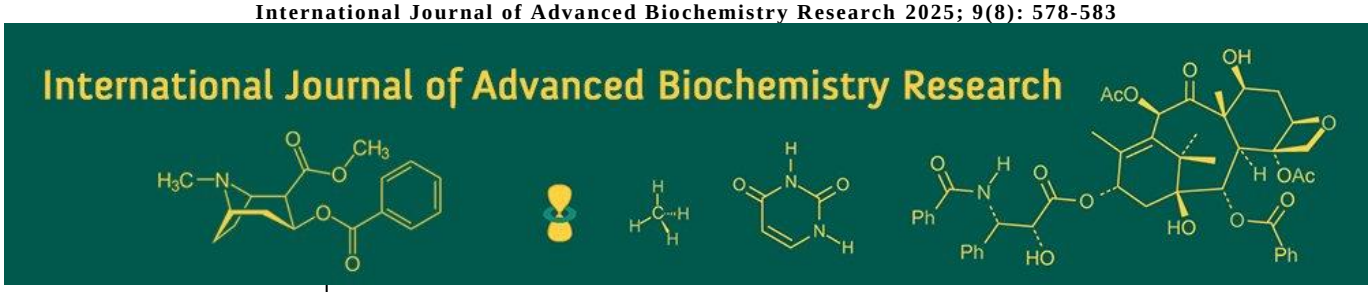

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Evaluation of betacyfluthrin 90 g/l + imidacloprid 210 g/l (Solomon 300 OD) against sucking pests of cumin (*Cuminum cyminum*)

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Abstract
The trial was conducted in the experimental area of the College of Horticulture, Mandsaur, during 2020-21 and 2021-22, using a Randomized Block Design with three replications and seven treatments. Three doses of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300, 400 and 500 ml/ha, Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC) @ 1800 ml/ha, Imidacloprid 200 SL (Imidacloprid 17.8% w/w SL) @ 525 ml/ha and Thiamethoxam 25.00% WG @ 100 gm/ha including untreated control were tested. Two sprays were made at 10-days intervals, and observations were recorded at pre-treatment and 3, 7 and 10 days after each application and the calculated percentage reduction over control (ROC) after the last observation of the last spray. In 2020-21, Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded minimum aphid population and showed significant difference with rest of the treatments with maximum% ROC (92.23%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (79.81%) and Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (74.97%), Imidacloprid 200 SL @ 525 ml/ha (73.88%) and Thiamethoxam 25.00% WG @ 100 gm/ha (69.68%). Similar findings were recorded during second season (2021-22), where Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha again recorded significant minimum aphid population and maximum% ROC (92.57%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (78.62%) and Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (74.97%). First year (2020-21) Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha again recorded minimum thrips population and maximum% ROC (85.80%) and found to be at par with Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (78.17%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (71.61%). Similar trend of efficacy was recorded during the second season, where Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded the minimum thrips population and maximum% ROC (85.53%) and did not differ significantly from Beta-cyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (75.89%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (72.95%). Treatments Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded the highest fruit yield of cumin among various treatments during both the season (2020-21 & 2021-22).

Keywords: Cumin, sucking pests, thrips, aphid, insecticides

1. Introduction
Cumin (*Cuminum cyminum* L.), an important spice crop, is mostly cultivated in the arid regions of Gujarat and Rajasthan states of India with a combined production of 90% of the country's cumin. It is also known as ‘Zeera’ that belongs to Apiaceae family is an important seed spice crop. Cumin is extensively used in the cuisines, antioxidants and therapeutics (Bettaieb *et al.* 2011, Nadeem and Riaz 2012) [3, 11]. India is the world's largest producer of cumin, accounting for roughly 70% of global production, occupied an area of 9.37 lakh hectares with an annual production of 5.77 lakh tonnes in 2022-23 (Anonymous, 2023) [2].
In India, cumin is infested by many insect pests *viz*., aphids, *Myzus persicae* (Sulzer) and *Aphis gossypii* (Glover); thrips, *Thrips tabaci* (Lindeman); leaf hopper, *Empoasca* spp.; whitefly, *Bemisia tabaci* (Gennadius); seed borer, *Hellula undalis* (Fabricius); seed bug, *Nysius* spp. and gram pod borer, *Heliothis armigera* (Hubner) (Meena *et al.*, 2018) [10]. Among them, aphid, *Aphis gossypii* is the major insect pest of cumin in Rajasthan (Yadav *et al.*, 2018) [14]. Its population increases very rapidly under favorable weather conditions. In unprotected crop, loss due to aphid infestation could be more than 50% of total yield

