African Crop Science Journal
AFRICAN CROP SCIENCE SOCIETY
ISSN: 1021-9730 EISSN: 2072-6589
VOL. 7, NUM. 1, 1999, PP. 59-69

African Crop Science Journal,
Vol. 7 No. 1 1999 pp. 59-69

Studies Of Pigeonpea Insect Pests And Their Management In Kenya, Malawi, Tanzania And Uganda

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(Received 26 October, 1998; accepted 25 January, 1999)

Code Number: CS99006

ABSTRACT

Systematic surveys were conducted in farmers= fields in Kenya, Malawi, Tanzania, and Uganda to determine the incidence, distribution and damage levels due to insect pests of pigeonpea seeds. Three surveys were conducted in eastern Kenya, one in 1992 and two in 1995. Two surveys, one per country per year - were conducted in Malawi, Tanzania, and Uganda in 1995 and 1996. Key insect pests were pod sucking bugs (dominated by *Clavigralla tomentosicollis* Stål), pod and seed boring Lepidoptera (*Helicoverpa armigera* Hübner, *Maruca vitrata (= testulalis)* Geyer, *Etiella zinkenella* Treitschke*)*, and pod fly (*Melanagromyza chalcosoma* Spencer). Seed damage due to insect pests were 22, 15, 14, and 16% in Kenya, Malawi, Tanzania, and Uganda, respectively. Damage levels indicated that pod sucking bugs were more damaging in Malawi (caused 69% of total seed damage) and Kenya (43%), while pod borers caused more damage in Tanzania (50%) and Uganda (54%). Pod fly caused more damage in Kenya than in the other countries. Pod borer damage was high in early maturing crops and pod fly in late maturing crops, while pod sucking bugs damage was high regardless of crop maturity period. Greater variations in seed damage were observed between locations in Kenya, Malawi, and Tanzania than in Uganda. Warm and dry locations had less seed damage than warm and humid, cool and dry, or cool and humid locations in Kenya, Malawi and Tanzania. None of the farmers visited in Malawi, Tanzania, and Uganda used conventional pesticides on pigeonpea in the field. Over 80% of these farmers used traditional methods in storage pest management. In contrast, 35 and 53% of farmers in Kenya had used conventional pesticides on long-duration pigeonpea genotypes in their fields.

Key Words: Distribution, Lepidoptera, pod fly, pod sucking bugs

RÉSUMÉ

On a conduit une série d=enquêtes en champs paysans au Kenya, au Malawi, en Tanzanie, et en Ouganda afin de déterminer l=incidence et la répartition des ravageurs de pois d=Angole ainsi que les taux de dégâts aux grains dus à ces ravageurs. Trois enquêtes ont été menées dans l=est du Kenya, une en 1992 et deux en 1995. Chacun des trois pays - Malawi, Tanzanie et Ouganda - ont fait l=objet d=enquêtes une fois en 1995 et une autre fois en 1996. Les ravageurs importants ont compris des punaises suceuses de gousse (surtout *Clavigralla tomentosicollis* Stal), des foreurs des gousses et des grains (*Helicoverpa armigera* Hubner, *Maruca vitrata* (= *testulalis*) Geyer, *Etiella zinkenella* Treitschke), ainsi que des mouches des gousses (*Melanagromyza chalcosoma* Spencer). En milieu réel, les dégâts aux grains dus aux ravageurs ont été 22% au Kenya, 15% au Malawi, 14% en Tanzanie, et 16% en Ouganda. Les taux de dégâts ont indiqué que les punaises suceuses de gousse ont été les plus graves au Malawi (69% des dégâts totaux aux grains) et au Kenya (43%), tandis que les foreurs des gousses ont occasioné plus d=atteintes en Tanzanie (50%) et en Ouganda (54%). Les mouches des gousses ont causé plus de dégâts au Kenya que dans d=autres pays. Les foreurs des gousses ont provoqué des dégâts importants chez les cultures précoces et les mouches des gousses chez les cultures tardives. Les punaises suceuses de gousse ont causé des atteintes graves sur tous les cycles de maturation. Il y a eu plus de variations dans les taux de dégâts parmi les localités au Kenya, au Malawi et en Tanzanie qu=en Ouganda. Les localités chaudes et sèches ont eu moins de dégâts que les localités chaudes et humides, fraîches et sèches, ou fraîches et humides au Kenya, au Malawi et en Tanzanie. Les paysans qu=on a rencontrés au cours des enquêtes au Malawi, en Tanzanie et en Ouganda n=ont pas appliqué de pesticides conventionnels sur le pois d=Angole aux champs. Plus de 80% de ces paysans emploient des méthodes de lutte traditionnelles contre les insectes des denrées. Par contre, 35% des paysans rencontrés au Kenya en juillet 1995 et 53% en août 1995 ont appliqué des pesticides conventionnels sur les génotypes de pois d=Angole tardifs dans leurs champs.

