CHAPTER VI

GENERAL DISCUSSION

Maintaining the quality of melons to satisfy consumers in the retail market during storage presents a challenge. In addition to storage conditions such as temperature and relative humidity, postharvest treatments of melon have a significant effect on the prevention of rots and on maintaining quality and marketability in the supply chain (Ragsdale and Sisler, 1994). Postharvest treatment of melons currently relies on using synthetic fungicides to control postharvest rots. Use of fungicides in horticulture generally is being increasingly restricted due to health and environmental pressure. To address the growing need to reduce fungicide use (Droby *et al.*, 1998), we have investigated possible alternatives for the control of pre and postharvest diseases of melons to determine a safer, non-toxic and integrated method for greater control of diseases and maintenance of quality of stored melons.

The results of the study provide information on the aspects of storage conditions that affect rot development, quality control and marketability of stored melons. The study has suggested a number of postharvest treatments that are comparable with synthetic fungicides and has discovered at least one treatment that is applicable as a fungicide alternative. Results of investigations conducted on chemical activators for the induction of systemic resistance against foliar diseases of melons have been confirmed through assessment of the various aspects of resistance mechanism. The optimal time and methods of application of the chemical activators have also been confirmed through several field experiments for the control of pre and postharvest diseases of melons. Finally, the integrated effect from a field application of SAR elicitor followed by a postharvest dipping

in hot water has been confirmed as an efficacious fungicide alternative for the control of storage rots of melons.

Results of the study of temperature and humidity (Chapter 4) indicated that these two factors significantly influenced infection and disease development in melons. Our data concur with the literature in suggesting that humidity levels during the infection process are critical for the establishment of disease involving storage pathogens of rockmelons (Halloran *et al*., 1999). A high level of humidity contributes to the acceleration of infection and the establishment of pathogens as well as the growth and development of rots in stored melons (Wadia *et al*., 1986). However, to maintain freshness of melons requires keeping them in high humidity during postharvest handling and storage (Lester and Burton, 1986). Storage temperature is therefore important in keeping disease to a minimum under high humidity conditions.

The study suggests that storage temperature plays a more critical role in the process of infection and disease development than humidity levels. The results confirmed that a high storage temperature promotes infection particularly when exposed to high humidity. Less resistance to postharvest pathogens is reported to eventuate from quick loss in cell integrity at high temperatures (Bonnardeaux and Robinson, 1994; Lester, 1988). Although low storage temperatures reduced infections, a high level of humidity at similar temperatures increased the level of diseases. Previously it has been speculated that the postharvest diseases of melons at high humidity occurs irrespective of their temperature and storage conditions (Morris *et al.*, 2001). Therefore, maintaining a low temperature and high humidity conditions is a prime consideration to preserve the quality of melons.

The results of the experiments indicated that a higher temperature causes a significant increase in weight loss in storage irrespective of the level of humidity. Similarly, a low humidity level resulted in increasing loss in the fresh weight of rockmelons, irrespective of storage temperature. To maintain the quality of melons it is necessary to minimize weight loss during storage which is an important issue for their marketability (Ben-Yehoshua, 1985). Fruit stored at a higher temperature and/or with a low level of humidity lose weight rapidly and lose marketability within a shorter period of time (Lester and Burton, 1986). The results of the study indicated that for longer storage, melons should be stored at a low temperature, close to 5° C with a humidity level more than 90%.

The data from the study (Chapter 4) indicated that the levels of maturity of the fruit at harvest were associated with variation in the level of infection by the pathogens. The variation in the aggressiveness of the pathogens with the state of maturity suggests differences in the pathway of infection and disease development by the pathogens. The increase in the rate and severity of infection in melon with advanced maturity was mainly because of diminution of resistance of the rind tissues (Paull *et al.*, 1999). The rind tissues of melons became softer with the advent of maturity and more prone to fungal infection than the greener rind of early stages of maturity (Barkai-Golan, 2001). The pathogens of *Alternaria* spp. and *Fusarium* spp. grow at different rates but have wide adaptability over a range of storage conditions. In contrast, *Rhizopus* spp. although very aggressive in growth rate and rot development, has temperature limitations and is less persistent on the less mature and resistant tissues of melons (Morris, 1992).

In the search for an environmentally friendly substitute for synthetic fungicides, the application of several physical and chemical methods for the postharvest treatment of

melons revealed a number of treatments that are promising for the control of storage diseases of melons (Chapter 5). Unfortunately, the physical and chemical treatments on their own were not as effective as a fungicide alternative. Further evaluation showed that combining the physical and chemical treatments provided an additive effect on the control of storage rots. Studies using hot water treatment and others using safe chemicals along with hot water treatment were a positive advancement towards the goal of fungicide-free postharvest treatment technologies.

Disease reduction on melons after hot water treatments and a reduction in spore viability due to the dip in hot water confirmed the partial fungicidal effect of hot water treatment. The induction of peroxidase in melon rind by the hot water treatment indicated a heightened level of resistance from the hot water treatment that helped to restrict the infection and rot development in storage (Reuveni *et al*., 1997). Moreover, hot water treatment that keeps fruit fresh reduces disease development by delaying the infection process (Schirra *et al*., 2000). Thus disease reduction by postharvest treatments with safe chemicals along with hot water is achieved via the cumulative effects of hot water and the fungicidal effects of the safe compounds.

