Journal of Plant Biochemistry & Physiology
ISSN: 2329-9029

Gaikwad et al., J Plant Biochem Physiol 2017, 5:4
DOI: 10.4172/2329-9029.1000201

Research Article Open Access

Influence of Different Pesticides on Chemical, Biochemical and Yield Parameters of Brinjal (*Solanum melongena* L.)

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Abstract

Pesticides have become an essential part of agricultural and horticultural practices. There is continuous development of new pesticides to address specific requirement (insect /pest control). New pesticides with specific mode of action, combination to two or more pesticides for enhanced bio-efficacy, new innovation in the field of slow and sustained delivery of chemical are making the pesticides influence positively in growth and development of plant. In present investigation, all four pesticides used at recommended dosage suggested by agricultural experts. These pesticides are most proffered by farmers to control fruit and shoot borer on brinjal. A study on the influence of pesticides persistence on biochemical and yield parameters of brinjal was conducted during *kharif* and *rabi* 2013-14 and 14-15 with the objective of physiological responses of different varieties of brinjal (Malapur local-V_1, Kalpataru-V_2, Manjula-V_3, Manjari-V_4) sprayed with four different pesticides (thiodicarb-P_1, spinosad-P_2, profenophos-P_3 and chlorantranillipröle-P_4). The P_0 treatment considered as a non-sprayed control. The experiment was laid out in factorial randomized block design with three replications. The pesticides sprayed at recommended dose (thiodicarb 75WP@1 g^{-1}l, spinosad 45SC@0.1 ml^{-1}l profenophos 50EC@2 ml^{-1}l and chlorantraniliprole 20 SC@0.5 ml^{-1}l) suggested by agricultural experts. Results indicated highly significant differences between the varieties and pesticides treatments at all the stages and in both the seasons. The interaction between the varieties and pesticide treatments was also significant at all the stages. The values of chlorophyll content successive increased from 70 to 90 DAT and decreases from 115 and 125 DAT in both the seasons. The magnesium content in fruits was recorded highest at 90 DAT followed by 80 DAT irrespective of varieties and pesticides. It is clear from the data that Manjar treated with Profenophos indicated maximum magnesium content recorded followed by Manjari treated with chlorantraniliprole compared to other interaction. Total marketable yield noticed maximum in Manjari followed by Manjula and Kalpataru while least was in Malapur local. The profenophos treatments observed with highest marketable yield over the chlorantraniliprole. Spinosad and thiodicarb treatments. Among all the interaction, V_4P_3 (6.12 kg plant^{-1}) recorded maximum marketable fruit yield and minimum was in untreated Malapur local varity of brinjal interaction. Different varieties of brinjal used in investigation to assess its behavior in regard to find its optimum tolerance limit for healthy growth for maximizing quality production and to minimize the risk of stress created by pesticides in the brinjal during different growing seasons. Lot of work done on plant protection by different agrochemical/pesticides, but this study helpful to know the effects of different pesticides on plant growth and metabolism.

Keywords: Pesticides; Residues; Chlorophyll; Magnesium; Brinjal

Introduction

Pesticides are one of the most essential inputs in modern agriculture and horticulture for insuring food security. Among various strategies adapted to combat pest of brinjal, pesticides from the first choice of farmers. Most of the pesticides that are used against pest on brinjal is belong to organophosphates. But the indiscriminate use of pesticides, has led to various secondary effect on plant growth and development. Some pesticides remain persistent and take a long time to move into the environment. The brinjal, *Solanum melongena* L. is an important vegetable crop grown throughout the year in the India. However, brinjal heavily suffers from shoot and fruit borer from seedling stage to fruiting, which reduced not only the yield but also quality of fruits. The pesticides created stress in plants when they applied on high concentration which adversely affects the chlorophyll stability, membrane stability index and relative water content [1]. Pesticides play an important role in plant protection, but their excess and continuous use has harmful effect on growth, development, yield and grown in crop plant. In present investigation the organophosphate group of pesticides (profenophos) play an important role in controlling shoot and fruit bore followed by chlorantraniliprole at recommended dosage. At recommended dosage of pesticides with minimum frequency results increase in chlorophyll content of leaves and magnesium content of fruits. This study represents pesticides exposure to brinjal plant and its effects on growth and metabolism. Due to this exposure, plant system leading to alteration in biochemical, physiological, enzymatic and minerals which ultimately affects the yield and resulted in residues in brinjal fruits. Foliar application of these pesticides is reported to be beneficial for plant growth if used at their recommended concentrations/dosage which are suggested by agricultural experts from University of Agricultural Sciences, Dharwad, Karnataka and its persistence resulted changes in chlorophyll and magnesium content in leaves and fruits respectively compare to control treatment. Keeping these points in view, the present investigations were undertaken with the objectives to study the biochemical and physiological changes due to pesticide application and relate changes to the persistence of

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Received August 26, 2017; **Accepted** September 12, 2017; **Published** September 19, 2017

Citation: Gaikwad SB, Chetti MB, Jirali DI (2017) Influence of Different Pesticides on Chemical, Biochemical and Yield Parameters of Brinjal (*Solanum melongena* L.). J Plant Biochem Physiol 5: 201. doi: 10.4172/2329-9029.1000201

pesticides in brinjal. The study of plant pesticide interaction at the physiological and biochemical level is largely an unexplored discipline which offers a tremendous opportunity for fruitful research.

