Varietal Screening and Management of Major insect pests of groundnut (*Arachis hypogaea* L.)

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Dated: /06/2003

This is to certify that **Mr. Khuman Singh Rupawat** has successfully completed the Comprehensive Examination held on 10th April, 2003 as required under the regulation for the degree of **Master of Science in Agriculture.**

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Dated: / 06/ 2003

This is to certify that this thesis entitled **"Varietal Screening and Management of Major Insect Pests of Groundnut [*Arachis hypogaea* L.]"** submitted for the degree of **Master of Science in Agriculture** in the subject of **Agricultural Zoology and Entomology** embodies bonafide research work carried out by **Mr. Khuman Singh Rupawat** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on 24th June, 2003.

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ABSTRACT

Varietal Screening and Management of Major Insect Pests of Groundnut [*Arachis hypogaea* L.]

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Insect pests are an important biological constraint in the limiting production of groundnut. Field trails during *kharif* 2002, were conducted at the Research Farm, College of Technology and Agricultural Engineering, Udaipur, eleven germplasms and the local check, variety GG-2 were screened for their relative preference by the major insect pests; season al incidence of these pests was studied and the overall efficacy of different treatment combination were evaluated against these pests on variety TKG-19A. The results of seasonal incidence showed that the incidence of jassids has been maximum in the last week of August and in the third week of September; of aphid, in the third week of August and in the first week of September; of thrips, in the first and last week of September, of tobacco caterpillar and blister beetle in the third week of September.

The results of varietal/germplasm screening revealed that the germplasm ICR-10 to be least preferred while the germplasm ICR-02 to be most preferred by the groundnut jassid. The germplasm ICR –02 to be most preferred by aphid also. Whereas, variety GG-2 showed to be least preferred by aphid. The maximum hair density showed resistance against jassids and aphids. The germplasm JUN-40 was more preferred host and germplasm JAL-13 was least preferred host of thrips. The variety GG-2 showed to be least preferred by tobacco caterpillar and blister beetle, whereas, germplasms TIR-10 and UG-2 were preferred more by tobacco caterpillar and blister beetle, respectively. The insect pests of groundnut were effectively managed with monocrotophos (0.05%) than neem seed kernel extract (5%) and other treatment combinations were least effective.

Monocrotophos (0.05%) proved to be the best treatment as it gave the highest C:B ratio (1:12.05), followed by neem seed kernel extract (5%) with a C:B ratio of 1:9.69 and the treatment *Chrysoperla carnea* @ 4000 larvae/ha was least effective, giving the C:B ratio 1:0.64.

1. Introduction

Indi i one of the lrget producer of oileed in the orld. The nnul crege under oileed for the yer 2000-01 i 23.25 million hectre nd the production 18.40 million tonne. Oileed form the econd lrget griculturl commodity fter cerel. It hre 14 per cent of the GCA (Gro Cropped Are) nd ccount for nerly 5 per cent of the GNP (Gro Ntionl Product) nd 10 per cent of the vlue of ll griculturl commoditie.

The country ranks second in the production of groundnut. Out of the nine oilseed crops grown in India, groundnut accounts for 28.94 per cent of the total area cropped under oilseeds and 33.80 per cent of the total oilseeds production. Among oilseeds, groundnut occupies first place in area and production. The cultivated area being 6.73 million hectares with 6.22 millions tonnes of production and average yield was recorded 924 kg/ha in the year 2000-01 (Agricultural Statistics at a glance 2002).

In Rajasthan, groundnut is cultivated in 2.00 lac hectares with the production of 1.80 lac tonnes. The productivity being a mere 924 kg/ha. Groundnuts are a prominent source of dietary protein and lipid and often also provide a cash income (Padgham *et al.*, 1990). Groundnut is having 47-53 per cent oil, 18 per cent carbohydrates, 26gm protein, 69mg calcium, 401gm phosphorus and 2.1mg iron per 100gm of raw kernel. It contain vitamins like thiamine (B_1) 1.14 mg, Riboflavin (B_2) 0.13mg, niacin 17.2mg per 100gm of raw kernel. It can supply about 5.6 calories per gram.

Among the various constraints that limit the productivity and overall production of groundnut in India, the more important are edaphic, rainfall, temperature, insect-pests, weeds and diseases, besides the inadequate use of improved production technology. Moreover, groundnut has been traditionally cultivated on marginal and submarginal lands. A larger part of the cultivated area under groundnut is rainfed or with insufficient irrigation facilities.

Further to add, the losses inflicted by the major pests, *viz*., aphids (*Aphis craccivora* Koch.), white grubs (*Holotrichia consanguinea* Blanch.), red hairy caterpillar (*Amsacta* spp.) leaf miner (*Aproaerema modicella* Deventra), jassids (*Empoasca kerri* Pruthi) and tobacco caterpillar (*Spodoptera litura* Fab.) form a deciding factor in the production of groundnut.

The peanut plant is attacked by more than 40 species of injurious or potentially injurious insects and mites in USA (Smith, 1981). In India, more than 90 species of insects and mites attack groundnut, however, only a few are economically important over a large area. The leaf miner (*Aproaerema modicella* Dev.), white grubs (*Holotrichia* spp.), red hairy caterpillar (*Amsacta* spp.), tobacco caterpillar (*Spodoptera litura*), the aphid (*Aphis craccivora* Koch.), jassids (*Empoasca* spp.), thrips (*Scirtothrips dorsalis, Frankliniella Schultzei*) and termites (*Odontotermes* spp.) are recognizesed as important pests (Amin and Mohammad, 1980). The crop was attacked by as many as 37 insect and mite pests, belonging to different orders. Of the different major insect pests observed on crop, jassid, *Empoasca kerri* Pruthi, and thrips, *Caliothrips indicus* Bagnall, were recorded as major foliar pests, two soil inhabiting pests found to cause significant damage to the crop as well as maturing pods were identified as termite (*Odontotermes obesus* Rambur) and oriental army ant (*Dorylus orieatalis (*Westwood) (Sridhar and Mahto, 2000). The thrips (*Scirtothrips dorsalis, Frankliniella schultzei*) besides causing direct damage to the crop by sucking the sap, is also responsible for the transmission of tomato spotted wilt virus (TSWV) on groundnut in India (Ghanekar *et al*., 1979; Palmer *et al*., 1990).

Sharma (1977) reported 14 insect pests of groundnut at Udaipur. Of these, termites and white grubs were reported as major soil inhabiting pests, red hairy caterpillar and the aphid as the major pests of stem and leaves. Earlier, Narayanana (1953) reported termites to be the predominant soil inhabiting pest in north India as a whole. Ayyar (1963) and Feakin (1973) have mentioned the red hairy caterpillar as a serious pest of groundnut. The aphid (*A. craccivora*), besides causing direct damage to the crop by the sucking the sap, is also responsible for the rosette viral diseases (Farrells, 1976; Alegbejo *et al*., 1999; Alegbejo, 1999; Subrahmanyam *et al.*, 2000; Alegbejo and Abe, 2002).

Insect pests are a limiting factor in lowering the productivity of groundnut. The indiscriminate and injudicious use of synthetic pesticides has lead to pest build-up and as caused an imbalance of natural enemies, resulting into problems of pest resurgence and secondary pest out break. Progressively, we are becoming environment conscious and specially disenchanted with the use of pesticides (Kushwaha, 1995) over the past several centuries competition has been in favour of man, but not without negative effects to the biosphere. Accumulated experience and logic made it clear that it is necessary to integrate biological and chemical methods, into a single pattern aimed at profitable crop production together with minimal environmental disturbances. Keeping these facts in view, the present study entitled, “Varietal screening and management of major insect pests of groundnut *Arachis hypogaea* L.” was planned to be undertaken at CTAE Research Farm, Udaipur, during kharif 2002.

2. REVIEW OF LITERATURE

2.1 INSECT PEST COMPLEX OF GROUNDNUT

(1) Root and pod feeding insects

(a) White grubs:

Several species of white grubs are known to infest groundnut; *Holotrichia consanguinea* Blanch. is more common in north India (Kalra and Kulshrestha, 1961; Dwivedi *et al*., 1976; Kaul *et al*., 1966; Patel *et al*., 1967) and *H. serrata* F. in south India (Rao *et al*., 1976; Veeresh, 1977; David, 1978). White grubs are serious pests in north and north-east Gujarat, north Rajasthan, Punjab, Haryana and west Uttar Pradesh. In Andhra Pradesh, they are localized in parts of Anantapur district (Rao *et al*., 1976). Pest status records of white grubs from Orissa in scant, while from Madhya Pradesh reports indicate white grubs to be a serious pest in Indore district (Patel, 1978).

Many insect pests attack groundnut, of which, white grub, *Holotrichia consanguinea* Blanchard was the most destructive causing 50 to 100 per cent loss in groundnut yield (Bakhetia, 1982). This pest has been observed causing extensive damage to rainfed as well as irrigated groundnut in semi-arid Rajasthan (Kumawat and Yadava, 1990). Vekaria *et al*. (1998) also reported white grubs to be a serious pest of the groundnut. Similarly, white grubs were recognized as being the most important soil pests of groundnut in West Africa (Umeh *et al*., 1999; Umeh *et al*., 2001).

(b) Termites:

Termites are one of the more serious pests of groundnut in West Bengal, Uttar Pradesh (ICOC, 1962), Rajasthan (Srivastava *et al*., 1962), Madhya Pradesh (Kaushal and Deshpande, 1967), Gujarat, Haryana and Punjab (Amin and McDonald, 1981) and are of minor importance in Bhiar, (ICOC, 1962; Rai, 1976). A total of 18 species of termites infest groundnut, of which, the important ones belong to the genus *Odontotermes* (Verma and Kashyap, 1983).

Among the major Arthropods in soil and plant samples taken from groundnut farms during the cropping season in Mali, Burkina-Faso, Niger and Nigeria, termites in the genus *Microtermes* (Isoptera: Termitidae) were the most abundant and widely distributed species of economic importance. Mean percentage of plants attacked by termites in the surveyed groundnut fields was 39.4 per cent (Umeh *et al.*, 1999; Dicho *et al.*, 1999). Of the different major insect pests observed on the groundnut crop, two soil inhabiting pests were found to cause significant damage to the crop as well as maturing pods that were identified as termite (*Odontotermes obesus* Rambur) and oriental army ant [*Dorylus orientalis* (Westwood)] (Sridhar and Mahto, 2000).

Farmers in the groundnut belt of Mali, Burkina Faso, Niger, Nigeria and Benin in West Africa reported that termites, white grubs and millipedes were recognized by the farmers as being the most important soil pests, with termites being the most damaging group (Umeh et al., 2001).

(c) Earwig:

Cherian and Basheer (1940) observed bored pods to the extent of 2.7-6.1 per cent at Patur, 6.2-13.5 per cent at Tindivanam and 9.6-19.9 per cent at Coimbatore and attributed this to an earwig, *E. stali*. Subsequent identification showed this species to *be-Anisolabis annulipes*. In Israel, the same species of earwig is reported as a common pest of groundnuts (Melamed-Madjar and Shalomo, 1970). Among the pod damaging insect pests of groundnut earwig is important at mid-central table land zone of Orissa, this insect bores into the tender pods and feeds on the kernel (Mishra and Senapati, 1997).

(d) Groundnut root borer:

The groundnut root borer has been reported to injure groundnut crop in India (Narayanan, 1962) and is important in some localized areas in southern India (Jai Rao *et al*., 1976).

(e) Pod sucking bug:

This insect is regarded as a minor pest of groundnuts in India but is of considerable economic importance in Africa (Conway, 1976; Gillier, 1970). This pest has been reported from Bihar, Maharashtra, Gujarat, Tamil Nadu and Andhra Pradesh (Plant Protection Bulletin, New Delhi, 1959; ICOC 1962; Narayanan, 1962; Rai, 1976).

(2) Foliage feeding insects:

(i) Sucking pests:

(a) Groundnut jassid:

The groundnut jassid is a polyphagous pest inflicting economic damage to groundnut crop in India and abroad (Sandhu and Brar, 1977; Amin and Mohmmad, 1980; Patel and

Vora, 1981; Singh *et al*., 1991; Jayanthi, 1993). *E. kerri*, which was considered as one of the minor pests, has now assumed major status due to rapid increase in the groundnut area, at Bhubaneshwar (Jena and Kuila, 1996). *E. motti* and *E. kerri* on groundnut were found to have attained pest status from different areas of Andhra Pradesh, India (Jacob *et al.*, 2000). Of the different major insect pests observed on the groundnut crop Jassid, *E. kerri* Pruthi was recorded as the major foliar pest in Delhi (Sridhar and Mahto, 2000).

(b) Groundnut aphid:

The groundnut aphid (*Aphis craccivora* Koch.) has been reported as a major sporadic pest causing serious losses to the crop (Brar and Sandhu, 1975; Misari, 1975; Patel *et al*., 1976; Amin and Mohammed, 1980). Waghmare and Pokharkar (1974) reported *Aphis craccivora* Koch. as a serious pest of 13 different crops. Cow pea (*Vigna ungiuculata* Catjang) was found to be the most preferred host, followed by pigeon pea (*Cajanus cajan* L.) and country bean (*Phaseolus vulgaris* L.), while gram and french bean were least preferred. *A. craccivora* is probably the most injurious insect species of groundnut throughout Africa (Mayeux, 1984; Attia *et al*., 1981; Tarimo and Karel, 1987; Wightman and Wightman, 1994). *A. craccivora* is an important vector of plant viral disease, transmitting over 30 plant viruses, including groundnut rosette, groundnut (peanut) mottle and subterranean clover stunt. It is also reported to be a vector of many viruses of bean, cardamoms, pea, beet, etc. (Blackman and Eastop, 2000).