Despite the efficacy of some of the safe chemicals, their use was found to be phytotoxic or to accelerate ripening in storage which made them unsafe for the postharvest treatment of melons. However, these chemicals are still promising for postharvest treatment and may be useful for other produce where they may not be so phytotoxic. Furthermore, these chemicals warrant detailed studies on various fresh produce with different concentration levels and treatment methods in hot water solutions. Fine tuning their concentrations as well as finding a tolerable hot water temperature for a specific product may be interesting

directions for future research in the search for safe fungicide alternatives for postharvest treatment technologies.

Iodine was one of the GRAS chemicals found to be effective for the control of storage rots of melons. The increased effectiveness of iodine in a hot water solution makes it comparable to and a substitute for conventional fungicide. The non-phytotoxic nature of the chemical observed from the hot iodine dip makes it safer for the postharvest treatment of melons. In fact, hot iodine solution as a postharvest dip for melons reduced the rots and preserved the quality and freshness of the melons in storage. These positive responses from hot iodine dip would benefit growers marketing their product by taking advantage of fungicide-safe postharvest treatment as well as providing a longer period of marketability.

Enhancing plant resistance is another fungicide alternative that is being developed in the management of pre and postharvest diseases of various crops. The study (Chapter 6) observed that significant control of foliar as well as storage rots can be achieved by the induction of resistance in field plants by treating with chemical elicitors. The study also further evaluated the details of such chemical elicitors as INA, BABA and BTH for their treatment methods and mode of action for induction of resistance on melons in various growing conditions. The effectiveness of these chemicals for the induction of systemic resistance was studied through incidence of disease severity as well as other responses such as marker enzymes and symptoms on leaves or effects on plant growth. In this study a consistent level of control was observed from the treatment of both INA and BTH on different cultivars of melons across both growing places and periods.

The study (Chapter 6) suggests that the chemical activators INA and BTH can effectively control powdery mildew in melon seedlings in the glasshouse. It further observed that the occurrence of resistance against powdery mildew was correlated with increased activities of peroxidase, an enzyme responsible for a heightened level of resistance (Reuveni *et al*., 1997). The histological studies on infected leaf tissues also showed that fungal colonization was affected during the process of infection by the accumulation of antifungal phenolic compounds at and around the point of infection in leaves treated with chemical activators. Similar results for the control of powdery mildew and downy mildew in the field crops of melons were regarded as due to an induction of systemic resistance from the treatment of these activators. Strong correlation between increased activities of chitinase or peroxidase in the leaf tissues and reduction of disease incidence gave further evidence for the induction of systemic resistance from the treatment with chemical activators in the field crop of melon.

The reduced level of storage diseases from the application of INA and BTH in several field experiments indicated a long lasting effect of increased resistance in melon which has widened the possibilities of commercial use of these chemicals in the field. It suggests that induced resistance due to treatment of elicitors has also occurred in the fruit and persisted up to the time of harvest. The heightened level of chitinase and peroxidase in harvested fruit further confirmed the long lasting effect of induced resistance in the plants. The capability of INA and BTH of inducing long lasting resistance against a wide range of pathogens has also been reported earlier (Lucas, 1999; Uknes *et al*., 1992), while the use of BABA in field conditions is sometimes reported to be less effective (Silue *et al*., 2002; Si-Ammour *et al*., 2003).

This study not only explored the potential of SAR-elicitors but also the timing of their application on melons. Both INA and BTH have proven to be effective inducers of systemic resistance in melons against both their foliar and storage diseases. The wide spectrum and consistent control of pathogens across a range of growing conditions of melons by the treatment of INA and BTH again suggest their viability for commercial use. The study further suggests that instead of several continuous sprays only a few sprays at or during the possible disease outbreak and/or prior to harvest could make economical use of the chemicals. Besides the economical aspects, using the least application of SAR chemicals on melons also helps to avoid undesirable effects like phytotoxicity and/or early senescence of the plants. However, further efforts towards finding tolerable and effective methods of application of these chemicals would be necessary for environmentally friendly practices of disease control strategy.

The study also opens avenues for the approaches of integrated pest management (IPM) technologies which could minimize the use of pesticides in melon industries. Induction of SAR on melons in the field with these chemical elicitors and a postharvest wash with a safe chemical like iodine in hot water has proven to achieve much greater control of storage rots than a postharvest wash with fungicide on fruit of non-induced plants. Both the technologies of induction of systemic resistance by the application of chemical elicitors and postharvest wash treatment are feasible in lieu of the current disease control technology practised by growers.

In conclusion, this study has developed a viable postharvest treatment for postharvest control of storage rots of melons. By integrating the outcomes of Chapters four, five and six, a sustainable and environmentally friendly technology of postharvest management of

melons can be recommended. To adopt these technologies would not require any special knowledge or involve any extra expenses to the growers in the production line. Only a small modification of the existing dipping and washing machineries would enable the use of hot iodine for dipping melons for postharvest treatment. A prototype machine was used for iodine dip experiments that can maintain the iodine level by an electronic operational unit. The iodine machine can run up to 60° C and can regularly deliver iodine at a set concentration. Ordinary heating coils can be fitted in the dip tank to heat up and keep hot water at a set temperature during the operation of postharvest treatment of melons. The devices can be easily fitted in the dip tank of the existing postharvest treatment machinery. Further, the growers would benefit by marketing their melons as a "safe product", as well as reducing environmental pollution that is occurring through the continuous use of synthetic fungicides.

