LEAFLET 7

Assessment of damage caused to mangoes by fruit flies and calculation of the Economic Injury Level in Benin

Background

Mango production losses (Photo 1) in Benin during 2005 and 2006 due to attack by fruit flies were over 50% by the middle of the crop season (Vayssières et al., 2009). Such a major phytosanitary constraint poses huge difficulties in national, regional, and international markets, resulting in considerable loss of income for the planters and Sudanian populations for whom the mango is first and foremost a food crop (Vayssières et al., 2008). Integrated pest control i.e. the IPM package (see Leaflet No. 6), is recommended for controlling this regional crop pest because using one method alone does not guarantee sustainable control. However, certain techno-economic indicators are required so that effective control techniques can be implemented at the right time. The decision-making indicator we propose is the Economic Injury Level (EIL).

Photo 1: Internal damage caused to Eldon cultivar

Main objective

Provide everyone involved in the fruit production sector with a method for estimating yield losses due to fruit flies, and for calculating the Economic Injury Level (EIL).

DEFINITIONS

Injury: the effect of pest activities on host physiology that is usually deleterious.
Damage: the measurable loss of host utility most often including yield quantity or quality.
Damage boundary: the level of injury (or insect numbers used as an injury index) at which damage occurs.

Economic Threshold (ET)

The population density at which control measures should be determined (= initiated) to prevent an increasing pest population from reaching the Economic Injury Level.

Economic Injury Level (EIL)

This is the lowest population density that will cause economic damage.

Yield / yield loss

Yield is calculated using average weight of a mango fruit for a given cultivar.
Once the fruit is punctured, it cannot be sold. Yield loss is average number of punctured fruits/tree × average fruit weight × average tree density/hectare.

MATERIAL : Orchards and traps

- Criteria for choice of orchards: see Leaflet No. 3
- Trap setting in the orchards: four TePhriTraps (TPT) with methyl eugenol (Met) and four TPT traps with terpinyl acetate (Ter). For detection trapping, optimum average trap density is 1-2 para-pheromone traps (Met, Ter) per hectare.

METHODS: Data collection

• **Tephritidae population levels**

- Traps are set up at the beginning of the crop season (January).
- Fly collection each week (see Leaflet No. 3).

• **Yield assessment**

- Yield assessment should be done in March for early cultivars, in April for seasonal cultivars, and in May for late cultivars (as in Benin), for two consecutive crop seasons.
- Select 10 trees per cultivar in each orchard and collect 10 fruits per tree.
- Weigh each fruit.
- Count the number of fruits per tree.

• **Assessment of losses due to Tephritidae**

- Assessment should be done for a single entire crop season (e.g. April-June in Benin)
- Select 5 trees per cultivar in each orchard.
- Collect 10 fruits per tree each week.
- If a fly puncture is visible (Photo 2), the fruit can be considered as lost
- Observations are made for batches of 10 fruits. One punctured fruit = 10% loss per tree.

• **Other data required**

- Production costs.
- Price per kg of mangoes (minimum price, average price, maximum price).

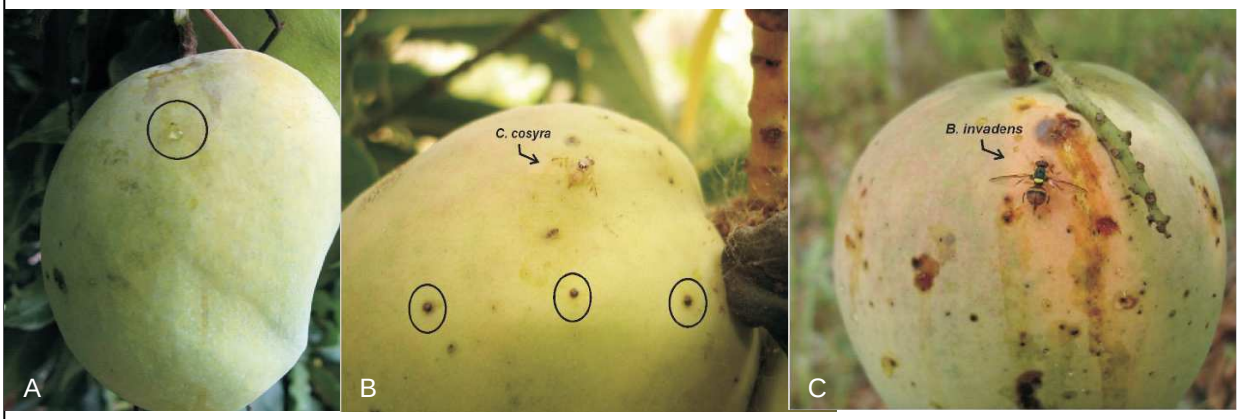

Photo 2: Tephritidae punctures on an Eldon cultivar after: A: a few hours ; B: 2-3 days; C: 3-6 days

ECONOMIC INJURY LEVEL: Formula by Pedigo et al.(1986).

