

References

- ABARE. (1998). *Australian commodity statistics. (1998)*. Commonwealth of Australia, Canberra.
- Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* **18**: 265-7.
- Abu, J.F., and Ellis, C.R. (1977). Toxicity of five insecticides to the Alfalfa Weevil, *Hypera postica* and its parasites, *Bathyplectes curculionis* and *Microctonus aethiopoulos*. *Environmental Entomology* **6**: 385-9.
- Adams, R.G., and Los, L.M. (1989). Use of sticky traps to aid in pest management decisions for summer populations of the pear psyllid (Homoptera: Psyllidae) in Connecticut. *Journal of Economic Entomology* **82**: 1448-54.
- Adamson, D., Thomas, G., and Davis, E. (1997). *An economic estimate of Helicoverpa's effect on Australian agricultural production*. Cooperative Research Centre for Tropical Pest Management, Brisbane. pp. 108.
- Adjei-Mafo, I.K., and Wilson, L.T. (1983). Association of cotton nectar production with *Heliothis punctigera* (Lepidoptera: Noctuidae) oviposition. *Environmental Entomology* **12**: 1166-70.
- Ahmad, S., and Forgash, A.J. (1976). Toxicity of carbaryl to gypsy moth larvae parasitized by *Apanteles melanoscelus*. *Environmental Entomology* **5**: 1183-6.
- Ahmad, S., O'Neill, J.R., Mague, D.L., and Nowalk, R.K. (1978). Toxicity of *Bacillus thuringiensis* to gypsy moth larvae parasitized by *Apanteles melanoscelus*. *Environmental Entomology* **7**: 73-6.
- Alcock, B., and Twine, P. (1981). The cost of *Heliothis* in Queensland crops. In *Workshop on biological control of Heliothis spp. 23-25 Sept. 1980, Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. 1-10.
- Ali, A.A., and Watson, T.F. (1982). Survival of tobacco budworm (Lepidoptera: Noctuidae) larvae after short-term feeding periods on cotton treated with *Bacillus thuringiensis*. *Journal of Economic Entomology* **75**: 630-2.
- Anon. (1970). Standard method for detection of insecticide resistance in *Heliothis zea* (Boddie) and *H. virescens* (F.). *Bulletin of the Entomological Society of America* **16**: 147-53.
- Anon. (1980). Sex is a trap for *Heliothis*. Maquarie Irrigation Department. NSW, Agriculture. *Agricultural Gazette of NSW* **8**: 5.
- Anon. (1981). Workshop report to SCA. In *Workshop on biological control of Heliothis spp. 23-25 Sept 1980. Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. 123-4.
- Anon. (1983). *Heliothis* develops resistance to pyrethroids. *The Australian Cotton Grower* **4**: 18-9.
- Anon. (1997). *Envirofeast®. Integrated pest management system, user's guide*. First edition. Rhône-Poulenc, Australia. Brisbane. pp. 11.

- Anon. (1999). *EntomoLOGIC® V3.0. Manual*. CSIRO Plant Industry, Cotton CRC, and Cotton Research and Development Corporation, Narrabri.
- Atwood, D.W., Young, S.Y., and Kring, T.J. (1997a). Development of *Cotesia marginiventris* (Hymenoptera: Braconidae) in *Heliothis virescens* (Lepidoptera: Noctuidae) larvae treated with *Bacillus thuringiensis*. *Journal of Economic Entomology* **90**: 751-6.
- Atwood, D.W., Young, S.Y., and Kring, T.J. (1997b). The impact of Bt and thiodicarb alone and in combination on tobacco budworm, mortality and emergence of the parasitoid *Microplitis croceipes*. *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1305-10.
- Atwood, D.W., Young, S.Y., and Kring, T.J. (1995). Development of *Cotesia marginiventris* in *Bacillus thuringiensis* exposed *Heliothis virescens* larvae. *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 853-5.
- Austin, A.D., and Dangerfield, P.C. (1992). Synopsis of Australasian Microgastrinae (Hymenoptera: Braconidae), with a key to genera and description of new taxa. *Invertebrate Taxonomy* **6**: 1-76.
- Austin, A.D., Dangerfield, P.C., and Adams, M. (1993). Differentiation of the Australian species in the genus *Microplitis* Foerster (Hymenoptera: Braconidae) and the *Microplitis demolitor* complex, using comparative morphological and electrophoretic data. In *Pest control and sustainable agriculture*. Corey, S., Dall, D., and Milne, W. (eds.). Division of Entomology, Canberra, Australia. pp. 219-22.
- Barbosa, P., Saunders, J.A., Kemper, J., Trumbule, R., Olechno, J., and Martinat, P. (1986). Plant allelochemicals and insect parasitoids: effects of nicotine on *Cotesia congregata* (Say) (Hymenoptera: Braconidae) and *Hyposoter annulipes* (Cresson) (Hymenoptera: Ichneumonidae). *Journal of Chemical Ecology* **12**: 1319-28.
- Barret, J.W.H., Peterson, S.M., and Batley, G.E. (1991). *The impact of pesticides on the riverine environment with specific reference to cotton growing. A report to the Cotton Research and Development Corporation and the Land and Water Resources Research and Development Corporation*. Cotton Research and Development Corporation, Narrabri. pp. 91.
- Bartlett, B.R. (1964). Integration of chemical and biological control. In *Biological control of insect pests and weeds*. DeBach, P. (ed.). Chapman and Hall, London. pp. 844.
- Bartlett, B.R. (1966). Toxicity and acceptance of some pesticides fed to parasitic Hymenoptera and predatory Coccinellids. *Journal of Economic Entomology* **59**: 1142-9.
- Beckage, N.E. (1985). Endocrine interactions between endoparasitic insects and their hosts. *Annual Review of Entomology* **30**: 371-413.
- Beegle, C.C., and Oatman, E.R. (1974). Differential susceptibility of parasitised and non-parasitised larvae of *Trichoplusia ni* to a nuclear polyhedrosis virus. *Journal of Invertebrate Pathology* **24**: 188-95.
- Beegle, C.C., and Oatman, E.R. (1975). Effect of a nuclear polyhedrosis virus on the relationship between *Trichoplusia ni* and the parasite *Hyposoter exiguae* (Hymenoptera: Ichneumonidae). *Journal of Invertebrate Pathology* **25**: 59-71.

- Bell, J.V., King, E.G., and Hamalle, R.J. (1974). Interactions between bollworms, a braconid parasite, and the bacterium *Serratia marcescens*. *Annals of the Entomological Society of America* **67**: 712-4.
- Betts, M.D., and Gregg, P.C. (1993). A field trial of mating disruption for *Helicoverpa* spp. in cotton. In *Pest control and sustainable agriculture*. Corey, S.A., Dall, D.J., and Milne, W.M. (eds.). CSIRO, Canberra. pp. 298-300.
- Bishop, A.L., and Blood, P.R.B. (1980). Arthropod ground strata composition of the cotton ecosystem in southeastern Queensland, and the effect of some control strategies. *Australian Journal of Zoology* **28**: 693-7.
- Bottrell, D.G., and Adkisson, P.L. (1977). Cotton insect pest management. *Annual Review of Entomology* **22**: 451-81.
- Bottrell, D.G., Young, J.H., Price, R.G., and Adams, R.H. (1968). Parasites reared from *Heliothis* spp. in Oklahoma in 1965 and 1966. *Annals of the Entomological Society of America* **61**: 1053-5.
- Boyer, W.P., and Bell, R. (1961). The relationship of spider mite infestations in cotton to early season use of insecticides. *Journal of the Kansas Entomological Society* **34**: 132-4.
- Brewer, F.D., and King, E.G. (1980). Consumption and utilization of a soyflour-wheat germ diet by larvae of the tobacco budworm parasitised by the tachinid *Eucelatoria* sp. *Entomophaga* **25**: 95-101.
- Brewer, F.D., and King, E.G. (1981). Food consumption and utilization by sugarcane borers parasitised by *Apanteles flavipes*. *Journal Georgia Entomological Society* **16**: 185-92.
- Broadly, R.H. (1984). Seasonal incidence and parasitism of *Heliothis* spp. (Lepidoptera: Noctuidae) larvae in south Queensland sunflowers. *Journal of the Australian Entomological Society* **23**: 145-7.
- Broadly, R.H., and Butler, D.G. (1983). Longevity of adult *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae). *Queensland Journal of Agricultural and Animal Sciences* **40**: 27-8.
- Browning, H.W., Federici, B.A., and Oatman, E.R. (1986). Occurrence of a disease caused by a rickettsia-like organism in a larval population of the Cabbage Looper, *Trichoplusia ni*, in southern California. *Environmental Entomology* **11**: 550-4.
- Bryan, D.E., Jackson, C.G., and Patana, R. (1969). Laboratory studies of *Microplitis croceipes* a Braconid parasite of *Heliothis* spp. *Journal of Economic Entomology* **62**: 1141-4.
- Bull, D.L., King, E.G., and Powell, J.E. (1989). Effects and fate of selected insecticides after application to *Microplitis croceipes*. *Southwestern Entomologist. Supplement* **12**: 59-70.
- Bull, D.L., Pryor, N.W., and King, E.G., Jr. (1987). Pharmacodynamics of different insecticides in *Microplitis croceipes* (Hymenoptera: Braconidae) a parasite of lepidopteran larvae. *Journal of Economic Entomology* **69**: 731-6.
- Burleigh, J.G. (1975). Comparison of *Heliothis* spp. larval parasitism and *Spicaria* infection in closed and open canopy cotton varieties. *Environmental Entomology* **4**: 574-6.
- Burleigh, J.G., and Farmer, J.H. (1978). Dynamics of *Heliothis* spp. larval parasitism in southeast Arkansas. *Environmental Entomology* **7**: 692-4.

- Busvine, J.R. (1971). *A critical review of the techniques for testing insecticides*. Commonwealth Agricultural Bureau, Farnham Royal, Slough, England. pp. 345.
- Carner, G.R., and Hudson, J.S. (1983). Histopathology of virus-like particles in *Heliothis* spp. *Journal of Invertebrate pathology* **41**: 238-49.
- Carson, R.L. (1962). *Silent Spring*. Penguin Books Australia Ltd, Victoria, Australia. pp. 317.
- Cate, J.R. (1985). Cotton: status and current limitations to biological control in Texas and Arkansas. In *Biological control in agricultural IPM systems*. Hoy, M.A., and Herzog, G.A. (eds.). Academic Press, New York, USA. pp. 537-56.
- Cate, J.R., Ridgway, R.L., and Lingren, P.D. (1972). Effects of systemic insecticides applied to cotton on adults of an Ichneumonid parasite, *Campoletis perdinctus*. *Journal of Economic Entomology* **65**: 484-8.
- Cayrol, R., Poitout, S., and Anglade, P. (1974). Étude comparée des caractères biologiques respectifs de quelques espèces de Noctuidae plurivoltines migrantes et sédentaires. I. Exposé des hypothèses de travail. Orientation des recherches entreprises. *Annales de Zoologie- Ecologie Animale* **6**: 1-10.
- Chamberlin, F.S., and Tenhet, N. (1926). *Cardiochiles nigriceps* Vier., an important parasite of the tobacco budworm, *Heliothis virescens* Fab. *Journal of Agricultural Research* **33**: 21-7.
- Chao, A. (1989). Estimating population size for sparse data in capture-recapture experiments. *Biometrics* **45**: 427-38.
- Clarke, L., and Churches, T. (1992). Health and safety in the Australian cotton industry. *Proceedings of the 5th Australian Cotton Conference, Broadbeach, Gold Coast, Queensland, Australia*. Australian Cotton Growers Research Association, Brisbane. pp. 403-12.
- Cobb, C.H. (1983). *Life history and behavior of Microplitis demolitor Wilkinson (Hymenoptera: Braconidae) an imported parasitoid of the corn earworm, Heliothis zea (Boddie) and the soybean looper, Pseudoplusia includens (Walker) (Lepidoptera: Noctuidae)*. M.S. thesis, Clemson University, Clemson, S.C., USA. Cited in Cobb et al., 1985.
- Cobb, C.H., Grant, J.F., and Shepard, M. (1985). Effects of parasitism by *Microplitis demolitor* (Hymenoptera: Braconidae) on foliage consumption by *Heliothis zea* (Lepidoptera: Noctuidae) larvae. *Florida Entomologist* **68**: 490-2.
- Common, I.F.B. (1953). The Australian species of *Heliothis* (Lepidoptera: Noctuidae) and their pest status. *Australian Journal of Zoology* **1**: 319-44.
- Commonwealth Institute of Entomology. (1968). Distribution maps of insect pests, *Heliothis armigera* (Hübner). Map number **15**. Commonwealth Agricultural Bureau, London.
- Commonwealth Institute of Entomology. (1969). Distribution maps of insect pests, *Heliothis punctigera* Wallengren. Map number **263**. Commonwealth Agricultural Bureau, London.
- Copenhaver, T.W., and Mielke, P.W. (1977). Quantity analysis: a quantal assay refinement. *Biometrics* **33**: 175-86.
- Croft, B.A. (1977). Susceptibility surveillance to pesticides among natural enemies: modes of uptake and basic response. *Zeitschrift fuer Pflanzenkrankheiten und Pflanzenschutz* **84**: 140-57. Cited in Croft and Whalon, 1982.