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APPENDIX I

i. ANALYSIS OF VARIANCE FOR TABLES AND GRAPHS IN CHAPTER 3
Environment and biology of disease development

3.3.1 Temperature and Humidity effect on Storage Rots

Fig. 3.3.1.1 *Rot development from Fusarium or Alternaria or Rhizopus affected by levels of relative humidity at 20°C*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	357.238	2	178.619	210.739	<0.001
Humidity levels	1251.874	5	250.375	295.399	<0.001
2-way interactions	157.937	10	15.794	18.634	<0.001
Residual	472.951	45	0.848		
Total	2240.000	71	3.896		

Table 3.3.1.1 *Infection rate for Fusarium at 20°C affected by levels of humidity*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	1.845	5	0.369	10.713	<0.001
Residual	0.620	15	0.034		
Total	2.465	23	0.107		

Table 3.3.1.1 *Infection rate for* Alternaria *at 20°C affected by levels of humidity*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	2.779	5	0.556	22.700	<0.001
Residual	0.441	15	0.024		
Total	3.220	23	0.140		

Table 3.3.1.1 *Infection rate for Rhizopus at 20°C affected by levels of humidity*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	6.023	5	1.205	25.504	<0.001
Residual	0.850	15	0.047		
Total	6.873	23	0.299		

Fig. 3.3.1.2 *Rot development from Fusarium or Alternaria affected by relative humidity at 5°C*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	11.781	1	11.781	20.868	<0.001
Humidity levels	31.541	2	15.770	27.935	<0.001
2-way interactions	1.170	5	0.585	1.036	0.357
Residual	105.005	15	0.565		
Total	149.496	23	0.783		

Table 3.3.1.2 *Infection rate for Fusarium at 5°C affected by levels of humidity*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	1.445	2	0.723	25.893	<0.001
Residual	0.251	6	0.028		
Total	1.697	11	0.154		

Table 3.3.1.2 *Infection rate for Alternaria at 5°C affected by levels of humidity*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	1.681	2	0.840	26.278	<0.001
Residual	0.288	6	0.032		
Total	1.969	11	0.179		

Fig. 3.3.1.3 *Rot development from Fusarium or Alternaria or Rhizopus affected by relative humidity at 30°C*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	924.167	2	62.084	165.042	<0.001
Humidity levels	849.465	2	424.732	151.701	<0.001
2-way interactions	239.674	8	59.918	21.401	<0.001
Residual	781.143	24	2.800		
Total	2794.449	35	9.737		

Table 3.3.1.3 *Infection rate for Fusarium at 30°C affected by humidity levels*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	0.075	2	0.038	6.924	0.015
Residual	0.049	6	0.005		
Total	0.124	11	0.011		

Table 3.3.1.3 *Infection rate for Alternaria at 30°C affected by humidity levels*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	0.126	2	0.063	9.939	0.005
Residual	0.057	6	0.006		
Total	0.183	11	0.017		

Table 3.3.1.3 *Infection rate for Rhizopus at 30°C affected by humidity levels*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	0.108	2	0.054	9.905	0.005
Residual	0.049	6	0.005		
Total	0.157	11	0.014		

Table 3.3.1.4 *Percent weight loss of fresh rockmelon affected by humidity levels*

Source of Variation	S.S	DF	M.S.	F	P
Humidity levels	32.131	2	2.921	428.423	<0.001
Residual	0.573	6	0.007		
Total	32.704	11	0.344		

Fig. 3.3.2 *Effect of variety and storage conditions on storage rots by different pathogens*

Source of Variation	S.S	DF	M.S.	F	P
Variety	219.902	1	219.902	141.714	<0.001
Covering	349.626	1	349.626	225.312	<0.001
Pathogen	700.257	2	350.129	225.637	<0.001
2- way interactions	212.831	2	42.566	27.431	<0.001
Variety X Covering	4.910	1	4.910	3.164	0.075
Variety X Pathogen	172.619	2	86.309	55.621	<0.001
Covering X Pathogen	35.302	2	17.651	11.375	<0.001
3-way interactions	10.293	2	5.147	3.317	0.037
Residual	2364.848	28	1.552		
Total	3857.758	47	2.513		

Fig. 3.3.3 *Effect of maturity on rot development of rockmelon by different pathogens*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	315.099	2	157.549	61.398	<0.001
Maturity levels	524.020	2	262.010	102.107	<0.001
2-way interactions	402.579	4	100.645	39.222	<0.001
Residual	2904.743	24	2.566		
Total	4116.045	35	3.611		

ii. ANALYSIS OF VARIANCE FOR GRAPHS IN CHAPTER 4

Postharvest treatments to control storage diseases of melons

Fig. 4.3.1 *Efficacy of conventional fungicides for the control of storage rots of melons*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	12.082	2	6.041	7.828	<0.001
Fungicide treatment	557.986	5	111.597	144.609	<0.001
2-way interactions	62.726	17	6.273	8.128	<0.001
Residual	430.617	68	0.772		
Total	1063.411	89	1.849		