Mots Clés: Distribution, Lepidoptera, foreurs de gousses, punaises suceuses

INTRODUCTION

The southern and eastern Africa regions, particularly Kenya, Malawi, Mozambique, Tanzania and Uganda, constitute the second largest pigeonpea (*Cajanus cajan* [Linnaeus] Millspaugh) growing areas in the world, after India (Singh, 1991). In this region, the crop is grown in different areas varying in altitude from sea level to 2000 m (Silim *et al*., 1994). Pigeonpea is a perennial shrub, but it is cropped annually in most farming systems mainly as an intercrop with cereals, short-duration legumes and other annuals (Acland, 1971). Intercrops are often harvested before pigeonpea flowers and it completes its life cycle as a monocrop. Pigeonpea seed is an important source of protein in the diet of people in many countries, both as green pea or as dry grain. The dry grain (Kenya, Malawi, Mozambique, Tanzania and Uganda) and the green pea (Kenya) are also important export forms of the crop.

Insect pests are some of the major biotic constraints to pigeonpea production in the region (Reed and Lateef, 1990). In Kenya, Okeyo-Owuor (1978) assessed losses in pigeonpea using data from a pesticide trial and attributed 13% seed loss to lepidopteran borers and 11% to pod fly (*Melanagromyza* sp.). Omanga *et al*. (1991) reported 16 to 72% and 39 to 70% seed damage due to insect pests on pigeonpea in Kenyan Eastern and Coastal Provinces, respectively. Lateef (1991) reviewed damage levels from insect pests on pigeonpea in Kenya and reported that damage to pods by pod borers ranged from 30 to 35% and that by pod fly (*Melanagromyza chalcosoma* Spencer) from 4 to 11% in Central Province. In the Coast Province, he reported that *Maruca vitrata (= testulalis)* Geyer (Lepidoptera: Pyralidae) caused 32% damage to pigeonpea pods.

Insect pest infestations have also been reported in Malawi (Reed, 1987). Sithanantham and Reddy (1990) gave a short list of arthropods associated with pigeonpea in Kenya, Malawi and Zambia. Munthali (1991) also listed some of the important insect pests of pigeonpea in Malawi, while Johansen *et al.* (1993) gave an overview of the major insect pests of pigeonpea in the region.

In Tanzania, insect pests have been reported on pigeonpea (Le Pelley, 1959) and are considered one of the major constraints to pigeonpea production (Materu, 1970). However, information on the incidence and damage by different insect pests on the crop is limited (Materu, 1970; Myaka, 1994). Materu (1970) reported that over 50% of pigeonpea seeds were disfigured and unmarketable because of damage by pod sucking bugs (mainly *Clavigralla* spp., Hemiptera: Coreidae). Myaka (1994) reported that pod borers (mainly *Helicoverpa armigera* Hübner, Lepidoptera: Noctuidae) activity on pigeonpea decreased in cool and dry months, but that of pod sucking bugs increased. Mphuru (1978) reported the occurrence of *Callosobruchus* species in stored pigeonpea.

