Status Of Groundnut Leaf Miner In Peninsular India: Management Options

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Abstract

The groundnut leaf miner (GLM) *Aproaerema modicella* is a serious pest of groundnut in peninsular India. Two distinct GLM population peaks July-August in the rainy season and February- March in the post rainy season are common. Though it is sporadic, under epidemic situations GLM can cause complete crop loss, particularly severe in moisture stress conditions. The identification of sex pheromone facilitated easy monitoring compared to tedious light traps. Several larval parasitoides and predators have been found effectively controlling this pest in the nature. Among diseases Metarrhizium anisopliae was observed to be a potential larval pathogen. In addition to ICGV 86031 some more good sources of resistance have been identified. Meaningful control decisions are possible with crop phenology based economic thresholds clubbed with activity of natural enemies. Further studies on the cultural control, insect pathogens, host plant resistance, mass trapping and mating disruption effects of the pheromone are needed for strengthening the future GLM, IPM program.

A. Introduction: The groundnut leaf miner (GLM) *Aproaerema modicella* (Deventer) (Lepidoptera: Gelichiidae) is one of the most important pests of groundnut in the peninsular India. This species is widely distributed in south and south-east Asia. Though it is present in different parts of India it occurs in more serious form in the southern states. It has limited host range, among which soybean (*Glycine max*) is a more favored alternative to groundnut. GLM is oligophagous and mostly feeds on leguminous hosts and some weeds such as *Boreria hispida* (Shanower *et al.*, 1993 b). The literature on GLM was first reviewed by Mohammed (1981), later by Shanower (1989) and the bio-ecology by Reddy *et al.*, (1993). Though this species is known as serious pest on groundnut crops in

several countries the knowledge in it's management is not satisfactory. During recent years researchers have devoted lot of time in developing the meaning full control strategies for this species. However the information generated has not desipated to the needy. Though this species present through out the cropping season in different parts of groundnut distribution in Asia its economic status varied very widely across the seasons, locations and even in the same farm from one side to the other. There were several reports of severe crop losses caused by this species alone on groundnut in peninsular India. In this paper the authors tried to discuss the present status of this species on groundnut crops in peninsular India and the existing feasible control strategies.

B. Biology: The adult is a brownish-grey moth, only 6 mm long, with a 10 mm wing span. Shiny white eggs are laid singly, usually on the underside of the leaflets, close to the midribs, and are just visible to the naked eye. One female moth lays about 200 eggs. The young larvae make mines in the leaves as soon as they hatch. This means that infestation is usually detected by the presence of small brown blotches on (or in) the leaf. The mines are about 1 mm long when first noticed. If the mines are opened, the minute caterpillar can be seen. In peninsular India the larvae pass through five instars. The larval period varies from 15-28 days. The larval development requires 325 degree days above a threshold temperature of 11.3 (Shanower 1993a). Male larvae can be easily distinguished from females by the presence of distinct gonads visible through the cuticle.

The blisters enlarge as the larvae grow. Larvae emerge from the mines and web adjacent leaflets together. Then they feed on the leaves from inside the webbed leaves. Pupation takes place in the webbing. The pupal period varies from 3-10 days and it requires 72 degree days above 14.7 threshold. Males emerge two days before the females and the sex ratio is 1:1 (Lalita Kumari 1989). The adults

live for about 5-10 days. Total life cycle require about 45 days in the north and a month in the south. Shanower (1993a) indicated 45 degree day requirement for a single life cycle.

C. Economic Importance and Threshold Populations: The GLM reduces yields by feeding on leaves, thereby reducing the photosynthetically active leaf area. Shanower (1989) measured the consumption of individual larvae and calculated that on average 179.3 mm of leaf area is eaten. The estimation of Islam *et al.* (1983) of 348 mm of leaf tissue (equivalent to 6-10 groundnut leaflets, depending on the genotype) appears to be too large for such a small caterpillar.