Fig. 4.3.2 *Safe chemicals for the control of storage rots of melons*

Source of Variation	S.S	DF	M.S.	F	P
Melon variety	2.475	1	2.475	6.467	0.011
Dip treatment	82.695	7	11.814	30.869	<0.001
2-way interactions	22.603	15	3.229	8.437	<0.001
Residual	238.806	60	0.383		
Total	346.579	79	0.542		

Fig. 4.3.3 *Comparison of hot GRAS treatments for the control of storage rots of melo*

Source of Variation	S.S	DF	M.S.	F	P
Melon variety	8.845	1	8.845	27.957	<0.001
Dip treatment	75.867	7	10.838	34.255	<0.001
2-way interactions	5.69	15	0.813	2.569	<0.001
Residual	197.43	60	0.316		
Total	287.832	79	0.45		

Fig. 4.3.5 *Hot water dips of melons at different temperatures*

Source of Variation	S.S	DF	M.S.	F	P
Treatment	37.342	4	9.335	15.038	<0.000
Residual	39.731	8	0.621		
Total	77.072	14	1.133		

Fig. 4.3.6.1 *Effect of temperature and duration of water dip for the control of storage rots of melon: Experiment 1*

Source of Variation	S.S	DF	M.S.	F	P
Time	49.779	2	24.889	82.018	<0.001
Temperature	7.796	2	3.898	12.844	<0.001
2-way interactions	0.795	8	0.199	0.655	0.624
Residual	133.827	32	0.303		
Total	192.197	44	0.428		

Fig. 4.3.6.2 *Effect of temperature and duration of water dip for the control of storage rots of melon: Experiment 2*

Source of Variation	S.S	DF	M.S.	F	P
Treatment	762.350	5	152.470	235.308	<0.000
Residual	276.031	13	0.648		
Total	1038.380	26	2.409		

Fig. 4.3.7.1 *Effect of hot water on disease resistance mechanisms: Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
Treatment	28.558	1	28.558	84.669	<0.001
Melon	3.686	1	3.686	10.927	<0.001
2-way interactions	0.901	1	0.901	2.671	0.001
Residual	128.171	33	0.337		
Total	161.315	47	0.421		

Fig. 4.3.7.2 *Effect of hot water on disease resistance mechanisms: Peroxidase activity*

Source of Variation	S.S	DF	M.S.	F	P
Sampling time	1.721	4	0.430	34.854	<0.001
Dip temperature	1.374	1	1.374	111.263	<0.001
2-way interactions	1.040	4	0.260	21.067	<0.001
Residual	0.247	15	0.012		
Total	4.382	29	0.151		

Fig. 4.3.8.1 *Combination of hot water and safe chemicals: Experiment 1*

Source of Variation	S.S	DF	M.S.	F	P
Treatment	164.642	6	27.440	98.077	<0.001
Residual	139.052	49	0.280		
Total	303.694	63	0.604		

Fig. 4.3.8.2 *Combination of hot water and safe chemicals: Experiment 2*

Source of Variation	S.S	DF	M.S.	F	P
Treatment	26.353	1	26.353	28.701	<0.001
Dip	561.330	2	280.665	305.669	<0.001
2-way interactions	13.982	2	6.991	7.614	0.001
Residual	391.152	40	0.918		
Total	992.818	53	2.304		

4.3.9 *Storability of rockmelons after dipping in safe chemical in hot water*

Fig. 4.3.9.1 *Effect on total rots*

Source of Variation	S.S	DF	M.S.	F	P
Dip treatment	34.265	2	17.133	70.541	<0.001
Residual	18.944	16	0.243		
Total	53.210	26	0.665		

Fig 4.3.9.1 *Effect on Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
Dip treatment	33.574	2	16.787	67.404	<0.001
Residual	19.426	16	0.249		
Total	53.000	26	0.662		

Fig. 4.3.9.1 *Effect on Alternaria rot*

Source of Variation	S.S	DF	M.S.	F	P
Dip treatment	31.599	2	15.799	62.662	<0.001
Residual	19.667	16	0.252		
Total	51.265	26	0.641		

Fig. 4.3.9.2 *Effect on flesh firmness*

Source of Variation	S.S	DF	M.S.	F	P
Dip treatment	0.143	2	0.071	8.385	0.001
Residual	0.663	16	0.009		
Total	0.806	26	0.010		

Fig. 4.3.10 *Efficacy of hot iodine in killing pathogenic spores of melons*

Source of Variation	S.S	DF	M.S.	F	P
Pathogen	0.379	2	0.190	0.629	0.541
Dip solution	48.434	2	24.217	80.285	<0.001
2-way interactions	1.016	4	0.254	0.842	0.511
Residual	8.144	25	0.302		
Total	57.973	36	1.656		

iii. ANALYSIS OF VARIANCE FOR GRAPHS IN CHAPTER 5
SAR by the treatment of chemical elicitors to control melon diseases

Fig. 5.3.1.1 *Powdery mildew on glasshouse melon seedling after treatment with SAR elicitors; detached leaf*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	231.500	2	115.750	15.496	<0.001
Residual	246.500	8	7.470		
Total	478.000	14	13.657		

