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Evaluating Compatibility of Atonik with Pesticides in Tomato and Cotton

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Abstract: A pot culture experiment was conducted in tomato and cotton to evaluate the compatibility of Atonik with insecticide and fungicide. Atonik was sprayed at four different concentrations (0.1, 0.2, 0.4 and 0.8%) along with monocrotophos (2 ml L^{-1}) or Atonik 0.4% and monocrotophos (2 ml L^{-1}) alone and at three different concentrations (0.1, 0.25 and 0.5%) along with Confidor (0.2 ml L^{-1}) or Atonik 0.25% and Confidor (0.2 ml L^{-1}) alone to assess the bioefficacy on 25 and 45 DAS, in tomato and cotton, respectively. To assess the compatibility with fungicide the above mentioned Atonik concentration with fytolon and carbendazim in tomato and cotton, respectively was tested. The results revealed that Atonik is compatible with tested pesticides. The insecticidal property of monocrotophos or confidor or fungicidal property of carbendazim or fytolon was not altered along with growth promoting activity of Atonik. The plants sprayed with Atonik or in combination with pesticides showed zero grades of phytotoxic symptoms.

Key words: Atonik, insecticide, compatibility, tomato

INTRODUCTION

Plant growth regulators and pesticides are being applied separately for enhancing plant growth and for the control of insect pests and diseases, respectively. This becomes rather costly and also involves more of labour and time in applying. If plant growth regulators and insecticides are applied in association in a single operation it could be cheaper in the view of farmers. Since the pesticides and plant growth regulators are chemically different in nature, their compatibility may pose a problem. Hence it requires thorough investigation before its widespread commercial application. Mixture of two pesticides may produce a greater insecticidal action than the sum of their individual components by exhibiting synergism[1], thus minimising the pesticidal load on the environment. Mixtures may also bring about significant cost efficiency[2].

The fungicide (hexaconazole) and insecticide (monocrotophos) were found to have synergistic effect and exerted high efficiency towards pests and disease of grapes[3]. Padmaja and Kameshwara Rao[4] reported that monocrotophos and carbendazim, carbaryl and mancozeb were highly compatible and recorded higher mortality than their individual insecticidal spray. The combination of herbicides fluchloralin and alachlor with carbendazim, benomyl and carboxin altered their fungicidal action and showed synergistic effect against *Fusarium oxysporum*, *Sclerotium rolfsii*, *A. brassicicola* and *Colletotrichum capsici*[5].

All the fungicides and their combination with the insecticide were effective in reducing the sheath blight disease and indicated the compatibility nature[6]. Hence, the present study was formulated to evaluate the possibility of compatibility of Atonik with insecticide and fungicide in cotton and tomato.

MATERIALS AND METHODS

Insecticide: The compatibility of Atonik with insecticides in tomato and cotton, a pot culture study was conducted during 2002-2003 at the glasshouse of the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, India.

Tomato: The experiment consisted of seven treatments with ten replications in Randomized Block Design. The treatment details are as follows:

T_1 = Atonik 0.1%+Monocrotophos 2 ml L^{-1}
T_2 = Atonik 0.2%+Monocrotophos 2 ml L^{-1}
T_3 = Atonik 0.4%+Monocrotophos 2 ml L^{-1}
T_4 = Atonik 0.8%+Monocrotophos 2 ml L^{-1}
T_5 = Monocrotophos 2 ml L^{-1} alone
T_6 = Atonik 0.4% alone
T_7 = Control

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The first round of spraying was given at 45 days after planting and the spraying was repeated once at 15 day intervals as per the treatment schedule. The incidence of whitefly and aphids was visually recorded before treatment and 1, 3, 5 and 7 days after treatment on six leaves per plant, two each from top, middle and bottom portions of ten plants and the population was arrived at for each treatment, according to the method of Sudhakar *et al.*[7] for whitefly and Uthamasamy *et al.*[8] for aphid as described earlier.

Yield and yield components namely fruit set percentage, fruit weight and yield per plant were recorded on ten plants.

