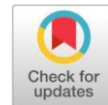


## Original Research Article

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# Management of foliar diseases and thrips of garlic through clove treatment and spray with fungicides, insecticides and bio-agents



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## ABSTRACT

Garlic is valued for its unique flavor and aroma and is used in various forms, including fresh, dried, powdered, pickled, and in oil. Garlic has been utilized for its health benefits for millennia. Garlic's extensive history of medicinal use across cultures and its validation through scientific research underlines its status as a versatile therapeutic agent. The field study was carried out to find out the best insecticides, fungicides, and bio-agents for the management of garlic foliar diseases and thrips. The trial was conducted during rabi season 2020-21 and 2021-22 on garlic variety Agrifound White at the Regional Research Station, NHRDF, Nashik in Maharashtra. The data revealed that, the significantly lowest stemphylium blight incidence (45.0%) with intensity (6.27%), purple blotch incidence (15.0%) with intensity (1.07%), and the lowest thrips population (6.80 nymphs/plant) was recorded at 90 DAP in the treatment - Garlic clove treated with Carbosulfan @ 2.0ml/L + Carbendazim @ 1.0g/L (dip for 5 minutes) + Spray of Carbosulfan @ 2.0ml/L + Carbendazim @ 1.0g/L at 45 DAP + fipronil @ 1.0ml/L + Tricyclazole @ 1.5g/L at 60 DAP + Carbosulfan @ 2.0ml/L + Carbendazim @ 1.0g/L at 75 DAP + Fipronil @ 1.0ml/L + Tricyclazole @ 1.5g/L at 90 DAP]. The significantly highest gross yield (67.85 q/ha) as well as marketable yield (64.18 q/ha) was recorded in the same treatment.

**Keywords:** Garlic, Clove, Thrips, Disease, Stemphylium blight, Purple blotch, Nymph, Insecticides, Fungicides, Incidence, Intensity, Treatment, Management.

## INTRODUCTION

Garlic is a vital spice and condiment crop with significant economic importance. Garlic is native to Central Asia and is cultivated globally in temperate climates, with an annual production of 28 million tons from approximately 1.6 million hectares (source: <http://fao.org/faostat>). Garlic plays a key role in the agricultural economy of many countries as a major foreign exchange earner wherein China being the largest and India being the second largest producer of garlic, wherein India contributes to 10.4% of the world's production with a substantial 3.22 million metric tons in 2024 (Sonwani et al., 2024) [24]. Its bioactive compounds and diverse pharmacological effects make it effective for managing a wide range of conditions such as cardiovascular diseases, wherein it reduces the risk of heart disease by lowering blood pressure, and cholesterol, and improving blood circulation. It also acts as a mild anticoagulant, helping to prevent blood clots (Rana et al., 2011) [20].

Thrips attack garlic at all the stages of crop growth but their count increases from bulb initiation and remains high up to bulb development and maturity. Both nymphs and adults caused damage directly through feeding and indirectly through the transmission of lethal plant viruses. Kalola et al., (2017) [9] reported that profenofos was more effective for thrips and gave a higher bulb yield of garlic. The purple blotch disease mainly affects the leaves and reduces their yield by up to 97%. Purple blotch disease is severe in high humidity and moderate temperature of 80-90% and 25-30°C, respectively (Dar et al., 2020) [2]. According to Patel (2011) [15], deltamethrin was most effective for thrips control in garlic. Gajera et al., (2009) [3] found that spinosad combined with endosulfan was effective for thrips control in garlic. The garlic crop is affected by several diseases caused by fungi, bacteria, nematodes and viruses which play a major role in reducing the yield per unit area. In favorable conditions, the epidemic may cause total failure of the crop caused by Stemphylium. Garlic yield was also reduced by 30% on average, with up to 70% yield losses in some field during the winter season. Ritesh et al., (2017) [19] reported that tebuconazole was very effective in reducing the purple blotch disease. Jhala and Mali (2017) [8] reported that the use of difenaconazole was best control of foliar diseases in onion. Gupta and Pandey (2011) [4] reported that propiconazole and mancozeb were found most effective for foliar diseases.