Materials and Methods

Brinjal was harvested next day after pesticide application as per routine practices of local farmers. The pesticides (thiodicarb, spinosad, profenophos and chlorantriniliprole) treated and non-sprayed (control-Po) samples were collected from field at 1, 4, 8, 12, 16 DAS for residues analysis and after sampling, samples were packed in properly labeled polythene bags and brought to the laboratory and stored in deep freezer at -20 °C until analysis within 24 hours. The samples were collected to study the influence of different pesticides on morpho-physiological, biochemical and yield parameter at 70, 80, 90, 115 and 125 days after transplanting (DAT) during both the seasons of *kharif* and *rabi* 2013-14 and 14-15 respectively (Figure 1).

Chlorophyll content in the leaves of different genotypes of brinjal leaves was determined by using dimethyl sulphoxide (DMSO) as given by Shoaf et al. [2]. Chlorophyll estimated through a spectrophotometer (ELICO, connecting science and Lab, BL222 Double beam, Biospectrophotometer). All pesticide residues analyzed by liquid chromatography and tandem mass spectroscopy and calculated in mg kg^{-1} of fruit weight at different days after spraying. A LC-MS/MS system equipped with API 4000 Qtrap hybrid triple quadrupole/linear ion trap (QqQLIT) mass spectrometer (Applied Biosystem, Foster City, CA, USA), Agilent 1200 series HPLC and analyst (version 1.5) software was used for data acquisition and processing. All experiments for pesticides residue analysis were conducted under Turbo Spray (pneumatically assisted electrospray) mode. The chromatographic separation was carried out using an Atlantis dC_{18} column (100 × 2.1 mm, 5 m) from Waters India Pvt Ltd., Bangalore. Magnesium in digested samples was determined by EDTA titration. The marketable fruit yield per plant was calculated by substituting the fruit weights of borer infected fruits and unmarketable fruits of each picking and expressed in gm per plant. Fisher's method of analysis of variance was applied for the analysis and interpretation of the experimental data as suggested by Panse et al. [3].

Results

Total chlorophyll content (µg g^{-1})

The results of total chlorophyll content of brinjal leaf due to application of pesticides given in Table 1a indicated significant differences between the varieties and pesticide treatments at all stages and in both the seasons. The interaction between varieties and pesticide treatments was also significant at all the stages. The pooled data showed that V_4 noted maximum value (659.4 µg g^{-1}) followed by V_2 and V_3 and least was in V_1 at all stages. While, among the pesticide treatments, it was maximum in P_3 followed by P_4, P_2, P_1 and the minimum was in P_0. Among different stages, it was maximum at 90 DAT followed by 115 and 80 DAT; while, least was at 125 DAT. It increased from 70 to 90 DAT in all treatments and declined slowly at 125 DAT. A maximum chlorophyll content (970 µg g^{-1}) was recorded in V_4P_3 while, the lowest content was recorded in V_1P_0 followed by V_1P_1 and V_1P_2 at all the stages. The treatment V_1P_4 did not differ significantly with V_2P_0 at 70, 80, 90 and at115. Similar results were obtained in *rabi* as that of *kharif.* Data presented in Table 1b showed maximum total chlorophyll content in V_4P_3 (961.7 µg g^{-1}) among all interactions. The treatment V_4P_1 did not

Figure 1: Pesticides used at the rate of recommended dose during experiments.

differed significantly with V_4P_0 at 125 DAT.

Magnesium content in fruits (mg 100 g^{-1})

The data on magnesium content presented in Table 2a indicated significant differences between the varieties and pesticide treatments at all stages and in both the seasons. The pooled data showed that V_4 recorded maximum value (11.70 mg 100 g^{-1} at 90 DAT) followed by V_2 and V_3 and least was in V_1. While, among the pesticide treatments, it was maximum in P_3 followed by P_4 and minimum in P_0. Among different stages, it was maximum at 90 DAT followed by 80 and 115 DAT; while least was at 125 DAT. A maximum magnesium content was noted in P_3 (9.90 mg 100 g^{-1}).

