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CROP LIFE TABLE STUDIES OF THE PESTS OF BEANS (*Phaseolus vulgaris* L.) AT GOIÂNIA, GOIÁS[1]

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1. INTRODUCTION

From 1975 to 1977, entomological research with beans (*Phaseolus* spp., *Vigna* spp.) at the National Research Center for Rice and Beans (EMBRAPA/CNPAF), Goiânia, Goiás, was concentrated on three major lines of inquiry: the biosystematics of insect species associated with beans (principally with *P. vulgaris* L.); the bioclimatology of bean production and bean pest problems; and, the development of ecological methodology to assess pest importance (*6*).

One of these latter developments was the adoption of the crop life table, proposed by HARCOURT (*16*) in the study of cabbage pests, and its modification for use with beans. The crop life table approach in entomological research with beans has been continued and expanded (*1, 9, 28*), but in a different geographic region of Brazil and under very different conditions; and, has undergone a considerable evolution. The purpose of this paper is to treat the bean pest fauna as encountered at Goiânia with special consideration of species not previously or not commonly reported from Brazil (*3, 23, 34*).

The rationale of the crop life table does, however, require brief treatment because there exist certain divergences from generally-held pest management research approaches.

The use of the crop life table does not require a prescribed experimental design. It is multidimensional in that it considers the initial variables of implantation, subsequent management or experimental variables, host development,

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and the vagaries of time and weather. It is based on the tenet that density (stand), at any point in time, is the residue of natality (planting rate) less mortality (plant losses) in a system where there is no dispersal. Mortality can be considered as both plant and reproductive structure losses and as production losses resulting from plant injury. As such, the crop life table approach has an enormous experimental flexibility.

The crop life table does not deal with pest population numbers but with plant response to damage, pest populations are really unknown (32). These considerations are important in entomological studies of bean agrosystems (*18*) because beans are subject to multiple attacks by pests and these defy a singular method of sampling or of treatment; thus, there is no initial attempt to establish traditional economic injury levels in recognition of this complexity and the diverse interactions (*23, 24, 27*). Moreover, there are questions as to the practicability of such an approach in low technology systems (*10*).

The term, «bean agrosystem», is expressive of a fundamental departure from general pest management considerations which usually employ the term «agroecosystem». «Agroecosystem» most often refers to the growing season pest problems, or from planted seed to harvested product. In tropical agriculture, pest considerations cannot be terminated with harvest but must continue through the post-harvest interval (*18*). «Agrosystem» expresses this continuity of planted seed to harvested product to planted seed and is of great importance in recognition of the high pest losses that occur in storage (*18, 25*); and, moreso, that most storage pest problems have their origin in the field (*1, 9, 18, 25, 28, 34*).

The major departure of the bean crop life table from that proposed by HARCOURT (*16*) for cabbage was the development of a life table section for the reproductive sequence (flower-pod-ovule-grain-seed). This sequence is the integrated expression of productivity (*6, 14*) and is the measure of plant response to injury. Thus, by appropriate experimental manipulation, these responses can be precisely determined. Great attention must be given to the bean plant because of its very plastic response behavior (*20*). Beans have an extraordinary compensatory capacity, and these compensations are expressed differently in the reproductive sequence (*5*).

The crop life table method leads to the systematic development of research heirarchies (*7, 19*), production potentials (*6, 9, 11, 28*), and identifies potentially promising research-management approaches (*13*). Summarily, it is another way in which to conceptualize bean pest management, establish priority sequences, and to arrive at meaningful solutions.

2. MATERIALS AND METHODS

The research reported herein was carried out at the first EMBRAPA/CNPAF site at Km 4, Goiânia, and not at the present location at Fazenda Capivara.

Plot size was 12 m x 12 m, subdivided into 16 subplots, each 3 m x 3 m. Row spacing was 0.5 m which resulted in 6 rows, each 3 m in length, per subplot. The planting rate was 10 seeds/m as 2 seeds/hill and 20 cm between hills (planting rate of 200,000 plants/ha). Fertilizer (NPK) was applied in the row at planting at rates determined by soil materials analysis. The studies were of beans in monoculture.

The original research emphasis was mostly of direct losses (*i.e.*, based on plant mortality) because first observations indicated high stand mortalities (*11*), and because of the need to identify the pest species of the region as a supplement to existing literature (*8, 15, 30, 35*). Studies of indirect losses (*i.e.*, yield reductions from pest-caused plant injury, but not mortality) were initiated, but on a lesser scale, pending the development of crop life table methodology to incorporate these kinds of data.

