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nvestigations on avian pests of oil palm, *Elaeis guineensis* Jacq. in India†

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bstract. The common myna *Acridotheres tristis* Linn., the jungle row *Corvus macrorhynchus* Wagner and the house crow *Corvus plendens* Viellot are the major pests of oil palm in India. Other birds ke crow pheasant *Centropus sinensis* Stresmann, parrot *Loriculus* p. and pariah kite *Milvus migrans* Sykes also feed on oil palm fruits. hese birds feed on the fleshy mesocarp of the ripe fruits resulting in eavy fruit loss, significantly reducing oil yield. Gizzard and intestinal ontent analysis indicated that oil palm fruits are the major source of od for these birds. Observations on 1657 oil palm fruit bunches ring 1985–86 revealed that 76% of the ripe bunches and 5·6% of e unripe bunches were damaged by birds. The damage by birds as either 'partial' or 'complete', where 40–50% and 80–100% spectively, of the individual fruit weight was lost. The partial fruit amage was more common in 130–160 day-old bunches and the mplete fruit damage increased after 150 days of fruit set. Fruit loss e to bird damage was higher in palms in the border area of the antation (2·3 kg/bunch) than in the interior (1·3 kg/bunch). It is timated that around 2·8 tonnes of fresh fruits/ha/yr, equivalent to 0 kg of palm oil, are lost due to bird damage.

troduction

Many insects, mites, birds and mammals are recognised pests of oil palm *Elaeis guineensis* Jacq. (Ng and Khoo, 82). But the extent of damage done by birds is little known. rds feeding on oil palm fruits have been reported from ny countries. In Malaysia, several species of birds such as e Long-tailed parrot *Psittinus longicauda* (Boddaert), the ue-rumped parrot *Psittinus cyanurus* (Forster), the Malay keet *Loriculus galgulus* (Linn.), the Philippine glossy rling *Aplonis panayensis* Mayr., the common myna *idotheres tristis* Linn., and the crows *Corvus macrorhyn-s* Wagner and *C. splendens* Viellot have been reported to d on oil palm fruits (Wood, 1969; Siew *et al.*, 1979; Chau *al.*, 1980). In Brazil, Colombia and Honduras, the erican black vulture *Goragyps atratus* causes consider-e damage to oil palm fruits (Turner, 1970; Hartley, 1977). e palm-nut vulture *Gopohierax angolensis* eats oil palm ts in Africa (Turner and Gillbanks, 1974). However, no empt has been made so far to estimate the economic loss e to avian pests of oil palm. In India, a recent survey of sts of oil revealed that many birds cause considerable mage to oil palm fruits (Dhileepan, 1987). In the present udy, the status of birds as a major pest of oil palm in India is ported. An attempt has also been made to assess the mage intensity and economic loss due to avian pests ng with their feeding behaviour.

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Materials and methods

Study area

Birds feeding on oil palm fruits were studied in the oil palm plantations (*Tenera* hybrid) at Palode (15 ha), Thodupuzha (40 ha), Chithara (1018 ha), Yeroor (1753 ha) and Kulathupuzha (1000 ha), in Kerala state, India. At Palode (where shooting of birds was carried out twice a week), 200 ten year old palms and 100 five year old palms were selected and observed every 4 months, when the number of bunches damaged by birds was recorded. A total of 1000 adult palms and 400 young palms were observed during 1985 and 1986.

Feeding behaviour

To estimate the damage potential of each species of birds, bunches fed upon by only one of the species of birds were observed and average weight lost/fruit was estimated. Thus, damage potential of each species of birds was estimated individually. To study the food preference, birds were killed at regular intervals in the oil palm plantations and the gizzard and intestinal contents were analysed and weighed.

Estimation of fruit loss

The oil palm fruit bunch is ovoid, with 400–3500 fruits/bunch, and takes 150–188 days after pollination to ripen. The fresh fruit bunch (FFB) weight varies from 5 to 100 kg, depending upon the number of fruits/bunch. The average number of fruits/bunch and bunch weight were 1450 and 12·1 kg, respectively. Numerical fruit loss/bunch was assessed by counting the number of partially and completely damaged fruits in each FFB. Quantitative fruit loss in each FFB was estimated using the following regression:

$$Y = -3{\cdot}31 + 1{\cdot}23X_1 + 0{\cdot}78X_2 + 0{\cdot}99X_3 + 1{\cdot}00X_4,$$

$$r^2 = 0{\cdot}99,$$

where,

X_1 = age of the palm,

X_2 = location of the palm,

X_3 = partial fruit damage,

X_4 = complete fruit damage.

