STUDIES ON PESTS OF COTTON AND THEIR CONTROL

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DISSERTATION ADVISOR — SRI B. SENAPATI

DEDICATED TO MY GRAND MOTHER

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Girija Bhusan Mohanty
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CONTENTS

LIST OF TABLES

PAGE

LIST OF FIGURES

CHAPTER-I
INTRODUCTION

CHAPTER I

INTRODUCTION

The problems posed by such genetically plastic and evolutionarily resourceful organisms as insects and their interactions with a rapidly changing agriculture are too dynamic to be solved by reliance on one-component control systems, particularly by use of chemical control agents alone. It has now become evident that the new pest control strategy drawn under the name " Integrated System of Pest Management " which must be based on sound ecological principle can provide solutions to the problems rather than serving as temporary palliatives. The successful application of the pest management systems demands that the types of pest species in each ecosystem be identified first. Secondly,

thorough knowledge on the principles underlying the fluctuations of pest populations has to be gained in order to devise an effective control programme.

'Treat - when - necessary' principle, or the need-based application of pesticides against arthropod pests is the modern concept of the Pestologists. To adopt this principle, the prime need is to study the population ecology of pest / pests of a crop under different agro-climatic conditions and to determine the economic injury and economic threshold levels.

Application of minimum selective hazards which implies the minimum use of chemical control agents in such a manner that the target populations are kept just below the economic-injury thresholds has received considerable attention of the entomologists in the current decade. This principle, in addition to other advantages, will definitely reduce the adverse effects on non-target organisms, amount of environmental contaminations and minimise the cost of control. From a synthesis of these above concepts

it is evident that a pestologist is to (a) select a suitable pesticide, (b) apply it at right time at right dose, (c) apply it in right manner and (d) minimise the number of applications as far as possible.

In Orissa, cotton is cultivated in 4500 hectares area with a very low rate of production (200 kg / ha fibre). It is an admitted fact that the low yield is attributed mainly to the infestation of insect pests. Yield loss to the extent of 50 per cent by jassid and 34 per cent by bollworms in badly infested areas has been reported by Agarwal (1978). Under Orissa conditions, investigations on cotton pests except the record of Earias vitella F. and Amrasca biguttula biguttula (Ishida) by Sengupta and Behura (1957) and the preliminary studies on seasonal incidence of A. biguttula biguttula and E. vitella on okra by Senapati and Khan (1976) have not been made earlier.

Control of insect pest is a must for successful cultivation of cotton and it is an established fact that use of synthetic organic

insecticides on cotton cannot be avoided. The importance of the chemicals can be judged by the fact that 46 % of the insecticides used in India are on cotton alone. However, there are diversified opinion as to the number of applications, dose, manner of application, etc. In India the States of Gujarat, Tamil Nadu, Punjab, Haryana, Karnataka, IARI, Maharashtra, Rajasthan and Madhya Pradesh have suggested 12, 10, 8, 7, 6, 6, 6, 4 and 3 rounds of spraying respectively during the crop season (Agarwal, 1978). According to Newson and Brazzel (1966), on an average, 10.5 applications were needed as determined by population densities instead of 19.5 when the fixed time schedule or the automatic application concept was adopted. So it seems that there is ample scope for minimising the number of insecticidal applications on cotton under the supervised or economic injury level control concept.

Keeping the above facts in view, the present investigation was undertaken to (i) study the occurrence and population ecology of cotton pests, (ii) evaluate

the comparative performance of four granular insecticides, viz., carbofuran, phorate, nephosfolan and quinalphos against them through soil treatment, (iii) find out the possibility of limiting the number of applications to two, once in the vegetative stage and the other in reproductive stage to combat the early season insect pests and the bollworms respectively and (iv) assess the relative effects of granular compounds in increasing the yield through insect control.

The results of these studies along with a comprehensive review of the available literatures on the subject are discussed in the following pages.

CHAPTER-II
REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

(A) SEASONAL ACTIVITIES OF MAJOR INSECT PESTS OF COTTON :

Studies on population dynamics of major insect pests of cotton, influence of various abiotic and biotic factors on their population fluctuation and the magnitude of damage they caused to the crop in different parts of the country and abroad have been made widely by earlier workers. The information, most pertinent to the present work, are briefly discussed in the following pages :

(i) Earias vitella F. :

The incidence of the bollworm E. vitella (fabia stoll) on cotton has been studied by several earlier workers in India. Depending upon the climatic conditions and prevalence of alternate hosts and

natural enemies the insect has shown seasonal and regional variation in its occurrence and damage to cotton crop.

According to Hussain and Lal (1923) in the Punjab, the pathogenic diseases during winter reduced the population of bollworms with the result that in January and February, there were very few caterpillars in the field.

Donald (1939) reported that in Fiji islands, cotton planted in November and later was heavily infested by E. fabia, and in some cases there was shedding of the squares and young bolls of the entire first crop.

Dutt et al. (1943) reported from C.P. and Berar that E. fabia appeared in July and caused very slight damage to cotton seedlings, but its progress was reduced by heavy rains in August and September. The population increased rapidly in October and remained active until the end of the season. The larvae damaged the young shoots until the squares and bolls were produced. The author further stated that

during the interval between the harvest and sowing, the larvae of E. fabia were found until April on cotton plants and from March to August mainly on Hibiscus esculentus and perennial cotton (Gossypium arboreum). They were not observed after June on cotton plants which were allowed to remain in the field during the summer.

Khan (1965) stated that E. fabia was common and of some importance as a pest only in parts of the South-eastern, Central and Sub-mountainous (Eastern) regions of the Punjab. This insect was rare in places with extreme temperature and was common in some months in monsoon season when there was good rainfall and sudden drop in summer temperature. E. fabia was restricted to India and parts of South-east Asia, where the climate was comparatively humid and mild. Khan and his co-workers (1965) further observed that the bollworm was very common during July to October when the fruits of Hibiscus esculentus were plentiful and attacked cotton when populations had built up.

Cherian and Kylasam (1947) gave an account of bionomics of E. fabia in Coimbatore where cotton

was sown in September or October and the attack first became visible in November. High larval population appeared from the middle of December until early January and from the middle of May to July. Infestation of green bolls was low in January and increased until the crop was harvested in April.

Nangpal (1948) reported that in the Punjab, the bollworm population was the lowest during December to March and they began to multiply in April and May and were numerically most abundant during July to September.

Sengupta and Behura (1957) reported that E. fabia was a major pest of cotton in Orissa and the period of incidence was from August to December. During the early growth stage of cotton plant, the caterpillar bored into the top shoot and when bolls were formed, it bored into the bolls.

Kulkarni et al. (1958) stated that the cultivation of summer and Kharif bhindi and ratoon

crop encouraged the multiplication of spotted bollworms in Khandesh.

Katagihallimath (1962) reported that in the North Mysore districts, the bollworms first attacked the growing shoots when the cotton crop was 8 to 10 weeks old. After the formation of buds, flowers and bolls, they attacked those and infestation continued till the harvest of the crop. Incidence was more at the time of first flush of buds and flowers and boll formation. Sometimes percentage attack of buds, flowers and bolls, which were actually born on the plant (excluding those already shed), went upto 65.

Kaushik et al. (1969) reported from Indore that the peak period of infestation by Earias spp. to cotton was October to November in M.P. The caterpillars attacked the seedlings making shoots bored upto two months after germination and also the bolls and to a less extent the flowers and squares. They further stated that there was no appreciable variation in incidence between the drought years (1964-66) and the normal years (1966-68).

Rawat and Sahu (1973) estimated the percentage damage of bhindi fruits by Earias spp. and reported that in untreated plots, on the average, 22.6 % fruits were damaged in Kharif season at Jabalpur.

(ii) Amrasca biqutulla biqutulla (Ishida,) :

The jassid, A. biqutulla biqutulla (Empoasca devastans Dist.) is widely distributed on several cultivated plants in India. A critical review of the published information reveals that the insect maintained high population level in South India during the Rabi season and in Northern States of the country in the Kharif season.

Cherian and Kylasam (1938) reported that in Coimbatore the jassid E. devastans was started its activity from October and reached its peak in December and January, after which the population went down. The insect maintained very low population in the months of April and May.

Hussain and Lal (1940) observed the cessation of activities of the jassid under the Punjab conditions

for two months beginning from last week of January. From the end of June, cotton seedlings were attacked and from this time bhindi and American cotton were heavily infested till November. From the beginning of November, the population declined on both the crops, but it appeared on potato, hollyhock and brinjal and survived throughout the winter.

Observation of Lal (1941) indicated that the maximum infestation of cotton crop by E. devastans in different locality depended on several factors, the main factor being the time, the crop came to the most susceptible stage. In North-west India, this period was from July to September, but in South India it was December to January. Multiplication was rapid in warm and humid weather.

Abbas and Afzal (1946) carried out a survey from July, 1940 to October, 1942 to determine the species of jassid present on cotton in different parts of the Punjab. According to their observations, the population of E. devastans was initially low but increased towards the end of the season.

Afzal and Ghani (1946) reported that under the Punjab conditions, jassids appeared on cotton crop in early July, about a month or half after sowing of the crop with very low population. The population reached its peak generally in mid-August and remained high throughout September. It declined during October and the insects practically disappeared from the cotton crop in November. Years of high rainfall and consequent relative humidity synchronised with heavy jassid infestation. The authors expressed the relationship by the following mathematical equation:

$$JI = 1.5227 + 0.025527\ R + 0.50425\ H$$

when, JI = Jassid Index (Log average jassid infestation + 1)

R = Total rainfall during the jassid season

H = Average relative humidity during jassid season.

Their further studies on the fluctuation of jassid population in 1953 confirmed the above observations. Delay in sowing and wide spacing encouraged multiplication of the jassid population.

Maximum damage to cotton crop by E. devastans in the Punjab and Sind was found from July to September in Kharif season and in the Southern States (Madras, Mysore and parts of Hyderabad) from December to January in Rabi season (Nangpal, 1948).

Phandish (1954) stated that in Bombay excessive rainfall was conducive to the development of jassids.

Sengupta and Behura (1957) considered E. devastans as a major pest of cotton in Orissa. In the beginning of the season, the infestation by the pest was light until mid-September, after which the population increased rapidly and reached its peak at the end of October. The jassid population declined after October until February, when few jassids were left on the plants.

According to Appa Rao et al. (1959) the nymphal population of the jassid increased with the increase of nitrogen level. Between the two sources of nitrogen, plots receiving ammonium sulphate attracted more jassids than groundnut cake.

Katagihallimath (1962) reported that the jassid appeared for the first time on cotton when the seedlings were three to four weeks old and continued till harvest. Its occurrence followed the incidence of thrips but sometimes they appeared together. The peak period of incidence was observed during August and September on Kharif crop and December on Rabi crop in north Mysore districts.

Studies on population dynamics of E. devastans were carried out by Jayraj and Basheer (1964) at Coimbatore on Bhindi in 1960. The weekly counts of adults and nymphs indicated higher population level in the humid North-east monsoon season than in the comparative dry South-west one. A negative correlation was found between the minimum temperature and the cicadellid population, but maximum temperature, relative humidity and rainfall appeared to have no significant effect on the jassid number. Population of E. devastans was low on plants infested by Aphis gossypii Glov.

Jayraj and Venugopal (1964) reported that application of nitrogen at 22.4 lb / acre could

significantly increase the incidence of jassids on cotton field. None of the other nutrients influenced the incidence of jassids. The population of the leaf-hopper was reached its peak during the sixteenth week after sowing because of the palatability of the crop at this stage.

Results of field studies on population density of E. devastang on cotton in two places of Cairo showed that climatic factors were responsible for higher jassid population. Adults appeared two weeks before the nymphs appeared on the plants and the jassid incidence reached at peak between early August and mid-September. Females comprised 100 % of the population at the beginning of the season in April, but fell to 22 - 47 % of the total by September (Hosny and El-Dassouki, 1967).