Interaction between varieties and pesticides revealed significant differences at 80, 90 and 125 DAT. While there were no significant differences at 70 and 115 DAT. It is clear from the data that V_4P_3 indicated maximum value at all the stages compared to other treatment combinations. The maximum magnesium content was recorded at 90 DAT followed by 80 DAT irrespective of varieties and pesticides. However, significantly lower magnesium content was recorded in V_1P_0 at all the stages. The magnesium content increased from 70 to 90 DAT in all treatments and declined slowly thereafter until 125 DAT. A maximum magnesium content of 17.65 mg 100 g^{-1} was recorded in V_4P_3 at 90 DAT; while the lowest magnesium content (10.32 mg 100 g^{-1}) was recorded in V_1P_0 at 70 DAT. The data on magnesium content presented in Table 2b indicated significant differences between the varieties and pesticide treatments at all stages and in both the *rabi* seasons. The interaction between varieties and pesticide treatments was also significant at all the stages in both the seasons. Similar results were obtained in *rabi* as that of *kharif* with respect to in varieties and pesticide treatments. Maximum magnesium content was observed in V_4P_3 (17.65 mg 100 g^{-1}) among all interactions followed by V_4P_3 and V_2P_3 at all the stages. The minimum magnesium content was noticed in V_1P_0 (10.31 mg 100 g^{-1}) at 70 DAT.

Marketable fruit yield

The highest marketable fruit yield was recorded in V_4 at 90 DAT among all the varieties. V_1 produce significantly lowest yield compared to other varieties at all the stages. It was calculated highest from P_3 which was closely followed by P_4, P_2 and P_1 whereas lowest in P_0 (non-sprayed control). Pesticide treatments, varieties and their interactions differed significantly among themselves at all the stages.

It is clear from the data in Table 3a that V_4P_3 recorded maximum value at all the stages compared to other treatment combinations. The highest marketable fruit yield was observed at 90 DAT followed by 80 DAT; irrespective of varieties and pesticides. However, significantly lowest was calculated from V_1P_0 at all the stages. It is clear from the data that highest total marketable yield (7.09 kg) was recorded in V_4P_3 while the lowest in V_1P_0 (1.88 kg plant^{-1}). The treatment V_2P_1 did not differ significantly with V_2P_2 at 90 DAT. Similarly, the treatments V_1P_1 and V_3P_3; at 90 and V_2P_2 and V_2P_3; V_4P_3 and V_4P_4; V_1P_3 and V_1P_4 at 125 DAT did not differ significantly among themselves. Pooled data recorded showed significantly differ marketable fruit yield in *rabi* at all the stages in varieties, pesticide treatments and their interactions respectively. Results obtained was followed same trend as that of *kharif*. The highest marketable yield was noticed in V_4P_3 (1.43 kg plant^{-1}) at 90 DAT; while lowest in V_1P_0 (0.21 kg) at 80 DAT (Table 3b).

Discussion

Data presented in Tables 1a and 1b revealed a significant difference

Treatments	Pooled data (*kharif* 2013-14 and 14-15)				
	DAT				
	70	80	90	115	125
Varieties (V)					
V_1	441.1	464.5	509.0	492.2	421.9
V_2	563.2	586.1	632.6	611.5	547.1
V_3	563.1	584.4	629.1	614.5	544.8
V_4	599.5	621.0	664.6	643.2	572.0
Mean	541.7	564.0	608.8	590.4	521.5
S.Em ±	0.29	0.29	0.29	0.28	0.29
LSD@5%	0.83	0.83	0.83	0.81	0.83
Pesticides (P)					
P_0	391.2	409.4	445.4	428.6	374.8
P_1	413.2	430.4	466.4	454.6	397.0
P_2	423.0	440.4	476.1	463.8	405.0
P_3	481.7	499.4	536.4	517.0	464.6
P_4	457.9	476.5	511.0	497.5	444.6
Mean	433.4	451.2	487.1	472.3	417.2
S.Em ±	0.30	0.26	0.26	0.25	0.26
LSD@5%	0.90	0.74	0.74	0.73	0.74
Interactions (V × P)					
V_1P_0	481.0	511.5	571.5	544.7	441.0
V_1P_1	514.3	544.8	604.8	585.7	494.8
V_1P_2	530.6	561.2	621.2	599.2	501.2
V_1P_3	727.1	757.8	814.7	792.7	704.7
V_1P_4	687.8	721.2	781.2	759.2	671.2
V_2P_0	696.0	726.5	786.5	755.3	669.8
V_2P_1	736.5	767.0	827.0	805.0	712.0
V_2P_2	747.0	777.5	837.5	815.5	727.5
V_2P_3	812.8	843.3	912.8	868.3	794.8
V_2P_4	762.6	793.2	853.2	832.2	743.2
V_3P_0	683.3	713.3	773.3	751.3	663.3
V_3P_1	735.7	764.0	824.0	812.5	710.7
V_3P_2	761.2	787.8	846.2	833.7	734.5
V_3P_3	799.5	826.5	886.5	860.2	772.2
V_3P_4	774.2	804.2	864.2	839.2	751.2
V_4P_0	747.7	777.7	837.7	805.8	724.2
V_4P_1	768.5	793.5	853.5	827.2	729.2
V_4P_2	781.0	809.3	869.3	843.3	736.7
V_4P_3	871.7	901.7	961.7	925.3	825.3
V_4P_4	828.0	858.0	908.2	886.2	798.2
Mean	722.3	752.0	811.7	787.1	695.3
S.Em ±	2.60	2.58	2.58	2.53	2.58
LSD@5%	7.44	7.40	7.39	7.25	7.40

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen. V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4-Manjari, P_0-Control (water sprayed), P_1-Thiodicarb 75 WP@1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4-Chlorantraniliprole 20 SC@0.5 ml/L.

