Vegetal dew and fog harvesting west of Mazar-Karak (1992-1994) Jordan

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Occult precipitation or hidden precipitation of dew and fog deposition on vegetation has been known for a long time in many regions in the world, especially in the Middle East. This study tried to quantify this type of occult precipitation, using direct soil moisture measurement methodology in nine neighboring plots (10x10m) of land, to find the influences of four variables on amounts of water collected: vegetation cover, stone mulching, barriers, and two meters trees. It was found that most of occult precipitations are due to fog not dew in the study area which explains the negative influences of the barriers and the positive influences of the higher vegetations (trees) which intercept fog flow in the first two meters from the earth surface.
المطر الخفي كما يدعونه والمتمثل بتساقط الندى والضباب على المسطحات الخضراء معروف منذ زمن بعيد في شتى أرجاء العالم وخاصة في الشرق الأوسط. وهذه الدراسة تحاول تبيان كميات هذا النوع من المطر الخفي باستعمال الطرق المباشرة لقياس رطوبة التربة في تسع قطع من الأرض المتجاورة (١٠×١٠) م لكل منها، من أجل إيجاد تأثيرات أربعة متغيرات على الكميات المجموعة. وهذه المتغيرات هي: الغطاء النباتي والغطاء الحجري والجدار الحاجز والأشجار بارتفاع مترين . وقد أوجدت الدراسة إن أغلب هذا النوع من المطر الخفي متصل بتكاثف الضباب أكثر من تكاثف الندى، ولذلك كان للجدار الحاجز الأثر السلبي الأكبر، وللأشجار المعترضة للضباب الأثر الإيجابي الأكبر في اعتراضها لتيار الضباب في أول مترين من سطح الأرض.

Key words: Precipitation, Fog, Dew, Harvesting, Vegetal and stone covers

1. Introduction

Water vapor condensation is in several forms: rainfall, fogfall, dewfall, frost fall and snowfall. The region of Al- Mazar, where the study area, has the same condensations. The main concern of this experimental study is dewfall and fogfall on vegetations in the designed plots.

In certain hilly sites in Jordan, fogfall and dewfall could be very important factors affecting the water cycle, water supply, and the general ecosystems. Proper vegetation increases fogfall and dewfall, and they have positive effects in the vegetation itself. This study is quantifying the vegetal fog and dew harvesting in a specific region west of Al-Mazar region.

This type of precipitation is called also occult or concealed precipitation. Occult precipitation has been studied in several regions in the world. It has been found that its contribution to hydrological cycle is very important, especially in high elevated regions facing large water bodies, or moist winds [1].

This experimental study examined the process of harvesting water from fog and dew using the natural water-catching properties of trees and vegetation. Actually it is not a new method. Occult or concealed precipitation is the portion of precipitation which is induced when low clouds encounter trees or certain natural or man-made barriers. Several representative examples with their related references are to be stated in this introduction.

Occult precipitation is regularly not captured by precipitation gages. It appears in two forms: firstly, in a liquid state as fog drips, or secondly in a solid state as rime, depending on the surrounding temperature. In the study area occult precipitation appears mostly in liquid form because freezing cold fronts are not very frequent in the study area [2].

Stone mulching around trees is an ancient method of collecting dew and fog drips. Stone piles in south of Jordan were used extensively more than two thousand years ago to grow grapes. Also, fog and dew drips are collected by stones which are placed around trees in Canary Islands [3].

Fog harvesting has the ability of reforestation of many potential hillsides in the world. Initial supplementary water is to be stopped once the trees have reached a height of two meters. It is found in many experimental projects that trees of this size could collect sufficient water to be self-sustaining with respect to water [1].

Grass surface usually cools to a lower surface temperature than bare ground. This phenomenon is due to the smaller thermal capacity of the grass. Therefore, grass surfaces and other vegetal cover have more dew deposition than bare ground which enhances dew harvesting [4].

Radiation fogfall like dewfall happens at the end of the night, which increases the intermixing between fog and dew when they appear together occasionally [5]. Fogfall and dewfall are direct water deposition into solid cooler surfaces like vegetal cover or stone multching around trees. Fogs or low clouds are major contributor of occult precipitation when properly intercepted by trees in Central America. In certain areas specially the up land regions, fog harvesting by tall trees provides these trees by the necessary water. The extra harvested fog water irrigates the smaller surrounding vegetations, enhances the soil moisture content, and sometimes replenishes the ground water aquifers below the forested watershed [1].