Daily counts of dead plants were made as these occurred in the two central rows of each subplot. These counts began at seedling emergence and continued to plant harvest. Dead plants were excavated and the cause o' mortality determined when possible. Because of the climatic and soil conditions at Goiânia it was necessary to complete these counts before 0900 hours, otherwise the soil pests had descended to a depth far below that of recovery and association.

Plant mortality was calculated from the base of the planting rate. The data for the reproductive sequence were obtained by the random collection of 10 plants from the two central rows of each subplot just prior to harvest. Reproductive sequence «mortality» was subdivided as: flowers-total pods-formed pods; and, ovules-grains-seeds. The former yields per plant information; the latter, per pod.

The life table symbols are standard: x, the bean developmental stage (germination-emergence, vegetative, reproductive, maturation); 1_X, the number of plants alive at the beginning of stage x; d_X, the number of plants dying during a developmental stage; d_XF, the factor (s) of mortality; 100_qx, the per cent mortality during a developmental stage; and, 100_{rx}, the cumulative mortality of successive developmental stages, in per cent.

3. RESULTS AND DISCUSSION

3.1. *General Considerations*

Two crop life table are presented (Tables 1 and 3), with their respective reproductive sequence life tables (Tables 2 and 4). These were constructed from two plantings made 9 days apart with two black bean cultivars, 'Rio Tibagi' and 'Tambo'. The experiments were implanted as being 'typical' of those of small producers in the region and were designed to test the life table method, to serve as an 'overview' for delineating pest problems, and as a basis for future adjustments in pest management practices. No insect controls were applied.

Although there was a great difference in mortality between the two plantings, survivorship curves would take the same form as a hollow curve (*31*) with the greatest mortality occurring in the germination-emergence and vegetative stages. This has been true for all traditional planting date studies (*6, 9, 28*), but CALIL (*1*) found a great departure from this with interim plantings. In general, there is little or no plant mortality in the reproductive and maturation stages.

GUAZZELLI (*15*) recommended a planting rate of 12-15 seeds/m to obtain a population of 250,000 planta/ha. He assumed a 20% germination failure. FINLEY (*11*) reported, that a 30% pre-flowering plant loss was considered to be «normal» for Brazil, but that his observations revealed losses of 50-90% during these periods. As can be read from Tables 1 and 3, the pre-flowering plant mortality was 38.1% and 10.35%, respectively; whereas total season plant mortality was 41.3% and 14.03%, respectively.

Information derived from these two life tables proved most instructive in the design of subsequent research. Although a planting rate of 10 seeds/m is not necessarily a condition of 'underplanting', a frequently cited cause of low production in Latin America (*12*), the pattern of 2 seeds/hill, a practice used to obtain seedling emergence force, resulted in this condition. This pattern is inefficient

TABLE 1. A crop life table developed for beans (*Phaseolus vulgaris* L., cv. 'Rio Tibagi'), at Goiânia, Goiás (22 Dec. 1975 - 15 Mar. 1976)

X	l'_x	d_xF	d_x	$100q_x$	$100r_x$
Germination/ Emergence	966	No germination	148	15.3	15.3
		No emergence	35	3.6	3.6
			183	18.9	18.9
Vegetative	783	*Elasmopalpus*	49	6.3	5.1
		Elasmopalpus/ Diplatys	50	6.4	5.2
		Diplatys	15	1.9	1.6
		Ataenius	18	2.3	1.9
		Diabrotica	10	1.3	1.0
		Elateridae[2]	1	0.1	0.1
		Spodoptera	11	1.4	1.0
		Rainfall/ Competition[3]	15	1.9	1.6
		Cultivation	4	0.5	0.4
		Unknown	13	1.7	1.3
			186	23.8	38.1
Reprodutive	597	*Elasmopalpus*	13	2.2	1.3
		Diplatys	2	0.3	0.2
		Ataenius	5	0.8	0.5
		Diabrotica	1	0.2	0.1
		Elateridae[2]	2	0.3	0.2
		Ceuthophilus	2	0.3	0.2
		Competition[3]	2	0.3	0.2
		Unknown	3	0.5	0.3
			30	4.9	41.1
Maturation	567	*Ataenius*	1	0.2	0.1
		Diabrotica	1	0.2	0.1
			2	0.4	41.3
Harvest	565	-	401	-	41.3

1/ l_x is based on the number of seeds planted per 2 rows, each 3m, for 16 subplots (96 meters).

