inhibition induced by CCC was prevented either by irradiating seeds with red light or by treating with gibberellin or Kinetin. Actually with the problems of germination and dormancy encountered in
In these studies are essentially very complex but these have widened the scope for further exploration of the problems. Although this vast domain of germination and dormancy has been explored for long time from different points of view adding substantially to our knowledge, intensive studies are yet to be done on many more aspects.

With the premise enunciated above it was considered pertinent to make a detailed investigation on the germination behaviour of positively photoblastic tobacco (*Nicotiana tabacum*) seeds in light and dark in consequence of the application of germination promoters, vis., inorganic nitrogen compounds (*KNO₃ ammonium nitrate Thiourea, etc.*), gibberellic acid and kinetin and growth retardants and inhibitors vis., CCC and Coumarin. Further, experiments were designed to provide supplementary informations on the interactions of light, *GA₃* and other germination stimulating and retarding chemicals which might be relevant for clearer appraisal of their actions on the germination of photoblastic seeds.