Some plants and animals in the Namibia desert depend almost entirely on fog and dew for their water supply. One of these trees is the rare ancient tree, which was called by Charles Darwin the platypus of the plant kingdom [6].

Cloud forests contribution to the annual water budget of a watershed depends on three basic components: firstly, the density of trees, secondly, the total surfaces area of foliage, and thirdly, the exposure of trees to wind-blown fog [3].

Two-third of the annual moisture input at cloud forests in northern Chile is attributed to the interception of fog atmospheric moisture. This moisture flows inward from the Pacific Ocean and subsequently condenses. It is now known that trees and their foliage are natural barriers to fog and drizzles. Therefore, the green area underneath trees is naturally irrigated by fog harvested by trees [3].

Vegetal fog and dew water collection can produce sufficient water for some trees in certain forests and irrigate neighboring plants sometimes. Fog and dew harvesting could be a very attractive method for reforestation of hillside facing the west-east winds of Jordan plateau as practiced in several places in the world. Trees would need supplement irrigation until they reach two meters of height, then they start to satisfy their needs from fog and dew vegetal harvesting besides the rainfall.

While deforestation reduces fog water input in certain watersheds, a forestation increases that input. The percentage of reduction or increase is site-specific, but most research specially in semi-arid regions specify that deforestation inhances desertification partly because of fog water input reduction [1].

Trees and their foliage are natural barriers to fog and drizzles, therefore, green areas underneath trees in the study areas are naturally irrigated by trees fog harvesting besides rainfall and dewfall. Cloud forests contribution to the annual water budget of a watershed depends on the density of trees, the total surface area of trees to wind-blown fog. Cloud forests in northern Chile can contribute significantly to the annual water budget. Two-third of the annual moisture input is attributed to the interception of atmospheric moisture (fog) [3]. Therefore, the three types of condensation are measured together by special techniques of soil moisture measurements then the rainfall was subtracted from total water moisture measured. Dew deposition could reach 0.3 mm during 12 hours night, but regularly it is around 0.12 mm/night/m^2 [7]. This indicates the magnitude of the difference between vegetal dew and vegetal fog water harvested which could be ten times as much.

Cloudless nights are making an atmospheric windows. These windows have a major impact on the amount of longwave radiation emitted to space. This emission has the major role of ground surface and grass surface cooling. This cooling cools down the surrounding air by conduction which squeezes the air's ability to carry moisture, therefore dew deposition process is initiated closer to the end of cold clear nights [10].

Radiation fog is correlated with dew, since both form due to night cooling. Radiation fog or ground fog is formed at night if the suface air is moist and the ground is cooled by long wave radiation to a clear sky. It is more likely when the ground has been wetted by earlier rain, and at high latitudes where long winter nights allow prolonged cooling [7]. Radiation fog is most likely early in the morning not only at the plateau of Jordan but even in the Badia and desert during moist days.

It is well known now that forests with frequent and persistent low clouds or fog can intercept large amounts of atmospheric moisture, which condenses and drips from foliage or runs down the stems. This process adds additional water to the soil that would not be added if the areas were devoid of vegetation or contained low-growing vegetation [3]. Cloud forest in the tropics have been reported to add significant amounts of water to local watersheds [8]. The amounts in the study area are not comparable to the tropics but not negligible.

Dew in Mazar area is a valuable source of moisture for many plants during low rainfall periods. In many places in the world dew yields up to 50 mm of water specially on vegetal cover [1]. There is appreciable dew in many days of the year in the west of Mazar around the study area.

In the hilly regions south of Karak like Dhabab mount most of dew is extracted from the overlying air masses, but some of the moisture is supplied from the underlying soil which increases or initiates the dew deposition [11].

2. Methods

To measure the amounts of water harvested from fog fall and dewfall, the conventional rainfall gages are not appropriate because they represent too small area of the studied site. Therefore the study here resort to soil moisture measurement, assuming the evapotranspiration during the end of the cold night is very negligible. Fog and dew quantification is a very difficult task because rain, dew and fog intermix in any site to complicate the quantification of each condensation process.