2/ Elateridae - species in the genera *Agriotes* and *Conoderus*.

3/ Competition resulting from 2 plants/hill.

TABLE 2. A reproductive sequence life table developed for beans (*Phaseolus vulgaris* L., cv "Rio Tibagi"), at Goiânia, Goiás (22 Dec. 1976 - 15 Mar. 1977)

X	l_x	d_xF	d_x	$100q_x$	$100r_x$
(per plant)					
Flowers	23.94	*Lytta*	4.03	16.83	16.83
		Unknown	12.10	50.54	50.54
			16.13	67.37	67.37
Total pods	7.81	Not developed	0.32	4.09	1.34
		Birds	0.03	0.38	0.13
			0.35	4.47	68.84
Formed pods	7.46				
	7.46		16.48	—	68.84
(per pod)					
Ovules	5.57	No development	1.22	21.90	21.90
			1.22	21.90	21.90
Grains	4.35	Mold, germination	0.27	6.20	4.85
		Etiella	0.05	1.15	0.90
			0.32	7.35	27.65
Seeds	4.03				
	4.03		1.54	—	27.65

Productivity:

Plants/m (harvest) = 5.89 (Table 1) No seeds/m = 117.08
Formed pods/plant = 7.46 (Table 2) Wt seeds/m = 17.708 g
Seeds/pod = 4.03 (Table 2) kg/ha = 354.16
Wt. 100 seeds = 10g

TABLE 3. A crop life table developed for beans (*Phaseolus vulgaris* L., cv 'Tambó'), at Goiânia, Goiás (31 Dec. 1976 - 24 Mar. 1977)

x	l'x	dx F	dx	100 qx	100 rx
Germination/ Emergence	928	Failure to germinate/emerge	32	3.45	3.35
			32	3.45	3.45
Vegetative	896	*Megalotomus*[2]	4	0.44	0.43
		Elasmopalpus	36	4.03	3.88
		Diplatys	4	0.44	0.43
		Spodoptera	8	0.89	0.86
		Cultivation	6	0.67	0.65
		Unknown	6	0.67	0.65
			64	7.14	10.35
Reproductive	832	*Elasmopalpus*	18	2.16	1.94
		Spodoptera	2	0.24	0.22
		Elateridae[3]	2	0.24	0.22
		Competition[4]	2	0.24	0.22
		Cultivation	2	0.24	0.22
		Unknown	8	0.96	0.86
			34	4.08	14.03
Maturation	798		—	—	14.03
Harvest	798	—	130	—	14.03

1/ lx is based on the number of seeds planted per 2 rows, each 3 m, for 16 subplots.
2/ Result of damaged seed.
3/ Elateridae - species in the genera *Agriotes* and *Conoderm*.
4/ Competition resulting from 2 plants/hill.

TABLE 4. A reproductive sequence life table developed for beans (*Phaseolus vulgaris* L., cv 'Tambô'), at Goiânia, Goiás (31 Dec. 1975 - 24 Mar. 1976)

x	lx	dx F	dx	100 qx	100 rx
(per plant)					
Flowers	21.72	Unknown	11.91	54.80	54.80
Total pods	9.81				
		Not developed	0.78	7.90	58.43
Formed pods	9.03				
	9.03		12.69	—	58.43
(per pod)					
Ovules	5.25				
		No development	1.20	22.90	22.90
Grains	4.05				
		Etiella	0.90	2.20	24.57
Seeds	3.96				
	3.96		1.29	—	24.57

Productivity:

Plants/m (harvest) = 8.31 (Table 3) No. seeds/m = 297.16
Formed pods/plant = 9.03 (Table 4) Wt. seeds/m = 45.287 g
Seeds/pod = 3.96 (Table 4) Kg/ha = 905.74
Wt. 100 seeds = 15.24 g.

(space, fertilizer use), increases interplant competition (one plant of a pair dies or remains barren), and increases pest damage. 'Overplanting' is an often-used strategy to compensate for anticipated losses (*22*), but pattern remains an important consideration.

As plant mortality is expressed as a per cent of the initial planting rate, and productivity is calculated on the basis of number of survivors, it is necessary to evaluate production losses both from mortality sustained and from final survivorship.

3.2. *The Pests of Beans*

The order of discussion of the pest species follows that of their occurrence on developing bean plants as indicated in the life tables.

