CHAPTER - I

INTRODUCTION

Soybean is an oilseed crop with a large number of cultivars. It is an important global crop providing high (38 - 45%) protein content and high (20%) oil content. Soybean being the richest, cheapest and easiest source of best quality proteins and fats and having a vast multiplicity of uses as food and industrial products is sometimes called a 'wonder crop'. As it has wide adaptability to climate, soil stress tolerance, instant market at remunerative price, it has played prominent role in rapid spread of soybean in the country. Soybean is first in rank in cultivation in oilseed crops in world and India. Soybean has revolutionised socio-economic status of soyafarmers as well as other classes of India.

Area of cultivation :

Soybean is first in rank in cultivation in oilseed crops in world and India. Cultivation of soybean is mainly confined to China, gradually Indonesia, the Philippines, Vietnam, Thailand , Malaysia, Burma, Taiwan, Nepal, India, North America and Europe.

In India, the production of oil seed crops have doubled in 1993 -1994 (21.5 million MT) as compared with 10.8 million MT of 1985 - 1986. It is grown in Madhya Pradesh, Uttar Pradesh, Maharashtra, Gujrat, Himachal Pradesh, Punjab and Delhi. With approximately 75 % share in national area and production of soybean in India, Madhya Pradesh has distinguished as 'soya-state.' At present time, production of soybean of India is 8 - 9 qui / ha while that of world is 22 - 38 qui / ha. In India about 4-25 million hectares land is under soybean cultivation producing about 4.62 million tonnes of soybean. In Maharashtra , 4.60 lakh hectares land is under cultivation of soybean.

Description and Morphology:

Soybean varies in growth, habit and height. It may grow prostrate, not higher than 20 cm, or grow upto 2 meters in height. The pods, stem and leaves are covered with fine brown or grey hairs. The leaves are trifoliate having 3-4 leaflets per leaf. The leaves fall before the seeds are mature. The big, incospicuous, self fertile flowers are borne in the axil of leaves and are white, pink or purple. The fruit is hairy pod in cluster of 3-5. Each pod is 3-8 cm long and usually contains 2-4 seeds. Soybean fruits are in many hull colours like black, blue, yellow, green and mottled.

Chemical Composition of the seed :

The oil and protein content together account for about 60 % of dry soybeans by weight ; oil at 20 % and protein at 40 % . The remainder consist of 35% carbohydrate and about 5% ash. Soybean protein is rich in valuable amino acid lycine (5%) in which most of the cereals are deficient. In addition it contains a good amount of minerals, salts and vitamins. The principal soluble carbohydrates, saccharides of mature soybeans are the sucrose (2.5-82 %), raffinose (0.1-1.0 %) and stachyose (1.4-4.1 %). The insoluble carbohydrates in soybean consist of cellulose, hemicellulose and pectin.

Cultivation :

Soybean grows well in warm and moist climate. A temperature of 26.5^{O} to 30^{O} C appears to be the optimum for most of the varieties. Soil temperature 15.5^{O} C or above favour rapid germination and vigorous seedling growth. Day length is the key factor in most of the soybean varieties as they are short day plants. Most of the varieties will flower and mature quickly if grown under condition where the day length is less than 14 hours provided that temperature is also favourable.

Soil :

Well drained and fertile loamy soil with a pH 6 to 7.5 is most suitable for the cultivation of soybean. Sodic and saline soils inhibit the seed germination

Rotation :

Mixed cropping of soybean with maize and sesamum has been found feasible and more remunerative. Soybean has tremendous scope as an intercrop in arhar, cotton and upland rice in northern India. In southern part of country, soybean has a good scope as intercrop in sorghum, cotton, sugarcane, arhar and groundnut. In central India, soybean has been found very remunerative on the fallow lands in kharif.

In general soybean requires a good seedbed with a reasonable fine texture. One deep ploughing with mould board plough followed by two harrowing or two ploughing with local plough are sufficient. There should be optimum moisture in the field at the time of sowing.

The sowing should be done in lines 45 - 60 cm apart with the help of seed drill or behind the plough. The plant to plant distance should be 4- 5 cm. The depth of sowing should not be more than 3 -4 cm. Seed rate of soybean depends upon germination percentage, seed size and sowing time.