Cotton: The experiment consisted of six treatments with ten replications in Randomized Block Design. The treatment details were as follows:

T_1 = 0.1% Atonik+confidor 0.2 ml L^{-1}
T_2 = 0.25% Atonik+confidor 0.2 ml L^{-1}
T_3 = 0.5% Atonik+confidor 0.2 ml L^{-1}
T_4 = Confidor 0.2 ml L^{-1} alone
T_5 = Atonik 0.25% alone
T_6 = Control

The first round of spraying was given at 25 days after planting and the spraying was repeated once at 15 day intervals. The population of whitefly and aphid was recorded prior to application and 1, 3, 5 and 7 days after spraying. The population of both nymphs and adult whiteflies was counted every morning when the insects were inactive. The population count was recorded on top two, two middle and one bottom leaves in each of ten tagged plants. Finally mean number of whiteflies per ten plants was calculated[7]. The population count of aphid was recorded on ten plants. In each plant, three leaves one each from the top, middle and bottom regions of the plant were examined for the presence of aphids and the total number of aphids per 10 plants was calculated[8].

Yield and yield components namely number of bolls, boll weight, seed cotton yield and fertility co-efficient were recorded on ten plants.

The observations on phytotoxicity in cotton and tomato were made on 1, 3 and 7 days after each application by recording injury to leaf tip and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty and graded by adopting the following scale[9].

Fungicide: Compatibility of Atonik with fungicides was tested using carbendazim and fytolon to check the growth of four pathogens viz., *Fusarium oxysporum* f. sp. *asinfectum* and *Colletotrichum capsici* for cotton and *Alternaria alternata* and *Botrysis cinerea* for tomato by using poisoned food technique[10] with three replications.

Cotton:

T_1 = Control
T_2 = 0.1% Atonik+200 mg carbendazim
T_3 = 0.25% Atonik+200 mg carbendazim
T_4 = 0.5% Atonik+200 mg carbendazim
T_5 = 40 ppm NAA+200 mg carbendazim
T_6 = 200 mg carbendazim
T_7 = 0.1% Atonik
T_8 = 0.25% Atonik
T_9 = 0.5% Atonik
T_{10} = 40 ppm NAA

Tomato:

T_1 = Control
T_2 = 0.1% Atonik+200 mg fytolon
T_3 = 0.2% Atonik+200 mg fytolon
T_4 = 0.4% Atonik+200 mg fytolon
T_5 = 0.8% Atonik+200 mg fytolon
T_6 = 50 ppm PCPA+200 mg fytolon
T_7 = 200 mg fytolon
T_8 = 0.1% Atonik
T_9 = 0.2% Atonik
T_{10} = 0.4% Atonik
T_{11} = 0.8% Atonik
T_{12} = 50 ppm PCPA

The radial mycelial growth of the fungus and per cent inhibition in the growth of fungus was studied according to Varalakshmi *et al.*[3]. The percent growth inhibition was calculated as per Vincent[11].

RESULTS

Insecticides

Tomato: Effect of Monocrotophos with Atonik against tomato whitefly revealed that the pre-treatment population count recorded prior to first spray ranged between 13.00 and 14.67 with non-significant result. One day after the spray 1st, lowest population was observed in T_5 (4.67) followed by T_4 (5.33), both of them were on par. Atonik 0.25% alone (T_6) recorded a population of 12.00, whereas the control had the highest population count of 16.33. At 5 day after treatment, T_2, T_3, T_4 and T_5 were on par with each other and T_4 and T_5 recorded a population count of one per 10 plants. At 7 DAT, the population of whitefly increased slightly irrespective of the treatments. At this time, maximum population was observed in T_7 (16.33),

followed by Atonik 0.25% alone (10.67). T_3, T_4 and T_5 were on par (Table 1).

After 2nd spray, the population of whitefly decreased from 1 DAT to 5 DAT. The pretreatment count ranged between 21.00 and 22.67 and the treatment did not differ significantly. On the 5th day after treatment, the lowest population was observed in T_4 and T_5 (1.0). The treatments, T_4 and T_5 were on par and T_1 and T_3 were on par with each. The best treatments T_4 and T_5 recorded a control of 96.1%, followed by next best T_3 (91.0%). Prior to spray 1st, the population count of aphid ranged between 35.33 and 38.00. Here also, the difference was non-significant. After application of chemical, the population reduced drastically at 1 and 3 DAT, the reduction extended upto the 5th day after application. At that time, control had a population of 37.0, followed by Atnoik alone (T_6) (Table 2). Maximum control was achieved in T_5 (monocrotophos 2 ml L^{-1} alone) to a tune of 90.0%, followed by T_4 (monocrotophos 2 ml L^{-1} +Atonik 0.8, 89.1%). Atonik alone had reduced the population by 16.2% over control. The same trend was also observed in spray 2nd also. T_5 showed a % decrease of 72.7, followed by T_1 (60.2%). Minimum population was observed on the 5th DAT. Atonik alone reduced the population by 9.0% over T_7. On the 5th DAT, during 2 spray T_1, T_2, T_3 and T_4 were on par.