(Lal *et al.*, 2014) [9]. Thrips cause considerable damage and the yield is affected quantitatively and qualitatively which produce significant harm (Patel *et. al.*, 2013) [12].

Lonely dependence on synthetic chemicals for the management of aphid and thrips is very well known but the increasing resistance against various insecticides created challenges to manage these pests. In present scenario, ready mix insecticides are in trend due to separate mode of action of each insecticide.

Keeping this in view, to overcome lacunae and to develop an effective pest management strategy, the present experiments was carried out to study the Efficacy of various doses of ready mix insecticide betacyfluthrin 90 g/l + imidacloprid 210 g/l against sucking pests of cumin (*cuminum cyminum*) as beta-cyfluthrin, is a synthetic pyrethroid insecticide provides rapid knockdown and contact activity while imidacloprid, is a neonicotinoid pesticide that interferes with nerve signal transmission.

2. Materials and Methods

The trial was conducted in experimental area of college of Horticulture, Mandsaur during 2020-21 and 2021-22 in Randomized Block Design with three replication and seven treatments. Cumin variety GC-4 was sown on 19.11.20 during first season and on 26.11.21 during second season in 4x4 M plots with 30x20 spacing under specified crop geometry (30 x 20 cm row to row and plant to plant spacing) followed all recommended good agricultural practices. Three doses of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300, 400 and 500 ml/ha, Betacyfluthrin 25 SC (Betacyfluthrin 2.45% w/w SC) @ 1800 ml/ha, Imidacloprid 200 SL (Imidacloprid 17.8% w/w SL) @ 525 ml/ha and Thiamethoxam 25.00% WG @ 100 gm/ha including untreated control were tested. First spray of insecticides was made at ETL of pest and second spray was given after 10 days. The population of aphid and thrips were counted on 5 randomly tagged plants per plot and top 10 cm part of each plant as per standard methodology at Pre Treatment and 3, 7 and 10 days after each application and per cent reduction over control (ROC) was calculated after last observation of last spray. Cumin yield at harvest for each treatment was expressed in q/ha and statistically analyzed. The per cent reduction in the population was determined using the Henderson and Tilton (1955) [8] equation referring it to be modification of Abbott (1925) [1]:

$$\text{Percent reduction in pest population} = 1-\frac{Ta\ x\ Cb}{Tb\ x\ Ca}\ x\ 100$$

Where,

T_a = Number of insects after treatment;

T_b = Number of insects before treatment

C_a = Number of insects in untreated check after treatment

C_b = Number of insects in untreated check before treatment

The per cent data thus obtained were subjected to analyses after transforming them into angular transformed values (Gomez and Gomez, 1976).

3. Results and Discussion

3.1 Bio-efficacy against Aphid (*Myzus persicae*): (Table 1 & 2 and Fig. 1)

During first season (2020-21) it was revealed that all the insecticidal treatments (table 1) reduced aphid population significantly as compared to untreated control. Among different treatments, Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded minimum aphid population and showed significant difference with rest of the treatments with maximum% ROC (92.23%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (79.81%) and Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (74.97%), Imidacloprid 200 SL @ 525 ml/ha (73.88%) and Thiamethoxam 25.00% WG @ 100 gm/ha (69.68%). Betacyfluthrin 25 SC @ 1800 ml/ha showed least population reduction (64.65%).