- Croft, B.A., and Brown, A.W.A. (1975). Responses of arthropod natural enemies to insecticides. *Annual Review of Entomology* **20**: 285-355.
- Croft, B.A., and Whalon, M.E. (1982). Selective toxicity of pyrethroid insecticides to arthropod natural enemies and pests of agricultural crops. *Entomophaga* **27**: 3-21.
- Culin, J.D., and Debose, W.P. (1987). Insecticide interference with *Microplitis demolitor* (Hymenoptera: Braconidae) parasitization of *Heliothis zea* (Lepidoptera: Noctuidae). *Journal of Economic Entomology* **80**: 1188-91.
- Cullen, J.M. (1969). *The reproduction and survival of Heliothis punctigera Wallengren in South Australia*. Ph.D. thesis, University of Adelaide.
- Dale, M., Gregg, P.C., and Drake, V.A. (1992). *Report of a workshop on developing a Heliothis forecasting service in Australia. December 1992, Narrabri, New South Wales, Australia*. CRC for Tropical Pest Management, Brisbane. pp. 43.
- Daly, J., and Gregg, P. (1985). Genetic variation in *Heliothis* in Australia: species identification and gene flow in the two pest species *H. armigera* (Hübner) and *H. punctigera* (Wallengren) (Lepidoptera: Noctuidae). *Bulletin of Entomological Research* **75**: 169-84.
- Daly, J.C. (1988). Insecticide resistance in *Heliothis armigera* in Australia. *Pesticide Science* **23**: 165-76.
- Daly, J.C., and McKenzie, J.A. (1986). Resistance management strategies in Australia: the *Heliothis* and 'wormkill' programs. In *Proceedings, British Crop Protection Conference on Pests and Diseases (Brighton, 1986)*. The British Crop Protection Council, Surrey. Crop Protection Meeting. Bristol. pp. 951-9.
- Daly, J.C., Fisk, J.H., and Forrester, N.W. (1988). Selective mortality in field trials between strains of *Heliothis armigera* (Lepidoptera: Noctuidae) resistant and susceptible to pyrethroids: functional dominance of resistance and age class. *Journal of Economic Entomology* **81**: 1000-7.
- DeBach, P. (1974). *Biological control by natural enemies*. Cambridge University Press, London, U.K.
- DeBach, P., and Rosen, D. (1991). *Biological control by natural enemies*. Cambridge University Press, Cambridge, UK. pp. 440.
- Devore, J., and Peck, R. (1993). *Statistics: The exploration and analysis of data*. 2nd ed. Duxbury Press, Belmont, California. pp. 881.
- Dietrick, E.S. (1961). An improved backpack motor fan for suction sampling insect populations. *Journal of Economic Entomology* **54**: 394-5.
- Dillon, G., Fitt, G.P., and Forrester (1994). Natural mortality of *Helicoverpa* eggs on cotton. *Proceeding of the 7th Australian Cotton Conference. Gold Coast, Queensland, August, 1994*. Australian Cotton Growers Research Association, Brisbane. pp. 75-80
- Ditman, L.P., Weiland, G.S., and Guill, J.H., Jr. (1940). The metabolism of the corn earworm. III. Weight, water and diapause. *Journal of Economic Entomology* **33**: 282-95.
- Drost, Y.C., Lewis, W.J., Zanen, P.O., and Keller, M.A. (1986). Beneficial arthropod behaviour mediated by airborne semiochemicals. I. Flight behavior and influence of preflight handling of *M. croceipes* (Cresson). *Journal of Chemical Ecology* **12**: 1247-62.

- Dubbeldam, A.A., and McCaffery, A.R. (1997). The optimum range of weights of the tobacco budworm (*Heliothis virescens*) for use in the third instar topical bioassay. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1341-3.
- Dumbre, R.B., and Hower, A.A. Jr. (1976). Relative toxicities of insecticides to the Alfalfa Weevil parasite *Microctonus aethiops* and the influence of parasitism on host susceptibility. *Environmental Entomology* **5**: 311-5.
- Dunbar, D.M., Kaya, H.K., Doane, C.C., Anderson, J.F., and Weseloh, R.M. (1973). Aerial application of *Bacillus thuringiensis* against larvae of the elm span-worm and gypsy moth and effects on parasitoids of the gypsy moth. *Connecticut Agricultural Experiment Station Bulletin* **735**. pp. 23. Cited in Weseloh and Andreadis, 1982.
- Dunnam, E.W., Clarke, J.C., and Calhoun, S.L. (1943). Effect of removal of squares on yield of upland cotton. *Journal of Economic Entomology* **36**: 896-900.
- Duodo, R.B., and Davis, D.W. (1974). A comparison of growth, food consumption and food utilization between unparasitized alfalfa weevil larvae and those parasitized by *Bathyplectes curculionis* (Thomson). *Environmental Entomology* **3**: 705-10.
- Ebbels, D.L. (1980). Cotton diseases. *Outlook on Agriculture* **10**: 176-83.
- Edge, V. (1996). Environmental issues facing the cotton industry related to pesticide use. In *Proceedings of the 8th Australian Cotton Conference, 14-16 August 1996, Broadbeach*. Australian Cotton Growers Research Association, Broadbeach, Queensland. pp. 47-54.
- Edger, J.E., Sterling, W.L., and Hartstack, A.W. (1983). Winter survival of *Heliothis virescens* and *H. zea* (Lepidoptera: Noctuidae) in College Station Texas. *Environmental Entomology* **12**: 970-5.
- Eid, M.A.A., El-Nagar, S., Salem, M.S., and Badawy, E. (1985). Effect of nuclear polyhedrosis virus ingestion on consumption and utilization of food by *Spodoptera littoralis* larvae. *Bulletin of the Entomological Society of Egypt* **13**: 67-74.
- Elliott, M., Farnham, A.W., Janes, N.F., Needham, P.H., Pulman, D.A., and Stevenson, J.H. (1973). A photostable pyrethroid. *Nature* **246**: 169-70.
- Elzen, G.W., O'Brien, P.J., and Powell, J.E. (1989). Toxicity and behavioral effects of selected insecticides on the *Heliothis* parasitoid *Microplitis croceipes*. *Entomophaga* **34**: 87-94.
- Elzen, G.W., O'Brien, P.J., Snodgrass, G.L., and Powell, J.E. (1987). Susceptibility of the parasitoid *Microplitis croceipes* (Hymenoptera: Braconidae) to field rates of selected cotton insecticides. *Entomophaga* **32**: 545-50.
- England, M., Minzenmayer, R., and Sansone, C. (1997). Impact of selected insecticides on boll weevil and natural enemies. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 989-93.
- Evans, J.W. (1943). *Insect pests and their control*. Government Printer, Hobart. pp. 178.
- Ewing, K.P., and Ivy, E.E. (1943). Some factors influencing bollworm populations and damage. *Journal of Economic Entomology* **36**: 602-6.

- Farrow, R.A., and McDonald, G. (1987). Migration strategies and outbreaks of Noctuid pests in Australia. *Insect Science and its Applications* **8**: 531-42.
- Fast, P.G., and Regeniere, J. (1984). Effect of exposure time to *Bacillus thuringiensis* on mortality and recovery of the spruce budworm (Lepidoptera: Noctuidae). *Canadian Entomologist* **116**: 123-30.
- Felton, G.W., and Dahlman, D.L. (1984). Nontarget effect of a fungicide: toxicity of Maneb to the parasitoid *Microplitis croceipes* (Hymenoptera: Braconidae). *Journal of Economic Entomology* **77**: 847-50.
- Finney, D.J. (1971). *Probit analysis*. 3rd edition. Cambridge University Press. pp. 333.
- Fitt, G.P. (1989). The ecology of *Heliothis* species in relation to agroecosystems. *Annual Review of Entomology* **34**: 17-52.
- Fitt, G.P. (1997). Risks, deployment and integration of insect resistant crops expressing genes from *Bacillus thuringiensis*. In *Commercialisation of transgenic crops: risk, benefit and trade considerations. Proceedings of a workshop held in Canberra, 11-13 March 1997*. McLean, G.D., Waterhouse, P.M., Evans, G., and Gibbs, M.J. (eds.). CSIRO, Canberra. pp. 273-84.
- Fitt, G.P. (2000). IPM with two-gene cotton. *Proceedings of the 10th Australian Cotton Conference, 16-18th August, 2000*. Australian Cotton Growers Research Association, Brisbane. pp. 175-84.
- Fitt, G.P., Forrester, N.W., and Cahill, M. (1984). Use of pheromone traps as indicators of the species composition of *Heliothis* eggs laid in cotton crops. In *Proceedings of the Australian Cotton Growers Research Conference, Toowoomba*. Cooperative Research Centre for Tropical Pest Management, Brisbane. 194-206.
- Fitt, G.P., Gregg, P.C., Zalucki, M.P., and Murray, D.A.H. (1995). New records of *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) from South Australia and Western Australia. *Journal of the Entomological Society of Australia* **34**: 65-7.
- Fitt, G. (1995). Management strategies for Bt transgenic cottons: some points of view. In *IPM in cotton strategic planning forum report*. Edge, V., and Pyke, B. (eds.). Cotton Research and Development Corporation, Narrabri. pp. 19-21.
- Fix, L.A., and Plapp, F.W. Jr. (1987). Effects of parasitism on several detoxification enzymes in the tobacco budworm (Lepidoptera: Noctuidae). *Journal of the Kansas Entomological Society* **60**: 421-5.
- Fletcher, R.K., and Thomas, F.L. (1943). Natural control of eggs and first instar larvae of *Heliothis armigera*. *Journal of Economic Entomology* **36**: 557-60.
- Forrester, N. (1993). Guidelines for using the new *Heliothis* identification kit. *The Australian Cottongrower* **14**: 12-5.
- Forrester, N.W. (1981). Biological control agents of *Heliothis* spp. on sunflower. In *Workshop on biological control of Heliothis spp. 23-25 Sept 1980. Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. pp. 49-53.
- Forrester, N.W., and Bird, L.J. (1996). Conventional insecticide and Bt transgenic resistance management in Australian cotton. In *Proceedings of the 8th Australian Cotton Conference*. Australian Cotton Growers Research Association, Broadbeach, Queensland. pp. 159-72.

- Forrester, N.W., Cahill, M., Bird, L.J., and Layland, J.K. (1993). Management of pyrethroid and endosulfan resistance in *Helicoverpa armigera* (Lepidoptera: Noctuidae) in Australia. *Bulletin of Entomological Research Supplement Series. Supplement 1*: 1-132.
- Franz, J.M., Bogenschütz, H., Hassan, S.A., Huang, P., Naton, E., Suter, H., and Viggiani, G. (1980). Results of a joint pesticide test program by the working group: pesticides and beneficial arthropods. *Entomophaga* **25**: 231-6.
- Furlong, M.J., and Wright, D.J. (1993). Effect of the acylurea insect growth regulator teflubenzuron on the endo-larval stages of the hymenopteran parasitoids *Cotesia plutellae* and *Diadegma semiclausum* in a susceptible and an acylurea-resistant strain of *Plutella xylostella*. *Pesticide Science* **39**: 305-12.
- Fusco, R.A. (1980). Field evaluations of a commercial preparation of *Bacillus thuringiensis*, DIPEL 4L, progress report, Gypsy Moth Pest Management Methods Development Project. Pennsylvania Bureau of Forestry. Pennsylvania.
- Gaines, R.C. (1954). Effect on beneficial insects of several insecticides applied for cotton insect control. *Journal of Economic Entomology* **47**: 543-4.
- Gast, R.T. (1959). The relationship of weight of lepidopterous larvae to effectiveness of topically applied insecticides. *Journal of Economic Entomology* **52**: 1115-7.
- Gillespie, D. (1993). Probit 5 for Windows Manual. Computer program.
- González, D., Orphanides, van den Bosch, R., and Leigh, T.F. (1970). Field-cage assessment of *Trichogramma* as parasites of *Heliothis zea*: development of methods. *Journal of Economic Entomology* **63**: 1292-6.
- Goodyer, G.J., and Greenup, L.R. (1980). A survey of insecticide resistance in the cotton bollworm, *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in New South Wales. *General and Applied Entomology* **12**: 37-9.
- Goodyer, G.L., Wilson, A.G.L., Attia, F.I., and Clift, A.D. (1975). Insecticide resistance in *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in the Namoi Valley of New South Wales, Australia. *Journal of the Australian Entomological Society* **14**: 171-3.
- Govindarajan, R., and Federici, B.A. (1990). Ascovirus infectivity and effects on the growth and development of Noctuid larvae. *Journal of Invertebrate Pathology* **56**: 291-9.
- Graham, H.M., Hernandez, N.S., and Llanes, J.R. (1972). The role of host plants in the dynamics of populations of *Heliothis* spp. *Environmental Entomology* **1**: 424-31.
- Graves, J.B., Roussel, J.S., and Phillips, J.R. (1963). Resistance to some chlorinated hydrocarbon insecticides in the bollworm, *Heliothis zea*. *Journal of Economic Entomology* **56**: 442-4.
- Gregg, P.C. (1993). Future scenarios for IPM in rain-grown cotton. In *Workshop Report: Second workshop on Integrated Pest Management in rain-grown cotton in north-east Australia*. Murray, D., Marshall, J., Pyke, B., and Brough, E. (eds.). Cooperative Research Centre for Tropical Pest Management, Brisbane. pp. 25-42.
- Gregg, P.C., and Wilson, A.G.L. (1991). Trapping methods for adults. In *Heliothis: Research methods and prospects*. Zalucki, M.P. (ed.). Springer-Verlag, New York. pp. 30-49.