Similarly, in Uganda, insect pests have been cited as one of the major biotic factors limiting pigeonpea production (Le Pelley, 1959; Musaana *et al*., 1992; Silim-Nahdy and Odong, 1993; Night and Ogenga-Latigo, 1994). Information on the incidence, distribution, damage levels, consequent yield losses and strategies for the management of storage insect pests in Uganda is also available (Silim-Nahdy, 1994, 1996). However, detailed information on field pests in Uganda is limited, although Koehler and Rachie (1971)

recorded 5% seed damage due to *H. armigera* on pigeonpea.

Systematic surveys of pest incidence, distribution, and consequent seed and pod damage levels in farmers= fields have not been conducted in most countries in eastern and southern Africa. A series of surveys were, therefore, conducted in the major pigeonpea cultivation areas in Kenya, Malawi, Tanzania, and Uganda to address this lack of information (Fig. 1).

Figure 1: Pigeonpea growing areas surveyed for insect pests in Kenya, Malawi, Tanzania and Uganda in 1995 and 1996.

MATERIALS AND METHODS

The surveys were conducted in the major pigeonpea growing areas of eastern Kenya in August 1992, July 1995, and August 1995. In Malawi, surveys were conducted in southern and part of northern region in June 1995 and July 1996. In Tanzania, surveys were conducted in southern region in August 1995 and 1996, and northern region in September 1995 and 1996. Surveys in northern Uganda were carried out in October 1995 and 1996.

Field work was planned to coincide with similar growth stages in each of the four countries. The survey technique involved selection of fields at random, depending on the visibility and accessibility from the roads. Between 30 and 150 pigeonpea pods were collected from each field. Sample sizes were drawn according to farm size, plant population, and the degree of farmer=s cooperation. Pods were later examined and opened to determine pest damage and the type of insect pests which caused damage to pods and seeds.

In the field, records were taken on insect pests and their natural enemies, cropping practices, and grain storage management. Farmers were interviewed about their perceptions of important pests, their damage levels, and management practices. Samples of insect pests and emerging natural enemies were collected for further identification.

RESULTS

The insect pest complex on pigeonpea in farmers= fields was similar in Kenya, Malawi, Tanzania, and Uganda. However, the incidence, distribution, and damage levels varied among the countries, and locations and seasons within a country. The key insect pest groups on pigeonpea in the field in Kenya, Malawi, Tanzania, and Uganda included pod sucking bugs (dominated by *Clavigralla tomentosicollis* Stål), pod boring Lepidoptera (*Helicoverpa armigera* Hübner, *Maruca vitrata* (=*testulalis)* Geyer, and *Etiella zinkenella* Treitschke), and pod fly (*Melanagromyza chalcosoma* Spencer) (Table 1). The common and widespread insect pests in store were bruchids (*Callosobruchus chinensis* Linnaeus and *Callosobruchus* sp.). Farmers in Malawi were concerned about bruchid damage during storage but the pest was not observed in the fields during the surveys and there were no documented reports or crops stored by farmers for inspection (Table 1).

The pod fly species was identified as *Melanagromyza chalcosoma* Spencer [I.M. White (IIE) det.]. Its biology is different from *Melanagromyza obtusa* Malloch, which is mainly found in India, in that, while *M. obtusa* has one or two larvae feeding and boring in a single pigeonpea seed, *M. chalcosoma* has more than two larvae seed^{-1}. Over 50% of pods sampled in the four countries had more than 5 larvae locule^{-1}. Up to 15 larvae were observed in single locules and as many as 40 larvae and or pupae pod^{-1} were recorded in pods with an average of five seeds in eastern Kenya. There were indications that some of the larvae had migrated to neighbouring locules when the contents of one seed were devoured.

Kenya. Overall seed damage was 25% in August 1992, 13% in July and 27% in August 1995 (Table 2). Damage levels by major insect pest groups indicated that pod sucking bugs caused more damage (11.7%) than pod fly (9.0%) and pod borers (6.6%). There were variations in seed damage levels among districts. Damage was highest in Kilifi (42.0%) and Meru Districts (40.0%), and lowest in Makueni District (13.8%). In Kilifi, the weather is predominantly warm and humid, and crops mature fast in the season. In Meru, the weather is cool and semi-humid, and crop maturity is slow. The weather in Makueni is predominantly warm and dry, and crops mature relatively faster than in Meru.