Similar findings were recorded during second season (2021-22), where Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha again recorded significant minimum aphid population and maximum% ROC (92.57%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (78.62%) and Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (72.47%). Rest of the treatments exhibited comparatively poor population reduction after last observation of second spray. The lowest population reduction was recorded in Betacyfluthrin 25 SC @ 1800 ml/ha (64.29%).

Chandi (2020) [4] reported significantly lowest population of wheat aphids per ear head in solomon 300 OD (Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD) @ 200, 300 and 400 ml/ha, being at par with each other and standard check thiamethoxam 25 WDG @ 50 ml/ha and imidacloprid 17.8SL @ 405 ml/ha followed by betacyfluthrin 25 SC @ 1450 ml/ha. Dangi *et al.* (2017) [6] noted poor performance of thiamethoxam 25% WG at 25 g a.i. ha-1, imidacloprid 17.8 SL at 25 g a.i. ha-1 against aphid (*Myzus persicae*) in cumin which is similar to the present study. Choudhary *et al.* (2024) [5] observed highest efficacy of imidachloprid 17.8 SL against cumin aphid, *Myzus persicae* (Sulzer) in yield as well as in the economics. These findings are in partial agreement with the present study. Patel *et al.* (2013) [12] also recorded comparatively lower efficacy of imidacloprid 17.8SL @ 25g a.i./ha and thiamethoxam 25WG @ 25g a.i./ha against cumin aphids.

3.2 Bio-efficacy against Thrips (*Thrips tabaci*): (Table 3 & 4 and Fig. 2)

All the insecticidal treatments reduced thrips population by significant level as compared to untreated control during both the seasons. First year resulted exhibited (table 3) that among the different treatments, Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded minimum thrips population and maximum% ROC (85.80%) and found to be at par with Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (78.17%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (71.61%). Rest of the treatments exhibited less than 70% population reduction after last observation of second spray. Betacyfluthrin 25 SC @ 1800 ml/ha showed least population reduction (53.81%).

Similar trend of results were recorded during second season (table 4), where Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded minimum thrips population and maximum% ROC (85.53%) and not differed significantly with Beta-cyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (75.89%) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ha (72.95%). Rest of the treatments exhibited comparatively poor population reduction after last observation of second spray. Betacyfluthrin @ 1800 ml/ha exhibited least population reduction (48.42%).

Patel *et al.* (2013) [12] noted poor efficacy of imidacloprid 17.8SL @ 25g a.i./ha and thiamethoxam 25WG @ 25g a.i./ha against thrips in cumin. Zote *et al.* (2018) [15] reported that Solomon 300 OD (Betacyfluthrin 90% + Imidacloprid 210%) 1.5ml/10 lit found most effective for management of cashew thrips. These findings are in partial agreement with the present investigation as Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ is not tested widely in other crops.

3.3 Yield

Maximum cumin yield was recorded from Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD (Solomon 300 OD) @ 500 ml/ha (10.60 q/ha in 2020-21 and 11.40 q/ha in 2021-22) followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha (9.67 q/ha in 2020-21 and 9.77 q/ha in 2021-22). All the other treatments were also found superior over untreated control (Table: 5 & Fig. 3).

Little support was observed by Patel (2018) [13] and Yadav (2018) [14] as they tested the product on wheat and stated that Solomon 300 OD @ 400 ml/ha was found to superior for higher grain yield of wheat. Chandi (2020) [4] reported among all the treatment, significantly higher yield was obtained in solomon 300 OD @ 200, 300 and 400 ml/ha (43.28, 43.62 and 43.77 q/ha) and was at par with thiamethoxam 25 WDG @ 50 g/ha (43.13 q/ha) and imidacloprid 17.8 SL @ 405 ml/ha (43.02 q/ha).

