PN-ACU-093

(First) Annual Report

Covering period from: July 2002 to July 2003

Submitted to the U.S. Agency for International Development; bureau for Economic Growth, Agriculture and Trade

Comparing the efficiency of native and domesticated bees in the pollination of field and orchard crops

Project Number (C21-046) Grant No. TA-MOU-01-C21-046

Principal Investigator:
Professor Avi Shmida
Dept of Evolution, systematics and Ecology
Hebrew University of Jerusalem, Israel

Collaborators:
Dr S Shihadeh
Bee research unit,
National Center for Agricultural Research, Jordan
Dr W Kemp
USFA-ARS-NPA,
Bee Biology and Systematics Laboratory
Logan, Iowa

Project Officer: Mr. L. Gumbiner, Science Attache
U.S. Embassy, Tel Aviv

Project Duration: April 1, 2002 – March 31, 2005

Table of Contents

Executive Summary	p. 3
Section I	p. 5
Research Objectives	p. 5
Future Work	p. 5
Section II	p. 6
Managerial Issues	p. 6
Budget	p. 6
Special Concerns	
Collaboration, Travel, Training and Publications	p. 7
Request for Tel Aviv A.I.D. or BOSTID Actions	
Appendices:	p. 9
Map 1: NCARTT Experimental Stations	
Pollination In Agriculture Course	
Apple Observations Tasks List	
Apple Observations Forms Sheet	
Cucurbits Observations' Sheet	
June 2003 Planting Plots' Schemes	

Executive Summary:

Project purpose: Improving crops pollination through advancement of applied Pollination Techniques and investigating the potential for using new, additional, insect pollinators in Jordan and Israel.

Important Notes:

1. Although the budget for the Israeli Institute was allocated at mid-summer, the money for the Jordanian Institute arrived only at the beginning of April 2003, which is the end of the growing season for all crops in the Arava Valley. So, we missed spring growing season at the Jordanian side. Practically, out of the reported year, we have had about three months, namely April to June, to work.
2. Due to the political and security constraints created in Jordan, it is not plausible for the Israeli partners to work in the Northern parts of Jordan and, so we are forced to conduct the study in South of Jordan.

Albeit this detention, we conducted frequent visits to Jordan, in an effort, with the collaboration of Mr. Shihadeh, to establish, towards the expected budget allocation, a team of field researchers and technicians. Efforts were made to survey main agricultural regions for collaborative planning of the research. Contacts of good personal cooperation have been created with staffs of Experimental Stations (Al-Shoubak, Rabba and Ghor Al-Safi) and Faculty of Agriculture of Mu'tah University (seed detailed description in the semi-annual report of May 2003). As an example of degree of cooperation, see the proposal of a "Pollination Biology and Beekeeping for Pollination in Agriculture" course, proposed with, among others, the Mu'tah University Faculty of Agriculture staff (see Appendices).

Simultaneously, on the Israeli side, we conducted pilot studies of Pollination at commercial cucurbits fields in the Arava Valley and apple orchards at the heights of Galilee, during which we developed and tested protocols for pollination studies for those crops and orchards.

Wild Pollinators Research Activities: We continued Setting Up Artificial Nests for Xylocopa and Studying Bees Preferences and Behavior in several sites in Israel.

From April on, with a Jordanian team, headed by our colleague, Mr. Shihadeh with Mrs. Hodda (a Biologist from The Shoubak Regional Agricultural Service Center (RASC) NCARTT Station) and Mr. Ahmad Khraisat (field technician) we started field training and studies on apples and cucurbits. We studied quantitatively bloom phenology and fruit set, flower reward and foraging insects characteristics. Also, Mrs. Hodda started, under our guidance, a systematic collection of wild pollinators of Al-Shoubak area.

Successively, we transferred to Jordan Melon, Watemelon and Zucchini seedlings from Israeli cultivars and planted them in three experimental plots at Al-Shoubak, Rabba and private farm in Rabba region (see Map 1, Appendices) located on Edom mountains (900m to 1400m). This enable us to exploit summer season to grow and study those crops and to asses the potential for vegetable growth, which is almost not exist in the region.

Findings:

Current Pollination Practices: Awareness of farmers of the importance of pollination for getting yield, is quite low. Watermelons of the Ras-Abbadii local cultivar, grown in Ghor Al-Safi region get very good prices on seasonal market at Amman, but the yield is moderate to low and could be increased significantly with improved pollination.

Section I

Research Objectives:

We surveyed agricultural regions in South Jordan and Israel Arava Valley to identify Target Crops and Orchards.

We developed and started tests of protocols for pollination studies in Apples, Melons, Watermelons and Zucchini in Jordan and Israel (see appendices).

Experimental plots of Melons, Watermelons and Zucchini in Jordan had been planted toward summer season.

We worked with our Jordanian collaborators to establish a team of researchers and technicians, trained them and worked with them in Pollination Field Studies.

Wild Pollinators Research Activities: We set up Artificial Nests for Xylocopa in eight different sites in Israel to get nested bees and to study bees preferences and Behavior. Currently, a net house in "BeeHave", Prof. Shmidas' lab, is under construction for foraging behavior studies along summer.

We conducted Pilot Study of Apple Orchards in Galilee region of Israel to evaluate protocols for quantifying apple flowers' reward.

