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FORUM

# History and Contemporary Perspectives of the Integrated Pest Management of Soybean in Brazil

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**Abstract**

The integrated pest management (IPM) of soybean developed and implemented in Brazil was one of the most successful programs of pest management in the world. Established during the 1970s, it showed a tremendous level of adoption by growers, decreasing the amount of insecticide use by over 50%. It included outstanding approaches of field scouting and decision making, considering the economic injury levels (EILs) for the major pests. Two main biological control programs were highly important to support the soybean IPM program in Brazil, i.e., the use of a NPVAg to control the major defoliator, the velvet bean caterpillar, *Anticarsia gemmatalis* Hübner, and the use of egg parasitoids against the seed-sucking stink bugs, in particular, the southern green stink bug, *Nezara viridula* (L.). These two biological control programs plus pests scouting, and the use of more selective insecticides considering the EILs supported the IPM program through the 1980s and 1990s. With the change in the landscape, with the adoption of the no-tillage cultivation system and the introduction of more intense multiple cropping, and with the lower input to divulge and adapt the IPM program to this new reality, the program started to decline during the years 2000s. Nowadays, soybean IPM is almost a forgotten control technology. In this mini-review article, suggestions are made to possibly revive and adapt the soybean IPM to contemporary time.

## Introduction

The history of the integrated pest management (IPM) on soybean, *Glycine max*, is linked to the change in the conception of pest control that occurred in the 1960s, at the time that the world was alerted by the danger of the abusive use of pesticides (Carson 1962, see also van den Bosch 1978). The overuse of pesticides led to several government policies all over the world in order to mitigate the side effects of such chemicals, and a major component of this change was the implementation of integrated pest management (IPM) programs. These IPM programs were considered a great technological advance in the concept of pest control (see Kogan 1998 for the history of IPM). As it is widely known today, the IPM seeks to integrate several control tactics instead of basing the pest control on the exclusive use of pesticides. In essence, the IPM concept consists in taking the pest control decision considering the coordination of multiple tactics to optimize the control of all types of pests in a compatible economic and ecological way (Prokopy & Kogan 2003). This control “philosophy” spread out fast in Brazil and was readily incorporated to control pests of major crops, including soybean. In this mini-review, the chronology of the soybean IPM implementation in Brazil, how it changed along the years, and what are the perspectives in the contemporary time will be analyzed.

## Chronological Development of Soybean IPM in Brazil

### *The beginning during the 1970s*

Soybean integrated pest management was perhaps the most successful IPM program developed in Brazil. A program implemented in the 1970s was for a long time the most known pest control technology associated with the soybean crop. The first major impact was a prompt reduction on the amount of insecticide use to control insect pests, which reached a level of mitigation of about 50% of the total (Moscardi 1983, Gazzoni 1994). The IPM concepts were fast adopted by the extension personnel who passed the message on to the growers. Several publications on the soybean IPM concept were released based on the economic injury levels developed in the USA and adapted to the Brazilian conditions. Some of them had a regional impact, such as the bulletins published in the states of São Paulo (Williams *et al* 1973) and of Rio Grande do Sul (Turnipseed 1974). Few years later, the National Soybean Research Center of Embrapa in Londrina, state of Paraná, released its first technical bulletin entitled *Insetos da Soja no Brasil* (Soybean Insects in Brazil) (Panizzi *et al* 1977a) which had a national impact. This publication, first with color photos of the main pests and their natural enemies (parasites, predators, and diseases), stressed the IPM concepts considering the sampling methods to survey pest insects and their natural enemies, and economic injury levels for the main pests (caterpillars and stink bugs) to allow a better decision-making process regarding the use of insecticides. At the international scenario, Kogan *et al* (1977) reported the Brazilian IPM program for soybean and its implementation at the national level based on research work conducted during the mid-1970s at the Agronomic Institute of Paraná at Londrina, state of Paraná, and in Cruz Alta, state of Rio Grande do Sul. The soybean IPM radically changed the usual practice of preventive insecticide application based on the calendar to a more efficient and economic control technique.