Cotton: Application of Confidor had a profound effect on the whitefly population reduction after 1st and 2nd sprays. The population reduction was drastically reduced after first day of application and the effect was maintained for two more days due to both the sprays. In both the sprays, T_4 was the best. During 1st spray on the 3rd day after application, treatments T_1, T_2, T_3 and T_4 were on par with each other (Table 3). The other treatments (T_5 and T_6) were significant at all days at both the stages. After 1st spray, the treatments T_1, T_2, T_3 and T_4 showed a decrease of 89.5, 92.1, 92.1 and 92.1%, respectively over control at 3rd DAT, whereas after 2nd spray T_1, T_2 and T_3 recorded a% reduction of 86.0, 86.0 and 88.0%, respectively over control. The best treatment T_4 had a reduction of 92.1 and 94.0% over control at 1st and 2nd stages, respectively. Atonik reduced the population by 52.6 and 56.0% over control after 1st and 2nd sprays, respectively.

The pre-treatment population count of aphid ranged between 63.00 and 65.67% (Table 4). After application of chemical, the population reduced drastically at 1 and 3 DAT and the reduction extended upto 5 days after application. At that time, control had a population of 61.67, followed by T_5 (46.67). Maximum control was achieved in T_4 to a tune of 92.4%, followed by T_1 and T_2 (90.2). Atonik alone had reduced the population by 24.3% over control. The same trend was also followed in the 2nd spray also. T_3 and T_4 treatments showed a % reduction of 94.7, followed by T_1 and T_2 (91.6%). Minimum population was observed on 5th day after treatment. Atonik alone reduced the aphid population by 24.3 and 38.5% over control during 1st and 2nd sprays, respectively. On the 5th day after treatment, during 1st and 2nd sprays, T_1, T_2, T_3 and T_4 were on par.

Fungicide

Cotton: Among the treatments imposed maximum control of *Fusarium oxysporum* f.sp. *vasinfectum* was observed in the treatment T_3, T_4, T_5 and T_6 which recorded a decrease of 100.0% over control. The corresponding decrease in T_2 was 92.3. The treatments T_3, T_4, T_5 and T_6 were on par with each other. Effect of Atonik with carbendazim on control of *C. capsici* revealed that maximum inhibition of growth was achieved in treatment T_4 and T_5 (87.3%) over control. This was followed by T_6 and T_3 with the reduction of 87.1 and 85.8%, respectively over control. The treatments T_5 and T_6 were found to be on par whereas the other treatments differed significantly (Table 5).

Tomato: Among the treatment exercised, maximum inhibition of *Alternaria alternate* growth was achieved in T_1 (100.0%) and was followed by T_6 (87.6%). The treatments differed significantly among themselves. The maximum reduction in the growth of *Botrytis cinerea* was seen in T_4, T_5, T_6 and T_7 treatments with a percent reduction of 100.0 over control. The other treatments differed significantly (Table 5).

Yield components of tomato: Among the treatments imposed, maximum number of fruit clusters per plant was observed in T_3 (Monocrotophos 2 ml L^{-1}+Atonik 0.4%), followed by T_4, T_2 and T_6. The difference between the treatments was significant. Among the treatment imposed, maximum number of fruits per plant was observed in T_3 followed by T_4. The % increase was 16.44 and 11.80 over control. The treatments differed significantly among themselves. Fruit weight was maximum in T_4 (66.32), followed by T_3 (64.86). These treatments recorded an increase of 33.0 and 30.0% over control, respectively. The treatments differed significantly for fruit weight. Among the treatments imposed, T_3 recorded the highest yield per plant followed by T_4 and T_7 recorded the lowest yield per plant. The percent increase was 37.7 (T_3) and 36.4 (T_4) over control. The mean difference between the treatments was found to be significant (Table 6).