Atwal et al. (1969) recorded population of cotton jassid for two years in the Punjab and observed its peak in August and September when the temperature ranged from 28.3 to 30° C and the relative humidity from 50 to 70 % in 1965 and 74 to 83 % in 1966. The

authors observed low population of the insect in the peak period of second year and opined that it was due to high humidity.

Hassanein et al. (1971) reported that in 1964-65 heavy incidence of Empoasca spp. was observed on cotton crop sown on 13th February than a crop sown on 16th March. The population was at its peak in late May and early August.

Senapati and Khan (1976) studied the seasonal activity of A. devastans on bhindi during 1975-76 at Bhubaneswar. According to them, the jassid occurred throughout the year on bhindi and maintained high population during the months of December and January. From March to June, the jassid incidence was low which had been attributed to warm weather during these months.

(iii) Aphis gossypii Glov. :

Several earlier workers have studied the seasonal occurrence of A. gossypii on cotton and effects of its incidence on growth and yield of the crop in India and abroad. According to the opinion of these

past workers, the abiotic factors chiefly temperature and humidity and the biotic factors mainly the prevalence of natural enemies in a locality had profound influence on population density of the aphid and consequently on the magnitude of loss to cotton crop.

Preliminary investigations conducted by Yakhontov (1929) in Eastern Uzbekistan on aphids attacking cotton indicated that the crop was infested by several species of aphids including A. gossypii and A. flava which were the predominant species in August. In the same area, Stepantzev (1939) observed two peaks i.e. May - June and August - September in occurrence of this aphid. Further observations of the author on population fluctuation indicated that weather conditions had profound influence on abundance and distribution of the aphid. Low temperature and high humidity were favourable for the aphid. The author concluded that weather with the daily mean temperature of about 20° C and relative humidity of about 60 % was the optimum for its mass increase.

Tseng and Tao (1936) reported that in 1934 infestation of cotton crop by A. gossypii in Shantung

resulted in reduction of bolls from over 10 per a healthy plant to 3 per infested plant and in 26.53 % plants, there was no boll formation. The loss in yield was 71.86 %. The other effect of aphid infestation was manifested by delayed boll opening, lowering the strength of the fibres and deterioration of spinning quality.

Mc Garr (1942) reported that the use of nitrogenous fertilisers or nitrogen producing crops grown before cotton on the same land stimulated the development of A. gossypii. Application of nitrogenous fertiliser alongwith calcium arsenate favoured multiplication of aphid.

According to Mc Knistry (1946) in London A. gossypii appeared on cotton in isolated groups of plants in mid-February. There was a marked increase in population during April and early part of May, which affected the yield of the crop.

Young and Garrison (1949) reported that in Tallulah and Louisiana incidence of A. gossypii commenced from the seedling stage of cotton until the plants were defoliated by frost.

Describing the occurrence of A. gossypii in Sao Paulo and the effect of its incidence, Calcagnolo and Sauer (1954) reported that the infestation began from twenty to thirty days after germination of the cotton seedlings. The aphid inflicted deformation and retardation of growth of the crop and heavy infestation caused reddening of the leaves which dried up and fell. Sometimes the attack was delayed until the appearance of the buds and flowers which shed due to aphid infestation.

According to Katagihallimath (1962) the aphid appeared on cotton when the crop was 3 to 4 weeks old. The incidence was conspicuous on 6 to 8 weeks old plants, but the highest population was observed on 8 to 10 weeks old crop during November to December. The author concluded that insecticides might be applied after 4 weeks of germination and second application be given on eight to nine week old crop.

Weisman et al. (1971) studied the population dynamics of A. gossypii on cotton in the arid conditions

of upper Egypt from third May to twentyth July, 1969. Their results revealed that the abiotic factors like temperature and humidity had marked influence on population fluctuation of the aphid and the crop in the beginning of flowering or after irrigation succumbed to aphid infestation more than its other stages. At this time, the transpiration of the plants increased, creating conditions favourable for the development of A. gossypii in the lower part of the canopy.

Hassanein et al. (1971) reported that in the Assiut region of Egypt, the population of A. gossypii and A. craccivora were very high from 1st March to 1st April on cotton sown on 13th February. After 1st April, the population gradually declined. There were three population peaks during July to mid-August. It was also observed that the nymphs were numerous than adults and the alate form of A. craccivora migrated to cotton from leguminous plants. The author concluded that the best date for sowing cotton in Assiut region was the first week of March.

Ismailov and Gasanov (1974) reported from Shirvan stepple area of Azerbaidzhan that A. gossypii

infested 60 % of plants in normal year and 100 % in moist ones. The aphid overwintered on weeds or plants in nymphal or adult stages, then reproduced massively in Spring and migrated to cotton or any economic plant in mid-May when the crop was at 2 - 3 leaf stage. The reproduction was continuous until late June and the population decreased with commencement of natural enemies and hot weather. The population on cotton increased again towards autumn, but feeding damage at this stage was less important than excretion, which spoiled the lint. The above damage mainly occurred in the valley of the river Kura, where air humidity was high and require control measures.

Armentac and Rodriguesv (1974) examined cotton fields in the State of Sinaloa, Mexico at weekly intervals and observed that in the beginning of the season A. gossypii was the most abundant on cotton crop grown in November.

(iv) Scirtothrips dorsalis Hood.

Available literatures on occurrence and seasonal activity of S. dorsalis on cotton are inadequate.

Katagihallimath (1962) reported that S. dorsalis occurred as a major pest on cotton in north Mysore districts. When the seedlings were two to three weeks old the thrips appeared on the field and the infestation continued till harvest. The insect caused maximum damage when the crop was three to eight weeks old. In case of Rabi season when the crop was three to six weeks old the leaves became curled up and turned brown bronzy due to heavy attack of the thrips. In serious cases, the leaves dried up and fell down where the cultivators called it as 'adhura roga'. The crop at 12 to 16 weeks age also succumbed to thrips attack very badly.

(v) Sylepta derogata Fabricius :

The leaf-roller, S. derogata is considered as a sporadic pest of cotton, but could inflict severe damage to the crop when the larval population is increased during the flowering and fruiting stage of the cotton plants.

Sen (1923) reported that the leaf-roller, S. derogata was a serious pest of cotton with large

leaves, which it attacked from July to October in the State of Bengal. The larvae rolled the leaves and feed on it leaving the shelter part. As the moth lays eggs on lower part of leaves the young larvae feed on the epidermis for a few days before beginning to roll the leaf.

Monteil (1934) reported from Paris that the injury caused by S. derogata F. to cotton leaves was most serious during flowering and fruiting season (August - October).

Soyer (1935) stated that cotton plants infested by S. derogata could be recognised by the rolled leaves. The larvae did not move far from the point of oviposition and remained grouped around one centre on the plant. The injury was serious when the larvae were numerous and destroyed sufficient foliage to impair the development of the plant. The author suggested that the infestation could be avoided by early planting in Belgian Congo.

According to Golding (1938) in Nigeria, S. derogata was unusually numerous in August and

September, 1937, in areas of early sown cotton, because the length of the dead season was reduced.

From Burma, Bate (1939) reported that the foreign cotton varieties were damaged seriously by S. derogata. The infestation could be reduced by delaying the sowing upto August.

Katagihallimath (1962) described S. derogata as a sporadic pest which became active during the period from September to December in North Mysore districts. The peak period of incidence was November.

Thimmaiah et al. (1975) tested three varieties of cotton in Karnataka for resistance to S. derogata. The average number of leaves rolled per plant was 7.7 for hybrid-4, 3.0 for Varalaxmi and 4.4 for JK-97. The authors suggested that the susceptibility of hybrid-4 was a result of its soft broad leaves, in comparison to the thick coarse leaves of Varalaxmi.

(B) EFFECTS OF GRANULAR INSECTICIDES ON INSECT PESTS OF COTTON :

During recent years, much emphasis has been given on the replacement of sprayable and dust

formulations of pesticides by granules, capsules, etc. mainly because the latter groups offer ecological selectivity in their action. Several past workers have used the granular insecticides against pests of cotton, particularly the sucking pest complex with varying degrees of success. However, reports on the use of the newer granular compounds on cotton are inadequate.

(1) Toxicity of phorate :

In the past, phorate has been successfully used against several sucking pests of cotton. Its application to soil in-furrows during sowing, treatment of seeds or impregnation of the compound with fertilisers at varying doses proved effective in reducing the early season attack of pests and considerably increased the yield of seed cotton.

Macskaylo and Clark (1957) treated cotton seeds with thimet and observed that the treated seeds germinated earlier to the untreated seeds. Seed treatment with thimet gave protection of cotton plants from the attack of A. gossypii upto 49 days after sowing. In 1961, the author alongwith his co-workers

further observed that the application of phorate granules at 1.7 lb / acre in the furrows at sowing time was almost equal to seed treatment at 1 lb / acre in combating A. gossypii for nine weeks after sowing.

Sithanantham (1973) evaluated the endotherapeutic efficacy of insecticides by seed coat application. Among four insecticides disulfotan found to be the best at the dose of 1, 2 and 4 % ai. At the highest dose disulfotan and phorate brought about effective mortality of aphids within 72 hours upto seven weeks, while it was only five weeks for dimethoate. BHC was not effective as a systemic insecticide. The persistency was higher in case of disulfotan followed by phorate and dimethoate. The knock-down effect of the insecticides was found to be influenced directly by the dose and inversely with the increase in time lag after sowing.

Ivy et al. (1957) reported that treatment of cotton seeds with thimet at 4 lbs / 100 lbs of seeds gave promising results in controlling the

sucking pests like A. gossypii, A. grandis and T. tabaci. There was no adverse effect on germination or growth of the plants at 4 to 8 lbs of the compound per 100 lbs of seeds, but the insecticide at 16 or 30 lbs / 100 lbs of seeds caused small necrotic lesions on leaves.

In Sao Paulo, Padigas and Giannotti (1959) conducted experiments with systemic insecticides against the early pest attack on cotton. Phorate and di-syston were used as powders in activated carbon and applied to the seeds at 2 % of its weight. Phorate granules were applied to the furrows at the time of sowing at an equivalent-rate. The results revealed that the three treatments gave good control of thrips (Hercothrips and Frankliniella spp.) for 38 days and of A. gossypii for 66 days, but di-syston was still effective after 101 days when the infestation was at its peak.

In Formosa, Tsai and You (1961) evaluated the effectiveness of phorate as soil treatments against Empoasca (chlorita) biqutulla and A. gossypii.

At the sowing time 10 % phorate granules at 2 lbs ai/ acre were applied into the furrows on 16th May at the depth of 1 cm, under the seeds, immediately beneath the seeds or laterally 3 cm from the seeds. Observations in June - July showed that both pests could be controlled without any significant difference between the methods of application. In another experiment, the insecticide was applied to soil at sowing time on 22nd June or as side dressing on 3rd August at 1 or 2 lbs ai./ acre. The result revealed that the furrow treatment significantly reduced the population of E. biqutulla and A. gossypii for 53 and 72 days respectively. When the dose was increased to 2 and 4 lbs ai./ acre as side dressing, the insecticide gave good control of both the pests for 49 days and remained toxic for 80 days. All the treatments though increased the yield were not effective against E. fabia.

Fadigas and Suplicyfiko (1961) applied granular di-syston and phorate into furrows, separately or in combination with fertilisers against cotton pests in Sao Paulo and found that di-syston controlled

A. gossypii better than phorate against ants and thrips (Frankliniella sp. and Caliothrips sp.). All the insecticidal treatments reduced germination, particularly where the insecticides were added to the fertiliser. The authors suggested not to mix these two compounds with fertilisers for control of cotton pests.

Ridgway et al. (1967) evaluated phorate, disulfotan and cyanamide CL 47031 against cotton pests in green house and field conditions in Texas. The insecticides were applied to soil either alone or with fertilisers. The initial uptake of the toxicant by the plant was greater from the insecticide and fertiliser mixture. The results indicated that the insecticides gave similar effects in controlling A. gossypii, A. grandis and Frankliniella spp. by both the methods of application.