*The 1980s and the Baculovirus era*

During the 1980s, a new powerful tool was added to the already successful soybean IPM program in use by the Brazilian growers. In those days, the major soybean pest was the velvet bean caterpillar (VBC), *Anticarsia gemmatalis* (Hübner), which caused severe defoliations to soybean plants. A virus known as *Baculovirus anticarsia*, a nuclear polyhedrosis virus (AgNPV), which naturally occurred in Brazil (Allen & Knell 1977, Carner & Turnipseed 1977), showed potential to control VBC. A pilot program to develop the use of the AgNPV was developed and implemented (Moscardi 1983). The program initially tested in the states of Paraná and Rio Grande do Sul spread out to other states during the 1980s and reached nearly 1.6 million hectares, representing close to 10% of the total area cultivated with soybean (Moscardi & Souza 2002). The AgNPV initially applied to the field used a homemade solution made from diseased caterpillars collected from soybean fields (50 larvae equivalent/ha). Later, a wettable powder formulation was developed and widely used (Moscardi 1983). The IPM program was then even better, with a tremendous success. This IPM program was so successful that it was disseminated to several other countries of Latin America (see Moscardi 1999 for details).

*The 1990s and the egg parasitoids momentum*

In the 1990s, a new control tactic was included in the already successful soybean IPM. Egg parasitoids were introduced in the system by rearing stink bugs in the laboratory to obtain egg masses, which in turn were exposed to parasitization by these micro-hymenopterans (Corrêa-Ferreira 1993). The biological control of stink bugs, which became the major pests since the 1980s (Panizzi & Slansky 1985), was performed through the use of two species of egg parasitoids, *Trissolcus basalis* (Wollaston) and *Telenomus podisi* Ashmead. These parasitoids lay their eggs inside the eggs of stink bugs, killing the embryo. Although polyphagous, they show preference for certain species of stink bugs. For instance, *T. basalis* prefer eggs of the Southern green stink bug, *Nezara viridula* (L.), while *T. podisi* prefer eggs of the Neotropical brown stink bug, *Euschistus heros* (F.) (Corrêa-Ferreira & Peres 2003).

In order for the egg parasitoids to function well in the system, growers were recommended to use the AgNPN to control the VBC, and to use microbial and/or selective insecticides, such as those based on *Bacillus thuringiensis* or insect growth regulators (e.g., diflubenzuron), to avoid killing the parasitoids that colonize the fields early in the season. To obtain the best results, it was recommended to release 5,000 egg parasitoids/ha at the edge of the fields, where the stink bugs infestation generally occurs, during soybean blooming (Corrêa-Ferreira 1993). Egg parasitoids were multiplied in laboratory on egg masses of stink bugs, which were glued on small cardboard tags that were distributed in the field (see Corrêa-Ferreira & Peres 2003 for further details).

During the 1990s, other important information was added to the IPM program in use, such as the economic threshold level to control the stem borer, *Sternechus subsignathus* Boheman (Coleoptera: Curculionidae) (Hoffmann-Campo *et al* 1999).

*Soybean IPM in the new millennium*

At the beginning of the soybean IPM implementation in Brazil, the so-called conventional cultivation system was used in the totality of the area under cultivation. This cultivation system included several machinery operations to plow the soil and to level it off (Fig 1a). Eventually, this system was abandoned, mainly due to the severe soil erosion, loss of soil nutrients, and due to economic


Fig 1 Change in the landscape of the cultivated area with soybean in Brazil. **a** Area under the conventional cultivation system; **b** area under the no-tillage cultivation system [photos by Embrapa Soybean (author unknown), reproduced with permission].

reasons, and a new system was then proposed and implemented, the so-called no-tillage cultivation. Under this cultivation system, the soil is left undisturbed and covered with crop residues (Fig 1b). This change in the rural landscape was dramatic. From the less than 5,000 ha under no-tillage cultivation at the beginning of the 1970s, it increased to over 25,000,000 ha in mid-2010, and the expectation is to reach over 32 million hectares for the coming soybean season of 2012/2013 (Fig 2). This change, although important from the ecological (mostly soil conservation) and economical viewpoints, caused a great impact on the current IPM system used by growers.

