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EVALUATION OF THE VERTICAL DISTRIBUTION METHOD IN SURVEYING IMMATURES OF THE SILVERLEAF WHITEFLY, *Bemisia argentifolii* BELLOWS & PERRING, ON FOUR PLANT HOSTS.

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ABSTRACT

Field experiments were conducted during the two seasons of 1997 & 1998 to evaluate the vertical distribution method in surveying the silverleaf whitefly (SLWF) immature stages on the four hosts, cotton, cucumber, cantaloupe and cabbage. The results revealed that the vertical distribution of eggs and nymphs was similar on the four hosts. The majority of eggs were found on the newly formed leaves followed by upper-middle and middle leaves. The lowest number was recorded on lower and middle-lower leaves. The percentages of eggs on the top and upper-middle leaves ranged from 31.43 to 40.61, 23.93 to 26.24% in 1997 and 34.40 to 38.07, 25.11 to 27.42% in 1998, respectively, on various plant hosts. Meanwhile, the corresponding percentages were 3.35-10.06 and 5.13-7.05% on the lower leaves during 1997 and 1998. The same trend was observed with the nymphs on the lower to upper leaves of the plant. The high population densities per sample were recorded on the lower leaves with percentages varying from 35.33 to 41.07 in 1997 and 35.93 to 40.28 in 1998. The densities on the middle-lower leaves came next, being 27.91 to 28.54% in 1997 and 27.47 to 30.86 in 1998. There were no nymphs on the new-formed leaves of all four hosts except cabbage plant. The distribution of nymphal instars of SLWF, on the same plant, was discussed. The immature counts from the different combinations of top, top-middle, middle, middle-lower and lower leaves of the whole-plant were compared with those sampled as an indication of immature levels within field population. The results proved the efficiency of vertical distribution in surveying SLWF immature stages.

Keywords: Silverleaf whitefly, *Bemisia argentifolii*, homoptera, alyerodidae, within-plant distribution, vertical distribution, insect sampling, cotton, cabbage, cucumber, cantaloupe, eggs, nymphs.

INTRODUCTION

The silverleaf whitefly (SLWF), *Bemisia argentifolii* Bellows & Perring, is an important constraint on the production of food and fiber crops throughout the world. The increase of worldwide concern regarding the adverse impact of *B. argentifolii* in crop production systems emphasizes the need to develop control strategies based on its biology, population dynamics and distribution in relation to cultivated and wild host ecosystem (Henneberry & Faust 1999).

The polyphagous and inter-host movement of this insect contributes to the complexity and difficulty of pest management. In particular, efficient monitoring and management of this pest over a large area and in a number of cropping systems could reduce the upsets of this insect when favorable conditions are available. There is certainly a need for monitoring *B. argentifolii* population levels to decide the success and continuous reliability of any control program. In this case, it is important to know the effects of control procedures on the immature stages, where the eggs and nymphs are most likely to be found on the plant (Ekbom & Rumei 1990; Liu et al., 1993; Tasi & Wang 1996).

Sampling methods are essential to study the biology and ecology of *B. argentifolii*. They have played a significant role in recent advances in the study of insect population dynamics and in determination of the economic decision levels of whiteflies (Southwood 1978). The advantage of SLWF immature sampling provides a better measure of the actual population density of *B. argentifolii* in the field (Riely 1997).

SLWF populations are distributed both on and between plants (Naranjo, 1995). Because densities of the immature stages can reach extremely high numbers, sampling can become a difficult and very time-consuming endeavor. Eggs and nymphs stages tend to be distributed vertically on the plant with more mature stages found on progressively older leaves (Melamed-Madjor et al., 1982; Arx et al., 1984; Ohnesorge & Rapp, 1986; Abisgold & Fishpool 1990; Naranjo & Flint 1994; Tonhasca et al., 1994). These sampling methods permit efficient monitoring of eggs and nymphs for research purposes, but they create difficulties to make accurate counts of these stages in the field.

Therefore, the objective of the current study was to study the distribution of eggs and nymphs of *B. argentifolii* on cotton, cucumber, cantaloupe and cabbage. This would help to find the target stage for counting and to show the interaction between the stage and its host.