Regupathy and Jayraj (1973) reported that phorate, disulfotan, methyl-demeton and dimethoate as granules at 0.5 and 1.5 kg ai./ ha were more effective than the sprays in controlling A. gossypii and A. devastans. The most effective chemical was

disulfotan followed by phorate, methyl-demeton and dimethoate. Pest resurgence was noticed from eighth week after sowing and reached maximum during the eleventh week.

In 1971-74, Dhanorkar applied several granular insecticides at 1 kg ai./ ha against three sucking pests of cotton, such as A. bigutulla bigutulla, A. gossypii and T. tabaci. In most of the years, the population of all the three species were significantly lower than the untreated plots. Di-syston and aldicarb proved the best of all the compounds tested in controlling the jassid, aphid and thrips. These two insecticides and phorate were significantly more effective than carbofuran and dimethoate against A. gossypii in 1971-72. Significantly higher yield was harvested from plots receiving di-syston, aldicarb and carbofuran in 1971-72, but in 1972-74 except dimethoate, application of other insecticides resulted in significantly greater yield than control.

The results of laboratory tests conducted in Egypt by Abdel-Gawaad and Shazli (1970) revealed

that based on LD 50 values phorate was the most toxic insecticide followed by disulfotan, gamma-BHC, DDT, thiometon and carbophenothion to the pre-pupae of T. tabaci.

Gawaad and Shazli (1971) reported that phorate and disulfotan at 2 and 4 kg ai./ ha as seed and soil treatments were found superior to heptachlor, carbophenothion, lindane, DDT in controlling T. tabaci on cotton seedlings.

Sorour (1968) grew cotton plants in pots from seeds coated with phorate or di-syston at 3 kg / 44 kg of seeds and from untreated seeds in Egypt and observed that the two insecticides caused faster seedling emergence at the early stage followed by a slight reduction in emergence percentage as compared with the untreated series. However, in the final count, the number of seedlings was almost same in treated and untreated pots. The insecticides did not affect the growth and fruiting qualities rather increased the yield of seed cotton without affecting the boll size, seed and lint index.

(ii) Toxicity of Carbofuran :

Literatures on the use of granular carbofuran against pests of cotton are inadequate.

Beckham (1967) reported that in 1965-66, application of granular aldicarb, carbofuran, Niagara 10242, disulfoton and phorate in furrows at various dosages resulted in reducing the population of five species of thrips for 4 to 6 weeks. In 1967-68, the author evaluated eleven systemic insecticides alone or in combination by applying to furrows at sowing time against Frankliniella spp. on cotton. All the insecticides including carbofuran and phorate significantly reduced the population of thrips on cotton seedlings when compared with no treatment. However, there was no significant increase in yield of seed cotton in any of the treated plots.

The results of field experiments conducted by Bindra et al. (1973) in the Punjab for the control of Dysdercus fabaei, D. bigutulla bigutulla and D. cingulatus on cotton with soil application of granular

insecticides suggested that though all treatments reduced infestation upto 10 weeks, the best results were obtained with disulfotan, phorate and carbofuran at 1 to 1.5 kg ai./ ha. With aldicarb and fensulfothion control did not last long. Higher yield in 1969 was obtained with all treatments but in 1970 the plot treated with disulfotan gave significant increase in yield when compared with no treatment.

(iii) Toxicity of Quinalphos :

Information on the use of granular quinalphos against pests of cotton are lacking. However, the insecticide has been used as sprays with varying degrees of success in controlling the cotton pests.

Sundarmurthi et al. (1973) in Tamil Nadu, carried out a field experiment on control of cotton pests with chemicals during 1971-72 and found that the spray application of monocrotophos, endosulfan, quinolphos, and a mixture of dicrotophos and DDT, quinolphos and DDT and chlorofenvinphos and DDT gave promising results in controlling the larvae of Earias spp., Pectinophora gossypiella and Heliothis armigera on irrigated Cambodia cotton and resulted in higher yields.

Singh et al. (1974) evaluated 10 insecticides against B. tabaci and A. biguttula biguttula on cotton in Ludhiana. The insecticides were applied as sprays twice at an interval of two weeks. Promising results in controlling both the pests were obtained with quinolphos, carbofuran and mephosfolan at 0.025 and 0.05 %.

Parameswarn et al. (1976) tested nine insecticides against bollworms. Each compound was applied six times as spray at fortnight interval commencing from 50th day of sowing and the quantity of spray fluid was kept at 1000 litres / ha. The incidence of bollworms was recorded once prior to each spraying and after 15 days of the last spraying. The results indicated that all insecticides were significantly effective compared to the untreated check. The bollworm incidence was low in plots sprayed with monocrotophos, quinolphos, chlorofenvinphos, tetrachlorofenvinphos, and carbaryl + sulphur, which resulted in higher yields.

(iv) Toxicity of mephosfolan :

In majority of the cases reported mephosfolan as sprays gave promising results in the control of

borers and sucking pests of cotton. Information on its efficacy as granules against pests of cotton are not available.

Badawi (1971) reported from Sudan that cytrolane 500 emulsion concentrate and malathion at 450 ml in 3 litres of water / ha gave approximately similar results against P. gossypiella and E. insulana. The damage of bolls in untreated, cytrolane and malathion treated plots was 21.3, 13 and 11.7 per cent. The percentage of bolls containing larvae was relatively high after 19 days but decreased after 39 days of treatment. Further studies by the author and his co-workers (1972) revealed that low volume concentrate of malathion and DDT at 1.5 litres / ha, cytrolane 500 emulsion concentrate at 750 ml / ha, carbaryl 85 % WP at 2.25 lbs / ha and a mixture of DDT, methyl-parathion and toxaphene 5 % at 2 litres / ha were effective against P. gossypiella and E. insulana. Cytrolane was effective for 4 weeks.

Zeid et al. (1972) tested 26 insecticides against larvae of Spodoptera littoralis on cotton in laboratory and field conditions in Egypt. Cytrolane,

cyolane and monitor at 325 - 350 g ai./ 4200 sq m gave promising results. These insecticides afforded good mortality and effectiveness was retained for a considerable period in the field.

Lindley and Seval (1973) carried out an experiment in Southern Turkey from 1968 to 1969 for control of S. littoralis with spray applications of cyolane and cytrolane. Cyolane at 0.75 and 0.875 kg ai./ ha was effective against the larvae of all size giving high initial kill and persisted for 14 days, but cytrolane was less effective than cyolane.

Hassan et al. (1975) in Egypt reported that spraying of mephosfolan, methamidophos, monocrotophos and phosfolan gave good result against aphids, cicadellids, white flies and red spider mites. Methamidophos and mephosfolan were effective against S. littoralis and monocrotophos and mephosfolan against E. insulana and P. gossypiella. Increase in boll formation was observed in plots treated with monocrotophos.

CHAPTER-III
MATERIALS AND METHODS

CHAPTER XII

MATERIALS AND METHODS

Investigations on the seasonal activity of certain insect pests of cotton such as the jassid, Amrasca biguttula biguttula (Ishida), the aphid, Aphis gossypii Glov., the thrips, Scirtothrips dorsalis Hood., the spotted bollworm, Earias vitella F. (fabia, stoll) and the leaf-roller, Sylepta derogata Fabricius, and their control with granular insecticides were undertaken at Bhubaneswar Research Station during the year, 1977-78. The methods adopted and materials used for these studies are described below.

(A) SEASONAL ACTIVITY :

Cotton, Gossypium hirsutum L. was grown in a plot of 12 x 10 metre area in the University Agricultural Farm once in every four months beginning from August, 1977 to April, 1978 to permit studies

on the seasonal incidence of various pest species. The crop was available in the field from first week of September, 1977 to the last week of August, 1978.

(i) Incidence of E. vitella :

Weekly observations on infestation of shoots, flowers and bolls by the spotted bollworm were taken. On each day of observation, ten cotton plants were randomly selected and the total number of shoots and number of affected shoots were counted on each plant. During the reproductive stage of the crop total number and the affected number of flowers and bolls were counted to determine the percentage infestation. The percentage damage of shoots, flowers and bolls separately and together were estimated.

(ii) Population fluctuation of important sucking insect pests :

The sucking insect complex on which the studies on population dynamics were made comprised of A. biguttula biguttula, A. gossypii and S. dorsalis. Observations on the nymphal and adult populations of

these three species were taken every week beginning from first week of September, 1977 to last week of August, 1978. On each day of observation, ten plants were randomly selected and from each plant, three leaves, one from the top, one from the middle, and the other from the bottom were selected for sampling. The nymphs and adults of the three insect species present on either side of the leaf samples were counted. The size of each leaf was measured by graph paper in the field and the number of jassids, aphids and thrips per 100 sq cm area was calculated.

(iii) Distribution of sucking insects on different leaves of cotton plant :

Observations on distribution of A. bigutulla bigutulla, A. gossypii and S. dorsalis on cotton leaves were taken once on a two month old crop which was sown in the month of November, 1977. The adult and nymphal population was recorded on all leaves of a plant and 10 such plants were examined randomly. The percentage population of jassid, aphid, and thrips on different leaves was calculated.

(iv) Incidence of S. derogata :

Population of larvae and pupae of the leaf-roller was recorded once in a week on 10 randomly selected plants. Observations were also taken on the total number of leaves and number of rolled leaves on these 10 plants and percentage of infested leaves was estimated.

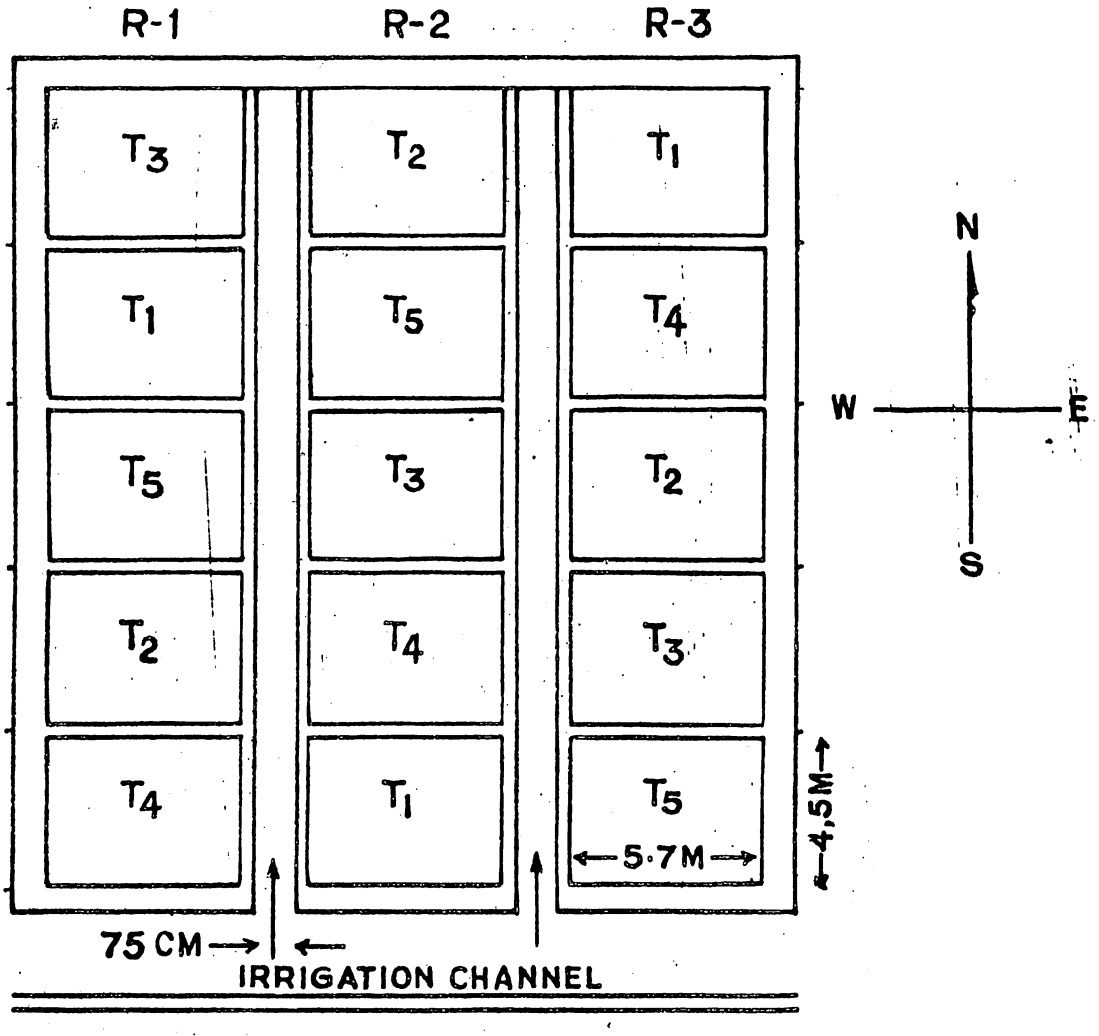
(B) FIELD EXPERIMENT :

(i) Field layout and sowing :

The experimental plot measured 24 x 20 m which was divided into 15 equal sized plots of 5.7 x 4.5 metre each. The experiment was laid out under randomised block design and there were three replications. Each replication was separated from the other by a 75 cm channel and each plot from the neighbouring plot / plots by a 50 cm wide bond. Cotton seeds were sown on 25th November maintaining the spacing of 60 x 25 cm. The plant population in all the plots were almost uniform.