Elasmopalpus lignosellus (Zeller) (Lepidoptera: Pyralidae). — From the standpoint of plant mortality, this species is the most important pest of beans in the Goiânia area. A plant that survives an early attack will often break at a later time when laden with pods if subjected to wind and rain. Conditions of bean production at Goiânia favor high populations of *E. lignosellus*. Because of the severity of angular leaf spot (*Isariopsis griseola* Sacc.) during the rainy season, this planting epoch is avoided by many growers. This results in the planting of most of the beans during the dry season. *E. lignosellus* is polyphagous (*3, 15, 30, 34*); a dry weather pest (*17, 34*); and, requires only 400 day-degrees above 15ºC to complete one generation (*17*).

Diplatys sp. (Dermaptera: Pygidicranidae). — This large earwig is a «Dr. Jekyl-Mr. Hyde» pest. The nymphs are phytophagous and feed on the rootlets of the bean plant. Females of this species often construct brood chambers within the root systems so that aggregated and sustained nymphal feeding occurs.

The adults are voracious predators, especially of *E. lignosellus* and mole crickets (Orthoptera: Gryllotalpidae). This would tend to make then beneficial insects were it not for their habits of destroying uninfested plants, as well as infested ones, in their quest of prey. In the planting pattern used here of 2 seeds/hill, the earwigs would attack both plants although apparently only one was infested. VARLEY *et al* (*33*) made a very important observation that an individual could be killed but once! Thus, a bean plant attached by *E. lignosellus* which, in turn, was attached by *Diplatys* sp., had the mortality attributed to *E. lignosellus*; a non-infested plant attached by *Diplatys* sp. was attributed thusly; but, when it could not be ascertained as to the real situation, the two species were treated together.

Ataenius sp. (Coleoptera: Scarabaeidae). — This species remains undetermined which is unfortunate considering its importance. As is characteristic of species of *Ataenius*, adults are found in organic matter (beneath fruit, cattle droppings, decaying plant material, etc.), but the adults of this species also feed on plant roots.

The larvae are root feeders and were taken from the roots of beans, rice, corn, various grasses and herbaceeus weeds. Typically, the roots were attacked by several equal age larvae. When the soil is moist, the larvae feed in exposed positions and move freely among the rootlets. However, when the soil is dry, the larvae construct domed mud cells that are affixed to the larger roots and the larvae feed singly within these. The moisture required to construct these cells appears to be plant sap that issues from the feeding sites. Pupation occurs within these cells, or in similar ones.

Diabrotica speciosa (Germar) (Coleoptera: Chrysomelidae). — The adults of this species are the most frequently cited defoliators of beans (*3, 8, 30, 34*).

However, at Goiânia, even though omnipresent and abundant, this species never caused measurable defoliation in the two years of study. In fact, at Goiânia, defoliation was never a factor in bean production.

On the other hand, the larvae caused considerable damage by their root feeding (*6, 23, 29*) and were one of the principal factors of plant mortality. The larvae are extremely active and show great lateral and vertical movement. In moist soil, the larvae will remain closely associated with the root system at all times; but, during dry periods, they will descend to depths of 30 cm during the day and return to feeding positions at night. This was confirmed in the field after original observations were made of their behavior in glass tanks with growing rice plants.

The larvae have been generally described (*23, 34*) as being cream-colored to white with a dark brown or black pygidial plate. An additional diagnostic character is the pair of minute tubercles on the pygidial plate.

Pupation occurs near the soil surface directly beneath plants. Pupae were taken more often beneath the plants of corn, *Brachiaria* spp., and herbaceous weeds than from beneath beans. The pupal stage persists until rainfall and this results in the accumulation of pupae. Immediately following the irregular rains of the dry season, there were spectacular flights of teneral adults in synchronized emergence.

Agriotes sp., *Conoderus* sp. (Coleoptera: Elateridae). — Larvae of species in these two genera were frequently encountered in the first plantings made in the area, but their importance diminished with continued cultivation. Wireworms can be very damaging in newly-developed, cultivated land.

Ceuthophilus sp. (Orthoptera: Gryllacrididae). — An unidentified species of camel cricket was taken from burrows excavated at the bases of the bean plants. Plant mortality was caused by the subterranean feeding on the portion of the stem below ground.

Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae). — This species is the most diverse in habits of all bean pests at Goiânia. It was the only species of cutworm encountered and its activity was observed in all four categories of cutworm behavior, *i.e.*, subterranean, surface, climbing, and army (*21*). Species activity is greater during wet periods and damage is more severe to younger plants; activity generally declines with the onset of dry weather and damage diminishes with plant growth (*1, 28*).

