I REVIEW OF LITERATURE

The treads and extent of growth for the production and use of pesticides since World War II are documented for the industrial countries. The major role played by pesticides in the great advances made in agricultural technology and public health is widely recognised. In order to meet the enormous needs for food and fibre in future, heavy dependence on pesticides will be necessary for more effective control of insects and other pests. Hence use of pesticides for control of pests and diseases of crops is one of the critical inputs for stepping up the agricultural production.

Recently, anticipated consumption rate of pesticides in Maharashtra for 1986-87 was reported to be 2200 M. tons whereas the demands of pesticides for 87-88 for India as a whole were reported to be 74,545 M. tons (Plant Pathology, Courier 5(1): 1987). In Maharashtra during year 1983-84, large scale of plant protection campaign against important pests of crops were organised over an area of 8.5 lakh hectares. When all out efforts are being made to maximise agricultural production such as use of hybrid and high yielding varieties of crops and adoption of improved agricultural technology, it is needless to emphasize the necessity of undertaking large scale plant protection measures to save huge annual losses caused due to vagaries of pests and diseases.

Though the consumption of pesticides for protecting the crops from the attack of pests and diseases has increased considerably, there is necessity for guiding the cultivators to use right type of pesticides for control of different pests and diseases. Large number of pesticides putforth by various commercial firms are available in the market, several new products are being added annually. It has often experienced that cultivators find it difficult to select proper pesticides for pest and disease control or otherwise without knowing the danger of pesticides they use heavy dose which ultimately results into health hazards.

In order to provide information regarding the suitable pesticides against crop pests and diseases, the time of application precautionary measures to be taken while handling the pesticides etc. has been incorporated into number of books and booklets. Since the problems of plant protection have become particularly important in recent years, the scientists are engaged in studying the after effects of pesticides in seed germination, metabolic activities in plants residual problem and cytotoxicity.

A. Germination and growth under pesticidal treatment

Pesticides have became an essential part of chemical control of the pests. Among the vast number of plant protection chemicals some show favourable effects such as better fruit set, better seed set etc. (Philomena and David 1985). However, some have shown adverse toxic effects on the treated plants in various ways (Stocker, 1948; Puchkova, 1965; Casida and Lykken, 1969; Prasad et al.,1980).

Effect of antracol and kitazin on Brassica nigra was studied by Krishnamurty and Rao (1980). They reported that increasing concentrations of kitazin and antracol grdually inhibited germination percentage, seedling growth and plant height. Leaf variations from normal trifoliate condition in control to tretra, penta and heptafoliate condition were observed when plants were treated with sumithione, an organophosphorus insecticide (Krishnamurty and Rao 1980a). Reddy and Vidyavati (1983) have found gradual decrease in germination percentage of Dolichos biflorus with increasing concentration of a fungicide kitazin.

Prasad and Mathur (1983) have studied the effect of metasystox and cuman-L on the germination of Vigna mungo. The results have revealed that metasystox inhibited seed germination at all the doses selected for the treatment viz. 0.05, 0.08, 0.10 and 0.15% and cuman-L had no or very little effect on the seed germination. Singh et al. (1979) have found interesting results in case of Hordeum vulgare. Here in general insecticidal treatment did not reduce germination percentage, but did reduce seedling height, pollen fertility and chiasma frequency.

Jaiprakash and Singh (1984) have reported that varying concentrations of isoproturon (herbicide) inhibit the germination percentage, root and shoot length in canary grass. Pathak and Mukherji (1986) studied the effect of sevin on growth parameters of mung bean Vigna radiata. They concluded that shoot length increased gradually with the increasing concentration. But at higher concentrations both shoot and root growth was inhibited. According to them when sevin is used at a concentration of 100-200 ppm it is safe and shows no detrimental effects on the treated seeds.

Effect of different pesticides on germination and seedling growth in Wheat (Sachan et al. 1967), Chick pea (Shrista and Kale, 1970), Vigna radiata (Gupta et al. 1983), Vigna mungo (Chandra et al. 1983), Cotton (Gawaad et al. 1972), ragi, sunflower, jowar bajra, maize, green gram etc. (Somashekhar and Sreenath 1986), Coffee seeds (Venkatasubbaiah and Safeeulla 1987) has been reported.

