C005. Eco-friendly management of lepidopterous pests in soybean

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A field experiment was conducted for two years for 1998-2000 to study the seasonal incidence, bio-efficacy on defoliator *Spodoptera litura* and pod borer *Cydia ptychora* mass production of *Nomuraea rileyi* and also its compatibility with pesticides in soybean eco-system. The mycopathogen occurred in epizootic form on *S.litura* in soybean between 31st and 38th with peak activity in 34th and 35th standard week. The treatment effect due to *N.rileyi* became visible at 7 DAS and its superiority was more evident at 14 DAS. In soybean the pathogen inflicted significantly higher reduction of *Spodoptera* larvae at higher concentration ($2.4x10^8$ conidia/l) at 14 DAS. Rice and barely were the most suitable substrate for quicker and better mass multiplication of *N.rileyi* with $1.22x10^8$ and 1.17×10^8 conidia per g of substrates after 20 days of inoculation. Fungicides, in general, proved highly toxic to mycopathogen inhibiting 82.71 per cent of spores from germination when compared to insecticides (53.99 % inhibition) and weedicides (21.50% inhibition). Among fungicides, cyperconazole and triademefon were comparatively safer permitting 69.42 and 65.89 per cent conidia to germinate, respectively.

C006. Identification and inheritance of resistance to leaf feeders in soybeans

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According to a field survey during 1983-1984 and 1992-1994, 49 insect species from five orders, i.e. Coleoptera, Hemiptera, Homoptera, Lepedoptera and Orthoptera, were identified to be leaf feeder insects (LFI) for soybeans in Nanjing, China and bean pyralid [*Lamprosena indicata*? (Fabricius)], mugwort looper [*Ascotis gelenaria* (Schiffermuller et Denis) and cotton worm [Prodenia litura (Fabricius)] were clarified to be the most important pests. Fifty one resistant or susceptible soybean entries screened out from 6724 accessions were evaluated for their resistance to LFIs in field in terms of their defoliation percentage and to cotton worm in net room in terms of both plant response and insect response (antibiosis). There existed significant difference in the resistance of soybeans among varieties, dates and years, and also significant interactions between varieties and dates, and between varieties and years. The accessions highly resistant to LFIs in field and to cotton worm alone in net room in terms of plant response and those highly resistant to cotton worm in terms of antibiosis were screened out for breeding purposes. The three sets of accessions were not consistent. The mechanism of resistance to leaf-feeding insect was mainly antibiosis in comparison with ovipositional preference. For plant response to LFIs, the results of joint analysis of multiple generations of P_1, F_1, P_2, F_2, $F_{2:3}$ of the crosses N21297 × N1178-2-2 and N21266 × N23860 showed a two major gene plus polygene mixed inheritance model with heritability values of major gene (h_{mg}^2) being about 81 ~ 94% much greater than those of polygene (h_{pg}^2) which were only 0 ~ 12%. While for plant response to cotton worm alone in net room, there also showed a two major gene plus polygene mixed inheritance model but with h_{mg}^2 67 ~ 98% and h_{pg}^2 0 ~ 25%. For insect response (larvae weight), the results of $F_{2:7:8}$ RIL populations of the two crosses showed also a two major gene plus polygene mixed inheritance with h_{mg}^2 51 ~ 69% and h_{pg}^2 22 ~ 24%. Whether the two major genes detected for plant response and insect response were in a same genetic system should be further studied.

C007. Effect of rutin on the biology and physiology of *Anticarsia gemmatalis* from strains of susceptible and resistant to the *Ag*MNPV

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Flavonoids in general have been related with plant protection against different sources of stress. Rutin (quercetin 3-*O*-rutinoside) is a flavonol identified in soybean resistant genotypes and it is known to play an important role on plant defenses against defoliating insects. Nevertheless, some authors have reported that rutin can also interfere with the nuclear polyhedrosis virus (NPV) infections. Experiments were carried out to evaluate the effect of rutin on two strains of *Anticarsia gemmatalis,* susceptible (S) and resistant (R) to the *A. gemmatalis* Multiple NPV (*Ag*MNPV). Since eclosion, larvae from both populations were fed on a diet without (control) or with rutin (0.65% and 1.30%) addition. At the end of second instar, larvae were weighed and individualized on the same diet and observed daily until reaching the pre-pupae stage. Analyse of covariance (ANCOVA), followed by bicoordinate utilization plots, was used to remove the effect of feeding time from consumption and weight of pupae and to separate pre- and post-ingestive effects of rutin on *A. gemmatalis* growth. Larval mortality rates were higher when R larvae were fed on 1.30% rutin-

