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Monitoring of Sweet Potato Whitefly, *Bemisia tabaci* (Gennadius) with Yellow Sticky Traps

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رصد أعداد الذبابة البيضاء باميسيا تاباسي (*Bemisia tabaci*) بواسطة المصايد الصفراء اللاصقة

الملخص : تم رصد تذبذب أعداد الحشرات الكاملة لذبابة البطاطس البيضاء (*Bemisia tabaci*) بمحطة التجـــارب الزراعيـــة بكليـــة الزراعـــة في جامعة السلطان قابوس بسلطنة عمان أسبوعيا ولمدة أربعة أعوام بدءا من الأسبوع الأول من شهر يناير ١٩٩٣م وحتى ديسمبر ١٩٩٦م باستخدام المصايد الصفراء اللاصقة. أوضحت الدراسة وجود الحشرة طـوال أيـام السـنة. وتكثر أعدادها في الفترة من يوليو إلى أكتوبر وكانت الذروة خلال الأعوام ٩٣ و ٩٤ و ٩٥ في شهر سبتمبر، أما في عـام ١٩٩٦م فقد سجلت الذروة في شهر أغسطس . وتتراجع أعداد الحشرة خلال الشهور الأخرى. أوضحت البيانات أن أعـداد الحشرة تتأثر بدرجة حرارة الطقس والرطوبة النسبية حيث تكون أعداد الحشـرة في أقصاها عندما تكون درجـات الحـرارة القصوى بين ٣٢,٦م و ٤٠,٨م والدرجات الدنيا بين ٢٣,٧ و ٣٢,٠ م و الرطوبة النسبية القصـوى بين ٥٧ و ٩٢% والدنيـا بين ١٣ و٧٦%. أوضح تحليل الارتباط لبيانات السنوات الأربعـة التأثير الإيجابي والفعال لدرجات الحـــرارة والرطوبـة النسبية على نشاط الطور البالغ من الذبابة البيضاء . كانت قيمة معامل الارتباط (r) لدرجات الحـرارة القصوى ٠,١٥ بينمـا كان تأثير الرطوبة النسبية أكثر وضوحا (٠,٣٣).

ABSTRACT: Population fluctuations of adult sweetpotato whitefly (*Bemisia tabaci* Gennadius) were monitored at the Agricultural Experiment Station, College of Agriculture, Sultan Qaboos University, Sultanate of Oman, for a period of four years on a weekly basis from 1st week of January 1993 through December 1996 by using yellow sticky traps. The pest was ubiquitous all round the year as it was found in all the weekly recordings in the four-year study. However, its activity was at peak with large populations from July to October. During 1993, 1994 and 1995 the highest catch of whitefly adults were recorded in the month of September. However, during 1996, the highest catch was recorded in August. Thereafter, whitefly populations started to decrease, fluctuating at lower levels during the other months. The effect of certain weather parameters revealed that the highest adult catches occurred when the maximum temperatures ranged from 32.6 to 40.8°C and the minimum temperatures were 23.7 to 32.0°C, while the maximum relative humidities ranged from 57 to 92% and minimum relative humidities ranged from 13 to 67%. The correlation analyses of four years pooled data revealed that both temperature and relative humidity have positive and significant effect on the activity of the adult whitefly. The 'r' value for maximum temperature was 0.15. However, the effect of maximum relative humidity was more profound (r = 0.33).

The sweetpotato whitefly (SPW) *Bemisia tabaci* Gennadius (Homoptera : Aleyrodidae), is regarded as a noxious pest and has considerable economic significance as a vector of plant viruses causing diseases of plants of economic importance. It is a polyphagous pest of world importance with at least 500 host plants (Greathead, 1986). It is distributed throughout warm and tropical areas of the world such as Oman, Sudan, India, Egypt, Turkey, Greece, Central America and Thailand. In view of its wide adaptability and ability to cause extensive crop damage directly and indirectly resulting in economic losses and its ability to withstand many of the commonly used insecticides, this pest poses major concerns among the vegetable growers in many parts of this country and the world.

In Oman, SPW is one of the major pests infesting several vegetables and pulses. Both nymphs and adults feed voraciously on the plants by sucking the sap and when present in sufficient numbers, they cause leaf drop and interfere with fruit maturation (Pollards, 1955). They produce honey dew which serves as a medium for the development of sooty mold fungus, which inhibits plant's photosynthesis (Perkins, 1983). SPW also plays a major role in the transmission and

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dissemination of tomato leaf curl virus (TLCV) in tomato causing curling and shortening of the leaves and stunting of the plant growth (Muniyappa, 1980; Dhanju and Verma, 1986).