- Gregg, P.C., Fitt, G.P., Zalucki, M.P., and Murray, D.A.H. (1995). Insect migration in an arid continent. II. *Helicoverpa* spp. in eastern Australia. In *Insect migration: tracking resources through time and space*. Drake, V.A., and Gatehouse, A.G. (eds.). Cambridge University Press. pp. 151-72.
- Gregg, P.C., Fitt, G.P., Zalucki, M.P., Murray, D.A.H., and McDonald, G. (1993). Spring migrations of *Helicoverpa* spp. from inland Australia 1989-1991: implications for forecasting. In *Pest control and sustainable agriculture*. Corey, S., Dall, D., and Milne, W. (eds.). CSIRO, Melbourne. pp. 460-3.
- Gullan, P.J., and Cranston, P.S. (1994). *The insects. An outline of entomology*. Chapman and Hall, Melbourne. Australia. pp. 491.
- Gunaseena, G.H., Vinson, S.B., and Williams, H.J. (1990). Effects of nicotine on growth, development and survival of the tobacco budworm (Lepidoptera: Noctuidae) and the parasitoid *Campoletis sonorensis* (Hymenoptera: Ichneumonidae). *Journal of Economic Entomology* **83**: 1777-82.
- Gunning, R.V. (1993). Comparison of two bioassay techniques for larvae of *Helicoverpa* spp. (Lepidoptera: Noctuidae). *Journal of Economic Entomology* **86**: 234-8.
- Gunning, R.V., and Easton, C.S. (1994a). Endosulfan resistance in *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in Australia. *Journal of the Australian Entomological Society* **33**: 9-12.
- Gunning, R.V., and Easton, C.S. (1994b). Response of *Helicoverpa punctigera* (Wallengren) (Lepidoptera: Noctuidae) to pyrethroids, DDT and endosulfan. *Journal of the Australia Entomological Society* **33**: 61-4.
- Gunning, R.V., Balfe, M.E., and Easton, C.S. (1992). Carbamate resistance in *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) in Australia. *Journal of the Australian Entomological Society* **31**: 97-103.
- Gunning, R.V., Easton, L.R., Greenup, L.R., and Edge, V.E. (1984). Pyrethroid resistance in *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in Australia. *Journal of Economic Entomology* **77**: 1283-7.
- Gunning, R.V., Moores, G.D., and Devonshire, A.L. (1997). Esterases and fenvalerate resistance in a field population of *Helicoverpa punctigera* (Lepidoptera: Noctuidae) in Australia. *Pesticide Biochemistry and Physiology* **58**: 155-62.
- Gunning, R.V., Moores, G.D., and Devonshire, A.L. (1998). Insensitive acetylcholinesterase and resistance to organophosphates in Australian *Helicoverpa armigera*. *Pesticide Biochemistry and Physiology* **62**: 147-51.
- Hafez, M. (1951). Notes on the introduction and biology of *Microplitis demolitor* Wilk. *Bulletin. Societe Fouad I d'Entomologie* **35**: 107-20.
- Hamel, D.R. (1977). The effects of *Bacillus thuringiensis* on parasitoids of the western spruce budworm, *Choristoneura occidentalis* (Lepidoptera: Tortricidae), and the spruce coneworm, *Dioryctria reniculelloides* (Lepidoptera: Pyralidae), in Montana. *Canadian Entomologist* **109**: 1409-15.
- Hamm, J.J., Nordlung, D.A., and Marti, Jr., O.G. (1985). Effects of a nonoccluded virus of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) on the development of a parasitoid, *Cotesia marginiventris* (Hymenoptera: Braconidae). *Environmental Entomology* **14**: 258-61.

- Hamm, J.J., Pair, S.D., and Marti, Jr., O.G. (1986). Incidence and host range of a new ascovirus isolated from Fall Armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). *Florida Entomologist* **69**: 524-31.
- Hardwick, D.F. (1965). The corn earworm complex. *Memoirs of the Entomological Society of Canada* **40**: 3-247.
- Hargreaves, H. (1948). *List of recorded cotton insects of the world*. Commonwealth Institute of Entomology, London. pp. 50.
- Harris, E.J., and Okamoto, R.Y. (1983). Description and evaluation of a simple method for the collection of the parasite *Biosteres oophilus*. *Entomophaga* **28**: 241-3.
- Hearn, A.B., and Fitt, G.P. (1992). Cotton cropping systems. In *Ecosystems of the world- field-crops ecosystems*. Pearson, C.J. (ed.). Elsevier, Amsterdam. pp. 85-142.
- Heimpel, A.M., and Angus, T.A. (1959). The site of action of crystalliferous bacteria in Lepidoptera larvae. *Journal of Insect Pathology* **1**: 152-70.
- Hendrix, W.H., Huckaba, R., Nead, B., Peterson, L., Porteous, D., and Thompson, G. (1997). Tracer insect control- 1996 EUP results. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1086-7.
- Herard, F., Keller, M.A., Lewis, W.J., and Tumlinson, J.H. (1988a). Beneficial arthropod behavior mediated by airborne semiochemicals. III. Influence of age and experience on flight chamber responses of *Microplitis demolitor* Wilkinson. *Journal of Chemical Ecology* **14**: 1583-96.
- Herard, F., Keller, M.A., Lewis, W.J., and Tumlinson, J.H. (1988b). Beneficial arthropod behavior mediated by airborne semiochemicals. IV. Influence of host diet on host-oriented flight chamber responses of *Microplitis demolitor* Wilkinson. *Journal of Chemical Ecology* **14**: 1597-606.
- Hopkins, A.R., Taft, H.M., and James, W. (1972). Comparison of mechanical cultivation and herbicides on emergence of bollworm and tobacco budworms. *Journal of Economic Entomology* **65**: 870-2.
- Hopper, K.R. (1986). Preference, acceptance, and fitness components of *Microplitis croceipes* (Hymenoptera: Braconidae) attacking various instars of *Heliothis virescens* (Lepidoptera: Noctuidae). *Environmental Entomology* **15**: 274-80.
- Hopper, K.R., and King, E.G. (1984a). Feeding and movement on cotton of *Heliothis* species (Lepidoptera: Noctuidae) parasitised by *Microplitis croceipes* (Hymenoptera: Braconidae). *Environmental Entomology* **13**: 1654-60.
- Hopper, K.R., and King, E.G. (1984b). Preference of *Microplitis croceipes* (Hymenoptera: Braconidae) for instars and species of *Heliothis* (Lepidoptera: Noctuidae). *Environmental Entomology* **13**: 1145-50.
- Hopper, K.R., Powell, J.E., and King, E.G. (1991). Spatial density dependence in parasitism of *Heliothis virescens* (Lepidoptera: Noctuidae) by *Microplitis croceipes* (Hymenoptera: Braconidae) in the field. *Environmental Entomology* **20**: 292-302.
- Horton, D.L., Teague, T.G., Phillips, J.R., and Yearian, W.C. (1986). Fungicide interference with parasitization of *Heliothis zea* by *Microplitis croceipes*. *Journal of Agricultural Entomology* **77**: 847-50.
- Huffaker, C.B., and Kennett, C.E. (1953). Differential tolerance to parathion of two *Typhlodromus* predatory on cyclamen mites. *Journal of Economic Entomology* **46**: 707-802.

- Hughes, P.R., van Beek, N.A.M., and Wood, H.A. (1986). A modified droplet feeding method for rapid assay of *Bacillus thuringiensis* and baculoviruses in noctuid larvae. *Journal of Invertebrate Pathology* **48**: 187-92.
- Hunter, K.W., Jr., and Stoner, A. (1975). *Copidosoma truncatellum*: effect of parasitisation on food consumption of larval *Trichoplusia ni*. *Environmental Entomology* **4**: 381-2.
- Ives, P.M. (1981). Review of studies on the relative effectiveness of various predators of *Heliothis*. In *Workshop on biological control of Heliothis spp. 23-25 Sept 1980. Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. pp. 70-7.
- Ives, P.M., Wilson, L.T., Cull, P.O., Palmer, W.A., Haywood, C., Thomson, N.J., Hearn, A.B., and Wilson, A.G.L. (1984). Field use of SIRATAC: an Australian computer based pest management system for cotton. *Protection Ecology* **6**: 1-21.
- Jackson, R.D., King, E.G., and Knipling, E.F. (1989). *Heliothis*: need for international research on biological control. In *Proceedings of the workshop on biological control of Heliothis: increasing the effectiveness of natural enemies. 15 Nov. New Delhi, India*. King, E.G., and Jackson, R.D. (eds.). 11-. Far Eastern Regional Research Office, U.S. Department of Agriculture, New Delhi, India. pp. 15-21.
- Johnson, S.J., Pitre, H.M., Powell, J.E., and Sterling, W.L. (1986). Control of *Heliothis* spp. through conservation and importation of natural enemies. In *Theory and tactics of Heliothis population management: 1. Cultural and biological control*. S.J., Johnson, E.G., King, and J.R., Bradley (eds.). *Southern Cooperative Series Bulletin* **316**: 132-54.
- Jones, R.L., and Lewis, W.J. (1971). Physiology of the host-parasite relationship between *Heliothis zea* and *Microplitis croceipes*. *Journal of Insect Physiology* **17**: 921-7.
- Kass, J.P., Elzen, G.W., and Ramaswamy, S.B.R. (1990). Learning in *M. croceipes* Cresson (Hym., Braconidae). *Journal of Applied Entomology* **109**: 268-73.
- Kay, I.R. (1977). Insecticide resistance in *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in areas of Queensland, Australia. *Journal of the Australian Entomological Society* **16**: 43-5.
- Kay, I.R. (1981). Overwintering of several parasites of *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in southeast Queensland. In *Workshop on biological control of Heliothis spp. 23-25 Sept 1980. Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. pp. 63-6.
- Kay, I.R., Greenup, L. R., and Easton, C. (1983). Monitoring *Heliothis armigera* (Hübner) strains from Queensland for insecticide resistance. *Queensland Journal of Agricultural and Animal Science* **40**: 23-6.
- Keller, M.A., and Change, Y.D. (1995). Assessment of populations of parasitic wasps using capture-recapture methods and live traps. *Biological Control: Theory and Application in Pest Management. Unpublished Manuscript*.
- King, E.G., and Bell, J.V. (1978). Interactions between a braconid, *Microplitis croceipes*, and a fungus *Nomuraea rileyli*, in laboratory-reared bollworm larvae. *Journal of Invertebrate Pathology* **31**: 337-40.

- King, E.G., and Coleman, R.J. (1989). Potential for biological control of *Heliothis* species. *Annual Review of Entomology* **34**: 53-75.
- King, E.G., Coleman, R.J., Phillips, J.R., and Dickerson, W.A. (1985a). Introduction: biological control of *Heliothis* spp. in cotton by augmentative releases of *Trichogramma*. *Southwest Entomologist. Supplement* **8**: 1-10.
- King, E.G., Coleman, R.J., Phillips, J.R., and Dickerson, W.A. (1985b). *Heliothis* spp. and selected natural enemy populations in cotton: a comparison of three insect control programs in Arkansas (1981-82) and North Carolina (1983). *Southwest Entomologist. Supplement* **8**: 71-98.
- King, E.G., Hopper, K.R., and Powell, J.E. (1985c). Analysis of systems for biological control of crop arthropod pests in the US by augmentation of predators and parasites. In *Biological Control in Agricultural IPM Systems*. M.A., Hoy, and D.C., Herzog. (eds.). Academic Press, New York. pp. 201-25.
- King, E.G., Powell, J.E., and Coleman, R.J. (1985d). A high incidence of parasitism of *Heliothis* spp. (Lepidoptera: Noctuidae) larvae in cotton in Southeastern Arkansas, USA. *Entomophaga* **30**: 419-26.
- King, E.G., Powell, J.E., and Smith, J.W. (1982). Prospects for utilization of parasites and predators for management of *Heliothis* spp. In *Proceedings of the International Workshop on Heliothis Management. 15-20 November, 1981, Patancheru. A.P., India*. International Crops Research Institutue for the Semi Arid Tropics, Patancheru, India. pp. 103-22.
- King, E.W. (1981). Rates of feeding of four lepidopterous defoliators of soybeans. *Journal of the Georgia Entomological Society* **16**: 283-8.
- Kinzer, H.G., and Henderson, C.F. (1968). Damage by larvae of the corn earworm to grain sorghum. *Journal of Economic Entomology* **61**: 263-7.
- Kirkpatrick, T.H. (1961). Queensland distributions and host records for *Heliothis* species (Lepidoptera: Noctuidae). *Queensland Journal of Agricultural Science* **18**: 195-202.
- Kirkpatrick, T.H. (1962). Notes on the life-histories of species of *Heliothis* (Lepidoptera: Noctuidae) from Queensland. *Queensland Journal of Agricultural Science* **19**: 567-70.
- Knight, J. (1999). Ten, nine, eight... you're under. *New Scientist* **2178**: 34-7.
- Knutson, L. (1985). Systematics of *Heliothis* species and their natural enemies as a basis for biological control research. In *Proceedings of the workshop on biological control of Heliothis: increasing the effectiveness of natural enemies. 11-15 Nov. New Delhi, India*. (1985). King, E.G., and Jackson, R.D. (eds.). Far Eastern Regional Research Office, U.S. Department of Agriculture, New Delhi, India. pp. 119-59.
- Knutson, L., and Nagararkatti, S. (1985). Distribution of *Heliothis* and their natural enemies and host plants: Introduction. In *Proceedings of the workshop on biological control of Heliothis: increasing the effectiveness of natural enemies. 11-15 Nov. New Delhi, India* (1985). King, E.G., and Jackson, R.D. (eds.). Far Eastern Regional Research Office, U.S. Department of Agriculture, New Delhi, India. pp. 115-8.