Lytta dimidiata (Fisch.) (Coleoptera: Meloidae). — Flower pests are not common and, usually, of little importance (*34, 35*). CAVALCANTE (*2*) reported a damaging infestation of *L. dimidiata* on bean flowers in São Paulo in 1967. In February, 1976, *L. dimidiata* occurred at Goiânia in enormous numbers, as many as 8/plant, with a resulting heavy flower loss. Because bean flower loss is normally high, it was difficult to evaluate the losses attribuitable to the presence and activity of this species. By data comparison, a loss of 25% was assigned, again using the tenet of VARLEY *et al* (*33*) that some of the flowers fed on by *L. dimidiata* would have fallen normally.

Etiella zinckenella (Treits.) (Lepidoptera: Pyralidae). — This species is favored by wet weather and the damage is greater in pods in contact with the soil or otherwise moisture-damaged. *E. zinckenella* was not important in these studies. *Thecla jebus* Goddard (Lepidoptera: Lycaenidae) is the dry weather counterpart of *E. zinckenella* and was of greater importance in the various experiments carried out; however, *T. jebus* did not occur in the studies presented here.

Megalotomus parvus Westwood (Hemiptera: Alydidae). — This species of big-headed bug can be a serious factor in seed and seedling mortality (*1, 11*). It was recognized and treated by GUAZZELLI (*15*) and PARADELA FILHO *et al* (*26*).

FINLEY (*11*, pers. comm.) recorded a great seed loss at Pirapora, Minas Gerais, from attacks by this species. Although germination may not be appreciably affected, damaged seeds produce abnormal seedlings that never attain the V2 stage (*4*). At Goiânia, a small and insignificant loss was sustained with the cv. 'Tambó' (Table 3), but excessive losses were sustained in other plantings, especially when seeds were used that were produced late in the dry season. *M. parvus* has the potential to be a major pest in dry season and/or fall-winter commercial seed production, but should not be of great concern to edible bean production during these epochs.

3.3. *Other Pest Considerations*

The mortality dichotomy as registered in the bean life table provides unique bases for both theoretical and practical considerations. «Stand» mortality (plant mortality) is one set of data. «Mortality» in the reproductive sequence is another set. Both sets contain non-entomological (indirect) and entomological (direct) information, and both are prerequisite for yield calculations.

«Stand» mortality is more readily understandable because the factors of mortality are generally assignable and the impact of plant loss is more easily quantified because such losses are based on a known planting rate. The development and expression of the reproductive sequence is a very complex process that involves a multitude of variables and includes various compensatory response mechanisms (*5*).

The research approach to evaluate both plant and reproductive sequence mortality was to adopt a series of uniform management practices and to employ selected insecticides designed to: partition the plant (*e.q.*, no treatment, treatments of the soil, foliage, and soil-foliage); produce population gradients; or, provide a time-series profile. Evaluations were made by a visual rating system of plant damage and not by population estimates. This approach, however, is appropriate only for those pests that cause a visible damage.

The bean leafhopper, *Empoasca kraemeri* Ross and Moore (Homoptera: Cicadellidae), does not always cause a visible damage although it can cause severe leaf curling. Importantly it does not often cause plant mortality. Thus, the life table method based on plant mortality would not record its presence or damage; nor would the visual rating system provide a measure of its impact on production.

This species is difficult to sample on beans for diverse reasons. Nymphal populations are sampled more often than adult because they are less active (*23, 24, 34*). During periods of intense heat and dryness that prevail at Goiania, especially during the afternoons, adults of *E. kraemeri* would leave the foliage and move to the underground stem portion and larger roots of the bean plants. The limited observations possible indicated feeding on these subterranean parts. There also appeared to be little or no reproductive activity during these periods as evidenced by the almost complete absence of nymphs.

Leafhopper damage is intensified when plants are under severe water stress. The bean leafhopper and the lesser cornstalk borer are the two most serious dry season pests of beans throughout much of Brazil.

The data in Table 5 are a comparison of reproductive sequence life tables, without and with the systemic insecticide, phorate, applied in the row at planting at 1 kg a.i./ha of 5G formulation. This experiment was conducted to assess pest control, in general, and bean leafhopper control, in particular. These life table data illustrate the information potential of the reproductive sequence.