Table 1a: Influence of pesticides on total chlorophyll content (µg g^{-1}) of brinjal in different growing seasons.

Pooled data (*rabi* 2013-14 and 14-15)					
Treatments	DAT				
	70	80	90	115	125
Varieties (V)					
V_1	440.6	464.4	508.0	483.0	405.5
V_2	562.6	585.5	630.2	596.8	533.8
V_3	562.6	585.1	629.8	604.5	538.5
V_4	591.0	613.0	659.6	634.4	548.4
Mean	539.2	562.0	606.9	579.7	506.6
S.Em ±	0.29	0.27	0.39	0.56	1.27
LSD@5%	0.82	0.78	1.11	1.62	3.62
Pesticides (P)					
P_0	391.3	410.3	445.6	419.1	359.7
P_1	402.4	420.7	456.1	441.8	388.7
P_2	415.3	433.6	470.7	450.7	401.2
P_3	488.9	506.5	543.0	513.2	447.6
P_4	458.9	476.9	512.2	493.8	428.9
Mean	431.4	449.6	485.5	463.7	405.2
S.Em ±	0.26	0.24	0.35	0.50	1.13
LSD@5%	0.73	0.70	0.99	1.44	3.24
Interactions (V × P)					
V_1P_0	476.8	511.0	566.8	517.3	401.5
V_1P_1	514.4	546.2	604.2	586.6	496.5
V_1P_2	535.4	567.8	627.8	604.2	516.2
V_1P_3	723.0	753.5	813.5	776.3	655.5
V_1P_4	687.7	717.7	774.6	735.7	633.3
V_2P_0	684.4	716.7	776.7	722.7	645.0
V_2P_1	711.5	741.5	799.6	771.5	683.5
V_2P_2	741.5	771.5	831.5	786.6	720.5
V_2P_3	836.0	866.0	926.0	853.7	770.4
V_2P_4	777.5	807.5	867.5	843.8	739.3
V_3P_0	693.8	723.8	783.8	729.9	645.5
V_3P_1	723.3	753.3	813.3	786.3	698.3
V_3P_2	739.5	769.5	829.5	805.8	717.8
V_3P_3	820.5	850.5	910.5	869.6	778.4
V_3P_4	773.3	803.3	861.7	838.0	750.0
V_4P_0	753.5	783.5	843.5	824.3	705.9
V_4P_1	733.7	763.7	823.7	801.2	713.2
V_4P_2	752.0	782.0	849.0	808.2	720.2
V_4P_3	880.0	906.5	970.0	921.3	779.8
V_4P_4	821.0	851.0	911.0	874.5	736.9
Mean	718.9	749.3	809.2	772.9	675.4
S.Em ±	2.55	2.43	3.46	5.05	11.32
LSD@5%	7.31	6.96	9.91	14.45	32.42

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen. V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4-Manjari, P_0-Control (water sprayed), P_1-Thiodicarb 75 WP@1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4–Chlorantraniliprole 20 SC@0.5 ml/L.

Table 1b: Influence of pesticides on total chlorophyll content (µg g^{-1}) of brinjal in different growing seasons.