Any management program for the whitefly should be based upon the initial detection and subsequent monitoring of population. Information regarding the densities of adult whitefly indicates the success or the failure of the current pest management practices. It further indicates if there is a need to switch to new techniques or to intensify the existing practices. Early detection and application of suitable pest management can reduce the pest population to certain extent. However, it is also essential to predict the peak activity period in order to develop and promote an ecologically suitable and environmentally compatible pest management strategy for the prevention of economic losses.

Since the information about the peak activity period of the pest and the effect of weather parameters on the population of the whitefly in Oman is not available, it was felt necessary to investigate its peak activity period and also to know the weather factors congenial for its population build up.

Materials and Methods

The population studies of whitefly were made for a period of four years from January 1993 to December 1996, at the Agricultural Experiment Station, College of Agriculture, Sultan Qaboos University, Sultanate of Oman, where many vegetable crops including tomato, egg plant, okra, potato, sweet potato and chilli are grown on an area of four hectares. The main cropping season here starts as early as August and goes up to the end of March. However, certain vegetable crops particularly cucumber, tomato and lettuce are grown in green houses as off season crops. In addition to this, certain ornamental plants like jasmine, china rose and red cap are present round the year as alternate hosts. Further, certain weeds like *Lantana camara, Amaranthus viridis, A. graecizans* and *Helitropium* sp are found growing in many places here as alternate hosts of SPW.

Adult whiteflies are attracted to yellow surfaces, and such surfaces coated with a sticky substance have been used to trap and monitor densities of adults whitefly by Stansly *et al*. (1991), Schuster *et al*. (1992), Ohnesorge and Rapp (1986), Butler *et al*. (1993) and a number of other workers. Taking advantage of this behaviour, it is recommended to monitor the adult population of whitefly by using yellow sticky traps (YST).

In the present studies the population of whitefly adults was monitored by using YST. Each trap consisted of a 36.5 x 22 cm. yellow plastic sheet, coated with a colourless adhesive (Soveurode aerosol, Societe Des Produits Chimiques, France) on both sides. Four such traps were installed vertically, 100 m apart, at a height of one meter from ground level, facing North-South. The YST were deployed at the boarders of a plot where tomato crop was grown. The traps were removed every week for counting the adult whiteflies and were replaced by new ones. The data, recorded as the mean number of whitefly caught in traps, were converted to per m^2 both on monthly and on standard weekly basis.

The data on the weather parameters such as maximum and minimum temperatures and maximum and minimum relative humidities were recorded daily at the Agricultural Experiment Station during the study period. These data were transformed to weekly averages for correlation studies with the trap catches of adult SPW.

Results and Discussion

The whitefly catches in YST during 1993 were high in July, September and October, the mean catches being 500, 1063 and 486 adults per m^2, respectively (Table 1). The population started decreasing in November and remained fluctuating at relatively lower levels during other months of the year, the least catch being 210 adults/m^2 in June. During 1994, the highest

TABLE 1

Yellow sticky trap catches of adult sweetpotato whitefly from January 1993 to December 1996

Month	Sweetpotato whitefly catches in YST*/m^2				Mean
	1993	1994	1995	1996	
January	419	249	555	35	314
February	509	364	390	63	331
March	461	1056	292	83	473
April	261	670	384	93	352
May	237	229	257	18	185
June	210	743	342	24	329
July	500	2141	820	35	874
August	412	1769	719	584	871
September	1063	2520	898	382	1215
October	486	783	808	72	537
November	451	667	490	174	445
December	220	328	107	174	207
TOTAL	5229	11519	6062	1737	6136

*YST - Yellow Sticky Trap

catch of 2520 adult whiteflies/m^2 was in September followed by 2141 adult whiteflies/m^2 in July and 1769 adults/m^2 in August. In 1995 also, the highest catch of the year (898 adults/m^2) was in September followed by 820 adults whiteflies/m^2 in July, 808 whiteflies/m^2 in October and 719 whiteflies/m^2 in August. The catches during 1996 in general were low but still the trend remains the same as in other years. There was heavy rain (112.3 mm) in December 1995. It also rained in January (17.6 mm), February (19.7 mm) and March (5.6 mm) 1996. This might have resulted in low population build up in the first few months of 1996. The detrimental effect of heavy rainfall on whitefly population is reported by Gill and Rataul (1988), Singh (1990) and Singh *et al*. (1990). The catches were high in August and September, being 584 and 382 whiteflies/m^2, respectively. None the less, the whiteflies were present all the year round throughout the four years study.