(c) Thrips:

Several species of thrips infest groundnut, the major being *Scirtothrips dorsalis* Hood and *Caliothrips indicus* (Bagnall). Another thrips of economic importance is *Frankliniella schultzei* (Trybom), which transmits the tomato spotted wilt virus. It is also the causal agent of bud necrosis disease of groundnut, leaf curl in green gram and black gram and necrosis in pea and tomato. *S. dorsalis* species is well distributed throughout India and has been recorded as a major pest of groundnut in parts of Karnataka (Thimmaiah and Panchabhavi, 1973) and Orissa (Senapathi and Patnaik, 1973). *Caliothrips indicus* is also distributed throughout India and is reportedly a serious pest of groundnut particularly in dry weather (Anantha Krishnana, 1973). Amin (1979, 1980) regarded *S. dorsalis* as a serious pest of *Arachis hypogea*. It also infests several other crop plants. *F. schultzei* is more harmful as a vector of tomato spotted wilt virus that causes diseases of economic importance in several crops including groundnut (Amin *et al*., 1981; Amin and Reddy, 1983). The thrips have been reported to cause heavy losses in Andhra Pradesh and Tamil Nadu by transmitting spotted wilt virus (Amin and Reddy, 1983). Of the different major insect pests observed on the groundnut crop, thrips *C.*

indicus Bagnall, was recorded as the major foliar pest in New Delhi (Jayanthi *et al*., 1993; Sridhar and Mahto 2000; Jayanthi *et al*., 2000).

(ii) Defoliators:

(a) Tobacco caterpillar:

Among the insects attacking groundnut in India, the tobacco caterpillar has been reported as one among the more important pests (Amin and Mohammad, 1980; Panchabhavi and Rai, 1987; Singh and Sachan, 1992; Ratnoo, 1995 and Singh *et al*., 1999). *Spodoptera litura* larvae are polyphagous defoliators, severe infestations lead to skeltonisation of leaves as well as feeding holes in roots.

(b) Red hairy caterpillar:

In south India, the red hairy caterpillar has been reported as the most important pest of groundnut (Nagarajan *et al*., 1957; Nagarajan and Ramachandran, 1958; Narayana and Ranga Rao, 1959; Mukunden, 1964; Venkataraman *et al*., 1970; Saroja *et al*., 1971 and Paramasivam *et al*., 1973). However, the attack of this pest is now sparadic, though, in certain years it can become serious and cause heavy losses. There are well marked localities in Tamil Nadu, Andhra Pradesh and Karnataka where it is known to appear regularly in kharif (Venkataraman *et al*., 1970; Abdul Kareem *et al*., 1974; Sandhu and Brar, 1977; Siva Rao *et al*., 1977 and Singh and Pandey, 1995). The red hairy caterpillar was also recorded to infest groundnut at Udaipur in Rajasthan (Kumar, 1997).

(c) Bihar hairy caterpillar:

Reportedly a major out break in Bihar occurred in 1975 in September, causing severe damage to blackgram, green gram, soybean, cowpea, sweet potato, sesame, sunflower, groundnut and jute (Sinha *et al*., 1975). Kumar (1997) has reported this pest on groundnut at Udaipur in Rajasthan.

(d) Leaf miner:

Leaf miner attack has been endemic to south India, but, of late, it has become a pest of economic importance in Maharashtra and a potential pest in Gujarat because of availability of groundnut throughout the year. It has been reported as a major pest in Andhra Pradesh (Channabasavanna, 1957; Krishnamurthy Rao *et al*., 1962), Karnataka (Channabasavanna, 1951, 1954, 1957 and Usman and Puttarudriah, 1955), Maharashtra and Tamil Nadu Plant Protection Bulletin, 1963; Nair, 1975 and Rai, 1976) and has been recorded from Gujarat (Kapadia *et al*., 1982). The groundnut leaf miner, *Aproaerema modicella* (Dev.) has also been recorded as a major pest of groundnut causing heavy loss (Prabhakar *et al*., 1994). It has also been reported from Bhubaneshwar (Jena and Kulia, 1997).

2.2 INCIDENCE AND LOSSES

(i) Seasonal incidence

(a) Groundnut jassid:

Amin (1988) reported tht jid infettion negligible during hot ummer month from April to June, but it hppened to incree grdully from the firt eek of July reching to the mximum in erly eptember.

The seasonal incidence of *Empoasca kerri* and defoliating pests including *Spodoptera litura* was studied on fodder cow peas (*Vigna unguiculata*) in the Bundelkhand region of Jhansi, India, in the kharif season. The peak infestation was the 3rd week of August. The highest population of *E. kerri* were 56 and 29 per 10 leaves in the two respective years, and the maximum damage caused by defoliators was 85.53 and 23.2% (Ram *et al*., 1989). Jayanthi *et al*. (1993a) observed the maximum incidence of this pest from active vegetative stage to flowering. Population of cicadellid *Empoasca kerri* showed a positive correlation with maximum daily temperature, sunshine, rainfall and evening relative humidity and a negative correlation with minimum daily temperature, morning relative humidity and wind speed (Jayanthi *et al*., 1993b).

The relationship between meteorological conditions and the incidence of *Empoasca kerri* on groundnut, were investigated in Maharashtra. Cloudy weather indicated the possibility of attack by the cicadellid on groundnut after 1-2 weeks, and increased hours of sunshine in the week could be responsible for increased activity in July-August (Dubey and Thorat, 1994). The jassid population was lower in last week of July while it reached the peak in the second fortnight of September and then declined gradually to a minimum up to October (Ratnoo, 1995). Studies on determination of extent of plant infestation caused by *E. kerri* at Bhubaneswar, Orissa, revealed that the pest attained its peak activity in the early part of September (Jena and Kuila, 1996).

(b) Groundnut aphid:

Bakhetia and Sidhu (1977) studied the seasonal occurrence of *Aphis craccivora* Koch, a major pest of groundnut under screen-house and field conditions at Ludhiana in India. The aphids remain active throughout the year and had 31 overlapping generations. Kanchaiah and Porte (1989) observed the maximum incidence of aphid population between July to

September; and the average relative humidity and average temperature showed negative correlation with aphid population.

Malik *et al*. (1989) reported that the maximum population of the aphid, *Aphis craccivora* Koch was recorded in bean (*Dolichus lab lab*) during October and minimum in January. The temperature between 28-30^{0}C and relative humidity between 60-67 per cent was found more conductive for bean aphid.

In Asia, *A. craccivora* appeared in groundnut early in the rainy season (Jagtap *et al*., 1984). The aphid activity was observed to start in the first week of August, which gradually increased upto the third week (Ratnoo, 1995). The studies on the build-up of aphid (*Aphis craccivora* Koch) infestation on groundnut at Bhubaneshwar revealed that highest plant infestation was observed during August (Jena *et al*., 1997). A field experiment was conducted in Malwa region of Madhya Pradesh, India and the results indicated that the pests, thrips (*Caliothrips indicus*), bean aphid (*Aphis craccivora*) and jassid (*Amrasca kerri*), reached peak population density in the fourth and fifth weeks of August, when the average weekly maximum and minimum temperatures and relative humidity were 28^{0}C, 23^{0}C and 89.5 per cent, respectively (Devesthali and Saran, 1998). Alegbe jo *et al*. (1999) observed significant negative correlations between numbers of alate aphids and age of plant; sunshine hours and relative humidity.

(c) Thrips:

Saxena (1971) reported that the population of *Caliothrips indicus* (Bagnal) in Rajasthan was maximum during June and July and that its breeding continued upto August and September. Singh *et al*. (1990) reported that chilly thrips *Scirtothrips dorsalis* (Hood) was found infesting groundnut from seedling to peg penetration stage all through the season. The maximum incidence of pests occurred from active vegetative stage to flowering (Jayanthi *et al*., 1993a). Population of *Caliothrips indicus* had a positive correlation with temperature, sunshine, rainfall and morning relative humidity and a negative correlation with evening relative humidity and wind speed, (Jayanthi *et al*., 1993b).

The incidence of thrips *Scirtothrips dorsalis* Hood was recorded on the cotton crop in Madhya Pradesh, India and the peak population was during the second fort night of August to the first fortnight of October (30^{0}C and 74-85% R.H.) (Gupta *et al*., 1997).

(d) Tobacco caterpillar:

Joshi (1987) reported that the infestation of *Spodoptera litura* Fab. started in the second week of August with 1.6 larvae/5 plants and then consistently increased reaching to its peak in the last week of September (8.3 larvae/5 plant). During the peak period of incidence the mean maximum and minimum temperatures and morning and evening relative humidity were 32.2 and 20.98^{0}C; 83.02 and 50.3 per cent, respectively. However, none of the abiotic factors had significant correlation with its incidence. *Spodoptera litura* Fab. was reported to defoliate groundnut during the vegetative stage (Singh *et al*., 1990).

(ii) Losses Due to Major Insect Pest in Groundnut:

(a) Groundnut jassid:

Saboo and Puri (1979) obtained a yield increase of more than 40 per cent by controlling jassids and thrips; however, partitioning of yield loss between thrips and jassids was not done. At the ICRISAT loss of 9 per cent in pod yield and 18 per cent in haulm weight was attributed to jassids (ICRISAT Annual Report, 1982).

(b) Groundnut aphid:

Aphis craccivora Koch. has been reported as the most injurious species of groundnut throughout Africa. The presence of aphids, known not to be carrying plant viral diseases, caused groundnut yields to drop by about 48% compared with control, in a study in Nigar (Mayeux, 1984). In South Africa, groundnut yields of 0.6-0.7 tons dry pods/ha well below that could be achieved on research farms (for example, 2.0 t/ha) was recorded mainly because of losses due to crop pests and diseases (Wightman and Wightman, 1994).

Reduction in yield to the tune of about 40 per cent had been estimated by Khan and Hussain (1965). Three years trial at Jalgaon Research Farm (Maharashtra state) indicated an average loss of 16 per cent in pod yield (AICORPO, 1981). Yield loss of about 16 per cent was recorded in groundnut in India due to a complex of insect pests, the prominent one being *A. craccivora* (Jagtap *et al*., 1984).

(c) Thrips:

In Dharwar area of Karnataka by controlling *Scirtothrips dorsalis* with systemic insecticides about 40 per cent yield increase was recorded (Thimmaiah and Panchabhavi, 1973). In Orissa, Senapathi and Patnaik (1973, 1980) mentioned *S. dorsalis* as a serious pest causing 29 per cent yield loss. At the ICRISAT trials conducted from 1980-81 to 1982-83 in the post rainy season on average of 17 per cent loss in pod yield and 30 per cent in haulm yield, mainly by *S. dorsalis* was reported, Anantha Krishnan (1973) described *Caliothrips indicus* as a menace to groundnuts in South India.

In field experiments conducted to assess yield loss due to insects in groundnut in Uttar Pradesh, Singh and Sachan (1992) observed that, the losses were caused by the thrips Scirtothrips dorsalis, the cicadellids *Empoasca* spp. and the noctuid *Spodoptera litura* that were 31.4 per cent in 1988 and 23 per cent in 1989.

(d) Tobacco caterpillar:

Field experiments were conducted by Panchabhavi and Rai (1987) for 2 years, wherein they used artificial infestation of groundnut plots of $15m^2$ with differing densities of *S. litura*. Infestation levels of just 3 egg masses (of 250 egg each) caused significant loss to groundnut pods and haulms. Infestation with 12 egg masses per plot led to a haulm yield reduction upto 43.7 per cent and pod yield reduction as high as 27 per cent when compared with an insecticide-protected control treatment. In other field experiments, over 3 consecutive years, leaf damage attributed to *S. litura* tended to decline with delayed sowing time, irrespective of the groundnut cultivar (Patil *et al*., 1996). Leaf damage fell from 51.8% for mid-June sown crops to 19.2 per cent for late-July sown crops. Mean pod yields were 2.68 and 0.99 t/ha, respectively.

In another field study to determine the effect of artificially infested groundnut plants with third-instar *S. litura* larvae 15, 30 or 45 days after emergence showed that the most sever damage occurred when plants were infested with 3 larvae 15 D.A.E. A loss of 98.3 per cent of leaf area, and reduction in pod yield by 50 per cent was recorded. Even single larva release caused the leaf area to be reduced by more than half and the pod yield to fall by 27.3 per cent. Plants infested 30 D.A.E. suffered similar levels of damage, but those infested 45 D.A.E. were less severely affected.

2.3 GERMPLASMS /VARIETAL SCREENING:

Certain in born natural preference / resistance to insect pest and disease in some varieties/germplasms of most crops make them less preferred. The idea underlying this fact has become a strategy in pest management. Thus, cultivating a relatively resistant or less preferred host plant is an important tool in the management of populations of such pests. Even low levels of resistance have great value because it may work as one of the many possible integrated suppressive factors to prevent the target species from reaching the economic threshold level. Further, a low level of resistance may favour the activities of natural enemies

(Maxwell, 1972). Evaluation of different techniques of IPM in groundnut have been made by Lynch and Douce (1992).

Brar and Sandhu (1975) screened some groundnut varieties against aphids (*Aphis craccivora* Koch) and grey weevils. Accordingly, they reported Ah 7983 and Faizpur I-5, the bunch cultivars, and spreading cultivar, Ah 8048 to have lower rate of aphid multiplication. Jai Rao *et al*. (1976) reported 0.3 per cent infestation of groundnut root borer in 'Gujarat Narrow Leaf Mutant' genotype compared with 5 per cent in bunch types and 3.6 per cent in semi-spreading types.

According to Hamid *et al*. (1977) hair density, its length and stiffness on leaves interfered with the build up of aphid colonies. These may be important factors in breeding aphid resistant varieties.

In USA, several genotypes have been found resistant to the pod-boring insect *Diabrotica undecimpuntata* Howardi (Campbell *et al*., 1977). These genotype may prove useful sources of resistant against earwig also. Mohammad (1980) reported some groundnut germplasms lines to be promising for resistance to *Frankliniella schultzei, Empoasca kerri, Aphis craccivora* and pod Scarifying termites. Groundnut varieties screened for incidence of *Aphis craccivora* Koch indicated that varieties of spreading type supported significantly higher populations than those of semi-spreading and bunchy types (Brar, 1981).