- Laigo, D., and Tamashiro, P. (1967). Interactions between a microsporidian pathogen of the lawn-armyworm and the hymenopteran parasite *Apanteles marginiventris*. *Journal of Invertebrate Pathology* **9**: 546-54.
- Lewis W.J., Snow, J.W., and Jones, R.L. (1971). A pheromone trap for studying populations of *Cardiochiles nigriceps*, a parasite of *Heliothis virescens*. *Journal of Economic Entomology* **64**: 1417-21.
- Lewis, W.J. (1970a). Life history and anatomy of *Microplitis croceipes* (Hymenoptera: Braconidae) a parasite of *Heliothis* spp. (Lepidoptera: Noctuidae). *Annals of the Entomological Society of America* **63**: 67-70.
- Lewis, W.J. (1970b). see Appendix 1.
- Lewis, W.J. (1970c). Study of species and instars of larval *Heliothis* parasitized by *Microplitis croceipes*. *Journal of Economic Entomology* **63**: 363-5.
- Lewis, W.J., and Brazzel, J.R. (1968). A three year study of parasites of the bollworm and the tobacco budworm in Mississippi. *Journal of Economic Entomology* **61**: 673-6.
- Lewis, W.J., and Gross, H.R. (1989). Comparative studies on field performance of *Heliothis* larval parasitoids *Microplitis croceipes* and *Cardiochiles nigriceps* at varying densities and under selected host plant conditions. *Florida Entomologist* **72**: 6-14.
- Lewis, W.J., and Tumlinson, J.H. (1988). Host detection by chemically mediated associated learning in a parasitic wasp. *Nature* **331**: 257-9.
- Lewis, W.J., Jones, R.L., and Sparks, A.N. (1972). A host-seeking stimulant for the egg parasite *Trichogramma evanescens*: its source and a demonstration of its laboratory and field activity. *Annals of the Entomological Society of America* **65**: 1087-9.
- Li, L. (1984). Research and utilization of *Trichogramma* in China. In *Proceedings of the Chinese Academy of Science.-US National. Academy of Science Joint Symposium on Biological Control of Insects*. P.L. Adkisson, (ed.). S. Ma, Science, Beijing. pp. 204-23.
- Lincoln, R.J., Boxshall, G.A., and Clark, P.F. (1982). *A dictionary of ecology and evolution systematics*. Cambridge University Press.
- Lingren, P. D., Ridgway, R.L., and Jones, S.L. (1968a). Consumption by several common arthropod predators of eggs and larvae of two *Heliothis* species that attack cotton. *Annals of the Entomological Society of America* **61**: 613-8.
- Lingren, P. D., Ridgway, R.L., Cowan, C.B., Davis, J.W., and Watkins, W.C. (1968b). Biological control of the bollworm and tobacco budworm by arthropod predators. *Journal of Economic Entomology* **61**: 1521-5.
- Lingren, P.D. (1977). *Campoletis sonorensis*: maintenance of a population on tobacco budworm in a field cage. *Environmental Entomology* **6**: 72-6.
- Lingren, P.D., Wolfenbarger, J.B., Nosky, J.B., and Diaz, M., (1972). Response of *Campoletis perdistinctus* and *Apanteles marginiventris* to insecticides. *Journal of Economic Entomology* **65**: 1295-9.
- Lisansky, S.G. (1984). Biological alternatives to chemical pesticides. *World Biotechnology Report* **1**: 455-66. Online Publications, Pinner, UK.
- Long, T. Boyce, M., Pyke, B., and Slack-Smith, P. (1997). Ingard performance in the 1996-97 cotton season. *The Australian Cottongrower* **18**: 62-8.

- Luck, R.F., Shepard, B.M., and Kenmore, P.E. (1988). Experimental methods for evaluating arthropod natural enemies. *Annual Review of Entomology* **33**: 367-91.
- Lutwanna, J.J., and Mukwaya, L.G. (1994). Mark-release-recapture studies on three anthropophilic populations of *Aedes (Stegomyia) simpsoni* complex (Diptera: Culicidae) in Uganda. *Bulletin of Entomological Research* **84**: 521-7.
- Lytton-Hitchins, J.A., Longstaff, B.C., and McBratney, A.B. (1996). Soil arthropod predators at "Doreen" for 1995-96 season. In *Proceedings of the 8th Australian Cotton Conference*. Australian Cotton Growers Research Association, Broadbeach, Queensland. pp. 279-86.
- Manson, W.R.M. (1981). The polyphyletic nature of *Apanteles* Foerster (Hymenoptera: Braconidae): a phylogeny and reclassification of *Microgastrinae*. *Memoirs of the Entomological Society of Canada* **115**: 1-147.
- Marshall, J., Murray, D., Lloyd, R., Thomson, S., Salmond, G., Tann, C., and Fitt, G. (1996). Heliothis pupal control: the double cropping dilemma. *The Australian Cotton Grower* **17**: 18-9.
- Mascarenhas, R.N., Boethel, D.J., and Leonard, B.R. (1997). Development of discriminating concentrations for insecticide resistance monitoring in the soybean looper. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1021-4.
- Matthews, M. (1991). *Classification of the Heliiothinae*. NRI Bulletin No. 44, Natural Resources Institute, Chatham, UK. pp. 198.
- Matthews, M. (1999). *Heliiothine moths of Australia. A guide to the pest bollworms and related noctuid groups*. CSIRO, Melbourne. pp. 320.
- McGahan, P., Lloyd, R.J., and Rynne, K.P. (1991). The cost of Heliothis in Queensland crops. In *A review of Heliothis Research in Australia. Conference and Workshop series, No. QC91006*. Twine, P.H., and Zalucki, M.P. (eds.). Queensland Department of Primary Industries, Brisbane. pp. 11-28.
- McNeil, J. (1975). Juvenile hormone analogs: detrimental effects on the development of an endoparasite. *Science* **189**: 640-2.
- McPherson, J.E., Newsome, L.D., and Roussel, J.S. (1956). Response of *Heliothis zea* (Boddie) and *H. virescens* (F.) to DDT and endrin in laboratory toxicity studies. *Journal of Economic Entomology* **49**: 368-71.
- Mensah, R., and Harris, W. (1994). Can beneficial insects be conserved in cotton? In *Proceedings of the 7th Australian Cotton Conference*, Broadbeach. Australian Cotton Growers Research Association, Brisbane pp. 87-90.
- Mensah, R., and Harris, W. (1996). Envirofeast[®] IPM in cotton: Part 2. Integration with lucerne crop to generate beneficial insects. In *Proceedings of the 8th Australian Cotton Conference, Broadbeach*. Australian Cotton Growers Research Association, Brisbane. pp. 229-37.
- Mensah, R., Harris, W., and Teakle, R. (1996). Envirofeast[®] IPM in cotton: Part 3. Integration with nuclear polyhedrosis virus. In *Proceedings of the 8th Australian Cotton Conference, Broadbeach*. Australian Cotton Growers Research Association, Brisbane. pp. 237-46.
- Messing, R.H., and Wong, T.T.Y. (1992). An effective trapping method for field studies of opiine braconid parasitoids of tephritid fruit flies. *Entomophaga* **37**: 391-6.

- Metcalf, R.L. (1982). Insecticides in pest management. In *Introduction to Insect Pest Management*. Metcalf, R.L., and Luckmann, W.H. (eds.). Wiley-interscience Publications. John Wiley and Sons, New York. pp. 217-77.
- Micheal, P.J., and Woods, W.M. (1980). An Entomological review of cotton growing in the Ord River Area of Western Australia. *Western Australian Department of Agriculture Technical Bulletin* **48**.
- Micheal, P.J., Woods, W., Lawrence, P.J., and Fisher. (1984). Introduced parasites for the control of Australian Noctuid pests. In *Proceedings of the fourth Australian Applied Entomological Research Conference, September 1984, Adelaide, Australia*. Government Printer, Adelaide. pp. 294-303.
- Miller, L.W. (1945). The insect pests of tomatoes. *Tasmanian Journal of Agriculture* **16**: 144-8.
- Morton, R., Tuart, L.D., and Wardhaugh, K.G. (1981). The analysis and standardisation of light-trap catches of *Heliothis armigera* (Hübner) and *H. punctigera* Wallengren (Lepidoptera: Noctuidae). *Bulletin of Entomological Research* **71**: 207-25.
- Murray, D. (1994). Beneficials parasitising *Heliothis*: augmentation and efficacy. In *Proceedings of the 7th Australian Cotton Conference. Broadbeach, Queensland*. Australian Cotton Growers Research Association, Brisbane. pp. 51-5.
- Murray, D. (1995a). *Heliothis* in the south Burnett- a case study. In *Heliothis management in Australia. Workshop report. 8-9 November 1995, Toowoomba, Queensland*, White, G.G., Murray, D.A.H., and Walton, M.P. (eds.). CRC for Sustainable Cotton Production and Cooperative Research Centre for Tropical Pest Management, Brisbane. pp. 76-8.
- Murray, D. (1995b). *Report on the use of NPV in cotton. Internal Report*. Queensland Department of Primary Industries, Toowoomba. pp. 23.
- Murray, D. (1996). *The effect of spinosad (NAF-85) on arthropod pest and beneficial populations on cotton. Internal report*. Queensland Department of Primary Industries, Toowoomba.
- Murray, D., and Mensah, R. (1996). Using predators and parasites to control cotton pests. In *Proceedings of the 8th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 147-51.
- Murray, D., and Rynne, K. (1992). Larval parasites- a biological option. In *Proceedings of the 6th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 247-51.
- Murray, D., Ingram, B., Lloyd, R., Marshall, J., Thomson, S., Scholz, B., and Rynne, K. (1996). Four years of IPM in raingrown cotton. In *Proceedings of the 8th Australian Cotton Conference*. Australian Cotton Growers Research Association, Broadbeach, Queensland. pp. 153-8.
- Murray, D., Scholz, B., Lloyd, R., and Rynne, K. (1994). Parasitoid releases on the Darling Downs. In *Proceedings of the 7th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 65-8.
- Murray, D.A.H., and Lloyd, R.J. (1997). The effect of spinosad (Tracer[®]) on arthropod pest and beneficial populations in Australian cotton. In *Proceedings Beltwide Cotton Insect Research and Control Conferences National Cotton Council of America, Memphis*. pp. 1087-91.

- Murray, D.A.H., and Rynne, K.P. (1992). Biocontrol of *Heliothis* using larval parasitoids. *Proceedings: Australian Sunflower Association 9th Conference/workshop. Yeppon. Qld. 98-10*. Queensland Department of Primary Industries, Brisbane.
- Nadgauda, D., and Pitre, H. (1983). Development, fecundity, and longevity of the tobacco budworm (Lepidoptera: Noctuidae) soybean, cotton, and artificial diet at three temperatures. *Environmental Entomology* **12**: 582-6.
- Newson, L.D., and Smith, C.E. (1949). Destruction of certain insect predators by applications of insecticides to control cotton pests. *Journal of Economic Entomology* **42**: 904-8.
- Niles, G.A. (1980). Breeding cotton for resistance to insect pests. In *Breeding Plants Resistant to Insects*. Maxwell, F.G., and Jennings, P. (eds.). John Wiley and Sons, New York. pp. 657.
- Nishida, T., and Napompeth, B. (1974). Trap for tephritid fruit fly parasites. *Entomophaga* **19**: 349-52.
- Niwa, C.G., Stelzer, M.J., and Beckwith, R.C. (1987). Effects of *Bacillus thuringiensis* on parasites of western spruce budworm (Lepidoptera: Tortricidae). *Journal of Economic Entomology* **80**: 750-3.
- Norlund, D.A., and Lewis, W.J. (1985). Response of females of the braconid parasitoid *Microplitis demolitor* to frass of larvae of the noctuids, *Heliothis zea* and *Trichoplusia ni* and to 13-methylhentriacontane. *Entomologia Experimentalis et Applicata* **38**: 109-12.
- Oakeshott, J.G., and Gregg, P. (1995). The future role of biotechnology and other novel approaches in cotton pest management. Appendix B. In *IPM in cotton strategic planning forum*. Edge, V., and Pyke, B. (eds.). Cotton Research and Development Corporation, Narrabri. pp. 28-37.
- Otis, D.L., Burnham, K.P., White, G.C., and Anderson, D.R. (1978). Statistical inference from capture data on closed animal populations. *Wildlife Monographs* **62**: 135.
- Pair, S.D., Laster, M.L., and Martin, D.F. (1982). Parasitoids of *Heliothis* spp. (Lepidoptera: Noctuidae) larvae in Mississippi associated with sesame interplantings in cotton, 1971-1974: implications of host-habitat interaction. *Environmental Entomology* **11**: 509-12.
- Parkman, P., and Shepard, M. (1981). Foliage consumption by yellowstriped armyworm larvae after parasitisation by *Euplectrus plathypenae*. *Florida Entomologist* **64**: 192-4.
- Parsons, F.S. (1940). Investigations of the cotton bollworm, *Heliothis armigera*, Hübner. Part III. Relationships between oviposition and the flowering curves of food-plants. *Bulletin of Entomological Research* **31**: 147-77.
- Parvin, D.W., Smith, J.W., and Cooke, F.T. (1988). Measurements of the impact of natural enemies on *Heliothis* populations. *In press. Cited in King and Coleman, 1989*.
- Pedigo, L.P. (1989). *Entomology and Pest Management*. Iowa State University Press, Macmillan Publishing Company, New York. pp. 646.
- Peterson, L.G., Porteous, D.J., Huckaba, R.M., Nead, B.A., Gantz, R.L., Richardson, J.M., and Thompson, G.D. (1996). Beneficial insects their role in cotton pest management systems founded on Naturalyte insect control. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 872-4.