Fertilizer and Nutrient Management :

For obtaining good yields of soybean apply 15 -20 tonnes of farm yard manure or compost per hectare. The fertilizers should preferably be placed, at sowing time, about 5-7 cm away from the seed at a depth of 5-7 cm from seed level.

Water Management :

The soybean crop generally does not require any irrigation during kharif season. However, if there were a long spell of drought at the time of pod filling, one irrigation would be desirable.

Harvesting :

Modern crop cultivars generally reach a height of around 1 metre and take 80 -120 days from sowing to harvesting. The maturity period ranges from 50-140 days depending on the varieties. At harvest, moisture content of the seeds should be 15 percent. Harvesting can be done by hand or with sickle. Threshing can be done with the mechanical soybean thresher. A moisture content of 13-14 percent is ideal for threshing.

Overview :

Soybean is a cultural variety with a large number of cultivars. The genus Glycine Willd. is divided into two subgenera, Glycine and Soja. The subgenus Soja includes the cultivated soybean, *G. max* (L.) Merr. and the wild soybean, *G. soja* Sieb. and Zucc.The soybean grows only under cultivation while *G. soja* grows wild in China, Japan, Korea and Russia. *Glycine soja* is the wild ancestor of the soybean : the wild progenitor.

Major pests of Soybean :

Soybean being the luxuriant crop, having lush green, soft, succulent and dense foliage is attacked by over 273 types of insects (Bhatnagar and Tiwari, 1993). Out of the whole range, only about 2 dozens of insects are of significant importance. On the basis of their feeding habits, soybean insects are categorised into 6 groups :

1. Seed and seedling feeders
2. Stem borers
3. Foliage feeders
4. Sap suckers
5. Flower and pod feeders
6. Storage insects

1. Seed and seedling feeders :

i) Cut worms [(*Agrotis ipsilon* (Hufn.) and *A. flammatara* (Schiff)]

ii) Field cricket (*Gryllus sp.*)

iii) Seed maggot [*Delia platura* (Meig)]

iv) White grub [*Holotrichea consanguinea* (Blan Chard)]

2. Stem Borers :

i) Girdle beetles [(*Obereopsis brevis* (Swed), *Nupserha bicolor* (Thomas) *N. Nitidior* (Brug)]

ii) Stem fly [*Melanagromyza sojae* (Zehnt) and *Ophiomyia phaseoli* (Tryon)]

3. Foliage feeders :

i) Brown stripped semilooper [*Mocis undata* (Fabr.)]

ii) Green semilooper (*Diachrysia orichalcea* (Fabr.) and *Chrysodeixis acuta* (WIK.)]

iii) Leaf miner [*Bilobata subsecivella* (Zell.)]

iv)Tobacco caterpillar [*Spodoptera litura* (Fabr.)]

v) Linseed caterpillar *[Spodoptera exigua* (Hb)]

vi) Bihar hairy caterpillar [*Spilosoma obliqua* (WIK)]

vii) Green pod borer [*Heliothis armigera* (Hub)]

viii) Blue Beetle [*Cneorane sps.*]

ix) Grey weevil [*Myllocerus maculosus* (Desb)]

4. Sap suckers :

i) White fly [*Bemisia tabaci* (Genn.)]

ii) Green jassids [*Empoasca terminalis* (Dist.)]

iii) Thrips [*Caliothrips indicus* (bag), *Thrips tabaci* (Linn.)]

iv) Green sting bug [*Nezara vindula* (Linn.)]

5. Flower and pod feeders :

i) Blester beetle [*Mylabris pustulata* (Thunb), *Epicauta mannerheim* (Makl.)]

ii) Pod borer [*Cydia ptychora* (Meyrick)]

6. Storage Insects :

i) Pulse beetle [*Callosobruchus chinesis* (Linn.)]

ii) Khapra beetle [*Trogoderma graynarium*)]

iii) Almond moth [*Ephestia cautella* (Hb)]

Major Diseases of Soybean :

Soybean is also attacked by a large number of fungi. Soil borne pathogens including Phytopthora rot, charcoal rot, and brown stem rot and the soybean cyst nematode have caused the greatest losses in temperate regions. Foliage and stem diseases, bacteria, viruses, seed pathogens and root knot nematodes attacks soybean and causes great losses. The major diseases of soybean are listed below:

1. Seedling diseases and stem or root diseases caused by fungi :

i) Charcoal Rot (Ashy stem blight, Dry root rot and stem rot)

Macrophomina phaseolina (Tassi) Gold

Rhizoctonia bactericola (Taub) Butler

ii) Collar rot or sclerotial blight :

Sclerotium rolfsii (Sacc.)

iii) Frog eye leaf spot

Cercospora sojina (Hora)

iv) Anthracnose

Colletotrichum dematium f. sp. Truncatum (Schw)

v) Rust

Phacospora pachyrhizi (Syd.)

vi) Rhizoctonia aerial blight

Rhizoctonia solani (Kuhn)

vii) Myrothecium leaf spot

Myrothecium roridum (Tode ex. Fries)

2. Foliage/ Pod Diseases caused by bacteria :

i) Bacterial Pustule

Xanthomonas campestris Pv. Glycines (E.F. Smith)

3. Foliage Diseases caused by Viruses :

i) Soybean mosaic

Soybean mosaic virus

ii) Yellow mosaic

Mung bean yellow mosaic virus

Uses :

Soybean possess a very high nutritional value. It contains about 20 % oil and 40 % high quality protein, good amount of minerals, salts and vitamins. A large number of Indian and Western dishes like bread, chapatti, milk, sweets, pastries etc. can be prepared with soybean. Soybean is a primary ingredient in many processed foods like soybean oil, tofu, veggie burgers, soynut butter, dairy product substitutes (eg. margarine, soyice, cream, soy milk, soy yogurt, soycheese). Soybeans are processed to produce a texture similar to other foods (eg. butter, ice - cream, milk, olive oil, potato chips etc.). Soybeans are used in industrial products like oils, soap, cosmetics, resins, plastics, inks, solvents and clothings. Soybean oil is the primary source of biodiesel in the US, accounting for 80% of domestic biodiesel production. Soybean oil is used for manufacturing vanaspati ghee and several other industrial products. Soybean is used for making high protein food for children. Soybean is widely used in the industrial production of different antibiotics. Soybean was considered sacred for its use in crop rotation as a method of fixing nitrogen. Soybean builds up the soil fertility by fixing large amount of atmospheric Nitrogen. It can be used as fodder and forage. Its forage and cake are excellent nutritive foods for poultry and livestock. Soybean being the richest, cheapest and easiest source of best quality proteins and fats and having vast multiplicity of uses as food and industrial products is sometimes called a wonder crop. Today very high quality textile fibres are made from okara (soy pulp).

About pesticide :

The present world population of 6 billion is likely to cross 8 billion mark by 2025 and 90% of this increase would occur in developing countries. In hierarchy of human need, the provision of substantial amount of food and feed products to the increasing population and environmental security comes the foremost. There are limits to the expansion of land area under cultivation. Hence most of the gains in agricultural production would come from increased productivity. The future strategies should therefore be carefully planned to sustain food production with least disruption to the fragile agroecosystem. In many developing countries an innovative approach to problems has made agriculture more knowledge intensive by developing management systems and application of modern technologies. As a result, a large number of new varieties and hybrids of food, fibre and export oriented crops having desirable traits mainly of high productivity and consumer oriented quality attributes

have been developed and released,but these hybrid varieties are badly infected and infested by various serious diseases and insect pests, which cause huge amount of loss in agricultural production and to overcome this problem, pesticides play important role. Assessment of realistic strategies indicate that to achieve such an expansion, the usage of different groups of pesticides will make an essential contribution.

In today's intensive agriculture pest and disease problems have been made worse by practices such as cultivation of high yielding varieties, increased use of irrigation and fertilizers, greater number of plants per unit area or per unit time. Such practices aim to provide an unusually rich, dense, continuously available substrate that favours the rapid multiplication of pathogens.

An important reserve for raising productivity and increasing the gross out put of agricultural products is the elimination of losses of the harvest due to pests, plant diseases and weeds. Indeed biological factors lead to losses of about 35 % of the worlds harvest. This figure includes 14% due to harmful animals and insects, 12% due to diseases and 9 % due to weeds. By groups of crops, these losses are 45% for sugarbeet and sugarcane, 37% for coffee, cacao, tea, tobacco, 35% for cereals, 33% for oil yielding plants, 32% for potatoes,32% for fibrous plants and rubber, 29% for fruits and 28% for vegetables.