(ii) Insecticides used :

The details of the granular insecticides used and the method of their application during the course of this study are given below :



DESIGN – RANDOMISED BLOCK DESIGN
REPLICATION – 3
TREATMENTS → 5 (INCLUDING UNTREATED CHECK)
NO. OF PLANTS PER PLOT – 54

T_1 – PHORATE (THIMET)
T_2 – CARBOFURAN (FURADON)
T_3 – QUINOLPHOS (EKALUX)
T_4 – MEPHOS FOLAN (CYTROLANE)
T_5 – UNTREATED CHECK

Fig.-1 PLAN OF LAYOUT

Name of the insecticides	Source	% of ai in the product	Dose kg of ai/ha
Phorate (Thimet)	M/S Cyanamide India Ltd.	10 G	1.5
Carbofuran (Furadon)	M/S Rallis India Ltd.	3 G	1.5
Quinolphos (Ekalux)	M/S Sandoz India Ltd.	5 G	1.5
Mephosfolan (Cytrolane)	M/S Cyanamide India Ltd.	5 G	1.5

The insecticides were applied in localized placement method at a depth of about 4 cm in rings around each plant. The first insecticidal treatment was given on 7th February, 1978 and the second on 22nd March, 1978, when the crop was 65 days and 107 days old respectively.

(iii) Pest species concerned and sampling technique :

The insecticides were evaluated against two sucking insect pests, viz., A. bigutulla bigutulla

and S. dorsalis and the bollworm, E. vitella which occurred on the trial crop. Observations on the incidence of these pests were taken one day before and one, three, seven and fourteen days after application of the insecticides. The techniques employed for sampling the pests or observations on their incidence were same as described under the studies on " seasonal activity ".

(iv) Yield :

The dried bolls were picked up treatmentwise separately. There were six pickings altogether. The seed cotton obtained from each treatment was weighed and the data were subjected to statistical analysis.

(v) Presentation of Experimental findings :

The modified Abbott's formula reported by Holmes et al. (55) was used to find out the percentage control of different pests by the insecticides. The formula is :

$$\% \text{ Control} = \left(1 - \frac{TA \times CB}{TB \times CA} \right) \times 100$$

where, TB and TA and CB and CA are the number of insects in treated and control plots

both before and after the insecticidal applications respectively.

The data of the field trial were subjected to statistical analysis to find out the critical differences between the treatments.

CHAPER-IV
RESULTS

CHAPTER IV

RESULTS

(A) OCCURRENCE AND SEASONAL ACTIVITY OF INSECT PESTS OF COTTON :

Observations on occurrence and seasonal activity of insect pests of cotton were made from first week of September, 1977 to the last week of August, 1978 at Bhubaneswar. Incidence of three sucking pests, viz., the jassid, A. bigutulla bigutulla, the aphid, A. gossypii and the thrips, S. dorsalis and two lepidopterous pests viz., the spotted bollworm, E. vitella and the leaf-roller, S. derogata was observed on the crop during the one year period. The jassid, the thrips and the bollworm occurred on cotton throughout the year whereas the other two pest species were recorded in certain months.

(i) Seasonal incidence of E. vitella :

The data on the incidence of bollworm embodied in Table 1 indicate that the percentage damage of shoots, flowers and bolls together of cotton by the insect was the highest (18.86) during the month of April, 1978 and the lowest (2.66) in December, 1977 (Fig. 2). The bollworm inflicted appreciable damage to the crop during the months from March to August, 1978 and its incidence was low in September, 1977 to January, 1978. The results of comparative study on shoot, flower and boll infestation indicated that the bollworm preferred flowers followed by bolls and shoots. The highest percentage damage of flowers was recorded during the second week of April, 1978 (56.66), the average of four weekly observations for the month being 37.88. Damage to shoot was the maximum in the second week of June (24.08 %) and that to bolls in third week of May, 1978 (33.10 %).

Table 1

Seasonal incidence of E. vitella on cotton from September, 1977 to August, 1978 at Bhubaneswar

Month	* Percentage damage of			
	shoot	flower	boll	shoot + flower + boll
September,1977	2.63	0.88	1.25	2.88
October,1977	3.26	5.66	4.96	5.02
November,1977	0.85	10.00	4.06	3.71
December,1977	2.66	0	0	2.66
January,1978	2.95	0	0	2.95
February,1978	3.23	6.24	0.62	4.36
March, 1978	5.94	18.10	7.99	11.23
April,1978	10.55	37.88	9.18	18.86
May, 1978	10.55	21.42	24.80	14.27
June,1978	16.36	12.95	6.58	18.29
July,1978	13.86	11.68	8.63	13.83
August,1978	13.18	6.32	7.72	11.55

* Average of 4 or 5 weekly observations for each month

(ii) Incidence of S. derogata :

The leaf-roller, S. derogata occurred on cotton from September to November, 1977 on the crop sown in August, 1977 and in April and May, 1978 on the crop sown in November, 1977. Its incidence was not seen until August, 1978 when a few larvae and pupae were observed on the cotton crop sown in April, 1978 (Table 2 and Fig. 2). The data on percentage damage of leaves revealed that the insect caused the highest damage in the month of October during which highest larval population was recorded.

(iii) Population fluctuation of A. biguttula biguttula :

The jassid, A. biguttula biguttula occurred on cotton throughout the year and maintained high population, compared to other months, from January to March, 1978 with its peak in the month of January (Table 3 and Fig. 3). The population from September to November, 1977 and from May to August, 1978 was very low. The jassid started increasing in number from the second week of December, 1977 and reached its peak in third week of January, 1978. From second

Table 2

Larval and pupal population of *S. derogata* and percentage infestation of leaves in different months from Septeber, 1977 to August, 1978 at Bhubaneswar

Month	* Population / plant			* Leaves infested (%)
	larvae	pupae	total	
September,1977	3.47	0.07	3.54	3.73
October,1977	5.42	0.30	5.72	15.52
November,1977	0.97	0.07	1.04	6.32
December,1977	0	0	0	0
January, 1978	0	0	0	0
February,1978	0	0	0	0
March,1978	0	0	0	0
April,1978	1.02	0.20	1.22	4.22
May, 1978	0.17	0.10	0.27	1.93
June,1978	0	0	0	0
July,1978	0	0	0	0
August,1978	0.20	0.03	0.23	0.74

* Average of 4 or 5 weekly observations for each month

Table 3

* Population density of A. bigutulla bigutulla on cotton in different months from September, 1977 to August, 1978 at Bhubaneswar

Month	Population / 100 sq cm leaf area			
	adult	nymph	total	adult : nymph
September,1977	0.30	0.40	0.70	1 : 1.33
October,1977	0.06	0.43	0.49	1 : 7.16
November,1977	0.05	0.22	0.27	1 : 4.40
December,1977	0.48	2.17	2.65	1 : 4.31
January,1978	0.61	6.52	7.13	1 : 9.04
February,1978	0.76	5.47	6.23	1 : 7.19
March,1978	0.48	4.06	4.54	1 : 8.45
April, 1978	0.06	1.65	1.71	1 :27.50
May, 1978	0.05	0.11	0.16	1 : 2.22
June,1978	0.01	0.17	0.18	1 :17.00
July,1978	0.05	0.12	0.26	1 : 2.40
August,1978	0.26	0.22	0.48	1 : 0.84

* Nymphal and adult population was counted once in every week on 10 plants and monthly average has been calculated basing on 4 or 5 weekly observations.

week of March, a gradual decrease in population trend was observed. The ratio of adult and nymph ranged from 1 : 1.33 to 1 : 27.50 in different months.

(iv) Population fluctuation of A. gossypii :

The data on population density of the aphid, A. gossypii on cotton in different months are presented in Table 4 and Fig.3. Occurrence of this aphid on cotton was observed from the first week of September to first week of February, 1978 after which it disappeared until the third week of July. The aphid maintained high population level in December and January with the peak period of infestation from the fourth week of December to first week of January.

(v) Population fluctuation of S. dorsalis :

The population density of S. dorsalis estimated for 100 sq cm leaf area in different months are presented in Table 5 and Fig.3. The insect maintained a high population from January to March, 1978. From third week of March the population

Table 4

* Population density of A. gossypii on cotton in different months from September, 1977 to August, 1978 at Bhubaneswar

Month	Population / 100 sq cm leaf area		
	adult	nymph	total
September, 1977	3.70	14.48	18.18
October, 1977	8.82	17.26	26.08
November, 1977	3.51	5.78	9.29
December, 1977	17.99	21.18	39.17
January, 1978	18.47	27.14	45.61
February, 1978	0.38	0.55	0.93
March, 1978	0	0	0
April, 1978	0	0	0
May, 1978	0	0	0
June, 1978	0	0	0
July, 1978	2.71	1.56	4.27
August, 1978	10.05	13.38	23.43

* Nymphal and adult population was counted once in every week on 10 plants and monthly average has been calculated basing on 4 or 5 weekly observations

Table 5

* Population density of S. dorsalis on cotton in different months from September, 1977 to August, 1978 at Bhubaneswar

Month	Population / 100 sq cm leaf area		
	adult	nymph	total
September, 1977	1.02	0.78	1.80
October, 1977	0.72	0.65	1.37
November,1977	0.70	0.63	1.33
December, 1977	1.13	1.37	3.50
January, 1978	4.73	5.84	10.57
February, 1978	10.85	5.75	16.60
March, 1978	5.58	6.21	11.79
April, 1978	1.26	1.01	2.27
May, 1978	0.82	1.41	2.23
June, 1978	0.47	0.34	0.81
July, 1978	1.08	1.05	2.13
August, 1978	1.21	1.55	2.76

* Nymphal and adult population was counted once in every week on 10 plants and monthly average has been calculated basing on 4 or 5 weekly observations