- Pietrantonio, P.V., and Benedict, J. (1997). Effects of new chemistry insecticides towards beneficial insects of cotton. In *Proceedings of the Beltwide Cotton Insect Research and Cotton Conference*. National Cotton Council of America, Memphis. pp. 1339-40.
- Pimentel, D. (1976). World food crisis: energy and pests. *Bulletin of the Entomological Society of America* **22**: 20-6.
- Pivnick, K.A. (1993). Response of *Meteorus leviventris*, (Hymenoptera: Braconidae) to mustard oils in field trapping experiments. *Journal Chemical Ecology* **19**: 2075-9.
- Plapp, F.W. and Bull, D.L. (1978). Toxicity and selectivity of some insecticides to *Chrysopa carnea*, a predator of the tobacco budworm. *Environmental Entomology* **7**: 431-4.
- Plapp, F.W. and Bull, D.L. (1985). Modifying chemical control practices to preserve natural enemies. In *Workshop on biological control of Heliothis: increasing the effectiveness of natural enemies. 11-15 Nov. 1985, New Delhi, India*. Far Eastern Regional Research Office, U.S. Department of Agriculture, New Delhi, India. pp. 537-46.
- Plapp, F.W., and Vinson., S.B. (1977). Comparative toxicities of some insecticides to the tobacco budworm and its ichneumonid parasite, *Camponotus sonorensis*. *Environmental Entomology* **6**: 381-4.
- Potter, C.H., Tattersfield, F., and Gillhan, E.M. (1947). A laboratory comparison of the toxicity as a contact poison of DDT with nicotine, derris products and the pyrethrins. *Bulletin of Entomological Research* **37**: 469-96.
- Powell, J.E. (1989). Food consumption by tobacco budworm [Lepidoptera: Noctuidae] larvae reduced after parasitisation by *Microplitis demolitor* or *M. croceipes* [Hymenoptera: Braconidae]. *Journal of Economic Entomology* **82**: 408-11.
- Powell, J.E., and King, E.G. (1984). Behavior of adult *Microplitis croceipes* (Hymenoptera: Braconidae) and parasitism of *Heliothis* spp. (Lepidoptera: Noctuidae) host larvae in cotton. *Environmental Entomology* **13**: 272-7.
- Powell, J.E., and Scott, W.P. (1985). Effect of insecticide residues on survival of *Microplitis croceipes* adults (Hymenoptera: Braconidae) in cotton. *Florida Entomologist* **68**: 692-3.
- Powell, J.E., and Scott, W.P. (1991). Survival of *Microplitis croceipes* (Hymenoptera: Braconidae) in contact with residues of insecticides on cotton. *Environmental Entomology* **20**: 346-8.
- Powell, J.E., Edgar, G., King, J.R., and Jany, C.S. (1986). Toxicity of insecticides to adult *Microplitis croceipes* (Hymenoptera: Braconidae). *Journal of Economic Entomology* **79**: 1343-6.
- Pyke, B. (1997). Second Ingard® consultants' survey highlights variation. *The Australian Cottongrower* **18**: 10-1.
- Rahman, M. (1970). Effect of parasitism on food consumption of *Pieris rapae* larvae. *Journal of Economic Entomology* **68**: 820-1.
- Ramaswamy, S.B., Roush, R.T., and Kitten, W.F. (1985) Release and recapture-probabilities of laboratory-adapted and wild-type *Heliothis virescens* (F.) (Lepidoptera: Noctuidae) in pheromone-baited traps. *Journal of Entomological Science* **20**: 460-4.
- Rechov, Y. (1974). Effects of common insecticides applied to cotton on adults of a Braconid parasitoid, *Chelonus inaitus* (L.). *Environmental Entomology* **3**: 737-8.

- Reynolds, H.T., Adkisson, P.L., Smith, R.F., and Frisbie, R.E. (1982). Cotton insect pest management. In *Introduction to Insect Pest Management*. Metcalf, R.L., and Luckmann, W.H. (eds.). Wiley-Interscience Publications. John Wiley and Sons, New York pp. 375-441.
- Ridgway, R.L., and Jones, S.L. (1968). Field-cage releases of *Chrysopa carnea* for suppression of populations of *Heliothis* spp. on cotton. *Journal of Economic Entomology* **61**: 892-8.
- Ridgway, R.L., and Jones, S.L. (1969). Inundative release of *Chrysopa carnea* for suppression of *Heliothis* on cotton. *Journal of Economic Entomology* **62**: 177-80.
- Ridgway, R.L., and Lingren, P.D. (1972). Predaceous and parasitic arthropods as regulators of *Heliothis* populations. *Southern Cooperative Series Bulletin* **169**: 48-56.
- Ridgway, R.L., and Morrison, R.K. (1985). Worldwide perspective on practical utilization of *Trichogramma* with special reference to control of *Heliothis* on cotton. *Southwestern Entomologist. Supplement* **8**: 190-8.
- Ridgway, R.L., King, E.G., and Carillo, J.L. (1977). Augmentation of natural enemies for control of plant pests in the Western Hemisphere. In *Biological Control by Augmentation of Natural Enemies*. Ridgway, R.L., and Vinson, S.B. (eds.). Plenum Press, New York pp. 379-416.
- Ridgway, R.L., Lingren, P.D., Cowan, C.B., Jr., and Davis, J.W. (1967). Populations of arthropod predators and *Heliothis* spp. after applications of systemic insecticides to cotton. *Journal of Economic Entomology* **60**: 1012-6.
- Ripper, W.E. (1956). Effect of pesticides on balance of arthropod populations. *Annual Review of Entomology* **1**: 403-38.
- Robertson, G.C. (1942). Toxicity of pyrethrins to *Ornithodoros*. *Parasitology* **34**: 113.
- Roome, P.M. (1979a). A prototype 'on-line' system for management of cotton pests in the Namoi Valley, New South Wales. *Protection Ecology* **1**: 245-64.
- Roome, P.M. (1979b). Parasites and predators of *Heliothis* spp. (Lepidoptera: Noctuidae) in cotton in the Namoi Valley, New South Wales. *Journal of the Australian Entomological Society* **18**: 223-8.
- Roome, P.M. (1983). Calculations of temperature-driven development by *Heliothis* spp. (Lepidoptera: Noctuidae) in the Namoi Valley, New South Wales. *Journal of the Australian Entomological Society* **22**: 211-5.
- Roome, R.E. (1975a). Field trials with nuclear polyhedrosis virus and *Bacillus thuringiensis* against larvae of *Heliothis armigera* (Hb.) (Lepidoptera: Noctuidae) on sorghum and cotton in Botswana. *Bulletin of Entomological Research* **65**: 507-14.
- Roome, R.E. (1975b). Activity of adult *Heliothis armigera* Hübner (Lepidoptera, Noctuidae) with reference to the flowering of sorghum and maize in Botswana. *Bulletin of Entomological Research* **65**: 523-30.
- Ruberson, J.R., Herzog, G.A., and Lewis, W.J. (1993). Parasitism of the Beet Armyworm, *Spodoptera exigua* in south Georgia cotton. In *Proceedings of Beltwide Cotton and Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 993-7.
- Salt, G. (1937). The sense used by *Trichogramma* to distinguish between parasitized and unparasitized hosts. *Proceedings Royal Society of London. Series B* **122**: 57-75.

- Sawicki, R.M., and Denholm, I. (1987). Management of resistance to pesticides in cotton pests. *Tropical Pest Management* **33**: 262-72.
- Scriber, J.M., and Slansky, F. (1981). The nutritional ecology of immature insects. *Annual Review of Entomology* **26**: 183-211.
- Self, L.S., Guthrie, F.E., and Hodgson, E. (1964). Metabolism of nicotine by tobacco-feeding insects. *Nature* **204**: 300-1.
- Seymour, J.E. (1991). *Aspects of the ecology of Microgaster demolitor, a larval parasitoid of Helicoverpa punctigera and Helicoverpa armigera in Australia*. Ph.D. thesis, Department of Zoology, James Cook University. Queensland.
- Shaw, A.J. (1999). *Cotton pest management guide, 1999-2000*. NSW Agriculture, Orange, NSW. pp. 64.
- Shaw, G., and Browne, D. (1995). Integrated pest management and the Australian cotton industry. In *IPM in cotton strategic planning forum*. Edge, V., and Pyke, B. (eds.). Cotton Research and Development Corporation, Narrabri. pp. 61-4.
- Sheehan, W., Wäckers, F.L., and Lewis, W.J. (1993). Discrimination of previously searched, host-free sites by *Microplitis croceipes*. *Journal of Insect Behaviour* **6**: 323-31.
- Shepard, M., and Sterling, W. (1972). Incidence of parasitism of *Heliothis* spp. (Lepidoptera: Noctuidae) in some cotton fields of Texas. *Annals of the Entomological Society of America* **65**: 759-60.
- Shepard, M., Lawn, R.J., and Schneider, M. (1983a). *Insects on grain legumes in north Australia: a survey of potential pests and their enemies*. University of Queensland Press, Brisbane. Australia. pp. 90.
- Shepard, M., Powell, J.E., and Jones, W.A., Jr. (1983b). Biology of *Microplitis demolitor* (Hymenoptera: Braconidae), an imported parasitoid of *Heliothis* (Lepidoptera: Noctuidae) spp. and the Soybean Looper, *Pseudoplusia includens* (Lepidoptera: Noctuidae). *Environmental Entomology* **12**: 641-5.
- Slack-Smith, P., Larsen, D., and Rea, M. (1997). *Australian Dryland Cotton. Production Guide*. Cotton Research and Development Corporation, Narrabri, NSW. pp. 102.
- Smilowitz, Z., Martinka, C., and Jowyk, E.A. (1976). The influence of a juvenile hormone mimic (JHM) on the growth and development of the cabbage looper, *Trichoplusia ni* (Lepidoptera: Noctuidae) and the endoparasite, *Hyposoter exiguae* (Hymenoptera: Ichneumonidae). *Environmental Entomology* **5**: 1178-82.
- Smith, J.W., King, E.G., and Bell, J.V. (1976). Parasites and pathogens among *Heliothis* species in the central Mississippi Delta. *Environmental Entomology* **5**: 224-6.
- Southwood, T.R.E. (1966). *Ecological methods with particular reference to the study of insect populations*. Chapman and Hall, London. pp. 391.
- Stanley, J., and Gregg, P. (1994). *Helicoverpa* predators: do we know anything about them? In *Proceedings of the 7th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 45-50.
- Stanley, J.N. (1997) *The seasonal abundance and impact of predatory arthropods on Helicoverpa spp. in Australian cotton fields*. Ph.D. thesis, University of New England, Armidale, NSW.

- Stinner, R.E., Ridgway, R.L., Copedge, J.R., Morrison, R.K., and Dickerson, W.A. (1974). Parasitism of *Heliothis* eggs after field releases of *Trichogramma pretiosum* in cotton. *Environmental Entomology* **3**: 497-500.
- Strand, M.R., Johnson, J.A., and Culin, J.D. (1988). Developmental interactions between the parasitoid *Microplitis demolitor* (Hymenoptera: Braconidae) and its host *Heliothis virescens* (Lepidoptera: Noctuidae). *Annals of the Entomological Society of America* **81**: 822-30.
- Takasu, K., and Lewis, W.J. (1993). Host- and food- foraging of the parasitoid *Microplitis croceipes*: learning and physiological state effects. *Biological Control* **3**: 70-4.
- Teakle, R.E., and Jensen, J.M. (1985). See Appendix 1.
- Teakle, R.E., Caon, G., Grimshaw, J.F., and Byrne, V.S. (1992). Larvicidal activity of strains of *Bacillus thuringiensis* for *Helicoverpa armigera* (Hübner) and *Helicoverpa punctigera* Wallengren (Lepidoptera: Noctuidae) estimated using the droplet-feeding method. *Journal of the Australian Entomological Society* **31**: 209-13.
- Teakle, R.E., Jensen, J.M., and Giles, J.E. (1985a). Susceptibility of *Heliothis armigera* to a commercial nuclear polyhedrosis virus. *Journal of Invertebrate Pathology* **46**: 166-73.
- Teakle, R.E., Jensen, J.M., and Mulder, J.C. (1985b). Susceptibility of *Heliothis armigera* (Lepidoptera: Noctuidae) on sorghum to nuclear polyhedrosis virus. *Journal of Economic Entomology* **78**: 1373-8.
- Teakle, R.E., Page, F.D., Sabine, B.N.E., and Giles, J.E. (1983). Evaluation of *Heliothis* nuclear polyhedrosis virus for control of *Heliothis armigera* on sorghum in Queensland, Australia. *General and Applied Entomology* **15**: 11-8.
- Temerak, S.A. (1980). Detrimental effects of rearing a braconid parasitoid on the pink borer larvae inoculated by different concentrations of the bacterium, *Bacillus thuringiensis* Berliner. *Zeitschrift Fur Angewandte Entomologie* **89**: 315.
- Thompson, C.G., Neisess, L., and Batzer, H.O. (1977). Field tests of *Bacillus thuringiensis* and aerial application strategies on western mountainous terrain. U.S. Department of Agriculture Forest Service. Research Paper. PNW-230.
- Thomson, N.J. (1987). Host plant resistance in cotton. *Australian Journal of Agricultural Science* **53**: 262-70.
- Thorp, K.W., and Barbosa, P. (1986). Effects of consumption of high and low nicotine tabasco by *Manduca sexta* (Lepidoptera: Shingidale) on survival of gregarious endoparasitoid, *Cotesia congregata* (Hymenoptera: Braconidae). *Journal of Chemical Ecology* **12**: 1329-37.
- Thurston, R., and Fox, P.M. (1972). Inhibition by nicotine of emergence of *Apanteles congregatus* from its host, the tobacco hornworm. *Annals of the Entomological Society of America* **65**: 547-50.
- Ticehurst, M.R., Fusco, R.A., and Blumenthal, E.M. (1982). Effects of reduced rates of Dipel 4L, Dylox 1.5 oil, and Dimilin W-25 on *Lymantria dispar* (L.) (Lepidoptera: Lymantriidae), parasitism and defoliation. *Environmental Entomology* **11**: 1058-62.
- Tillman, G.P. (1995). Recent accomplishments in biological control of *Heliothis virescens* and *Helicoverpa zea*. In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1036-8.