Reduced groundnut yields were associated with severe infestations in south India (Kulshreshta, 1964). Yield losses due to GLM were reported to be >50% in Tamil Nadu by GLM alone (Logiswaran and Mohanasundaram, 1985) and 16% pod dry weight (equivalent to 303 kg ha^{-1}) by GLM and *Aphis craccivora* Koch, (Jagtap *et al.*, 1984). Yield reductions in the range of 20-30% in groundnuts have been reported from China (Yang and Liu, 1966). Most of the yield reduction studies were based on insecticidal protection of groundnuts (compared to unprotected groundnuts) resulting in increased pod yields. Yield increases up to 24% (Palaniswamy and Ramachandran, 1978); 36% (Lewin *et al*,. 1973); 65% (Sivasubramanian and Palaniswamy, 1983; Rajput *et al.*, 1985); 71% (Lal *et al.*, 1974); 76% (Vittal *et al.*, 1964). 85% (Sangappa and Ali, 1977); 88% (Vittal and Saroja, 1965); 89% (Abdul-Kareem and Subramanian, 1976); 92% (Krishnanand and Kaiwar, 1965); represent yield increases compared to insecticidal protection and include the total effects of the insecticides on the groundnut arthropod pest fauna, rather than their effects on the leaf miner populations alone. Ghewande *et al.* (1987) recommended an action threshold of 61-70 GLM larvae per 100 leaflets. The impact of GLM on groundnut growth and yield is in part determined by the time of infestation. An infestation of five larvae per plant 10

days after emergence (DAE) has a much greater impact than 20 larvae per plant at 75 DAE (Shanower *et al.*, 1993b). Ghule *et al.*, (1987) suggested that groundnuts need protection from GLM between 45 and 75 DAE; however, this is true only if GLM populations are low, early in the season. Recently suggested action thresholds of five, 10 and 15 miners plant^{-1} at 30,45 and >50 DAE by Ranga Rao and Wightman (1993) appear to be very sound and reliable for groundnut. However they cautioned that one must look for parasites and if 50% of the larvae pupae-1 are parasitized and the population is close to the threshold no protection is necessary.

A severely GLM attacked field looks `burnt` from a distance. Epidemics can result in total crop loss. In south Indian conditions this species completes 3-4 generations in a groundnut crop season. The severity of the pest is favored by dry or moisture stress conditions.

D. Sex Pheromone and its Importance: Before the advent of pheromone the populations of this small gelichiid was estimated by the use of light traps. Sorting out this micro lepidoptera from the whole light trap collection is a difficult activity which involves special skills. The identification and synthesis of the sex pheromone of A. modicella and demonstration of it's attractiveness in the field facilitated easy monitoring of this pest. Though the pheromone consists of several components presently the septa were impregnated with a blend of Z-7, 9-10 decadinyle acetate and E-7-10 decenyl acetate in 5:1 ratio (Hall *et al.*, 1993) has made it possible to use traps baited with synthetic pheromone as practical monitoring device for this pest. Water traps baited with the pheromone caught more moths positioned at 0.5m above the ground. Traps baited with large septa released pheromone more slowly and caught more moths than those baited with the small septa, but the attractiveness of the large septa declined after 2 weeks of exposure where as there was no change in

the effectiveness of the small septa after 9 weeks of exposure. However for a long term monitoring it would be better to use small septa. Though there was no change in the septum longevity for 9 weeks it is generally recommended to renew the lure every 4 weeks. Most of the basic work on the pheromones has been done at ICRISAT, however further studies on it's role as control strategy need to be checked.

The pheromone data over five years indicated clear cut trends during rainy and post rainy seasons. There were two distinct peaks (Fig.1) indicating the populations of rainy and post rainy season pest activity. This data need to be processed further in relation to various weather parameters.