Pooled data (*kharif* 2013-14 and 14-15)					
Treatments	DAT				
	70	80	90	115	125
Varieties(V)					
V_1	9.08	9.95	10.44	9.46	9.44
V_2	9.85	9.99	11.28	9.79	9.76
V_3	9.77	9.99	10.99	9.85	9.87
V_4	10.45	10.80	11.70	10.65	10.53
Mean	9.79	10.18	11.10	9.94	9.90
S.Em ±	0.05	0.01	0.01	0.04	0.03
LSD@5%	0.14	0.04	0.03	0.12	0.08
Pesticides(P)					
P_0	6.73	6.93	7.77	6.82	6.65
P_1	7.65	7.93	8.62	7.74	7.69
P_2	7.91	8.32	8.87	8.10	8.08
P_3	8.64	9.06	9.90	8.77	8.85
P_4	8.23	8.49	9.25	8.33	8.33
Mean	7.83	8.15	8.88	7.95	7.92
S.Em ±	0.04	0.01	0.00	0.04	0.03
LSD@5%	0.13	0.03	0.01	0.11	0.07
Interactions (V × P)					
V_1P_0	10.31	11.17	12.24	10.80	10.44
V_1P_1	11.93	13.02	13.75	12.21	12.42
V_1P_2	12.37	13.97	14.12	12.96	13.19
V_1P_3	13.11	14.53	15.24	13.95	13.54
V_1P_4	12.85	13.62	14.26	13.18	13.33
V_2P_0	11.48	11.67	13.44	11.63	11.35
V_2P_1	12.83	12.85	14.45	12.63	12.32
V_2P_2	12.80	13.22	14.91	13.04	13.17
V_2P_3	14.89	15.15	16.88	14.22	14.97
V_2P_4	13.64	13.71	15.53	13.72	13.29
V_3P_0	10.98	11.25	12.84	11.08	11.22
V_3P_1	12.48	13.30	14.22	12.85	13.26
V_3P_2	13.47	13.35	14.48	13.33	12.84
V_3P_3	14.45	14.69	16.24	14.48	14.35
V_3P_4	13.76	14.02	15.50	13.90	14.14
V_4P_0	12.09	12.09	13.32	11.96	11.34
V_4P_1	13.75	13.69	15.02	13.89	13.28
V_4P_2	14.08	14.92	15.65	14.66	14.65
V_4P_3	15.15	16.06	17.65	15.79	16.15
V_4P_4	14.59	15.25	16.36	14.71	14.79
Mean	13.05	13.58	14.80	13.25	13.20
S.Em ±	0.44	0.12	0.04	0.39	0.25
LSD@5%	NS	0.33	0.10	NS	0.72

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen NS-Non-significant, V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4-Manjari, P_0-Control (water sprayed), P_1-Thiodicarb 75 WP@1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4-Chlorantraniliprole 20 SC@0.5 ml/L.

Table 2a: Influence of pesticides on magnesium content (mg 100 g^{-1}) of brinjal in different growing seasons.

Pooled data (*rabi* 2013-14 and 14-15)					
Treatments	DAT				
	70	80	90	115	125
Varieties(V)					
V_1	9.17	9.96	9.97	9.38	9.49
V_2	9.90	9.95	10.13	9.89	9.81
V_3	9.83	9.95	10.02	9.89	9.85
V_4	10.46	10.76	10.87	10.59	10.56
Mean	9.84	10.16	10.25	9.94	9.93
S.Em ±	0.02	0.01	0.01	0.02	0.01
LSD@5%	0.07	0.03	0.03	0.06	0.04
Pesticides(P)					
P_0	6.79	6.93	6.93	6.81	6.67
P_1	7.66	7.90	8.07	7.72	7.72
P_2	7.93	8.27	8.39	8.05	8.11
P_3	8.78	9.06	9.11	8.90	8.88
P_4	8.20	8.48	8.51	8.26	8.33
Mean	7.87	8.13	8.20	7.95	7.94
S.Em ±	0.02	0.01	0.01	0.02	0.01
LSD@5%	0.06	0.03	0.03	0.05	0.03
Interactions (V × P)					
V_1P_0	10.57	11.18	11.03	10.62	10.32
V_1P_1	11.70	13.08	13.19	11.82	12.35
V_1P_2	12.36	14.05	13.97	12.74	13.38
V_1P_3	13.52	14.54	14.74	14.14	13.76
V_1P_4	12.98	13.55	13.55	13.21	13.45
V_2P_0	11.40	11.60	11.76	11.45	11.44
V_2P_1	13.04	12.64	13.17	13.00	12.52
V_2P_2	12.83	13.22	13.60	12.99	13.14
V_2P_3	15.15	15.17	15.16	14.88	15.04
V_2P_4	13.57	13.72	13.83	13.60	13.27
V_3P_0	11.10	11.25	11.42	11.20	11.22
V_3P_1	12.43	13.29	13.49	12.65	13.24
V_3P_2	13.48	13.01	13.29	13.39	12.86
V_3P_3	14.59	14.66	14.79	14.66	14.25
V_3P_4	13.91	14.14	13.85	14.04	14.13
V_4P_0	12.17	12.14	11.97	12.12	11.49
V_4P_1	13.91	13.64	13.94	14.03	13.35
V_4P_2	14.18	14.84	15.05	14.56	14.69
V_4P_3	15.26	16.04	16.02	15.67	16.13
V_4P_4	14.21	15.10	15.48	14.19	14.72
Mean	13.12	13.54	13.66	13.25	13.24
S.Em ±	0.21	0.10	0.11	0.18	0.11
LSD@5%	0.59	0.28	0.30	0.53	0.31

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen. V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4-Manjari, P_0-Control (water sprayed), P_1-Thiodicarb 75 WP@1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4-Chlorantraniliprole 20 SC@0.5 ml/L.