- Tillman, G.P., Laster, M.L., and Powell, J.E. (1993). Development of the endoparasitoids *Microplitis croceipes*, *M. demolitor*, and *Cotesia kazak* (Hymenoptera: Braconidae) on *Helicoverpa zea* and *H. armigera* (Lepidoptera: Noctuidae). *Journal of Economic Entomology* **86**: 360-2.
- Titmarsh, I.J. (1981). Parasites of *Heliothis* spp. on tobacco in far north Queensland. In *Workshop on biological control of Heliothis spp. 23-25 Sept 1980. Toowoomba, Queensland, Australia*. Queensland Department of Primary Industries, Brisbane. pp. 59-62.
- Titmarsh, I.J. (1985). *Population dynamics of Heliothis spp. on tobacco in far north Queensland*. M.Sc., thesis, James Cook University of North Queensland, Townsville.
- Titmarsh, I.J. (1992). *Mortality of immature Lepidoptera: a case study with Heliothis species (Lepidoptera: Noctuidae) in agricultural crops on the Darling Downs*, Ph.D., thesis, University of Queensland.
- Titmarsh, I.J., Zalucki, M.P., Room, P.M., Evans, M., Gregg, P.C., and Murray, D. (1991). Estimating the abundance of adults and immatures. In *Heliothis: Research methods and prospects*. Zalucki, M.P. (ed.). Springer-Verlag, New York. pp. 46-69.
- Trowell, S., Garsia, K., Skerritt, J., Holl, A., Forrester, N., and Bird, L. (1994). The LepTon® test kit (Pat. pending)-the *Heliothis* ID project comes to fruition. In *Proceedings of the 7th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 17-20.
- Tugwell, N.P., and Waddle, B.A. (1974). Yield and lint quality of cotton as affected by varying production practices. *Arkansas Agricultural Experimental Station Bulletin* **682**, Arkansas, USA. pp. 44.
- Twine, P.H. (1971). Cannibalistic behavior of *Heliothis armigera* (Hubn.). *Queensland Journal of Agricultural and Animal Sciences* **28**: 153-7.
- Twine, P.H. (1973). Egg parasites of *Heliothis punctigera* and *H. armigera* in southeastern Queensland. *Queensland Journal of Agriculture and Animal Science* **30**: 331-6.
- Twine, P.H. (1978a). Effect of temperature on the development of larvae and pupae of the corn earworm, *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae). *Queensland Journal of Agriculture and Animal Science* **35**: 23-38.
- Twine, P.H. (1978b). Variations in the number of larval instars of *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae). *Journal of the Australian Entomological Society* **17**: 289-92.
- Twine, P.H. (1989). Distribution and economic importance of *Heliothis* (Lepidoptera: Noctuidae) and their natural enemies and host plants in Australia. In *Proceedings of the workshop on biological control of Heliothis: increasing the effectiveness of natural enemies*. King, E.G., and Jackson, R.D. (eds.). 11-15 Nov. 1985, New Delhi, India. Far Eastern regional research office, U.S. Department of Agriculture, New Delhi, India. pp. 177-84.
- Twine, P.H., and Kay, I.R. (1973). *Heliothis* species and DDT resistance. *Queensland Agricultural Journal* **99**: 520-3.
- Twine, P.H., and Lloyd, R.J. (1982). Observations on the effects of regular releases of *Trichogramma* spp. in controlling *Heliothis* spp. and other insects in cotton. *Queensland Journal of Agriculture and Animal Science* **39**: 159-67.

- Van den Bosch, R. Leigh, T.F., Gonzalez, D., and Stienner, R.E. (1969). Cage studies on predators of the bollworm in cotton. *Journal of Economic Entomology* **62**: 1489-99.
- Van Driesche, R.G. (1983) Meaning of "percent parasitism" in studies of insect parasitoids. *Environmental Entomology* **12**: 1611-22.
- Vargas, R.I., Stark, J.D., Prokopy, R.J., and Green, T.I. (1991). Response of Oriental Fruit fly and associated parasitoids to colored balls. *Journal of Economic Entomology* **84**: 1503-7.
- Vinson, S.B. (1974). Effect of an insect growth regulator on two parasitoids developing from treated tobacco budworm larvae. *Journal of Economic Entomology* **67**: 335-7.
- Vinson, S.B. (1976). Host selection by insect parasitoids. *Annual Review of Entomology* **21**: 109-33.
- Vinson, S.B., and Guillot F.S. (1972). Host marking: source of a substance that results in host discrimination in insect parasitoids. *Entomophaga* **17**: 241-5.
- Wäckers, F.L., and Lewis, W.J. (1994). Olfactory and visual learning and their combined influence on host site location by the parasitoid *Microplitis croceipes* (Cresson). *Biological Control* **4**: 105-112.
- Walker, P.W., Fitt, G.P., Franzmann, B.A. Lloyd, R.J., and Mensah, R.K. (1996). Alternative crops for producing natural enemies of cotton pests. In *Proceedings of the 8th Australian Cotton Conference*. Australian Cotton Growers Research Association, Brisbane. pp. 247-55.
- Waller, G.D., Estes, B.J., Buck, N.A., Taylor, K.S., and Crowder, L.A. (1988). Residual life and toxicity to honey bees (Hymenoptera: Apidae) of selected pyrethroid formulations applied to cotton in Arizona. *Journal of Economic Entomology* **81**: 1022-6.
- Wallner, W.E., Dubois, N.R., and Grinberg, P.S. (1983). Alterations of parasitism by *Rogas lymantriae* (Hymenoptera: Braconidae) on *Bacillus thuringiensis*-stressed gypsy moth (Lepidoptera: Lymantriidae) hosts. *Journal of Economic Entomology* **76**: 275-7.
- Wardhaugh, K.G., Room, P.M., and Greenup, L.R. (1980). The incidence of *Heliothis armigera* (Hübner) and *H. punctigera* Wallengren (Lepidoptera: Noctuidae) on cotton and other host-plants in the Namoi Valley of New South Wales. *Bulletin of Entomological Research* **70**: 113-31.
- Weseloh, R.M., and Andreadis, T.G. (1982). Possible mechanism for synergism between *Bacillus thuringiensis* and the gypsy moth (Lepidoptera: Lymantriidae) parasitoid, *Apanteles melanoscelus* (Hymenoptera: Braconidae). *Annals of the Entomological Society of America* **75**: 435.
- Weseloh, R.M., Andreadis, T.G., Moore, E.B., Anderson, J.F., Dubois, N.R., and Lewis, F.B. (1983). Field confirmation of a mechanism causing synergism between *Bacillus thuringiensis* and the gypsy moth parasitoid, *Apanteles melanoscelus*. *Journal of Invertebrate Pathology* **41**: 99-103.
- White, G.C. (1982). CAPTURE, <http://www.cnr.colostate.edu/~gwhite/software.html>
- White, G.C., Anderson, D.R., Burham, K.P., and Otis, D.L. (1982). *Capture-recapture and removal models for sampling closed populations*. Los Alamos Nation Laboratory, New Mexico. pp. 235.
- White, G.C., Murray, D.A.H., and Walton, M.P. (1995). *Workshop report: Heliothis management in Australia*. Cooperative Centre for Tropical Pest Management, Brisbane. pp. 100.

- Whitman, D.W., and Eller, F.J. (1992). Orientation of *Microplitis croceipes* (Hymenoptera: Braconidae) to green leaf volatiles: dose-response curves. *Journal of Chemical Ecology* **18**: 1743-53.
- Wilkinson, J.D., and Ignoffo, C.M. (1973). Activity of a juvenile hormone analogue on a parasitoid *Apanteles rubecula*, via its host, *Pieris rapae*. *Journal of Economic Entomology* **66**: 643-5.
- Wilkinson, J.O., Biever, K.D., and Ignoffo, C.M. (1979). Synthetic pyrethroids and organophosphates against the parasitoid *Apanteles marginiventris* and the predator *Geocoris punctipes*, *Hippodamia convergens* and *Podisus maculiventris*. *Journal of Economic Entomology* **72**: 473-5.
- Williams, C.B. (1973). Field tests of four insecticides against the Douglas-fir tussock moth in Oregon. Proceedings, Western Forestry Conservation Association. Portland, Oregon. 77-83.
- Wilson, A.G.L, Hughes, R.D., and Gilbert, N. (1972). The response of cotton to pest attack. *Bulletin of Entomological Research* **61**: 405-14.
- Wilson, A.G.L. (1974). Resistance of *Heliothis armigera* to insecticides in the Ord River Irrigation area, northwestern Australia. *Journal of Economic Entomology* **67**: 156-8.
- Wilson, A.G.L. (1982). Past and future *Heliothis* management in Australia. In *Proceedings of the International Workshop on Heliothis management*. Reed, W. and Kumble, V. (eds.). Patancheru, India, 1981. Patancheru, India: International Institute for Crop Research in the Semi Arid tropics, Patancheru, India. pp. 343-54.
- Wilson, A.G.L. (1983). Abundance and mortality of overwintering *Heliothis* spp. *Journal of the Australian Entomological Society* **22**: 191-9.
- Wilson, A.G.L., and Morton, R. (1989). Some factors affecting the reliability of pheromone traps for measurement of the relative abundance of *Helicoverpa punctigera* (Wallengren) and *H. armigera* (Hübner) (Lepidoptera: Noctuidae). *Bulletin of Entomological Research* **79**: 265-273.
- Wilson, L.T., and Gutierrez, A.P. (1980). Fruit predation submodel: *Heliothis* larvae feeding upon cotton fruiting structures. *Hilgardia* **48**: 24-36.
- Wolfenbarger, D.A., Riley, D.G., and Cartwright, B. (1997). Can response levels to any insecticide be maintained by a population of Beet Armyworm? In *Proceedings of the Beltwide Cotton Insect Research and Control Conference*. National Cotton Council of America, Memphis. pp. 1025-8.
- Wollam, J.D., and Yendol, W.G. (1976). Evaluation of *Bacillus thuringiensis* and a parasitoid for suppression of the gypsy moth. *Journal of Economic Entomology* **69**: 113-8.
- Woods, W. (1981). Controlling cotton pests with egg parasites. *Journal of the Department of Agriculture Western Australia* **22**: 63-4.
- Wright, W.E. (1970). Cotton pests and their control. *Agricultural Gazette of NSW* **81**: 268-78.
- Wright, W.E. and Nikitin, M.I. (1964). Survey of insects of cotton of New South Wales. *Australian Journal of Science* **27**: 178-9.
- Yanes, J., and Boethel, D.J. (1983) Effects of a resistant soybean genotype on the development of the soybean looper (Lepidoptera: Noctuidae) and an introduced parasitoid, *Microplitis demolitor* Wilkinson (Hymenoptera: Braconidae). *Environmental Entomology* **12**: 1270-4.

- Young, J.H. and Price, R.G. (1975). Incidence, parasitism and distribution patterns of *Heliothis zea* on sorghum, cotton, and alfalfa for southwestern Oklahoma. *Environmental Entomology* **4**: 777-9.
- Zalucki, M.P., Daghli, G., Firepong, S., and Twine, P.H. (1986). The biology and ecology of *Heliothis armigera* (Hübner) and *H. punctigera* Wallengren (Lepidoptera: Noctuidae) in Australia: what do we know? *Australian Journal of Zoology* **34**: 799-814.
- Zalucki, M.P., Murray, D.A.H., Gregg, P.C., Fitt, G.P., Twine, P.H., and Jones, C. (1994). Ecology of *Helicoverpa armigera* (Hübner) and *H. punctigera* (Wallengren) in the inland of Australia: larval sampling and host plant relationships during winter and spring. *Australian Journal of Zoology* **42**: 329-46.

Appendix 1

Insect rearing

M. demolitor

The *M. demolitor* colony was established from approximately 50 parasitised *H. armigera* larvae collected from cotton and sorghum in southeast Queensland during February and March 1990. *M. demolitor* were cultured using methods modified from Shepard *et al.* (1983b), Lewis (1970b) and Powell and Hartley (1987). The culture was initially maintained in *H. armigera* larvae. From November 1991 to November 1997, *Chrysodeixis argentifera* (Guenee) (Lepidoptera: Noctuidae) were used as hosts. During 1995-6, *H. armigera* was used as hosts due to problems with the *C. argentifera* colony. New field material, collected either as adults or from parasitised larvae was been added periodically.

H. armigera and *C. argentifera* larvae used for *M. demolitor* colony maintenance and for experimentation were reared using methods described below. Parasitoids were reared at 25°C, 60-70% relative humidity and a 14:10 light: dark photoperiod.

H. armigera* and *C. argentifera

H. armigera larvae were reared using methods modified from Teakle and Jensen (1985), and Gunning *et al.* (1984). The *H. armigera* culture has been maintained for approximately 10 years. Larvae were fed artificial diet modified from Shorey and Hale (1965), by the substitution of navy beans for pinto beans and the addition of 4 g wheat germ per 10 g of beans. Cultures were maintained at 25°C, 60-70% relative humidity and a 14:10 light: dark photoperiod.

Diet preparation

Navy beans were weighed and washed several times with tap water. The beans/water and agar/water mixtures were steamed separately in covered beakers for about 2 hours. Beans and agar were then cooled to about 70°C (about 5-8 minutes). All ingredients were then combined in an industrial blender and mixed thoroughly. Diet was then poured into stainless steel trays or Solo® cups and allowed to set at room temperature.

Standard *Heliothis* diet

Navy Bean	172 g.
Tap water	940 ml.
Agar	25 g.
Tap water	606 ml.

Mould inhibitor preparation

Propionic acid	42 ml.
Phosphoric acid	4 ml.
Water	54 ml.

Sugar solution for moths

Wheat germ	120 g.	Water	1000 ml.
Torula yeast	100 g.	Sugar	100 g.
L-Ascorbic acid	6 g.	Ascorbic acid	6 g.
Nipagin	6 g.	Teramycin 100 soluble	
Sorbic acid	2 g.	powder concentrate	
Formaldehyde	2 ml.	(anti-biotic)	2 g
Mold inhibitor	5.2 ml.		

References

- Gunning, R.V., Easton, L.R., Greenup, L.R. and Edge, V.E. (1984). Pyrethroid resistance in *Heliothis armigera* (Hübner) (Lepidoptera: Noctuidae) in Australia. *Journal of Economic Entomology*. **77**: 1283-1287.
- Lewis, W.J. (1970b). Rearing *Microplitis croceipes* in the laboratory with *Heliothis zea* as hosts. *Journal of Economic Entomology*. **63**: 656-658.

- Powell, J.E. and Hartley, G.C. (1987). Rearing *Microplitis croceipes* (Hymenoptera: Braconidae) and other parasitoids of Noctuidae with multicellular host-rearing trays. *Journal of Economic Entomology*. **80**: 968-71.
- Shepard, M., Powell, J.E. and Jones, W.A. Jr. (1983b). Biology of *Microplitis demolitor* (Hymenoptera: Braconidae), and imported parasitoid of *Heliothis* (Lepidoptera: Noctuidae) spp. and the Soybean Looper, *Pseudoplusia includens* (Lepidoptera: Noctuidae). *Environmental Entomology*. **12**: 641-645.
- Teakle, R.E. and Jensen, J.M. (1985). *Heliothis punctigera*. In *Handbook of insect rearing*. P. Singh and Moore, R.F. (eds.). Elsevier, Amsterdam. **2**: 313-322.
- Shorey, H.H. and Hale, R.L. (1965). Mass-rearing of the larvae of nine noctuid species on a simple artificial medium. *Journal of Economic Entomology*. **58**: 522-4.