Variety JL-24 was most suitable for the growth and development of the leaf miner (*Aproaerema modicella*). Further, the bunch types of varieties were more suitable for larval development than the spreading type (Motka, *et al*., 1985). Screening a total of 300 groundnut entries for resistance to the gelechiid, *Aproaerema modicells* in the field, Mahadevan *et al*. (1988) reported "IGGS 50" (a cross between *Arachis cardenasii* and *A. hypogaea*) to have the lowest damage, minimum larval populations, and the highest pod yield (3000 kg/ha). This genotype also had resistance against the noctuids *Spodoptera litura* and *Heliothis armigera*. Rajagopal *et al*. (1988) assessed resistance to a natural infestation of the gelechiid pest in 6 Virginia bunch and 18 Virginia runner accessions in the filed during the rainy season in 1986. The highest resistance was shown by the Virginia bunch varieties "V-40" and "Ah 6429" and the Virginia runner varieties "NCA 17840", NFG 79" and EC 21989". Of the 193 groundnut entries testes for resistance to the gelechiid (*Aproaerema modicella*) none was completely resistance, 18 showed moderate resistance while "ICG 7758" and ICG 8322" were the most promising with 20.53 per cent and 21.53 per cent infestation, respectively (Ghule *et al*., 1988).

Kalaimani, *et al*. (1989) screened eighteen derivatives of a cross between *Arachis cordenasii* (a wild diploid species) and cultivated groundnut (*A. hypogaea*) for damage by the gelechiid (*Aproarema modicella*) in unprotected fields. The lowest incidence of damage (4.0%) was recorded in the entry "VG 101"; although there was no significant difference between "VG 101" and "VG 11", whereas, in other entries the percentage leaf damaged ranged from 4.3 to 11.4. Few entries tested combined resistance with high yield. Venkateswarulu and Swamy (1992) reported cultivar JL-24 as the most preferred host of the gelechid, *Aproaerema modicella*, on the basis of low consumption index and highest conversion rate. Singh *et al*. (1992) have reported that groundnut variety CSMG 84-1 to be insect and fungus tolerant with comparatively higher yields.

Amin (1988) reported that jassids were less fecund on resistant than on susceptible genotypes and the nymphal mortality was higher on the resistant ones. The number of jassid adults obtained from the nymphs released on resistant genotype was also lower than on susceptible ones. High degree of resistance was observed in genotypes with hairy leaves and / or higher densities of hairs ("NC Ac 2214", NC Ac2230" and "NC Ac 2242"), which hindered feeding of young nymphs. In addition to hairiness, resistant genotypes had thick or "curduroy" type leaves. Nanda gopal *et al*. (1993) measured leaf toughness in 3 released varieties, 4 germplasm accessions and 11 advanced intra-and inter-specific derivatives in relation the resistance to the jassid (*Balcutha hortensis*) and reported a negative relationship between percentage intensity of yellowing and commulative leaf toughness. Of the six varieties screened for their relative susceptibility against major insect pests at Udaipur, the varieties "JL-24" and GG-2" were found least susceptible to all pests, but ICGS-44 was highly susceptible (Ratnoo, 1995). Fifteen groundnut varieties collected from all over India were screened for the incidence for *Empoasca kerri*. Groundnut variety GG-3 had the lowest jassid population, whereas, variety Somnath harboured the maximum number of jassids per plant (Sherasiya, 1997).

The over all growth and development of tobacco caterpillar *Spodoptera litura* Fab. on groundnut variety C-501 was not found to be satisfactory, while on variety dwarf mutant its growth was better. The larvae reared on C-501 consumed less food per unit body weight, but its growth was slow as compared to that on dwarf mutant (Tiwari *et al*., 1988), Singh *et al*. (1993) screened fifteen *Arachis hypogaea* genotypes in the laboratory using choice tests for resistance to *Helicoverpa armigera* (third instar) and *Spodoptera litura* (I^{st}, III^{rd} and IV^{th} instar). The Virginia bunch variety BG-2 was found resistant to both pests.

Resistance of cultivated groundnut and wild species of Arachis to many major arthropod pests (*Frankliniella schultzei*, *F. fusca*, *Aphis craccivora*, *Empoasca kerri*, *E.*

fabae, *Heliothis zea*, *Spodoptera frugipenda, S. litura*, *Aproaerema modicella*, *Diabrotica undecimpunctata*, *Elasmopalpus lignosellus*, *Tetranychus urticae* and pod borer) has been confirmed in USA. Several groundnut cultivars have been found resistant to multiple pests (Lynch, 1990). Resistance to *Aphis craccivora* has been identified in the cultivar 'EC 36892'. Field and laboratory behaviour studies in Malawi showed that this resistance takes effect only after the insect has fed for about 2 hrs. Electrical studies of probe penetration showed that phloem location is almost as successful in the resistant cultivar "EC 36892" as in the susceptible cultivar "TMV2", but the mean feeding duration on the resistant cultivar was only half that on the susceptible cultivar. Chemical analysis suggests that in the resistant germplasm "EC 36892" an isofavonoid like substance may confer limited resistance at the probing stage; while a high concentration of the condensed tappin procyanidin in the phloem sap may be a major constraint to prolonged ingestation. Wild species of *Arachis* also show evidence of resistance (Padgham *et al*., 1990).

Mahto (1991) screened 63 varieties of groundnut against *Dorylus orientalis*. The variety AH-7903 was most susceptible with maximum damage (52%), whereas, varieties VR-3317, U/414/38, NS-78 and NCAc-17840 were not susceptible, showing no damage, Nakat *et al*. (1992) evaluated 238 groundnut assessions and found that only 5 were resistant to *Holotrichia serrata* grub infestation.

Satyanarayana Rao (2000) recorded lesser damage rating and a higher yield for genotype NCAC 17090. Pubescent genotype like NC Ac 2230, NCAC 2214 and NCAC 2242 were found to have higher egg load than the glabrous genotype. Genotype NCAC 2575 was found resistant to GLM.

Bred by the bulk pedigree method from a cross between F 334 A-B14 and NCAc 22, this Spanish type groundnut germplasm (PI561917) was released in 1991 as a source of resistance to *Thrips palmi*, *Empoasca kerri*, *Spodoptera litura*, *Aproaerema modicella* and bud necrosis virus. ICGV 86031 was recommended for cultivation in areas where the pests *Spodoptera* spp., *A. modicella* and bud necrosis disease were endemic (Dwivedi *et al*., 1993).

Fifteen groundnut genotypes and improved local cultivar Mahesa were evaluated at Muneng, Indonesia. Of these, cultivars, ICGV 90265, 91167 and 91176 exhibited moderate resistance to thrips (*Scirtothrips dorsalis*, *Caliothrips indicus* and *Frankliniella schultzei*), showing relatively low percentages of leaf damage and pod yield of most of the genotypes that was higher than that of Mahesa. ICGV 90226 gave the highest average pod yield (2.05 t/ha), followed by ICGV 90227 and ICGV 90228 (both 1.8 t/ha) (Nugrahaeni, 1997).

Of the seven germplasms / variety screened for preference by the groundnut jassid, germplasm IBK-I-9502 was the most preferred host (pooled jassid population per plant being 8.291) whereas, variety JL-24 was the least preferred (pooled mean jassid population per plant being 6.996) (Kumar, 1997).

Some 37 F_6 breeding populations were compared with 4 control varieties in a screen house study to combine rosette virus (groundnut rosette umbravirus) resistance with resistance to the vector *Aphis craccivora*. Following artificial infestation, mean aphid populations were recorded 10 and 15 days after infestation. The genotype ICG 12991 had the lowest rate of nymph development, low fecundity and smaller aphids compared with the controls (Minja, *et al.*, 1999).

Investigation on susceptibility of promising genotypes of groundnut against the jassid, *Empoasca kerri* Pruthi in summer season was carried out at Junagarh in Gujarat. Among the 15 genotypes screened, GG-5 and GG-2 were least susceptible (1.93 and 1.98 nymph per three leaves, respectively), whereas, J-36, JB-978, TG-26 and J-42 were most susceptible (2.68 to 2.93 nymphs per three leaves) (Khanpara and Vyas, 2001).

2.4 MANAGEMENT OF INSECT PESTS

(i) Efficcy of bio-peticide:

Of late, botanical pesticides have attracted worldwide attention as possible substitutes or even complements to synthetic insecticides. Of these, the neem tree probably has the greatest promise. Extract from its seeds and leaves have shown marked insect control potential (Schmutterer and Ascher, 1987). The use of biologically active substances from neem for the control of agricultural pests has been undertaken in different parts of the world. The repellent, antifeedant and growth regulator properties of the toxic principles from the seeds of *meliaceae*, combined with low cost, local availability, safety to the environment, and compatibility with the agro ecosystem, enhance their potential in insect pest management systems (Nadia, 1993).

Simple aqueous extract of seed kernel may be as effective or even better than synthetic insecticides against freely feeding larvae of Lepidoptera, Coleoptera and nymphs of Orthoptera because they are subjected to both contact and ingestion effect of neem. Nymphs of Hemiptera are exposed only to contact effect and hence difficult to manage with aqueous or even ethanolic extracts unless high concentration is used. *Azadirachtin* rich oil-based formulation has been suggested for the management of borers belonging to Diptera and Lepidoptera and nymphs and adults of Hemiptera (Singh and Raheja, 1993).

Patel and Srivastava (1889) observed that 0.5 and 1.0 per cent formulations of neem oil gave complete control of cowpea aphid (*Aphis craccivora* Koch.). They further recorded a positive correlation between concentration and mortality.

Akhauri *et al*. (1993) compared the efficacy of two indigenous natural plant products (neem and mahua oil) against the spotted pod borer (*Maruca testulalis* Geyar) in early pigeon pea. They reported neem oil (2 per cent) to be better than mahua oil (2 per cent), which significantly reduced the mean pod damage (27.2 to 18.9 per cent), while increased the mean number of matured pods (67.4 to 85.8 per cent) and grain yield (13.5 to 17.4 gm per plant) in comparison to untreated check.

Methanol, petroleum ether, and water extract of neem seed kernel and neem oil were found to be as effective as the commercial insecticides, chlorfluazuran, ethofesiprox, and triflumuron and more effective than methamediphos, cartap, *Bacillus thuringiensis,* and diflumuron against leaf eating caterpillar complex on cabbage. Neem seed extract did not cause any harmful effect on *Apanteles plutellae* Kurdjumov and the quality of cooked cabbage. Use of neem seed kernel water extract and neem oil was found to be more cheaper than metha mediphos and chlorfluazuron; they should, however, be applied at a lower action threshold to avoid significant loss (Bandara and Kudagamage, 1993). Krishna Moorthy and Srinivasan (1993) reported 5 per cent neem seed kernel extract application, at the time of appearance of puncture marks in the unfoliate leaf stage and again at petiole mining stages, to be most effective against the bean fly [*Ophiomyia phaseoli* (Tryon)].

Neem products reduced the population / damage in rice as well as pulse crop but lesser than the conventional insecticides which were deleterious to spiders. Grain yield was 13.41 and 13.43 per cent more in neem seed kernel extract and neem oil, while in pigeon pea it was 26.29 and 4.29 per cent more and chickpea 12.55 and 6.61 per cent more, respectively over control (Shukla *et al*., 1993). Sachan and Gururaj (1993), in large scale multilocational field trials, found that neem seed kernel extract (NSKE) and neem leaf extract (NLE) at 5 per cent each provided significant and cost-effective control of the pod borer (*Heliothis armigera*) compared to conventional insecticides in chick pea. In pigeon pea two sprays of NSKE (5%) and a single spray of Cypermethrin (0.01%) gave significantly better cost benefit ratio of (1:3.81) than endosulfan 0.07 per cent (1:3.39) applied against *H. armigera*. Soil treatment with phorate @ 20 kg/ha at pre-flowering stage followed by NPV application and NSKE 5 per cent spray was effective in reducing *H. armigera* larval population to the extent of 4.16 per cent equal to monocrotophos 0.04 per cent, endosulfan 0.07 per cent and quinolphos 0.05 per cent. Ayyanagar and Rao, (1989) reported that neem seed kernel suspension has good oviposition deterrent property for controlling *S. litura* on caster plants and also reported by Patel and Patel (1998).

The efficacy of neem extracts, indigenous plant extracts against *Scirtothrips dorsalis* was determined on groundnut in Tamil Nadu, and it was observed that all the neem products significantly reduced the thrips population, with Achook, Neem Gold and 3 per cent neem oil resulting in 29, 29 and 28 per cent lower populations, respectively, than no treatments (Senguttavan, 1999).

(ii) Efficacy of bio-agents:

Hussan *et al*. (1985) investigated the role of *Chrysoperla carnea* as a predator of *Myzus persicae* on sugar beet in green house experiments in the German Federal Republic using various predatory-prey ratios. Releases of early second instar larvae of *C. carnea* at predator-pray ratio of 1:5, 1:10, 1:20 and 1:40 were found effective against *M. persicae*, as each release completely eliminated the pest. Adequate control was obtained for 5-6 weeks at ratios of 1:5 and 1:40. Releases at ratios of 1:50 and 1:60 did not eliminate the pest, but considerably reduced its abundance. The plants on which the predators were released reached normal size, while untreated ones died during the first two months of the experiments.

Shuvakhina (1985) investigated the possibility of using the common lace wing *C. carnea* and the Chinese lace wing, *C. sinica* for the biological control of the Colorado potato beetle, *Leptinotarsa decemilineata* in the central cheronozem region of the U.S.S.R. the Ukrainian SSR and the Maldovian SSR. The technical effeteness of *C. carnea* was 85-96%, while that of *C. sinica* was 81-89%. Adashkevich (1987) reported the aphis lion, *C. carnea* to be potentially the most promising natural enemy for release against sucking pests of cotton and other crops in Uzbek, SSR, USSR. Li (1987) intercropped safflower in the cotton field as a means of Augmentating *chrysoperla* spp. to control the cotton aphid, *A. gossypii* in Liaoning, China. The safflowers were naturally infested with *M. persicae* and attracted as many as 41,000 specimens of chrysoperla /mu (1 mu = 0.067 ha) including *C. Formosa*, *C. sinica* and *Coccinella septempunctata*. The species of *Chrysoperla* multiplied and gave effective control of the cotton aphids.