Many soil-inhabiting pests and other arthropods damaging soybean plants at the beginning of the cultivation season required early insecticide applications, which disrupted the much needed balance of pests/natural enemies, and the IPM system started to be affected. Polyphagous pests that live on or in the ground during their life time or part of their life time, such as the root sucking burrower bug, *Scaptocoris castanea* Perty (Lis *et al* 2000), the Neotropical brown stink bug, *Euschistus heros* (F.) (Panizzi & Niva 1994), the Green-belly stink bugs, *Dichelops furcatus* (F.), and *Dichelops melacanthus* (Dallas) (Panizzi *et al* 2000, Chocorosqui & Panizzi 2004), and several species of root-feeding beetles (Oliveira & Salvadori 2012) were favored and their population boomed.

The current system of cultivation of multiple crops during the year with soybean and/or corn double cropping, leaving no time during the year without food resources, created a non-stop situation favorable for the growth of pest populations. In addition, the reduction of the costs of conventional insecticides in the Brazilian market, which started to be overused, many times mixed with herbicides to control weeds and/or with fungicides used to control the soybean rust, completely abolished the use of the classical, successful

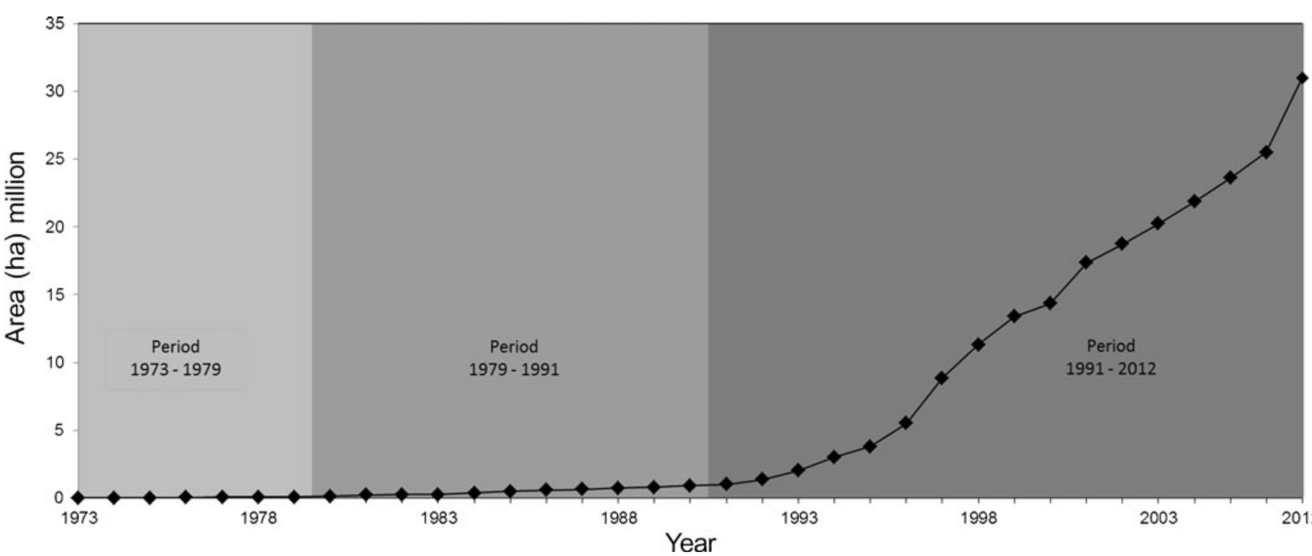


Fig 2 The evolution of the adoption of the no-tillage cultivation system in Brazil. Note that at the beginning small areas were incorporated to the no-tillage cultivation system, which increased dramatically from the beginning of the 1990s through the 2000s (source: adapted from Denardin *et al* 2008).

IPM program that was in use. Moreover, secondary pests such as chewing caterpillars that feed on pods and leaves (*Spodoptera* spp.), the soybean looper, *Pseudoplusia includens* Walker, mites, thrips, and white flies increased in their abundance and gained the status of major pests (Sosa-Gómez *et al* 2010). Finally, the side effects caused by the intensive use of fungicides to control the soybean rust on the naturally occurring entomopathogenic fungi that was so effective against pests (Sosa-Gómez 2006) added even more pressure to the already weak role the natural enemies play against soybean pests with the current agricultural practices. The summation of all these factors led to the almost complete abandonment of the IPM program on the soybean crop in Brazil toward the end of 2010.