Table 1: Bio-efficacy of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD against aphids, *Myzus persicae* on Cumin during Rabi 2020-2021.

Sl. No.	Treatments	Dosage (ml/gm/ha)	*Myzus persicae*							
			First Spray				Second Spray			
			1DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	% ROC
T_1	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	300	21.40 (4.68)	10.53 (3.32)	9.97 (3.24)	11.23 (3.43)	7.60 (2.85)	7.80 (2.88)	9.13 (3.10)	74.97
T_2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	400	21.57 (4.70)	7.80 (2.88)	7.23 (2.78)	8.07 (2.93)	5.20 (2.39)	5.33 (2.42)	7.37 (2.80)	79.81
T_3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	500	21.90 (4.73)	5.50 (2.45)	4.17 (2.16)	5.20 (2.39)	1.20 (1.30)	1.47 (1.40)	2.83 (1.83)	92.23
T_4	Betacyfluthrin 25 SC	1800	21.37 (4.68)	10.00 (3.24)	10.27 (3.28)	14.63 (3.89)	10.17 (3.27)	11.00 (3.39)	12.90 (3.66)	64.65
T_5	Imidacloprid 200 SL	525	20.43 (4.58)	10.53 (3.32)	9.43 (3.15)	12.00 (3.54)	8.63 (3.02)	9.20 (3.11)	9.53 (3.17)	73.88
T_6	Thiamethoxam 25.00% WG	100	20.0 (4.54)	9.90 (3.22)	9.27 (3.13)	11.93 (3.53)	9.50 (3.16)	10.10 (3.26)	11.07 (3.40)	69.68
T_7	Untreated check	-	21.50 (4.69)	24.97 (5.05)	28.37 (5.37)	29.83 (5.51)	33.20 (5.81)	34.67 (5.93)	36.50 (6.08)	-
SE.m% (±)			NS	0.10	0.17	0.22	0.21	0.23	0.20	
CD at 5% (P = 0.05)			NS	0.30	0.55	0.71	0.66	0.74	0.64	

*Figures in parentheses are square root transformed values

Table 2: Bio-efficacy of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD against aphids, *Myzus persicae* on Cumin during Rabi 2021-2022.

Sl. No.	Treatments	Dosage (ml/gm/ha)	*Myzus persicae*							
			First Spray				Second Spray			
			1DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	% ROC
T_1	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	300	23.07 (4.85)	11.57 (3.47)	11.43 (3.45)	12.80 (3.65)	7.70 (2.86)	9.93 (3.43)	12.10 (3.35)	72.47
T_2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	400	24.07 (4.96)	8.43 (2.99)	8.13 (2.94)	9.60 (3.18)	5.33 (2.42)	6.50 (2.65)	9.40 (3.15)	78.62
T_3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	500	23.57 (4.91)	5.70 (2.49)	5.17 (2.38)	5.83 (2.52)	2.00 (1.58)	2.33 (1.68)	3.27 (1.94)	92.57
T_4	Betacyfluthrin 25 SC	1800	24.07 (4.96)	11.87 (3.52)	12.17 (3.56)	16.90 (4.17)	11.43 (3.45)	13.30 (3.71)	15.70 (4.02)	64.29
T_5	Imidacloprid 200 SL	525	23.63 (4.92)	10.67 (3.34)	10.33 (3.29)	12.47 (3.60)	9.23 (3.12)	10.83 (3.37)	11.73 (3.50)	73.31
T_6	Thiamethoxam 25.00% WG	100	23.17 (4.86)	11.27 (3.45)	10.00 (3.24)	12.70 (3.63)	9.67 (3.19)	11.13 (3.41)	12.33 (3.58)	71.94
T_7	Untreated check	-	22.93 (4.84)	28.21 (5.36)	32.63 (5.76)	33.97 (5.87)	36.37 (6.07)	40.67 (6.42)	43.97 (6.67)	-
SE.m% (±)			NS	0.12	0.16	0.18	0.27	0.25	0.29	
CD at 5% (P = 0.05)			NS	0.39	0.52	0.57	0.87	0.81	0.93	