MATERIALS AND METHODS

Plant growing conditions:

Studies with SLWF were carried out at Mansoura Experimental Station, Faculty of Agriculture, Mansoura University during 1997 & 1998 on four plant hosts namely, cotton (*Gossypium barbadense* L.), cucumber (*Cucumis sativus* L.), cantaloupe (*Cucumis melo* L.) and cabbage (*Brassica oleracea var. capitata* L.). The cultivated area of each host was about 200 m^2 and the plants were given the normal cultural practices. The examination was started after one week of the natural infestation with the insect.

Within-plant distribution:

Vertical distribution of SLWF eggs and nymphs on the four hosts was examined by inspecting the lower surfaces of the upper youngest leaves and lower ones of the plant. Twenty-five plants were chosen at random from each host (five from each corner and center of the field). Eggs and nymphs were counted on eleven nodes of cotton and six or seven on the other three hosts. The distribution of eggs and nymphs within each host was examined by randomly selecting one leaf from the top, between top and middle, middle, between middle and bottom and bottom of the plants. A total of 125 leaves from 25 randomly selected plants were collected. The leaves from each category were placed inside transparent plastic bags, tightly closed and taken to the laboratory for inspection. Numbers of immatures per cm^2 area of each leaf were recorded in the laboratory.

Statistical analysis:

Numbers of silverleaf whitefly eggs and nymphs within-plant were subjected to analysis of variance (ANOVA) (CoStat, 1990). In addition, correlation coefficient analysis was completed to determine the relationship between the counts of SLWF immature stages and position of leaf samples on the plant, and combinations of these numbers with the whole-plant counts of *B. argentifolii* immatures on the four selected plants in the field.

RESULTS

SLWF eggs:

The mean numbers of *B. argentifolii* eggs per leaf of cotton, cucumber, cantaloupe and cabbage during 1997 & 1998 are summarized in Tables 1 & 2. The number of deposited eggs was contrary to the leaf age and position. It was higher in the terminal leaves of main stem of the plant and decreased in a descending order from the upper leaves (Table 1). The majority of eggs were placed on the newly formed and top-middle leaves of the tested plants. In 1997, the average numbers of eggs/cm^2 on the upper leaves were 19.14±2.1 on cotton, 21.06±1.21 on cucumber, 14.08±0.58 on cantaloupe and 20.15±1.07 on cabbage. In 1998, the corresponding averages were 14.13±1.71, 21.39±1.50, 15.40±0.80, 20.33±1.38 on the same host plants, respectively. The top-middle leaves were also preferred for female oviposition. These numbers were 13.44±1.78, 15.59±0.96, 10.72±0.56 and 15.24±0.67 in 1997 and 10.56±1.22, 16.09±0.72, 10.21±0.61 and 14.11±0.76 eggs/cm^2 in 1998, on those hosts. On the contrary, the lowest numbers of SLWF eggs were recorded on both middle-lower and lower leaves of the four hosts (Table 1). The percentages of eggs on each host varied according to the leaf position or age. The trend of eggs vertical distribution was similar in the four plant hosts. Moreover, the statistical analysis showed high significant variations in egg distribution on each host (Table 1).

SLWF Nymphs:

Table (2) presents the nymphs distribution on cotton, cucumber, cantaloupe and cabbage in both 1997 and 1998. The results showed that there were no nymphs on the upper leaves of the plant (nodes 1-3) during the two successive years. Most of the nymphal population was found on the lower leaves of the main stem (lower and middle-lower) and decreased towards the upper third of the plant (Table 2).

In 1997, the average numbers of nymphs/cm^2 on the lower and middle-lower were 10.14±1.472, 12.59±1.09, 10.61±0.66, 17.80±1.32 and 8.94±0.57, 8.94±0.57, 7.43±0.55, 12.33±0.73 on cotton, cucumber, cantaloupe and cabbage, respectively. In addition, they formed 35.33, 40.07, 39.86 and 41.07% of the total nymphal numbers on the lower leaves and 28.54, 28.45, 27.91 and 28.45% of the total on the middle-lower leaves during 1997 for cotton, cucumber, cantaloupe and cabbage, respectively. The lowest population of SLWF nymphs was recorded on the top-middle leaves during the two successive years. Moreover, the same trend of nymphal distribution on each host was observed during 1998 (Table 2).