Fog or dew models use numerical detailed microphysics, multi-phase chemistry and a multi-layered vegetation module. A chemical microphysical fog model for the description of moist deposition of oersols and atmospheric trace gages on vegetation. Those sophisticated models were not conducted in this field experiment because they are beyond the scope and the intended accuracy of this experimental field study.

Vegetal dew harvesting has been measured in (Israel) by observing and comparing the difference in growth rates of plants exposed to dew versus plants protected from dew. Plants exposed to dew at night (along the coastal plain of (Israel)) grew about twice as much as those protected from dew [9].

This study understands the difficulty of an exact quantification of the vegetal dew and fog water harvested. But with this challenging difficulty in mind, this experimental study tried through designated plots tables 1,2 to approach some quantification through soil moisture measurement assuming negligible evapotranspiration during the cold nights (studied at site prior to the experiment). Every day, an exposed and a protected soil samples are over -dried to measure the Total Water Collected (TWC) due to fog and dew water harvested plus rainfall. For every month, Fog and Dew (FD) water harvested is calculated by subtracting Monthly Precipitation (MP) from the measured TWC Appendix, tables 1-3.

Spatial and temporal variations of fog and dew harvesting if needed would require more extensive studies in the country with an extensively distributed stations in potential sites for several years to come up with a realistic map of such harvesting.

3. Discussion

3.1. Correlation analysis

As expected, the highest correlations are between MP and TWC. The least correlation in this case is (0.95) and (0.951) for plots 1,2,3,4,5, and 6, while the highest correlations is 0.997 for plots 7 and 8. the physical reason for such high correlation is due to the fact

Table 1
Dew and fog vegetal harvesting plots * (1992-1994)

No.	Complete title **	Code
1.	Olive trees plot, no vegetal cover, no stones.	FD1
2.	Olive trees plot, vegetal cover, no stones.	FD2
3.	Olive trees plot, no vegetal cover, with	FD3

	stones.	
4.	Vegetal plot, no barrier, no stones.	FD4
5.	Vegetal plot, no barrier, with stones.	FD5
6.	Vegetal plot, with barrier, with stones.	FD6
7.	Bare land, no barrier, no stones.	FD7
8.	Bare land, no barrier, with stones.	FD8
9.	Bare land, with barrier, with stones.	FD9

* Study site description:
Elevation: 1280 m, Latitude: 31° 05` N, Longitude: 35° 41` E

** A) Each plot has an area of 10x10m
B) Olive trees average height = 2.5m
C) Olive trees per plot = 4 Trees
D) Vegetation average height = 0.3m
E) Vegetation average density = 70%
F) Stone mulching average diameter = 8cm
G) Stone mulching average density = 30%
H) Barrier height = 2 m
I) Olive trees plots have no barriers

Table 2
Dew and fog vegetal harvesting (west of Mazar – Karak) (1992-1994)

No.	Complete title	Code
1.	Monthly precipitation	MP
2.	Total water collected	TWC
3.	Fog and dew water harvested	FD
4.	Mean monthly relative humidity	MMRH
5.	Lowest grass minimum temperature	LGMT
6.	Mean daily grass temperature	MDGT

Table 3
Correlations between climatological parameters

	MP	MMRH	LGMT	MDGT
MP	1	0.699	-0.62	-0.618
MMRH	0.699	1	-0.643	-0.663
LGMT	-0.62	-0.643	1	0.913
MDGT	-0.618	-0.663	0.913	1