*Figures in parentheses are square root transformed values

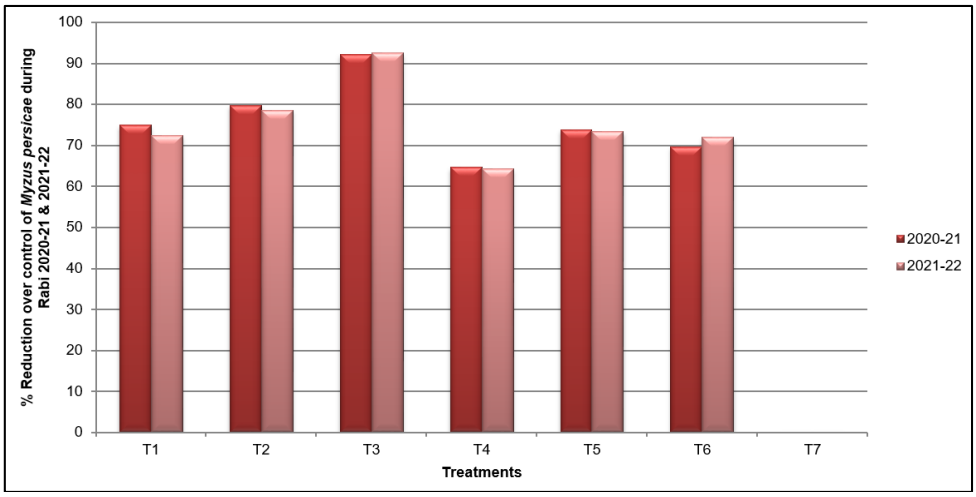

Fig 1: % Reduction over control (% ROC) of various treatment of aphids, *Myzus persicae* on Cumin during Rabi 2020-2021 & 2021-22.

Table 3: Bio-efficacy of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD against thrips, *Thrips tabaci* on Cumin during Rabi 2020-2021.

Sl. No.	Treatments	Dosage (ml/gm/ha)	*Thrips tabaci*							
			First Spray				Second Spray			
			1DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	% ROC
T_1	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	300	10.03 (3.25)	3.50 (2.00)	3.77 (2.02)	5.43 (2.44)	3.47 (1.99)	3.87 (2.09)	4.47 (2.23)	71.61
T_2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	400	10.20 (3.27)	2.57 (1.75)	2.93 (1.85)	4.13 (2.15)	2.87 (1.83)	3.10 (1.90)	3.43 (1.98)	78.17
T_3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	500	10.07 (3.25)	2.13 (1.62)	2.23 (1.65)	3.03 (1.88)	1.67 (1.47)	1.97 (1.57)	2.23 (1.65)	85.80
T_4	Betacyfluthrin 25 SC	1800	9.17 (3.11)	5.47 (2.44)	6.33 (2.61)	7.13 (2.86)	5.93 (2.54)	6.47 (2.64)	7.27 (2.79)	53.81
T_5	Imidacloprid 200 SL	525	9.73 (3.20)	4.57 (2.25)	5.13 (2.37)	5.93 (2.54)	4.50 (2.24)	4.57 (2.25)	5.70 (2.49)	63.77
T_6	Thiamethoxam 25.00% WG	100	9.53 (3.17)	4.80 (2.30)	5.50 (2.45)	6.17 (2.58)	4.93 (2.33)	5.07 (2.36)	6.13 (2.58)	61.01
T_7	Untreated check	-	9.43 (3.15)	10.97 (3.39)	12.73 (3.64)	14.13 (3.83)	14.67 (3.89)	15.17 (3.96)	15.73 (4.03)	-
SE.m% (±)			NS	0.11	0.13	0.18	0.12	0.14	0.19	
CD at 5% (P = 0.05)			NS	0.35	0.40	0.56	0.37	0.46	0.58	

*Figures in parentheses are square root transformed values

Table 4: Bio-efficacy of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD against thrips, *Thrips tabaci* on Cumin during Rabi 2021-2022.

