FIELD EXPERIMENTATION FOR ASSESSMENT OF YIELD LOSS ASSOCIATION WITH INSECT PESTS OF GROUNDNUTS

P.W. AMIN*

Damage from insect pests results in heavy losses to groundnut crops in India. However, precise estimates of yield loss are not available. One of the reasons for this lack of information is the non-availability of accurate experimental techniques. While knowledge of pests abundance and distribution is required to select the most suitable stage for experimentation, only the use of appropriate experimental design and methods of measuring pest damage severity will give realistic estimates of yield loss. A methodology for pauning and conducting yield loss assessment experiments and measuring the severity of damage caused by the major pests of groundnuts is given.

Insect pests cause severe damage to groundnut but precise estimates of yield loss are not available. This lack of quantitative data makes it difficult to judge the effectiveness of various plant protection schemes. One reason for the lack of precise information on yield loss has been the inadequacy of experimental and pest damage assessment techniquses used in the estimation of pest-caused losses in groundnuts. The present paper describes the methodology for conducting field experiments aimed at assessing the yield loss from individual insect pests and pest complexes infesting groundnut crops.

1. PLANNING AND CONDUCTING EXPERIMENTS

a) Duration of experiments : In agriculture no season can be regarded as 'typical' and variations between seasons are large. Therefore, assessment based on year's experiments may be unrealistic and experiments on crop loss assessment should be carried out for at least three years.

b) Number of locations : It is difficult to determine the number of locations needed for pest control trials. Pest abundance and distribution varies considerably within a given climatic zone. After considering pest population and distribution, at least three to five locations should be chosen in each zone.

c) Selection of site : The sites for field experiments should be representative of farmers' condition of that region.

d) Plot size : For entomological trials the plots should be large enough to allow free movement of insects. At ICRISAT a plot size of 10 rows, each 6 meter long with 30 cm distance between rows and 10 cm distance between plants was found adequate.

*Groudnut Improvement Program, International Crops Research Institute for the Semi-Arid Tropics, ICRISAT, Patancheru P.O., Andhra Pradesh 502 324, India.

e) Guard rows : Guard rows, lm wide of the same variety should be planted on all sides of a plot. Such guard rows reduce the effect of individual treatments on the neighbouring plots and also reduce the effect of pesticide drift Pesticide drift can also be reduced by holding partitions between plots at the time of spray application. Statistically, the co-efficient of variation is considerably reduced in trials with guard rows as compared to those without guard rows (Jenkyn *et. al.*, 1979).

f) Replications : A minimum of 4 and an optimum 5 or 6 replications are adequate. (Le clerg. 1971.) However' for pests such as termite grups which are not distributed randomly, more replications are desirable.

g) Plant stand : For any yteld trial, the plant stands in different plots should be comparable. In addition to the effect on total yield, the plant stand can also affect the insect infestation. We observed more thrips, jassids and leafminers per plant and higher leaf injury in plots with high plant populations. At ICRiSAT we follow two methods to ensure good plant stands in experimental plots : (1) we sow more than one seed per hill, or (2) we use a high seeding rate, followed by thinning. A third method, sowing of partially germinated seeds is also useful particularly for gap-fi ling. Other factors that reduce the plant stand are soil-borne fungi and insects. Seed treatment with Thiram 3.0 g/kg of seeds is useful. For the control of soil insects such as ants, termites or millipedes that can reduce plant stand soil treatment with chlordane or heptachlor is required

h) Pest control : In yield loss assessment triais it is essential to obtain good control of insect pests. Otherwise, estimates of yield loss will not be accurate Occasionally one may need to consider the effect of one group of insects only, and aovid interference rrom other pests. For example, when the effect of foliar pests is investigeted all plots should receive uniform treatment of non-systemic soil insecticides to control soil pests.

i) Disease control : All entomological trial plots must be protected from fungal diseases. Care should be taken to choose a fungicids that has no adverse effect on insects. Chlorothalonil is a good general purpose contact fungicide that controls both rust and leafspot diseases. A mixture of dithane M-5 and Benlate is a useful alternative.

l) Harvesting : Prior to harvest, the plants in at least 0.3m border on all sides of the plot should be discarded to avoid border effects. When the effects of the pests such as termites are under investigation, special care should be taken to harvest all the pods in each plot since termites can damage pegs which results in pods being left in the ground at lifting.