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Kanzaria et al., (2011) [10] reported tricyclazole, propiconazole and hexaconazole are most effective for *A. porri*. According to Tripathy et al. (2014) [25] combined application of mancozeb, methomyl, tricyclazole, propiconazole, carbosulfan, copper oxychloride and profenofos at 30, 45 and 60 DAT for effective control of diseases and thrips as well as increased the yield. Gupta et al. (2013) [6] reported that mancozeb @ 0.25 %, deltamethrin @ 0.1% and fipronil @ 0.15 % were found effective for the control of foliar diseases and thrips in onion as well as increased the yield. In view of this, the present study has planned to assess the effect of different fungicides, insecticides, and bio-agents through clove treatments and foliar sprays in controlling foliar diseases and thrips of garlic.

## MATERIAL AND METHODS

The field experiment was conducted at NHRDF, Regional Research Station, Nashik, Maharashtra during the *rabi* season 2020-21 and 2021-22. The clove of garlic variety Agrifound white was planted in a bed size of 1.50m x 2.50m at 15 cm x 10 cm spacing. A randomized Block Design with 3 replications was followed. The crop was harvested after attaining the maturity. The data on the thrips (Nymphs/plant) population were counted at the inner-most leaves in 10 plants marked randomly in each treatment. Scoring of the disease was also done on a scale of 0-5, while the Percent Disease Index (PDI) or disease intensity was recorded as described format by Wheeler (1969) [27] as given below. All other agronomical practices were performed uniformly as needed in all the treatments. After attaining maturity the crop was harvested from all the treatments for further assessment of yield.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of all disease ratings}}{\text{Total number of observed leaves} \times \text{Maximum rating value (5)}} \times 100$$

$$\text{Percent Disease Incidence} = \frac{\text{Infected plants}}{\text{Total no. of plants}} \times 100$$

### Details of Treatments

**T<sub>1</sub>**- Garlic clove treated with neem oil @ 4ml/L (dip for 5 minutes) + Spray of neem oil @ 4ml/L + *T. viride* @ 5g/L at 45 DAP + Deltamethrin @ 1.5ml/L + Mancozeb @ 2.5g/L at 60 DAP + Spray of neem oil @ 4ml/L + *T. viride* @ 5g/L at 75 DAP + Deltamethrin @ 1.5ml/L + Mancozeb @ 2.5g/L at 90 DAP

**T<sub>2</sub>**- Garlic clove treated with *T. viride* @ 5g/L (dip for 5 minutes) + Spray of *T. viride* + Carbosulfan @ 2ml/L at 45 DAP + Hexaconazole @ 2g/L + Fipronil @ 1ml/L at 60 DAP + Spray of *T. viride* + Carbosulfan @ 2ml/L at 75 DAP + Hexaconazole @ 2g/L + Fipronil @ 1ml/L at 90 DAP

**T<sub>3</sub>**- Garlic clove treated with Carbosulfan @ 2ml/L + Carbendazim @ 1g/L (dip for 5 minutes) + Spray of Carbosulfan @ 2ml/L + Carbendazim @ 1g/L at 45 DAP + Fipronil @ 1ml/L + Tricyclazole @ 1.5g/L at 60 DAP + Carbosulfan @ 2ml/L + Carbendazim @ 1g/L at 75 DAP + Fipronil @ 1ml/L + Tricyclazole @ 1.5g/L at 90 DAP

**T<sub>4</sub>**- Garlic clove treated with Neem oil @ 4ml/L + *T. viride* @ 5g/L (dip for 5 minutes) + Spray of Lambda cyhalothrin @ 1ml/L + Propiconazole @ 2g/L at 45 DAP + Neem oil @ 4ml/L + *T. viride* @ 5g/L at 60 DAP + Lambda cyhalothrin @ 1ml/L + Propiconazole @ 2g/L at 75 DAP + Neem oil @ 4ml/L + *T. viride* @ 5g/L at 90 DAP (Foliar spray as standard check)

**T<sub>5</sub>**- Lambda cyhalothrin @ 1ml/L + Propiconazole @ 2g/L at 45 DAP + Neem oil @ 4ml/L + *T. viride* @ 5g/L at 60 DAP + Lambda cyhalothrin @ 1ml/L + Propiconazole @ 2g/L at 75 DAP + Neem oil @ 4ml/L + *T. viride* @ 5g/L at 90 DAP (standard check).