Sl. No.	Treatments	Dosage (ml/gm/ha)	*Thrips tabaci*							
			First Spray				Second Spray			
			1DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	% ROC
T_1	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	300	10.33 (3.29)	3.83 (2.08)	3.87 (2.02)	5.57 (2.46)	3.67 (2.04)	3.97 (2.11)	4.30 (2.19)	72.95
T_2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	400	10.77 (3.36)	2.97 (1.86)	3.03 (1.88)	4.17 (2.16)	2.93 (1.85)	3.07 (1.89)	3.83 (2.08)	75.89
T_3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	500	10.33 (3.29)	2.40 (1.70)	2.43 (1.71)	3.03 (1.88)	1.73 (1.49)	1.97 (1.57)	2.30 (1.67)	85.53
T_4	Betacyfluthrin 25 SC	1800	10.57 (3.33)	6.27 (2.60)	6.43 (2.63)	7.50 (2.83)	6.03 (2.56)	6.70 (2.68)	8.20 (2.95)	48.42
T_5	Imidacloprid 200 SL	525	10.46 (3.31)	5.37 (2.42)	5.40 (2.43)	5.87 (2.52)	4.27 (2.18)	4.57 (2.25)	5.43 (2.44)	65.82
T_6	Thiamethoxam 25.00% WG	100	10.65 (3.34)	5.77 (2.50)	5.80 (2.51)	6.23 (2.59)	4.60 (2.26)	5.07 (2.36)	6.00 (2.55)	62.26
T_7	Untreated check	-	10.10 (3.26)	12.53 (3.61)	12.93 (3.67)	14.00 (3.81)	14.80 (3.91)	15.27 (3.97)	15.90 (4.05)	-
SE.m% (±)			NS	0.11	0.10	0.15	0.14	0.15	0.11	
CD at 5% (P = 0.05)			NS	0.24	0.33	0.50	0.46	0.48	0.34	

*Figures in parentheses are square root transformed values

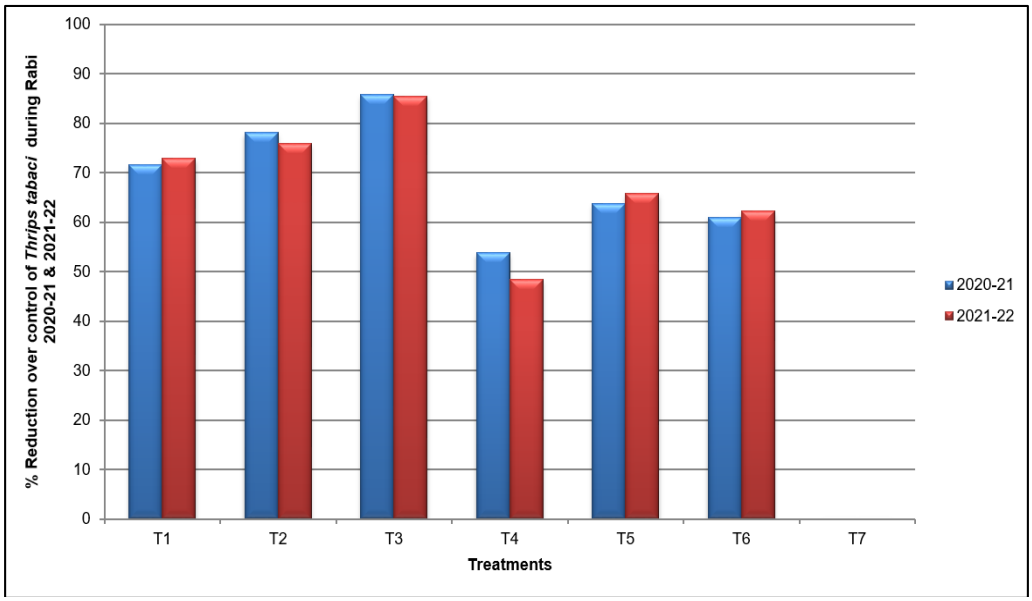

Fig 2:% Reduction over control (% ROC) of various treatment of thrips, *Thrips tabaci* on Cumin during Rabi 2020-2021 & 2021-22.