The monthly mean catches of the four years data, expressed in m^2 basis, revealed that significant differences exist in the numbers of adults captured on YST in different months of the year (Table 1). The peak activity period of whitefly was during July to October. The mean highest catch of 1216 adults/m^2 was in September followed by 874 whiteflies/m^2 in July, 871 in August and 537 in October. The population then started decreasing and reached to 207 whiteflies/m^2 in December. The population was fluctuating at relatively lower levels in the other months. During weeks 19 to 21 each year, the SPW populations were low because during this period the weather was hot and dry.

To correlate the effect of certain weather parameters on the adult SPW populations, the weekly trap data were plotted against the maximum and minimum temperatures (Figure 1) and with maximum and minimum relative humidities (Figure 2). It is evident that during the entire four-year period the population in general was very high during July to September (standard weeks No.27 to 39). However, sometimes high and low peaks alternated though not with uniform intervals. This is perhaps due to adult emergence in different overlapping generations. During July to September the maximum temperatures ranged from 32.6 to 40.8°C and minimum temperatures ranged from 23.7 to 32.0°C while maximum relative humidities ranged from 57 to 92% and minimum relative humidities ranged from 13 to 67%. These conditions seemed to be favourable for the insect to build up its population. Bhattacherjee (1990) while monitoring whitefly from June to December in 1978 and 1979 reported that its activity increases from June to September when both temperatures and relative humidity are high. Singh *et al*. (1990) monitored whitefly for two Kharif (rainy) seasons and one Rabi (winter) season and reported that ambient temperatures of 32 - 34°C favoured population increase. They also reported that a high relative humidity (80-90%) resulted in an increase in pest abundance. However, Dhuri *et al*. (1984) reported that the mean ambient temperatures of around 30 to 32°C appeared to be the most conducive factor to population build-up of whitefly.

The data also indicate that SPW remains active during the major parts of the year and warrants necessary plant protection measures. It is also evident that high humidity is very congenial for the population build up of whitefly as also pointed out by Dhuri *et al*. (1984), Singh and Butter (1988), Singh *et al*. (1990) and Nandihalli *et al*. (1993). Another possible reason for the population build-up of whitefly is the limited rainfall in this area being 30.7, 44.3 and 43.0 mm during 1993, 1994 and 1996, respectively, except in 1996 when 219.0 mm rainfall was recorded.

Simple correlation analysis between adult whitefly trap catches and certain weather factors namely, maximum and minimum temperatures and maximum and minimum relative humidities indicated negative and not significant correlation during 1993 and 1996 (Table 2). During 1995 the correlation was positive but not significant with maximum temperature ($r = 0.18$) while it was positive and significant with minimum temperature ($r = 0.24$). The low trap catches from April to June indicate aestivation of SPW in some stage or cessation of its development. The effect of higher temperature leading to aestivation has also been reported by Butler *et al*. (1983). The low correlation values in the present studies are indicative of this factor. However, in 1994, this relationship was found positive and significant with maximum and minimum temperatures, the 'r' values being 0.30 and 0.43, respectively. Correlation analyses of the pooled data suggested that there exists a significant and positive relationship between trap catches and temperature ($r = 0.15$). Coikesen and Sekeroglu (1987) indicated a positive and linear relationship between the development of each stage of whitefly and temperature. Simwat and Gill (1992) with their one year study claimed that the correlation of *Bemisia tabaci* was significant ($r^2 = 0.45$) only with temperature and not with other environmental factors. On the contrary, Nandihalli *et al*. (1993) found a significant negative correlation between trap catches of whitefly on cotton and maximum and minimum temperatures and a significant positive correlation with morning relative humidity. Such differences are usually expected when monitoring studies are done for a short period of few months to one or two years.