4. CONCLUSIONS

The crop life table is an exceptional way to record pest-caused production

TABLE 5. A comparison of the reproductive sequence life tables for beans (*Phaseolus vulgaris* L., cv 'Tambô') without treatment and with the application of phorate (1 kg a.i./ha) at planting, at Goiânia, Goiás (31 Dec. 1975-24 Mar. 1976)

Character		Without phorate (Table 4)	With phorate
(per plant)			
Flowers		21.72	33.29
Total pods		9.81	14.50
Formed pods		9.03	13.08
(per pod)			
Ovules		5.25	5.18
Grains		4.05	4.18
Seeds		3.96	4.15
Seed weight (g) of 100 seeds		15.24	14.82
Production per plant	(No. seeds)	35.75	54.28
	(Seed weight)	5.45 g	8.04 g

losses. It is amenable to the individual needs and facilities of research. It provides a broad overview, as well as specific insights, as to pest importance. Based on plant response, it frees the researcher from pest sampling problems and from many of the complexities of multiple pest attack.

A priority emphasis must be placed on its intended and extended use. In a high technology-maximum output cropping system, importance could be given to the benefits of the control of pests as based upon production losses attributable to them. In a low technology-minimum input cropping system, importance could be given to yields obtained in spite of pest losses.

Brazilian bean production is, by and large, an example of this latter system. Moreover, bean are a high risk crop, principally for reasons of unfavorable weather at harvest (*34*). The crop life table organizes the fundamental data for the development of new concepts concerning tropical pest management in keeping with those developing in plant-soil relationships (*12*). These data are of the kinds required in the search for «a gentle technology which is mostly self-operating and with minimum input» (*18*). With an understanding of the pest problems, we may develop the capacity to avoid many of them (*7*) and to tolerate the others.

5. SUMMARY

The crop life table is one approach to the study of loss factors in crop production and is of special value in the identification and quantification of insect pest losses. This report concerns the adaptation and development of the crop life table for the study of bean pests as based on research conducted at EMBRAPA/CNPAF, Goiânia, Goiás, from 1975-1977. Consideration is also given as to the rationale of crop life table use as a means to conceptualize bean insect pest management; and, on a broader scale, to develop a better understanding of warm climate, agricultural entomology.

For beans, the crop life table was divided into two parts: plant mortality (stand loss), and losses in the reproductive sequence (flowers to seeds). Plant mortality was greater in the bean developmental stages of germination-emergence (non-pest factors) and vegetative (pest factors), with little or no stand reduction in the reproductive and maturation stages. The most important pest was *Elasmopalpus lignosellus* (Zeller), and this damage was greatly increased by the searching activities of the predaceous earwig, *Diplatys* sp. The variable cutworm behavior of *Spodoptera frugiperda* (Smith and Abbott), and root-feeding by the larvae of *Ataenius* sp. and *Diabrotica speciosa* (Germar) resulted in significant plant losses.

In the studies reported herein, direct pest losses to the reproductive sequence structures were not important, although this is not generally true. An unusual, but severe, attack of the flowers by *Lytta dimidiata* (Fisch.) was recorded, and light losses were caused by *Etiella zinkenella* (Treits.)

Defoliation was not important, but heavy damage was sustained from infestations of *Empoasca kraemeri* Ross and Moore. The incorporation into crop life tables of indirect damage is discussed as to methodology and evaluation.

Summarily, the crop life table can have two basic interpretations: 1 — the benefits of pest control as based on crop losses; or, 2 — the value of satisfactory yields in spite of pest losses. The kind of pest management system will differ radically depending on the alternative selected.

6. RESUMO

(ESTUDOS SOBRE A TABELA DE VIDA DAS PRAGAS DO FEIJOEIRO (*Phaseolus vulgaris* L.) EM GOIÂNIA, GOIÁS)

A tabela de vida da cultura é um método que visa estudar os fatores que causam prejuízo à produtividade e tem especial valor na identificação e na quantificação das perdas provocadas por pragas. O presente trabalho cuida da adaptação e desenvolvimento da tabela de vida da cultura do feijão, para o estudo das suas pragas, em Goiânia, Goiás, no período 1975-77. São também feitas considerações sobre a lógica do uso da tabela de vida da cultura para conceituar o manejo das pragas do feijoeiro e, em escala mais ampla, para propiciar melhor conhecimento da entomologia agrícola em climas quentes.

Para o feijão, a tabela de vida da cultura foi dividida em duas partes: mortalidade das plantas (perda de «stand») e perdas na seqüência reprodutiva (de flores até sementes). A mortalidade foi maior no estádio de germinação-emergência (fatores não ligados às pragas) e vegetativo (fatores ligados às pragas), com pequena ou nenhuma redução do «stand» no estádio reprodutivo e de maturação. A praga mais importante foi *Elasmopalpus lignosellus* (Zeller), cujos danos foram grandemente aumentados pelas atividades de procura do predador *Diplatys* sp. A lagarta *Spodoptera frugiperda* (Smith & Abbott) e as larvas comedoras de raízes de *Ataenius* sp. e *Diabrotica speciosa* (Germar) provocaram danos significantes.