TABLE 1. Major insect pests on pigeonpea in farmers' fields in Kenya, Malawi, Tanzania, and Uganda

ORDER/Scientific name	Family	Pest status			
		K	M	T	U

COLEOPTERA					
Callosobruchus chinensis Linnaeus	Bruchidae	***	-	***	***
Callosobruchus spp. (Probably *C. rhodesianus*)	Bruchidae	-	-	**	-
DIPTERA					
Melanagromyza chalcosoma Spencer	Agromyzidae	***	*	***	***
HEMIPTERA					
Clavigralla tomentosicollis Stål	Coreidae	***	***	***	***
LEPIDOPTERA					
Etiella zinkenella Treitschke	Pyralidae	**	**	**	**
Helicoverpa armigera Hübner	Noctuidae	***	***	***	***
Maruca vitrata (testulalis) Geyer	Pyralidae	***	***	**	***

- Not seen
* Occasionally serious, sporadic or of local importance
** Common, causes widespread concern
*** Serious, widely distributed, causes heavy economic losses
K=Kenya, M=Malawi, T=Tanzania, U=Uganda

TABLE 2. Pod and seed damage due to major insect pests of pigeonpea in farmers' fields in Kenya (1992 and 1995)

District	Agro-ecological zone*	Pod damage by borers	Seed damage (%)			
			Pod borers	Sucking bugs	Pod fly	Total
Embu	LM3, LM4	15.8	5.3	9.1	10.0	24.4
Kilifi	CL3, CL4	21.0	9.4	32.4	0.2	42.0
Kirinyaga	LM3	14.9	4.5	11.6	13.2	29.3
Kitui	LM4, LM5	16.5	7.8	5.9	6.1	19.8
Machakos	LM4, UM4	15.8	7.2	5.8	4.8	17.8
Makueni	LM5	20.6	6.1	5.0	2.7	13.8
Meru	LM3, UM4	19.6	6.3	10.3	23.4	40.0
Tharaka Nithi	LM4, LM5	11.5	6.0	13.8	11.8	31.6
Range	-	11.0-30.6	4.0-10.7	2.8-42.4	0-36.4	11.3-51.4
Mean	-	17.0	6.6	11.7	9.0	22.3

± SE	-	3.5	1.1	2.5	2.1	3.2
CV (%)	-	29.3	26.4	32.8	-	32.4

Zones:
UM Upper Midland zone
LM Lower Midland zone
L Lowland zone
CL Coastal lowlands
Zonal climatic conditions:
CL Humid, 800-1250 mm rainfall, 24-26.6° C mean temperature
Zone 3 Semi-Humid, 800-1400 mm rainfall, 16-18° C mean temperature
Zone 4 Semi-Humid to Semi-Arid, 600-1000 mm rainfall, 16-20° C mean temperature
Zone 5 Semi-Arid, 450-900 mm rainfall, 20-24° C mean temperature

Malawi. The differences between damage by borer larvae and sucking bugs were explained to farmers. Discussions with farmers during surveys revealed that lepidopteran pod boring larvae ("mbozi") are associated with both chewed and sucked pigeonpea seeds. None of the farmers visited in Malawi used insecticides on pigeonpea in the field. Most farmers (70%), however, used wood ash ("phuluza") and about 10% used pirimiphos-methyl (Actellic® dust) to protect food grain and seeds stored for planting.

Seed damage levels in southern Malawi indicated that pod sucking bugs, mainly *C. tomentosicollis*, were the most damaging insect pests in the two seasons, accounting for 68.9% of total seed damage (Table 3). Pod boring Lepidoptera were the second most important field pests of pigeonpea causing 30.5% of total seed damage. Pod fly (*M. chalcosoma*) incidence and damage were very low in both seasons. Among the pod borers *E. zinkenella* was most abundant, followed by *H. armigera*. *M. vitrata* which was reported to be severe in March 1995 and 1996 was observed in only a few fields in Zomba during the June and July surveys. Bruchids were not observed in the fields in Malawi and farmers did not have any stored peas for inspection (Table 3).