We conducted Pollination Study of several Apple cultivars (Ain shamer, Golden, Doraset, Grany spertayab, hazza, Golden Doraset, Golden Anna, Adina, Gersy mack, Vestebla, red melia and Grany smith) in Al-Shoubak NCARTT Experimental Station.

Future Work: (Until next semi-annual report)

Pollination Studies:

Pollination Studies will be conducted along summer seasons at the cucurbits plots mentioned above. Along August and September, Apples' yield will be measured to conclude the 2003 season at Al-Shoubak Res. Station. From October on we will have access to cucurbits and tomatoes plots in the Arava region, where we will be able to compare different pollinators' efficiency. These studies will be conducted at open field areas in Ghor-Al-Safi region and in undercover growth of Cucurbits, Tomatoes and Pepper in Al-Haq Farms' Um-Mitleh Station (our meetings with Al-Haq farms staff turned us optimistic in regard of future cooperation).

Wild Pollinators Research Activities:

Within middle of July, active Xylocopa nests will be transferred to the net house in "BeeHave", Prof. Shmida lab. With them, several kinds of flowering plants will be transferred for foraging behavior studies along summer.

Toward cold season, along October, a greenhouse equipped with heating system, will be allocated in the coastal plain of Israel (Achva College campus). There we will conduct experiments with sustenance of Xylocopa nests along winter. Success of breeding Xylocopa in the greenhouse, will enable us to transfer nests to plots in Jordan next spring.

Next spring, Osmia artificial nests, recently purchased from Oxford Univ. will be installed in Shoubak and Jerusalem.

Section II

Managerial Issues:

Practically, this report ends a term of three months study work in Jordan instead of twelve months. The implication is that along next six months we will have to continue, at least partially, to develop and validate protocols for pollination study.

Additional delay caused by need to accommodate the plans to the political and security constraints created in Jordan. Since it is not plausible for the Israeli partners to work in the Northern parts of Jordan, we were forced to conduct the study in South of Jordan.

Cooperation with Al-Haq Farms: As noted in former report, Al-Haq Farms is a private firm which got concession for agricultural development in this area, from Um-Mitleh to Aqaba. Al-Haq own five farms (Um-Mitleh, Wadi Musa, Risha, Rahme and Aqaba). Al-Haq has exceptional positive cooperation with the Israeli Research and Development South-Arava Station at Yotvata, cooperation initiated by the head of the station, Mr. Amnon Greenberg. During our visits to Jordan we went also to all Al-Haq farms and got acquainted with the common crops grown, main growing seasons and Agrotechnical systems

Budget:

From the beginning of C46 project we have made already seven visits to Jordan and this experience taught us that for keeping good contact and efficient cooperation we have to make more, though shorter, visits to Jordan than planned originally. WE suggest that the Israeli team, two persons, will visit Jordan twice a month for three days each visit. Current situation enforce us to pass the border through Aqaba (alternative air flights are more expensive), and we have to come with and leave a car on the border. The table below shows updated costs of such travel, as we learned during recent trips.

Items:	JOD	USD	USD per two persons
Cross Border, Both Directions, custom	16.3	23	46
Transportation (Taxi) for 1 day	50	70	70
Average Per Diem*	12	17	86
Total for One Day	78.3	110	202
Total for Three Days	232.3	307	435**

* Average Per Diem include: Hotel-25 JOD per night, 5 JOD at the NCARRT station. We calculate for three days visit to sleep one night at a hotel and two at NCARRT station. Daily expenses for food -10 JOD.

** To this amount we should add travel by car Eilat to and forth – USD 300

Local: Each team will make 40 annual trips to domestic field sites ($0.5/km x 250 km/day x40 trips = $5,000 annually).

Due to budget constraints we cut part of the planned local as well as international travels. We assume that toward the second half of the project this will be possible.

Collaboration, Travel, Training and Publications:

Table 1: **Collaboration, Travel and Training** - Activities' Summary

Date	Location	Activity & Collaborators
13-17 Sept 2002		Visit to Jordan: Prof. Shmida, Mr. Shihadeh
13-16 Oct 2002		Visit to Jordan
4-6 Nov 2002		Visit to Jordan
27-29 Jan 2003		Visit to Jordan
17 Feb 2003	Jordan	Al-Haq Farms Staff: Visit fields of Muskmelon and Watermelon to choose observations' plots.
7-9 Apr 2003	NCARTT Res. Station at Al-Shoubak, Jordan	Prof. Shmida, Mr. Shihadeh, Mr. Dan Weil, Mrs. Hodda and Mr. Ahmad Khraisat. Apples: Developing protocol, training and performing study of: Flower phenology, Assessing bloom volume, Nectar reward, Pollinators' activity Pollination Efficiency
7-9 Apr 2003	NCARTT headquarters - Amman	DR. Fardous (NCARTT DG), Prof. Shmida, Mr. Shihadeh and Mr. Dan Weil: Discussion of collaborative project(s) – current (C46) and future ones.
7-9 Apr 2003	NCARTT Res. Station at Al-Rabba and Ghor Al-Safi, Jordan	Dr. Majali (NCARTT A-Rabba Station GM), Prof. Shmida, Mr. Shihadeh, Mr. Dan Weil, Muskmelon and Watermelon: Planning a plot at Al-Rabba Station for those crops to be blooming on May 2003 (seeds brought from Israel for this purpose). At Ghor Al-Safi Station: Planning for work in Watermelons at September – December 2003. Meeting farmers to evaluate the current