Table 4
Correlations between harvested fog & dew and related parameters

FD 1	MP	TWC 1	FD 1	MMRH	LGMT	MDGT
TWC 1	0.95	1	0.672	0.694	-0.633	-0.62
FD 1	0.641	0.672	1	0.566	-0.497	-0.519
FD 2	MP	TWC 2	FD 2	MMRH	LGMT	MDGT
TWC 2	0.993	1	0.767	0.721	-0.646	-0.647
FD 2	0.693	0.767	1	0.639	-0.623	-0.635
FD 3	MP	TWC 3	FD 3	MMRH	LGMT	MDGT
TWC 3	0.951	1	0.685	0.697	-0.636	-0.623
FD 3	0.657	0.685	1	0.593	-0.511	-0.537
FD 4	MP	TWC 4	FD 4	MMRH	LGMT	MDGT
TWC 4	0.95	1	0.678	0.696	-0.637	-0.624
FD 4	0.647	0.678	1	0.586	-0.518	-0.541
FD 5	MP	TWC 5	FD 5	MMRH	LGMT	MDGT
TWC 5	0.95	1	0.693	0.698	-0.637	-0.625
FD 5	0.661	0.693	1	0.607	-0.532	-0.562
FD 6	MP	TWC 6	FD 6	MMRH	LGMT	MDGT
TWC 6	0.951	1	0.701	0.7	-0.64	-0.629
FD 6	0.679	0.701	1	0.636	-0.561	-0.601
FD 7	MP	TWC 7	FD 7	MMRH	LGMT	MDGT
TWC 7	0.997	1	0.757	0.717	-0.632	-0.635
FD 7	0.705	0.757	1	0.676	-0.57	-0.615
FD 8	MP	TWC 8	FD 8	MMRH	LGMT	MDGT
TWC 8	0.997	1	0.76	0.715	-0.633	-0.636
FD 8	0.709	0.76	1	0.662	-0.578	-0.627
FD 9	MP	TWC 9	FD 9	MMRH	LGMT	MDGT
TWC 9	0.972	1	0.764	0.782	-0.669	-0.659
FD 9	0.673	0.764	1	0.623	-0.576	-0.608

Table 5
Descriptive statistics of related parameters

	Range	Minimum	Maximum	Mean	Std. deviation	Skewness	Kurtosis
MP	306	0	306	46.58	70.92	1.91	4.04
MMRH	37	46	83	64.69	11.35	0.33	-1.28
LGMT	19	-8	11	1.53	5.72	0.07	-1.39
MDGT	18	-2	16	7.72	5.54	-0.15	-1.49

Table 6
Descriptive statistics of TWC

	Range	Minimum	Maximum	Mean	Std. deviation	Skewness	Kurtosis
TWC 1	325	3	328	56	75.86	1.84	3.65
TWC 2	339	1	340	61.5	80.06	1.73	3.08
TWC 3	326	7	333	61.36	76.26	1.82	3.52
TWC 4	326	4	330	58.14	76.06	1.82	3.57
TWC 5	326	5	331	59.44	76.26	1.81	3.5
TWC 6	326	2	328	56.78	76.37	1.8	3.45
TWC 7	328	4	332	62	76.95	1.77	3.25
TWC 8	328	2	330	59	76.99	1.78	3.32
TWC 9	225	0	225	51.56	67.76	1.28	0.56

Table 7
Descriptive statistics of collected FD

	Range	Minimum	Maximum	Mean	Std. deviation	Skewness	Kurtosis
FD 1	27	1	28	9.58	7.78	1.03	-0.19
FD 2	37	1	38	14.47	11.92	0.77	-0.69
FD 3	27	6	33	14.78	8.1	1.02	-0.22
FD 4	27	3	30	11.56	7.88	0.96	-0.36
FD 5	26	5	31	12.86	7.99	0.94	-0.38
FD 6	25	2	27	10.19	8.06	0.88	-0.55
FD 7	29	4	33	15.42	8.24	0.81	-0.47
FD 8	28	2	30	12.42	8.25	0.86	-0.4
FD 9	25	0	25	7.69	8.08	0.9	-0.49

Table 8
Correlations between fog & dew harvested for all studied plots

	FD1	FD2	FD3	FD4	FD5	FD6	FD7	FD8	FD9
FD1	1	0.966	0.993	0.995	0.989	0.984	0.944	0.949	0.985
FD2	0.966	1	0.971	0.972	0.973	0.978	0.955	0.955	0.981
FD3	0.993	0.971	1	0.998	0.996	0.99	0.953	0.959	0.988
FD4	0.995	0.972	0.998	1	0.997	0.991	0.953	0.958	0.989
FD5	0.989	0.973	0.996	0.997	1	0.996	0.965	0.971	0.993
FD6	0.984	0.978	0.99	0.991	0.996	1	0.973	0.978	0.996
FD7	0.944	0.955	0.953	0.953	0.965	0.973	1	0.992	0.973
FD8	0.949	0.955	0.959	0.958	0.971	0.978	0.992	1	0.978
FD9	0.985	0.981	0.988	0.989	0.993	0.996	0.973	0.978	1

that most of the water collected in the rainy months is from rainfall precipitation, and most of the moisture for fog and dew is in rainy months also tables 3-7.