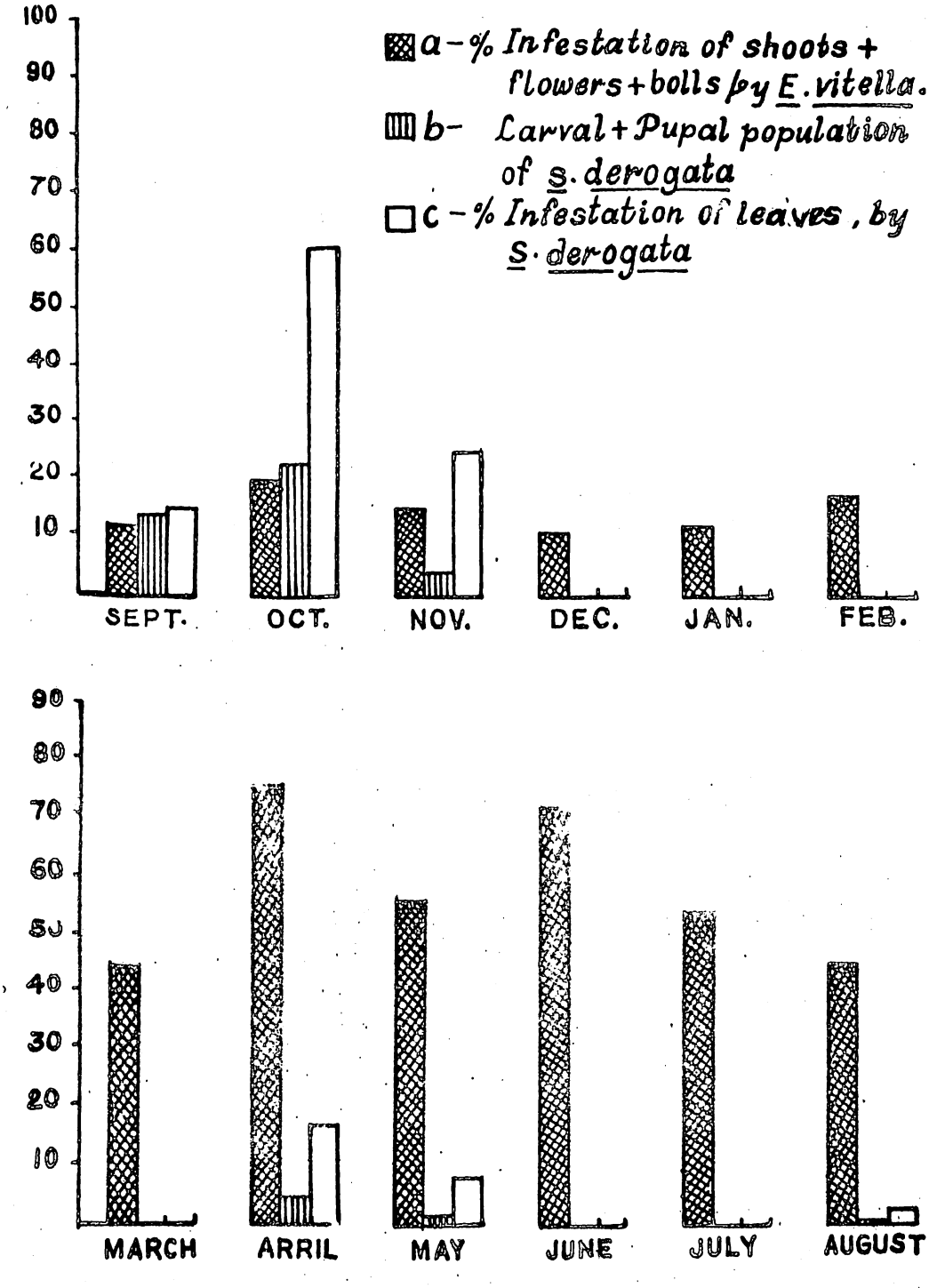
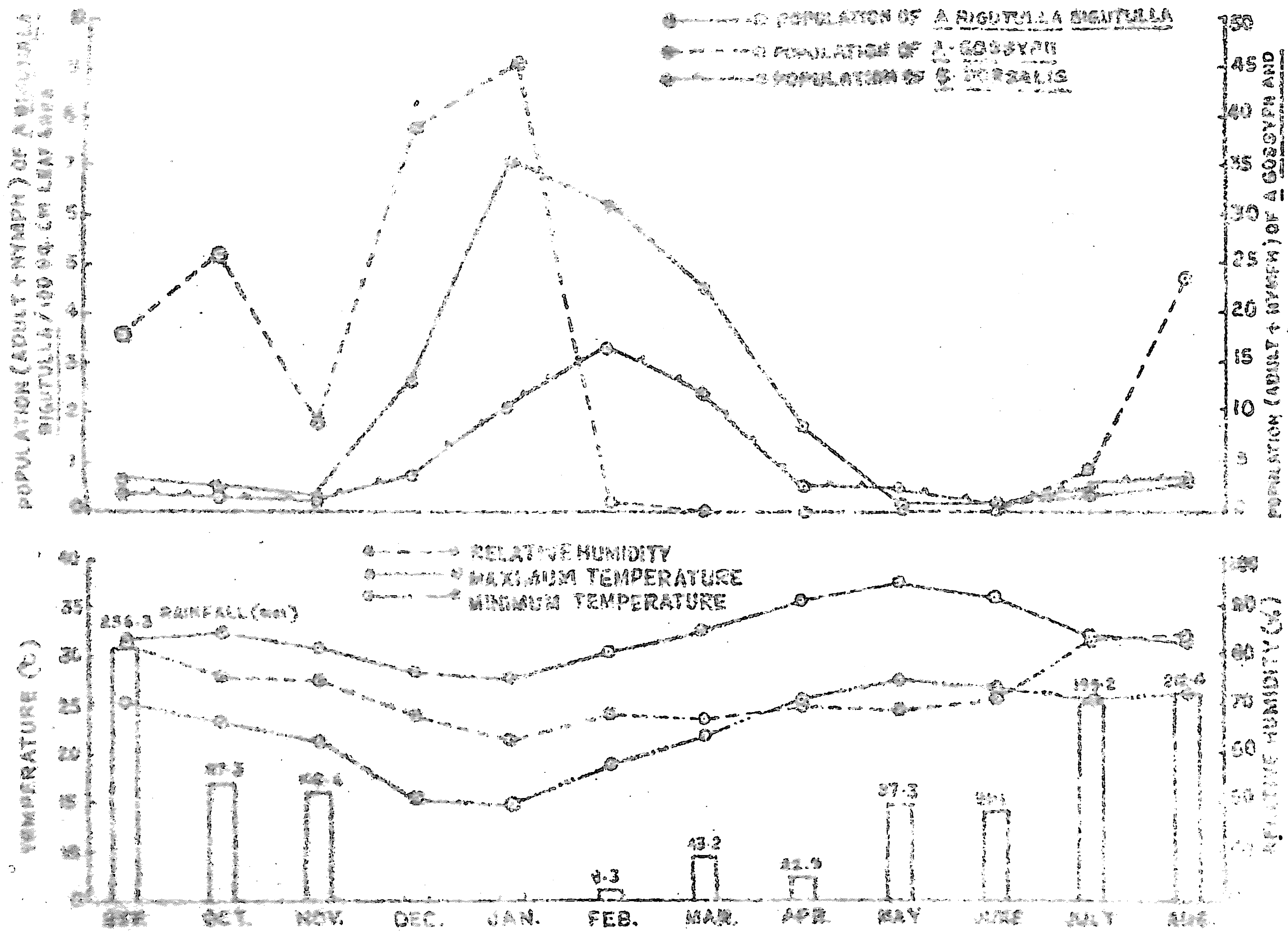


Fig. 2 - INCIDENCE OF E. Vitella and S. derogata ON COTTON FROM SEPTMBER, 1977 TO AUGUST, 1978 AT BHUBANESWAR



METEOROLOGICAL DATA AT BHUBANESWAR RESEARCH STATION AND SEASONAL INCIDENCE OF A. BIGUTULLA BIGUTULLA, A. GOSSYPII AND S. DORSALIS

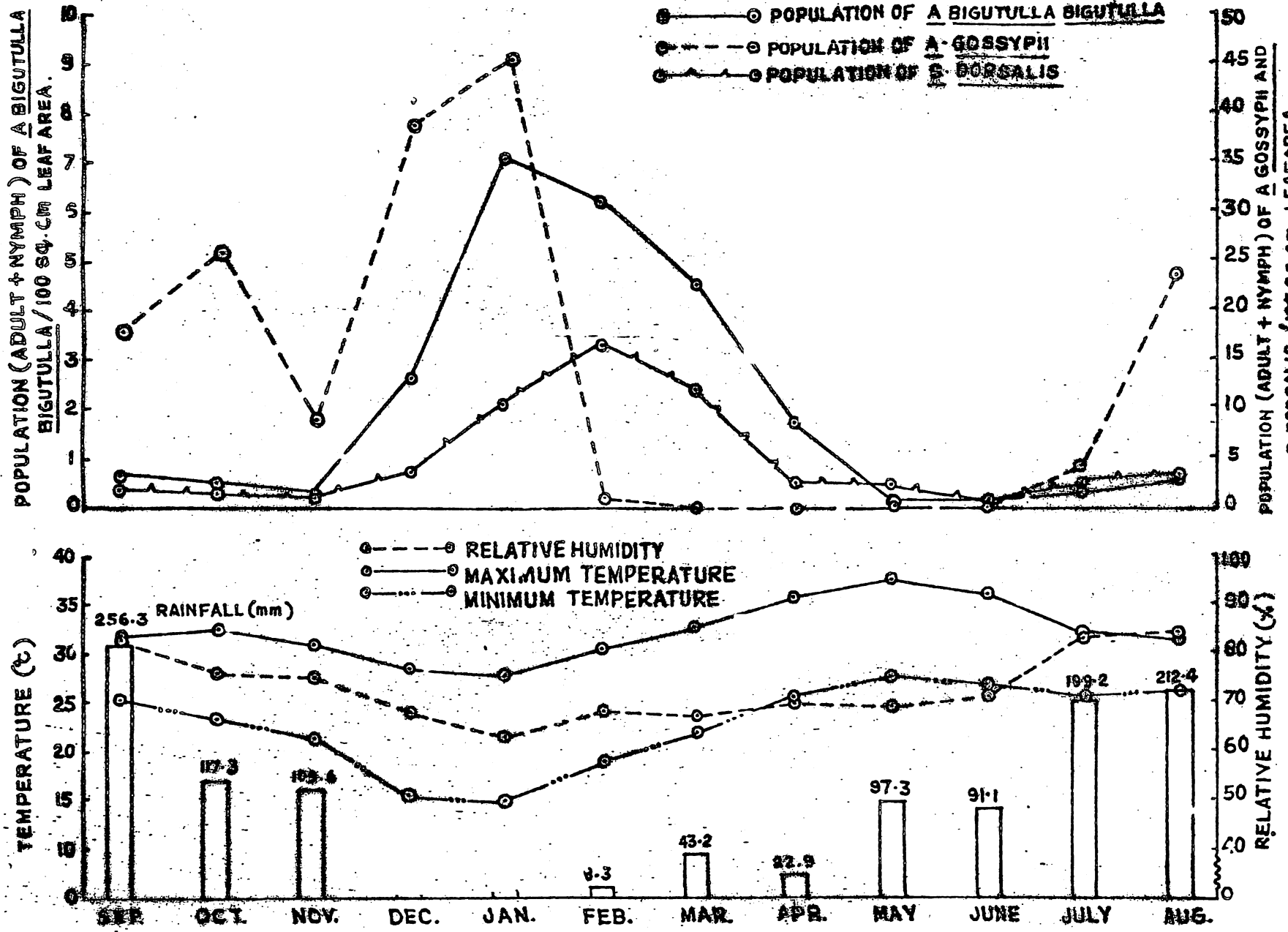


Fig.3. METEOROLOGICAL DATA AT BHUBANESWAR RESEARCH STATION AND SEASONAL INCIDENCE OF A. BIGUTULLA BIGUTULLA, A. GOSSYPII AND S. DORSALIS FROM Sept, 1977 TO Aug, 1978.

started declining gradually upto the second week of June when the lowest population of the insect was recorded. From the third week of June the thrips started increasing in number and reached its peak in the first week of August. From the second week of August the population again started declining until the second week of December. The highest population in Rabi season was recorded in 1st week of March (26.46 / 100 sq cm leaf area) though the monthly average was estimated to be the highest in February.