		situation of pollination activity in Ghor Al-Safi area.
7-9 Apr 2003	NCARTT Res. Station at Ghor Al-Safi, Jordan	Mr. Said (NCARTT Ghor Al-Safi Station deputy manager), Prof. Shmida, Mr. Shihadeh, Mr. Dan Weil, Planning for work in Watermelons at September – December 2003. Meeting farmers to evaluate the current situation of pollination activity in A-Safi area.
5-8 May 2003	NCARTT Res. Station at Al-Shoubak, Jordan	Dr. Ismail Tawissyi (Shoubak StationGM), Prof. Shmida, Mr. Shihadeh, Mrs. Hodda and Mr. Ahmad Khraisat.
5-8 May 2003	Al Quwayra region	Prof. Shmida, Mr. Shihadeh and Mr. Ahmad Khraisat. Al Quwayra area, where some thousand dunams of watermelons are cultivated by local Bedouin tribesmen. There we worked with our Jordanian colleagues, training pollination study methods developed in the Israeli Arava Valley.
2-6, June 2003	NCARTT Res. Stations at Al-Shoubak and at Al-Rabba and Al-Qasser, private farm.	Prof. Shmida, Mr. Shaul Ravid and Mr. Shihadeh, *Planting Seedless Watermelons and Zucchini* in three plots, one an intercropping at an Olive Orchard (see appendices).
17-25, June 2003	NCARTT Res. Stations at Al-Shoubak and at Al-Rabba and Amman. NCARTT Res. Stations at Al-Shoubak	Prof. Shmida and Mr. Shihadeh *Tour with AID representatives.* Prof. Shmida and Mr. Dan Weil Checking watermelons' growth problem, reported by Stations' staff.