Rossmann and Fortmann (1989) intensively surveyed the use of *C. carnea* for the bio control of *A. solani* and *N. ribisnigri* on lettuce under field and semi-field conditions in the German Federal Republic and in the incidence of effectiveness of the other natural enemies in the test garden. The application of first and third instar larvae of *C. carnea* reduced aphid population by 83-88 and 90%, respectively.

Ushchekov (1989) successively used *Chrysoperla* for control of *Aphis gossypii* on cucumber in the green house in USSR eggs and larvae were used for initial colonization. The predator could be released at any time of year at any stage of growth of the plants and was found active over a wide range of temperature. It was effectively dynamic under experimental and commercial conditions for use against *M. persicae* too. Darwish and Ali (1991) investigated the natural enemies of aphids in maize crops. The infestation of maize in upper Egypt with *Schizaphis graminum* and *Rhapalosiphum maidis* in 1988 and 1989 occurred in the beginning of August and aphid reached their maximum abundance (406 and 518/plant) in the fourth week of August, when the plants were in their reproductive stages. Aphid population began to decrease from the third week of September, to reach their lowest level in mid October, when the plants were mature *C. carnea* was one of the commenest predators associated with the aphids.

Peri *et al.* (1993) conducted experiment in Emilia-Ramagne, Italy, in 1990-92 to evaluate the effectiveness of biological control techniques against arthropod pests on strawberries in protected cultivation. The chrysopid *C. carnea* was released against infestations of the aphids *M. europhorbiae* and *C. fragaefolii* at a density of at least 20 larvae/linear/m of each period row. The predator effectively reduced the pest populations. Mannan *et al.* (1995) studied the seasonal fluctuations and host-predator relationship of *C. carnea* Stephens in Punjab and indicated a clear positive correlation between the predator and its prey.

Rana and Srivastava (1998) studied the feeding potential and growth rate index of *Chrysoperla carnea* Stephan by feeding. The I, II and III instars larvae of the predator preferred and consumed *Lipaphis erysimi* Kalt and *Aphis craccivora* Koch, in maximum numbers.

(iii) Efficacy of different insecticides:

The superiority of monocrotophos at 0.05 per cent in the control of *Spodoptera litura*, defoliator was reported by (Ayyanna *et al*., 1982). Nair *et al*. (1991) conducted studied on the control of the rose thrips (*Scirtothips dorsalis*) using seven insecticides at two doses. Monocrotophos, quinolophos or phosphomidon could effectively suppress the leaf damage by the pest at 0.05%.

The efficacy of 9 insecticides against *Scirtothrips dorsalis* Hood on chilli (*Capsicum annum*) (CV. NP-46A) was investigated in Maharashtra, India. Four sprays of 0.015% permethrin or 0.05% monocrotophos given at 21 days, intervals commencing 45 days after transplantation were the most effective treatment in reducing nymphal populations of the thrips for up to 15 days after application and in giving the highest yields (864.9 and 837.6 kg/ha) respectively (Sanap and Nawale, 1987). Monocrotophos at 250, Pyraclofos at 500 and 100, and deltamethrin at 15 g a.i./ha were the most effective of 6 insecticides tested in sprays against *Empoasca sp*., *Scirtothrips dorsalis*, *Frankliniella schultzei*, *Caliothrips impurus* and groundnut leaf miner (*Aproaerema modicella)* on groundnuts in Tamil Nadu, India (Peter and Sunderarajan, 1991).

The optimum crop stage and number of applications of monocrotophos were determined for the control of *Scirtothrips dorsalis* on chillies (*Capsicum annum*) in the field in Gujarat, India Five sprays of monocrotophos at 0.5 kg a.i./ha. at fortnightly intervals beginning 35 days after transplanting suppressed thrips damage and increased yield (Bagle, 1993).

In a field experiment conduced during the rainy season to evaluate the efficacy of different insecticide schedules for controlling *Scirtothrips dorsalis* infesting chilli in Gujarat, India, it was found that soil application of carbofuran at 0.5 kg a.i./ha or phorate at 0.7 kg a.i./ha 15 days after transplanting, followed by spray application of 0.04% monocrotophos or 0.1% triazophos alone at 10 day intervals, commencing from 40 days after transplanting, effectively checked the pest population and gave the highest yield (Patel *et al*., 1997).

Senguttuvan (1999) determined the efficacy of 0.05% monocrotophos against *Scirtothrips dorsalis* on groundnut in Tamil Nadu, India, resulting in a 45-50% reduction of the pest population.

Mishra and Senapath, (1997) recorded minimum pod infestation and the highest yield when phorate 10G was used. Jena *et al*. (1997) evaluated several pesticides and observed that dimethoate was superior over other pesticides in relation to reduction in plant infestation and increased production of groundnut.

Jayanthi *et al*. (2000) obtained maximum returns by the application of carbofuran 3G at the rate of 0.5 kg a.i./ha. followed by application of fenvalerate 20EC at 0.01%.

3. MATERIALS AND METHODS

The mteril ued nd methodology dopted during the coure of invetigtion on germplm creening; incidence of mjor inect-pet of groundnut nd their mngement hve been decribed in thi chpter.

3.1 GENERAL DETAILS OF THE EXPERIMENTS

3.1.1 Site and location of the experiments:

The preent invetigtion ere crried out t the Reerch Frm, College of Technology nd Agriculture Engineering, Udipur during khrif, 2002-03.

Geogrphiclly, Udipur i locted t 23.4^0 N longitude nd 75^0 E ltitude t n elevtion of 579.6 ML in the tte of Rjthn.

3.1.2 Climate and Weather conditions of location:

The climate of the region is subtropical characterized by mild summers and winters. The average annual rainfall is ranged from 367.9 to 810.6 (during the 13 year period from 1990-2002, the rainfall average recorded was 540.2 mm), most of which was received during July to September with the occasional rains during the winter seasons. The maximum temperature reaches 45.5^0C, sometimes even beyond; and the minimum falls to 4.5^0C. During the 13 year period (1990-2002). The average relative humidity recorded was 57 per cent. This region is quite suitable for most of the crops.

3.1.3 Preparation of land and manuring:

The experimental field was prepared during last week of June by ploughing once using disc plough, followed by cross harrowing and planking.

Ten tonnes of Farm yard manure and inorganic fertilizers as half of the recommended dose of nitrogenous fertilizer (20 kg N/ha) and full dose of phosphatic fertilizer (60 kg P_2O_5/ha); potassic fertilizer (80 kg K_2O/ha) and gypsum (125 kg $CaSo_4$/ha) were applied at the time of last ploughing.

3.1.4 Procurement of experimental material:

Table 1: Details of experimental material

S.No	Common name	Trade name	Source of supply	**Amount (quantity)**
1.	Farm yard manure	FYM	Live Stock Farm; RCA, Udaipur	1 tonne
2.	Urea	-	Deptt. of Agronomy	10 kg
3.	Muriate of Potash	-	Deptt. of Agronomy	20 kg
4.	Gypsum	-	Deptt. of Agronomy	30 kg
5.	Groundnut seed	(i) TKG-19A	National Seed Corporation, India	8 kg
		(ii) Germplasms of groundnut	Deptt. of PBG, RCA, Udaipur	200 gm each germplasm
6.	Kernel extract	Neemax	Ecomax Agro System Ltd., Mumbai-20	250 gm
7.	Monocrotophos 36SL	Crotocel	Excel Industries Ltd., Bhavnagar	100 ml
8.	Carbofuran 3G	(Diafuran) 3G	Nagarjuna VIPL Hyderabad	1 kg
9.	*Chrysoperla carnea*	Green lacewing	Deptt. of Agril. Zool. & Entomology, RCA, Udaipur	1000 nos.

3.1.5 Field layout and sowing:

The crop was sown in a randomized block design. The plot size was 5m x 0.90m (Fig. 1)

3.1.6 Irrigation schedule and cultural practices:

Due to errtic rinfll four irrigtion ere given. The firt irrigtion given 5 DA folloed by thinning 20 DA. Other recommended gronomicl prctice ere folloed nd hen needed.

3.1.7 Meteorological data:

Data on weather factors *viz*., atmospheric temperature, (minimum and maximum), relative humidity (morning and evening), and the total rainfall were obtained from the meteorological observatory, College of Technology and Agriculture Engineering, Udaipur. The data have been presented in Table-2 and Fig.-3.

3.1.8 Interpretation of data:

The dt on popultion of mjor pet ere trnformed to ure root vlue. In order to tudy the influence of vriou meteorologicl prmeter (biotic fctor) on the popultion build up of mjor pet, imple correltion coefficient ere orked out. The verge pet popultion ere correlted to the biotic fctor (verge temperture, verge reltive humidity nd verge rinfll). pecific methodology ued for individul experiment re decribed belo.

3.2 SPECIFIC DETAILS OF THE EXPERIMENTS

3.2.1 Germplasms screening in groundnut against the major pests:

(i) Experimental layout:

In lieu of limited quantity of germplasm material available, only three rows were sown. The crop was sown on 6th July, 2002. A row to row spacing of 30 cm and plant to plant distance of 10 cm was maintained.

(ii) Treatment details:

Eleven germplm of groundnut ere creened for their preference by the mjor pet in comprion to the vriety GG-2, the locl check. The germplm creened ere UG-2, UG-3, UG-9, UG-17, UG-21, UG-31, ICR-10, ICR-02, JAL-13, JUN-40, TIR-10.

(iii) Observation:

Observations on the populations of major pests were made soon after the appearance of the pests and continued every week till a week before the harvest of the crop. the observations were taken by employing suitable techniques on the randomly selected 5 plants that were tagged.

Jassid:

Sudden trapping: Two petri-plates were used. The petri-plates were placed over the leaves of the tagged plants; the jassids disturbed hopped on to the petri plates; after 30 second, the patri plates were gradually pulled out along with the jassids, the jassids (both nymphs and adult) so trapped only from three leaves viz., lower, middle and upper leaves in the petri plates were counted. Observations were carried out in the early hours of the day.

Aphid:

The aphid population was counted only on three leaves as per method suggested by Satpathy (1973) for recording aphid population, marked leaf was grasped at the petiole and twisted until underside of the leaf was clearly visible. Aphid population was counted, which was expressed on per three leaves basis (trifoliate).

Thrips:

For estimation of thrips population three leaves were selected from the upper, middle and lower portion of each plant and population was counted. Observations were carried out in the early hours of day since these insects remain inactive during early hours of the day.

Tobacco caterpillar and blister beetle:

Direct count method: The tagged plants were visually observed for numerical abundance of tobacco caterpillars and blister beetles.

To evaluate host plant resistance based on morphological leaf characters of eleven germplasms and local check GG-2 of groundnut, the observations on three morphological characters of leaves *viz*., leaflet length, leaflet width and density of hairs were recorded. The numbers of hairs were counted in 2 x 2 mm areas of leaf. The length and width of the leaflets were also measured. To study the individual and cumulative effects of three leaf characters on the build up of foliar pests *viz*., jassids, aphids, thrips population, the data recorded at successive intervals on foliar pests count as well as morphological character were pooled for each germplasm separately and subject to simple correlation.

3.2.2 Evaluation of bio-intensive management practices against major insect pests of groundnut:

(i) Experimental layout:

The experiment was laid out in a simple RBD with eight treatments including control. These treatments were replicated three times. The plot size was 5m x 3m. A row to row distance of 30 cm and plant to plant distance of 10cm was maintained. The crop was sown on 6^{th} July, 2002 and variety TKG-19A was taken.

(ii) Treatment details:

1. Spray of N.S.K.E. 5 per cent at 30 and 50 days after sowing.
2. Three release of *C. carnea* Stephan at the rate of 2000 newly hatched grubs/ha. at 30, 40 and 50 days after sowing.
3. Three release of *C. carnea* Stephan at the rate of 4000 newly hatched grubs/ha at 30, 40 and 50 days after sowing.
4. Two releases of *C. carnea* at the rate of 4000 newly hatched grubs/ha. at 30 and 40 DAS and monocrotophos @ 0.05 per cent at 50 DAS.
5. Monocrotophos @ 0.05 per cent at 30 DAS and two release of *C. carnea* at the rate of 4000 newly hatched grubs/ha. at 40 and 50 DAS.
6. Basal application of carbofuran 3G at the rate of 0.5 kg a.i./ha and two releases of *C. carnea* at the rate of 4000 newly hatched grubs/ha. at 30 and 40 DAS.

7. Monocrotophos @ 0.05% 2 spray at 30 and 50 DAS (standard check).

8. Control (untreated).

The pesticides were sprayed in the evening hours on the crop with the help of a knapsac sprayer.

(iii) Economics of treatments:

In order to evaluate the most profitable treatment, economics of different treatments was worked out in term of net profit over untreated check and cost benefit ratio. In calculating the economics only groundnut pod yield was considered as the economic value.

The cost benefit ratio (C:B) was calculated as follows :

$$C:B = \frac{\text{Net profit treatments used}}{\text{Cost of insecticidal treatment}}$$

4. ExpErimEntal findings

The results obtained after analysing the data from different experiments are presented below:

4.1 SEASONAL INCIDENCE

The observations recorded on the incidence of major insect pest of groundnut during July-October 2002 have been presented in Tables-3, 4 & 5 and depicted in Fig. 4 & 5.

4.1.1 Groundnut jassid (*Empoasca kerri* Pruthi):

The activity of jassids started during the first week of August (32^{nd} Standard Meteorological Week) recording 1.93 individuals per trifoliate. The mean atmospheric temperature, average relative humidity and total rainfall were 25.7^0C, 87.5 per cent and 59.8 mm, respectively. The population reached to the maximum of 3.07 individuals per trifoliate in the last week of August when mean temperature, average relative humidity and total rainfall were 25.5^0C, 75 per cent and 22.2mm, respectively. The population started declining and reached to 2.67 individuals per trifoliate. The population again built-up reaching to the peak, (4.87 individuals per trifoliate) in the third week of September (39^{th} SMW) when the mean temperature, average relative humidity and total rainfall were 27.6^0C, 60 per cent and 10.2mm, respectively. Therefore, the population started declining and reached to 2.07 individuals per trifoliate.