Table (3) shows the distribution of the nymphal instars on each host. The results indicated that the 1st, 2nd, 3rd, and 4th instars of nymphs were distributed on all leaf positions except the upper leaves on cotton, cucumber and cantaloupe. The population of the first instar was higher on the top-middle and middle leaves only. Meanwhile, the majority of the second was on the middle and middle-lower leaves (Table3). The 3rd instar was occurred in a high population on the middle-lower leaves of the four plant hosts. Moreover, the percentages of the red-eye nymphs (pupae) on the lower and middle-lower leaves were 50.09, 53.81, 53.15, 37.17% and 39.47, 35.24, 37.5, 30.93% of the total nymphal stages on cotton, cucumber, cantaloupe and cabbage during the period of study (Table 3).

The correlation coefficients between the numbers of SLWF eggs and nymphs on the top leaf, top-middle leaf, middle leaf, middle-lower leaf, lower leaf and combinations of these leaves of the whole-plant counts on the four plants are presented in Table (4). The results indicate that the relationship between eggs and leaf position was higher on the top, top-middle and middle leaves of all the tested plants. On the contrary, the nymphs were highly correlated with the total numbers per plant on the lower, middle-lower and middle leaves, respectively (Table 4).

DISCUSSION

The distribution of any insect is a behavioral response to its feeding, ovipostion and mating and to environmental variations (Southwood 1978). The host plant has a pronounced impact on SLWF biology affecting, among other factors, adult behavior, development, selection of ovipostional and feeding sites and its fecundity (Lenteren & Noldus 1990; Bethke *et al*., 1991; Simmons 1994; Chu *et al.,* 1995). Selection a suitable leaf or plant by an insect can be mediated by its intrinsic qualities (e.g., fixed feeding preferences) and the ecological factors in the community (Simmons 1994).

The distribution of *B. argentifolii* is not uniform on the leaves of the four plant hosts (Tables 1 & 2). The similarity of the population size of this insect pest on these hosts may reflect its full adaptation on cotton, cucumber, cantaloupe and cabbage hosts and other plants in Egypt (Abdel-Baky et al., 2000). Both eggs and nymphs are distributed on most of the plant leaves. Meanwhile eggs distribution occurs with high abundance on the top and top-middle leaves and decreases towards the lower leaves of the plant. This may be due to the ovipositional behavior of the female, leaf texture, age, intraplant, interplant movement of the crawlers and the nutritional status of the plant host (Lenteren & Noldus 1990; Byrne and Bellows, 1991; Summers *et al*., 1996; Simmons 1999; Cardoza *et al*., 2000 and Chu *et al.,* 2000). Walker and Perring (1994) showed that *B. argentifolii* oviposition takes place most often after females have penetrated the cuticle of the leaf, but before they have ingested the phloem sap. They also suggested that the selection of oviposition sites was determined during the penetration phase. Therefore, the females have an ability to assess the leaf age and its nutritional case during the stylet penetration phase. Based on these results, the chemical constituents of the intercellular fluid are apparently responsible for egg distribution within each plant (Bentz *et al.,* 1995). The reason that SLWF females prefer to oviposit on young leaves is likely related to the fact that nymphs become essentially immobile after their first moult (Veenstra & Byrne 1998).

According to Byrne and Draeger (1989), the age of a plant and its leaves can alter its relative importance as a host of *B. agrentifolii*. They found 150-fold greater oviposition in the three-leaf stage of lettuce versus older leaves. With regard to SLWF biology, the leaf age and, to some extent, the position on the plant, and the insect stage occurring on the leaf are correlated together (Arx et. al., 1984; Ohnesorge & Rapp, 1986 and Cardoza *et al.,* 2000). Moreover, studies by Yano (1983) and Xu (1985) have stressed the importance of the vertical distribution of the greenhouse whitefly (GHWF) on the plant. As with SLWF, the immature stages of the insect and leaf age and/or position on the plant are also correlated.

