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Recent advances in agricultural acarology (*)

Abstract - The authors describe the recent advances in agricultural acarology and briefly examine the principal research lines that have been involving during the last years various researchers. In particular, the use of informatic application and mathematical models in crop protection against phytophagous mites, the population dynamics, the behaviour of preys and predators, the population genetics and also the molecular biology are discussed.

Riassunto - *Recenti progressi in acarologia agraria.*
Gli autori illustrano le recenti acquisizioni in acarologia agraria ed esaminano brevemente i principali filoni di ricerca che vedono impegnati negli ultimi anni gli studiosi del settore. Si tratta in particolare dell'applicazione dell'informatica e dei modelli matematici nella protezione delle colture dagli acari fitofagi, dell'analisi della dinamica delle popolazioni, del comportamento dei fitofagi e dei predatori, della genetica delle popolazioni, nonché della biologia molecolare.

Key words: advances, agricultural acarology.

INTRODUCTION

As in other branches of biology, fundamental research in modern agricultural acarology has benefited by technical progress in calculation with the development of computing and in biochemistry with that of molecular methods. From this point of view it can be considered that three main lines have been followed. The first consists of the mathematical models developed thanks to progress in data processing. They have led either to the establishment of models applied to crop protection or models for research on population dynamics. The second concerns the analysis of the different aspects of the behaviour of pests and predators. This has developed in particular thanks to progress in data recording methods. The third concerns population genetics. This has expanded considerably with the recent progress in biochemistry and mole-

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cular biology. Mites form excellent material for research on population dynamics and the development of models, and many of these appear in recent literature. They are not easy to describe, but we have tried to separate them into crop protection models and research models.

CROP PROTECTION MODELS

Crop protection mathematical models are either tactical or strategic. Tactical models aim at forecasting the scale of attacks, determining the best intervention periods and the quantity of predators to be released or at simulating interactions between prey and predators studied by a stochastic model and pilot experiments (Pearl et al., 1989; Hayes et al., 1993; Sadof & Alexander, 1993). Strategic models approach the population dynamics of phytophagous pests according to the development of the plants attacked (Baumgärtner & Zahner, 1984; Zeng et al., 1985; Wilson et al., 1992). Other authors have examined a simulation model which included the effects of temperature, humidity and predation and coupled to a comprehensive plant-microenvironment model (Berry et al., 1991).

RESEARCH MODELS

Research models are more analytical and explanatory. They examine population dynamics taking into account the plant-mite system, the predator-prey system or the tritrophic plant-mite-predator system.

The first point has been the focus of several studies by Gutierrez et al. (1988), one of the leading initiators of this type of model.

The predator-prey system has been studied according to various special factors, among these the microclimate, with temperature variations or seasonal changes (Rabbinge, 1976; Woolhouse & Harmsen, 1989; Collings et al., 1990), the spatial distribution (Walde et al., 1992) or the dispersal (Sabelis & Laane, 1986; Diekmann et al., 1988; Metz et al., 1988; Janssen & Sabelis, 1992).

As regards the tritrophic system the research has been carried out by different authors (Gutierrez et al., l.c.; Baumgärtner et al., 1988; Wermelinger et al., 1992).

BEHAVIOUR OF PESTS AND PREDATORS

The behaviour of pests and predators involve different aspects; among these the most important are the mating, the spinning, the defence subsocial life, the foraging dispersal, the choice of prey olfactometry and the acaricide resistent populations.

The mating and spinning behaviour of pests and predators have been investigated by various acarologists (Everson & Addicot, 1982; Aponte & McMurtry, 1992; Kumari & Sadana, 1992; Enders, 1993).

Saito (1986), Saito (1990) has studied the sociobiological relations between pests and Yamamura (1987) the biparental defence in a subsocial spider mite.

Foraging dispersal has been examined by Berry et al.(1990) and Zhang et al. (1992). The choice of prey, the predatory and searching behaviour have been studied by Dicke et al. (1986), Dicke (1988), Clements & Harmsen (1990), Santos (1991), Ferragut et al. (1992), Clements & Harmsen (1993) and Sabelis & Van der Weel (1993).

Finally, the population behaviour of acaricide-resistant pests has been investigated by Berry et al. (l.c.), Kolmes et al. (1990) and Kolmes et al. (1994).

POPULATION GENETICS

Much research on isoenzyme variability has been carried out on the Tetranychidae. Initiated by Ward et al. (1982) and by Grafton-Cardwell et al. (1988) in the USA, it was considerably developed in Japan, China and Korea. Investigations have concerned inter and intraspecific polymorphism in Tetranychid and Tenuipalpid mites (Lee, 1988; Kuang & Cheng, 1990; Gotoh & Ishikawa, 1992; Osakabe, 1991a; Osakabe, 1991b; Osakabe 1993; Osakabe et al., 1993; Osakabe & Sakagami, 1993; Hinomoto & Takafuji, 1994; Hinomoto & Takafuji, 1995; Osakabe & Komazaki, 1996; Tsagkarakou et al., 1996b), relationships between Eriophyid mite families (Kuang et al., 1992), polymorphism linked to the diapause status of populations (Gotoh et al., 1991; Osakabe, l.c.) and to acaricidal resistance (Kim & Lee, 1990; Mowry et al., 1996; Tsagkarakou et al., 1996a).

MOLECULAR BIOLOGY

Molecular biology should enable accurate identification of species, the establishment of phylogenies, the discovery of markers for phytophagous and predators and lead to interesting genetic transformation of predators. For the Tetranychid mites are well known the contributions of Kaliszewski et al. (1992), Navajas et al. (1992), Fournier et al. (1994), Navajas et al. (1994), Navajas et al. (1996a) and Navajas et al. (1996b). The Eriophyid identification has been investigated by Fenton et al. (1995). The stable genetic transformations of predators has been treated by Presnail & Hoy (1992). Jeyaprakash & Hoy (1995) refer on the complete sequence of a mariner transposable element from a Phytoseiid isolated by an inverse PCR approach.

CONCLUSION

We can generally affirm that the today's agricultural acarology foster great interests not only for the morphological or traditional systematics and for the qualitative settlement of the agroecosystems, but also for the quantitative analysis of the problem, with particular interest for the relation pest-predator-plant and environment. This needs a better knowledges of biology (sensu lato) and involves different competences. From this point of view in the recent years the behaviour of pests and predators, the population dynamics, the crop protection models, the genetic populations and the molecular biology have polarized the interest of many scientists. Mathematical and statistical analysis, biochemical and physiology supports have consented flattering aims.

In conclusion research in agricultural acarology has tended to be less abundant in recent years, but the problems investigated are still there or have been replaced by others. In particular, we are confronted by the problem of resistance to acaricides and modification of mite fauna by the accidental introduction of pests or the intentional introduction of predators. The use of recent research techniques is resulting in rapid progress in the discipline and also highlights the advantages of this biological material for more general research.

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