Yield components of cotton: Maximum flower number was attained in the treatment T_6 (39.48), followed by T_4 (38.42).

Table 1: Compatibility of Atonik with monocrotophos against tomato whitefly-1st and 2nd spray

	Mean whitefly population per 10 plants–days after treatment**									
	1st spray					2nd spray				
Treatments	*PTC	1	3	5	7	*PTC	1	3	5	7
T_1	13.00 (3.67)	6.67 (2.68)	4.33 (2.20)	2.00 (1.58)	3.67 (2.04)	21.00 (4.64)	4.33 (2.20)	3.67 (2.04)	2.67 (1.78)	4.00 (2.12)
T_2	13.67 (3.76)	6.67 (2.68)	4.00 (2.12)	1.67 (1.47)	3.67 (2.04)	21.33 (4.67)	5.67 (2.48)	4.33 (2.20)	3.67 (2.04)	4.00 (2.12)
T_3	13.33 (3.72)	6.67 (2.68)	3.67 (2.04)	1.67 (1.47)	3.00 (1.87)	21.67 (4.71)	4.33 (2.20)	3.67 (2.04)	2.33 (1.68)	3.67 (2.04)
T_4	14.33 (3.85)	5.33 (2.41)	2.67 (1.78)	1.00 (1.22)	3.00 (1.87)	21.00 (4.64)	3.67 (2.04)	2.67 (1.78)	1.00 (1.22)	2.00 (1.58)
T_5	14.67(3.89)	4.67 (2.27)	2.00 (1.58)	1.00 (1.22)	2.33 (1.68)	22.00 (4.74)	3.67 (2.04)	2.67 (1.78)	1.00 (1.22)	1.67 (1.47)
T_6	13.67 (3.76)	12.00 (3.54)	14.33 (3.85)	13.00 (3.67)	10.67 (3.34)	22.67 (4.81)	20.00 (4.53)	21.67 (4.71)	22.00 (4.74)	20.00 (4.53)
T_7	14.00 (3.81)	16.33 (4.10)	17.00 (4.18)	17.00 (4.18)	16.33 (4.10)	22.67 (4.81)	24.67 (5.02)	25.67 (5.12)	26.00 (5.15)	24.00 (4.95)
CD (p=0.05)	NS	0.201	0.219	0.260	0.204	NS	0.258	0.344	0.314	0.438

* - Pre-treatment count, ** - Mean of three replications, Number in parentheses indicates square root transformed value

Table 2: Compatibility of Atonik with Monocrotophos against tomato aphid-1st and 2nd spray

	Mean aphid population per 10 plants-days after treatment**									
	1st spray					2nd spray				
Treatments	*PTC	1	3	5	7	*PTC	1	3	5	7
T_1	35.33 (5.99)	17.00 (4.18)	7.00 (2.74)	5.33 (2.41)	8.67 (3.03)	28.33(5.37)	11.33(3.44)	9.00(3.08)	11.67(3.49)	14.00(3.81)
T_2	36.67(6.10)	17.00(4.18)	7.67(2.86)	5.67(2.48)	9.00(3.08)	29.00(5.43)	11.00(3.39)	9.00(3.08)	12.67 (3.63)	14.67 (3.89)
T_3	36.67 (6.10)	16.00 (4.06)	7.67 (2.86)	5.33 (2.41)	8.67 (3.03)	29.33 (5.46)	11.33 (3.44)	11.00 (3.39)	13.00 (3.67)	14.33 (3.85)
T_4	37.33 (6.15)	14.00 (3.81)	7.33 (2.80)	4.00 (2.12)	6.33 (2.61)	29.33 (5.46)	11.33 (3.44)	11.00 (3.39)	12.67 (3.63)	13.67 (3.76)
T_5	37.67 (6.18)	14.00 (3.81)	6.67 (2.68)	3.67 (2.04)	4.67 (2.27)	30.00 (5.52)	6.67 (2.68)	6.67 (2.68)	8.00 (2.92)	9.33 (3.14)
T_6	38.00 (6.20)	36.00 (6.04)	33.33 (5.82)	31.00 (5.61)	27.00 (5.24)	30.33 (5.55)	27.67 (5.31)	28.33 (5.37)	26.67 (5.21)	27.33 (5.28)
T_7	35.67 (6.01)	38.33 (6.23)	38.00 (6.23)	37.00 (6.12)	36.33 (6.07)	30.33 (5.55)	29.67 (5.49)	30.33 (5.55)	29.33 (5.46)	29.67 (5.49)
CD (p=0.05)	NS	0.315	0.475	0.134	0.434	0.020	0.323	0.351	0.128	0.261