Table 2b: Influence of pesticides on magnesium content (mg 100 g^{-1}) of brinjal in different growing seasons.

between the varieties, pesticide treatments and their interactions at different days after transplanting and in both the seasons (*kharif* 2013-14 and 14-15 and *rabi* 2013-14 and 14-15) after fifth sprays in chlorophyll content. There was a increase in chlorophyll content during the growth period 70-90 DAT appeared in treated brinjal leaves. This result adds further support to the changes in photosynthetic activity and/or alteration in chloroplast. In addition, the pesticides act as a chemical stressor which may interrupt the electron transport activity in PSII, cytochrome b6/f or PSI or may alter the structure of the chloroplast, or inhibit the calvin cycle [4]. Generally, there might be different responses according to the concentrations and frequency of spraying of the pesticide. It also depends on type of pesticides and its period of persistence.

Previously, an increase in the chlorophyll content was observed in *S. tuberosum* by deltamethrin [5] and in *H. esculentus* and *C. annuum* by Topsin [6]; whereas reduction by butachlor on rice [7] was recorded. He also observed carbofuran, butachlor and carbendazim on chlorophyll and ultra-structural alternation to solanum tuberosum chloroplasts in *Solanum melongena*. Effects of different doses of endosulfan on total chlorophyll contents of cabbage leaf on 1, 7, 14, 21, 28 and 35 days after application (DAA) increases of 25.64, 23.81 and 27.50 per cent respectively in chlorophyll content were found on 35th DAA with respect to recommended dose of 0.844 L ha^{-1} [8]. In this work, chlorophyll content is highly relevant to well determine the effect of thiodicarb, spinosad and profenophos and chlorantraniliprole on photosynthesis of four different varieties of brinjal. For this, all measurements were preferred on a young leaf. This study confirms that at recommended dose of profenophos, rynaxypyre and spinosad and thiodicarb respectively increases the total chlorophyll content in brinjal leaves (Manjari, Kalpataru, Manjula and Malapur local). The variety Manjari noticed with maximum chlorophyll content at 90 DAT with respect to prophenofos treatments (V_4P_3) followed by V_2P_3 and V_4P_4 might be due to persistence of pesticide of profenophos and chlorantraniliprole, due to low dose of pesticides. The lowest chlorophyll content observation in thiodicarb followed by spinosad pesticide treatments probably due to its easy volatilization or degradation rate.

In contrast to this study the researchers like Abbas et al. [9] claimed that phenolics inhibit CO_2 dependant O_2 evolution in intact chloroplast. Phenolic compounds inhibit photosynthesis in intact plants, which results in reduced growth and yield. The decrease in chlorophylls and photosynthetic rate may affect the plant growth. The pesticides may affect some biochemical composition of plant. The organophosphorus compounds used in agriculture usually alter the chemical composition and nutritive value of plant product. Despite the simplicity in structure and simple mode of action, the cyanophos (phosphorothioate) is typical xenobiotics [10] and has an adverse effect on the plant. The common mechanism of its toxic action is inhibition of biological pathways such as photosynthesis and mitochondrial electron transport. Plant productivity depends on the conversion of light energy into stable chemical energy. If the photosynthetic apparatus is inhibited by environmental contaminates, changes in plant cell physiology, growth and biomass yield are inevitable. As well it has been shown that inhibition of photosynthesis is a reliable assay of the potential toxicity and xenobiotics contaminants towards plants [11]. Therefore, in the present study, recommended dose fixed by agricultural experts with the logic of spraying less often and using fewer and better selected pesticides only when needed can reduce the pesticides stress in brinjal plants by minimizing residues. The toxic effects of pesticidesin on *Hordeum vulgare* with chlorpyrifos on seed germination and growth has been recently reported. The amount of