The elimination of such losses is achieved by Integrated Pest Management, including agrotechnical, quarantine, physical, mechanical, biological and chemical methods. The chemical protection of plants is based on the use of various organic and inorganic compounds toxic to harmful organisms. Pesticides are defined as the chemical compounds used to control pests. Pesticides are distinguished by their high universality.

The adoption of crop protection procedures through use of pesticides therefore become essential, if the escalating demand for increased food production is to be met through already diminishing fertile land resources (Brooks and Roberts 1999). Every rouble spent on pesticides, brings in 3 - 4 roubles worth of additional crop yield and the saving in the cost of caring for crops. Pesticides have made a great impact on human health, production and preservation of food, fibre and other cash crops by controlling disease vectors and by keeping in check many species of unwanted insects and plants. Use of pesticide is inevitable and constitutes an integral part of crop management practices (Mathur 1998). With the introduction of pesticides, farm practices have undergone revolutionary changes leading to

incredible possibility that hunger can be vanished from the earth.

Although various methods are used to control pests in different pest management programmes, pesticides continue to be the major component of most of the pest control programmes and will probably remain so during the near future. In the present day agriculture, use of chemicals for management of plant diseases has not only become important but forms an essential component of various inputs for increasing productivity from limited resource.

All the world's countries at present use about 1400 chemical compounds on whose basis thousands of various formulations are produced. Total production of pesticides exceeds 2 million tonnes. Among the third world countries India was one of the first to start large scale use of pesticides for the control of insect pests of health and agriculture importance (Mehrotra, 1991). Consumption of technical grade pesticides in agriculture in India and in some of the states of India is represented in tables 1 and 2 respectively.

Table 1 : Yearwise consumption of technical grade pesticides in agriculture in India

Year	Total consumption of pesticides (MT)	Consumption (g/ha)
1994-1995	80,000	431
1995-1996	73,652	392
1996-1997	66,677	354
1997-1998	60,143	320
1998-1999	57,240	304
1999-2000	54,135	288

Ref. : Agnihotri (2000).

Use of pesticides in India commenced about 1948 - 49. The pesticide industry in India grew rapidly during the period from 1966 -1977. The total installed capacity increased from 6600 MT in 1986 to 61000 MT in 1988 - 1989. Today the total installed capacity stands at over 1,16,000 tonnes(Mathur 1998). During the last four decades, the consumption of pesticides in

India has increased several hundred folds from 154 MT in 1953 -1954 to 80,000 MT in 1994 -1995. Thereafter the general hostility to the use of pesticides has declined to the present level of 54,135 MT during 1999 – 2000. This is a good sign because we now realise that agricultural chemicals can not be wished away, these will have to be used judiciously to sustain the increase in food production that is needed to feed ever increasing population in most countries of the world.

Table 2 : Consumption of technical grade pesticides in some of the states of India

State	Gross cropped area (ha)	Consumption of technical grade pesticides (MT)	Consumption of pesticides (g/ha)
Uttar Pradesh	25,738	7,400	288
Punjab	7,693	7,100	923
Andhra Pradesh	12,783	7,000	548
Haryana	5,963	5.030	481
Gujrat	11,188	5,000	447
West Bengal	8,718	4,626	531
Maharashtra	21,418	3,942	184
Rajasthan	20,380	3,300	162
Tamilnadu	7,113	2,882	410
Karnataka	12,013	2,600	216
Kerala	3,048	1,168	383

Ref. : Agnihotri, 2000.

Chemical means of plant protection occupy the leading place as regards their total volume of application in general system of Integrated Pest Management programmes of pests and diseases of plants and of weeds. But in addition to their large merits, it is also necessary

to note the shortcomings of pesticides. They have also created some global problems. First of all their toxicity to humans and warm blooded animals, accumulation in natural conditions. The frequent use of some formulations leads to the appearance of resistant races of insects, plant pathogens, weeds and nematodes to pesticides. In addition, these chemical means eradicate both harmful and beneficial insects leading to the violation of biocoenoses, killing of birds, predatory and parasitic insects, bees etc., loss of biodiversity, biomagnification on nonbiodegradable xenobiotics in food chain, environmental degradation, socioeconomic, political and environmental problems encountered with pesticides and latrogenic diseases. The above mentioned problems come into existence particularly after green revolution. Many pesticides are extremely toxic to mammals and other nontarget organisms and plants. The extent of hazards depends on the concentration of pesticides used, amount of residue left and its toxicity.