On the other hand, the monthly precipitation is correlated with fog and dew vegetal harvested water (FD), but not as high as the monthly precipitation correlation with total water collected. The range of this type of correlation is between (0.641) for plot 1 and (0.709) for plot 8. Even though the correlation range is different, there is a systematic pattern of correlation with the lowest in both in plots 1,4,5 and the highest in both in plot 8 (table 8).

The Mean Monthly Relative Humidity (MMRH) is correlated to both, the TWC and the fog and dew water harvested (FD). Its correlation to (TWC) is more than its correlation to FD. The correlation range with TWC is from (0.694) to (0.782), and with FD from (0.566) to (0.623), The correlation is higher with TWC than FD because TWC depends on the monthly relative humidity, while FD depends more on daily relative humidity, because fog and dew are hourly phenomena which do not stay for several days like storms which produce rain.

The Lowest Grass Minimum Temperature (LGMT), and Mean Daily Grass Temperature (MDGT) are both negatively correlated to total water collected TWC and fog and dew water harvested FD. This negative correlation is due to the fact that most of the collected water is either rain or fog or both with minimal amount of dew in all studied plots. It is well known that foggy and rainy nights are not as cold as clear nights. Dew in general and particularly in the study region is more correlated with clear cold nights.

Regarding the average amounts of dew and fog vegetal harvesting FD, all amounts are attractive for proper practice with plot of Olive trees and stone multching as the highest mean (14.78) mm, then comes next Olive trees with vegetal cover (14.47) mm, which indicates that trees with their larger exposure to moist air have the highest effects on vegetal dew and fog harvesting.

Regarding the basic variables in each plot, the land use with olive trees or vegetal cover, the stone multching, and the barrier of some plots, the variability was apparent to allow for arranging the variables depending on their influence on the harvested amounts of fog and dew. The tree effects come first then the stone multching and the vegetal cover. The barrier, as expected, reduced the amount harvested to almost half for plot 9 (the bare land with barrier) reduced the amount 30% for plot 6 (vegetal plot with barrier). This result is due to having most of the harvested moisture, other than rain, as fog. Also this result indicates that exposure to moisture is a paramount parameter in vegetal dew and fog harvesting.

4. Dew and fog vegetal

4.1. Harvesting amounts (mm/month)

The amounts vary from month to month for each technique with non-zero minimum for most plots except for plot (FD9) bare land, with stones and barrier. The next lowest was (FD1) and (FD2) with 1.00 mm. The highest minimum (6.00 mm) was for (FD3) Olive trees plot with stone mulching.

On the other hand, olive trees with vegetal cover has the highest maximum 38.0 mm which is a very attractive amount of moisture. Also the Olive trees with stone mulching plot and the bare land plot. with stone mulching with no barrier has very high maximum (33.00mm) which indicates that vegetal cover and stone mulching have very substantial effects on fog and dew water harvesting.

5. Conclusions

This study investigated four parameters which could influence the amounts of vegetal fog and dew water harvesting. The parameters are vegetation cover, stone mulching, barriers placed west of certain plots, and Olive trees of about two meters high.

The result were very promising for Olive trees with the vegetal cover and stone mulching being next. The barriers had very high negative influence because most of the trapped moisture was due to fog flow in the first two meters not from dew which is mostly trapped by stone mulching and low vegetation.

It is apparent that the wet years like (1992) had more dew and fog vegetal harvesting than a drier year like (1993). The wet months like Dec., Jan. and Feb. had more dew and fog vegetal harvesting than the other months. During the wet year (1992), the month of August was unusually wet regarding the amount of collected dew and fog using the vegetation.

This study encourages performing more of such experiments in the same region and other regions in Jordan, specially in the western parts of Jordan plateau. The results also encourage afforestation program in these regions specially in the upsloping hills facing the westerly winds, because the trees after certain height could irrigate themselves and the surrounding vegetation by enhancing such occult precipitation.