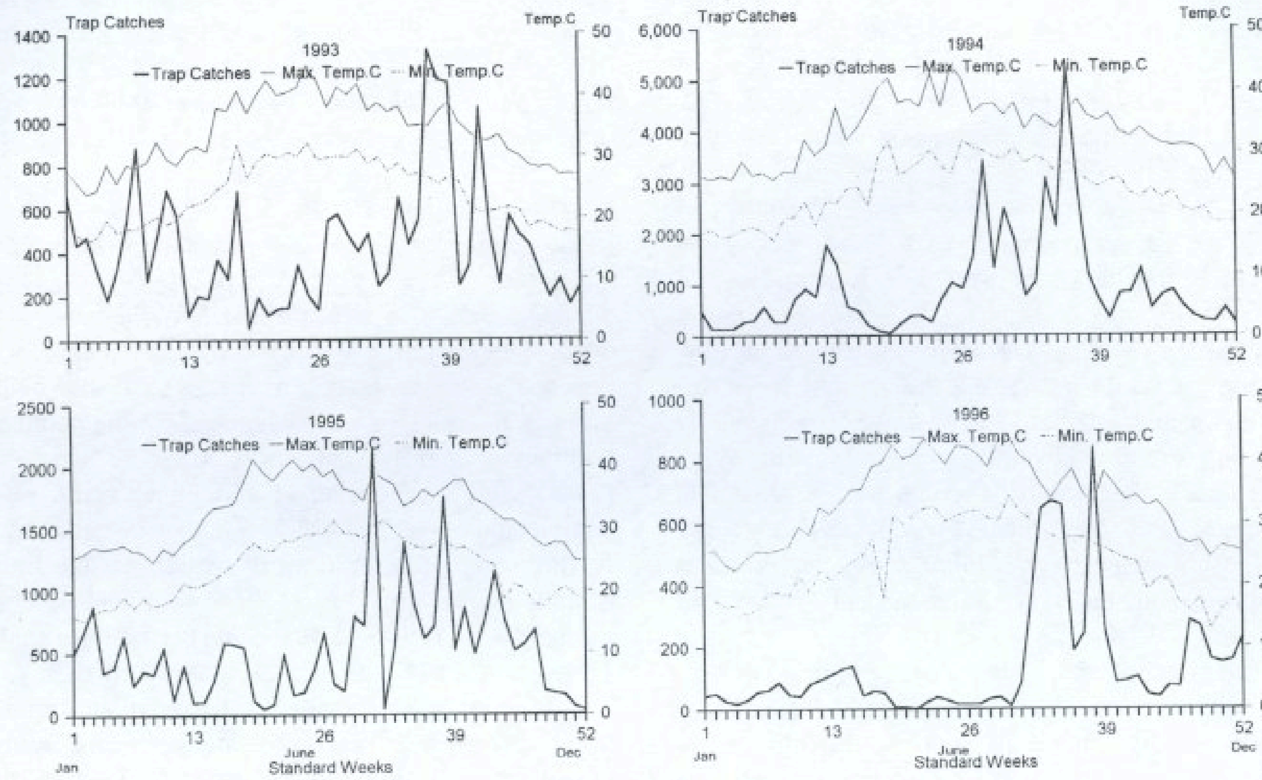

Figure 1. Effect of temperature on the yellow sticky trap catches of whitefly (*Bemisia tabaci* Gennadius)