Shirashyad (1988) has studied effect of different concentrations of metacid-50 and dimecron on seed germination and seedling growth of bean, okra, guar and onion. He reported that response of seed germination to both the insecticides was inhibitory at higher concentrations while stimulatory at lower concentrations. He also reported some morphological abnormalities induced by both the insecticides. They are coiling, bulging and formation of constriction in the radicle. Necrosis and secondary root production was also reported by him.

B. Enzyme activity under pesticidal treatment

Pesticides are being used extensively for plant protection in recent years in developing countries. The adverse effects produced by these pesticides is an important subject of growing concern today (Tatekar et al. 1977). Therefore, it is essential to screen the seeds or plants for the biochemical effects induced by commercially used pesticides. Effect of pesticides on enzyme activity is very interesting and the work done in this regard is reviewed below.

Arnison and Boll (1976) have studied action of 2,4-D and kinetin on peroxidase activity and isoenzyme pattern in cotyledon cell suspension of bush bean (Phaseolus vulgaris). According to them peroxidase activity was minimum during cell division phase and was maximum during cell expansion phase.

Manoharan et al. (1981) have reported effect of fluchloralin a pre-emergence herbicide on metabolic processes of Vigna unquiculata seedlings. Their study revealed that activity of hydrolytic enzymes was altered and the rae of respiration and permeability of cells was disturbed

Reddy and Vidyavati (1983) have studied effect of kitazin on hydrolytic enzymes in Dolichos biflorus and reported that activity of amylase, catalase and protease was stimulated slightly in lower concentrations and was decreased at higher concentrations. However, peroxidase activity was less at lower concentrations and was higher at higher concentration. Prasad and Mathur (1983) have investigated the effect of cuman-L and metasystox on the activity of amylase in germinating seeds of Vigna mungo. Their data indicate that amylase activity was found to be inhibited even with a little dose of cuman-L.

Effect of endosulfan on endogenous IAA cell wall polysaccharide peroxidase activity and its isoenzyme patterns in germinating Cicer arietinum seeds has been reported by Agarwal and Beg (1982). According to them endosulfan resulted in a fall in pectin, hemicellulose and cellulose content of the cell wall when the germinating seeds of Cicer arietinum were exposed to endosulfan. They reported that activity of peroxidase was stimulated in shoot and inhibited in roots. Similarly IAA content was declined with the seedling growth.

Karadge and Karne (1985) have reported the influence of bavistin and calixin (systemic fungicides) on tomato leaves. According to them both the fungicides caused increase in free organic acids, chlorophylls and polyphenols in the leaves whereas total nitrogen and proline content was decreased. Similarly IAA oxidase and catalase enzymes were increased and peroxidase, acid phosphatase were decreased.

Effect of different concentrations of metacid and dimecron on the hydrolytic enzymes in the seedlings of bean okra, guar and onion has been studied by Shirashyad (1988). According to him respiratory enzyme, peroxidase increases with the increasing insecticide concentrations, while catalase showed stimulatory response at lower concentrations only. No consistency was recorded in the activity of protease and acid phosphatase in response to insecticides.

C. Chromosomal behaviour under pesticidal treatment

Pesticides are the chemicals without which we are unable to stabilize our agricultural outputs. But they are injurious to man, animals and also to plants. These injuries may be genic, chromosomal or genomic leading to mutagenicity, turbagenicity and clastogenicity. Recent studies on cyto and chromotoxic effect of agro and environmental chemicals and their possible genotoxic effects have prompted several international agencies to recommend the screening of mutagenic and chromotoxic effects of almost all chemicals being used commercially (Alacevic, 1980; Kaur and Grover, 1985). Studies carried out in this regard are reviewed below.

It is very interesting to note that about 400 basic pesticidal chemicals are used all over the world constituting about thousands of formulations (Sharma, 1986). It is estimated that about 20 billion tons of pesticides are used in U.S.A. alone around 1975. In India about 80 different chemicals are in use.