Neste estudo, não foram importantes os danos diretos causados pelas pragas

às estruturas da seqüência reprodutiva, embora isso não ocorra com freqüência. Foi registrado um ataque incomumente severo de *Lytta dimidiata* (Fisch.) às flores. Pequenos danos foram causados por *Etiella zinkenella* (Treits.).

O desfolhamento não foi importante, mas prejuízos pesados foram provocados por infestações de *Empoasca kraemeri* Ross & Moore. A incorporação de danos indiretos às tabelas de vida da cultura é discutida nos aspectos de metodologia e avaliação.

Em suma, a tabela de vida da cultura pode ter duas interpretações básicas: 1) os benefícios do controle de pragas, quando baseados nas perdas culturais, ou 2) o valor de rendimentos satisfatórios, apesar das perdas causadas pelas pragas. A natureza do sistema de manejo das pragas diferirá radicalmente, dependendo da alternativa escolhida.

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8. LITERATURE CITED

1. CALIL, A.C.P. *Avaliação das populações de pragas do feijoeiro (Phaseolus vulgaris* L.), *em seis épocas de plantio, utilizando a tabela de vida*. Viçosa, U.F.V., Imprensa Universitária, 1983. 92 p. (Tese M.S.).

2. CAVALCANTE, R.D. *Lytta dimidiata* (Fisch., 1827), praga do feijoeiro (*Phaseolus vulgaris*) em S. Paulo. *Fitossanidade, 1*(2): 56. 1975.

3. CAVALCANTE, R.D. *Dicionário de entomologia*. Brasília, Editerra Editorial, 1983. 802 p.

4. CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL (CIAT). Una escala de desarrollo para el frijol propone el CIAT. *Hojas de Frijol, 5*(2):1-2. 1983.

5. CHAGAS, J.M.; VIEIRA, C.; MAESTRI, M. & CARDOSA, A.A. Resposta de duas variedades de feijão (*Phaseolus vulgaris* L.) ao desfolhamento artificial. *Ciência e Cultura, 31*(6):683-687. 1979.

6. CHANDLER, L. *Annual report for 1976*. Goiânia, USAID/EMBRAPA/Purdue University Contract, CNPAF, 1977. 47 p.

7. CHANDLER, L. Pragas — «O melhor mesmo é evitar». *Informe Agropecuário, 9*(104):59. 1983.

8. COSTA, C.L.; ROSSETTO, C.J.; VIEIRA, C.; BITRAN, E.A.; FREIRE, J.A.H.; LIMA, J.O.G. de; CAVALCANTE, R.D.; GUAZZELLI, R.J. & CAMPOS, T.B. Investigações sobre pragas do feijoeiro no Brasil. In: SIMPÓSIO BRASILEIRO DE FEIJÃO, 1.º, Campinas, 1971. Anais. Viçosa. Universidade Federal, 1972, 2.º volume, p. 283-302.

9. DELLA LUCIA, T.M.C. *Aplicação da tabela de vida das culturas às pragas de Phaseolus vulgaris* L. *em quatro níveis de adubação*. Viçosa, U.F.V., Imprensa Universitária, 1983. 128 p. (Tese D.S.).

10. FARRINGTON, J. Economic thresholds of insect pest infestation in peasant agriculture: a question of applicability. *PANS, 23*(2):143-148. 1977.

11. FINLEY, A.M. *End of tour report*. USAID Loan Agreement 512 — L — 077, USAID/EMBRAPA/Purdue University Contract, 1976. 20 p.

12. FOOD AND AGRICULTURAL ORGANIZATION (FAO). *Final report*. Expert consultation on food legume production for the Caribbean, Central America and Panama. Santo Domingo, D.R., 1979. 64 p.

13. FOY, C.D. Plant adaptation to mineral stress in problem soils. *Revista Ceres, 29*(144):551-560. 1982.

14. GONÇALVES, M.C. *Correlações genotípicas, fenotípicas e de ambiente em feijoeiro (Phaseolus vulgaris* L.). Viçosa, U.F.V., Imprensa Universitária, 1979. 42 p. (Tese M.S.).