**T<sub>6</sub>**- Water spray only (no clove treatment)

**T<sub>7</sub>**- Control (no clove treatment and no spray)

## RESULT AND DISCUSSION

### Rabi 2020-21

The data presented in Table-1 revealed that stemphylium blight and purple blotch disease appeared after 60 and 90 days of planting of garlic clove respectively, while thrips was observed after 45 days of planting. The incidence of stemphylium blight ranged from 26.67% to 66.67% and intensity varied from 1.73% to 14.27% during the cropping period. The significantly lowest stemphylium blight incidence (26.67%), as well as intensity (1.73), was recorded in treatment T<sub>3</sub> (Garlic clove treated with Carbosulfan @ 2.0 ml/L + Carbendazim @ 1.0g/L (dip for 5 minutes), sprays of Carbosulfan @ 2.0 ml/L + Carbendazim @ 1.0g/L, at 45 DAP, Fipronil @ 1.0 ml/L + Tricyclazole @ 1.5g/L at 60 DAP, carbosulfan @ 2.0 ml/L + Carbendazim @ 1.0g/L, at 75 DAP, Fipronil @ 1.0 ml/L + Tricyclazole @ 1.5g/L at 90 DAP) at 60 DAP and the incidence was found at par with T<sub>5</sub> (Sprays of Lambda - cyhalothrin @ 1.0 ml/L + Propiconazole @ 2.0ml/L at 45 DAP, Neem oil @ 4.0 ml/L + *T. viride* @ 5.0 g/L at 60 DAP, Lambda - cyhalothrin @ 1.0 ml/L + Propiconazole @ 2.0ml/L at 75 DAP, Neem oil @ 4.0 ml/L + *T. viride* @ 5.0 g/L at 90 DAP). The disease progresses as per the advancement of the crop stage. The significantly lowest incidence (30.0%) as well as intensity (4.40%) was recorded in the same treatment T<sub>3</sub> at 75 DAP and it was found at par with T<sub>5</sub>. Further, data revealed that, the significantly lowest incidence (40.0%) as well as intensity (5.47%) was recorded in the same treatment T<sub>3</sub> at 90 DAP and incidence was found at par with T<sub>5</sub>. The purple blotch disease appeared at a later stage with the lowest incidence (10.0%) as well as intensity (0.67%) was recorded in treatment T<sub>3</sub> at 90 DAP and incidence was found at par with T<sub>5</sub>. The lowest thrips population at 45 DAP (6.73 nymphs/plant) and at 60 DAP (5.10 nymphs/plant) were recorded in treatment T<sub>5</sub> and it was found at par with T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>. Further, the lowest thrips population at 75 DAP (5.97 nymphs/plant) and at 90 DAP (5.0 nymphs/plant) were recorded in treatment T<sub>3</sub> and it was found at par with T<sub>2</sub> at 75 DAP while at par with T<sub>2</sub>, T<sub>4</sub> and T<sub>5</sub> at 90 DAP. The highest stemphylium blight incidence (66.67%) and intensity (14.27%), as well as purple blotch incidence (36.67%) and intensity (4.40%) along with thrips population (118.10 nymphs/plant), were recorded in T<sub>7</sub> (Control-No clove treatment and no spray) at 90 DAP. The significantly highest gross yield (38.57 q/ha) as well as marketable yield (34.13 q/ha) was recorded in T<sub>3</sub> and the marketable yield was found at par with T<sub>5</sub>. The lowest gross yield (23.15 q/ha) and marketable yield (19.73 q/ha) were recorded in T<sub>7</sub> (Control-No clove treatment and no spray).

Table-1 Management of foliar diseases and thrips of garlic through clove treatment and spray with fungicides, insecticides and bio-agents during rabi, 2020-21

Treatments	Stemphylium blight							
	45 DAP				60 DAP			
	Incidence (%)		Intensity (%)		*Incidence (%)		Intensity (%)	
T1	0.00	(0.71)	0.00	(0.71)	33.33	(35.22)	3.47	(1.98)
T2	0.00	(0.71)	0.00	(0.71)	40.00	(39.23)	3.07	(1.89)
T3	0.00	(0.71)	0.00	(0.71)	26.67	(31.00)	1.73	(1.49)
T4	0.00	(0.71)	0.00	(0.71)	36.67	(37.22)	2.80	(1.81)
T5	0.00	(0.71)	0.00	(0.71)	30.00	(33.21)	2.40	(1.70)
T6	0.00	(0.71)	0.00	(0.71)	43.33	(41.15)	4.27	(2.17)
T7	0.00	(0.71)	0.00	(0.71)	43.33	(41.15)	4.67	(2.26)
<b>S.Em±</b>	-	-	-	-	-	<b>1.77</b>	-	<b>0.09</b>
<b>CD at 5%</b>	-	-	-	-	-	<b>3.86</b>	-	<b>0.20</b>
<b>CV %</b>	-	-	-	-	-	<b>5.87</b>	-	<b>5.98</b>