The partial fruit loss (X_3) and the complete fruit loss (X_4) in each FFB were assessed using the following formulae:

$$X_3 = [(a - p) \times p_1],$$

$$X_4 = [(a - c) \times c_1].$$

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Where,

a = average weight of undamaged fruits,

p = average weight of partially damaged fruits,

c = average weight of completely damaged fruits,

p_1 = number of partially damaged fruits/bunch,

c_1 = number of completely damaged fruits/bunch.

Damage intensity being uniform throughout the year, approximate fruit loss/ha/year was estimated as follows:

fruit loss/ha/year (Y_t) = $y_a \times (F_1 \times 140)$

Y_a = average weight of loss/bunch,

F_1 = average number of bunches harvested/palm/yr,

140 = number of palms/ha.

Results

Birds — as pests of oil palm in India

Many birds cause extensive damage to oil palm fruits, and are emerging as major pests of oil palm in India. Among them the common Indian myna *Acridotheres tristis* Linn., the jungle crow *Corvus macrorhynchus* Wagner and the house crow *C. splendens* Viellot caused greatest fruit damage. Other birds like crow pheasant *Centropus sinensis* Stresmann, parrot *Loriculus* sp. and pariah kite *Milvus migrans* Sykes also feed on oil palm fruits. These birds feed on the fleshy mesocarp of the ripe fruits, resulting in heavy fruit loss, significantly reducing the oil yield. Damage by birds was evident throughout the year and no significant seasonal variation in the damage intensity was evident (Table 1). Damage intensity was significantly higher in ripe bunches (150–180 days old) than in the immature (30–100 days old) and mature (100–150 days old) bunches. Observations carried out on 1657 oil palm fruit bunches during 1985 and 1986 revealed that 429 out of 587 ripe bunches were damaged by birds. Among the 1070 unripe bunches, only 60 were damaged by birds (Table 1).

Nature of damage

Feeding damage by birds in individual oil palm fruits can be identified and differentiated from that of rodent damage by their specific feeding marks. Rodents feed on the pericarp with their incisors and make characteristic sharp gnawing marks. Sometimes they also cut open the seeds and feed on the kernel. Feeding marks by birds are unique in that they feed exclusively on the mesocarp, and the fibres of the mesocarp are left attached to the seeds. Damage by *Acridotheres tristis* can be recognised, as they leave fragments of mesocarp attached to the fibres after feeding, and they also do not remove the seeds from the bunch. Both *Corvus macrorhynchus* and *C. splendens*, while feeding leave no fragments of mesocarp attached to the fibres and usually remove the seeds from the bunch. It is not possible to distinguish the damage caused by these two species of crows.

Damage by all these birds was either 'partial' or 'complete'. In bunches with partial fruit damage, the fruits remained attached to the bunch and the mesocarp at the proximal end of the fruits was alone eaten. In bunches with complete fruit damage, either the entire mesocarp was eaten, leaving the seeds attached to the bunch, or the whole fruits were removed and after eating the mesocarp, only the seeds were scattered on the ground (Figure 1). In partially damaged fruits, 40–50% of the total weight of the individual fruits were eaten by birds. In bunches with complete fruit damage, 68–73% of the individual fruit weight were lost, when the entire mesocarp was eaten leaving the seeds attached to the bunch. However in many ripe bunches the whole fruits were removed, resulting in loss of 100% of the individual fruit weight (Table 2).

The ripe bunches were more susceptible to bird damage than the unripe bunches, though damage in the latter group was not uncommon. There was a positive correlation between the maturity of the bunches and the numerical fruit loss by birds (Figure 2). During the initial stages of ripening of fruits (130–150 days old), partial fruit damage was more common, whereas the complete fruit damage increased as the ripening of the fruits progressed. The overall number of fruits damaged/bunch was found to increase after 150 days of fruit set and was very high in fully ripe (160–180 days old) bunches.