## Tactics Used on the Soybean IPM in Brazil

### *Economic injury levels of major pests*

The economic injury levels (EIL) of main pests of soybean in Brazil were established mostly during the 1970s (Panizzi *et al* 1977a), and new information has been gradually added to other new pests since then (Hoffmann-Campo *et al* 2000). For instance, control measures for chewing insects (defoliators) should be taken only when 30% defoliation occurs and the population of caterpillars reaches 20 larvae/m during the vegetative stage. As plants start to bloom, the level of defoliation accepted is reduced to 15%. For stink bugs, sampling of 2 adults/m from the pod-setting stage to the physiological maturation requires control measures. This level is reduced in half (1 adult/m) in fields aimed to produce seeds. For the shut and axil borer, *Crosiodosema aporema* (Walsingham), the EIL is reached when 25–30% of the growing points are damaged; for the pod-feeding caterpillars (*Spodoptera* spp.) when 10% of pods are damaged; and for the gall maker *S. subsignathus* when 1–2 adults/m are sampled during the vegetative stage. These economic injury levels were, in general, adopted and passed on to growers by extension personnel. Despite the continuous efforts by some research institutes, cooperatives, and official and private extension agencies to promote the EIL, these decision-making criteria were slowly forgotten and fell in complete disuse.

### *Sampling major pests*

Sampling soybean insects as a tool to decide to control or not the pest species was a common practice to evaluate the population levels back in the 1970s and 1980s. The first attempts to survey pest species and their natural enemies on soybean used different sampling methods, which included the use of D-vac, sweep net, and the ground cloth or beat cloth methods (e.g., Boyer & Dumas 1963, Shepard *et al* 1974). Later, a classical book on sampling methods in soybean entomology was published (Kogan & Herzog 1980). In this book, the several feeding guilds (defoliators, underground feeders, stem and axil feeders, pod feeders, predators, parasites, and pathogens) were covered regarding the appropriate sampling procedure. Moreover, basic information on the concepts and techniques of sampling techniques were stressed. From these various sampling methods, the ground or beat cloth method became the most popular not only because of its practical use but because it served to sample several species of pests and natural enemies. From its more basic design (1-m-long piece of cloth) (Boyer & Dumas 1963), it evolved to a more sophisticated design using a plastic "cloth" to allow insects to slide into a plastic container by raising one of the ends of the cloth during sampling (Shepard *et al* 1974, Shepard & Carner 1976). Later on, the use of galvanized metal flashing (91.4-cm wide) crimped to provide a vertical beating surface (86.2-cm tall and a trough 10.1-cm wide) was implemented (Drees & Rice 1985). This last model, despite its practicability of use, did not become popular in Brazil, and the plastic version of the beat cloth was the mostly used. As the space between soybean rows reduced to better manage weed infestation, the beat cloth was used shaking plants of one row only against one side of the cloth lifted in a similar way of the vertical metal "cloth". Today, this method is still used, but in a much reduced scale if compared to the sampling carried out by growers in the 1970s and 1980s. This is due to the mitigation in the use of IPM systems in soybean as a whole, as we will discuss later.

### *Biological control of major pests*

Two main programs in biological control of soybean insect pests were responsible for making the concept of biological control popular among growers: the use of the NPVAg against the most important defoliator, the velvet bean caterpillar, *A. gemmatalis*; and the use of egg parasitoids against stink bugs, in particular against the Southern green stink bug, *N. viridula*, as earlier discussed in more detail. It must be said that the Brazilian soybean growers, despite their enthusiasm and eagerness to learn new techniques and use new tools to control insect pests, were, from the very beginning, resistant to believe on the effect that natural enemies could have on the suppression of pest populations.

Efforts to demonstrate that by eliminating all natural enemies on soybean fields using non-selective insecticides in high dosages, which caused pest resurgence (Panizzi *et al* 1977b), were not enough to convince them on the important role of natural enemies. The annual occurrence of the entomopathogenic fungus *Nomuraea rileyi*, causing extreme high mortality of the velvet bean caterpillar, was also pointing to the "help" coming from nature to aid growers to get rid of pests. However, it was only when the NPVAg was developed and implemented through a pilot program with spectacular results (Moscardi 1983) that growers became convinced on the key role of natural enemies on the natural control of pest insects. The egg parasitoid program against the seed-sucking stink bugs (Corrêa-Ferreira 1993) also yielded very interesting results, reinforcing the important role of such beneficials in the soybean agroecosystem. Unfortunately, these two programs almost completely disappeared nowadays, and they were overtaken by the "easiness" of the use of conventional pest control through the sole use of insecticides.