Treatments	Stemphylium blight							
	75 DAP				90 DAP			
	*Incidence (%)		Intensity (%)		*Incidence (%)		Intensity (%)	
T1	40.00	(39.15)	6.67	(2.67)	50.00	(45.00)	7.73	(2.86)
T2	46.67	(43.08)	9.47	(3.16)	56.67	(48.85)	10.67	(3.34)
T3	30.00	(33.21)	4.40	(2.21)	40.00	(39.23)	5.47	(2.44)
T4	43.33	(41.15)	8.40	(2.97)	53.33	(46.92)	9.60	(3.17)
T5	36.67	(37.22)	5.20	(2.38)	46.67	(43.08)	6.67	(2.67)
T6	53.33	(46.92)	11.33	(3.44)	60.00	(50.85)	12.80	(3.63)
T7	56.67	(48.85)	12.00	(3.53)	66.67	(54.78)	14.27	(3.84)
<b>S.Em±</b>	-	<b>2.12</b>	-	<b>0.15</b>	-	<b>2.84</b>	-	<b>0.22</b>
<b>CD at 5%</b>	-	<b>4.62</b>	-	<b>0.33</b>	-	<b>6.19</b>	-	<b>0.48</b>
<b>CV %</b>	-	<b>6.28</b>	-	<b>6.18</b>	-	<b>7.41</b>	-	<b>8.57</b>

Treatments	Purple blotch				Nymphs/plant	
	90 DAP				45 DAP	60 DAP
	*Incidence (%)		Intensity (%)			
T1	20.00	(26.57)	1.60	(1.44)	9.63	50.47
T2	23.33	(28.78)	1.87	(1.53)	7.77	6.33
T3	10.00	(15.00)	0.67	(1.05)	7.47	5.87
T4	23.33	(28.78)	1.60	(1.44)	7.17	7.63
T5	16.67	(23.86)	1.07	(1.25)	6.73	5.10
T6	30.00	(33.21)	3.73	(2.05)	8.13	67.77
T7	36.67	(37.22)	4.40	(2.21)	10.20	71.00
<b>S.Em±</b>	-	<b>4.58</b>	-	<b>0.14</b>	<b>1.31</b>	<b>2.44</b>
<b>CD at 5%</b>	-	<b>9.98</b>	-	<b>0.31</b>	<b>NS</b>	<b>5.32</b>
<b>CV %</b>	-	<b>20.28</b>	-	<b>11.10</b>	<b>19.70</b>	<b>9.77</b>

Treatments	Nymphs/plant		Gross yield (q/ha)	Marketable yield (q/ha)
	75 DAP	90 DAP		
T1	36.80	59.00	28.80	25.33
T2	6.83	5.70	26.87	23.20
T3	5.97	5.00	38.57	34.13
T4	33.30	12.00	27.29	23.54
T5	33.47	9.90	31.12	29.33
T6	89.30	105.67	25.15	21.95
T7	92.67	118.10	23.15	19.73
<b>S.Em±</b>	<b>1.33</b>	<b>4.56</b>	<b>2.84</b>	<b>3.04</b>
<b>CD at 5%</b>	<b>2.90</b>	<b>9.94</b>	<b>6.19</b>	<b>6.62</b>
<b>CV %</b>	<b>3.82</b>	<b>12.40</b>	<b>12.11</b>	<b>14.70</b>

Note- Data in the parenthesis shows \*arcsine/Square root transformed values

### Rabi- 2021-22

The data presented in Table-2 revealed that stemphylium blight and purple blotch disease was appeared after 60 and 90 days of planting respectively, while thrips was observed after 45 days of planting. The incidence of stemphylium blight ranged from 16.67% to 76.67% and intensity varied from 1.47% to 16.27% during the cropping period. The significantly lowest stemphylium blight incidence (16.67%) as well as intensity (1.47%) was recorded in treatment T<sub>5</sub> (Sprays of Lambdacyhalothrin @ 1.0 ml/L+ Propiconazole @ 2.0ml/L at 45 DAP, Neem oil @ 4.0 ml/L + *T. viride*@ 5.0 g/L at 60 DAP, Lambdacyhalothrin @ 1.0 ml/L+ Propiconazole @ 2.0ml/L at 75 DAP, Neem oil @ 4.0 ml/L + *T. viride*@ 5.0 g/L at 90 DAP) at 60 DAP.