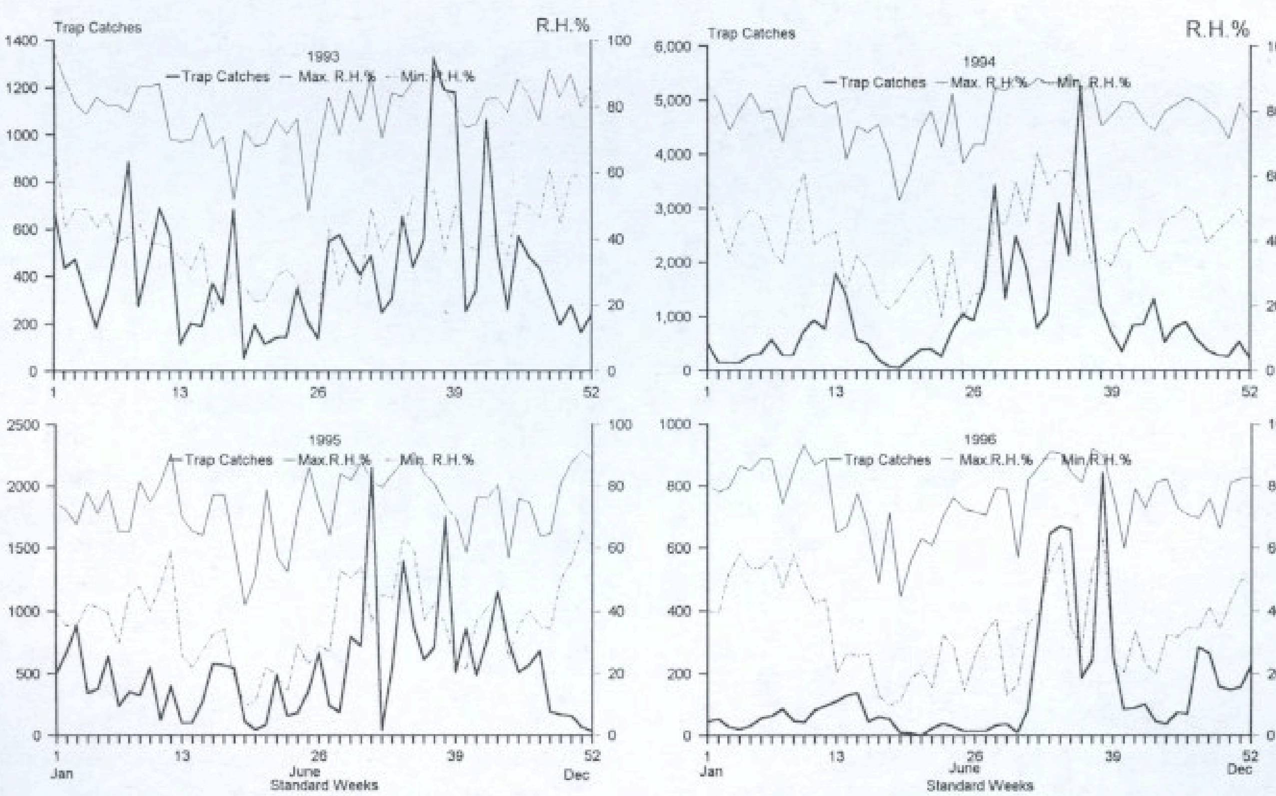

Figure 2. Effect of relative humidity on the yellow sticky trap catches of whitefly (*Bemisia tabaci* Gennadius)

TABLE 2

Correlation between yellow sticky trap catches of adults Sweetpotato whitefly and certain weather factors

Year	Adult whitefly catches in YST Mean ±SD	Temperature (°C)				Relative Humidity (%)			
		Maximum		Minimum		Maximum		Minimum	
		Mean ±SD	Correlation Coefficient	Mean ±SD	Correlation Coefficient	Mean ±SD	Correlation Coefficient	Mean ±SD	Correlation Coefficient
1993	434 ±286	33.9 ±5.6	-0.02	24.0 ±5.0	-0.02	78.8 ±9.3	0.32*	39.6 ±12.0	0.30*
1994	951 ±994	33.3 ±5.1	0.30*	23.8 ±4.8	0.43**	79.2 ±8.4	0.39**	40.8 ±12.1	0.29*
1995	513 ±418	32.8 ±5.2	0.18	23.6 ±4.9	0.24*	74.5 ±11.2	0.16	37.4 ±13.4	0.13
1996	136 ±185	33.6 ±6.5	-0.04	23.8 ±6.1	-0.07	76.2 ±11.1	0.41**	35.2 ±14.6	0.42**
Pooled Analysis	509 ±632	33.0 ±5.0	0.15*	24.2 ±11.5	0.15*	75.6 ±16.2	0.33**	39.9 ±4.9	0.13*

* $P<0.05$; ** $P<0.01$.

Simple correlations analyses between the trap catches and maximum and minimum relative humidities indicate positive and significant relationships in all years except 1995 where it was positive though not significant (Figure 2). The 'r' values for each year are presented in Table 2.

The four-year data of relative humidity and SPW trap catches when pooled and subjected to correlation analyses revealed a positive and significant correlation between maximum and minimum relative humidities with YST catches (the 'r' values: 0.3338 and 0.1337 for maximum and minimum relative humidity, respectively). The effect of maximum relative humidity was more profound indicating that it is the most important factor in governing the pest population. Hence the four years study gave a better understanding about the effect of the weather parameters on the population build up of the pest.

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