In the present investigation, the results were in harmony with the findings of Godfery et al., (1994) regarding the trend of nymphs distribution on cotton plants. They noticed that the highest number of eggs was deposited on leaves 2 to 6 with 12 to 15% of the total eggs population. Small nymphs were most abundant on leaves 3 to 5 with 15.5 to 22.9% of the total and the majority of the red-eye nymphs were found on leaves 5 to 8 with 15.1 to 19.8% of the total. These results were also in agreement with those of Naranjo and Flint (1994); Naranjo et al., (1994); Naranjo (1995); and Naik and Lingappa (1992) on cotton in India and Zimbabwe. Moreover, the positions of these most infested leaves changes less than one node over the course of the growing season, reflection the synchronization between insect and plant development. Melamid-Major et al. (1982) and Arx et al. (1984) reported that the location of cotton leaf most infested with *Bemisia* nymphs varies with the stage of plant development and that nymphs aggregate on leaves along the main stem.

Several works have developed techniques to reduce sampling time in cotton, peanuts, cantaloupe, and certain ornamental plants. This was enhanced by determining the location of the most frequently infested leaves (Melamid-Major et al., 1982; Butler & Henneberry 1984; Rao *et al*., 1991; Lynch & Simmons 1993; Naranjo & Flint 1994; Naranjo et al., 1994 and Tonhasca et al., 1994) or by counting the immatures on only a portion of a leaf (Arx et al., 1984; Ohensorge & Rapp 1986). Since the distribution of immatures is not similar on the plant, sampling periods can be reduced by counting eggs on the new formed and upper-middle aged leaves, while the nymphs can be counted on the lower and middle-lower aged leaves.

In conclusion, the present results provide distinctive and precise information that are useful for sampling eggs and nymphs of SLWF on the four plant hosts. It is suggested that sampling the young-middle aged and lower-middle aged leaves will give a reliable indication of level of infestation with SLWF. The results also indicate that the vertical distribution of SLWF eggs and nymphs may vary depending on the oviposition site selected by the females and/or intraplant movement of the first instars. However, additional work is needed to determine *B. argentifolii* spatial distribution patterns in the field to estimate the optimal sample size and to develop its sequential sampling plans.

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تقييم طريقة التوزيع الرأسى فى حصر الأطوار غير الكاملة لحشرة الذبابة البيضاء *Silverleaf whitefly, Bemisia argentifolii* على أربعة من العوائل النباتية.

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أجريت تجارب حقلية فى عامى 1997 و 1998 وذلك بغرض تقييم طريقة التوزيع الرأسى Vertical distributionأو ما يعرف بالتوزيع داخل النبات Within-plant distribution فى حصر الأطوار غير الكاملة لحشرة الذباب الأبيض (بيض و حوريات) على أربعة من العوائل النباتية (القطن – الخيار – الكنتالوب – الكرنب)، وخلصت النتائج إلى :-