*Chemical control of major pests*

Among the several control tactics used to manage insect pests of soybean, the use of conventional chemical insecticides still remains as the most important. At the beginning of soybean cultivation in Brazil, in the late 1960s and early 1970s, the use of insecticides was widespread, and chemicals such as toxaphene and DDT were commonly used. Later, other broad-spectrum chemicals such as endrin, malathion, methyl parathion, methomyl, carbaryl, and monocrotophos became popular. With the introduction of the IPM program in the mid-1970s, a great reduction (>50%) in the use of insecticides was observed (Moscardi 1983, Gazzoni 1994). The "side effects" of the widespread use of insecticides on soybean were demonstrated in the USA (Shepard *et al* 1977) and in Brazil (Panizzi *et al* 1977b), with the resurgence of pests due to their impact on natural enemies.

The introduction of the NPVAg to control the velvet bean caterpillar and of the egg parasitoids to control stink bugs in the soybean IPM program greatly improved the chemical control of soybean pests by reducing the amount of chemicals used. In addition, the so-called Brazilian salt technology used in Australia to manage mired pests on mungbeans (Brier *et al* 2004) and implemented to control stink bugs on soybean (Corso 1990, Corso & Gazzoni 1998) reduced the amount of insecticides used even more. It consisted in the addition of a solution of 0.5% table salt, sodium chloride (NaCl), into the insecticide solution at 50% of the recommended dosage without any loss in efficiency (Corso 1990, Corso & Gazzoni 1998). This effect, first considered a result of an attraction of the stink bugs to salt-treated areas, proved later to be due to an arrestment of the stink bugs in salt-treated plants due to an increase in their probing behavior (Niva & Panizzi 1996). The prolonged probing behavior increased the contact of the bugs with insecticide-treated surfaces leading to an increased intoxication and a higher mortality.

The chemical control of soybean pests in Brazil, which was effective and reached a good balance within the framework of IPM in the late 1990s, started to change early in 2000. With the reduction in price of conventional pesticides, the greater adoption of the use of pyretroids, and the reduced use of the IPM principles, the successful management of the soybean pests started to fail. A greater increase in the number of insecticide applications was observed (e.g., Quintela *et al* 2006), and the resistance of pests, such as stink bugs, to common conventional insecticides started to occur (Sosa-Gómez *et al* 2001). Moreover, the impact of fungicides to entomopathogenic agents (Sosa-Gómez 2006) reduced their pressure on defoliating caterpillars and contributed to the rise in insecticide use. Nowadays, we are back to the situation when IPM started in the early 1970s, when insecticides were used over five times per season to control insect pests.

## Landscape Phenology, Pest Incidence, and Management of Crop Residues

The change in the landscape phenology, which dramatically impacted pest incidence on soybean in Brazil, might be considered the most important factor to explain the present status of insect pests on this crop. The change in the landscape phenology occurred in two fronts: (a) the massive adoption of the no-tillage cultivation system by growers (Fig 1b) and (b) the multiple cultivation of crops in sequence during the year (see section on "Soybean IPM in the new millennium"). Several feeding guilds, including the seed-sucking bugs (Heteroptera) and the root-feeding insects (mostly Coleoptera), were greatly favored. Also, caterpillars (Lepidoptera) that pupate in the soil had their population increased.

In view of this new situation, the management of crop residues is becoming increasingly important in order to mitigate the impact of pests that live at least part of their lives in the soil or on the soil under debris. Monitoring overwintering niches in areas with crop residues and alternating host plants to determine the abundance of pest populations and time of crop invasion is essential to implement effective IPM programs. This "preventive" step is, in general, overseen and its importance underestimated (Panizzi 2003, 2007).