Fig. 5.3.1.1 *Powdery mildew on glasshouse melon seedling after treatment with SAR elicitors* ; intact plants

Source of Variation	S.S	DF	M.S.	F	P
Treatment	11.011	2	5.506	21.355	<0.001
Residual	45.633	8	0.258		
Total	56.644	14	0.316		

Fig. 5.3.1.2 *Powdery mildew in the field plants at Camden due to treatment with SAR chemicals*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	542.150	2	271.075	18.822	<0.001
Residual	1685.050	6	14.402		
Total	2227.200	11	18.716		

Fig. 5.3.1.3 *Downy mildew in the field plants at Griffith (2004) affected by chemicals spray*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	54.170	3	18.057	24.139	<0.001
Residual	296.220	9	0.748		
Total	350.390	15	0.878		

Fig. 5.3.2.1 *Storage rots in melons treated with SAR inducing chemicals at Camden during 2002: Effect on total rots*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	49.292	2	24.646	26.112	<0.001
Dip treatment	34.028	1	34.028	36.052	<0.001
2-way interactions	0.181	2	0.090	0.096	0.909
Residual	130.250	15	0.944		
Total	213.750	23	1.495		

Fig. 5.3.2.1 *Storage rots in melons treated with SAR chemicals at Camden during 2002: Effect on Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	42.875	2	21.438	23.866	<0.001
Dip treatment	21.007	1	21.007	23.387	<0.001
2-way interactions	1.097	2	0.549	0.611	0.544
Residual	123.958	15	0.898		
Total	188.938	23	1.321		

Fig. 5.3.2.1 *Storage rots in melons treated with SAR chemicals at Camden during 2002: Effect on Alternaria rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	16.125	2	8.063	14.592	<0.001
Dip treatment	23.361	1	23.361	42.280	<0.001
2-way interactions	0.264	2	0.132	0.239	0.788
Residual	76.250	15	0.553		
Total	116.000	23	0.811		

Fig. 5.3.2.2 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2003: Effect on total rots*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	31.040	3	10.347	40.269	<0.001
Maturity	5.382	1	5.382	20.947	<0.001
Dip treatment	25.595	1	25.595	99.615	<0.001
2-way interactions	0.699	7	0.116	0.453	0.842
SAR x Maturity	0.008	3	0.004	0.016	0.984
SAR x Dip	0.684	3	0.228	0.887	0.448
Maturity x Dip	0.007	1	0.007	0.027	0.869

3-way interactions	0.006	3	0.002	0.008	0.999
Explained	62.722	15	4.480	17.437	<0.001
Residual	78.365	15	0.257		
Total	141.087	31	0.442		

Fig. 5.3.2.2 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2003: Effect on Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	13.149	3	4.383	17.718	<0.001
Maturity	2.652	1	2.652	10.723	0.001
Dip treatment	14.084	1	14.084	56.937	<0.001
2-way interactions	1.890	7	0.270	1.092	0.368
SAR X Maturity	1.517	3	0.506	2.044	0.108
SAR X Dip	0.255	3	0.085	0.344	0.793
Maturity X Dip	0.118	1	0.118	0.475	0.491
3-way interactions	0.647	3	0.216	0.872	0.456
Explained	32.422	15	2.161	8.738	<0.001
Residual	75.199	15	0.247		
Total	107.621	31	0.337		

Fig. 5.3.2.2 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2003: Effect on Alternaria rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	20.577	3	6.859	42.784	<0.001
Maturity	1.582	1	1.582	9.868	0.002
Dip treatment	21.788	1	21.788	135.904	<0.001
2-way interactions	0.612	7	0.087	0.545	0.800
SAR X Maturity	0.265	3	0.088	0.551	0.648
SAR X Dip	0.121	3	0.040	0.252	0.860
Maturity X Dip	0.226	1	0.226	1.408	0.236
3-way interactions	0.109	3	0.036	0.226	0.878
Explained	44.668	15	2.978	18.574	<0.001
Residual	48.737	15	0.160		
Total	93.405	31	0.293		

Fig. 5.3.2.3 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2004: Effect on total rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	30.455	3	10.152	37.452	<0.001
Maturity	3.542	1	3.542	13.069	<0.001
Dip treatment	15.644	1	15.644	57.713	<0.001
2-way interactions	2.083	7	0.298	1.098	0.364
SAR X Maturity	0.312	3	0.104	0.383	0.765
SAR X Dip	1.603	3	0.534	1.972	0.118
Maturity X Dip	0.167	1	0.167	0.618	0.433
3-way interactions	0.020	3	0.007	0.025	0.995
Residual	86.738	15	0.271		
Total	138.481	31	0.413		

Fig. 5.3.2.3 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2004: Effect on Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	27.413	3	9.138	37.557	<0.000
Maturity	2.953	1	2.953	12.138	0.001
Dip treatment	15.644	1	15.644	64.297	<0.000
2-way interactions	2.856	7	0.408	1.677	0.114
SAR X Maturity	0.699	3	0.233	0.957	0.413
SAR X Dip	2.068	3	0.689	2.833	0.038
Maturity X Dip	0.090	1	0.090	0.370	0.543
3-way interactions	0.026	3	0.009	0.036	0.991
Residual	77.857	15	0.243		
Total	126.749	31	0.378		