In the tropical country like India in general and Maharashtra in particular due to lack of proper extension activities and insufficient literature supplied with pesticides, the illiterate rural people use pesticides indiscriminately. The excess use of pesticides for seed treatment or as foliar spray cause harmful effects on plants and other living organisms in nature.

Pesticides appear in the air as pollutant by drift of aerial or ground application of spray or dust formulations. As air pollutant, they may affect adversely the quality of plants (Levit,1972).The influence of pesticides on the yield can be attributed by two factors. In addition to their primary fungicide or weed killing effects often they have physiologically advantageous or depressive side effects. Indiscriminate use of chemicals to control insect pests causes environmental pollution. These chemicals are toxic to the animals as well as to the human beings. There is not much information on the effect of pesticides on plant growth and development. Pesticides influence various physiological and biochemical processes, which are mediated by several enzymes that are often altered. Some compounds are converted into pest toxic products, while a few become innocuous and still others modify the host physiology in such a way that plant acquires resistance against diseases. There are also reports that pesticides caused insults to genetic material. These insults may be genic, chromosomal or genomic leading to mutagenecity, clastogenecity and turbagenecity. When pesticides remains in food material as a residue, they cause many ill effects in man and different kinds of animals. The residue contaminate soil and may lead to ground water

pollution.

From the foregoing discussion, it is clear that further it seems inevitable that ultimate solution is a compromise which will use the smallest possible quantities of pesticides, combined with other control measures so that environmental pollution by pesticides is kept at minimum.

Very little is known about physiological response of plant to pesticide and morever the existence of different species and kinds of plants to pesticide is based on their biochemical differences in their physiological reactions to these pesticides. To control the insect pest attack and fungal diseases of soybean, different fungicides and insecticides are wide in use. Most of the farmers knowingly or unknowingly use these pesticides rather at higher doses which may seriously affect the physiological metabolism. The objective of the present investigation is to examine physiological effect of fungicide Mandy M - 45 (Mancozeb 75% WP) and insecticide Anth (Chlorpyriphos 50% + Cypermethrin 5% EC) on *Glycine max* L.Merr.

Mancozeb is a contact fungicide. It has successfully used against rust of soybean. While Anth (Chlorpyriphos 50 % + Cypermethrin 5% EC) is a broad spectrum insecticide used to control the insect pests.

The *Glycine max* L. Merr. is a oilseed crop. It is one of the important rainy season cashcrop, pre - eminent for its high protein and oil content. At present, this wonder crop is suffering a lot by over 273 types of insects (Bhatnagar and Tiwari 1993) and a large number of fungi, bacteria, viruses, root knot nematodes (Patil et al. 1995).

Mandy M- 45 (Mancozeb 75% WP) and Anth (Chlorpyriphos 50% + Cypermethrin 5% EC) are commonly used for the control of fungal diseases and insect pests respectively. The physiological and biochemical effects on soybean after the application of Mancozeb and Anth(Chlorpyriphos 50% + Cypermethrin 5%) have been investigated in the present piece of work. The application of these pesticides in the form of both seed treatment and foliar sprays was analysed. In order to select a proper range of concentrations, a vast germination study was carried out initially, using a wide range of concentrations of both the pesticides. From this study, a few selected concentrations with a proper exposure period were further selected for physiological and biochemical work. The effect of pesticides as a seed treatment followed by foliar sprays during vegetative growth was analysed with respect to different physiological

and biochemical parameters. Accordingly the work was carried out in two major parts viz. germination and growth, effect of seed treatment and foliar spray.

The dissertation consists of five chapters. The first chapter includes general information about the use of pesticides, their effects on living organisms, plant selected for the present work, and scope of present study. A precise review of the work done by pertinent to the present study is compiled in the second chapter of Review of Literature. Different analytical methods and procedures followed during the work are described in the third chapter of Materials and Methods. Results obtained are discussed in the light of recent literature in the fourth chapter of Results and Discussion. Significant findings of the present study are summarized in the last chapter of Summary and Conclusion. The literature referred in the form of research papers, research articles, reviews, books, dissertations, monographs etc. has been systematically listed in Bibliography given at the end.