* - Pre-treatment count, ** - Mean of three replications, Number in parentheses indicates square root transformed value

Table 3: Compatibility of Atonik with Confidor against cotton whitefly-1st and 2nd spray

	Mean white fly population per 10 plants-days after treatment**									
	1st spray					2nd spray				
Treatments	*PTC	1	3	5	7	*PTC	1	3	5	7
T_1	10.33 (3.29)	1.00 (1.22)	1.33 (1.35)	1.67 (1.47)	2.33 (1.68)	10.33 (3.29)	4.33 (2.20)	2.33 (1.68)	4.67 (2.27)	7.00 (2.74)
T_2	10.33 (3.29)	1.33 (1.35)	1.00 (1.22)	2.00 (1.58)	2.33 (1.68)	9.67 (3.19)	4.33 (2.20)	2.33 (1.68)	3.67 (2.04)	6.33 (2.61)
T_3	10.67 (3.34)	1.33 (1.35)	1.00 (1.22)	1.67 (1.47)	2.67 (1.78)	8.67 (3.03)	2.67 (1.78)	2.00 (1.58)	2.67 (1.78)	4.33 (2.20)
T_4	10.00 (3.24)	1.00 (1.22)	1.00 (1.22)	0.67 (1.08)	1.33 (1.35)	8.00 (2.92)	1.33 (1.35)	1.00 (1.22)	1.00 (1.22)	2.33 (1.68)
T_5	10.00 (3.24)	7.00 (2.74)	6.00 (2.55)	8.33 (2.97)	9.67 (3.19)	9.67 (3.19)	8.00 (2.92)	7.33 (2.80)	6.00 (2.00)	6.67 (2.68)
T_6	10.33 (3.29)	12.00 (3.54)	12.67 (3.63)	13.00 (3.67)	11.67 (3.49)	10.33 (3.29)	13.67 (3.76)	16.67 (4.14)	14.33 (3.85)	13.00 (3.67)
CD (p=0.05)	NS	0.132	0.132	0.133	0.288	NS	0.273	0.134	0.128	0.120

* - Pre-treatment count, ** - Mean of three replications, Number in parentheses indicates square root transformed value

Table 4: Compatibility of Atonik with Confidor against cotton aphid-1st and 2nd spray

	Mean aphid population per 10 plants-days after treatment**									
	1sr spray					2nd spray				
Treatments	*PTC	1	3	5	7	*PTC	1	3	5	7
T_1	65.67 (8.13)	32.67 (5.76)	15.33 (3.98)	6.00(2.55)	10.00(3.24)	32.00(5.70)	12.00(3.54)	5.67(2.48)	2.67(1.78)	6.67(2.68)
T_2	64.67(8.07)	33.67(5.85)	15.67(4.02)	6.00(2.55)	9.33(3.14)	31.33(5.64)	11.33(3.44)	5.00(2.35)	2.67(1.78)	5.67(2.48)
T_3	64.00(8.03)	32.67(5.76)	15.67(4.02)	6.33(2.61)	8.67(3.03)	31.67(5.67)	11.33(3.44)	5.00(2.35)	1.67(1.47)	5.33(2.41)
T_4	63.67(8.01)	30.00(5.52)	13.33(3.72)	4.67(2.27)	7.63(2.85)	32.33(5.73)	11.67(3.49)	3.66(2.04)	1.67(1.47)	4.33(2.20)
T_5	63.00(7.97)	36.33(6.07)	30.33(5.55)	46.67(6.87)	38.33(6.23)	33.67(5.85)	25.00(5.05)	17.66(4.26)	19.67(4.49)	20.67(4.60)
T_6	64.67(8.07)	65.33(8.11)	47.00(6.89)	61.67(7.88)	58.67(7.69)	34.33(5.9)	32.67(5.76)	30.33(5.55)	32.00(5.70)	32.67(5.76)
CD (p=0.05)	NS	0.294	0.289	0.438	0.263	NS	0.134	0.243	0.357	0.345