(vi) Distribution of A. biguttula biguttula, A. gossypii and S. dorsalis on cotton plant :

Observation on distribution of the jassid, the aphid and the thrips on different leaves were taken on two month old (from germination) cotton plants. On the day of observation, the plant had 11 or 12 leaves. The average number of jassids, aphids and thrips per plant and the percentage population of each species on different leaves are presented in Table 6. In a two month old cotton plant, the average number of jassids, aphids and thrips was 31.3, 88.6 and 25.7 respectively. The jassids and aphids were distributed

Table 6

Distribution of *A. biguttula biguttula*, *A. gossypii* and *S. dorsalis* on different leaves of two month old cotton crop * (Average of 10 plants)

Leaf No. (from top)	Percentage population of								
	A. biguttula biguttula			*A. gossypii*			*S. dorsalis*		
	adult	nymph	total	adult	nymph	total	adult	nymph	total
1	1.60	1.30	2.90	2.25	3.49	5.74	13.65	18.48	32.13
2	1.30	4.57	5.87	2.93	4.56	7.49	9.83	13.92	23.75
3	2.30	11.20	13.50	4.62	6.43	10.05	8.37	7.15	15.52
4	3.25	10.64	13.89	4.56	5.69	10.25	2.72	4.28	7.00
5	3.65	17.57	21.22	5.75	7.44	13.19	3.50	3.50	7.00
6	4.35	12.87	17.22	7.16	8.91	16.07	2.73	3.61	6.34
7	1.60	8.08	9.68	5.07	6.54	11.61	3.50	1.94	5.44
8	0.95	7.58	8.53	5.19	5.64	10.83	1.28	0.77	2.05
9	0.95	3.40	4.35	4.27	4.66	8.93	0.77	0	0.77
10	0.73	1.38	2.11	2.25	2.70	4.95	0	0	0
11	0	0.73	0.73	0.56	0.33	0.89	0	0	0
12	0	0	0	0	0	0	0	0	0
Average No. / plant	6.30	25.00	31.30	40.20	48.40	88.60	11.60	14.10	25.70

* Sown on 25.11.77 and observation taken on 30.1.78

on all the leaves except the last leaf, i.e. the 12th leaf from the top. The 5th and the 6th leaf harboured the highest jassid and aphid population respectively. In case of S. dorsalis the highest population was recorded on the first leaf which was followed by the second and the third. First six leaves from top harboured 74.60, 62.19 and 91.74 % population of A. biqutulla biqutulla, A. gossypii and S. dorsalis respectively.

(B) CONTROL OF INSECT PESTS OF COTTON BY GRANULAR INSECTICIDES :

During the Rabi season of 1977-78, a replicated field trial was laid out to evaluate the relative efficacy of four granular insecticides, viz., phorate, carbofuran, quinolphos and mephosfolan against the insect pests of cotton. One day before the application of insecticides the crop was examined to study the relative abundance of different insect pests. Three insect species such as the jassid, A. biqutulla biqutulla, the thrips, S. dorsalis and the spotted bollworm, E. vitella infested the trial crop and hence, observations on the efficacy of the insecticides were taken against these three species.

(i) Toxicity to A. bigutulla bigutulla :

The population of the jassid in different plots before and after application of insecticides are presented in Table 7 and the percentage control of the insect by different compounds at different time intervals calculated by the revised Abbott's formula are embodied in Table 8. A closer examination of the data in Table 7 reveals that the jassid population on 6th February was quite high in all the plots and after one day of insecticidal application the population increased except in the plot treated with quinolphos. The jassid number was low when the second application was made on 22nd March. Observations taken after 3, 7 and 14 days of insecticidal application indicated that the plots treated with carbofuran were almost free from the pest, but in case of mephosfolan excellent control of the jassid was obtained after 7 and 14 days of its application. Phorate and quinolphos did not give adequate protection of the crop from jassid attack.

The results summerised in Table 8 and Fig.4 show that carbofuran gave 87.03 % control of the jassid

Table 8

Percentage control of jassid (A. biguttula biguttula) following the insecticidal treatments

Insecticide	Dose (kg a.i. / ha	Percentage control							
		Days after 1st application				Days after 2nd application			
		1	3	7	14	1	3	7	14
Phorate	1.5	0	10.45	34.26	33.66	0	35.65	71.34	46.91
Carbofuran	1.5	0	87.03	100.00	100.00	100.00	100.00	100.00	100.00
Quinolphos	1.5	30.83	35.52	66.58	0	16.81	54.28	60.36	0
Nephosfolan	1.5	0	39.80	95.55	88.54	58.33	58.42	100.00	100.00
'F' test		N.S.	*	*	*	*	*	*	*
C.D at 5 %			35.45	34.22	38.51	55.83	34.05	24.59	50.71

* Significant at 5 % level

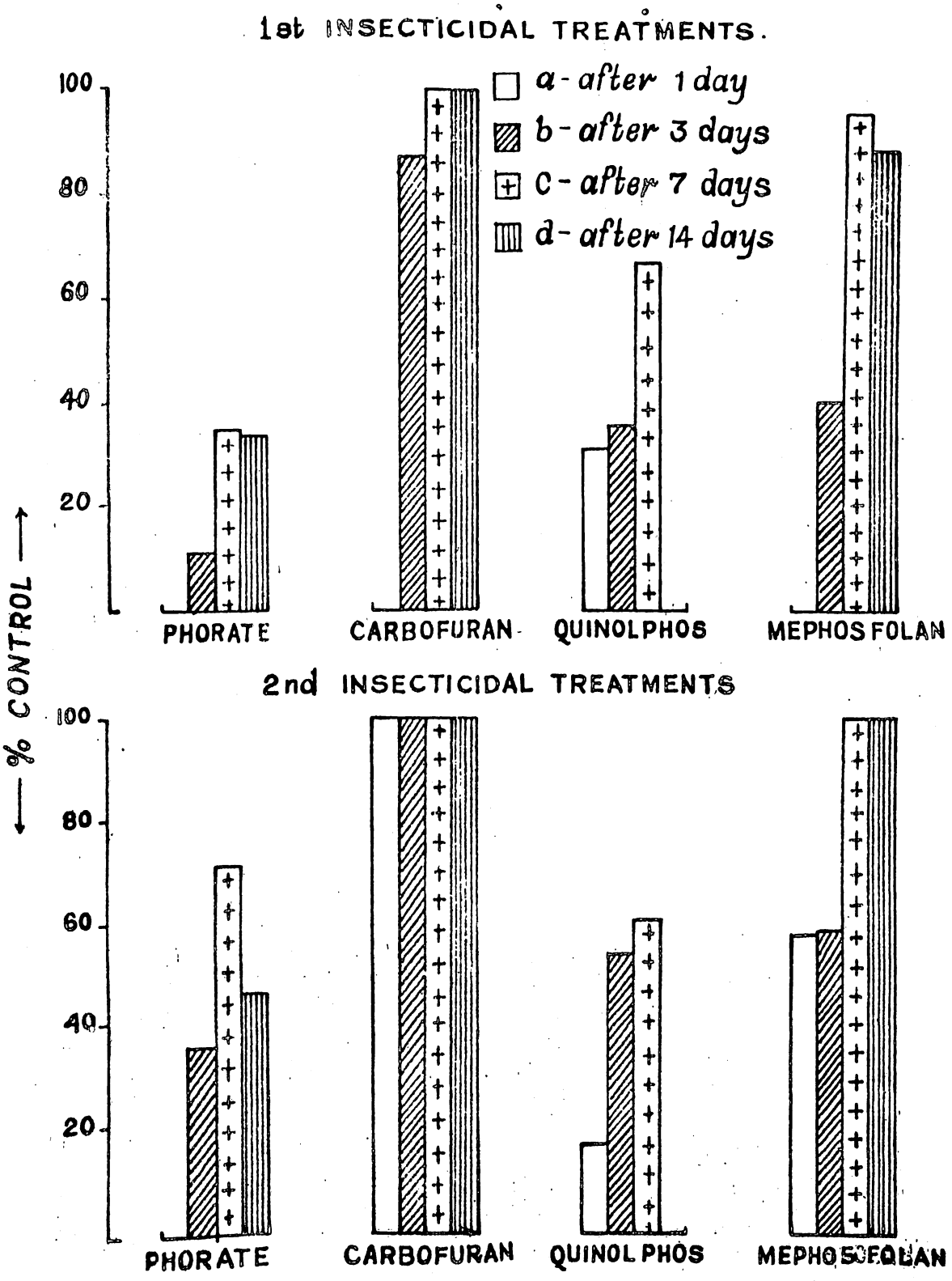


Fig. 4 - EFFECT OF INSECTICIDES AGAINST JASSIDS

Days	after second application
1	Carbofuran 7 mephosfolan 7 quinolphos 7 phorate
3	Carbofuran 7 mephosfolan 7 quinolphos 7 phorate
7	Carbofuran = mephosfolan 7 phorate 7 quinolphos
14	Carbofuran = mephosfolan 7 phorate 7 quinolphos

(ii) Toxicity to S. dorsalis :

In case of the thrips, S. dorsalis, the population of the insect increased following one day after the first application of all the insecticides except phorate whereas one day after the second application the population increased in all the treatments except carbofuran. But, in comparison to the untreated check, the rate of population increase was low in all the treatments (Table 9). None of the insecticides could make the crop thrips free upto 14 days of first application. In the second application carbofuran treatment resulted in very low population of the thrips after 3 and 7 days of its application and after 14 days of application there was no thrips in this treatment.

The data presented in Table 10 and Fig.5 indicate that after one day of application, protection afforded by all the insecticides from thrips infestation was not satisfactory. However, subsequently the toxicity of carbofuran and phorate was higher than the other two insecticides. In the second insecticidal application, excellent control of thrips was obtained by carbofuran only which gave 87.61 to 100 % control from 3rd to 14th day of its application. The effect of phorate application was not consistent in the first and second applications. It gave 49.53 and 9.37 % control of the thrips after one day of its first and second applications respectively. The percentage kill of thrips by phorate after 7 days of first application was 73.27 and that after 14 days of second application was 86.69.

The order of toxicity of insecticides are given below and the significant differences between treatments are indicated by lines below the treatments.

Table 10

Percentage control of thrips, S. dorsalis following the insecticidal treatments

Insecticide	Dose (kg a.i. / ha	Percentage control							
		Days after 1st application				Days after 2nd application			
		1	3	7	14	1	3	7	14
Phorate	1.5	49.53	58.38 a	73.27 c	51.13 e	9.37 i	57.57 k	58.15 n	86.69 q
Carbofuran	1.5	36.94	64.07 a	85.04 c	53.92 e	52.43 h	87.61 j	88.38 n	100.00 p
Quinolphos	1.5	39.65	22.19 b	23.06 d	23.02 g	13.48 i	31.18 l	32.06 o	30.97 s
Nephosfolan	1.5	16.35	35.97 b	65.00 c	42.60 f	19.91 i	66.02 k	66.63 n	69.18 r
'F' test		N.S.	**	**	**	**	**	**	**
CD at 5 %			17.76	27.66	3.67	12.34	15.43	11.27	12.74
C.D at 1 %			26.89	41.88	5.56	18.69	23.37	17.06	19.29

** Significant at 1 % level

N.B. : Figures indicating same letters on different days after insecticidal applications are not significantly different at 5 % level