Sass (1937) has investigated hypertrophy in maize induced by ceresan (ethyl mercury phosphate). He observed that cells of hypertrophied organs become multinucleate containing nuclei ranging from micronuclei to polyploid giant nuclei. Number of chromosomes often exceeds 200. He considered the malformation to be due to incomplete meiosis. Kurinnyi (1975) has done a comparative investigation of cytogenetic effects of certain organophosphorus insecticides. Georgian (1975) studied cytogenetic effect of aldrin and phosphamidon in some plants. Mann (1977) has studied cytological and genetical effects of dithane fungicide on Allium cepa. He found that reproductive cells are more sensitive than somatic cells because high frequency of chromosomal aberrations are found in reproductive cells. These fungicides caused pollen sterility and have lowered the seed set. Mishra (1979) has studied effect of malathion on mitotically dividing onion root tip cells and observed abnormalities like stickiness, laggards, bridges, multipolar spindles etc. Sawamura (1965) has observed the suppression of spindle development, coagulation of protoplasm, inhibition of mitosis in hair cells of Tradescantia treated with 12 herbicides. deKergommeaux et al. (1983) investigated clastogenic and physiological response of chromosomes to different pesticides in Vicia faba in vivo root tip assay system. Rahman and Bhattacharya (1985) have studied cytological effect of sevin on Allium cepa and Lathyrus sativus and concluded that two plant taxa of which former reproduced vegetatively and later sexually show differential response to sevin insecticide.

Recently Halvankar and Patil (1987) have extensively studied effect of some agrochemicals like dithone Z-78 and deconil 2787 (fungicides), sevin and BHC (insecticides) and 2,4-D (herbicide) on meiotic chromosome behaviour in tetraploid and hexaploid wheat and showed that hexaploid wheat appeared to be more affected than tetraploid wheat. Grover and his coworkers have published series of papers on genotoxic effects of different pesticides (Grover and Ladhar, 1987; Grover and Dhingra, 1987; Grover et al.,1987; Grover and Malhi, 1988). Similarly, induction of increased frequency of mitotic aberrations due to metacid-50 and dimecron treatment in bean, okra, guar and onion root tips was shown by Shirashyad (1988).

D. Pesticide residue problem

The role of pesticides in modern warfare against agricultural pests and diseases is well known and needs no repeatition and canvassing more so in a country like India which is just in the take-off stage so far as use of pesticides and coverage under the plant protection measures are concerned. A closer peep into the pattern and quantum of pesticide used in India in the light of various works and reports brought within and outside the country will help in dispelling the fear about the pesticides indicated and inspired in the minds of the general public in this country. In India the actual manufacture of pesticides and agrochemicals started during the post World War II period (Ramchandran 1969) and imported formulations of DDT and BHC were introduced in agriculture around 1947-48. Since then BHC, DDT and organomercuric compounds were the foremost chemicals found to be used in Indian agriculture.

1. Pesticide Consumption

Roughly 55,000 tons of pesticides are annually applied in the field crops. Out of this 40,000 tons are insecticides, 8000 tons are fungicides and the rest are herbicides (Singh, 1981). On an average the pesticides used in India is one tenth of what is applied per unit area of crop field in the advanced countries (Rangaswamy, 1976). According to Singh (1981) in a country like ours the consumption of pesticides is very much reduced as compared to that in advanced countries. He further states that extensive application has not at all taken place and intensive consumption of pesticides is limited to a few pockets in the country which are rather decimal. In contrast to this, according to the Bulletin of Plant Pathology extension (Plant Pathology Courier Vol.5(1), 1987) the demand of pesticides for 1987-88 reported to be 75,545 M.tons which clearly indicates that there is considerable increase in the consumption of pesticides in India. Against this background if we peep into the magnitude of pesticide pollution and residual problem as reported by various workers in the country, one may be evident of the situation in which pesticides are apparently put.

2. Pesticide residues in water

Several workers have reported that most of the pesticides are appeared to be water polluted. As such wars against pesticides as water pollutants and fish toxicants had been waged since the early fiftees. The entry of pesticide into a variety of cycles such as soil, air, water and food has been reported by Metcalf (1986). Johnels _et al._ (1967) in Swedan reported large scale poisoning of fish in the Minimata Bay in

Japan and rivers in Sweden where factories of wood pulp industries are located. Wurster (1968) raised a world wide alarm about a residue of DDT on the marine plankton. Presence of residues of dieldrin in the natural water was reported by Brown and Nishioka (1967). Likewise, Hunt (1964), Holden (1965) and Lichtenstein et al. (1966) found that dieldrin was accumulated in the mud bottom of lakes, ponds and in the bodies of aquatic animals.