1- أن التوزيع الرأسى لكل من بيض وحوريات الذباب الأبيض كانا متشابهين على العوائل النباتية الأربعة موضع الدراسة.
2- أشارت النتائج أن توزيع بيض الحشرة على النبات كان مرتفع الكثافة على الأوراق الحديثة ثم انخفض تدريجيا فى ترتيب تنازلي تجاه الأوراق السفلية من ساق النبات.
3- الغالبية العظمى من البيض وجد على الأوراق الحديثة يليها الأوراق الحديثة متوسطة العمر، حيث تراوحت النسبة المؤوية لتواجد البيض من 31.43 إلى 40.61%، و من 23.93 إلى 26.24 % فى عام 1997 , من 34.40 إلى 38.07% و من 25.11 إلى 27.42 % فى عام 1998 لكل من الأوراق الحديثة و الحديثة متوسطة العمر،على التوالى.
4- وصل توزيع البيض إلى أقل معدل له على الأوراق السفلية والسفلية متوسطة العمر خلال عامى الدراسة، حيث تراوحت النسبة المؤوية على الأوراق السفلية من 3.35 إلى 10.06 عام 1997 ، من 5.13 إلى 7.05 عام 1998.
5- أما توزيع الحوريات فكان على عكس توزيع البيض على العوائل النباتية الأربعة، حيث كانت الكثافة العددية للحوريات مرتفعا على الأوراق السفلية والسفلية متوسطة العمر ثم انخفض تدريجيا فى ترتيب تصاعدى تجاه قمة النبات.
6- لم توجد آي حوريات علي الأوراق الحديثة لكل من القطن – الخيار والكنتالوب فى حين وجدت حوريات العمر الأول على الأوراق الحديثة لنبات الكرنب وبمعدلات منخفضة.
7- حوريات العمر الرابع (العذراء) كانت أكثر تواجدا على الأوراق السفلية والسفلية متوسطة العمر عن باقى أوراق النبات، بينما حوريات العمر الثالث فكان توزيعها مكثف على الأوراق السفلية متوسطة العمر . فى حين أن الغالبية العظمى من حوريات العمر الثانى كانت موزعه على الأوراق العلوية متوسطة العمر والأوراق الوسطى من ساق النبات.
8- أشارت نتائج الدراسة أن الإرتباط بين توزيع البيض والحوريات على الأوراق العلوية ، العلوية متوسطة العمر ، الأوراق الوسطى ، السفلية متوسطة العمر و السفلية وبين تعدادهما على النبات الواحد أن هناك إرتباط قوى بين تعداد البيض والحوريات على كل ورقة وبين عمر الورقة ووضعها على ساق النبات.

لذلك فإن طريقة التوزيع الرأسى تعتبر من الدراسات البيئية الهامة والتى تساعد فى تقليل زمن أخذ العينة والوصول إلى طور الحشرة المستهدف دراسة على النبات الواحد مع تقليل معدل الخطأ المترتب على اختيار الجزء النباتى لدراسة العينة. علاوة على ذلك ،فإن دراسة تعداد الأطوار غير الكاملة من الحشرة يدل على حجم التعداد الحقيقى للحشرة فى الحقل وما يترتب علية من زيادة عددية متوقعه فى حالة توافر الظروف البيئية المناسبة.

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Table (1): Distribution of eggs of the silverleaf whitefly, *B. argentifolii* on different leaf positions on each plant of four selected hosts during 1997 & 1998.

Plant host	1997									
	Top		Top-Middle		Middle		Middle-Lower		Lower	
	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%
Cotton	19.14±2.1 a	40.61	13.44±1.78 b	25.52	10.42±1.47 c	22.11	2.55±0.47 d	05.41	1.58±0.43 d	03.35
Cucumber	21.06±1.21 a	35.45	15.59±0.96 b	26.24	12.22±0.80 c	20.56	6.39±0.54 d	10.75	4.16±0.47 e	07.00
Cantaloupe	14.08±0.58 a	31.43	10.72±0.56 b	23.93	10.04±0.52 c	22.41	5.45±0.25 c	12.17	4.51±0.33 c	10.06
Cabbage	20.15±1.07 a	33.61	15.24±0.87 b	25.41	12.74±0.87 c	21.24	6.74±0.43 d	11.24	5.10±0.41 d	08.50
	1998									
Cotton	14.13±1.71 a	34.40	10.56±1.22 b	25.63	09.91±1.08 b	24.10	04.17±0.59 c	10.12	02.42±0.69 c	05.85
Cucumber	21.39±1.50 a	36.45	16.09±0.72 b	27.42	12.78±0.40 c	21.78	05.41±0.33 d	09.22	03.01±0.34 e	05.13
Cantaloupe	15.40±0.80 a	37.88	10.21±0.61 b	25.11	08.05±0.61 c	19.80	0.4.13±0.21 d	10.10	02.89±0.28 d	07.05
Cabbage	20.33±1.38 a	38.07	14.11±0.76 b	26.42	11.34±0.66 c	21.24	04.82±0.33 d	09.03	02.80±0.29 e	05.24

[a] **Means within a row followed by the same letter are not significantly different (P≤0.05).**

Table (2): Distribution of nymphs of the silverleaf whitefly, *B. argentifolii* on different leaf positions on each plant of four selected hosts during 1997 & 1998.