* - Pre-treatment count, ** - Mean of three replications, Number in parentheses indicates square root transformed value

Table 5: Compatibility of Atonik with fungicides on control of pathogens of cotton and pathogens of tomato

	Cotton					Tomato			
	Fusarium oxysporum f.sp. *vasinfectum*		*Colletotrichum capsici*			*Alternaria alternata*		*Botrytis cinerea*	
Treatments	Growth (mm)	% Inhibition	Growth (mm)	% Inhibition	Treatments	Growth (mm)	% Inhibition	Growth (mm)	% Inhibition
T_1	83.0	-	68.3	-	T_1	80.6	-	82.3	-
T_2	6.3	92.3	10.3	84.8	T_2	21.6	73.0	9.0	89.0
T_3	0.0	100.0	9.6	85.8	T_3	20.6	74.4	8.3	89.9
T_4	0.0	100.0	8.6	87.3	T_4	18.3	77.3	0.0	100.0
T_5	0.0	100.0	8.6	87.3	T_5	16.6	79.4	0.0	100.0
T_6	0.0	100.0	8.8	87.1	T_6	10.0	87.6	0.0	100.0
T_7	78.0	6.0	66.3	2.9	T_7	0.0	100.0	0.0	100.0
T_8	75.0	9.6	61.3	10.2	T_8	65.0	19.4	82.0	0.4
T_9	73.0	10.0	57.6	15.6	T_9	59.3	26.4	81.0	0.6
T_{10}	77.0	7.2	55.3	19.0	T_{10}	57.3	28.9	69.3	15.7
Mean	39.2		35.5		T_{11}	31.3	61.1	44.6	45.7
CD (p=0.05)	1.042		2.134		T_{12}	30.6	62.0	14.6	82.1
					Mean	34.3		32.6	
					CD (p=0.05)	1.460		2.246	

Table 6: Compatibility of Atonik with Monocrotophos and Confidor on yield components at different growth stages in tomato var PKM 1 and cotton var MCU 12

	Tomato					Cotton			
Treatments	Number of fruit clusters plant^{-1}	Number of fruitsplant^{-1}	Fruit weight (g)	Yield plant^{-1} (g)	Treatments	Number of flowers plant^{-1}	Number of bolls plant^{-1}	Boll weight (g)	Seed cotton yieldplant^{-1}(g)
T_1	12.32	23.72	61.20	940.58	T_1	34.86	13.42	4.00	37.72
T_2	13.00	24.85	63.40	990.24	T_2	30.33	15.84	4.12	48.36
T_3	13.38	27.62	64.86	1102.24	T_3	31.42	14.00	4.10	42.56
T_4	13.24	26.52	66.32	1092.42	T_4	38.42	13.64	4.09	39.43
T_5	12.14	23.00	61.32	903.36	T_5	31.00	14.00	4.08	46.36
T_6	13.00	26.00	62.53	983.46	T_6	39.48	12.00	3.83	32.54
T_7	11.12	20.24	49.86	800.38	Mean	35.32	14.07	3.99	41.34
Mean	12.86	25.03	61.06	992.14	CD (P=0.05)	4.14	1.64	0.004	4.88
CD (p=0.05)		1.48	2.89	7.07	114.80				

Table 7: Phytotoxicity grade of confidor and combination of Atonik and monocrotophos and combination of Atonik in cotton var MCU 12 and tomato var PKM 1

	1 DAT*						3 DAT*						5 DAT*					
Crops	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
Tomato																		
T_1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cotton																		
T_1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T_6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* - Mean of three samples. A–Phytotoxicity, B–Scorching, C–Vein clearing, D – Epinasty, H – Hyponasty, F – Leaf injury

The treatments, T_2, T_3 and T_5 were on par with each other. The mean difference of the treatments was found to be significant. Maximum number of bolls was observed in T_2 (15.84), followed by T_3 and T_5 (14.00). The mean difference of the treatments was significant. The lowest boll number was observed in control (12.00). Among the treatments, the mean difference in boll weight was found to be significant. T_2 had a slightly higher value (4.12) followed by T_3 (4.10). Maximum yield per plant was attained in the treatment T_2 (48.36), followed by T_5 (46.36). The best treatment recorded an increase of 48.6% over control. The other treatments, T_1, T_3, T_4 and T_5 showed an increase of 15.9, 30.7, 4.05 and 42.4%, respectively over control (Table 6).