Appendix A

Table A-1
Dew and fog vegetal harvesting data FD 1,2,3

Year	Month	M_No	MP	FD1		FD2		FD3		MMRH	LGMT	MDGT
				TWC	FD	TWC	FD	TWC	FD			
1992	Jan.	1	133	154	23	166	33	160	27	79	-8	-2
	Feb.	2	198	222	25	236	38	229	31	83	-5	0
	Mar.	3	306	328	22	340	34	333	27	71	-5	0
	Apr.	4	2	22	20	28	26	26	24	59	-2	3
	May	5	5	9	4	13	8	14	9	54	2	7
	Jun.	6	3	8	5	8	5	14	11	52	7	11
	Jul.	7	0	3	3	1	1	7	7	62	7	12
	Aug	8	0	28	28	37	37	33	33	61	8	14
	Sept.	9	0	4	4	4	4	8	8	60	4	13
	Oct.	10	0	6	6	8	8	10	10	46	6	13
	Nov.	11	105	117	12	124	19	122	17	67	-5	12
	Dec.	12	110	133	23	144	34	140	30	81	-3	5
1993	Jan.	13	61	72	12	85	24	78	18	80	-7	0
	Feb.	14	67	81	12	88	21	87	18	78	-6	0
	Mar.	15	19	28	11	38	19	35	16	68	-5	1
	Apr.	16	0	3	3	9	9	8	8	53	-4	4
	May	17	1	5	5	10	9	10	9	56	-1	8
	Jun.	18	0	4	4	5	5	8	8	51	5	13
	Jul.	19	0	4	4	1	1	9	9	60	8	14
	Aug	20	0	3	3	4	4	9	9	55	9	15
	Sept.	21	0	3	3	3	3	10	10	56	5	12
	Oct.	22	3	10	4	10	7	16	10	57	7	12
	Nov.	23	6	49	5	16	10	54	10	71	-1	5
	Dec.	24	44	163	13	63	19	169	19	69	-2	4
1994	Jan.	25	150	125	23	188	38	133	31	81	-1	4
	Feb.	26	102	67	12	142	24	73	18	78	-2	3
	Mar.	27	55	48	12	74	19	53	17	79	-1	3
	Apr.	28	36	10	8	45	9	16	14	50	0	4
	May	29	2	6	4	11	9	11	9	51	4	10
	Jun.	30	0	5	5	10	10	9	9	56	9	12
	Jul.	31	0	4	4	1	1	8	8	61	11	14
	Aug	32	0	4	4	1	1	8	8	60	10	15
	Sept.	33	0	5	5	7	7	10	10	63	10	16
	Oct.	34	17	18	1	21	4	23	6	57	6	13
	Nov.	35	144	156	12	160	16	161	17	81	0	7
	Dec.	36	108	109	1	113	5	115	7	83	-5	1