Plant host	Top		Top-Middle		Middle		Middle-Lower		Lower	
	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%	Mean ± SE	%
1997										
Cotton	0 d	0	2.54±0.42 c	09.20	07.73±1.11 b	26.93	08.19±1.21 b	28.54	10.14±1.42 a	35.33
Cucumber	0 e	0	2.93±0.24 d	09.45	06.92±0.74 c	22.02	8.94±0.57 b	28.45	12.59±1.09 a	40.07
Cantaloupe	0 d	0	2.93±0.18 c	11.01	05.65±0.62 b	21.22	07.43±0.55 b	27.91	10.61±0.66 a	39.86
Cabbage	0 e	0	3.38±0.21 d	07.80	09.83±0.63 c	22.68	12.33±0.73 b	28.45	17.80±1.32 a	41.07
1998										
Cotton	0 d	0	03.30±0.67 c	12.25	06.56±1.28 b	24.35	07.40±1.30 b	27.47	09.68±1.33 a	35.93
Cucumber	0 d	0	03.03±0.26 c	08.75	08.57±0.61 b	24.73	09.83±0.50 b	28.40	13.19±0.97 a	38.12
Cantaloupe	0 e	0	02.18±0.20 d	07.47	06.64±0.50 c	22.76	08.60±0.52 b	29.48	11.75±0.90 a	40.28
Cabbage	0 e	0	03.06±0.33 d	07.01	10.37±0.62 c	23.74	13.78±0.54 b	30.86	16.77±0.86 a	38.39

[a] **Means within a row followed by the same letter are not significantly different ($P \leq 0.05$).**

Table (3): Distribution of nymphal instars of SLWF (*B. argentifolii*) on four selected plants.

Hosts	Leaf position	1st instar		2nd instar		3rd instar		4th instar	
		Mean	%	Mean	%	Mean	%	Mean	%
Cotton	Top	00.00 d	-	00.00 d	-	00.00 e	-	00.00 d	-
	Top-Middle	09.75 a	33.14	04.80 c	15.00	01.80 d	03.40	01.00 d	2.11
	Middle	10.18 a	34.60	09.90 b	30.79	11.60 c	21.93	03.95 c	8.33
	Middle-Lower	07.14 b	24.27	12.80 a	40.00	20.80 a	39.32	18.71 b	39.47
	Lower	02.35 c	07.99	04.50 c	14.06	18.70 b	35.35	23.75 a	50.09
Cucumber									
	Top	00.00 d	-	00.00 d	-	00.00 e	-	00.00 d	-
	Top-Middle	12.35 b	35.46	05.75 c	13.67	03.15 d	05.39	01.15 d	02.31
	Middle	14.60 a	41.91	13.41 a	31.88	13.35 c	22.84	04.30 c	08.64
	Middle-Lower	06.55 c	18.81	14.60 a	34.71	22.65 a	38.74	17.53 b	35.24
	Lower	01.33 d	03.82	08.30 b	19.74	19.31 b	33.03	26.77 a	53.81
Cantaloupe									
	Top	00.00 d	-	00.00 c	-	00.00 e	-	00.00 d	-
	Top-Middle	12.95 a	34.29	07.70 b	18.53	04.80 d	07.90	01.40	02.68
	Middle	13.66 a	36.17	13.10 a	31.53	14.60 c	24.03	03.50	06.67
	Middle-Lower	08.75 b	23.18	13.95 a	33.57	23.10 a	38.03	19.65	37.50
	Lower	02.40 c	06.36	06.80 b	16.37	18.25 b	30.04	27.85	53.15
Cabbage									
	Top	06.75 c	14.26	02.40 d	04.81	01.30 e	01.88	00.00 e	-
	Top-Middle	14.80 a	31.26	08.90 c	17.84	06.60 d	09.54	06.85 d	08.92
	Middle	12.60 a	26.60	14.50 b	29.06	15.35 c	22.20	17.65 c	22.98
	Middle-Lower	09.35 b	19.75	16.75 a	33.57	25.30 a	36.59	23.75 b	30.93
	Lower	03.85 d	08.13	07.35 c	14.72	20.60 b	29.79	28.55 a	37.17