Table 5: Effects of Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD on Yield of Cumin during Rabi 2020-21 & 2021-2022.

Sl. No.	Treatments	Dosage (ml/gm/ha)	2020-21	2021-22
			Q/ha	Q/ha
T_1	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	300	8.83	8.90
T_2	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	400	9.67	9.77
T_3	Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD	500	10.60	11.40
T_4	Betacyfluthrin 25 SC	1800	8.03	7.93
T_5	Imidacloprid 200 SL	525	9.60	9.87
T_6	Thiamethoxam 25.00% WG	100	9.63	9.83
T_7	Untreated check	-	6.50	5.73
SE.m% (±)			0.26	0.19
CD at 5%			0.83	0.59

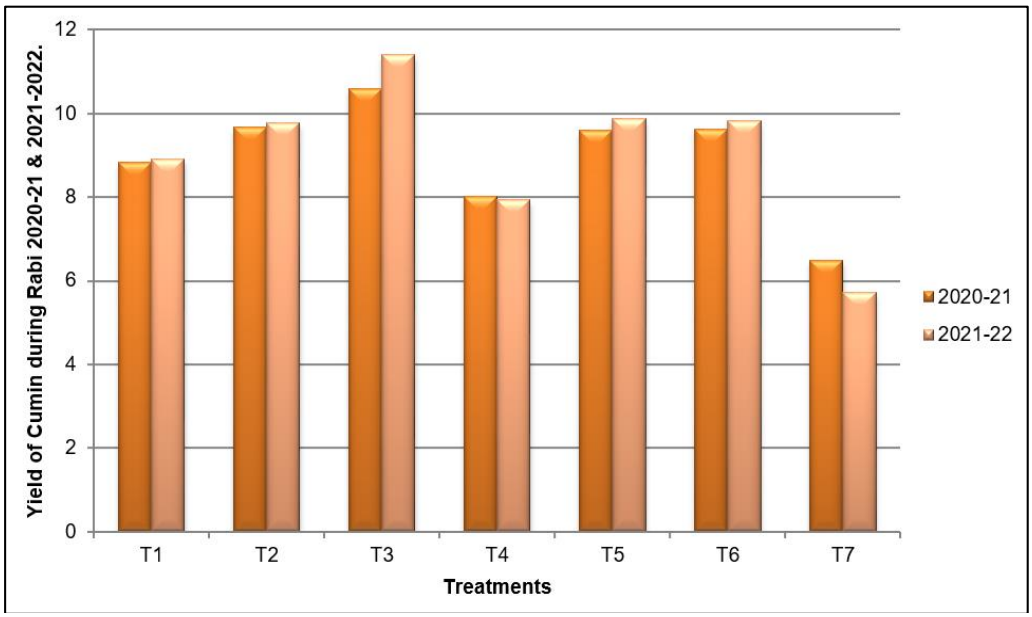

Fig 3: Yield of Cumin among various treatments during Rabi 2020-21 & 2021-2022.

4. Conclusion

Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 500 ml/ha recorded minimum aphid and thrips population with highest reduction over control and showed significant difference with rest of the treatments followed by Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 400 ml/ha and Betacyfluthrin 90 g/L + Imidacloprid 210 g/L OD @ 300 ml/ on Cumin. Higher yield was also recorded from same treatment because of better management of both the devastating pests.

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