3. Pesticide residues in soil

There is no doubt that many pesticides persist in the soil, for a comparatively long period. To strengthen this aspect there are number of reports. Edwards (1964) found 80% of DDT originally applied still persisting in the soil after one year against 75% of dieldrin, 60% of lindane and 55% of chlordane. He further reported that 50% of the applied chemicals end up in soils through missing the target of runoff from the foliage. Martin et al. (1963) have reported toxic effects of soil applied fumigants lasting as long as one year. Tripathi (1966) found that DDT was present in 87% of the soil samples analysed in which the residue level was ranging from 0.19 to 2.22 ppm. In U.S.A. the pesticide residues in the soils averaged 1.5 ppm maximum being 19.1 ppm (Gish, 1970). Muir and Baker (1973) observed higher levels of chlorinated pesticides in milk, hay and silage produced in orchard areas than those in nonorchard areas. Thompson et al. (1970) found very limited movement of dieldrin into water from treated soil and hence unlikely to be a major pathway for the contamination of water through soil.

Apart from these one sided reports there are also reports suggesting the harmlessness of the residual content in the soil. To quote a few, Acree et al. (1963) are of the opinion that pesticides that reach the soil or water leave again at various speeds by codistillation with water and by volatilization from soil surfaces (Bowmann et al., 1965).

It is true that residues of pesticides, persistent chlorinated hydrocarbons and chiolineestarase inhibitors can persist in soils repeatedly treated with substantial doses of pesticides. These residues are not harmful in any way except that their presence may result in possibly illegal residues in crops which are grown in the soil, especially where the tolerance for such residues are zero. The organophosphorus insecticides in current use break down so rapidly that measurable quantities exist in soil for only days, weeks or months after they are applied (Edwards, 1964). The organophosphorus insecticides whether of high or low acute toxicity and whether of short or long lasting effects breakdown into harmless substances in the plant or in the soil.

After the publication of Carson's "Silent Spring", in 1962 the use of pesticidesd became more suspected and most of the laboratories are engaged in screening the pesticides for their harmful as well as residual effects. Singh (1981) in his excellent review on Pesticide Pollution: An analysis of the problem' has overviewed all the aspects of harmful and residual aspects of pesticides. According to him though an alarm was created with the publication of Carson's Silent Spring, no proper scientific data supporting some of the statement in the book was available. This creates confusion in the mind whether pesticides are harmful or not to the environment. However, recent literature survey throws some light.

4. Pesticide residues in plants

Sharma and Chopra (1970) have studied persistance of malathion residues on cauliflower crop. They found that recommended waiting period between spraying and harvesting is 7 days, at which time, residue levels are below tolerance limit. Attri and Lal (1972) have studied residues and residual toxicity of ethyl and methyl parathion on cabbage. The residues on cabbage heart never exceeded to tolerance limit of 1 ppm (fixed by F.D.A. of U.S.D.A.). Higher dose of ethyl parathion was effective for about 17 days and that of methyl parathion for about 10 days. Dissipathion of malathion on caulifolower was studied by Gupta and Kapoor (1972). They found that cauliflower should not be harvested within 5 days of spraying. Deterioration of malathion residues on brinjal leaves was studied by Srivastava et al. (1973). They found that malathion deteriorates slowly on leaves and no detectable residue was found in leaves after 30 days of treatment. Rajukkannu et al. (1978) have measured residues of methyl parathion, quinalaphos, phosalone and fenitrothion in/on okra. They found that after 7 days of the final application of all the insecticides, the residues were below tolerance level. Similarly, Lalitha et al. (1984) have worked on residues of endosulfan in tomato and brinjal and concluded that washing the brinjal fruits harvested on the day of spray with water resulted in 49% reduction of initial deposits. In tomato the residue was found to be below tolerance level within one day after application.

Ten different pesticides have been screened for the residual content in safflower seeds by Goud et al. (1981). Maximum residual content of phosalone and ethiofencarb was noticed upto 90 days after harvest.

Rajukkannu and Balasubramanian (1982) have screened degradation and persistence of endosulfan, lindane, quinalphos and phosalone in black gram. Residues of quinalphos and phosalone dissipated quickly and have reached non detectable limits in 22 days. However endosulfan and lindane residues have persisted in pods upto harest whereas grain samples obtained from all four treatments did not contain any residues. Rajukkannu et al. (1984) have also worked on residues of phosalone, malathion and quinalphos in certain high yielding varieties of rice. The results revealed that all samples irrespective of varieties possessed residues of all three insecticides in grains at harvest, but were well below the tolerance level. Further they have observed that persistence of residues varied with rice varieties. Mishra and Saxena (1985) have studied the dissipation of quinalphos in pigeon pea. Their data reveals that grain and straw samples were free from toxic residues of quinalphos at harvest. Carbaryl residues in/on vegetable crops, field crops, fruit crops, and pulses have been reviewed by Garg et al. (1985, 1985a and 1986) and Sivasankaran et al. (1985).