[a] **Means within a column followed by the same letter are not significantly different (P≤0.05).**

Table (4): Correlation coefficients between the numbers of eggs and nymphs of SLWF at selected levels of plant leaves with the insect populations on four selects hosts.

Host	Leaf position	Eggs						Nymphs					
		1997			1998			1997			1998		
		R	Slope (b)	Y Int (a)	R	Slope (b)	Y Int (a)	R	Slope (b)	Y Int (a)	R	Slope (b)	Y Int (a)
Cotton	**Top**	0.9397	0.3417	3.024	0.9664	0.3245	0.848	-	-	-	-	-	-
	Top-Middle	0.9897	0.3067	-1.030	0.9735	0.2505	0.056	0.8721	0.0894	0.086	0.9008	0.1347	-0.352
	Middle	0.9528	0.2433	-1.044	0.9725	0.2067	1.448	0.9487	0.2565	0.257	0.9903	0.2862	-1.052
	Middle-Lower	0.7125	0.0584	-0.208	0.9537	0.1114	-0.387	0.9954	0.2980	0.298	0.9947	0.2892	-0.454
	Lower	0.6695	0.0500	-0.777	0.7929	0.1070	-1.964	0.9617	0.3378	0.338	0.9648	0.2867	1.935
Cucumber	**Top**	0.8594	0.4471	-5.509	0.9680	0.5887	-13.163	-	-	-	-	-	-
	Top-Middle	0.8559	0.3663	-6.281	0.9285	0.2610	0.849	0.5318	0.0664	0.066	0.7337	0.0948	-0.211
	Middle	0.4574	0.1468	3.900	0.4289	0.0593	9.329	0.6317	0.2663	0.266	0.7429	0.2263	0.897
	Middle-Lower	0.2478	0.0594	2.723	0.3129	0.0381	3.196	0.7677	0.2395	0.240	0.7042	0.1713	3.937
	Lower	0.0984	-0.0202	5.188	0.3665	0.0486	0.220	0.3566	0.4243	0.424	0.5794	0.2783	3.809
Cantaloupe	**Top**	0.7726	2.3704	11.428	0.8122	0.3384	1.579	-	-	-	-	-	-
	Top-Middle	0.9804	3.1623	10.897	0.9348	0.2966	-1.906	0.3566	3.3871	3.387	0.4392	0.0555	0.554
	Middle	0.8291	2.8634	16.059	0.9127	0.2881	-3.715	0.7500	2.3119	2.312	0.5950	0.1576	2.185
	Middle-Lower	0.8439	6.0464	11.825	0.4266	0.0473	2.196	0.8747	2.3762	2.376	0.8911	0.2921	0.036
	Lower	0.4683	2.5381	33.352	0.2937	0.0423	1.166	0.8957	2.3057	2.306	0.8688	04934	-2.741
Cabbage	**Top**	0.8813	0.3250	0.455	0.8617	0.4725	-4.905	-	-	-	-	-	-
	Top-Middle	0.9525	0.2184	2.005	0.8960	0.2718	-0.405	0.0064	5.3564	5.356	0.2959	0.0573	0.561
	Middle	0.8903	0.2663	-3.400	0.5987	0.1577	2.916	0.6518	0.1796	0.180	0.6945	0.2558	-0.784
	Middle-Lower	0.6369	0.0948	1.002	0.5609	0.0753	0.806	0.9478	0.3029	0.303	0.8775	0.2824	-1.164

	Lower	0.6800	0.0954	-0.675	0.1976	0.0226	1.588	0.8613	0.5011	0.501	0.8181	0.4170	-1.425