Fig. 5.3.2.3 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2004: Effect on Alternaria rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	27.848	3	9.283	42.106	<0.000
Maturity	2.333	1	2.333	10.584	0.001
Dip treatment	28.003	1	28.003	127.020	<0.000
2-way interactions	1.997	7	0.285	1.294	0.253
SAR X Maturity	0.196	3	0.065	0.297	0.828
SAR X Dip	1.693	3	0.564	2.560	0.055
Maturity X Dip	0.107	1	0.107	0.486	0.486
3-way interactions	0.411	3	0.137	0.621	0.602
Residual	70.548	15	0.220		
Total	131.140	31	0.391		

Fig. 5.3.2.4 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2005: Effect on total rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	14.083	1	14.083	32.116	<0.001
Dip treatment	19.643	2	9.822	22.398	<0.001
2-way interactions	2.206	2	1.103	2.515	0.084
Residual	81.563	16	0.439		
Total	117.495	23	0.615		

Fig. 5.3.2.4 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2005: Effect on Fusarium rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	12.762	1	12.762	20.259	<0.001
Dip treatment	13.031	2	6.516	10.344	<0.001
2-way interactions	1.344	2	0.672	1.067	0.346
Residual	117.164	15	0.630		
Total	144.301	23	0.756		

Fig. 5.3.2.4 *Storage rots in melons treated with SAR inducing chemicals at Griffith during 2005: Effect on Alternaria rot*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	4.230	1	4.230	16.154	<0.001
Dip treatment	33.117	2	16.559	63.228	<0.001
2-way interactions	1.336	2	0.668	2.551	0.081
Residual	48.711	15	0.262		
Total	87.395	23	0.458		

5.3.4 Enzyme Activity of SAR treated Leaves and Fruit

Fig. 5.3.4.1.1 *Peroxidase activity of glasshouse melon seedlings treated with INA or BTH: seven days after spray*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.121	2	0.060	28.731	0.001
Residual	0.013	10	0.002		
Total	0.133	17	0.017		

Fig. 5.3.4.1.2 *Peroxidase activity of glasshouse melon seedlings treated with INA or BTH: Detached leaf after inoculation*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.183	2	0.091	5.890	0.017
Inoculation treatment	0.073	1	0.073	4.719	0.051
2-way interactions	0.013	2	0.006	0.404	0.676
Residual	0.186	25	0.015		
Total	0.454	35	0.027		

5.3.4.2 *Chitinase and peroxidase activities in melon leaves grown in the field at Camden*

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 0 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	3.026	2	1.513	0.714	0.515
Residual	19.073	6	2.119		
Total	22.099	11	2.009		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 3 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	5.646	2	2.823	2.008	0.190
Residual	12.656	6	1.406		
Total	18.303	11	1.664		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden 7 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	13.627	2	6.813	8.852	0.007
Residual	6.927	6	0.770		
Total	20.553	11	1.868		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 14 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	23.432	2	11.716	35.130	<0.001
Residual	3.002	6	0.334		
Total	26.434	11	2.403		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 21 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	63.687	2	31.843	44.973	<0.001
Residual	6.372	6	0.708		
Total	70.059	11	6.369		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 28 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	66.506	2	33.253	39.792	<0.001
Residual	7.521	6	0.836		
Total	74.027	11	6.730		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 35 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	53.955	2	26.977	65.075	<0.001
Residual	3.731	6	0.415		
Total	57.686	11	5.244		

Fig. 5.3.4.2 *Chitinase in leaf sample of Camden - 42 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	25.164	2	12.582	24.961	<0.001
Residual	4.537	6	0.504		
Total	29.701	11	2.700		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 0 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment T	0.072	2	0.036	1.255	0.331
Residual	0.259	6	0.029		
Total	0.331	11	0.030		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 3 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.195	2	0.097	2.348	0.151
Residual	0.373	6	0.041		
Total	0.567	11	0.052		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 7 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.288	2	0.144	45.254	<0.001
Residual	0.029	6	0.003		
Total	0.317	11	0.029		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 14 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.390	2	0.195	104.222	<0.001
Residual	0.017	6	0.002		
Total	0.407	11	0.037		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 21 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.684	2	0.342	121.127	<0.001
Residual	0.025	6	0.003		
Total	0.710	11	0.065		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 28 day*

Source of Variation	S.S	DF	M.S.	F	P
TREATMENT	0.922	2	0.461	217.887	<0.001
Residual	0.019	6	0.002		
Total	0.941	11	0.086		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 35 day*

Source of Variation	S.S	DF	M.S.	F	P
TREATMENT	0.703	2	0.351	241.960	<0.001
Residual	0.013	6	0.001		
Total	0.716	11	0.065		

Fig. 5.3.4.2 *Peroxidase in leaf sample of Camden - 42 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.467	2	0.233	162.192	<0.001
Residual	0.013	6	0.001		
Total	0.480	11	0.044		

Fig. 5.3.4.3 *Activities of chitinase in harvested fruit at Camden*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	55.002	2	27.501	71.140	<0.001
Residual	3.479	6	0.387		
Total	58.481	11	5.316		