Appendices

Map 1: Experimental Stations in Jordan

Pollination In Agriculture Course

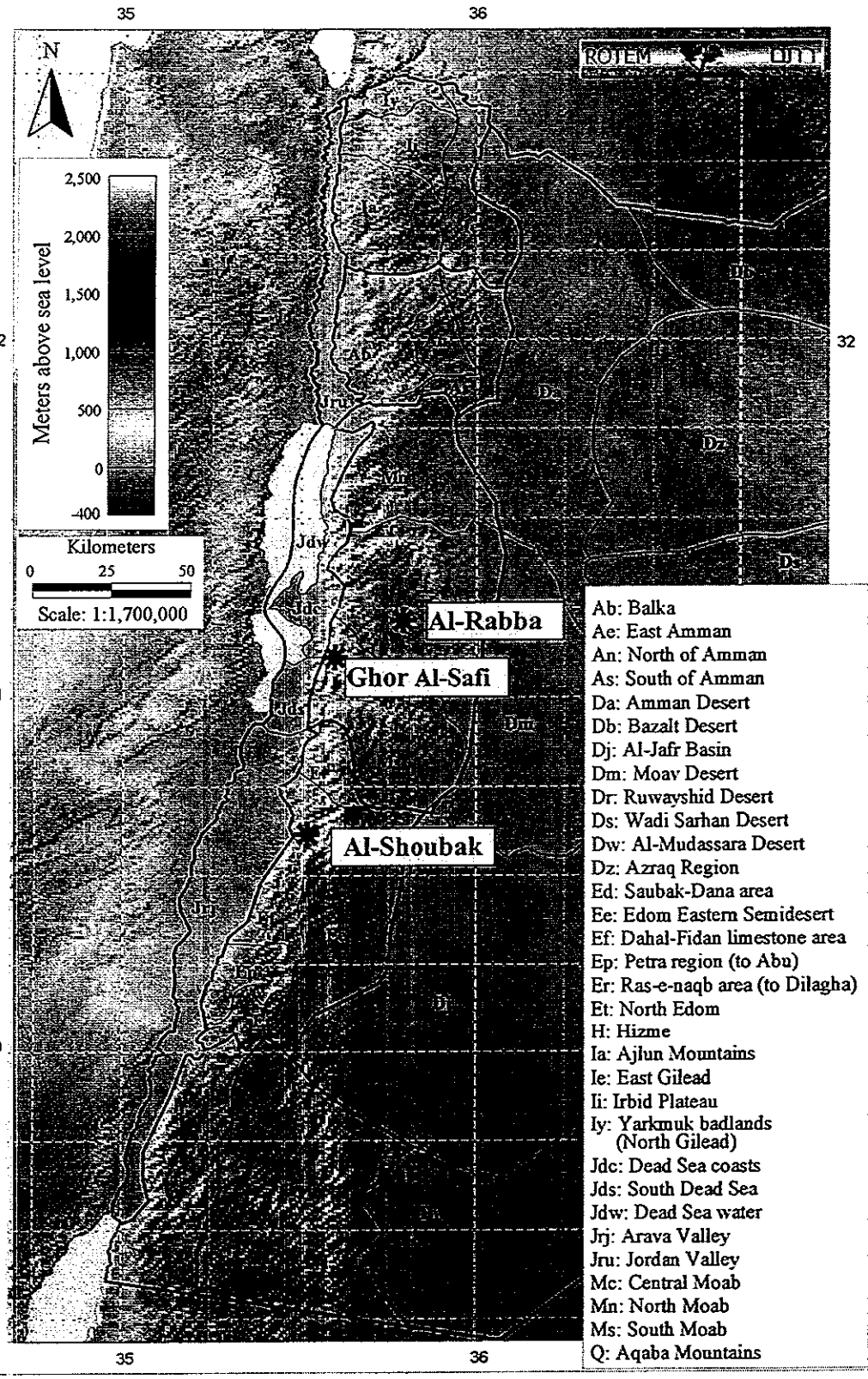
Apple Observations Tasks List

Apple Observations Forms Sheet

Cucurbits Observations' Sheet

June 2003 Planting Plots' Schemes

NCARTT Experimental Stations



Proposal for a Joint Jordanian – Israeli – American Course on –

Pollination Biology and Beekeeping for Pollination in Agriculture

Proposed by:

Jordanian Instructors:

Mr. Sayfuddin Shihadeh-	National Center for Agricultural Research and Technology Transfer (NCRATT), Jordan
Dr. Nizar Haddad -	National Center for Agricultural Research and Technology Transfer, Jordan
Dr. Nedal Majali -	Head of Rabba Experimental Station , National Center for Agricultural Research and Technology Transfer, , Jordan
Dr. Soudyousef Al-Abbadi	Faculty of Agriculture , Muta University at Raba ,Jordan
Dr. Ayed Omary	Dean , Faculty of Agriculture , Muta University at Raba ,Jordan
Eng. Rabeeh Salameh	Al Haq Farms , Um – Mitleh , Arava

American Instructors:

DR. Stephen Buchmann –	Bee Lab, USDA, Tucson Arizona.

Israeli Instructors:

Prof. Avi Shmida -	Dept of Ecology, The Hebrew University.
Mr. Dan Weil -	Dept of Ecology, The Hebrew University
Dr. Arnon Dag -	Bee Extension, Ministry of Agriculture
Mr. Haim Efrat-	Bee Extension, Ministry of Agriculture
Mr. Yossi Slavetzki -	Bee Extension, Ministry of Agriculture.

General Program:

It is proposed to establish a two-phase course, one week in September and another one in March, in which participants from diverse institutes and schools in Jordan will study the theoretical aspects as well as practical ones of Pollination Ecology in Agriculture. Each phase of the course will comprise five days of study in which in the first two days introductions will be given for the techniques and theories, which are used in different aspects of Pollination Ecology. The last two days will be devoted to independent project, which each pair of students will choose, implement and summarize. Both phases of the course will be held in Rabba Agricultural Station (NCARTT) with cooperation of the Faculty of Agriculture of Mutta University (situated in Rabba, next to NCARTT). One-day excursion including field training will depart Rabba to A-Zafi and to Shoubak NCARTT *Experimental Stations.*

It is suggested to choose about twenty students for the course, from diverse background. No academic degree is needed and students can come from governmental institutes, NGO's, Universities and farmers.

The following theoretical subjects will be studied:

1. The basic rules of The Pollination Market, Foraging Behavior and Nectar and Reward Relationships.
2. Floral Biology, Breeding Systems, Sex-Types in Plants and Fruit Abortion.
3. Bee Biology, The Bee Fauna and Systematics of the Middle East, The Five Major Insect Pollinators in the Region.
4. Crop Biology and Pollination: Melon. Watermelon, Pepper, Squash, Tomatoes and Almonds.
5. Beekeeping: Honeybees Natural History and Ecology, The Hive Life Cycle and Honeybees Foraging.
6. Natural Autumn Flower Market versus Spring one (study Colchicum and Uriginea *in September and Legumes in March).*

Methods and Techniques to be learned

During the first two days, the students will be divided to four groups, which will circulate among four stations. In each station they will learn and practice techniques in pollination ecology.

Learning and practicing methods in Pollination Ecology will be organized in the following four Training Stations:

1. Floral Biology and Breeding System
2. Pollen and Stigmas' Biology.
3. Nectar Reward Measurements.
4. Pollinators Systematics Behavior and Monitoring.
5. Beekeeping Practices.

Examples for Mini-Projects:

1. Net Production versus Nectar Yield in Melon (or Squash) and its relation to Frequency of Bee Visitation.
2. How Many Pollen Grains different Pollinators drop on the stigma in one visit.
3. Insect preferences to colors – the abundance of deferent pollinators trapped in color bowls, along different hours of the day.
4. Learning a new source of food in Honeybees – changing of handling time with experience and learn to prefer a green flower color with more reward.
5. Pollinators' abundance and nectar yield during different hours of the day in flowers of Colchicum and Uriginea.
6. Constancy in Advertising – the importance of different attractants (color, size, scent and reward) on visit frequency of bees.
7. Bee pollination efficiency – comparing the efficiency of pollen dispersing of Honeybees, Bumblebees and Solitary Bees (Anthophora spp.)