Prasad and Ramasubbaiah (1982) have studied persistence of phosphomidon in okra. They concluded that okra fruits are safe for human consumption ten days after spraying. Similar results were also reported by Ramasubbaiah and Lal (1974). Sosamma and Verma (1985) have investigated persistence of malathion on okra. They found that residue of malathion reached non detectable level on 4th day. Rao et al. (1986) have studied dissipation of monocrotophos and carbaryl in tomato. Based on the results it is said that monocrotophos treated fruits required waiting period of 8-11 days and carbaryl treated fruits required waiting period of 1-3 days for safer consumption of tomato. Gupta and Singh (1988) have reported residues of quinalphos on okra and found that residues degraded to maximum residue limit (MRL) after 0.73 to 1.5 days after treatment.

Most of the workers in different laboratories are also engaged in studying residual analysis of pesticides in different vegetables and crop plants, applied foliarly or by seeds treatments. They are Canuti et al. (1973) in vegetables and fruits, Rajukkannu et al. (1976) in vegetables, Kuem et al. (1977) in tomato and brinjal, Manzoor and Manzoor (1977) in vegetables, Patil and Dethe (1984) in chillies, Narasimha Rao et al. (1986) in okra and Kawamura et al. (1986) in vegetables and fruits.

Recently the estimation of residue content by TLC in/on leaves of okra, chillies, cowpea, tomato, sorghum and fruits of grapes and chillies after single spray of endosulfan and its dissipation pattern has also been reported by Phadnaik and Joshirao (1989).

E. Summary of work done and scope of present investigation

The problems of plant protection have become particularly important in recent years because of the threat to human health and the environment through the large scale use of pesticides (Finlayson and MacCarthy, 1973). Methylparathion an organophosphorus pesticide is widely used as an insecticide as a foliar spray whose residual effect is known to remain in the environment for long time (Sharma and Chopra, 1970; Deshpande and Swamy, 1987). Moreover most of the pesticides have been shown to cause toxic effects on plants in various ways (Prasad and Mathur, 1983; Karadge and Karne, 1985; Deshpande and Swamy, 1987).

Pesticides also play very important role in protecting vegetables, fruits and foodgrains right from the seed stage through germination to growth and then storing (Mann, 1977). However their use has many consequences (Brown, 1962, 1963; Cottam, 1965) and from studies of many environmental chemicals, biocides, the conclusion has been reacted that they can induce considerable damage into the human genepool (Grant,1970 and 1971). Recent studies on cyto and chromotoxic effects of agro and environmental chemicals and their possible genotoxic effects have prompted several international agencies to recommend the screening of mutagenic and chromotoxic effects of almost all the chemicals being used commercially (Alacevic, 1980; Kaur and Grover, 1985; Shirashyad 1988). The problem of residual persistence in the pesticide sprayed plants is alarmingly important and several workers are engaged in studying residual persistence on plant, in soil, and in water.

From the above foregoing literature survey it is very clear that, the maximum attention has been paid in emphasizing the effects of different pesticides on seedling growth, cytotoxicity and enzymes involved in germination. However not much information is available about the physiological response of pesticides in vegetables like tomato, okra and guar. It is also clear from the literature that studies pertaining to physio logical response of pesticides are very limited.

According to Gruzdyev (1983) different pesticides have a different physiological activity with respect to plants. The resistance of different species and kinds of plants to pesticides is based on their biochemical difference in metabolism and on the differences in their physiological reaction to these compounds. It has been established that among plants there is no systematic group (class, family, genus) within which all the representatives would be identically resistant to pesticides. Even within a single species, individual varieties of plants may behave differently with respect to pesticides. Hence it is equally important to study the physiological response of pesticides in different plants. Keeping this view in mind the study was undertaken to assess the physiological behaviour of tomato, okra and guar plant under the influence of two widely used organophosphorus pesticides viz. methylparathion and phosphamidon. The physiological parameters selected for study are leaf area expansion relative water content (RWC), organic constituents such as chlorophylls, polyphenols and carbohydrates, mineral content, stomatal behaviour and persistence of residual content in Lycopersicon esculentum (tomato), Abelmoschus esculentus (Okra), Cyamopsis tetragonoloba (guar) the vegetables of day to day diet.