How can one estimate the intensity of insect pests favored by the "new" landscape to colonize a soybean field? The answer to this question depends on several factors. Abiotic factors such as temperature and humidity (e.g., cold temperatures and heavy rain) may affect the soil-inhabiting insects preventing their abundance. Biotic factors such as previous crops, cultivation systems used, presence of preferred host plants in the area or nearby, and presence of crop residues providing shelter and/or food (i.e., fallen seeds) all influence pest incidence. These and other related factors should be considered in order to estimate the probability of occurrence of certain pests and their intensity. Their management might include plowing and burying the crop residues.

## Main Supporting Components of Soybean IPM

Every IPM program is based on four main components—research, extension, industry, and growers—which depend on each other and are all interrelated (Fig 3). The first component *research* is responsible for the generation of the information. In the case of the soybean IPM in Brazil, the knowledge on major pests, natural enemies, sampling, economic injury levels, and chemical and biological control has been satisfactory produced over the years. However, many questions on the management of pests in the new scenario considering the no-tillage cultivation system and the multiple cropping remain to be answered. *Research* has a greater effect on *extension* and on the *industry* (see arrows in Fig 3). It also has some influence on

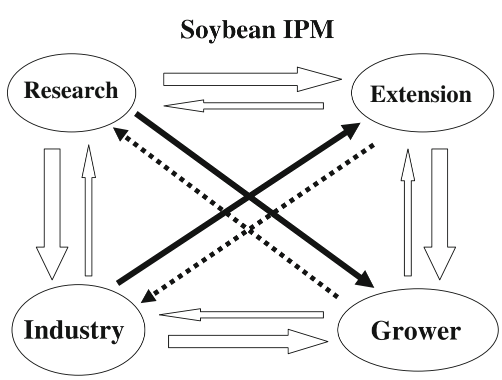


Fig 3 Main components of the soybean IPM developed and implemented in Brazil. *Arrows* indicate the multiple interactions among the components. The less thickness of the *arrow* or the *dotted line* indicates less intensity of the interaction (source: Panizzi 2006).

*growers* since researchers should have direct contact with the users of the information generated.

The second component of IPM, *extension*, is perhaps the most critical since it has a direct and strong impact on *growers* (Fig 3). In the past, the official extension service was more effective than nowadays, and the success of soybean IPM in Brazil in the beginning of its implementation should be credited to effort and commitment of the extension personnel with the program. However, mostly due to the lack of government support, the state extension service started to shrink. Currently, the great majority of the extension service is provided by cooperatives and private companies, and their commitment with IPM implementation is, in general, not the same as that of the state extension service. Clearly, there is a need to train and stimulate both the state and the private extension personnel on the basic concepts of IPM, how to proper identify pests and natural enemies, and make them to better understand the long-term sustainability of this pest control strategy.

The third component of IPM, the *industry*, has played a critical role in the soybean IPM in Brazil by providing efficient insecticides. However, the repetitive use of the same active ingredients resulted in the development of pest resistance to insecticides (Sosa-Gómez et al. 2001). The attempted solution to this problem by making mixtures of active ingredients generating products with very high toxicity, although efficient in the first moment, apparently caused the same problem due to the many complaints of growers about their lack of efficiency. The situation has not changed much nowadays due to the continuous use of the same active ingredients.

The development of soybean cultivars with the *B. thuringiensis* gene that produces toxins effective against defoliating caterpillars is creating a positive expectation. This new tool will greatly mitigate the use of the conventional insecticides early in the season against caterpillars, releasing the pressure against natural enemies. It is expected that this will help to create better conditions for the re-establishment of IPM programs, which should be accommodated to this new reality.

The fourth component of IPM includes the *growers*. There is no current data to show how extent is the area cultivated with soybean in Brazil in which IPM is used. I believe that the almost 2 million hectares under IPM in the 1980s (Moscardi & Souza 2002) should be almost null in the current days. To reverse this situation, great effort should be done to train, stimulate, and show growers the many advantages of IPM use, both in the short and long term. This can be achieved by the extension personnel who play the major role to motivate growers to once again implement IPM programs in their farms (Fig 3).

## Implementation of Soybean IPM Using the Reverse Technique

There are many ways to revive the soybean IPM in Brazil. Here it is suggested to use what was called the reverse technique (reverse IPM) (Panizzi 2006). It basically consists to make growers slowly move from their usual model of pest control to the IPM model, and not to impose the ideal IPM paradigm, based on inflexible parameters.