2. Field Layouts

The layout of an experiment depends upon its objective. Two types of yield loss experiment are conducted, to investigate [1] total yield loss from a pest or pest complex, and [2] to partition the yield loss between various pests.

a) Total yield loss assessment : Paired plots in which one plot is protected from all pests with appropriate pesticides and the other not protected are commonly used. Usually 5—6 replications are arranged as given by Le Clerg 1971.

Paried plots are compared by 't' test with a formula :

$$t = \frac{Xp - Xnp}{Sd}$$

where xp = mean yield of treated plots

Xnp = mean yield of non-treated plots

Sd = standard error of the difference between the two mean yields.

b) Multiple treatment experiments : These are aimed at partitioning yield loss among various insect pests in relation growth stages of groundnut and such trials are conducted after the total yield loss from pest complex has been experimentally estimated. Multiple treatment experimants are done by : [1] chossing appropriate insecticides that will most effectively minimize the pest damage, e.g. dimethoate to control thrips and leafminer, or carbaryl to control tobacco caterpillar, [2] assigning successive treatments by which one or more growth stages remain non-protected while protecting the others [Fig.1]

[3] having fully protected and and non-protected plots for comparison, [4] monitoring pests and their damage in all plots and [5] analysing the results statistically.

At ICRISAT we have used the randomized block and a schedule of protection given as shown. 1. Thus, the yield differnce between the treatments T 1 and T 8 reflects the yield loss during vegetative stage from thrips. Similarly yield difference between T 1 and T2 reflects loss at R 1 stage, from thrips; T 2 and T 3 at R2 from thrips; T3 and T4 at R3 from thrips; T4 and T5 at R4 from thrips; T8 and T5 as total loss from thrips; T5 and T6 at R5 from leafminer; T6 and T7 at R6 and R7 from leafminer and tobacco caterpillar; T5 and T7 as total loss from leaf miner and tobacco caterpillar and T8 and T7 as total loss from all insects. It is difficult to partition the loss caused by two simultaneously infesting pests such as leafminer and tobacco caterpillar unless selective insecticides are available which control only one pest without affecting the other.

I. Measurment of pest damage severity and sampling procedure

Assessment of crop loss always depends upon the realistic measurment of pest damage and the establishment of its relationship with yield. Methods to measure pest damage should be simple and reliable. Counting thrips-damaged leaflets is a simple and reliable method.

Before yield loss experiments are conducted it is necessary to standardize the methods used to measure the damage caused by insect pests. The following methods are suggested for groundnut pests :

Termites : The following methods are suggested for groundnut pests :

(1) Percentage of plants killed,
(2) Percentage of pods bored,
(3 Percentage of pods scarified,
(4) Injury rating of scarified pods on 1-9 scale where 1 is no scarification and 9 is total scarification of the pod.

The distribution of termites in a field is often not uniform or random, therefore, measurements should be taken at several locations in a plot or the entire should be treated as a sampling unit.

White grub : *Holotrichia spp.* The number of seedlings per plot killed by white grub attack is an adequate measure of damage.

As the distribution of white grub in the field is extremely patchy, it is necessary to use a higher number of replications and arrange them at several locations in a field.