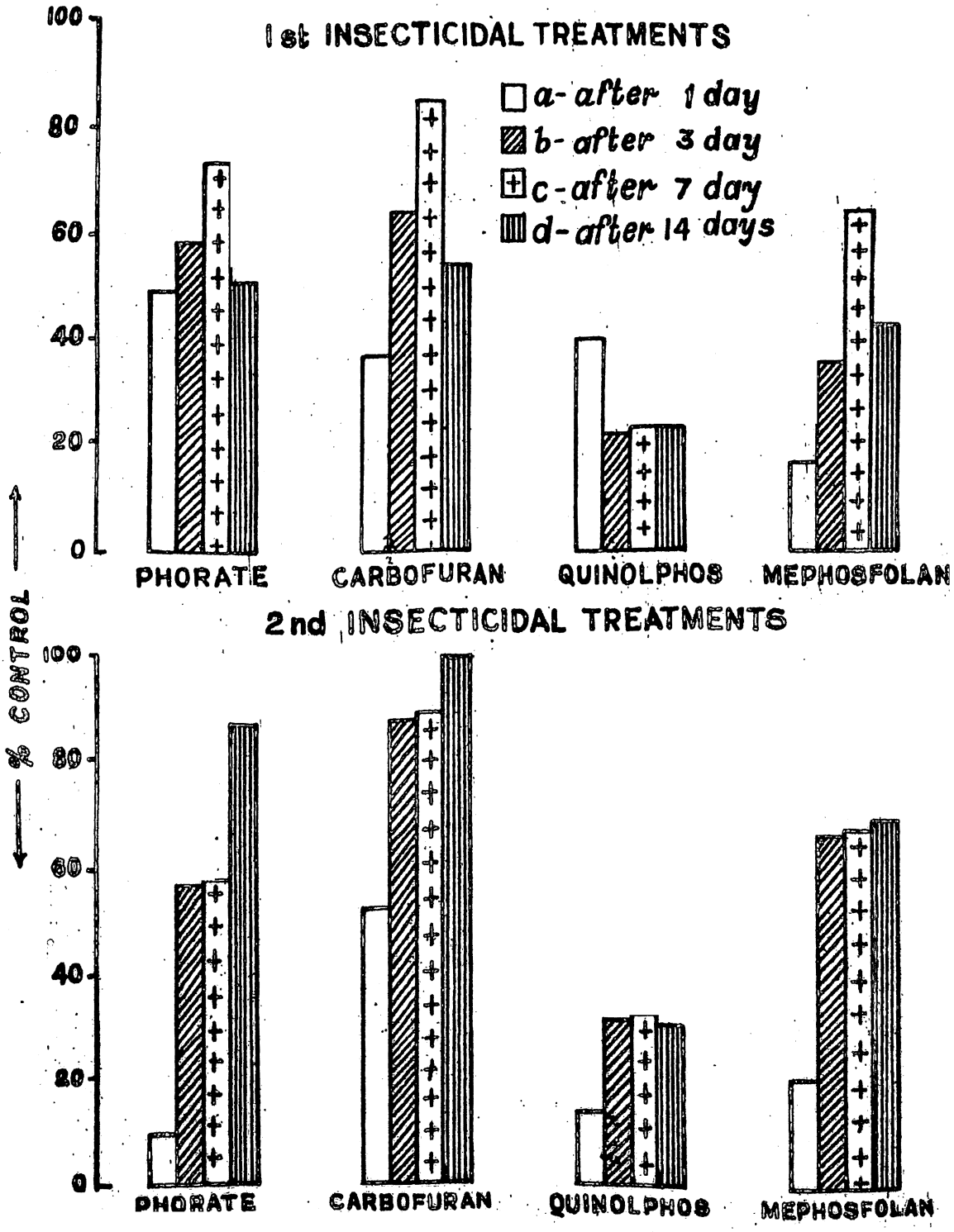


Fig.5. EFFECT OF INSECTICIDES AGAINST THRIPS

very low incidence of the bollworm on the trial crop. The data presented in Table 11 show that on March 21, the average number of shoots, flowers and bolls together ranged from 66.32 to 126.33 in different treatments, the highest and the lowest being in carbofuran and untreated check respectively. In untreated check, on an average, 10.33 (15.57 %) shoots, flowers and bolls together were infested as against 18.65 to 32.99 (21.66 - 26.11 %) in the insecticidal treated plots. Consequent upon the application of insecticides the number of infested shoots, flowers and bolls were not increased in plots treated with carbofuran and quinolphos upto seven days following their applications, whereas in plots treated with phorate and nephosfolan it increased slightly one day after their application. Observations recorded 14 days after application indicated some increase in infestation in all the insecticidal treatments. In the untreated check the activity of the insect increased resulting higher number of infested shoots, flowers and bolls.

The percentage control of the bollworm infestation calculated from the total number of

infested shoots, flowers and bolls before and after application of each insecticide in comparison to that of the untreated check is given in Table 12 and Fig.6. None of the insecticides gave satisfactory protection of the crop from the insect. The percentage control after 1,3 7 and 14 days of insecticidal application ranged from 16.91 to 40.41, 40.10 to 49.42, 37.65 to 50.42 and 33.88 to 54.24 respectively. There was no significant difference between any two treatments.

The order of toxicity of different insecticides is indicated below.

Days	after second application
1	Carbofuran 7 quinolphos 7 phorate 7 mephosfolan
3	Phorate 7 carbofuran 7 quinolphos 7 mephosfolan
7	Mephosfolan 7 phorate 7 carbofuran 7 quinolphos
14	Mephosfolan 7 phorate 7 carbofuran 7 quinolphos

(iv) Effect of insecticidal applications on yield of seed cotton :

The data on yields of seed cotton obtained from the treated and untreated plots are presented in Table 13. The yield in different plots ranged

Table 12

Percentage control of infestation by E. vitella following the second insecticidal application

Insecticide	Dose (kg a.i. / ha	Control of infested shoots, flowers and bolls (%) Days after 2nd application			
		1	3	7	14
Phorate	1.5	24.00	49.42	50.37	48.02
Carbofuran	1.5	40.41	44.30	49.92	37.68
Quinolphos	1.5	34.21	42.10	37.65	33.88
Nephosfolan	1.5	16.91	40.10	50.42	54.24
'F' test		N.S.	N.S.	N.S.	N.S.

N.S : Not significant

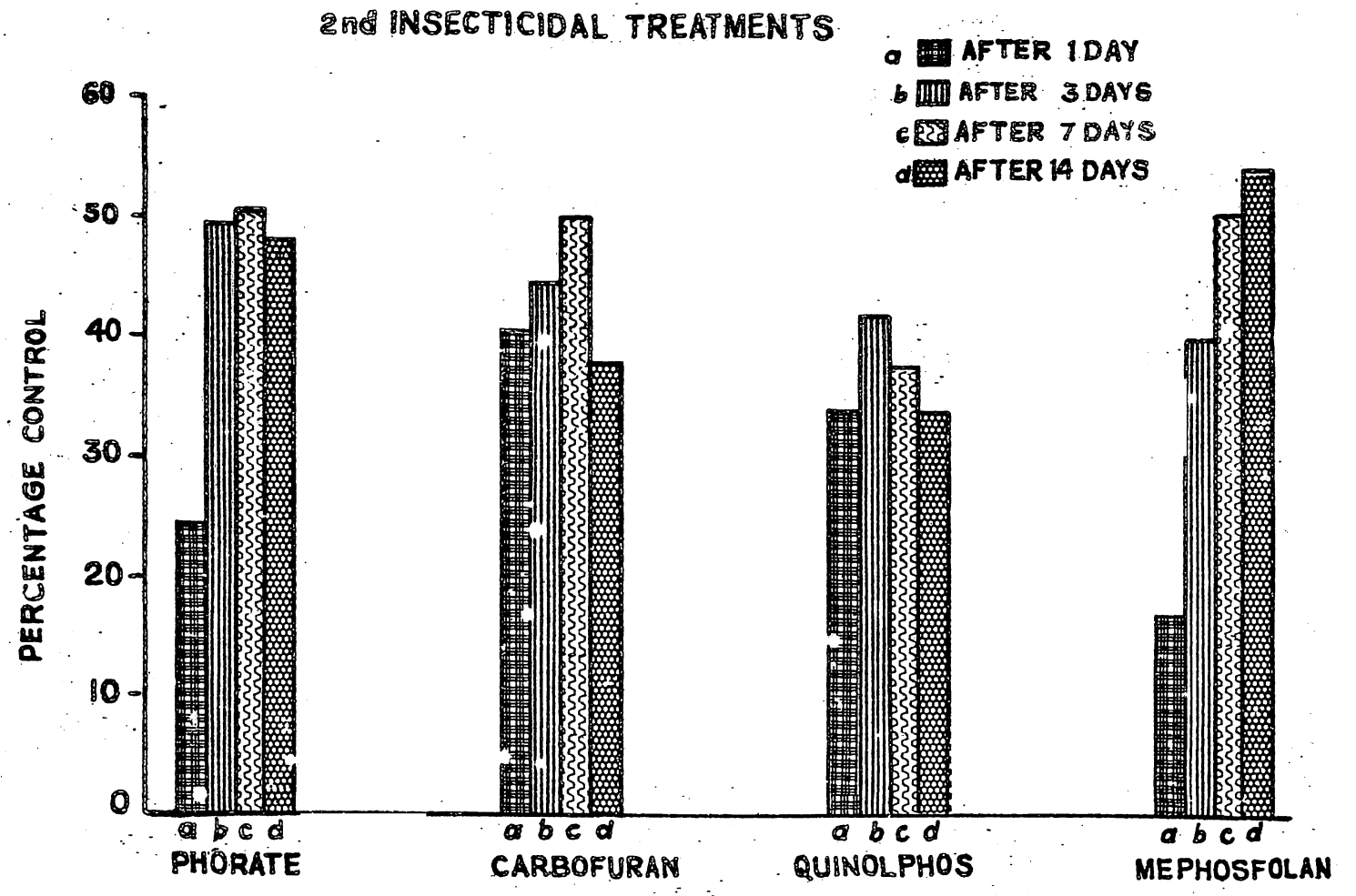


Fig. 6 - EFFECT OF INSECTICIDES AGAINST SPOTTED BOLL WORM

Table 13

Effect of granular insecticides on yield of seed cotton

Treatments	Yield of seed cotton (quintal/ha)	Percentage increase over control
Phorate	5.36 b	17.54
Carbofuran	15.13 a	231.79
Quinolphos	7.36 b	61.40
Mephosfolan	12.43 a	172.58
Control	4.56 b	-
'F' test	**	
C.D at 5 %	4.29	
C.D at 1 %	6.23	

** Significant at 1 % level

(Figures with same letter (a, b) are not significantly different at 5 % level)

from 4.56 to 15.13 quintals / ha and carbofuran treatment resulted in the highest yield followed by mephosfolan. The yield obtained from phorate and quinolphos treated plots were not significantly different from that harvested from the untreated control plot, whereas treatments with carbofuran and mephosfolan produced significantly higher yield than the other two compounds and the untreated control.

CHAPTER-V
DISCUSSION

CHAPTER V

DISCUSSION

Occurrence, relative abundance and seasonal activity of insect pests of cotton :

During the one year period of observation, i.e. from the first week of September, 1977 to last week of August, 1978, five species of insect pests such as the jassid, A. *biguttula biguttula*, the aphid, A. *gossypii*, the thrips, S. *dorsalis*, the spotted bollworm, E. *vitella* and the leaf-roller, S. *derogata* were recorded on cotton. The jassid, thrips and the spotted bollworm occurred throughout the year whereas the incidence of aphid was observed from September to February and from July to August and that of the leaf-roller from September to November, April to May and August. The problem of the sucking pests, viz., the jassid, aphid and

thrips was more in the Rabi season than in the Kharif, whereas the reverse was the fact in case of the bollworm and the leaf-roller.

The jassid maintained high population from January to March (Table 3 and Fig.3). The population started increasing from second week of December and reached its peak in the third week of January. From second week of March, the population declined gradually and was very low upto the end of August. During the months of September, 1977 to the end of November, 1977 the population was also very low. From December, 1977 to the end of February, 1978 the atmospheric temperature and the relative humidity were lower than the other parts of the year. In December and January, there was no rainfall and it was very low in the month of February. Thus the high population level of the jassid during the winter months was due to the favourable climatic conditions, chiefly the temperature and relative humidity that prevailed at Bhubaneswar. The warm and humid weather in other months might be responsible for the low population of the insect.

Review of the reports of several past workers revealed that there was regional variation in seasonal occurrence of this jassid. In South India and Orissa, the insect maintained high population during December and January on cotton and bhindi and the incidence was very low in the hot months of April and May (Cherian and Kylasam, 1938; Katagihallimath, 1962, and Senapati and Khan, 1976). The present observations are in agreement with these workers. Under the Punjab and Cairo conditions the peak period of incidence was recorded in August and September (Lal, 1941; Afzal and Ghani, 1946; Atwal et al., 1969 and Hosny and El-Dassouki, 1967).