To better explain this, let us analyze the schematic representation depicted in Fig 4. Line A demonstrates a high intensity in the adoption of a pest control technique in a relatively short time, as is the case with the use of conventional insecticides. Growers fast adopt this control tactic and use it as a general rule. Line B indicates a low intensity in the adoption of a control technique in a relatively long time. This is the case of when an alternative control strategy is proposed, including several tactics as is the case of IPM, with rigid parameters that, although valid, not always fit all growers' needs and conditions. Considering this situation, it is suggested to growers to change their practice of insecticide use (line A) towards the adoption of the IPM practice (line A′); on the other hand, the IPM model (line B) can flexibly move towards the growers practice (line B′) in order to reach a balance between the two models (point of equilibrium C). Clearly, this point C can move toward any direction, considering each grower's condition. Ideally, the more it moves toward the IPM model (line B), the better. The process for the full adoption of the IPM program from the growers' point of view might be slow, but it adds cumulative credibility with time. The adoption rate advances according to the growers will not be based on the theoretical point of view sometimes advocated by researchers. It must be clear that there is not an antagonism of ideas, but a summation of opinions with growers having a more active role according to their particular reality.

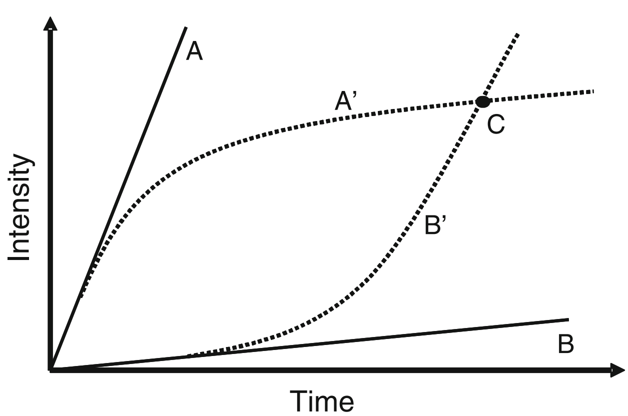


Fig 4 Model to explain the intensity of the adoption of control measures against soybean pests. Mostly the control is made through the use of insecticides following the grower decision without the use of the criteria established by the IPM program (*line A*). In few cases, the growers follow the inflexible criteria of IPM (*line B*). The *dotted lines* (*A′* and *B′*) derive from the previous two lines and converge to a point of equilibrium (*C*). The point C is a result of the adoption of the grower to some criteria of IPM, which are incorporated into its cropping system, by means of what is called reverse IPM (see text for details) (source: Panizzi 2006).

One way to test this IPM reverse technique is to use different field plots, each one following a pre-established treatment (e.g., growers pest control decision, decision solely based on IPM, and a balance between the previous two treatments) for comparison of the net benefits. This is similar to what was used in the introduction of soybean IPM in Brazil in the 1970s (Kogan *et al* 1977). This procedure is very powerful to demonstrate the advantages of IPM and to change the growers' approach in pest control.

## Concluding Remarks

Soybean IPM in Brazil was a very successful pest control program which was widely adopted by growers from the 1970s to the end of the 1990s. After that period, the IPM fell in disuse due to change in the landscape phenology (introduction of no-tillage cultivation and multiple cropping systems) and lack of adjustment of the traditional IPM to the new reality. In addition, the low price of conventional pesticides added to the low input of the state extension service to promote the IPM contributed to the present situation of its abandonment.

This fact has been discussed in several forums in the last years (Panizzi 2006, Moscardi *et al* 2009). It is a consensus that there is an urgent need to have IPM as a government goal and to stimulate the governmental funding agencies to support IPM projects not only for soybean but for other major commodities as well. IPM programs should be envisaged combining private investments with public support in a regional scale to yield longer-term benefits not only to farmers but to the broader community (Brewer & Goodell 2012).

With the fast development of transgenic plants, such as the upcoming release of *Bt*-soybean cultivars in Brazil, change in the soybean cultivars cycle (i.e., toward very early maturity varieties), and change in plant phenology (from determinate to indeterminate plant growing habits), a need to design modern IPM programs that will fit into these new traits is mandatory. This is critical to have growers back to adopt the IPM as their soybean pest control technology.

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