Crop mortality also results from fungal diseases and hence, fungicidal seed treatment with thiram is essential and it is also necessary to keep a record of fungus-killed plants. Because of the extremely uneven distribution of white grubs, the whole plot should be treated as a sampling unit

Thrips : Two types of observations are essential to assess damage caused by thrips ; (1) the number of leaflets showing thrips injury, and (2) the severity of damage recorded on a 1-9 scale where 1 is no damage and 9 is heavy damage indicated by curling of leaves in the case of *S. dorsalis*, malformation of leaflets in the case of *Eschultzei* and drying of foliage in the case of *C indicus*.

Thrips are normally randomly distributed in the field. Five sampling units each of 1 meter row arranged diagonally in a plot have been routinely used at ICRISAT for recording thrips injury.

Discussion on jassids missing

At ICRISAT we record two types of observations: (1) the percentage of yellowed foliage, and (2) the number of jassid nymphs on three terminal leaves. The observations are recorded from five, 1 mater row units arranged diagonally in a plot.

Aphids:

The distribution of aphids is not random or uniform, so the size of sampling unit needs to be increased. Five each 1 meter square sub-plots arranged diagonally in a plot are adequate for the sampling of aphids. At ICRISAT we record two types of observations: (1) the number of plants infested with aphids, and (2) the size of individual aphid colony as small (1-25 aphids), medium (26-100) and large (> 100).

Leafminer:

The leafminer pest is randomly distributed in a field and five 1-meter row plots arranged diagonally form the sampling unit. We routinely record percentage of dried foliage.

Tabacco caterpillar: *Spodoptera litura*, and hairy caterpillars, *Amsacta* spp. The percentage of defoliation is a good index of damage severity. Additional observations can be recorded on the number of larvae/2 meter rows arranged diagonally at 5 places in a plot.

The yield of groundnuts, as in any other crop, is the end result of several interacting factors such as variety, soil type and fertility, plant density, time of planting, temperature and rainfall in addition to pesr and diseases. It is difficult to obtain absolute values of losses, but, useful results can be obtained from properly designed and well conducted field experiments.

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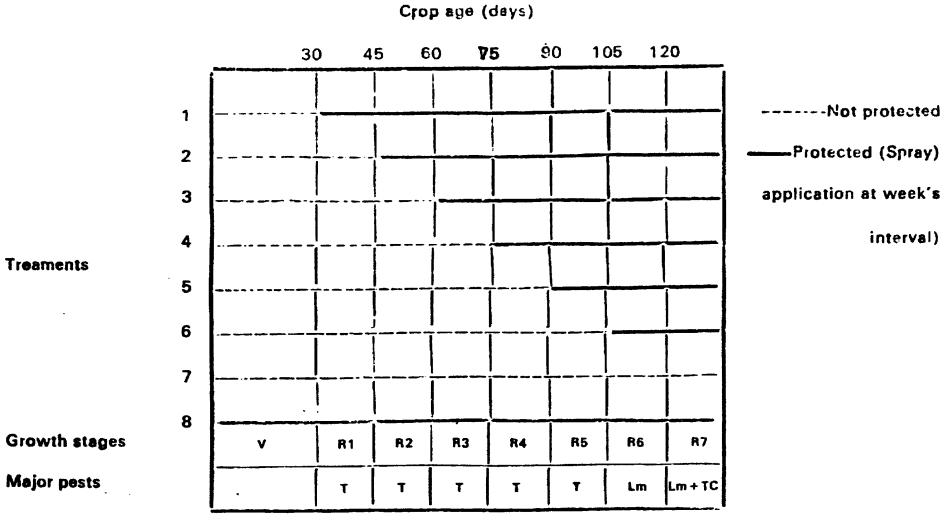

Figure : 1. Partitioning of yield loss among different pests of ground in postrainy (rabi) season at ICRISAT
Growth stages (Boote, 1982) : V = vegetative, R1 = bloome, R2 = pegging, R3 = podding,
R4 = full pod, R5 = seed formation, R6 = full seed, R7 = maturity.
Major pests : T = thrips, Lm = leafminer, TC = tobacco caterpillar.