E. Natural Control Process: In the past, the role of natural control in groundnut pest management was not given due importance. In recent years, with the increased awareness of the harmful effects of insecticides the importance of natural enemies gained considerable importance. At ICRISAT center the observations on natural enemies were mainly concentrated on Spodoptera and leaf miner. Periodic sampling for leaf miner larvae for parasitization over the past thirteen years revealed the occurrence of 38 species of which *Symphiasis dolicogaster* Ashmead, *Stenomesius japonicus* (Ashmea), *Chelonus spp.* and *Goniozus spp.* were the most important. Thirteen years data at ICRISAT on GLM larval parasitoids showed an average of 35% in the rainy season and about 40% in the post rainy season. (range 6-90%) (Table 1). These parasites have the ability of suppress the leaf miner populations. There were several situations where these parasites could restrict the further spread of populations from one generation to another. Hence looking at the larval parasites before taking the spray decisions, if the pest population is near the damage threshold and if the larval parasites are active with about 50% of the leaf miner webs with active parasites one can postpone the insecticidal application. This decision can keep the leaf miner under manageable levels

during the further crop stages. Some times if the insecticide is applied when parasites are active which would result in the destruction of natural enemies and further flare up of other defoliators like *Spodoptera*. So to avoid this type of secondary effects one need to be very careful in making control decisions. Pathogens such as virus, bacteria, nematodes and fungi are known to attack the leaf miner larvae in the field. Though this area of research was not well covered by the researchers in the past, recently the role of insect pathogens gained considerable importance. Recent field observations at ICRISAT center indicated the potency of *Metarrhizium anisolpliae* in managing this species. This fungus killed the final instar larvae with in 24hr of application. Further studies in mass multiplication of this fungus was also encouraging, with easy mass multiplication on sorghum diet in seven days. Studies on the epidimealogy, field persistency and effectiveness in different agronomic situations need to be studied to use this technology in future IPM programs.

F. Host Plant Resistance: The potential role of resistance to groundnut pests in the development of IPM programs has been well recognized since the early 70s. However up to late 70s researchers have not paid much attention to this area. During the past two decades substantial progress has been achieved in this area. Research at ICRISAT has demonstrated the availability of resistance in groundnut to jassids, thrips, aphids, leaf miner, and Spodoptera. Some of these genotypes have shown resistance to more than one pest. For example ICG 2271 (NCAC 343) has resistance to jassids, thrips, termites and leaf miner. Screening of wild *Arachis spp.* also revealed high levels of resistance to *Spodoptera*, leaf miner, aphids and root borers particularly *Sphenoptera*. In the past due to the sporadicity of groundnut insects the progress in the screening projects was hindered, but the development of artificial screening techniques for *Spodoptera* and leaf miner revealed the line ICGV 86031 with high levels of resistance to leaf miner in addition sevsral genotypes also found

to be good sources of resistance to GLM (Table 2). This line has been tested in farmers fields under high insect pressure. Further developments in this area are needed before putting these resistant sources in to IPM packages.

G. Cultural Control: Leafminer moths are attracted to light source. collection and destruction of moths by setting light traps early in the season, has been reported to reduce the pest incidence. Cherian and Basheer (1942) and Nayyar *et al.*, (1976) indicated more moth catches when light source was placed at ground level than those placed at 5-10 feet above the ground. Logiswaran and Mohanasundaram (1985) indicated profound effects of intercropping of groundnut with sorghum, millet and cowpea in reducing leafminer populations. Mulching with rice straw had no effect on GLM populations (Logiswaran and Mohanasundaram, 1985). Recent studies conducted at ICRISAT center revealed no effect of polythene mulch on GLM incidence, however the mulch showed profound influence on the sucking pest populations. Since soybean is highly preferred by this species, the possibilities of exploiting soybean as trap crop in groundnut need to be studied to manipulate GLM populations. Our observations on early sown rainy season crop and GLM incidence, where heavy infestations occurred at 15 DAE itself indicate the remote possibility of manipulating planting dates as control strategy.