The disease progresses as increasing the crop age. The significantly lowest incidence (40.0%) as well as intensity (6.53%), was recorded in treatment T<sub>3</sub> (Garlic clove treated with Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L (dip for 5 minutes), sprays of Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L, at 45 DAP, Fipronil @ 1.0 ml/L+Tricyclazole @ 1.5g/L at 60 DAP, Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L, at 75 DAP, Fipronil @ 1.0 ml/L+Tricyclazole @ 1.5g/L at 90 DAP) at 75 DAP and the incidence was found at par with T<sub>5</sub>. Further, data revealed that, the significantly lowest incidence (50.0%) as well as intensity (7.07%) was recorded in same treatment T<sub>3</sub> at 90 DAP. The purple blotch disease appeared at later stage with the lowest incidence (20.0%) as well as intensity (1.47%) was recorded in treatment T<sub>3</sub> at 90 DAP and incidence was found at par with T<sub>5</sub>. The lowest thrips population at 45 DAP (0.27 nymphs/plant) and at 60 DAP (0.80 nymphs/plant) were recorded in treatment T<sub>3</sub> and it was found at par with T<sub>2</sub> (Garlic clove treated with *T. viride* @ 5.0g/L (dip for 5 minutes), sprays of *T. viride* @ 5.0g/L + Carbosulphan @ 2.0ml/L at 45 DAP, Hexaconazole @ 2.0 ml/L+ Fipronil @ 1.0ml/L at 60 DAP, *T. viride* @ 5.0g/L + Carbosulphan @ 2.0ml/L at 75 DAP, Hexaconazole @ 2.0 ml/L+ Fipronil @ 1.0ml/L at 90 DAP) at 60 DAP. Further, the lowest thrips population at 75 DAP (0.47 nymphs/plant) was recorded in T<sub>2</sub> and it was found with T<sub>3</sub>. The lowest thrips population at 90 DAP (8.60 nymphs/plant) was recorded in treatment T<sub>3</sub> and it was found at par with T<sub>2</sub>, T<sub>4</sub>, and T<sub>5</sub> at 90 DAP. The highest stemphylium blight incidence (76.67%) and intensity (16.27%) as well as purple blotch incidence (46.67%) and intensity (5.20%) along with thrips population (135.63 nymphs/plant) were recorded in T<sub>7</sub> (Control-No clove treatment and no spray) at 90 DAP. The significantly highest gross yield (97.13 q/ha) as well as marketable yield (95.48 q/ha) was recorded in T<sub>3</sub> and it was found at par with T<sub>5</sub>. The lowest gross yield (71.29 q/ha) and marketable yield (67.81 q/ha) was recorded in T<sub>7</sub> (Control-No clove treatment and no spray).

**Table-2 Management of foliar diseases and thrips of garlic through clove treatment and spray with fungicides, insecticides and bio-agents during rabi, 2021-22**

Treatments	Stemphylium blight											
	60 DAP				75 DAP				90 DAP			
	*Incidence (%)		Intensity (%)		*Incidence (%)		Intensity (%)		*Incidence (%)		Intensity (%)	
T1	43.33	(41.15)	5.33	(2.41)	50.00	(45.00)	8.27	(2.95)	60.00	(50.85)	9.47	(3.15)
T2	36.67	(37.22)	5.07	(2.36)	56.67	(48.85)	11.07	(3.40)	66.67	(54.78)	12.53	(3.61)
T3	26.67	(31.00)	3.60	(2.01)	40.00	(39.23)	6.53	(2.65)	50.00	(45.00)	7.07	(2.75)
T4	26.67	(31.00)	2.40	(1.69)	53.33	(46.92)	10.00	(3.23)	63.33	(52.78)	11.33	(3.44)
T5	16.67	(23.86)	1.47	(1.39)	46.67	(43.08)	7.60	(2.84)	56.67	(48.85)	8.27	(2.95)
T6	33.33	(35.22)	4.67	(2.26)	63.33	(52.78)	13.20	(3.70)	70.00	(57.00)	14.40	(3.85)
T7	46.67	(43.08)	7.60	(2.83)	66.67	(54.78)	14.93	(3.93)	76.67	(61.22)	16.27	(4.09)
S.Em±	-	3.15	-	0.18	-	2.12	-	0.15	-	2.99	-	0.18
CD at 5%	-	6.86	-	0.39	-	4.62	-	0.33	-	6.51	-	0.39
CV %	-	11.13	-	10.48	-	5.50	-	5.79	-	6.92	-	6.58