April 2003

Apple Observations Tasks List for a Cultivar

1. General Biology

1.1. Tag & Mark four (4) representative trees of the cultivar. On each tree tag & mark Two (2) Branches for potential yield, fruit set and actual yield (see Task No. 4).

1.2. Tree Volume (Dimensions): Measure tree height (meters) and greatest two perpendicular diameters. Calculate and write down average diameter.

Timing: Once in the season.
Sample: Marked four trees.

1.3. Number of flowers on a tree: Count (estimate) number of flowers on the tree including buds. Buds will be expressed as percentage of all flowers.

Timing: Once in the season at the peak of the bloom..
Sample: Marked four trees.

1.4. Flower Dimensions: Measure flower diameter and Petal length in millimeters (mm).

Timing: Once in the season at the peak of the bloom.
Sample: Twenty (20) Fully Opened Flowers – NOT on the marked Trees!

1.5. : Dates of Beginning and End of Blossom (Flowering Period).

Timing:
Date of Beginning of Blossom defined when 30% of trees of the Cultivar are blooming.
Date of End of Blossom defined when 70% of trees of the Cultivar are Without Opened Flowers.
Sample: All trees of the Cultivar.

1.6. Flower Longevity: On 6:00 AM Tag One Hundred (or at least Twenty) Buds that are going to be Opened with plastic ring or coloured thread. Each Hour write down the number of Opened Ones. Simultaneously, measure and write down the Temperature. Continue until all buds are opened.

Timing: Once in the season at the peak of the bloom.
Sample: One Hundred (or at least Twenty) Buds – NOT on the marked Trees!

2. Flower Reward

2.1. Nectar Measurement Before Bee Visitations begin: Measure Nectar Volume and Concentration

Timing: Early in the Morning, On 6:00 AM, Before Bee Visitations begin. Once in the season at the peak of the bloom.
Sample: Twenty (20) Opened Flowers from at least Two Trees – NOT on the marked Trees!

2.2. Nectar Standing Crop - Nectar Measurement After Measuring Bee Visitations: Measure Nectar Volume and Concentration

Timing: After Measuring Bee Visitations, On about 9:00-10:00 AM. Once in the season at the peak of the bloom.
Sample: Twenty (20) Opened Flowers from at least Two Trees – NOT on the marked Trees!

2.3. Nectar Production - Nectar Measurement On Flowers Bagged for 24 Hours: Early in the Morning cover three branches on three diferrent trees, NOT on the marked Trees!, with net bags to prevent pollinators' visitation. After 24 hours remove the bags and Measure Nectar Volume and Concentration at the uncovered flowers.

Timing: Once in the season at the peak of the bloom.
Sample: Twenty (20) Opened Flowers.

2.4. Pollen Quantity: Collect (cut with scissors) All Anthers from Ten (10) Flowers into one paper bag. Write Details on Bag (Date, Crop, Cultivar, Location). Dry in Oven for 24 Hours at 70^0C and then weigh the sample.

Timing: Once in the season at the peak of the bloom.
Sample: Ten (10) Opened Flowers from at least Two Trees – NOT on the marked Trees!

2.5. Anther Openings (Anthesis, Explode): When Flowers start to open, count the number of anthers in Twenty (20) Flowers. Continue, each hour, to count and write down the number of opened (exploded) Anthers until all anthers are opened.

Timing: Once in the season at the peak of the bloom.
Sample: Twenty (20) Flowers from at least Two Trees – NOT on the marked Trees!

3. Pollinators' Activity

3.1. Measuring Bees Visitations: Observe Blossom for Ten (10) Minutes and Count Visiting Insects according to their Size. Choose such Area of Blooming Flowers that you can observe all Flowers in it. Stand with your back to the Sun

Timing: Twice in the season at the peak of the bloom
Sample: Two Observations on Two different trees.

4. Yield: Potential, Fruit set and Actual Yield

4.1. Potential Yield: On the Eight Tagged Branches count Number of Flowers and Buds.

Timing: Once, at the peak of the bloom.
Sample: Eight (8) Branches - ON the marked Trees!.

4.2. Fruit Set: Two weeks after End of Bloom in the Cultivar, Count Fruit Set on the Eight Tagged Branches.

Timing: Once, 14 Days after End of Bloom in the Cultivar.
Sample: Eight (8) Branches - ON the marked Trees!.

4.3. Fruit Yield: On August, just before Harvest of the Cultivar, Count and Weigh Fruits on the Eight Tagged Branches.

Timing: Once, On August, just before Harvest.
Sample: Eight (8) Branches - ON the marked Trees!.

5. Pollination Efficiency.

5.1. Preventing Insect Pollination: At the beginning of Bloom, Cover two Branches on the Marked Trees with nets for the whole Blooming Period.

Timing: At the beginning of Bloom.
Sample: Two Branches.

5.2. Potential Yield Without Insect Pollination: Count Flowers and Buds on the two Covered Branches.

Timing: At the peak of the bloom.
Sample: Two Branches.

5.3. Fruit Set Without Insect Pollination: 14 Days after End of Bloom in the Cultivar Count Fruit Set on the two Covered Branches.

Timing: Once, 14 Days after End of Bloom in the Cultivar.
Sample: Two Branches.

5.4. Yield Without Insect Pollination: On August, just before Harvest of the Cultivar, Count and Weigh Fruits on the two Covered Branches.