The population density of the thrips, S. dorsalis was high from January to March with its peak in first week of March in the Rabi season. In the Kharif crop the peak period of incidence was recorded in the month of August. Similar results have been reported by Senapati and Patnaik (1974) under Bhubaneswar conditions, who recorded the highest population of S. dorsalis in third week and second week of August in Kharif seasons of 1972 and 1973 respectively on groundnut. In the Rabi

season these authors observed the highest population in the first week of February, 1973 and the first week of March, 1974. Sivakami et al. (1965) also observed that this thrips occurred on Chekurmanis throughout the year and infestation was severe in January to April and July to October in Coimbatore, which is also in partial agreement with the present observations. According to Katagihallimath (1962), S. dorsalis occurred on cotton throughout its growth period and the crop at 12 - 16 weeks age was very badly damaged. At Bhubaneswar, both in Kharif and Rabi seasons, the highest population was recorded on the 12 week old crop.

Several earlier workers have studied the population fluctuation of A. gossypii and concluded that the abiotic factors particularly the temperature and humidity and the biotic factors mainly the prevalence of natural enemies in a locality had profound influence on the population density of the aphid (Stepantzev, 1939 and Weisman et al., 1971). Apart from these the growth stage of the crop had also marked influence on population fluctuation of the insect.

According to Stepantzev (1939), low temperature (mean daily temperature of about 20° C) and the relative humidity of about 60 % were quite favourable for this aphid. Katagihallimath (1962) observed the highest population on 8 - 10 weeks old cotton crop during the months of November and December. Weisman et al. (1971) reported that the crop at beginning to flowering succumbed to aphid infestation more because of increase in transpiration of the plants. With the commencement of natural enemies and hot weather population of A. gossypii decreased (Ismailov and Gasanov, 1974).

In the present studies the aphid infestation was high on cotton in August to October in Kharif crop and December to January in Rabi crop. However, the population recorded in December and January in the Rabi crop was more than that in the Kharif season which might be due to the low temperature (mean temperature of 21.4 - 22.0) and the humidity of 63 - 68 % observed in these months (Table 4 and Fig.3). The crop at 8 - 10 weeks age succumbed to aphid

infestation more than its other growth stages. These findings are in agreement with the observations of the above workers.

The incidence of the spotted bollworm E. vitella was recorded throughout the year on cotton with much variation in the level of infestation in different months. The insect inflicted considerable damage to the shoots, flowers and bolls from March to August, the maximum infestation being in the second week of April. The bollworm preferred to attack flowers followed by bolls and shoots. Thus in the flowering and boll formation stage the crop sufferred maximum from the bollworm infestation.

Variable results on seasonal incidence have been reported by the earlier workers. According to Khan et al. (1945), E. vitella was very common on bhindi from July to October when the pods were plenty in the plants. At Coimbatore, Cherian and Kylasam (1938) recorded heavy larval population on cotton from December to January and from May to July. The results of Nanggal (1948) also differed from others. According to him, the bollworm was numerically most abundant

from July to September and the population was the lowest during December to March. Kaushik et al. (1969) reported that the peak period of infestation to cotton by this insect was October to November in M.P. Under Orissa conditions, the incidence of the bollworm on bhindi was more from January to April with the maximum infestation in the month of March (Khan and Senapati, 1976), but on cotton the incidence was recorded from August to December (Sengupta and Behura, 1957). These reported variations in occurrence, peak period of incidence of the insect from the present observation and between the observations of different earlier workers might be due to the diverse climatic conditions, availability of alternate hosts and variation in sowing time of the crop, since flowering and boll formation stages of the crop are preferred over the other stages by the insect.

According to the reports of earlier workers the infestation of leaf-roller coincided with the flowering and boll formation stage of cotton plants and the incidence was generally

observed from July to October (Sen, 1923; Monteil, 1934 and Golding, 1938). However, Katagihallimath (1962) reported different results. According to him, the leaf-roller became active from September to December in Mysore with the peak period of incidence in November.

The present observations indicated that the leaf-roller incidence on cotton was a problem mostly to the Kharif crop. The larval and pupal population were recorded from September, 1977 to November, 1977, April, May and August, 1978. The highest population with the highest percentage of leaf damage was recorded in month of October. These findings are in partial agreement with the observations of Sen, 1923; Monteil, 1934 and Golding, 1938 but differed from that of Katagihallimath (1962).

Distribution of the sucking insect pests in different leaves of cotton plants :

The results of studies on distribution of the jassid, aphid and thrips on different leaves of a two-month old cotton plant revealed that all the three insect species preferred the young leaves.

In case of jassid the fifth leaf harboured the highest population whereas the highest number of aphids were found on the sixth leaf from the top. The highest number of S. dorsalis was recorded on the first leaf followed by second and the third.

Non-preference of the very young and the very old leaves by A. biguttula biguttula has been reported by Senapati and Khan (1976) on bhindi and by Afzal and Ghani (1946) on cotton. In case of S. dorsalis about 90 % population present on a groundnut plant were observed on the first four leaves from top (Senapati and Patnaik, 1974). Similar results were also reported by Rama Krishana Ayyar (1935) on chilli and by Dev (1964) on tea.

Relative effectiveness of granular insecticides against the pests of cotton :

The results of the field experiment conducted during the Rabi season of 1977-78 showed that the relative effectiveness of soil treatment

with granular phorate, carbofuran, mephosfolan and quinolphos at 1.5 kg a.i. / ha differed with the pest species involved. At different times following the insecticidal applications the order of toxicity of different compounds changed. Between the two applications the order of toxicity of the compounds at different time intervals following application was also variable even to the same insect species. However, basing upon the general pestwise performance of the compounds conclusion on their effectiveness has been drawn up.

Carbofuran proved to be the best of all the compounds in controlling the jassid A. biguttula biguttula and the thrips, S. dorsalis. This compound was followed by mephosfolan for jassid control and by phorate for the control of thrips.

None of the compounds afforded satisfactory control of the bollworm incidence on cotton. The level of control ranged from 16.91 to 40.41, 40.10 to 49.42, 37.65 to 50.42 and 33.88 to 54.24 per cent after 1, 3, 7 and 14 days of application respectively. None of the compounds proved

significantly better than others in any day following the insecticidal application.

Several workers have reported successful control of the jassid and the thrips by soil treatment with granular insecticides. Considerable variations in relative effectiveness of the compounds have been reported under field conditions.

According to Agarwal (1978), soil application of the systemic granular insecticides like carbofuran, phorate, di-syston proved highly effective in controlling the external pests like jassid, aphid, thrips and white flies, but the bollworms feeding squares and bolls were not controlled. Phorate application to soil was not effective against the bollworm, E. vitella in Formosa (Tsai and You, 1961). The results of the present investigation are in confirmity with these reports.

Successful control of the thrips and the jassid, A. biqutulla biqutulla by carbofuran and phorate has been achieved (Beckham, 1967; and Bindra et al., 1973). Fadigas and Gianotti (1959) reported that application of phorate granules to the furrows at sowing gave good control of thrips for 38 days.

Phorate occupied the second position in controlling the jassid, aphid and thrips on cotton the best being di-syston (Regupathy and Jayraj, 1973 and Dhanorkar, 1976).

None of the granular insecticides gave satisfactory control of the jassid, the thrips or the bollworm one day after application to soil. This might be due to poor absorption and translocation in the plant within the short period of 24 hours.

The success in soil application of the granular insecticides depends upon the soil type, organic matter, moisture conditions, cultural practices, temperature and humidity which have marked influence on absorption and translocation of the compounds by the plants. Variation in performance of these compounds reported might be due to diversity of these factors in different places. The granular insecticides tested under Bhubaneswar conditions might have not been absorbed and translocated in quantities sufficient to exert lethal action against the lepidopterous borer, E. vitella on cotton.

Effect of soil treatment on seed cotton yield :

As reported by earlier workers control of cotton pests has resulted in spectacular effect in increasing the yield of seed cotton. The investigation made in different States of India have established that the yield of cotton could be increased from 17.7 to 463 %, the average being 94 per cent. The data obtained from demonstration trials by Indian Cotton Mills Federation and other development agencies in the country showed that cotton yields could be easily increased from 50 - 100 % by controlling the insect pests alone (Agarwal, 1978). According to Dhanorkar (1976) significantly higher yield of cotton was harvested from plots treated with carbofuran, di-syston and aldicarb in the soil.

The present studies demonstrated that the application of granular insecticides twice in the soil resulted in reduction of pest infestation and consequently increased the yield considerably.

The percentage increase in yield in the treated plots over the untreated check ranged from 17.54 to 231.79, the highest being from carbofuran treatment followed by mephosfolan, quinolphos and phorate (Table 13). The increase in yield could be attributed to the control of jassid, thrips and the bollworms.

CHAPTER-VI
SUMMARY AND CONCLUSION

CHAPTER VI

SUMMARY AND CONCLUSION

Observations on occurrence, relative abundance and seasonal activity of insect pests of cotton were taken during 1977-78 at Bhubaneswar. A replicated field trial was also conducted in the Rabi season to evaluate the efficacy of granular insecticides, viz., carbofuran, phorate, mephosfolan and quinolphos in reducing the insect pests and their consequent effects in increasing the yield with minimum number of applications. The insecticides were applied at 1.5 kg a.i. / ha twice, once in the vegetative stage of the crop when the activity of sucking pest complex was increased and the other in flowering and fruiting stage when the activity of bollworm was noticed. The trial crop was infested

by the jassid, A. bigutulla bigutulla, the thrips, S. dorsalis and the spotted bollworm, E. vitella.

The results indicated that during the one year period of studies five insect pests, viz., the jassid, A. bigutulla bigutulla, the aphid, A. gossypii, the thrips, S. dorsalis, the spotted bollworm, E. vitella and the leafroller, S. derogata infested the cotton crop. The jassid, the thrips and the bollworm occurred throughout the year whereas the incidence of other two pests was noticed in certain part of the year. The jassid and the thrips maintained high population from January to March and reached the peak in 3rd week of January and the first week of March, 1978 respectively. The bollworm incidence was high from March to August, 1978 and the highest percentage of damaged shoots, flowers and bolls was recorded in the month of April, 1978. The aphid incidence on cotton was observed from September, 1977 to February, 1978 and July to August, 1978. Highest population of the aphid was recorded from fourth week of December to first week of January, 1978. The occurrence of leaf-roller was observed

from September, 1977 to November, 1977, April and May, 1978 and August,1978 with the highest percentage of leaf infestation and the highest number of larval and pupal population in the month of October, 1977.

The observations on the distribution of sucking insect pests on two month old cotton plants revealed that the jassid and the aphid did not prefer very young and the very old leaves. The fifth and the sixth leaf from top harboured the highest population of jassid and aphid respectively. The highest population of the thrips was recorded on the first leaf followed by the second and the third. The thrips population on the first three leaves from top constituted 71.4 of the total population supported on cotton plant.

The results of field trial on control of insect pests of cotton with gramular insecticides indicated that the performance of the compound differed with the pest species involved and the order of toxicity at different time intervals following application changed. In general, carbofuran gave

excellent control of the jassid and the thrips until 14 days from the date of application. Nephosfolan and phorate also gave satisfactory control of the jassid and the thrips respectively.

Soil treatments with any of the four compounds did not provide protection from the attack of pests after one day following application due to poor translocation.

None of the compounds afforded adequate control of the bollworm incidence and there was no significant difference in their performance against this borer.

Soil treatment with granular carbofuran resulted in the highest yield which was 231.79 % increase over the yield obtained from the untreated check plot. The plots treated with nephosfolan also gave significantly higher yield over the other two treatments and the control which did not differ significantly from each other.

Considering the overall performance of the insecticides against the insect pests of cotton and consequently their effects on increasing the yield, soil applications of carbofuran twice proved the best. However, further studies on the control of the bollworm are necessary.

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