Treatments	Purple blotch				Nymphs/plant				Gross yield (q/ha)	Marketable yield (q/ha)
	90 DAP				45 DAP	60 DAP	75 DAP	90 DAP		
	*Incidence (%)		Intensity (%)							
T1	30.00	(33.21)	2.27	(1.66)	0.47	8.03	5.07	63.73	79.07	75.73
T2	33.33	(35.22)	2.53	(1.74)	0.63	0.93	0.47	9.40	72.77	71.11
T3	20.00	(26.07)	1.47	(1.39)	0.27	0.80	0.60	8.60	97.13	95.48
T4	33.33	(35.22)	2.40	(1.70)	0.47	2.07	7.80	14.60	79.70	78.42
T5	26.67	(31.00)	1.87	(1.54)	0.73	6.50	9.03	10.80	95.18	93.24
T6	36.67	(37.22)	4.27	(2.17)	0.80	9.10	9.70	117.37	71.48	68.70
T7	46.67	(43.08)	5.20	(2.39)	0.83	10.90	11.07	135.63	71.29	67.87
S.Em±	-	3.17	-	0.14	0.06	0.37	0.44	3.75	2.92	3.46
CD at 5%	-	6.91	-	0.31	0.13	0.81	0.96	8.17	6.36	7.54
CV %	-	11.28	-	9.65	11.50	8.32	8.59	8.93	4.42	5.39

Note- Data in the parenthesis shows \*Arcsine/Square root transformed values

### Combined data (2020-21 & 2021-22)

The combined data of two year trial were presented in Table-3 revealed that stemphylium blight and purple blotch disease was appeared after 60 and 90 days of planting respectively, while thrips was observed after 45 days of planting. The incidence of stemphylium blight ranged from 23.33% to 71.67% and intensity varied from 1.93% to 15.27% during the cropping period. The significantly lowest stemphylium blight incidence (23.33%) as well as intensity (1.93%), was recorded in treatment T<sub>5</sub> at 60 DAP. The disease progresses as increasing the crop age. The significantly lowest incidence (35.0%) as well as intensity (5.47%) was recorded in treatment T<sub>3</sub> at 75 DAP and incidence was found at par with T<sub>5</sub>. Further, data revealed that, the significantly lowest incidence (45.0%) as well as intensity (6.27%) was recorded in same treatment T<sub>3</sub> at 90 DAP and the incidence was found at par with T<sub>5</sub>. The purple blotch disease appeared at later stage with the lowest incidence (15.0%) as well as intensity (1.07%) was recorded in treatment T<sub>3</sub> at 90 DAP and the incidence was found non-significant however, intensity at par with T<sub>5</sub>. The lowest thrips population at 45 DAP (3.73 nymphs/plant) was recorded in treatment T<sub>5</sub> and it was found non-significant. Further, the lowest thrips population at 60 DAP (3.33 nymphs/plant), 75 DAP (3.28 nymphs/plant) and at 90 DAP (6.80 nymphs/plant) were recorded in treatment T<sub>3</sub> and it was found at par with T<sub>2</sub>, T<sub>4</sub>, and T<sub>5</sub> at 60 DAP as well as 90 DAP while at par with T<sub>2</sub> at 75 DAP. The highest stemphylium blight incidence (71.67%) and intensity (15.27%) as well as purple blotch incidence (41.67%) and intensity (4.80%) along with thrips population (126.87 nymphs/plant), were recorded in T<sub>7</sub> (Control-No clove treatment and no spray) at 90 DAP. The significantly highest gross yield (67.85 q/ha) as well as marketable yield (64.80 q/ha), were recorded in T<sub>3</sub> and it was found at par with T<sub>5</sub>. The lowest gross yield (47.22 q/ha) and marketable yield (43.80 q/ha) was recorded in T<sub>7</sub> (Control-No clove treatment and no spray).