Pooled data (*rabi* 2013-14 and 14-15)						
Treatments	DAT					
	70	80	90	115	125	Marketable yield
Varieties (V)						
V_1	0.27	0.39	0.61	0.65	0.50	2.42
V_2	0.46	0.54	0.76	0.75	0.63	3.14
V_3	0.50	0.52	0.70	0.68	0.57	2.99
V_4	0.61	0.70	0.83	0.77	0.61	3.53
Mean	0.46	0.54	0.73	0.71	0.58	
S.Em ±	0.02	0.01	0.01	0.03	0.01	
LSD@5%	0.06	0.02	0.03	0.09	0.03	
Pesticides (P)						
P_0	0.23	0.20	0.33	0.39	0.32	1.46
P_1	0.31	0.38	0.55	0.57	0.43	2.23
P_2	0.37	0.45	0.60	0.60	0.48	2.51
P_3	0.51	0.61	0.77	0.69	0.57	3.15
P_4	0.42	0.52	0.65	0.61	0.52	2.72
Mean	0.37	0.43	0.58	0.57	0.46	
S.Em ±	0.02	0.03	0.01	0.02	0.02	
LSD@5%	0.04	0.09	0.03	0.04	0.06	
Interactions (V × P)						
V_1P_0	0.21	0.24	0.32	0.60	0.28	1.64
V_1P_1	0.27	0.44	0.83	0.87	0.68	3.09
V_1P_2	0.38	0.54	0.89	0.88	0.72	3.41
V_1P_3	0.51	0.76	1.06	1.01	0.83	4.18
V_1P_4	0.44	0.63	0.97	0.95	0.80	3.78
V_2P_0	0.41	0.35	0.59	0.76	0.75	2.86
V_2P_1	0.46	0.59	0.94	0.95	0.74	3.67
V_2P_2	0.63	0.78	0.98	1.05	0.86	4.31
V_2P_3	0.83	0.99	1.39	1.17	1.02	5.39
V_2P_4	0.74	0.90	1.15	1.04	0.88	4.71
V_3P_0	0.47	0.33	0.55	0.44	0.51	2.31
V_3P_1	0.67	0.65	0.87	0.97	0.73	3.89
V_3P_2	0.77	0.80	1.00	1.00	0.81	4.38
V_3P_3	0.89	0.99	1.26	1.13	0.93	5.20
V_3P_4	0.54	0.71	1.01	1.03	0.84	4.13
V_4P_0	0.43	0.39	0.74	0.79	0.61	2.95
V_4P_1	0.70	0.83	1.00	1.00	0.71	4.24
V_4P_2	0.72	0.91	1.16	1.04	0.84	4.66
V_4P_3	1.17	1.35	1.43	1.25	1.01	6.21
V_4P_4	1.08	1.22	1.24	1.05	0.92	5.50
Mean	0.62	0.72	0.97	0.95	0.77	
S.Em ±	0.01	0.01	0.02	0.01	0.03	
LSD@5%	0.02	0.02	0.05	0.04	0.10	

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen. V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4–Manjari, P_0-Control (water sprayed), P_1–Thiodicarb 75 WP @1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4-Chlorantraniliprole 20 SC@0.5 ml/L.

Table 3a: Influence of pesticides on marketable fruit yield (kg plant^{-1}) of brinjal in different growing seasons.

Treatments	Pooled data (*rabi* 2013-14 and 14-15)					
	DAT					
	70	80	90	115	125	Marketable yield
Varieties (V)						
V_1	0.27	0.39	0.61	0.65	0.50	2.42
V_2	0.46	0.54	0.76	0.75	0.63	3.14
V_3	0.50	0.52	0.70	0.68	0.57	2.99
V_4	0.61	0.70	0.83	0.77	0.61	3.53
Mean	0.46	0.54	0.73	0.71	0.58	
S.Em ±	0.02	0.01	0.01	0.03	0.01	
LSD@5%	0.06	0.02	0.03	0.09	0.03	
Pesticides (P)						
P_0	0.23	0.20	0.33	0.39	0.32	1.46
P_1	0.31	0.38	0.55	0.57	0.43	2.23
P_2	0.37	0.45	0.60	0.60	0.48	2.51
P_3	0.51	0.61	0.77	0.69	0.57	3.15
P_4	0.42	0.52	0.65	0.61	0.52	2.72
Mean	0.37	0.43	0.58	0.57	0.46	
S.Em ±	0.02	0.03	0.01	0.02	0.02	
LSD@5%	0.04	0.09	0.03	0.04	0.06	
Interactions (V × P)						
V_1P_0	0.21	0.24	0.32	0.60	0.28	1.64
V_1P_1	0.27	0.44	0.83	0.87	0.68	3.09
V_1P_2	0.38	0.54	0.89	0.88	0.72	3.41
V_1P_3	0.51	0.76	1.06	1.01	0.83	4.18
V_1P_4	0.44	0.63	0.97	0.95	0.80	3.78
V_2P_0	0.41	0.35	0.59	0.76	0.75	2.86
V_2P_1	0.46	0.59	0.94	0.95	0.74	3.67
V_2P_2	0.63	0.78	0.98	1.05	0.86	4.31
V_2P_3	0.83	0.99	1.39	1.17	1.02	5.39
V_2P_4	0.74	0.90	1.15	1.04	0.88	4.71
V_3P_0	0.47	0.33	0.55	0.44	0.51	2.31
V_3P_1	0.67	0.65	0.87	0.97	0.73	3.89
V_3P_2	0.77	0.80	1.00	1.00	0.81	4.38
V_3P_3	0.89	0.99	1.26	1.13	0.93	5.20
V_3P_4	0.54	0.71	1.01	1.03	0.84	4.13
V_4P_0	0.43	0.39	0.74	0.79	0.61	2.95
V_4P_1	0.70	0.83	1.00	1.00	0.71	4.24
V_4P_2	0.72	0.91	1.16	1.04	0.84	4.66
V_4P_3	1.17	1.35	1.43	1.25	1.01	6.21
V_4P_4	1.08	1.22	1.24	1.05	0.92	5.50
Mean	0.62	0.72	0.97	0.95	0.77	
S.Em ±	0.01	0.01	0.02	0.01	0.03	
LSD@5%	0.02	0.02	0.05	0.04	0.10	

Pesticides were detected only at 24 and 96 hr after the spray. No further detection was seen. V_1-Malapur local, V_2-Kalpataru, V_3-Manjula, V_4-Manjari, P_0-Control (water sprayed), P_1-Thiodicarb 75 WP@1g/L, P_2-Spinosad 45 SC@0.1 ml/L, P_3-Profenophos 50 EC@2 ml/L, P_4-Chlorantraniliprole 20 SC@0.5 ml/L.