Fig. 5.3.4.3 *Activities of peroxidase in harvested fruit at Camden*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	2.793	2	1.396	32.122	<0.001
Residual	0.391	6	0.043		
Total	3.184	11	0.289		

Fig. 5.3.4.4 *Activities of chitinase in leaf at Griffith - 14 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	22.824	3	11.412	9.407	0.014
Residual	7.279	9	1.213		
Total	30.103	15	3.763		

Fig. 5.3.4.4 *Activities of chitinase in leaf at Griffith - 28 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	42.920	3	21.460	65.725	<0.001
Residual	1.959	9	0.327		
Total	44.879	15	5.610		

Fig. 5.3.4.4 *Activities of chitinase in leaf at Griffith - 42 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	143.060	3	47.687	158.279	<0.001
Residual	2.410	9	0.301		
Total	145.470	15	13.225		

Fig. 5.3.4.4 *Activities of peroxidase in leaf at Griffith - 14 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.051	3	0.026	9.493	0.014
Residual	0.016	9	0.003		
Total	0.068	15	0.008		

Fig. 5.3.4.4 *Activities of peroxidase in leaf at Griffith - 28 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.199	3	0.100	7.356	0.024
Residual	0.081	9	0.014		
Total	0.280	15	0.035		

Fig. 5.3.4.4 *Activities of peroxidase in leaf at Griffith - 42 day*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	0.265	3	0.088	36.508	<0.001
Residual	0.019	9	0.002		
Total	0.285	15	0.026		

Fig. 5.3.4.5 *Activities of chitinase in harvested fruit at Griffith 2003*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	20.749	3	6.916	9.517	0.027
Residual	2.907	9	0.727		
Total	23.655	15	3.379		

Fig. 5.3.4.5 *Activities of Peroxidase in harvested fruit at Griffith 2003*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	1.600	3	0.533	84.845	<0.001
Residual	0.025	9	0.006		
Total	1.625	15	0.232		

Fig. 5.3.5.1 *Effects of SAR chemicals on leaf senescence*

Source of Variation	S.S	DF	M.S.	F	P
SAR treatment	122.700	2	61.350	80.140	<0.001
Residual	135.500	10	0.766		
Total	258.200	17	1.442		

Fig. 5.3.5.2 *Phytotoxic effects of SAR chemicals on growth of rockmelons plants: Effect on leaf area*

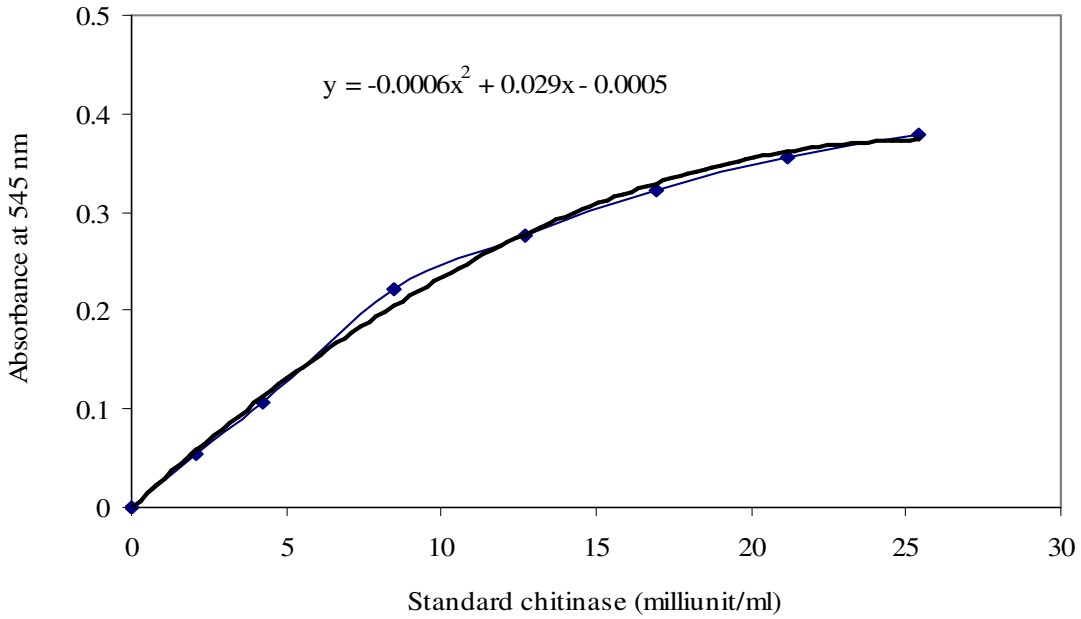
Source of Variation	S.S	DF	M.S.	F	P
Treatment	554.167	2	277.083	8.613	0.008
Residual	289.540	6	32.171		
Total	843.707	11	76.701		

Fig. 5.3.5.2 *Phytotoxic effects of SAR chemicals on growth of rockmelons plants: Effect on length of main vine*