Appendix 2

Insecticides

Topical testing

Insecticides used in the topical testing were technical grade chemicals. Insecticides used included:

- alpha-cypermethrin (Alpha-Scud[®], pyrethroid, 96.16%, Bayer),
- bifenthrin (Talstar[®], pyrethroid, 90.4%, Crop Care Australasia),
- chlorfluazuron (Helix[®], IGR compound, 97.3%, Crop Care Australasia),
- lambda-cyhalothrin (Karate[®], pyrethroids, 87.8%, Crop Care Australasia),
- deltamethrin (Decis Forte[®], pyrethroid, 98.9%, AgrEvo),
- dimethoate (Rogor[®], carbamate, 97.7%, Rhône-Poulenc),
- endosulfan (Endosulfan[®], organochlorine, 98.1% NSW agriculture),
- methoxyfenozide (Prodigy[®], MAC compound, 95%, Rohm and Haas),
- pirimicarb (Pirimor[®], carbamate, 97.6%, Crop Care Australasia),
- profenofos (Curacron[®], organophosphate, 100%, Ciba),
- spinosad (XDE-105) (Tracer[®], spinosyn, 90.0% Dow AgroSciences).

Stomach poisons

Unless otherwise noted emulsifiable concentrate formulations were used from the stomach poisons. Stomach poisons used included:

- *Bacillus thuringiensis* (Dipel[®], powder),
- chlorfluazuron (Helix[®], IGR compound, Crop Care Australasia),
- cyhalothrin (Karate[®] EC, pyrethroids, Crop Care Australasia),
- endosulfan (Endosulfan[®] 350EC, organochlorine, NSW agriculture),
- lufenuron (Match[®], 50 EC, Ciba-Geigy),

- methoxyfenozide (Prodigy[®], MAC compound, 210 EC, Rohm and Haas),
- profenofos (Curacron[®] Flexi, organophosphate, Ciba),
- spinosad (Tracer[®], NAF-85, 125 g ai/L, Dow AgroSciences),
- spinosad (Tracer[®], XDE-105, 125 g ai/L, Dow AgroSciences),
- thiodicarb (Larvin 375, Rhone-Poulenc).

Appendix 3

Equipment register

Table Appendix 3-1. Equipment used in this thesis.

Item	Model/size	Supplier
Acetone (analytical grade)	B & J Brand [®] high purity solvent	Selby Biolab, Musgrave North, Vic, 3170.
Acetone (laboratory grade)	Anala [®] laboratory grade acetone	See Acetone (analytical grade)
Alcohol	Laboratory grade alcohol	See Acetone (analytical grade)
Birdoff [®]	Tangle foot	Amalgamated Pest Control, Toowoomba.
Bleach	Hypo-10, 10% w/v Liquid chlorine,	Elite chemicals Pty Ltd., Lindum, Qld, 4178.
Cardboard milk containers	1 litre, 28 x 7 x 7 cm open ended	Tetrapac, Vic.
Conduit poles	10 cm diameter, 2 m long.	Mitre 10 hardware, Toowoomba.
Costar [®] tissue culture trays	12 wells trays	Linbro Cat. N. 76/053/05. ICN Biomedicals P/L. Seven Hills, NSW, 2147.
Dental wicks	No. 2, 6 inch	Dental Products Aust. P/L., Collaroy Beach NSW, 2097.
Diethyl ether	Univar analytical reagent	Ajax chemicals. Cnr Production st and Progress Rd, Wacol, Qld, 4076.
Falcon [®] dishes	50 mm diameter clear plastic	Science Supply Associates P/L Glen Waverly, Vic, 3150.
Microsyringe	Hamilton 25 :l microsyringe. 700 series	Alltech Associates (Aust.) Pty Ltd, Baulkhan Hills
Porous plastic sheet	Rapfast 15 film (water permeable). 15 x 15 cm perforated rolls	Kent Paper Company P/L., Spit Junction, NSW, 2088.
Plastic capsules	1.5 x .5 cm plastic capsules	QDL (Qld. Druggist Ltd.), 31 Vanity St. Toowoomba.
Repeat dispenser	For Hamilton microsinge	See Microsyringe.

Sartorius Balance	Type 1219 MP	See Acetone (analytical grade)
Solo [®] cups	P101M Graduated measuring cups. PL1 Lids	MPM Marketing, Albion, Qld, 4010.
Stereo Microscope	Wild M7A	Wild-Leitz, Brisbane.
UV steriliser	Type not available	Custom made by R. Lloyd, QDPI.
Vacuum sampler	McCulloch Super Air Stream IV Blower Vacuum	Mitre 10 hardware, Toowoomba.

Appendix 4

Field sites

Trials were carried out over 3 seasons, starting in the 1994/1995. Field trials described were carried out at 6 trial sites on the Darling Downs, southeast Queensland. These sites included: Witu, Nandi, Dalby and two sites at Warra. Trial location, configuration, and yields are described. Trial sites were often part of larger IPM trials, carried out by Dr D. Murray (Farming Systems Institute, QDPI) or unsprayed refuges, sown as part of the resistance management requirement for Ingard[®] crops. Often the layout and size of treatments were a compromise between experimental needs, and the interests of the farmers. Ground rig applications of insecticides were made at recommended rates, operating at 5 bar and a ground speed of 20 km/hr in 50 L/ha water.

1994/95

Warra site

This site was part of an IPM in raingrown cotton trial. It was situated near Warra (26°53'E, 150°54'S), about 150 km west of Toowoomba, Queensland. Cotton variety CS189 was sown on 31 October 1994 in a single skip row configuration. There were four large plot (3-6 ha) unreplicated treatments, including:

- Unsprayed. No insect control strategies were employed.
- Biological. No synthetic insecticide treatments were used. Natural enemies of *Helicoverpa* spp. were conserved and supplemented by releases of an egg parasite, (*Trichogramma* sp.) and larval parasites, such as *M. demolitor* and *C. kazak*. Food sprays (molasses), designed to attract predators were also used. *B. thuringiensis* and NPV sprays were the main control agent of *Helicoverpa* spp. This block was split into two, with different NPV formulations (a home made NPV spray and a commercially produced product, Gemstar[®]) were trialed in each.
- Reduced or soft block. Selective insecticides such as endosulfan, thiodicarb, and Bt were used for *Heliothis* spp. control. Food sprays were also used.

- Conventional block. Standard commercial control strategy was used. All insecticides available, including: endosulfan, thiodicarb and esfenvalerate were used for *Helicoverpa* spp. control. Dimethoate was used for mirid and thrip control.

Plot sizes and layout are shown in Figure Appendix 4.1. All insecticide applications were made using a ground rig at recommended field rates. Spray history for each treatment is displayed on Table Appendix 5-1.

Biological B 2.8 ha.	Biological A 3.0 ha.	Untreated 2.5 ha.
↑ N	Reduced 5.9 ha.	
Conventional 5.9 ha.		

Figure Appendix 4-1. Layout and treatment sizes for the Warra IPM trial site, 1994/95.

Yield and brief review

All treatments experienced relatively low *Helicoverpa* spp. activity throughout the season. Yield estimates, determined by machine harvest were similar for the five treatments. These were unsprayed 3.69, biological A 3.90, biological B 3.60, reduced 3.82, conventional 3.88 bales/ha. Harvest of the unsprayed treatment was delayed by 1 week.

Nandi site

This site was situated at Nandi (27°17'E, 151°11'S), about 100 km west of Toowoomba, Queensland. Cotton variety was CS189+ was sown on 14 November in a single skip row configuration after irrigation. No further irrigation was applied. Before commencement of work at this site, the entire site was treated with 2 insecticide treatments. There were four large plot (2 ha) unreplicated treatments, including:

- Unsprayed. No further insect control strategies were employed after the 2 initial treatments.
- NPV block. Treatments of nuclear polyhedrosis virus (Gemstar®) were made periodically to control *Helicoverpa* spp., when numbers justified treatment.
- NPV and spinosad. Spinosad (Tracer®) and NPV (Gemstar®) were used to control *Helicoverpa* spp.
- Conventional. Standard commercial control strategy was used. All insecticides available, including: endosulfan, thiodicarb deltamethrin, parathion and profenofos were used for *Helicoverpa* spp. control. Dimethoate was used for thrip control.

Plot sizes and layout are displayed on Figure Appendix 4.2. All insecticide applications were made using a ground rig at recommended field rates. Spray history for each treatment is displayed on Table Appendix 5-2.

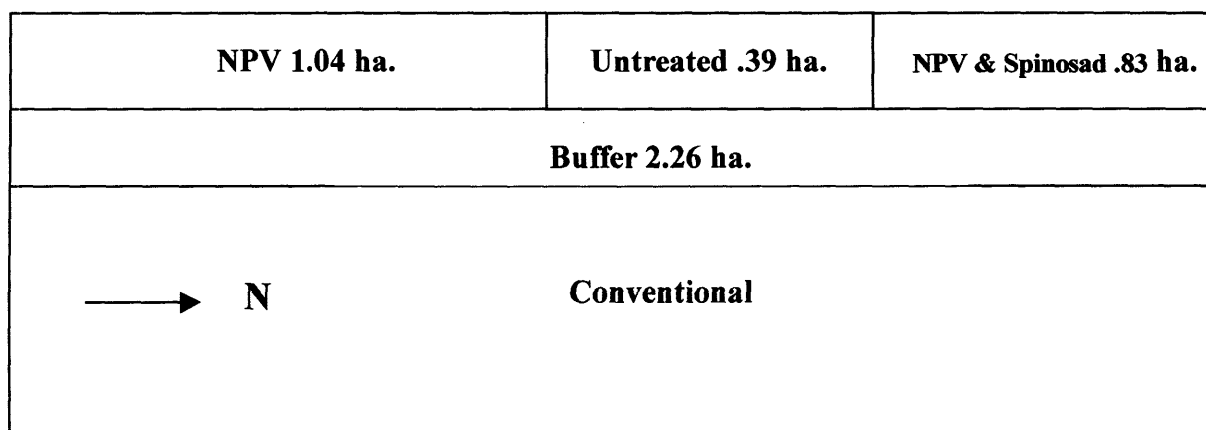


Figure Appendix 4-2. Layout and plot sizes for trial site at Nandi, 1994/95.

Yield and brief review

Yield estimates from machine harvest for the 4 treatments were as follows: untreated 4.99, Gemstar® 5.48, spinosad and Gemstar® 5.85 and conventional 6.82. *Helicoverpa* spp. pressure was light early in the season, but increased during January and February, where levels were maintained at about 7 grubs per metre in the unsprayed. *Helicoverpa* spp. activity was also high in all the other treatments. Poor timing and application problems were blamed for the lower yield in the NPV trial, which was considered satisfactory in controlling *Helicoverpa* spp.

1995/96

Warra

This site was part of an IPM in raingrown cotton trial. It was situated near Warra (26°53'E, 150°54'S), about 150 km west of Toowoomba, Queensland. Cotton variety CS189+ was sown on 29 September 1995 in a double skip row configuration (two rows planted, two rows missed). There were five large plot (2.5-5 ha) unreplicated treatments, including:

- Unsprayed. No insect control strategies were employed.
- Biological. No synthetic insecticide treatments were used. Natural enemies were conserved and supplemented by releases of egg parasites (*Trichogramma* spp.). Treatments of nuclear polyhedrosis virus (Gemstar[®]) were used for *Helicoverpa* spp. control.
- Spinosad. Spinosad (Tracer[®]) was used for *Helicoverpa* spp. control.
- Reduced block. Selective insecticides such as endosulfan, thiodicarb, and Bt were used for *Heliothis* spp. control.
- Conventional block. The standard commercial control strategy was used. All insecticides available, including endosulfan, *B. thuringiensis*, thiodicarb, cyfluthrin, profenofos, armitraz, bifenthrin and methomyl were used for *Helicoverpa* spp. control. Dimethoate was used for mirid and thrip control.

Plot sizes and layout are displayed on Figure Appendix 4.3. One insecticide application was made to the conventional block on the 6th January by aircraft due to wet conditions. All other insecticide applications were made using a ground rig at recommended field rates. Spray history for each treatment is shown in Table Appendix 5-3.

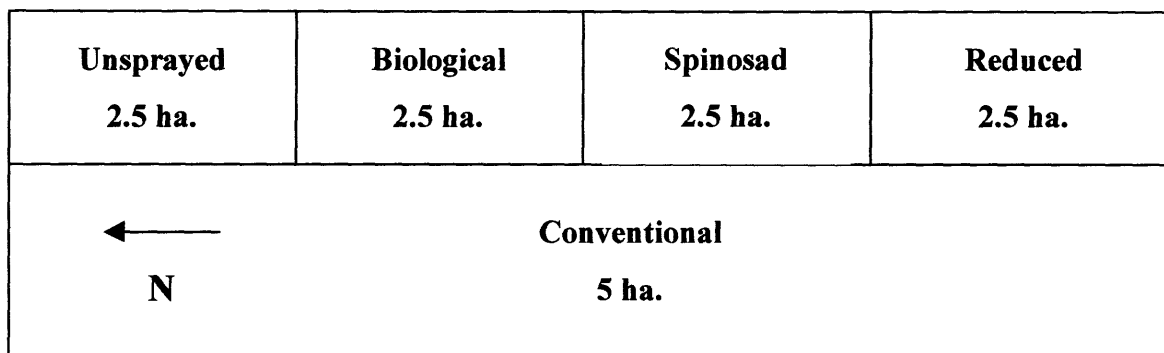


Figure Appendix 4-3. Layout and plot sizes of the Warra IPM trial site, 1995/96.