diet (97.9%), compared to the controls. Larvae from R and S populations that fed on diet with 0.65 and 1.30% of rutin, respectively, showed the same mortality rates (74.7%). Initial and final pupal weight, consumption, frass, lipid and development time of *A. gemmatalis* were all negatively affected by rutin, mainly in the R population. Consumption of the insect remained affected by diet (treatment), after removing the effect of feeding time by ANCOVA. Comparing control-diet insects, those from S population consumed more rapidly a larger amount of food than those from R population. Insect growth and the amount of frass produced depended on an interactive relationship between the amount of food eaten (covariate) and the treatments. Digested food and weight of pupae, as covariates, also affected the weight of pupae and the amount of lipid, respectively. Post-ingestive effect was observed on larvae from both populations when rutin was added to the diet, probably as a result of insect failing to detect this substance on the diet. Nevertheless, R larvae notably were more adversely affected by rutin than the S population, even in the lowest concentration of the flavonoid (0.65%). Results indicate that resistant soybean genotypes containing rutin may be an useful tool to break resistance of *A. gemmatalis* to *Ag*MNPV, although additional studies involving a second *A. gemmatalis* generation have to be carried out for a complete elucidation of this fact.

C008. An overview of the program for use of a Nucleopolyhedrovirus of *Anticarsia gemmatalis* in soybean and recent achievements to improve the program

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The velvetbean caterpillar, *Anticarsia gemmatalis*, is the key defoliating insect of soybean from northern Argentina to Southeastern USA. In Brazil it is abundant in all soybean growing regions, and demands an average of two insecticide applications per season. In the early 1980's a program for use of a nuclear polyhedrosis virus of *A. gemmatalis* (AgMNPV) was launched by Embrapa Soja and the official extension service of the state of Paraná (Emater-Pr), in the context of a soybean integrated pest management (IPM) program started in the mid 1970's. Currently the biological product based on the AgMNPV is produced by four private companies, through contracts with Embrapa Soja, and used in approximately 2.0 million hectares of soybean in Brazil (ca. 12% of the soybean cultivated area in the country), being the largest program worldwide regarding the use of a microbial insecticide in a single crop. Production of the AgMNPV has been effected mainly in the field, by applying the virus in farmer's fields and collecting dead larvae for further processing as a biological insecticide, with quality control of the final product batches being performed at Embrapa Soja. However, this method of virus production is dependent of biotic and abiotic factors, which influence abundance of the host insect and thus the yield of AgMNPV each season. In the last three seasons the demand for the biological insecticide was 20-30% over of its availability in the market. Previous attempts by private companies to produce the virus under laboratory conditions were not successful due to the high costs involved, mainly insect diet ingredients, insect-rearing recipients and labor, making the final AgMNPV product not cost competitive with chemical insecticides. In this paper, we report a new procedure for commercial production and processing of the AgMNPV under laboratory conditions that results in a final product with lower cost than that of chemical insecticides, which will be a breakthrough to attend the increasing demand for the biological insecticide. One of the companies (Coodetec) is currently implementing successfully the new procedures at commercial level. Furthermore, data on fluorescent brighteners mixed with the AgMNPV indicate that these products may improve the virus formulation by potentializing viral activity against susceptible *A. gemmatalis* larvae and breaking resistance in insects that were selected in the laboratory to high levels of resistance to the AgMNPV. Other important recent developments to improve the program will be discussed.

C009. Genetic enhancement for rust resistance in soybean

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Rust is one of the major diseases of soybean which is known to cause significant yield losses. Most of the popular cultivars are susceptible to rust. Keeping this in view, an investigation was carried out at the University of Agricultural Sciences, Dharwad, India during 1997–2002 with an objective to improve host plant resistance to rust. Three diverse genotypes *viz.*, Ankur, JS 335 and Local black soybean were treated with three doses of gamma irradiation (10, 20 and 30 kR) and ethyl methane sulphonate (0.4, 0.6 and 0.8 %). About 270 families of M_3 generation and subsequently M_4 and M_5 lines were screened for rust resistance. Ten lines confirmed their resistance in field as well as glass house conditions with artificial inoculation. Out of which, three were resistant and seven were moderately resistant compared to highly