Table A-2
Dew and fog vegetal harvesting data FD 4,5,6

Year	Month	M_No	MP	FD4		FD5		FD6		MMRH	LGMT	MDGT
				TWC	FD	TWC	FD	TWC	FD			
1992	Jan.	1	133	156	23	157	24	155	22	79	-8	-2
	Feb.	2	198	224	26	226	28	224	26	83	-5	0
	Mar.	3	306	330	24	331	25	328	22	71	-5	0
	Apr.	4	2	24	22	25	23	22	20	59	-2	3
	May	5	5	11	6	12	7	9	4	54	2	7
	Jun.	6	3	10	7	11	8	7	4	52	7	11
	Jul.	7	0	4	4	5	5	2	2	62	7	12
	Aug	8	0	30	30	31	31	27	27	61	8	14
	Sept.	9	0	5	5	5	5	3	3	60	4	13
	Oct.	10	0	7	7	8	8	5	5	46	6	13
	Nov.	11	105	119	14	120	15	116	11	67	-5	12
	Dec.	12	110	136	26	138	28	135	25	81	-3	5
1993	Jan.	13	61	75	15	76	16	73	13	80	-7	0
	Feb.	14	67	84	15	85	16	83	14	78	-6	0
	Mar.	15	19	32	13	33	14	31	12	68	-5	1
	Apr.	16	0	5	5	6	6	4	4	53	-4	4
	May	17	1	7	6	8	7	6	5	56	-1	8
	Jun.	18	0	5	5	6	6	3	3	51	5	13
	Jul.	19	0	6	6	7	7	4	4	60	8	14
	Aug	20	0	5	5	6	6	3	3	55	9	15
	Sept.	21	0	6	6	7	7	3	3	56	5	12
	Oct.	22	3	13	7	14	8	11	5	57	7	12
	Nov.	23	6	51	7	53	9	50	6	71	-1	5
	Dec.	24	44	166	16	168	18	165	15	69	-2	4
1994	Jan.	25	150	128	26	130	28	128	26	81	-1	4
	Feb.	26	102	70	15	71	16	70	15	78	-2	3
	Mar.	27	55	50	14	52	16	50	14	79	-1	3
	Apr.	28	36	13	11	15	13	13	11	50	0	4
	May	29	2	8	6	10	8	7	5	51	4	10
	Jun.	30	0	6	6	8	8	6	6	56	9	12
	Jul.	31	0	5	5	6	6	3	3	61	11	14
	Aug	32	0	5	5	5	5	2	2	60	10	15
	Sept.	33	0	7	7	8	8	5	5	63	10	16
	Oct.	34	17	20	3	22	5	20	3	57	6	13
	Nov.	35	144	158	14	160	16	158	14	81	0	7
	Dec.	36	108	112	4	115	7	113	5	83	-5	1

Table A-3
Dew and fog vegetal harvesting data FD 7,8,9

Year	Month	M_No	MP	FD7		FD8		FD9		MMRH	LGMT	MDGT
				TWC	FD	TWC	FD	TWC	FD			
1992	Jan.	1	133	156	23	159	26	154	21	79	-8	-2
	Feb.	2	198	225	27	228	30	222	24	83	-5	0
	Mar.	3	306	228	22	330	24	225	19	71	-5	0
	Apr.	4	2	22	20	23	21	19	17	59	-2	3
	May	5	5	12	7	13	8	8	3	54	2	7
	Jun.	6	3	7	4	8	5	5	2	52	7	11
	Jul.	7	0	2	2	2	2	0	0	62	7	12
	Aug	8	0	27	27	30	30	25	25	61	8	14
	Sept.	9	0	3	3	4	4	1	1	60	4	13
	Oct.	10	0	7	7	7	7	2	2	46	6	13
	Nov.	11	105	115	10	117	12	114	9	67	-5	12
	Dec.	12	110	135	25	136	26	132	22	81	-3	5
1993	Jan.	13	61	78	17	77	16	73	12	80	-7	0
	Feb.	14	67	82	15	82	15	78	11	78	-6	0
	Mar.	15	19	31	12	31	12	28	9	68	-5	1
	Apr.	16	0	6	6	5	5	2	2	53	-4	4
	May	17	1	7	6	8	7	4	3	56	-1	8
	Jun.	18	0	5	5	6	6	1	1	51	5	13
	Jul.	19	0	4	4	4	4	0	0	60	8	14
	Aug	20	0	5	5	6	6	1	0	55	9	15
	Sept.	21	0	4	4	5	5	1	0	56	5	12
	Oct.	22	3	9	6	10	7	5	2	57	7	12
	Nov.	23	6	13	7	14	8	9	3	71	-1	5
	Dec.	24	44	56	12	61	17	56	12	69	-2	4
1994	Jan.	25	150	176	26	178	28	173	23	81	-1	4
	Feb.	26	102	116	14	118	16	114	12	78	-2	3
	Mar.	27	55	68	13	70	15	66	11	79	-1	3
	Apr.	28	36	48	12	50	14	45	9	50	0	4
	May	29	2	9	7	10	8	5	3	51	4	10
	Jun.	30	0	8	8	9	9	3	3	56	9	12
	Jul.	31	0	5	5	5	5	0	0	61	11	14
	Aug	32	0	4	4	4	4	0	0	60	10	15
	Sept.	33	0	6	6	7	7	2	2	63	10	16
	Oct.	34	17	22	5	23	6	18	1	57	6	13
	Nov.	35	144	160	16	161	17	155	11	81	0	7
	Dec.	36	108	122	14	123	15	110	2	83	-5	1

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