Table 3b: Influence of pesticides on marketable fruit yield (kg plant^{-1}) of brinjal in different growing seasons.

chlorophyll was increased in some lower concentrations of Rogor up to 750 ppm, then there was a decrease in higher concentrations compared to control [12]. Magnesium is core component of chlorophyll and data reavealed that magnesium content in brinjal fruits also showed significant results during this investigation.

At low dose of imidacloprid significantly promoted the uptake of P and K by rice plants [13]. The presence of pesticides residues like chlorosulforon, dclofop, haloxyfopfluazifop have shown some specific effects on the micronutrient transport system and the plasma membrane of the root cells [14-16] which in turn affect the cations uptake including Zn, Cu and Mn [17]. Photosynthesis is a more general measurement of carbon dioxide intake and fixation (sugar production). Both processes are interrelated and are directly related to plant growth and productivity. The higher value of transpiration occurred on pesticides-free plants. Photosynthesis was also higher in the untreated check, suggesting that all pesticide treatments at higher rate adversely influenced both stomatal opening and overall photosynthetic rates and that the effect remained for at least one week. Reductions of lettuce head weight and diameter in plants treated weekly with methyl-parathion indicate the cumulative effect on yield that results from pesticide inhibition of physiological processes. Since no differences were observed between the photosynthesis and transpiration rates of plants treated in daylight or darkness, it may be assumed that pesticides uptake by the plant is independent of stomatal opening.

The pesticides used in experiments i.e., thiodicarb, spinosad, profenophos and chlorantraniliprole at recommended doses are from different classes, differ in their effects on plants. Additionally, the rates, number and timing of applications may alter a compound effect upon the plants, for either or short time or several days. Efficiency of pesticides treatment to reduce per cent fruit borer infestations may increase the yield from 70 to 90 DAT (10 to 20 days after fifth spraying) while, slightly decline in yield during both *kharif* and *rabi* due to increase in pest infestations after 90 DAT. Results obtained on the influence of different pesticides in different growing seasons on yield of brinjal varieties with certain environmental parameter, when relative effectiveness of pesticides in reducing pest populations is considered, the later compound are most desirable. As more data are obtained on the effect of pesticides and their compounds on photosynthesis and consequently on yield may become essential. Results indicate that the dual effect of profenophos treatments on different varieties, by measuring changes in photosynthesis (alteration in chlorophyll content) and most efficient pesticides among all pesticide treatments reduced per cent fruit borer infestations from brinjal plant.

Conclusion

The total chlorophyll content in brinjal leaves can be very useful in detecting the effects of different pesticides on the plant physiological processes caused by recommended dose of all four pesticides and its gave us an alternative view on the action mechanism of all four pesticides on photosynthesis of treated brinjal. Present study showed that there is a difference between all four varieties treated with different pesticides, and variety Manjari was more tolerant followed by Kalpataru, Manjula and most sensitive variety Malapur local to pesticide exposure. Results find that the difference between all four pesticides treatments in responses to varieties probably due to accumulation of ROS increasing rate vary with verities which contribute to oxidative stress that touches photosynthesis and the biosynthesis of photosynthetic pigments. The profenophos followed by cholrantraniliprole, spinosad and thiodicarb significantly promoted the uptake of phosphorus, sulphur, magnesium and calcium by brinjal plant. Thus, it is difficult to make any generalization about the impact of pesticides on brinjal plants. The present study demonstrates that there were no inhibitory effects on the growth, photosynthetic activity and yield of all brinjal varieties at low dosage and interestingly profenophos followed by chlorantraniliprole, spinosad and thiodicarb support the plant activity over the non-sprayed controls. It can be concluded that recommended dose of profenophos after 20 DAS (90 DAT) is beneficial for the growth, photosynthetic pigments and yield of brinjal varieties specifically in Manjari (V_4) among all varieties examined.

Acknowledgements

Here I am in hunt for words to express my pleasurable feelings and thankfulness to my well-wisher cum member of Advisory Committee, Dr. M. B. Chetti, ADG, HRD, ICAR. New Delhi, for his thought provoking, inspiring and valuable guidance in planning and execution of my research work as well as my study. Heartful thanks are extended to Dr. S. D Banergy, Dr. Ramteke, Sandip Hingmire and Abhijit from NRCG Grape for providing laboratory facilities. Dr. S. D. Banergy, senior scientist deserves special thanks for his sincere cooperation and help in analytical work. This work would not have been completed without his keen interest.

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