EIL = C / VIDK = number of flies captured / ha / week

C = Cost of pest control and related activities per production unit (F CFA/ha)

V = Market value per production unit (minimum, average, maximum prices)

I = Injury unit per insect per production unit

D = Damage per injury unit

K = Effectiveness of control measures.

CALCULATION OF ECONOMIC INJURY LEVEL (EIL)

➢ Cost of pest control + related activities: (C)

- Success Appat (GF-120) usually reduces damage by approximately 80%.
- Calculation procedure for 12 weeks: (see Leaflet No. 4)
- Product cost (C^1) = Number of litres (12) × price per litre (~ 10 000 F) = 120 000 F
- Cost of equipment required for treatment (C^2) = Price of sprayer = 50 000 F
- Upkeep costs before treatment (C^3) = Upkeep costs (20 000 F) × 2 = 40 000 F
- Cost of detection equipment (C^4) = Price of traps + price of pastilles = 20 000 F

$$\mathbf{C} = C^1 + C^2 + C^3 + C^4 = 230\ 000\ F$$

➢ Market value of a kg of mangoes: (V) (Table 1: example of Benin)

- Minimum price = Average weighted price in mid crop season (supply > demand)
- Maximum price = Average weighted price at start/end of crop season (supply < demand)
- Average price = Average of minimum and maximum prices
- Price per kg = Price × 1 kg / average fruit weight (in kg)

Table 1: Farm-gate price variability according to mango cultivar in the Borgou district in 2006

Cultivars	Minimum price (F CFA)			Maximum price (F CFA)				Average price (F CFA)	
	Unit price	Price per kg	Mid crop year	Unit price	Price per kg	Start of crop year	End of crop year	Unit price	Price per kg
Gouverneur	10	**40**	9 April-6 May	25	**100**	25 March-8 April		20	**70**
Eldon	10	**30**	18 April-15 May	25	**70**	3 April-17 April		20	**50**
Dabshar	10	**20**	1 May-29 May	20	**40**	17 April-30 April		15	**30**
Kent	10	**20**	1 May-29 May	25	**50**	17 April-30 April	30 May-19 June	20	**35**
Smith	10	**20**	1 May-29 May	25	**55**		30 May-19 June	20	**38**
Keitt	10	**25**	15 May-19 June	25	**60**		20 June-5 July	20	**43**
Brooks	10	**20**	29 May-25 June	25	**45**		25 June-14 July	20	**33**

➢ Injury unit per insect per production unit: (I)

- It is a linear relationship.
- If regression is calculated on log-transformed numbers of captures, then the EIL value is expressed in log.

➢ Damage per injury unit: (D)

- D = [(% of loss/ha)/100) × (Average no. fruits/tree) × (average tree density /ha)].

➢ Effectiveness of control measure: (K)

- GF-120 treatment applied weekly.
- Approximately 80% reduction in damage due to fruit flies K = 0.8

EXAMPLE OF EIL CALCULATION (Table 2)

- In this example, each cultivar has a specific value for I and D variables, e.g. Kent cv: I (0.039), D (5400). C and K are constants: C (230,000 F) and K (0.8); V is a variable.
- If V is the varying market price per kg of mangoes, three different EILs can be calculated for each cultivar (Table 2). If V = 20, 35 or 50 for the Kent cultivar, then the corresponding EILs = 30, 43 and 75.

Table 2: EIL for seven different mango cultivars according to different price levels (2006 crop year in Benin)

Cultivars	*EIL for minimum price*	*EIL for max price*	*EIL for average price*
Gouverneur	269	107	153
Eldon	21	9	13
Dabshar	156	78	104
Kent	75	30	43
Smith	36	13	19
Keitt	57	24	33
Brooks	20	9	12

HOW TO USE THE EIL

- Set up 1-2 fruit fly traps per hectare well before the start of the mango crop season (January).
- Count the number of flies captured per trap each week and then estimate the number per hectare.
- Compare the number of flies captured/ha to the EIL.

- If the EIL has been reached, GF-120 treatment should be applied (profits should be higher overall than production costs).
- However, beneath the EIL level, GF-120 treatment should not be applied because it would not be profitable.

REMARKS

- EIL calculation is an indicator for initiating pest control (using GF-120 in this case) and for neutralizing any large increase in the fly population.
- This EIL calculation does not differentiate between the different species of flies. Thus all fruit fly species that have an economic impact on mango production are included here.
- It should be noted that it is relatively difficult to control fruit fly populations effectively if the crop season is already underway.
- Any change in mango market price or in GF-120 treatment costs will affect EIL calculations.
- C (cost/hectare) is not stable and depends on farm structures.

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