15. GUAZZELLI, R.J. *Cultura do feijão*. Sete Lagoas, IPEACO, 1972. 38 p. (Circular n.º 14).

16. HARCOURT, D.G. Crop life tables as a pest management tool. *Canadian Entomol., 102*(8):950-955. 1970.

17. KISHINA, K. Biologia da lagarta elasmo. In: REUNIÃO DE PESQUISA SOBRE FITOSSANIDADE NA REGIÃO DE CERRADOS, 3.ª, Sete Lagoas, 1980. p. 26.

18. LABEYRIE, V. Ecological problems arising from weevil infestation of food legumes. In: LABEYRIE, V.ed. *Serie Entomologica*. The Hague, Dr. W. Junk Publ, 1981. 1-15.

19. LEVINS, R. & WILSON, M. Ecological theory and pest management. *Ann. Review Entomol., 25*:287-308. 1980.

20. LOPES, N.F.; OLIVA, M.A.; FREITAS, J.G. de; MELGE, E. & BELTRÃO, N.E. de M. Análise de crescimento e conversão energia solar em feijoeiro (*Phaseolus vulgaris* L.) submetido a três níveis de densidade do fluxo radiante. *Revista Ceres, 29*(166):586-606. 1982.

21. METCALF, C.; FLINT, W. & METCALF, R. *Destructive and useful insects*. New York, McGraw-Hill, 1962. 1087 p.

22. MUMFORD, J.D. *Social and institutional factors in the implementation of insect pest management*. West Lafayette, Purdue Entomology Celebration, 1980. p. 58-63.

23. NAKANO, O. Principais pragas da cultura do feijão. *Correio Agrícola,* fev.º: 522-529. 1983.

24. NAKANO, O.; SILVEIRA NETO, S. & ZUCCHI, R. *Entomologia econômica.* São Paulo, Edit. Agron. Ceres, 1981. 314 p.

25. NATIONAL ACADEMY OF SCIENCE. *Pérdidas de post-cosecha de alimentos en paises en desarrollo.* Trad. de Gonzalo Roa. Viçosa, Centro Nacional de Treinamento em Armazenagem, 1982. 213 p. (Série CENTREINAR n.º 4).

26. PARADELO FILHO, O.; ROSSETTO, C.J. & POMPEU, A. *Megalotomus parvus* Westwood (Hemiptera: Alydidae), vector of *Nematospora coryli* Peglion em feijoeiro. *Bragantia, 31*(2):5-10. 1972.

27. POLSTON, F.; PEDIGO, L. & WELCH, S. Economic injury levels: reality and practicality. *Bull. Entomol. Soc. America, 29*(1):49-53. 1983.

28. RAMOS, J.M.A. *Tabela de vida em duas épocas de plantio, para o feijão (Phaseolus vulgaris* L.), *em monocultivo e em consórcio com o milho* (*Zea mays* L.), *na região de Viçosa, Minas Gerais.* Viçosa, U.F.V., Imprensa Universitária, 1982. 59 p. (Tese M.S.).

29. SALGADO, L.O. Pragas que danificam sementes e plântulas. Características e controle. *Informe Agropecuário, 8*(9):41-44. 1982.

30. SILVA, A.G. d'A.; GONÇALVES, C.R.; GALVÃO, D.M.; GONÇALVES, A.J.L.; GOMES, J.; SILVA, M. do N. & SIMONI, L. de. *Quarto catálogo dos insetos que vivem nas plantas do Brasil, seus parasitos e predadores.* Parte II — 1.º tomo — Insetos, hospedeiros e inimigos naturais. Rio de Janeiro, Min. da Agric., Dept.º Defesa e Inspeção Agropec, 1968. 622 p.

31. SILVEIRO NETO, S.; NAKANO, O.; BARBIN, D. & VILLA NOVA, N.A. *Manual de ecologia dos insetos.* São Paulo, Agronômico Ceres, 1976. 419 p.

32. TURNBULL, A.L. & CHANT, D.A. The practice and theory of biological control of insects in Canada. *Canadian Jour. Zool., 39*:697-753. 1961.

33. VARLEY, G.; GRADWELL, G. & HASSELL, M. *Insect population ecology — An analytical approach.* Oxford, Blackwell, 1973. 212 p.

34. VIEIRA, C. *Doenças e pragas do feijoeiro.* Viçosa, Imprensa Universitária, 1983. 231 p.

35. VIEIRA, C.; FREIRE, J.A.H. & LIMA, J.O.G. de. Doenças e pragas do feijoeiro (*Phaseolus vulgaris* L.). *Revista Ceres, 18*(99):367-380. 1971.