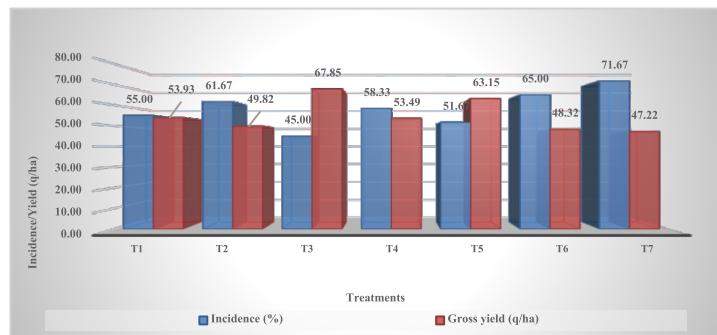
The highest benefit cost ratio (5.46:1) was also recorded in T<sub>3</sub>. Gupta et al. (2021) [7] reported that combined foliar spray of fungicides with insecticides is very effective against foliar diseases and thrips of onion. The results of present study in the accordance with the reports by Gupta and Sharma (2017) [5] soil application of *Ps.fluorescens* and foliar spray of Pyraclostrobin + Metiram was most effective for control of stemphylium blight in garlic. According to Agale, et al. (2014) [1] who reported the bio agent *Trichoderma viride* was effective against purple blotch with inhibition up to 56.15%. Pathak et al. (2020) [16] reported that the overall thrips population was controlled by about 72.94% in treated plot of onion with spray of spinosad@0.3 ml/L at 10 days intervals. The present study is in conformity with the result obtained by Pandey et al. (2014) [11] and Singh et al. (2011) [22] who reported that spinosad at 10 days intervals was effective for managing onion thrips. Similarly, Ullah et al. (2010) [26] reported that the insecticides thiodan, imidacloprid and spinosad were more effective against onion thrips as compared to control. Patil et al. (2009) [17] reported that spray of deltamethrin + triazophos and spinosad reduced the thrips population as well as increased yield. Seal et al. (2006), [21] Srinivas et al. (2007), [23] and Prasad and Ahmed, (2009) [18] also advocated that spinosad is an effective insecticide against thrips. This contradicts others' findings who had reported that alternative spray of bio-agents and combined fungicides for more effective in case of stemphylium blight and purple blotch as well as increased good quality of onion bulbs (Pandey et al. 2023a [12], b [13] and 2022 [14])

**Table-3 Management of foliar diseases and thrips of garlic through clove treatment and spray with fungicides, insecticides and bio-agents (Combined rabi, 2020-21 and 2021-22)**

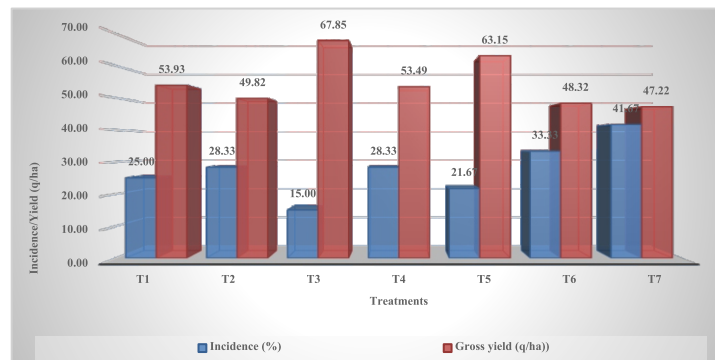
Treatments	Stemphylium blight					
	60 DAP		75 DAP		90 DAP	
	*Incidence (%)	Intensity (%)	*Incidence (%)	Intensity (%)	*Incidence (%)	Intensity (%)
T1	38.33 (38.19)	4.40 (2.20)	45.00 (42.07)	7.47 (2.81)	55.00 (47.93)	8.60 (3.01)
T2	38.33 (38.23)	4.07 (2.12)	51.67 (45.96)	10.27 (3.28)	61.67 (51.81)	11.60 (3.47)
T3	26.67 (31.00)	2.67 (1.75)	35.00 (36.22)	5.47 (2.43)	45.00 (42.12)	6.27 (2.59)
T4	31.67 (34.11)	2.60 (1.75)	48.33 (44.04)	9.20 (3.10)	58.33 (49.85)	10.47 (3.30)
T5	23.33 (28.53)	1.93 (1.55)	41.67 (40.15)	6.40 (2.61)	51.67 (45.96)	7.47 (2.81)
T6	38.33 (38.19)	4.47 (2.21)	58.33 (49.85)	12.27 (3.57)	65.00 (53.93)	13.60 (3.74)
T7	45.00 (42.12)	6.13 (2.55)	61.67 (51.81)	13.47 (3.73)	71.67 (58.00)	15.27 (3.97)
S.Em±	- 3.13	- 0.18	- 2.60	- 0.18	- 3.57	- 0.25
CD at 5%	- 7.66	- 0.44	- 6.36	- 0.44	- 8.74	- 0.61
CV %	- 8.74	- 8.79	- 5.87	- 5.98	- 7.15	- 7.57