The increase in jassid population was positively correlated with temperature (r = +0.48) but negatively correlated with average relative humidity (r = -0.31) and the total rainfall (r =-0.21), though not significant.

4.1.2 Groundnut aphid (*Aphis craccivora* Koch.)

The seasonal incidence of the aphids started from first week of August (32^{nd} Standard Meteorological Week) recording 2.87 aphids per trifoliate, when the mean atmospheric temperature, average relative humidity and total rainfall being 25.7^0C, 87.5 per cent and 59.8mm, respectively. The aphid population increased rapidly and reached to the maximum of 5.53 aphids per trifoliate in the third week of August when mean atmospheric temperature, average relative humidity and total rainfall of the week were 26.85, 77 per cent and 73.2mm, respectively. But is declined and reached to minimum of 1.73 aphids per trifoliate. Lateron, the population again started increasing and reached to the maximum of 4.20 aphids per trifoliate in the first week of September when the mean temperature, average relative humidity and total rainfall were 25.75^{0}C, 62 per cent and 0.000mm, respectively. Therefore, the population started declining and disappeared in the last week of September.

The increase in aphids population was negatively correlated with mean atmospheric temperature (r = -0.29) but was not significant. It was positively correlated with average relative humidity (r = +0.69) and was significant, whereas, with total rainfall (r =+0.52) the correlation was positive but not significant.

4.1.3 Thrips (*Scirtothrips dorsalis* Hood):

The initial population was recorded on 4th August (32nd SMW) being 2.13 thrips per trifoliate. The population of thrips increased to reach a high of 5.07 thrips per trifoliate in the first week of September, when the mean atmospheric temperature, relative humidity and total rainfall were 26.65^{0}C, 74 per cent and 18.6mm, respectively. Thereafter the population declined and again started to build-up reaching the peak of 4.47 thrips per trifoliate upto last-week of September and then again started declining and reached to 2.20 thrips per trifoliate.

The increase in thrips population was positively correlated with mean atmospheric temperature (r = +0.27) and average relative humidity (r = +0.07) but negatively correlated with weekly rainfall (r =-0.15) though not significant.

4.1.4 Tobacco caterpillar (*Spodoptera litura* Fab.):

The tobacco caterpillar *Spodoptera litura* Fab. appeared in the third week of August and started increasing reaching to the peak of 1.07 caterpillar per plant in the third week of September (39th SMW) when the mean atmospheric temperature, average relative humidity and total rainfall were 27.6^{0}C, 60 per cent and 10.2mm, respectively. The population started declining and disappeared soon.

The tobacco caterpillar population was positively correlated with mean atmospheric temperature (r = +0.21) but negatively correlated with average relative humidity (r = -0.16) and weekly rainfall (r =-0.30), though not significant.

4.1.5 Blister beetle (*Mylabris* sp.):

The activity of blister beetle started in the first week of September (36th SMW), 7 weeks after sowing, when 0.27 beetles, per plant were recorded; the mean atmospheric temperature, relative humidity, and rainfall being 26.65^{0}C, 74 per cent and 18.6mm, respectively. The population of blister beetle increased rapidly reaching to the peak of 1.33

beetle per plant in the third week of September (38th SMW) and remained constant for one week, when the mean atmospheric temperature, relative humidity and total rainfall were 27.6^{0}C, 64 per cent and 6.8mm, respectively. Thereafter the population started declining and reached to 0.20 beetles per plant at the time of last observation.

The blister beetle population had a positive correlation with the mean atmospheric temperature (r =+0.31) but and was negative correlation with relative humidity (r = -0.58) and weekly rainfall (r = -0.46), though not significant.

4.2 (A) EVALUATION OF GERMPLASMS FOR THEIR PREFERENCE BY THE MAJOR INSECT-PESTS

Eleven germplasms and the local check variety GG-2 (Tables-6, 7) of groundnut were screened for their relative susceptibility to major insect pests during kharif, 2002. The observation on major insect pests were recorded at weekly intervals (Tables-8-12).

4.2.1 Groundnut jassid:

Observation for jassid infestation started from 4th August, 2002. The mean groundnut jassid population ranged from 2.793 to 3.987 per trifoliate during the observational period (Table-6) in all the germplasms / variety. The germplasm ICR-10 had the lowest groundnut jassid population (2.793 per trifoliate) and significantly differed from the population on UG-31, UG-21, JAL-13, UG-17, UG-2, TIR-10 and ICR-02. The highest groundnut jassid population (3.987 per trifoliate) was recorded from the germplasm ICR-02 followed by that on TIR-10 and UG-2. The prefential sequence of germplasms to the groundnut jassids, in a descending order of susceptibility, was ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-21> UG 31> UG-3> GG-2> UG-9> JUN-40> ICR-10 (Table-7).

4.2.2 Groundnut aphid:

Observation on the pest population were started from 4th August, 2002. The mean groundnut aphid population ranged from 3.100 to 4.275 per trifoliate during the observational period (Table-6) in all the germplasms. The local check variety GG-2 had the lowest aphid population (3.100 per trifoliate), which significantly differed from nine other germplasms ICR-10, UG-3, UG-21, UG-31, JAL-13, UG-17, UG-2, TIR-10, ICR-02. The highest groundnut aphid population (4.275 per trifoliate) was recoded from the germplasm ICR-02 followed by that on TIR-10. The prefential sequence of germplasms to the groundnut aphids, in a descending order of susceptibility, was ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-31> UG-21> UG-3> ICR-10> JUN-40> UG-9> GG-2 (Table-7).

Table 7: Preferential sequence of different groundnut germplasms and the variety GG-2 to major pests.

S.No.	*Name of Pests*	**Descending order of susceptibility**
1.	Jassid	ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-21> UG-31> UG-3> GG-2> UG-9> JUN-40> ICR-10
2.	Aphid	ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-31> UG-21> UG-3> ICR-10> JUN-40> UG-9> GG-2
3.	Thrips	JUN-40> UG-9> UG-2> UG-31> ICR-02> UG-17> TIR-10> UG-21> GG-2> UG-3> ICR-10> JAL-13
4.	Tobacco caterpillar	TIR-10> ICR-02> UG-2> UG-17> UG-3> JAL-13> UG-21> UG-31> UG-9> ICR-10> JUN-40> GG-2
5.	Blister beetle	UG-2> TIR-10> JAL-13> ICR-02> UG-17> UG-3> UG-31> UG-21> ICR-10> UG-9> JUN-40> GG-2

4.2.3 Thrips:

The mean thrips population ranged from 2.940 to 3.653 per trifoliate during the period of observation (Table-6) in all the germplasms. The germplasm JAL-13 had the lowest thrips population (2.940 per trifoliate), which was significantly different from seven other germplasms TIR-10, UG-17, ICR-02, UG-31, UG-2, UG-9 and JUN-40. The highest groundnut thrips population (3.653 per trifoliate) was recorded from the germplasms JUN-40 followed by that on UG-9, UG-2, UG-31 and ICR-02.

The prefential sequence of the germplasms to the thrips, in a descending order of susceptibility, was JUN-40> UG-9> UG-2> UG-31> ICR-02> UG-17> TIR-10> UG-21> GG-2> UG-3> ICR-10> JAL-13 (Table-7).

4.2.4 Tobacco caterpillar:

The mean tobacco caterpillar population ranged from 0.533 to 1.075 per plant during the observational period (Table-6) in all the germplasms. The local check GG-2 had the lowest tobacco caterpillar population (0.533 per plant), which significantly differed from other nine germplasms UG-9, UG-31, UG-21, JAL-13, UG-3, UG-17, UG-2, ICR-02 and TIR-10. The highest tobacco caterpillar population (1.075 per plant) was recorded from the germplasm TIR-10 followed by that on ICR-02 (1.058 per plant). The prefential sequence of germplasms to the tobacco caterpillar, in a descending order of susceptibility, was TIR-10>

ICR-02> UG-2> UG-17> UG-3> JAL-13> UG-21> UG-31> UG-9> ICR-10> JUN-40> GG-2 (Table-7).

4.2.5 Blister beetle:

The mean blister beetle population ranged from 0.800 to 1.100 per plant during the period of observation (Table-6). The germplasms did not show any significant difference in their preference. However, the local check variety GG-2 had the lowest blister beetle population (0.800 per plant), whereas, on UG-2 the population was the maximum (1.100 per plant). The prefential sequence of germplasms to the blister beetle, in a descending order of susceptibility, was UG-2> TIR-10> JAL-13> ICR-02> UG-17> UG-3> UG-31> UG-21> ICR-10> UG-9> JUN-40> GG-2 (Table-7).

(B) RELATION BETWEEN LEAF CHARACTERS AND POPULATION OF FOLIAR PESTS OF GROUNDNUT

The effect of various leaf characters such as number of hairs (2x2 mm leaf bit), leaf let length (cm) and width (cm) on the incidence of groundnut jassids, aphids and thrips recorded on twelve germplasms was studied and their correlations between them were worked out. The various leaf characters such as number of hairs, leaflet length and width varied significantly among different germplasms. The population of groundnut jassid (Table-13a), aphid (Table-13b) and thrips (Table-13c) on the twelve germplasms was recorded from August to October 2002.

Table 13a: Linear relationship between jassid population and leaf morphological characteristics of different groundnut germplasms and variety GG-2

Germplasms	Mean jassid population	No. of Hairs (2x2 mm)	Leaflet Length (cm)	Leaflet Width (cm)
UG-2	**3.807**	**32.7**	**5.18**	**2.58**
UG-3	**2.913**	**54.1**	**4.27**	**2.10**
UG-9	**2.847**	**58.8**	**5.32**	**2.68**
UG-17	**3.320**	**35.9**	**4.68**	**2.25**
UG-21	**3.107**	**43.5**	**4.15**	**1.95**
UG-31	**3.033**	**46.8**	**3.32**	**2.79**
ICR-10	**2.793**	**63.1**	**4.21**	**2.00**
ICR-02	**3.987**	**28.1**	**4.28**	**2.77**
JAL-13	**3.273**	**39.3**	**3.80**	**1.76**
JUN-40	**2.807**	**59.7**	**5.68**	**2.99**
TIR-10	**3.953**	**28.6**	**4.61**	**2.30**

GG-2	**2.907**	**55.7**	**4.31**	**1.97**
Correlation coefficient (r)		**-0.942***	**+0.004**	**+0.150**
Tabulated r value at 5%		**.576**	**.576**	**.576**

*** Significant at 5% level**

The maximum number of hairs (63.10/2 x 2 mm leaf bit) was observed on ICR-10; leaflet length (5.68cm) and width (2.99cm) were maximum on JUN-40; While minimum number of hairs (28.10 hairs/2x2mm leaf bit) was observed on ICR-02; and the leaflet length (3.80cm) and leaflet width (1.76cm) were minimum on JAL-13. Consequently, the lowest population of jassids was recorded on ICR-10 (2.793/trifoliate). While, the lowest aphid population was observed on the local check GG-2 (3.100/trifoliate). While, ICR-02 supported the highest population of the jassids as well as aphids.

Table 13b: Linear relationship between aphid population and leaf morphological characteristics of different groundnut germplasms and variety GG-2

Germplasms	Mean aphid population	No. of Hairs (2x2 mm)	Leaflet Length (cm)	Leaflet Width (cm)
UG-2	**3.967**	**32.7**	**5.18**	**2.58**
UG-3	**3.525**	**54.1**	**4.27**	**2.10**
UG-9	**3.300**	**58.8**	**5.32**	**2.68**
UG-17	**3.917**	**35.9**	**4.68**	**2.25**
UG-21	**3.592**	**43.5**	**4.15**	**1.95**
UG-31	**3.592**	**46.8**	**3.32**	**2.79**
ICR-10	**3.425**	**63.1**	**4.21**	**2.00**
ICR-02	**4.275**	**28.1**	**4.28**	**2.77**
JAL-13	**3.758**	**39.3**	**3.80**	**1.76**
JUN-40	**3.308**	**59.7**	**5.68**	**2.99**
TIR-10	**4.275**	**28.6**	**4.61**	**2.30**
GG-2	**3.100**	**55.7**	**4.31**	**1.97**
Correlation coefficient (r)		**-0.93***	**-0.09**	**+0.11**
Tabulated r value at 5%		**.57**	**.57**	**.57**

*** Significant at 5% level**

The correlation between jassids and the leaf hair density was significantly negative (r = -0.94). Similarly, the correlation between aphids and the leaf hair density was also significantly negative (r = -0.93). In case of thrips, the correlation between thrips and the leaf hair density was negatively correlated but was not significant (r =-0.16).

The leaflet length and width was observed to have no significant effect on the groundnut jassid and aphid population and the correlation coefficients worked out were low, though positive (r = +0.004, +0.15 for jassids and r=-0.09 and + 0.11 for aphids).

Table 13c: Linear relationship between thrips population and leaf morphological characteristics of different groundnut germplasms and variety GG-2

Germplasms	Mean thrips population	No. of Hairs (2x2 mm)	Leaflet Length (cm)	Leaflet Width (cm)
UG-2	**3.513**	**32.7**	**5.18**	**2.58**
UG-3	**3.027**	**54.1**	**4.27**	**2.10**
UG-9	**3.553**	**58.8**	**5.32**	**2.68**
UG-17	**3.393**	**35.9**	**4.68**	**2.25**
UG-21	**3.147**	**43.5**	**4.15**	**1.95**
UG-31	**3.493**	**46.8**	**3.32**	**2.79**
ICR-10	**2.993**	**63.1**	**4.21**	**2.00**
ICR-02	**3.453**	**28.1**	**4.28**	**2.77**
JAL-13	**2.940**	**39.3**	**3.80**	**1.76**
JUN-40	**3.653**	**59.7**	**5.68**	**2.99**
TIR-10	**3.320**	**28.6**	**4.61**	**2.30**
GG-2	**3.093**	**55.7**	**4.31**	**1.97**
Correlation coefficient (r)		**-0.16**	**+0.57***	**+0.94***
Tabulated r value at 5%		**.57**	**.57**	**.57**

* Significant at 5% level

The germplasm “JAL-13” had the minimum size of the leaflet (3.80cm long and 1.76 cm wide). The leaflet length and width of different germplasms varied from 3.80 cm to 5.68 cm and 1.76 to 2.99cm. The correlation between leaflet length; leaflet width and thrips population for the different germplasms happened to be positive and was significant (r = +0.57 and +0.94).