TABLE 3. Pod and seed damage due to insect pests of pigeonpea in Malawi (1995 and 1996)

District	Pod damage by borers	Seed damage (%)			
		Borers	Sucking bugs	Pod fly	Total
Blantyre	11.6	3.8	7.3	0.0	11.1
Mulanje	11.6	3.8	11.7	0.1	15.6
Mwanza	13.5	5.2	10.8	0.30	16.4
Thyolo	12.9	5.2	15.7	0.00	20.9
Zomba	15.6	4.8	6.0	0.00	10.8
Range	0-37.5	0-25.0	0-36.4	0-3.9	2.7-39.3
Mean	13.0	4.6	10.3	<0.1	15.0
SE ±	1.65	0.72	2.43	-	2.16
CV(%)	28.4	18.6	32.6	-	39.3

There were some variations in seed damage levels among districts in Malawi. Seed damage was highest in Thyolo District (20.8%) and lowest in Zomba and Blantyre Districts (10.8% and 11.1%, respectively). The pigeonpea growing areas in Thyolo are cool and humid, while those in Zomba and Blantyre are warm and semi-humid. There were variations in damage levels by the major insect groups. Pod sucking bugs accounted for over 60 and 75% of total seed damage on pigeonpea in 1995 and 1996, respectively. Pod

borers caused 38 and 24% of the total seed damage in 1995 and 1996, respectively. In Malawi, the temperatures were lower in July (mean 16° C) than in June (mean 18° C).

Tanzania. In Mbulu District in the northern zone, farmers cited pod borers and sucking bugs as major insect pests in the northern zone. In the southern zone, farmers reported pod borers, sucking bugs (referred to as "ipukuu" and "malembele", respectively), and bruchids as major insect pests, while *Fusarium* wilt *(Fusarium udum* Butler*)* was one of the disease problems in heavy soils. None of the farmers visited in Tanzania had used conventional pesticides for pest management on pigeonpea and only a few owned boom sprayers for spraying sulphur on cashew trees. Some farmers (45%), however, used wood ash in grain stored for food or seed for planting, while others (12%) used chillies or smoke from cooking fires to preserve seeds for planting. Other farmers (36%) stored unthreshed pods as a strategy to minimise grain damage by bruchids. A few farmers (2%) boiled, fried or dehulled small quantities of their food grain before storage to avoid bruchid damage.

Overall, seed damage due to insect pests of pigeonpea in Tanzania was 14.4%. Damage levels indicated that pod borers and pod sucking bugs were the most important pests on pigeonpea, accounting for 50.1% and 46.0%, respectively, of total seed damage (Table 4). The most common pod borers in the south were *E. zinkenella*, *H. armigera* and *M. vitrata*, while in the north *H. armigera* and *E. zinkenella* were dominant. Pod sucking bugs, dominated by *Clavigralla* sp., were common in both zones. Pod sucking bugs caused more seed damage in the southern zone in 1996 (10.8%) compared to the same period in 1995 (5.0%). The incidence and damage due to pod fly (*M. chalcosoma*) and bruchids in the field (*Callosobruchus* spp.) were low in both seasons. Although on average pod fly incidence and damage were low (0.3%), substantial damage (7.0%) was recorded at high altitude areas (over 1400 m) in Mbulu District. In Tanzania, as in Malawi and Kenya, there were large variations in seed damage between the districts. The highest damage was in Masasi District (22.0%) and the lowest in Babati District (10.0%). Both districts have a long dry season but Babati is at a higher altitude (1300 m altitude) than Masasi (450 m) (Table 4).