Feeding behaviour

A. tristis, C. macrorhynchus and *C. splendens* feed on the oil palm fruits throughout the year. *A. tristis* was found to

Table 1. Damage intensity due to avian pests in oil palm fruit bunches

Season	No. of palms surveyed	No. of FFB surveyed			No. of FFB with bird damage		
		IM†	M‡	R§	IM	M	R
1. April–July 1985	300	159	139	145	2 (1·25)	8 (5·75)	107 (73·79)
2. January–April 1986	300	180	245	171	3 (1·66)	10 (4·86)	113 (66·08)
3. May–August 1986	300	64	39	131	5 (7·81)	11 (28·2)	111 (84·73)
4. September–December 1986	300	126	118	140	2 (1·58)	19 (16·1)	98 (70·00)

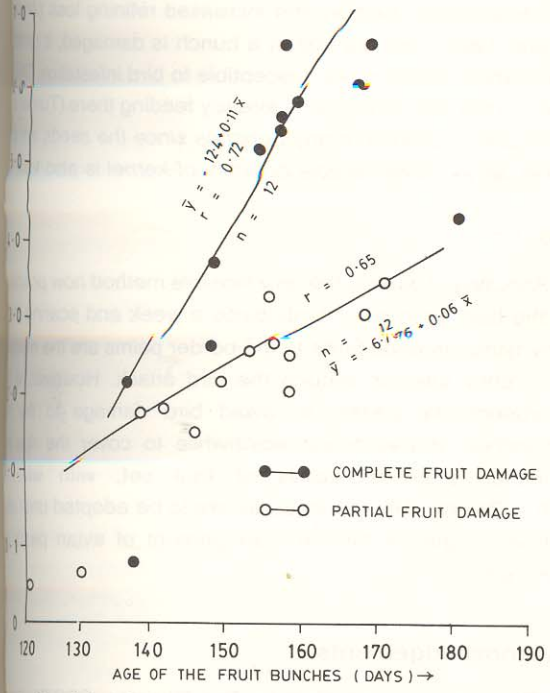
Figures in parenthesis indicate the percentage values.
Chi square test values: No. of bunches damaged vs. Maturity of the bunches = 72·954*; No. of bunches damaged vs. No. of bunches available = 835·25*; No. of bunches damaged vs. season = 8·59. *Significant at 1% level.
FFB = fresh fuit bunches.
†IM = immature bunches.
‡M = mature bunches.
§R = ripe bunches.

igure 1. Bird damage to oil palm fruit bunches in India. (a) Undamaged oil palm fruit bunch at an initial stage of ripening; (b) A ripe fruit bunch with most of the fruits removed by birds; (c) An empty fruit bunch, where all the fruits were removed by birds.

Table 2. Damage potential of birds in individual oil palm fruits

	Partial fruit damage		*Complete fruit damage*	
ian pests	Wt. loss/fruit (g)	% Of loss/fruit	Wt. loss/fruit (g)	% Of loss/fruit
ridotheres tristis	6·0 ± 1·83	31·1 ± 7·71	15·0 ± 1·60	78·3 ± 15·54
rnus macrorhynchus	4·4 ± 4·98	30·5 ± 19·42	19·5 ± 3·77	100·0 ± 0·00
rnus splendens	7·6 ± 3·93	40·7 ± 21·21	15·8 ± 2·16	82·4 ± 11·19

Mean ± S.D.
Mean of five fruits per bunch, for five bunches.



re 2. Correlation between the maturity of the oil palm fruit bunches and numerical fruit loss due to bird damage.

occur in flocks of 12–90, resting in the undergrowth of the oil palm plantations and moving to the palm crown for feeding. C. macrorhynchus and C. splendens occurred in small groups of 1–16 and frequently removed the fruits from the ripe bunches. Occurrence of other birds like C. sinensis, Loriculus sp and M. migrans within the plantations are only occasional. The gizzard and intestinal content analysis of these birds revealed only oil palm mesocarp with undigested fibres.

Fruit loss due to bird damage

Damage by birds was evident in 76% of the harvested FFB and the number of fruits damaged in each bunch ranged from 1 to 850. The numbers of fruit lost/bunch varied, depending upon the position of the palm, i.e. whether they are in the border area or in the interior of the plantation. In mature plantation, % of fruits damaged/bunch was significantly higher in the border palms (24·8%) than in those of the interior palms (11·4%). But in the young plantation, damage intensity was more in the interior palms (4·1%) than in the border palms (1·8%) (Table 3).

Table 3. Number and weight of fruits lost in ripe fruit bunches due to avian pests

Age of palms	Zone of survey	No of bunches surveyed	Average number of fruits damaged/bunch						Average weight of fruit loss		
			Partial damage		C.D.†	Complete damage		C.D.†	kg/bunch		C.D.†
10 yr	Border	131	16·5	(3·18)	(0·48)†	120·4	(8·09)	(1·18)†	2·24	(28.74)‡	(5·23)†
	Interior	136	20·0	(2·63)		70·2	(2·17)		1·30	(09·64)	
5 yr	Border	34	3·3	(1·67)	(0·80)†	6·1	(1·90)	(1·38)†	0·08	(5·84)	(4·32)†
	Interior	38	10·1	(3·09)		20·4	(2·97)		0·36	(16·25)	

Figures in parenthesis are values transformed into $\sqrt{x+1}$.
†Critical difference for the transformed values (significant at 1% level).
‡Transformed values expressed in grams.