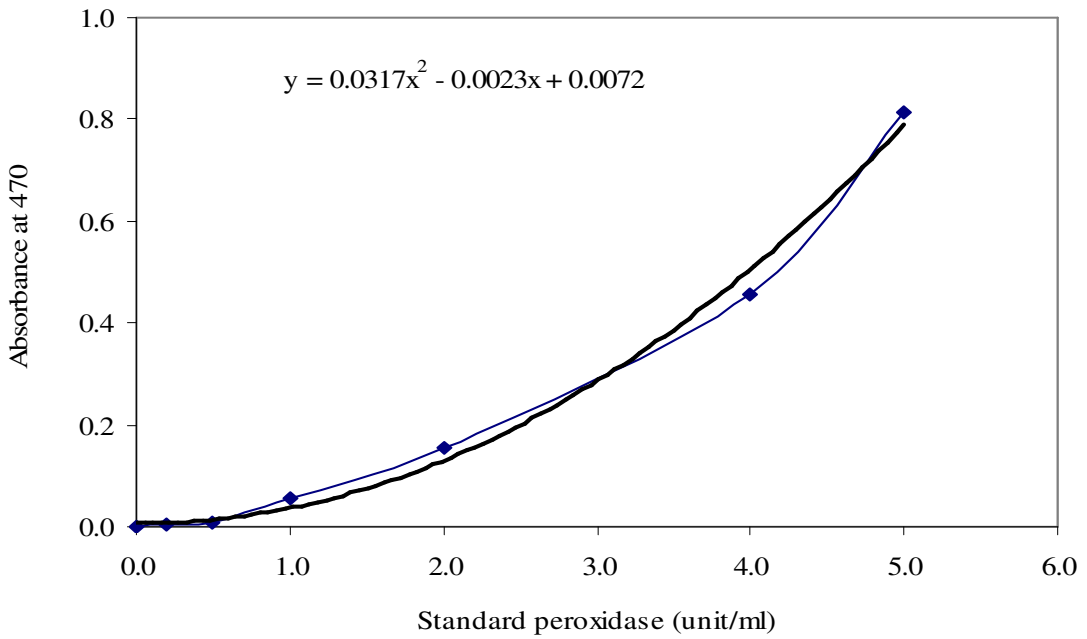
Source of Variation	S.S	DF	M.S.	F	P
SAR Treatment	3296.222	2	1648.111	7.157	0.003
Residual	7598.750	6	230.265		
Total	10894.972	11	311.285		

APPENDIX II

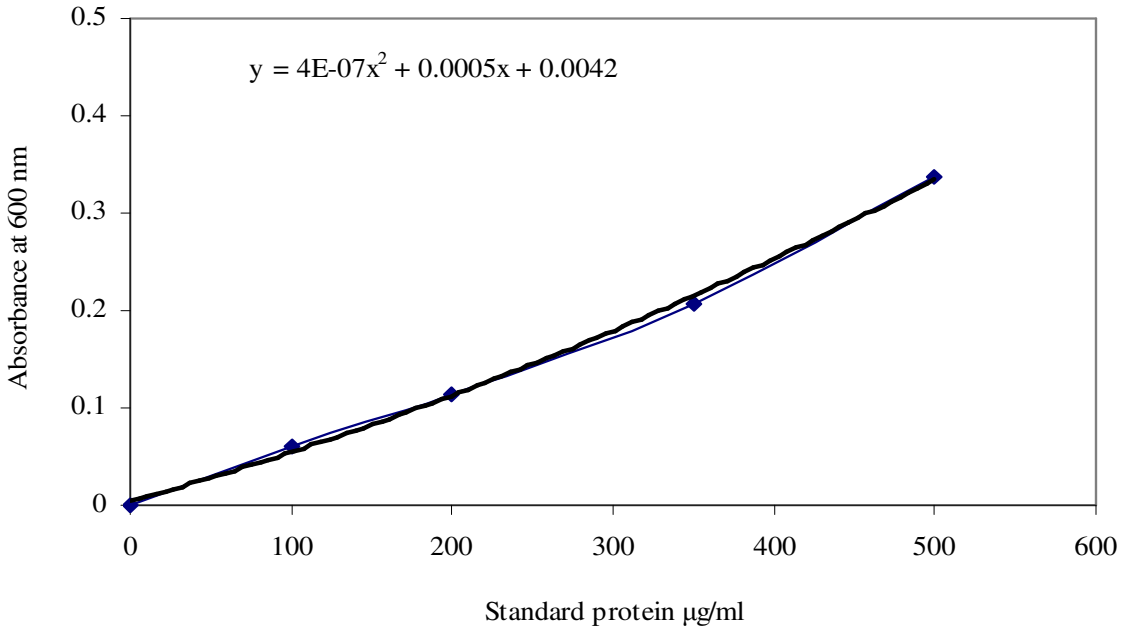
STANDARD CURVES FOR THE CALCULATION OF ENZYMES AND PROTEINS



Appendix i Standard curve of chitinase enzyme. Concentration of the enzymes in the analyses of leaf and fruit samples were calculated using equation in the box putting absorbance (x values) of the sample.



Appendix ii Standard curve of peroxidase. Concentration of peroxidase of leaf and fruit samples were calculated using equation in the box putting absorbance (x values) of the sample.



Appendix iii Standard curve of protein (Bovine serum albumin). Concentration of proteins of leaf and fruit samples of melons were calculated using equation by putting absorbance (x values) of the sample