TABLE 4. Pod and seed damage due to insect pests on pigeonpea in Tanzania 1995 and 1996

District	Pod damage by borers	Seed damage* (%)				
		Borers	Sucking bugs	Pod fly	Bruchids	Total
Aru Meru	19.2	7.5	5.4	0.20	0.00	13.11
Babati	10.9	5.5	4.2	0.3	0.00	10.0
Lindi	16.7	7.1	4.9	0.00	0.5	12.6
Masasi	15.2	5.7	15.7	0.00	0.4	21.9
Mbulu	14.9	9.5	4.2	1.50	0.00	15.2
Mtwara	19.5	8.5	6.7	0.00	0.00	15.2
Nachingwea	19.2	6.6	5.2	0.10	0.9	12.8
Range	4.0-40.3	1.5-19.7	0.0-16.0	0.0-7.0	0.0-4.6	3.7-26.1
Mean	16.5	7.2	6.6	0.3	0.3	14.4
SE ±	1.92	1.34	1.79	-	-	1.46
CV(%)	32.3	29.4	34.7	-	-	36.5

* Bruchids were only observed in sample pods from fields in southern Tanzania

Uganda. Farmers indicated that insect pests are major limiting factors to pigeonpea production in northern Uganda. However, none of the farmers used conventional pesticides in the field and most (94%) do not own sprayers. A few farmers (5%) who cultivated cotton owned sprayers, but they had not used them to spray pigeonpea. Bruchids (*Callosobruchus chinensis*) were considered to be important during storage. As such, some farmers (10%) used wood ash on grain stored for food and seed for

planting. Other farmers (30%) stored grain in sealed earthen pots to reduce damage by bruchids. Most farmers (80%), however, practiced sun-drying to reduce bruchid populations in their stored grain.

Seed damage due to insect pests on pigeonpea in Uganda averaged 16%. Seed damage levels by major insect pest groups indicated that pod borers were more damaging (53.5%) than pod sucking bugs (26.6%) and pod fly (19.9%) (Table 5). There were no marked variations in seed damage between Apac and Lira districts in the two seasons, probably because both districts are warm and humid.

Farmers= perceptions of pests and their attitudes to pesticide use. Farmers were concerned mostly about pod sucking bugs, bruchids, pod borers and *Fusarium* wilt as their major biotic constraints to pigeonpea production in the region (Table 6), but only a few farmers had used pesticides on pigeonpea fields in the recent past (Table 7). Lack of sprayers, water and information, and the high cost or unavailability of pesticides were among the major constraints to pesticide use by farmers in the region. The use of fungicides for insect pest management by 2% of farmers in Kenya is clear indication of lack of knowledge about types of pesticides for different uses.

TABLE 5. Pod and seed damage by insect pests on pigeonpea in Uganda 1995 and 1996

District	Pod damage by borers	Seed damage (%)			
		Borers	Sucking bugs	Pod fly	Total
Apac	13.7	8.1	2.6	4.40	14.1
Lira	15.7	9.1	5.9	2.0	16.0
Range	4.0-40.0	4.0-22.7	1.0-15.2	1.0-22.6	4.2-35.9
Mean	14.7	8.6	4.3	3.2	16.2
SE ±	0.34	0.27	0.56	0.43	0.96
CV(%)	15.2	12.6	21.7	32.8	27.4

TABLE 6. Farmers' perceptions of important biotic constraints to pigeonpea production in Kenya, Malawi, Tanzania and Uganda

Constraint	Farmers concerned about a given constraint (%)				
	All	Kenya	Malawi	Tanzania	Uganda
Pod sucking bugs	83	84	88	79	76
Pod boring Lepidoptera	51	42	39	62	70
Pod fly	19	36	0	16	22
Flower (pollen) beetles	32	28	41	27	25
Thrips	0	0	0	0	0
Termites	26	36	31	29	2
Aphids	0	0	0	0	0
Bruchids	72	68	54	80	78

Fusarium wilt	42	32	72	67	7

TABLE 7. Farmers' reaction to pesticide use in Kenya, Malawi, Tanzania and Uganda. Data are the percentage of positive responses to list of statements

Farmer practice/perception	Responses of farmers to questions about pesticide use (%)				
	All	Kenya	Malawi	Tanzania	Uganda
Insecticides used	14	46	0	0	0
Fungicides used*	1	2	0	0	0
Pesticides not used because:					
No need	12	9	15	14	14
Not available	23	34	26	16	12
Too expensive	70	79	68	61	59
No sprayer	93	87	100	98	96
No information	73	54	91	84	83
No water	78	86	87	85	46

* Fungicides were used against insect pests, but they did not work

DISCUSSION

The major insect pests on pigeonpea in Kenya, Malawi, Tanzania, and Uganda are similar but the incidence, distribution and damage levels are variable. Although Night and Ogenga-Latigo (1994) reported pod wasp [*Tanaostigmodes cajaninae* LaSalle (Hymenoptera: Tanaostig-matidae)] on pigeonpea in Central Uganda, this pest was not spotted in northern Uganda or in any of the other countries during the surveys.