Treatments	Purple blotch				Nymphs/plant				Gross yield (q/ha)	Market able yield (q/ha)	B:C ratio
	90 DAP				45 DAP	60 DAP	75 DAP	90 DAP			
	*Incidence (%)	Intensity (%)									
T1	25.00 (29.89)	1.93 (1.55)	5.05	29.25	20.93	61.37	53.93	50.53	1.78:1		
T2	28.33 (32.00)	2.20 (1.63)	4.20	3.63	3.65	7.55	49.82	47.15	1.74:1		
T3	15.00 (20.54)	1.07 (1.22)	3.87	3.33	3.28	6.80	67.85	64.80	5.46:1		
T4	28.33 (32.00)	2.00 (1.57)	3.82	4.85	20.55	13.30	53.49	50.98	1.62:1		
T5	21.67 (27.43)	1.47 (1.39)	3.73	5.80	21.25	10.35	63.15	61.28	5.13:1		
T6	33.33 (35.22)	4.00 (2.11)	4.47	38.43	49.50	111.52	48.32	45.33	2.14:1		
T7	41.67 (40.15)	4.80 (2.30)	5.52	40.95	51.87	126.87	47.22	43.80	-		
S.Em±	- 4.82	- 0.17	1.14	2.14	1.21	5.12	3.53	3.99	-		
CD at 5%	- NS	- 0.42	NS	5.24	2.96	12.53	8.64	9.76	-		
CV %	- 15.54	- 10.33	25.98	11.86	4.97	10.60	6.43	7.67	-		

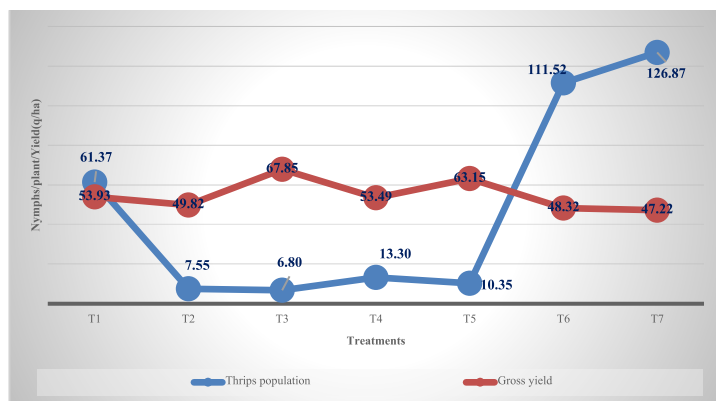
Note- Data in the parenthesis shows \*Arcsine/Square root transformed values



**Fig: 01: Stemphylium blight incidence (%) and gross yield in garlic combined 2020-21 & 2021-22**



**Fig: 02 Purple blotch incidence (%) and gross yield in garlic combined 2020-21 & 2021-22**



**Fig: 03 Thrips population (nymphs/plant) and gross yield in garlic combined 2020-21 & 2021-22**

## CONCLUSION

The combined data of two years trial conducted during *rabi*, 2020-21 and 2021-22 on garlic variety Agrifound White revealed that clove treated with Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L (dip for 5 minutes) followed by combined spray of Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L at 45 DAP, Fipronil @ 1.0 ml/L+Tricyclazole @ 1.5g/L at 60 DAP, Carbosulfan @ 2.0 ml/L+Carbendazim @ 1.0g/L, at 75 DAP and Fipronil @ 1.0 ml/L+Tricyclazole @ 1.5g/L at 90 days after planting performed superior for the management of foliar diseases with lowest intensity of stemphylium blight (6.27%) and purple blotch (1.07%) as well as lowest thrips population (6.80 nymphs/plant). The highest benefit- cost ratio (5.46:1) was also recorded in the same treatment.

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## Conflict of Interests

This research paper is for honestly reporting research results and useful for farmers, students and researcher of garlic crop.

## Future Scope of Study

More studies on new formulations of pesticides on controlling stemphylium blight, purple blotch and thrips should be done.

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