Phytotoxicity grade of confidor and monocrotophos and their combination with atonik: Among the treatments imposed all the treatments at 1, 3 and 5 days after treatment showed zero grades, for both cotton and tomato.

DISCUSSION

Insecticide: Application of confidor at 2 ml L^{-1} significantly reduced the whitefly and aphid population in cotton. When Atonik was mixed with confidor, it exhibited significant reduction in the population of whitefly and aphid. When Atonik alone was sprayed, it reduced the pest load significantly over control, but the reduction was very meager. Further, the cumulative effect was more than the single application. This might be due to the nature of pest damage and its manifestation. Similar type of result was also reported by Lingappa *et al.*[12] in cotton by using various insecticides. Dandale *et al.* [13] observed the same result that Imidacloprid, as seed dresser insecticide was effective against sucking pests of cotton. Humic acid (a phenolic acid mixture) as a tank mixture with fenvalerate significantly mitigated the problems of whitefly resurgence[14]. This indicates that Atonik, being a phenolic compound, can be mixed with other insectides for efficient control of insects as well as for better yield as evident from the study.

In tomato, the same trend was found, (i.e.) application of monocrotophos alone significantly reduced the whitefly and aphid population. When Atonik was mixed with monocrotophos, the reduction of population of whitefly and aphid was evident. This indicates its compatibility nature with monocrotophos. The above result was similar to the finding of Reddy and Joshi[15], that application of Endosulfan in combination with Planofix (NAA) gave higher yield and best pest control in brinjal. The results of the present study also are in agreement with the findings of Srinivas and Peter[16], Walunj *et al.*[17] and Anil Kumar *et al.*[18] in brinjal. Atonik alone also exhibited mild insecticidal property (as evidenced by population of pest).

The increased cotton yield in confidor (Imidacloprid) and Atonik+confidor treatments as observed in the present study may be due to the fact that imidacloprid enhances crop growth and leaf area as reported by Dandale *et al.*[13] and the auxin like activity of Atonik[19]. The same result was also observed by Graham[20], Almand[21] and Attique and Gaffar[22]. Phytotonic effect of imidacloprid treated plants was observed and it was positively correlated with plant height, growth and yield components in cotton[23].

The tomato plant, treated with monocrotophos along with Atonik produced significantly higher yield than other treatments and Atonik sprayed alone. The results of present study corroborated with the finding of Praveen and Dhandapani[24], Chitra *et al.*[25].

Fungicide: From the results of the experiments with cotton and tomato, it can be inferred that there is compatibility between Atonik and carbendazim or fytolon. Atonik, being a nitrophenol, may undergo enzymatic hydrolysis to yield the toxic compound, which exerts a negative environment in the fungus[26]. These toxic compounds may induce the swelling of hyphal tips and germ tubes, often resulting in lysis. Plant growth hormones and their synthetic analogues are well known as antagonists of fungal disease[27]. The auxin, by their effects on cell wall structure, might be particularly active against wilt diseases. Since Atonik exhibits auxin like activity as evidenced from the present study it can be concluded that Atonik challenges the growth of fungus by the above said mechanism[28]. The auxin like compounds like amino trichloro phenyl acetic acid[28], indolyl acetic acid, naphthalene acetamide[29] and 2, 3, 6-trichloro phenyl acetic acid[27] antagonize the effects of infection by *C. ulmi* on elm, *Ceratocystis fagacearum* on oak and *Verticillium alboatrum* on tomato. This may be direct evidence showing that auxin are involved in disease control as also observed in the present study.

Thus, it is concluded that the insecticides did not alter the plant growth promoting activity of Atonik as evidenced by increased yield. The efficacies of insecticides were also not hampered by Atonik as shown by reduced pest population. Monocrotophos and confidor treatments either alone and/or in combination with Atonik showed only zero grades of phytotoxicity symptoms in tomato and cotton.

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