The yield of different germplasms / variety screened showed significant difference ranging from a minimum (922.33 g per plot) for TIR-10 to a maximum (3018.33 g per plot) for JUN-40 (Table-14)

Table 14: Comparative pod yields of different groundnut germplasms and the variety (*kharif,* 2002)

S.No	Germplasms/Variety	Mean yield in g/plot
1.	UG-2	**1200.00**
2.	UG-3	**1845.33**
3.	UG-9	**2130.00**
4.	UG-17	**1581.00**
5.	UG-21	**1616.67**
6.	UG-31	**2086.67**
7.	ICR-10	**2231.00**
8.	ICR-02	**1125.33**
9.	JAL-13	**1601.67**
10.	JUN-40	**3018.33**
11.	TIR-10	**922.33**

12.	GG-2	**2255.33**
	SEm±	**45.2767**
	CD (at 5%)	**132.8004**

4.3 EVALUATION OF BIO-INTENSIVE MANAGEMENT PRACTICES AGAINST MAJOR INSECT PESTS OF GROUNDNUT

The data presented in Table-15 reveal that all treatments proved to be profitable over control. The yield of groundnut under the different treatment combinations showed a significant difference. The maximum yield (3.280 kg/plot) was obtained from monocrotophos (0.05%) with two spray, first spray at 30 days after sowing and second spray at 50 days after sowing and the minimum yield (2.435kg/plot) was obtained from *Chrysoperla carnea* Stephen @ 2000 larvae/ha with three release at 30, 40 and 50 days after sowings. The yield of (kg/plot) was converted into (quintal/ha.) (Table-15).

Among the different treatment combination evaluated, maximum net return of Rs. 10122/ha. was obtained with monocrotophos (0.05%) first spray at 30 days after sowing and second spray 50 days after sowing, giving the C:B ratio of 1:12.05. The second best treatment was neem seed kernel extract (5%) two spray first at 30 days after sowing and second at 50 days after sowing, giving net return of Rs. 6204/ha and the C:B ratio of 1:9.69. The treatment *Chrysoperla carnea* Stephen (4000 larvae/ha) was least effective three release at 30, 40 and 50 days after sowing, giving net return of Rs. 1764/ha and the C:B ratio of 1:0.64 only.

5. Discussion

The reult obtined during the preent invetigtion hve been dicued here belo ith vilble literture:

In order to provide a sound management practices, quantitative population of the major insect pests of groundnut were studied under agro-climatic conditions prevailing at Udaipur, Rajasthan. The most important insect pests recorded during the present investigation were groundnut jassid, *Empoasca kerri* Pruthi; groundnut aphid, *Aphis craccivora* Koch.; thrips, *Scirtothrips dorsalis* Hood; tobacco caterpillar, *Spodoptera litura* Fab. and blister beetle *Mylabris* sp. Besides these pests, the crop was also found infested with whitefly *Bemisia tabaci* Genn., Grey weevil, *Mylocerus discolor* Fitch; Castor hairy caterpillar, *Euproctis* sp.; surface grasshopper, *Chrotogonus trachypterous* Blance. But because of their very low population the data were not incorporated in present study.

5.1 EAONAL INCIDENCE

(a) Groundnut Jassid (*Empoasca kerri* Pruthi):

Studies conducted on seasonal incidence of groundnut jassid, *Empoasca kerri* Pruthi revealed that jassid, is one of the pests of regular occurrence. The attack of this pest was observed throughout the period of crop with maximum incidence from active vegetative to flowering stage.

The infestation of groundnut jassids started during first week of August [32nd Standard Meteorological Week (SMW)] with average population of 1.93 per trifoliate, which continuously increased upto the last week of August reaching to the maximum of 3.07 individuals per trifoliate and then declined gradually. The population again built-up reaching to the peak (4.87 individuals per trifoliate) in the third week of September, thereafter the population started declining (Table-3, Fig. 4).

Amin (1988) reported that the jassid infestation was negligible during hot summer months from April to June, but it happened to increase gradually from the first week of July reaching to the maximum in early September. Jena and Kuila (1996) also reported that the pest attained its peak activity in the early part of September. Ram *et al.* (1989) reported the peak infestation in the 3rd week of August. Jayanthi *et al.* (1993a) observed the maximum incidence of this pest from active vegetative stage to flowering. Ratnoo (1995) reported that the jassid population was lower in last week of July while it reached the peak in the second fortnight of September and then declined gradually to a minimum upto October. The works conducted by these earlier workers fully support the findings of the present investigation.

In the present investigation, it was found that the jassid population showed a positive correlation with maximum daily temperature and average temperature while a negative correlation was observed with minimum daily temperature, relative humidity and rainfall. Earlier work conducted by Jayanthi *et al*. (1993b) also indicates the similar effects of environmental factors on population of jassids.

(b) Groundnut Aphid (*Aphis craccivora* Koch.):

The infestation of groundnut by aphid started during first week of August (32^{nd} SMW) with the average population of 2.87 per trifoliate which increased and reached to the maximum of 5.53 aphids per trifoliate in the third week of August. During the investigations, it was observed that after heavy raining the aphid population was suddenly decreased, but cloudy weather and light shower of monsoon helped in population build-up, after raining it was observed that the population of aphid was very low and lateron the population again started increasing and reached to the maximum in the first week of September. Thereafter, the population started declining and disappeared during the last week of September (Table-3, Fig.4).

Kanchaiah and Porte (1989) observed the maximum incidence of aphid population between July to September. The aphid activity was observed in the first week of August, which gradually increased upto the third week (Ratnoo, 1995). Jena *et al*. (1997) reported that highest plant infestation was observed during August. The works conducted by these earlier workers fully support the findings of the present investigation.

The aphid population had a negative correlation with temperature (r = 0.29) but was positively correlated with relative humidity (r = +0.69) and total rainfall (r = +0.52). The results tally with the work of Kanchaiah and Porte (1989); Ratnoo (1995) who have reported the negative correlation of aphid incidence with average temperature.

(c) Thrips (*Scirtothrips dorsalis* Hood):

Studies conducted on seasonal incidence of thrips revealed that the thrips is one of the pest of regular occurrence. The attack of this pest was observed throughout the course of study. The infestation of groundnut by thrips started during first week of August, and continuously increased to reach a high of 5.07 thrips per trifoliate in the first-week of September. The maximum incidence was observed from active vegetative to peg penetration stage. Jayanthi *et al.* (1993a) also reported that the maximum incidence of thrips occurred from active vegetative stage to flowering. The incidence of thrips was recorded and the peak population was observed during the second fortnight of August to first fortnight of October (30^0C and 74-85% R.H.) (Gupta *et al.*, 1997). Singh *et al.* (1999) reported that chilly thrips, *Scirtothrips dorsalis* Hood was found infesting groundnut from seedling to peg penetration stages.

In the present investigation, it was found that the thrips population showed a positive correlation with mean atmospheric temperature (r = +0.27) and average relative humidity (r = + 0.07) and negative correlation with weekly rainfall (r = -0.15). Earlier work conducted by Jayanthi *et al.* (1993b) also indicates similar effect of environmental factors on the population of thrips (Table-3, Fig.5).

(d) Tobacco caterpillar (*Spodoptera litura* Fab.):

The Tobacco caterpillar appeared in third week of August and was maximum in the third week of September. Thereafter, the population started declining gradually. Sharma (1977) reported that tobacco caterpillar (*Spodoptera litura* Fab.) attacking the groundnut crop in August and September. Joshi (1987) reported that the infestation of *Spodoptera litura* started in the second week of August with 1.6 larvae / 5 plants and then consistently increased reaching to its peak in the last week of September (8.3 larvae / 5 plant). The tobacco caterpillar had a positive correlation with mean temperature (r = +0.21) and negative correlation with average relative humidity (r = -0.16) and total rainfall (r = 0.30), though not significant. Joshi (1987) reported that none of the abiotic factors had significant correlation with its incidence, which fully support the findings of the present investigation (Table-4, Fig.5).

(e) Blister beetle (*Mylabris* spp.)

The ctivity of bliter beetle trted t the time of floering nd peg penetrtion tge in the firt eek of eptember. The beetle ere found to feed on the floer nd inflorecence of the crop. The popultion of bliter beetle increed rpidly reching to the pek in the third eek of eptember. The bliter beetle popultion hd poitive correltion ith the men tmopheric temperture but negtively correlted ith reltive humidity nd eekly rinfll, though not ignificnt. Literture creened reveled no informtion on incidence of bliter beetle (Tble-4, Fig. 5).

5.2 EVALUATION OF GERMPLASMS FOR THEIR COMPARATIVE PREFERENCE BY THE MAJOR INSECT PESTS

During the present investigation eleven germplasms and one local check variety of groundnut were screened for preference to major insect pests, the order of preference based on the mean groundnut jassid population was ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-21> UG-31> UG-3> GG-2> UG-9> JUN-40> ICR-10 (Table-7). The germplasm ICR-10 was among the least preferred recording the minimum incidence of jassid followed by germplasms JUN-40, UG-9 and GG-2. This variation may be associated with different varietal characters. The germplasm ICR-02 was more susceptible to jassids followed by TIR-10 and UG-2 (Table-6).

The correlation between jassids and the leaf hair density was significantly negative (r = -0.94). The leaflet length and width have no significant effect on the groundnut jassid. The germplasms ICR-10, JUN-40, UG-9 and GG-2 are having maximum number of hairs, a bunch type, grow erect, have faster rate of growth (Table 13a). These seasons could possibly be the main cause for these germplasms being least preferred by the jassids. A perusal of literature revealed that several groundnut germplasms/genotypes have been screened for their susceptibility/resistant to jassids.

Amin (1988) reported that jassids were less fecund on resistant than on susceptible genotypes and nymphal mortality was higher on the resistant ones. High degree of resistance was observed in genotypes with hairy leaves and/or higher densities of hairs ("NC Ac 2214", NC Ac 2230" and NC Ac 2242"), which windered feeding of young nymphs. In addition to hairiness, resistant genotype had thick or "curduroy" type leaves. Nanda gopal *et al.* (1993) measured leaf toughness in 3 released varieties, 4 germplasm accessions and 11 advanced intea and inter-specific derivatives in relation the resistance to the jassid and reported a negative relationship between, percentage intensity of yellowing and cumulative leaf toughness. Of the six varieties screened for their relative susceptibility against insect pests at Udaipur, the varieties "JL-24" and "GG-2" were found least susceptible to all pests, but ICGS-44 was highly susceptible (Ratnoo, 1995). Among the 15 genotypes screened, GG-5 and GG-2 were least susceptible, whereas, J-36, JB-978, TG-26 and J-42 were most susceptible (Khanpara and Vyas, 2001).

Similarly in case of aphid, the order of preference based on the mean groundnut aphid population was ICR-02> TIR-10> UG-2> UG-17> JAL-13> UG-31> UG-21> UG-3> ICR-10> JUN-40> UG-9> GG-2 (Table-7). The local check variety GG-2 was among the least preferred recording the minimum incidence of aphid followed by UG-9, JUN-40; the germplasms UG-2, UG-17 and JAL-13 were moderately preferred; whereas, ICR-02, TIR-10 were most preferred (Table-6).

The correlation coefficient between aphid population and the leaf hair density was significantly negative (r = -0.93) but the leaflet length and width have no significant effect on groundnut aphid. The germplasm/local check GG-2 has maximum number of hairs and faster rate of growth. These reasons could possibly be the main cause for this germplasm being least preferred by the aphid (Table-13b).

According to Hamid *et al*. (1977) hair density, its length and stiffness on leaves interfered with the build-up of aphid colonies, which is an important factor in breeding aphid resistant varieties. Groundnut varieties screened for the incidence of *Aphis craccivora* Koch. indicated that varieties of spreading type supported significantly higher population than those of semi-spreading and bunchy type (Brar, 1981). Similar work on varietal/germplasm screening at Udaipur has indicated varieties JL-24 and GG-2 to be least susceptible to the groundnut aphid (Ratnoo, 1995).

The order of preference based on the mean thrips population was JUN-40> UG-9> UG-2> UG-31> ICR-02> UG-17> TIR-10> UG-21> GG-2> UG-3> ICR-10> JAL-13 (Table-7). It could be inferred that the germplasms JAL-13, TIR-10, UG-3 and GG-2 were among the least preferred; UG-21, TIR-10 and UG-17 moderately preferred; whereas, JUN-40, UG-9 and UG-2 the most preferred (Table-6). The correlation between thrips population and the leaf hair density was negatively correlated and non-significant. The correlation between leaflet length, leaflet width and thrips population for the different germplasms happened to be positively significant (r = +0.57 and +0.94) (Table 13c). Fifteen groundnut genotypes and improved local cultivar Mahesa were evaluated at Muneng, Indonesia. Which raveled that cultivars, ICGV-90267, 91176 and 91176 exhibited moderate resistant to thrips (*Scirtothrips dorsalis, Caliothrips indicus* and *Frankliniella schultzei*), showing relatively low percentage of leaf damage. The pod yield of most of these genotypes were found higher than that of Mahesa, where ICGV 90226 gave the highest average pod yield (2.05 t/ha), followed by ICGV 90227 and ICGV 90228 (both 1.8t/ha) (Nugrdaevi, 1997).