Yield and brief review

Wet conditions prevented ground rig application of insecticides and aerial applications were considered too disruptive to the small plots due to spray drift. As a result, *Helicoverpa* spp. control was disrupted in the period after 8th January. Yields estimated from machine harvest were as follows: unsprayed 3.24, biological 4.15, spinosad 4.10, reduced 3.93 and conventional 4.10. Green mirid attack during early squaring impacted heavily on the unsprayed and biological treatments. *Helicoverpa* spp. pressure was high during January and February and affected all treatments severely.

Dalby

This site was part of a trial testing arthropod diversity in raingrown Ingard[®] cotton. The site was situated at the Dalby Agricultural College (27°9'S, 151°17'E), about 100 km west of Toowoomba, Queensland. Cotton variety Ingard[®] (variety DP 5415) was sown in a solid configuration. The cotton was irrigated when required. There were three large plot (2.5-5 ha) unreplicated treatments, including:

- Unsprayed, conventional seed. No insect control strategies were employed.
- Ingard[®] cotton.
- Conventional insecticide program, conventional seed. All insecticides available were used to control *Helicoverpa* spp. Spray history is unknown.

Plot sizes and layout are displayed on Figure Appendix 4.4.

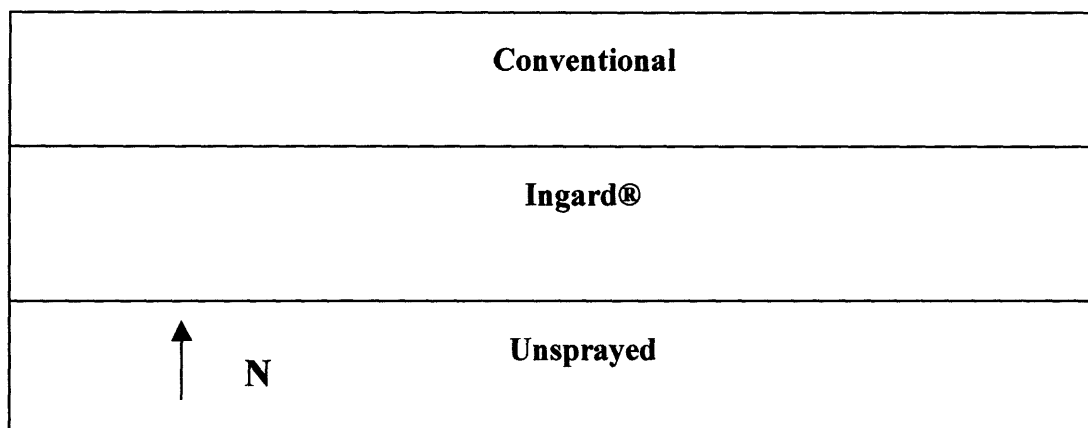


Figure Appendix 4-4. Layout and plot sizes of Bt trial at Dalby Agricultural College, 1995/96.

1996/1997

Warra

There were 3 sites situated at Warra during 1996/97. The first site was part of an IPM in raingrown cotton trial. It was situated near Warra (26°53'E, 150°54'S), about 150 km west of Toowoomba, Queensland. Cotton variety V15 was sown on 12 October 1995 in a single skip row configuration. There were four large plot (2.5-5 ha) unreplicated treatments, including:

- Unsprayed. No insect control strategies were employed.
- Spinosad. Spinosad (Tracer®) was the sole *Helicoverpa* spp. control agent. Other pests received no specific control measures.
- Best practice block. This treatment utilised the most selective products available. Selective insecticides such as Gemstar®, Thiodan® (endosulfan), Regent® (fipronil), and spinosad (Tracer®) were used for *Helicoverpa* spp. and other pest control. Pred. Feed® was used to attract predators.
- Conventional block. Standard commercial control strategy was used. All insecticides available, including: Thiodan® (endosulfan), pyrethroids, ovasyn® (amitraz), and Larvin® (thiodicarb) were used for *Helicoverpa* spp. control. Dimethoate was used for mirid and thrip control.

Two sites were unsprayed Ingard® refuges. The Ingard® refuges were 10 ha. Details of the cotton variety and sowing dates were not available. These sites were part of the farmers' obligation in growing Ingard® cotton. (Farmers were required to sow 1 ha of unsprayed cotton for every 10 ha of Ingard® cotton). No control measures could be taken against *Helicoverpa* spp., although other pests could be controlled normally.

- Ingard® refuge at Warra. No control measures were taken against *Helicoverpa* spp., but other pest insects, such as aphids were controlled normally. Dimethoate was used to control aphids.
- Ingard® refuge at Witu. No control measures were taken against *Helicoverpa* spp.
- Plot sizes and layout for The Warra IPM trial site are shown in Figure Appendix 4.5.

Spray history for each treatment is shown in Table Appendix 5-4.

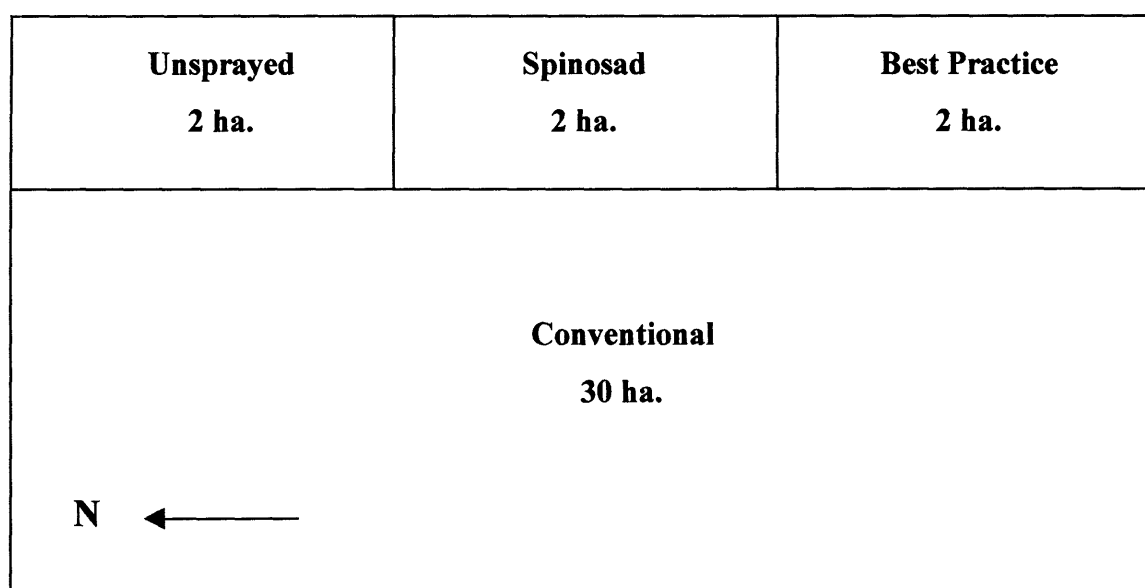


Figure Appendix 4-5. Layout and plot sizes of the Warra IPM trial, 1996/97.

Spray applications were made by ground rig at recommended rates. Dimethoate was applied to the unsprayed block on 22 March 1997, to control aphid infestations, as open bolls were present and contamination of lint with honeydew was a risk. The Ingard® refuge block at Warra was sprayed with dimethoate on the 26 November to control mirids.

Yield and brief review

Yield estimates from machine harvest for the treatments were as follows: unsprayed 3.82, spinosad (Tracer[®]) 2.17, best practice 3.17 and conventional 3.16. Harvests of all treatments other than the conventional were delayed, due mainly to green mirids. The reason for the poor yield of the spinosad treatment is unclear, as the spinosad treatment was considered to have controlled *Helicoverpa* spp. satisfactorily. Poor yield was possibly due to attack by *N. viridula* late season. The unsprayed yielded extremely well, due possibly to late season rain.

Appendix 5

Spray histories for trial sites

Table Appendix 5-1. Spray history of the IPM site at Warra during 1994/95. Trade name (active ingredient).

No.	Date	Biological A	Biological B	Soft	Conventional
1	19-December-94	Dipel (<i>B. thuringiensis</i>)	Dipel (<i>B. thuringiensis</i>)	Dipel (<i>B. thuringiensis</i>)	Endosulfan (endosulfan) & Larvin (thiodicarb)
2	23-December-94	"home made" (NPV)	Gemstar (NPV)	Endosulfan (endosulfan) & Larvin (thiodicarb)	
3	29-December-94				unknown pyrethroid & Larvin (thiodicarb)
4	13-January-95				Endosulfan (endosulfan) & Rogor (dimethoate)
	17-January-95	Pred Feed (Food spray)	Pred Feed (Food spray)	Pred Feed (Food spray)	
	23-January-95	Pred Feed (Food spray)	Pred Feed (Food spray)	Pred Feed (Food spray)	
5	3-February-95				Endosulfan (endosulfan) & Rogor (dimethoate)

Table Appendix 5-2. Spray history for Nandi during 1994/95. Trade name (active ingredient).

No.	Date	Commercial	Biological (Gemstar[®])
1	16-December-94	Larvin (thiodicarb)	Larvin (thiodicarb)
2	21-December-94	Endosulfan (endosulfan) & Larvin (thiodicarb)	Endosulfan (endosulfan) & Larvin (thiodicarb)
3	5-January-95	Decis (deltamethrin) & Folidol (parathion-methyl)	
4	16-January-95	Decis (deltamethrin) & Larvin (thiodicarb)	Gemstar (NPV)
5	26-January-95	Decis (deltamethrin) & Folidol (parathion-methyl)	Gemstar (NPV)
6	2-February-95	Decis (deltamethrin), Folidol (parathion-methyl) & (piperonyl butoxide)	
	8-February-95		Gemstar (NPV)
7	9-February-95	Curacron (profenofos)	
8	20-February-95	Larvin (thiodicarb)	
	23-February-95		Gemstar (NPV)
9	27-February-95	Larvin (thiodicarb)	
	3-March-95		Gemstar (NPV)
10	9-March-95	Larvin (thiodicarb)	
11	21-March-95	Larvin (thiodicarb)	

Table Appendix 5-3. Spray history for the IPM site at Warra during 1995/96. Trade name (active ingredient).

No.	Date	Conventional	Biological	Soft	Spinosad
1	27-November-95	Endosulfan (endosulfan) & Dipel (<i>B. thuringiensis</i>)			
	28-November-95		Gemstar (NPV)	Endosulfan (endosulfan) & Dipel (<i>B. thuringiensis</i>)	XDE-105 ULV
2	2-December-95	Endosulfan (endosulfan), Dipel (<i>B. thuringiensis</i>) & Rogor (dimethoate)			
	4-December-95		Gemstar (NPV)		
3	9-December-95	Bulldock (beta-cyfluthrin) & Dipel (<i>B. thuringiensis</i>)		Endosulfan (endosulfan) & Dipel (<i>B. thuringiensis</i>)	NAF-85
4	18-December-95	Bulldock (beta-cyfluthrin) & Lannate L (methomyl)			
	20-December-95		Gemstar (NPV)		NAF-85
5	22-December-95	Bulldock (beta-cyfluthrin) & Larvin (thiodicarb)		Endosulfan (endosulfan) & Larvin (thiodicarb)	
	28-December-95		Gemstar (NPV)		
6	29-December-95	Curacron (profenofos)		Dipel (<i>B. thuringiensis</i>) & Larvin (thiodicarb)	
	2-January-96		Gemstar (NPV)		NAF-85
7	6-January-96	Endosulfan (endosulfan) & Larvin (thiodicarb)		Endosulfan (endosulfan) & Larvin (thiodicarb)	
8	19-January-96	Bulldock (beta-cyfluthrin) & Dipel (<i>B. thuringiensis</i>)		Bulldock (beta-cyfluthrin) & Dipel (<i>B. thuringiensis</i>)	NAF-85
	22-January-96	Larvin (thiodicarb)	Gemstar (NPV)	Larvin (thiodicarb)	NAF-85
9	31-January-96		Gemstar (NPV)		
	1-February-96	Bulldock (beta-cyfluthrin) & Ovasyn (amitraz)		Bulldock (beta-cyfluthrin) & Ovasyn (amitraz)	
11	9-February-96	Larvin (thiodicarb)	Gemstar (NPV)	Larvin (thiodicarb)	
	12-February-96		Gemstar (NPV) (half rate)		NAF-85
12	13-February-96	Bulldock (beta-cyfluthrin), Ovasyn (amitraz) & Rogor (dimethoate)		Bulldock (beta-cyfluthrin), Ovasyn (amitraz) & Rogor (dimethoate)	
13	17-February-96	Talstar (bifenthrin)		Talstar (bifenthrin)	XDE-105
	24-February-96		Gemstar (NPV)		

Table Appendix 5-4. Spray history for the IPM site at Warra during 1996/97. Trade name (active ingredient).

No.	Date	Conventional	Ingard® (NuCotn 37i)
1	22-November-96	Thiodan (endosulfan)	
	27-November-96		Thiodan (endosulfan)
	29-November-96		
2	2-December-96	Thiodan (endosulfan)	
	6-December-96		Thiodan (endosulfan)
3	10-December-96	Thiodan (endosulfan)	
	16-December-96		
4	17-December-96	Thiodan (endosulfan)	Thiodan (endosulfan)
5	23-December-96	Scud (cypermethrin)	
	24-December-96		
	27-December-96		
	31-December-96		
6	3-January-97		
	6-January-97	Scud (cypermethrin) + Ovasyn (amitraz)	
7	7-January-97		
	13-January-97	Bulldock (beta-cyfluthrin) + Ovasyn (amitraz)	Bulldock (beta-cyfluthrin) + Ovasyn (amitraz)
	19-January-97		
	21-January-97		
8	24-January-97	Bulldock (beta-cyfluthrin) + Larvin (thiodicarb) + Rogor (dimethoate)	
	28-January-97		
	7-February-97		Rogor (dimethoate)
9	25-February-97	Rogor (dimethoate)	Rogor (dimethoate)