H. Chemical Control: The literature on the chemical control of groundnut leaf miner was voluminous. Range of insecticides have been tried against this species as dusts, granular soil treatment, seed applications and as systemic foliar sorays. Ramakrishna Ayyar (1940) first recommended DDT as synthetic insecticide against GLM. By early 60s BHC, carbaryl, dieldrin, endrin and parathion had been tried on this pest (Krishna Murthy Rao *et al.*, 1962, Vittal, Azeez Basha and soraja, 1964, Krishannada and Kaiwar, 1965, Vittal and Saroja, 1965). During 70s though the organochlorine compounds were still in use newer organophosphates and carbomates were also

recommended against this species.(Lewin *et al.*, 1973; Kapoor *et al.*, 1975, Devaraj Urs and Krishna Kothai, 1976). Pyrethroids were evaluated in the mid 80s (Sivasubrahmanian and Planiswamy, 1983, Rajput *et al.*, 1985) with effectiveness. Furrow application of carbofuran or phorate granules at sowing time were found effective against this species in soybean in Thailand (Arunin 1978). Lal *et al.*, (1974) tested the effectiveness of seed treatments of groundnuts with 50% carbofuran and found effective for 4-6 weeks with increased yields. The use of antifeedents TPTA TPTH was also found effective in controlling the leaf miner which resulted in increased yields (Abdul Kareem and Subrahmaniam 1976).

Previous studies with the use of Neem products failed to reduce the GLM populations (Sadakathulla *et al.*, 1976) however recent studies coducted at NRCG indicated significant ovipositional deterrance with neem products (Nanda Gopal personal communication) Surveys during 1988 by Ranga Rao and Shanower indicated the that the pesticide applications of GLM appeared to disturb the natural balance of *Helicoverpa and Spodoptera* otherwise these would remain under manageable levels. Though chemical were in use against this species for a long time still there were no reports of control failures indicating the non occurrence of insecticidal resistance in this pest. This is a good sign, however one should be very careful in recommending insecticides against GLM keeping in view of the role of natural enemies and the secondary pest problems.

Gaps in the existing Knowledge:

1. Off season biology
2. Use of botanical insecticides
3. Role of pathogens
4. Use of pheromones
5. Role of environmental factors

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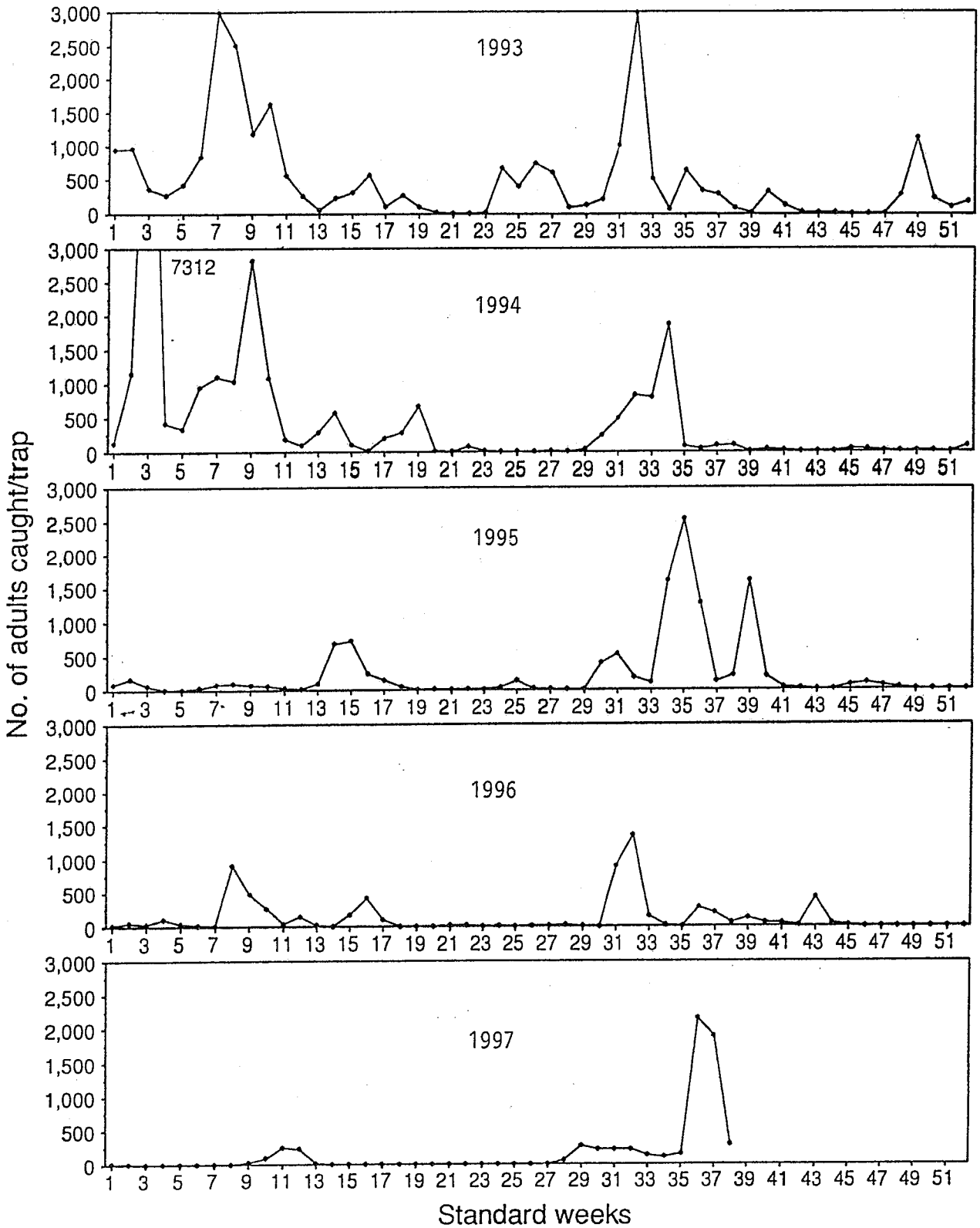