Eleven germplasms and one local check variety of groundnut were screened out and the order of preference based on the mean tobacco caterpillar population was TIR-10> ICR-02> UG-2> UG-3> JAL-13> UG-21> UG-31> UG-9> ICR-10> JUN-40> GG-2 (Table-7). It could be inferred that the germplasms GG-2, JUN-40 and ICR-10 were among the least preferred; UG-9, UG-31 and UG-21 moderately preferred; whereas, TIR-10, ICR-02 and UG-

2 most preferred (Table-6). Mahadevan *et al.* (1988) reported genotype "ICGS 50" had resistance against the noctuids *Spodoptera litura* Fab. and *Heliothis armigera* Hub. The overall growth and development of tobacco caterpillar, *S. litura* on groundnut variety C-501 was found to be satisfactory, while on variety dwarf mutant its growth was better. The larvae reared on C-501 consumed less food per unit body weight, and its growth was slow as compared to that on dwarf mutant (Tiwari *et al.*, 1988).

Singh *et al*. (1993) screened fifteen *Arachis hypogea* L. genotypes in the laboratory using choice tests for resistance to *H. armigera* (third instar) and *S. litura* (I^{st}, III^{rd} and IV^{th} instar), the virgina bunch variety BG-2 was found resistant to both pests. Groundnut germplasm (PI 561917) was released in 1991 as a source of resistance to *Thrips palmi*, *Empoasca kerri*, *Spodoptera litura*, *Aproaerema modicella*, ICGV 86031 was recommended for cultivation in area where the pests *Spodoptera* spp. was endemic (Dwivedi *et al*., 1993).

The prefential sequence of germplasms to the blister beetle, in a descending order of susceptibility was UG-2> TIR-10> JAL-13> ICR-02> UG-17> UG-3> UG-31> UG-21> ICR-10> UG-9> JUN-40> GG-2 (Table-7). The results do not lead us toward distinctly grouping the different germplasms/variety tested, however, it could be inferred that variety GG-2 was among the least preferred, whereas, UG-2 was most preferred. The variety GG-2 is a bunchy type, grows erect these reason could possibly be the main cause for this variety being least preferred by the blister beetle. Literature screened revealed no information on germplasm/vareital screening of blister beetle.

5.3 EVALUATION OF BIO-INTENSIVE MANAGEMENT PRACTICES AGAINST MAJOR INSECT PEST OF GROUNDNUT

In the present investigation the effectiveness of seven different treatments combination has been evaluated using the variety TKG 19A. The overall effectiveness of the treatment combinations against the major insect pests of groundnut has been worked out in term of increased yield as compare to the control. The data presented in Table-15 clearly indicate that the yield of groundnut under different treatment combination showed a significant difference and were significantly superior over control. The maximum yield (3.280kg/plot) was obtained from monocrotophos (0.05%) with two spray, first at 30 days after sowing and 50 second at 50 days after sowing and the minimum yield (2.435 kg/plot) was obtained from *Chrysoperla carnea* at the rate of 2000 larvae per hactare with three releases at 30, 40 and 50 days after sowing.

Besides it, the cost : benefit ratio was also worked out.

Economics and cost : benefit of different treatments combinations:

The ultimate aim of any control schedule is to get an economic return by increasing the yield and reducing the damage due to the pests. Thus the economics of different treatment combinations was worked out by taking into accounts the cost of different treatment combination and the profit gained from such treatment combination in term of increased yield. The sale price of groundnut pods was Rs. 1450 per quintal based on the current market price. The net return was worked out by deducting the gross income (return) of the untreated control from the gross returns of treatments used saved per hactare. In perasual of (Table-15) it indicates that all the treatments showed profit over the control. The maximum net return of Rs. 10122/ha was obtained from monocrotophos (0.05%) first spray at 30 days after sowing and second spray at 50 days after sowing, giving the C:B ratio of 1:12.05. The second best treatment was neem seed kernel extract (5%) two spray, first at 30 days after sowing and second at 50 days after sowing, giving net return of Rs. 6204/ha and the C:B ratio of 1:9.69. The treatment *Chrysoperla carnea* Stephan (4000 larvae/ha) was least effective at three release *viz.*, 30, 40 and 50 days after sowing, giving net return 1764/ha and the C:B ratio of 1:0.64 only. The superiority of monocrotophos at 0.05 per cent in control of *Spodoptera litura*, defoliator was reported by (Ayyanna *et al.*, 1982; Reddy *et al.*, 1985). Nair *et al.*, 1991; Peter and Sunderarajan, 1991; Bagle, 1993, Patel *et al.* (1997) and Sengutluvan, (1999) determined the efficacy of 0.05% monocrotophos against *Scirtothrips dorsalis* on groundnut effectively checked the pest population and gave the highest yield. Same result effectiveness of monocrotophos at 250g a.i./ha was also reported by peter and Sunderarajan (1991) against *Empoasca* sp., *Frankliniella Schultzei*, *Caliothrips impurus* and groundnut leaf miner *Aproaerema modicella* on groundnut in Tamil Nadu, India.

Singh and Raheja (1993) reported that simple aqueous extracts of neem seed kernel may be as effective or even better than synthetic insecticides against freely feeding larvae of Lepidoptera, Coleoptera and nymphs of Orthoptera, because they are subjected to both contact and ingestion effect of neem. Nymphs of Hemiptera are exposed only to contact effect and hence difficult to manage with aqueous or even ethanolic extracts unless high concentration is used. *Azadirachtin* rich oil based formulation has been suggested for the management of borers belonging to Diptera and Lepidoptera and nymphs and adults of Hemiptera. Sachan and Gururaj (1993), in large scale multilocational field trials, found that neem seed kernel extract (NSKE) and neem leaf extract (NLE) at 5 per cent each provided significant and cost effective control of the pod borer (*Heliothis armigera*) compared to conventional insecticides in chick pea. In pigeon pea two sprays of NSKE (5%) and a single spray of cypermethrin (0.01%) gave significantly better cost benefit ratio of (1:3.81) than endosulfan 0.07 per cent. (1: 3.39) applied against *H. armigera*.

Sharma *et al.* (1986) reported aphicidal action of neem seed kernal extract (4 per cent), sowing no survival (complete mortality 100 per cent) of the mustard aphid (*Lipaphis erysimi* Kalt) 24 hours after spray.

6. SUMMARY

During the present investigation, the groundnut jassid, groundnut aphid, thrips and tobacco caterpillar were recorded to infest groundnut. The blister beetle was found to feed on the flowers/inflorescence of the groundnut crop taken. Besides it, white flies, surface grasshopper, gray weevil and caster haring caterpillar were recorded.

6.1 SEASONAL INCIDENCE

The seasonal incidence of groundnut jassid, aphid, thrips, tobacco caterpillar and blister beetle was worked out on groundnut variety GG-2. There were two peak of jassid population found, first was in the last week of August and second was in the third week of September, the jassid population was positively correlated with temperature and negatively correlated with average relative humidity and rainfall. The groundnut aphid reached to the maximum in two times, first in the third week of August and second in the first week of September. The aphid population was negatively correlated with mean atmospheric temperature and positively correlated with average relative humidity and total rainfall. The population of thrips increased to reach a high of 5.07 thrips per trifoliate in the first week of September and the second peak of 4.47 thrips per trifoliate was upto last week of September. The correlation coefficient with mean temperature and average relative humidity was positive and negative with total rainfall. The tobacco caterpillar population was found to the peak of 1.07 caterpillar per plant in the third week of September. The tobacco caterpillar was positively correlated with mean temperature but negatively correlated with average relative humidity and weekly rainfall. The peak period for blister beetle was third week of September (28^{th} SMW).

6.2 EVALUATION OF GERMPLASM FOR THEIR PREFERENCE BY THE MAJOR INSECT PESTS

Of the twelve germplasm/variety screened for the preference by the groundnut jassid, germplasm ICR-02 was the most preferred host (mean jassid population per trifoliate being 3.987) whereas, germplasms ICR-10 was the least preferred (mean jassid population per trifoliate being 2.793) and by groundnut aphid, germplasms ICR-02 was the most preferred host (4.275 aphids per trifoliate) whereas, variety GG-2 was the least preferred (3.100 aphids per trifoliate). Germplasm preference by the groundnut thrips, germplasm JUN-40 was the most preferred host (thrips population per trifoliate being 3.653) and germplasm JAL-13 was the least preferred. In case of tobacco caterpillar, germplasm TIR-10 was the most preferred host (1.075 larvae per plant) and variety GG-2 was the least preferred.

No significant difference existed in the preference by the blister beetle, though the germplasms UG-2 was the most preferred host and variety GG-2 was the least preferred. The maximum number of hairs was observed on ICR-10; leaflet length and width were maximum of JUN-40, whereas minimum number of hairs was observed on ICR-02; leaflet length and width were minimum of JAL-13.

6.3 EVALUATION OF BIO-INTENSIVE MANAGEMENT PRACTICES AGAINST MAJOR INSECT PEST OF GROUNDNUT

The experiments on bio-intensive management practices against major insect pests of groundnut revealed that monocrotophos (0.05%), two spray; first at 30 days after sowing and second at 50 days after sowing; gave highest yield (3.280 kg/plot), maximum net return of Rs. 10122/ha and C:B ratio 1:12.05. Neem seed kernel extract (5 per cent) was second best treatment, yield, net return and C:B ratio were 2.855 kg/plot, Rs. 6204/ha and 1:9.69, respectively. Whereas, lowest yield from *Chrysoperla carnea* @ 4000 larvae/ha, three release at 30, 40 and 50 days after sowing, giving net return of Rs. 1764/ha and C:B ratio of 1:0.64.

Table 6: Comparative mean population of major pests on different groundnut germplasms and the variety GG-2

S.No.	Varieties	Jassid	Aphid	Thrips	Tobacco caterpillar	Blister .beetle
1.	UG-2	3.807 (2.075)	3.967 (2.113)	3.513 (2.003)	1.000 (1.225)	1.100 (1.265)
2.	UG-3	2.913 (1.847)	3.525 (2.006)	3.027 (1.878)	0.800 (1.140)	0.978 (1.215)
3.	UG-9	2.847 (1.828)	3.300 (1.948)	3.553 (2.013)	0.633 (1.065)	0.856 (1.163)
4.	UG-17	3.320 (1.954)	3.917 (2.101)	3.393 (1.973)	0.917 (1.190)	1.000 (1.225)
5.	UG-21	3.107 (1.899)	3.592 (2.023)	3.147 (1.909)	0.717 (1.103)	0.933 (1.197)
6.	UG-31	3.033 (1.880)	3.592 (2.023)	3.493 (1.998)	0.700 (1.095)	0.944 (1.202)
7.	ICR-10	2.793 (1.815)	3.425 (1.981)	2.993 (1.869)	0.542 (1.021)	0.856 (1.164)
8.	ICR-02	3.987 (2.118)	4.275 (2.185)	3.453 (1.988)	1.058 (1.248)	1.078 (1.256)
9.	JAL-13	3.273 (1.942)	3.758 (2.064)	2.940 (1.855)	0.792 (1.137)	1.089 (1.260)
10.	JUN-40	2.807 (1.818)	3.308 (1.951)	3.653 (2.038)	0.542 (1.021)	0.844 (1.158)
11.	TIR-10	3.953 (2.110)	4.275 (2.185)	3.320 (1.954)	1.075 (1.255)	1.089 (1.260)
12.	GG-2	2.907 (1.846)	3.100 (1.897)	3.093 (1.895)	0.533 (1.016)	0.800 (1.139)
SEm±		0.018	0.021	0.025	0.008	0.026
CD at 5%		0.054	0.063	0.072	0.025	0.077

Note: Data present are mean of three replications.

Figures in paranthesis are square root transformed values = $\sqrt{n + 0.5}$

Table 5: Correlation coefficient (r-values) between abiotic factors and population of jassid, aphid, thrips, tobacco caterpillar and blister beetle

S.No	Abiotic factors	r- values				
		Jassid	Aphid	Thrips	Tobacco caterpillar	B. Beetle
1	Temperature maximum (^{0}C)	+0.374	-0.680	-0.004	+0.179	+0.628
2.	Temperature minimum (^{0}C)	-0.198	+0.681	+0.154	-0.103	-0.608
3.	Temperature average (^{0}C)	+0.476	-0.292	+0.268	+0.214	+0.308
4.	Relative humidity (%) at 7.35 a.m.	-0.178	+0.619	+0.183	-0.070	-0.416
5.	Relative humidity (%) at 14-35 a.m.	-0.342	+0.695	+0.032	-0.192	-0.626
6.	Average relative humidity (%)	-0.036	+0.692	+0.074	-0.163	-0.585
7.	Total rainfall (in mm)	-0.211	+0.518	-0.152	-0.302	-0.458

Tabulated r-value at 5% level is 0.632

Table 3: **Seasonal incidence of Jassid (*Empoasca kerri* Pruthi), aphid, (*Aphis craccivora* Koch.) and thrips (*Scirtothrips dorsalis* Hood) on groundnut crop during *kharif* 2002**

S.No.	Standard week	Date of observations	Jassid	Aphid	Thrips	Temperature (^{0}C)			R.H.% at			Total rainfall of the week in mm
						Max.	Min.	Average	07.35 hrs. Morning	14.35 hrs. Evening	Average	
1.	32	4th August	1.93	2.87	2.13	28.0	23.4	25.70	93	82	87.5	059.8
2.	33	11th August	2.27	3.87	2.27	28.3	23.4	25.85	85	69	77.0	000.2
3.	34	18th August	2.80	5.53	2.40	30.4	23.3	26.85	85	69	77.0	73.0
4.	35	25th August	3.07	1.73	3.93	28.4	22.6	25.50	84	66	75.0	022.0
5.	36	1st September	2.93	3.00	5.07	31.3	22.0	26.65	89	59	74.0	18.6
6.	37	8th September	3.67	4.20	2.73	31.7	19.8	25.75	80	44	62.0	000.0
7.	38	15th September	3.00	2.67	3.27	32.0	20.1	26.05	79	49	64.0	006.8
8.	39	22nd September	4.87	0.93	4.47	34.1	21.1	27.60	78	42	60.0	010.2
9.	40	29th September	3.47	-	2.47	36.5	15.9	26.60	76	17	46.5	000.0
10.	41	6th October	2.07	-	2.20	36.4	18.0	27.20	66	24	45.0	000.2
Coefficient of correlations (r)			Jassid					0.48			-0.31	-0.21
			Aphid					-0.29			0.69*	0.52
			Thrips					0.27			0.07	-0.15
Tabulated r value at 5% L.O.S.								0.63			0.63	0.63