Seed losses due to insect pests on pigeonpea were similar to earlier reports in Kenya (Okeyo-Owuor, 1978; Omanga *et al*., 1991), Tanzania (Materu, 1970), and Uganda (Koehler and Rachie, 1971). Variations in the incidence and distribution of pests, and hence, seed damage levels in the four countries, appeared to be related to variation in altitude and time to crop maturity. In areas where pigeonpeas matured during warm and dry weather (Makueni, Kitui and Embu in Kenya) there was more damage from pod borers than from pod sucking bugs. Consequently, seed damage levels were relatively lower than in areas where the crops matured during warm and humid weather (Kenya coast, northern Uganda and parts of sourthern Tanzania), in which case severe seed damage was caused by pod borers and pod sucking bugs.

Pigeonpea maturing during cool and dry or cool and humid weather (Meru in Kenya, five districts in Malawi, and Mbulu in Tanzania) had high seed damage levels due to infestation by a greater range of pests, i.e., pod sucking bugs, pod fly, pod and seed borers, and aphids. The seed borers included *E. zinkenella,* whose first instar larvae tunnel the seeds and feed within the pod at all stages of larval development without obvious sign of external pod damage (apart from the exit holes for the adults). Yadava *et al*. (1988) similarly reported higher seed damage in pigeonpea maturing during cool weather in India.

The results from Malawi and southern Tanzania indicated that insect pests are likely to change in status with time to crop maturity, location, within a season (Malawi) and from one season to another (Tanzania). For example, in Malawi (Zomba) *M. vitrata* was mostly common during the rainy season (February to April) when temperatures and relative humidity were high. As such, its population was relatively low during cool and dry weather in June and July when the study was conducted. Regional, locational and seasonal variations in pest attack on pigeonpea have also been reported in India (Reed and Lateef, 1990).

The results further indicated that pigeonpea farmers in Kenya use conventional pesticides on their pigeonpea crops, as previously reported by Minja *et al*. (1996), while farmers in Malawi, Tanzania, and Uganda did not apply conventional pesticides for insect pest management on pigeonpea in the field. Thus, the pigeonpea growing environment is relatively undisturbed from its natural balance by pesticides.

Further observations revealed that some farmers could not differentiate the damage caused by the various insect pest groups or between some of the pests and their natural enemies. Some farmers in Kenya had used fungicides against insect pests and they complained of the large and increasing populations of pests despite their efforts. These farmers could not differentiate between insecticides and fungicides and the purpose for each of them. It is, therefore, important to train pigeonpea farmers and extension staff in the region on the identification of insect pests, the damage they cause, associated natural enemies, and different types of pesticides before they adopt pesticide use on a wider scale. Reed and Lateef (1990) highlighted the importance of farmers becoming familiar with insects and other animals that inhabit pigeonpea crops and not simply treating plants with pesticides as soon as they see a few insects. They also noted that many species of insects and other animals are found on pigeonpea plants and a substantial number of these are beneficial, feeding on the pests, either as predators or parasitoids, and should therefore be preserved.

ACKNOWLEDGEMENTS

We are grateful to the African Development Bank (ADB) for financial support and to the Executive Director, ICRISAT Southern and Eastern Africa Region, for availing the funds. We thank farmers and partners in National Agricultural Research and Extension Systems for facilitating the surveys. Valuable services were provided by International Institute of Entomology (IIE), Kenya Agricultural Research Institute (KARI), and the University of Nairobi (Crop Science Department). S. Silim, A. Wood and J. Romeis made valuable comments on the draft.

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