Timing: Once, On August, just before Harvest.
Sample: Two Branches.

Crop:

Daily Observation Sheet

Site Location	
Plot ID	
Cultivar	
Date	
Hour	

Observers:

Weather

Hour	Temp.	Humidity	Clouds Okta (One Eighth)	Wind (No / Med. / Strng.)	Rain (No / Drops / Heavy)	Time of Sunrise / Remarks
6:00						
7:00						
8:00						
9:00						
16:00						
17:00						

Tree Volume and Flowers' Quantity

Tree No.	Height m.	Diameter a	Diameter b	Average Diameter	Number of Flowers	Buds as percentage of all flowers
1						
2						
3						
4						

Flowers density and sex ratio

Hour	Number of flowers along _____m		
	♀	♂	Fruits

Hour	Number of flowers along _____m		
	♀	♂	Fruits

Bee Visits (note pollinators other than honeybees)

Hour	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m

Nectar in Flowers

	Bagged				Unbagged			
Hour								
Flower No.	Volume µl	Sugar concentration %	Volume µl	Sugar concentration %	Volume µl	Sugar concentration %	Volume µl	Sugar concentration %
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Start with 5 µl Capilary

TRANSECT - Foraging Bee Density (note pollinators other than honeybees)

Hour	Number of Bees along 50 m / 1min.	Number of Bees along 50 m / 1min.	Number of visits along __ m	Number of Bees along 50 m / 1min.

Honeybee Hives Activity

Hour	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____

L Low level: <15 entries
M Medium level: 16 to 60 entries
MH Medium-High level: 61 to 100 entries
H High level: >100 entries

Crop:

Daily Observation Sheet

Site Location	
Plot ID	
Cultivar	
Date	
Hour	

Observers:

Visiting Pollinators (Names) **FlyBy Pollinators (Names)**

Categories	Counts in 卌	SUM

Crop:

Daily Observation Sheet

Site Location	
Plot ID	
Cultivar	
Date	
Hour	

Observers:

Weather

Hour	Temp.	Humidity	Clouds Okta (One Eighth)	Wind (No / Med. / Strng.)	Rain (No / Drops / Heavy)	Time of Sunrise / Remarks
6:00						
7:00						
8:00						
9:00						
10:00						
11:00						
12:00						
13:00						
14:00						
15:00						
16:00						
17:00						

Flowers density and sex ratio

Hour	Number of flowers along _____m		
	♀	♂	Fruits

Hour	Number of flowers along _____m		
	♀	♂	Fruits

Bee Visits (note pollinators other than honeybees)

Hour	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m	PATCH - Number of visits along __ m

20

Nectar in Flowers

	Bagged					Unbagged			
Hour									
Flower No.	Volume µl	Sugar concentration %	Volume µl	Sugar concentration %	Start with 5 µl Capilary	Volume µl	Sugar concentration %	Volume µl	Sugar concentration %
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

TRANSECT - Foraging Bee Density (note pollinators other than honeybees)

Hour	Number of Bees along 50 m / 1min.	Number of Bees along 50 m / 1min.	Number of visits along __ m	Number of Bees along 50 m / 1min.

Honeybee Hives Activity

Hour	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____	Number of Foragers Entries per Minute Hive No. ____

L Low level: <15 entries
M Medium level: 16 to 60 entries
MH Medium-High level: 61 to 100 entries
H High level: >100 entries

Crop:

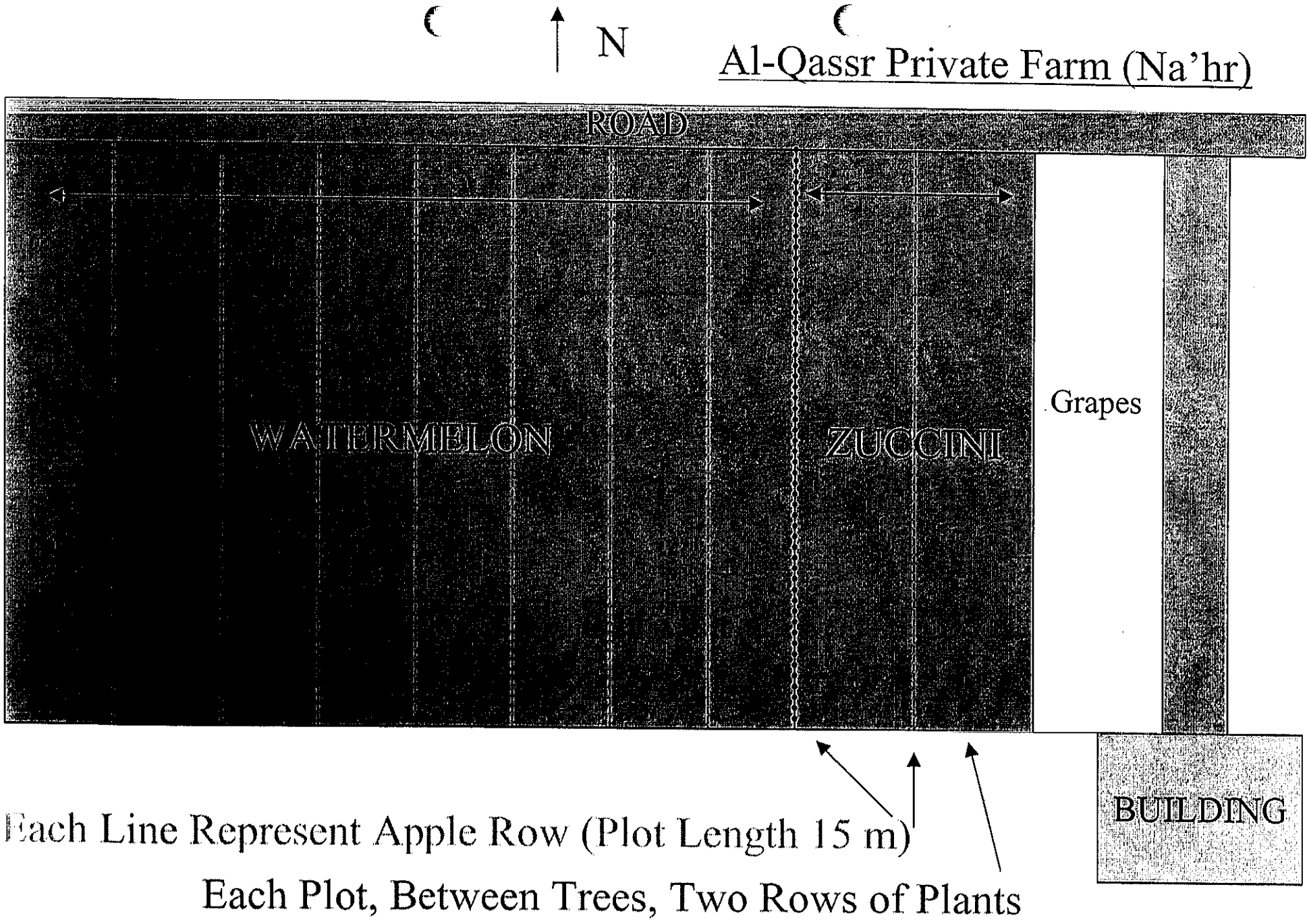
Daily Observation Sheet

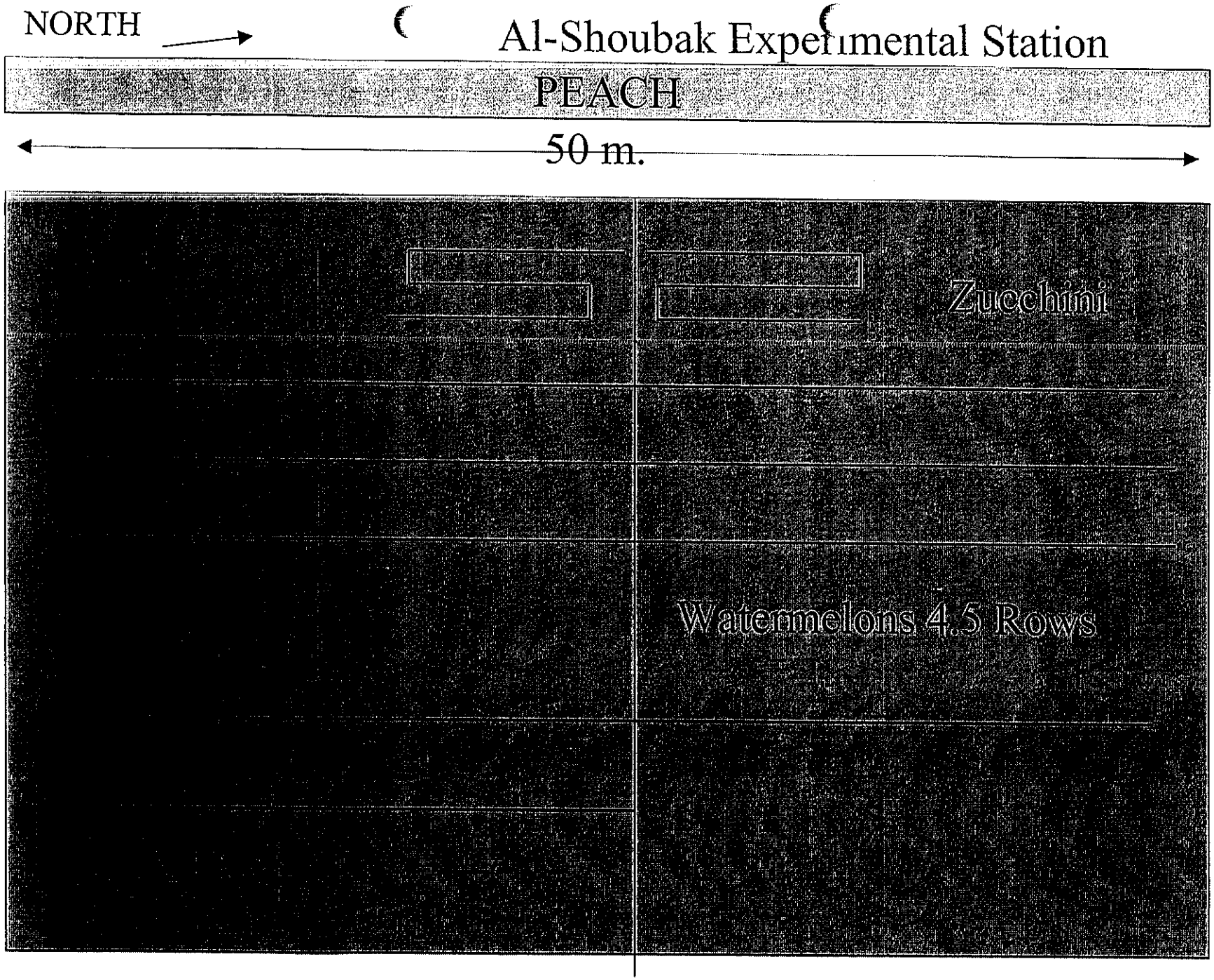
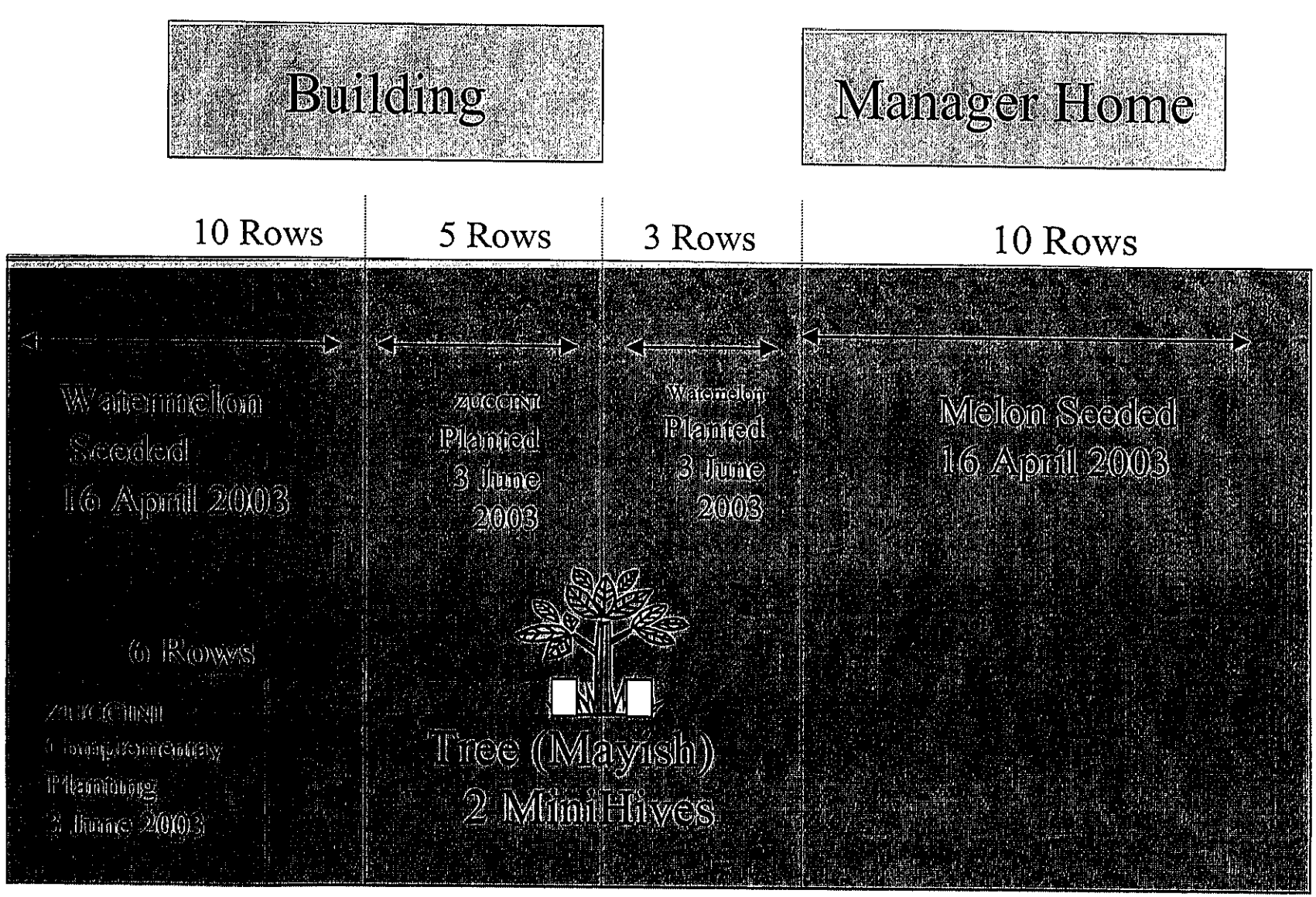
Site Location	
Plot ID	
Cultivar	
Date	
Hour	

Observers:

Visiting Pollinators (Names) **FlyBy Pollinators (Names)**

Categories	Counts in 卌	SUM


N
Al-Qassr Private Farm (Na'hr)
ROAD
WATERMELON
ZUCCINI
Grapes
BUILDING
Each Line Represent Apple Row (Plot Length 15 m)
Each Plot, Between Trees, Two Rows of Plants


NORTH
Al-Shoubak Experimental Station
PEACH
50 m.
Zucchini
Watermelons 4.5 Rows

Al-Rabba Station – Experimental Plot