*** Significant at 5% level**

Table 4: **Seasonal incidence of tobacco caterpillar (*Spodoptera litura* Fab.) and blister beetle (*Mylabris sp.*) on groundnut crop during *kharif* 2002**

S.No.	Standard week	Date of observations	Tobacco caterpillar	Blister beetle	Temperature (^{0}C)			R.H.% at			Total rainfall of the week in mm
					Max.	Min.	Average	07.35 hrs. Morning	14.35 hrs. Evening	Average	
1.	32	4th August	-	-	28.0	23.4	25.70	93	82	87.5	059.8
2.	33	11th August	-	-	28.3	23.4	25.85	85	69	77.0	000.2
3.	34	18th August	0.20	-	30.4	23.3	26.85	85	69	77.0	73.0
4.	35	25th August	0.33	-	28.4	22.6	25.50	84	66	75.0	022.0
5.	36	1st September	0.67	0.27	31.3	22.0	26.65	89	59	74.0	18.6
6.	37	8th September	0.87	0.40	31.7	19.8	25.75	80	44	62.0	000.0
7.	38	15th September	0.97	1.33	32.0	20.1	26.05	79	49	64.0	006.8
8.	39	22nd September	1.07	1.33	34.1	21.1	27.60	78	42	60.0	010.2
9.	40	29th September	0.20	1.27	36.5	15.9	26.60	76	17	46.5	000.0
10.	41	6th October	0.00	0.20	36.4	18.0	27.20	66	24	45.0	000.2
Coefficient of correlations (r)			T. caterpillar				0.21			-0.16	-0.30
			Blister beetle				0.31			-0.58	-0.46
Tabulated r value at 5% L.O.S.							0.63			0.63	0.63

*** Significant at 5% level**

Table 2 : **Mean weekly weather parameters recorded during the *Kharif* 2002**

S.No.	Standard week	Date of observations	Temperature (^{0}C)			R.H.% at			Total rainfall of the week in mm
			Max.	Min.	Average	07.35 hrs. Morning	14.35 hrs. Evening	Average	
1.	27	2nd July	31.5	25.4	28.45	71	51	61.0	000.0
2.	28	9th July	32.8	25.2	29.00	69	43	56.0	000.0
3.	29	16th July	32.3	25.2	28.75	71	54	62.5	002.4
4.	30	23rd July	30.6	24.6	27.60	71	54	62.5	000.0
5.	31	30th July	32.4	23.6	28.00	81	82	81.5	055.4
6.	32	6th August	28.0	23.4	25.70	93	82	87.5	059.8
7.	33	13th August	28.3	23.4	25.85	85	69	77.0	000.2
8.	34	20th August	30.4	23.3	26.85	85	69	77.0	73.0
9.	35	27th August	28.4	22.6	25.50	84	66	75.0	022.0
10.	36	3rd September	31.3	22.0	26.65	89	59	74.0	18.6
11.	37	10th September	31.7	19.8	25.75	80	44	62.0	000.0
12.	38	17th September	32.0	20.1	26.05	79	49	64.0	006.8
13.	39	24th September	34.1	21.1	27.60	78	42	60.0	010.2
14.	40	1st October	36.5	15.9	26.60	76	17	46.5	000.0
15.	41	8th October	36.4	18.0	27.20	66	24	45.0	000.2
16.	42	15th October	36.4	16.0	26.20	67	19	43.0	000.0
17.	43	22nd October	33.0	12.3	22.65	58	15	36.5	000.0

18.	44	29th October	33.3	11.9	22.60	57	21	39.0	000.0

Table 8: Jassid population (No./trifoliate) on different groundnut germplasms and variety GG-2 during the *kharif* 2002

Dates of observations	UG-2	UG-3	UG-9	UG-17	UG-21	UG-31	ICR-10	ICR-02	JAL-13	JUN-40	TIR-10	GG-2
4/8/2002	1.93	1.67	1.80	2.00	1.80	1.93	1.80	2.47	2.00	1.87	2.40	1.93
11/8/2002	2.80	2.40	2.27	2.67	2.40	2.33	2.20	2.93	2.60	2.07	2.80	2.27
18/8/2002	3.67	2.80	2.73	3.00	2.87	2.80	2.60	3.93	3.07	2.80	3.87	2.80
25/8/2002	4.33	2.87	2.80	3.20	3.00	3.00	2.80	4.47	3.20	2.80	4.47	3.07
1/9/2002	4.07	2.73	2.67	3.20	3.00	3.07	2.80	4.07	3.20	2.80	4.13	2.93
8/9/2002	3.33	2.67	2.60	3.00	2.87	2.80	2.53	3.73	3.00	2.53	3.67	2.67
15/9/2002	4.33	3.13	3.07	4.00	3.40	3.13	3.00	4.47	3.60	3.00	4.33	3.00
22/9/2002	6.27	4.93	4.80	5.33	5.20	4.93	4.80	6.40	5.40	4.80	6.33	4.87
29/9/2002	4.60	3.73	3.73	4.20	4.07	3.93	3.40	4.47	4.20	3.40	4.67	3.47

6/10/2002	4.73	2.20	2.00	2.60	2.47	2.40	2.00	2.93	2.47	2.00	2.87	2.07

Note: Data presented are mean of three replications.

Table 9: Aphid population (No./trifoliate) on different groundnut germplasms and variety GG-2 during the *kharif* 2002

Dates of observations	UG-2	UG-3	UG-9	UG-17	UG-21	UG-31	ICR-10	ICR-02	JAL-13	JUN-40	TIR-10	GG-2
4/8/2002	3.33	2.93	2.87	3.13	3.07	2.93	2.93	3.67	3.27	2.93	3.73	2.87
11/8/2002	4.73	4.13	4.07	4.60	4.47	4.33	4.13	4.80	4.33	3.60	4.67	3.87
18/8/2002	6.40	5.87	5.60	6.20	6.00	6.07	5.73	6.60	6.20	5.67	6.67	5.53
25/8/2002	2.13	2.00	1.80	2.33	2.00	2.00	2.13	2.80	2.27	1.87	2.80	1.73
1/9/2002	4.07	3.60	3.13	4.20	3.53	3.80	3.53	5.07	4.00	3.60	5.00	3.00
8/9/2002	6.00	5.13	5.00	5.67	5.13	5.20	4.93	6.20	5.27	5.00	6.20	4.20
15/9/2002	3.40	3.13	2.67	3.47	3.00	3.07	2.93	3.47	3.27	2.67	3.53	2.67
22/9/2002	1.67	1.40	1.27	1.73	1.53	1.33	1.07	1.60	1.47	1.13	1.60	0.93
29/9/2002	-	-	-	-	-	-	-	-	-	-	-	-

6/10/2002	-	-	-	-	-	-	-	-	-	-	-	-

Note: Data presented are mean of three replications.

Table 10: Thrips population (No./trifoliate) on different groundnut germplasms and variety GG-2 during the *kharif* 2002

Dates of observations	UG-2	UG-3	UG-9	UG-17	UG-21	UG-31	ICR-10	ICR-02	JAL-13	JUN-40	TIR-10	GG-2
4/8/2002	2.53	2.07	2.67	2.40	2.13	2.53	2.07	2.47	2.00	2.80	2.20	2.13
11/8/2002	2.73	2.20	2.73	2.60	2.33	2.73	2.20	2.73	2.13	3.00	2.33	2.27
18/8/2002	2.73	2.40	2.73	2.60	2.53	2.73	2.40	2.73	2.40	2.93	2.67	2.40
25/8/2002	4.27	3.93	4.33	4.13	4.00	4.33	3.87	4.20	3.80	4.40	4.20	3.93
1/9/2002	5.67	4.93	5.67	5.47	5.13	5.53	4.87	5.60	4.80	5.80	5.47	5.07
8/9/2002	3.13	2.73	3.20	3.00	2.73	3.13	2.53	3.00	2.53	3.20	3.00	2.73
15/9/2002	3.87	3.27	3.73	3.60	3.33	3.73	3.20	3.60	3.20	3.87	3.47	3.27
22/9/2002	4.73	4.13	4.80	4.53	4.27	4.73	4.07	4.60	4.07	4.87	4.60	4.47
29/9/2002	3.13	2.67	3.13	3.07	2.67	3.07	2.47	3.00	2.40	3.20	2.93	2.47

6/10/2002	2.33	1.93	2.53	2.53	2.33	2.40	2.27	2.60	2.07	2.47	2.33	2.20

Note: Data presented are mean of three replications.

Table 11: **Tobacco caterpillar population (No./plant) on different groundnut germplasms and variety GG-2 during the *kharif* 2002**

Dates of observations	UG-2	UG-3	UG-9	UG-17	UG-21	UG-31	ICR-10	ICR-02	JAL-13	JUN-40	TIR-10	GG-2
4/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
11/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
18/8/2002	0.40	0.40	0.20	0.40	0.33	0.40	0.20	0.40	0.33	0.20	0.60	0.20
25/8/2002	0.60	0.47	0.40	0.60	0.47	0.40	0.40	0.60	0.40	0.40	0.60	0.33
1/9/2002	1.07	0.80	0.67	0.93	0.73	0.73	0.60	1.13	0.87	0.60	1.13	0.67
8/9/2002	1.47	1.13	0.93	1.33	1.07	0.93	0.87	1.53	1.20	0.80	1.60	0.87
15/9/2002	1.73	1.40	1.20	1.67	1.27	1.27	1.07	1.87	1.47	1.00	1.73	0.93
22/9/2002	1.73	1.40	1.13	1.60	1.27	1.27	1.00	1.87	1.47	1.00	1.87	1.07

29/9/2002	0.60	0.60	0.33	0.60	0.40	0.40	0.20	0.67	0.40	0.20	0.67	0.20
6/10/2002	0.40	0.20	0.20	0.20	0.20	0.20	0.00	0.40	0.20	0.13	0.40	0.00

Note: Data presented are mean of three replications

Table 12: Blister beetle population (No./plant) on different groundnut germplasms and variety GG-2 during the *kharif* 2002

Dates of observations	UG-2	UG-3	UG-9	UG-17	UG-21	UG-31	ICR-10	ICR-02	JAL-13	JUN-40	TIR-10	GG-2
4/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
11/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
18/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
25/8/2002	-	-	-	-	-	-	-	-	-	-	-	-
1/9/2002	0.40	0.40	0.33	0.33	0.40	0.40	0.40	0.40	0.40	0.33	0.40	0.27
8/9/2002	0.60	0.53	0.47	0.53	0.47	0.47	0.47	0.60	0.60	0.47	0.60	0.40
15/9/2002	1.80	1.40	1.33	1.60	1.40	1.40	1.33	1.53	1.73	1.33	1.73	1.33
22/9/2002	1.73	1.60	1.40	1.60	1.47	1.47	1.40	1.80	1.87	1.47	1.80	1.33

29/9/2002	1.67	1.67	1.33	1.67	1.60	1.53	1.27	1.73	1.67	1.27	1.60	1.27
6/10/2002	0.40	0.27	0.27	0.27	0.27	0.40	0.27	0.40	0.27	0.20	0.40	0.20

Note: Data presented are mean of three replications

Table 15 : Comparative groundnut pod yields and economics of different treatment combinations during *kharif* 2002

	Basal application	**Ist application 30 DAS**	**IInd application 40 DAS**	**IIIrd application 50 DAS**	**Mean (yield in kg/plot)**	**Pod yield (q/ha)**	**Increased yield over control (q/ha)**	**Cost of increased yield (Rs./ha)**	**Management cost (Rs./ha)**	**Net profit (Rs./ha)**	**C: B ratio**
T_1		NSKE 5%	No treatment	NSKE 5%	2.855	19.03	4.72	6844	640	6204	1:9.69
T_2		*C. carnea* @ 2000 larva/ha.	*C. carnea* @ 2000 larva/ha	*C. carnea* @ 2000 larva/ha	2.435	16.23	1.92	2784	1560	1224	1:0.78
T_3		*C. carnea* @ 4000 larva/ha	*C. carnea* @ 4000 larva/ha	*C. carnea* @ 4000 larva/ha	2.615	17.43	3.12	4524	2760	1764	1:0.64
T_4		*C. carnea* @ 4000 larva/ha	*C. carnea* @ 4000 larva/ha	Monocrotophos @ 0.05%	2.750	18.33	4.02	5829	2260	3569	1:1.58
T_5		Monocrotophos @ 0.05%	*C. carnea* @ 4000 larva/ha	*C. carnea* @ 4000 larva/ha	2.828	18.86	4.55	6597.5	2260	4338	1:1.92
T_6	Carbofuran 3G @ 0.5kg a.i./ha	*C. carnea* @ 4000 larva/ha	*C. carnea* @ 4000 larva/ha	No treatment	2.763	18.42	4.11	5959.5	2982	2978	1:0.99
T_7		Monocrotophos @ 0.05%	No treatment	Monocrotophos @ 0.05%	3.280	21.87	7.56	10962	840	10122	1:12.05

T_8	No treatment	No treatment	No treatment	2.147	14.31	-	-	-	-	1:1.00
	SEm$\pm$			0.094						
	CD at 5%			0.286						

Note: 1. Rate of insecticides: Monocrotophos 36SL Rs. 300/litre
NSKE Rs. 40/kg
Carbofuran Rs. 65/kg

2. Rate of bio-agent *Chrysoperla carnea* Rs. 20/100 Nos.
3. Labour charge Rs. 120/ha. (2 labour @ Rs. 60)
4. Sale price of groundnut pods Rs. 1450/q

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