In each bunch, along with the number of 'partially' and 'completely' damaged fruits, average weight of the undamaged, partially damaged and completely damaged fruits were also assessed, and weight of fruits lost/bunch was estimated using the regression:

$$Y = -3{\cdot}13 + 1{\cdot}23X_1 + 0{\cdot}78X_2 + 0{\cdot}99X_3 + 1{\cdot}00X_4,$$

i.e. in a bunch damaged by birds if,

number of partially damaged fruits = 31,

number of completely damaged fruits = 180,

average weight of undamaged fruits = 18 g,

average weight of partially damaged fruits = 11·8 g,

average weight of completely damaged fruits = 6 g,

then,

$X_3 = [(19 - 11{\cdot}8) \times 31] = 199{\cdot}2$ g,

$X_4 = [(18 - 6) \times 180] = 2160{\cdot}0$ g,

$Y = -3{\cdot}13 + 1{\cdot}23X_1 + 0{\cdot}78X_2 + 197{\cdot}2 + 2160$

$= 2{\cdot}36$ kg.

The average weight of fruits lost/bunch due to bird damage was higher in the border palms (2·3 kg/bunch) than in the interior palms (1·3 kg/bunch) (Table 3). In each harvested FFB an average of 1·8 kg (14%) was lost due to bird damage. The average weight of fruits lost/ha/year was estimated as:

$Y_t = Y_a \times (F_1 \times 140)$

$= 1{\cdot}8 \times (11 \times 140)$

$= 2{\cdot}8$ tonnes/ha/yr.

Discussion

In many countries, birds feeding on oil palm fruits were considered to be of minor importance only (Wood, 1969; Ward and Wood, 1967; Corley *et al.*, 1976). However, the present study revealed that the birds are major pests of oil palm in India, causing considerable economic loss. In Malaysia also, *A. tristis, C. splendens* and *C. macrorhynchus* were known to feed on oil palm fruits, but only in localised areas and without causing much damage (Wood, 1969; Siew *et al.*, 1979; Chau *et al.*, 1980). However Wood (1968) suggested the possibility of *A. tristis* becoming a major pest of oil palm. Though these birds are highly polyphagous, gizzard and intestinal content analysis indicated that oil palm fruits, which are easily available throughout the year, are the major food source for these birds.

The number of fruits damaged in each FFB depends upon the maturity of the bunch as well as the location of the palm in the plantation. Birds preferred the ripe fruits, but they can also feed on the unripe bunches, a fact also reported by Wood (1969). Preference by birds towards ripe fruits can be due to the increased oil content. Because, the oil content of the mesocarp increases with the ripening, and reaches the peak at about 155–180 days after fruit set (Seng, 1983). Moreover the soft and fleshy mesocarp of the ripe fruits also facilitates its easy removal from the seeds. In the unripe bunches partial fruit damage was more frequent as the fruits could not be removed from the bunches. In the ripe bunches, complete fruit damage was more frequent, as the fruits could be easily removed.

Presently the average unit area production of oil palm FFB is about 16·4 tonnes/ha/yr, and around 14% of fruit loss is attributed to bird damage. At the rate of 15% of oil extraction, about 420 kg of palm oil, worth Rs.4200/– are being lost/ha/yr. Damage by birds also causes other indirect losses — the free fatty acid (FFA) content of the fruits increases rapidly due to bird damage, resulting in processing problems such as colour fixation and increased refining loss (Arumugam, 1987). Once a fruit in a bunch is damaged, it renders the whole bunch more susceptible to bird infestation. This is due to the calls of the birds already feeding there (Turner and Gillbanks, 1974). In many bunches since the seeds are also taken away, considerable quantity of kernel is also lost.

Control

Shooting of birds is the only feasible method now practised in the field. Hunting of birds twice a week and scaring them by tying the dead birds to the border palms are the methods currently used to reduce the bird attack. However, in the experimental palms, to avoid bird damage to the fruit bunches, it was found worthwhile to cover the ripe fruit bunches after 150 days of fruit set, with wire net (60 × 75 cm). These measures are to be adopted until other efficient methods for the management of avian pests are evolved.

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