Fig. 1 : Monitoring of leafminer adult populations with pheromone traps in groundnut during 1993-97, ICRISAT center, Patancheru.

Table 1. Groundnut leaf miner larval parasitism[1] in different seasons at ICRISAT Center (1984-1996)

Year	(%) Parasitism[2]	
	Rainy season	Postrainy season
1984	-	42
1985	90	58
1986	21	62[3]
1987	-	45
1988	44	48
1989	10	32
1990	36	6
1991	16	27
1992	33	40
1993	21	34
1994	28	45
1995	-	20
1996	28	48
Mean	33	39

1. Sample size 100 larvae season^{-1}

2. *Goniozus* sp. Is the dominant parasitoid in the postrainy season, *Stenomesius japonicus and Apantles* sp. In the rainy season.

3. In sprayed areas where population was low during April the parasitism was maximum (100%)

Table 2. Groundnut Leaf miner (GLM) incidence[1] on some selected genotypes under high pest pressure, ICRISAT Center, postrainy season 1990/91.

Genotype	Leaf area (cm^2 $plant^{-1}$)	Total GLM $plant^{-1}$ (larvae+pupae)	GLM population (100 cm^{-2})
ICG 1697	380	46	12
ICGV 86162	236	66	27
ICGV 87160	404	103	24
ICGV 86031	441	68	16
ICGV 87495	407	87	20
ICG 2271	335	82	26
ICG 5040	328	77	24
TMV 2	228	50	24
SE	±57.2	±17.4	±4.0
CV (%)	29	42	32

1. Mean of five plants per sample and three replicates under high pressure situation.

Table 3. Effect of polyethene mulch on some groundnut insects observed at ICRISAT Center during postrainy 1991-92.

Treatment	Insect pests				
	Thrips/ 10 shoots	Thrips damaged leaflets (%)	Jassids/ 10 plants	Jassid infestation (%)	Leafminer larvae/ 10 plants
With polyethene mulch	3.6	4.6	47.0	10.9	68.2
No mulch	16.6	24.3	92.8	20.7	64.8
SE	±1.95	±0.92	±4.04	±1.08	±4.44
CV(%)	43.2	14.3	12.9	15.2	14.9

1. Mean of 5 replications and 10 plants in each sample.