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Integrated approach for management of downy mildew in ridge gourd caused by *Pseudoperonospora cubensis*

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Abstract

The study was conducted in field during *kharif* 2023-24 at Chilli and Vegetable Research Unit, Dr. PDKV., Akola (MH) to develop an effective integrated approach against downy mildew of ridge gourd. In this study three sprays of six fungicides and six botanicals were used. The minimum disease intensity (12.16%) and maximum yield (75.45 q/ha) were observed in plants sprayed with Metalaxyl 4% + Mancozeb 64% WP, followed by Fosetyl Al – 80% WP (12.86% and 73.16 q/ha), Azoxystrobin 23% SC (14.61% and 72.14 q/ha), Cymoxanil 8% + Mancozeb 64% WP (14.73% and 71.63 q/ha), Metiram 55% + Pyclostrobin 5% WG (19.23% and 65.32 q/ha) and Chlorothalonil 75% WP (28.88% and 62.43 q/ha). Similar trend was observed in second and third spray. Among the botanicals least disease intensity (36.71%) and highest yield (56.36 q/ha) were observed in garlic clove extract, followed by Nilgiri (37.74% and 55.38 q/ha), Neem (40.62% and 54.45 q/ha), Onion pulp extract (44.26% and 50.22 q/ha), Pongamia (45.29% and 46.80 q/ha) and Tulsi (47.49% and 43.76 q/ha).

Keywords: Ridge gourd, downy mildew, percent disease control, fungicides, plant extracts

1. Introduction

Ridge gourd (*Luffa acutangula* L. Roxb.) is one of the most popular and favorite vegetable crop in different parts of the world. Where these crops exhibit robust growth and adaptability, thriving even in conditions of drought or higher temperatures. The fruit of ridge gourd are characterized by their ribbed structure and significant nutritive value. The fruit is a good source of Protein (0.5%), Carbohydrates (3.4%), Carotene (37 mg), Vitamin-A (410 IU), Vitamin-C (12 mg), Thiamin (0.050 mg), Riboflavin (0.060 mg) and Niacin (0.400 mg) present. Minerals (Calcium, Iron, Magnesium and Phosphorus) are also present in Ridge gourd. Ridge gourd is widely cultivated across India, both commercially and in kitchen gardens. The area of ridge gourd cultivation in India is about 24,500 acres and production of around 316,925 tonnes.

Ridge gourd, like other cucurbits, is susceptible to a wide array of fungal, bacterial and viral diseases. Among these diseases, the downy mildew of cucumber caused by *Pseudoperonospora cubensis* is one of the most economically important and widespread plant pathogens in many regions of the world (Lebeda and Cohen, 2011) [8]. The presence of downy mildew in cucurbits was first documented in 1868 in Cuba and over the past 146 years, it has remained a persistent and serious threat to ridge gourd crop (Butler, 1918) [4]. Downy mildew poses significant challenges for ridge gourd cultivation, often resulting in substantial yield losses. The severity of these losses can vary considerably depending on factors such as the stage of infection, genetic characteristics of the plants and prevailing environmental conditions. The pathogen responsible for downy mildew is an obligate parasite (Salcedo *et al.* 2022) [11].

While research on downy mildew exists for other cucurbitaceous vegetables, several aspects of its impact on ridge gourd remain unclear and require urgent investigation. The incidence and severity of downy mildew disease ranged from 50 to 100% and 20 to 78%, respectively (Sharma *et al.*, 2003) [13]. Considering the importance of ridge gourd in the current cucurbitaceous crop scenario of our country and the potential losses caused by Downy

mildew to ridge gourd in all crop-growing areas including Vidarbha, therefore, the present investigation was undertaken.

2. Materials and Methods

2.1 Experiment site

The field experiments was undertaken in the field of Chilli and Vegetable Research Unit, Dr. PDKV, Akola during Kharif season of 2023-24. It lies between North latitudes 20°16' and 21° 17' and; East longitudes 76° 38' and 77° 38'.

2.2 Layout and plan

The field experiments was conducted in Randomized Block Design with three replication and seven treatments of fungicides and plant extracts for disease management studies. A ridge gourd variety "Mahyco Surekha" was sown in kharif with three replication for integrated management of downy mildew on ridge gourd through fungicides and plant extracts.

2.3 In vivo evaluation of fungicides against downy mildew of ridge gourd

Fungicides namely, Ridomil of 0.2 percent were prepared by dissolving 2 g of Ridomil in 100 ml of water and then making up the volume to 1000 ml. Curzate M-8 of 0.2 percent was prepared by dissolving 2 g of curzate in 100 ml of water and then making up the volume to 1000 ml. Chlorothalonil (Kavach) of 0.2 percent was prepared by dissolving 2 g of Chlorothalonil in 100 ml of water and then making up the volume to 1000 ml. Cabrio Top of 0.2 percent was prepared by dissolving 2 g of Cabrio top in 100 ml of water and then making the volume up to 1000 ml. Fosetyl-Al (Aliette) of 0.1 percent was prepared by dissolving 1 g of Fosetyl-Al in 100 ml of water and making up the volume to 1000 ml. For Azoxystrobin (Amistar 23% SC) of 0.1 percent, 1 ml of it was dissolved in 100 ml water

and made up to 1000 ml. Control plots were sprayed with the same volume of water.

2.4 In vivo evaluation of plant extracts against downy mildew of ridge gourd

Fresh botanicals viz., Neem, Garlic, Pongamia, Tulsi, Onion pulp and Eucalyptus leaves free from damage or disease were collected from the plant. The leaves (10 g) of each species were rinsed in tap water for 3-4 times, juice was extracted in a blender by adding 100 ml of water and the contents were sieved through a muslin cloth to get the clear extract. The volume was made up to 100 ml with distilled water to obtain ten percent concentration. The extract was centrifuged for five minutes at 3000 rpm to get clear plant extract. This supernatant extract was used for spray. Control plots were sprayed with the same volume of water.

2.5 Disease rating scales used against all fungicidal treatments

Disease rating scales used from 0-5 scale for recording disease intensity of downy mildew.

Disease rating scales used from 0-5 scale for recording disease intensity of downy mildew

Grade	Percent Disease Index
0	No Infection
1	0-10% leaf area covered with downy mildew growth
3	10.1-15% leaf area covered with downy mildew growth
3	15.1-25% leaf area covered with downy mildew growth
4	25.1-50% leaf area covered with downy mildew growth
5	More than 50% leaf area covered with downy mildew growth

2.6 Percent Disease Index (%)

Further, these scales will be converted to the percent diseases index using the formula given by Wheeler (1969) [15]

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of numerical ratings}}{\text{Total No of samples observed} \times \text{Max. rating scale}} \times 100$$

2.7 Percent disease control (PDC)

The percent disease control was calculated by using the formula given below:

$$\text{PDC (\%)} = \frac{\text{PDI in Control} - \text{PDI in Treatment}}{\text{PDI in Control}} \times 100$$

Were,

PDC = Percent disease control

C = PDI in the control treatment plot

T = PDI in treatment plot

2.8 Yield

At the time of harvest, the fruits from all treatments and replications were collected separately and the fruit weight of each replication was recorded.

3. Results and Discussion

3.1 In vivo evaluation of fungicides against downy mildew of ridge gourd

The result obtained after first spray revealed, that all the treatments were significantly effective over untreated

control. Metalaxyl 8% + Mancozeb 64% WP @ 0.2% was found significantly superior with the least disease intensity (8.41%), this was followed by Fosetyl-Al 80% WP @ 0.1% (10.14%) and Azoxystrobin 23% SC @ 0.1% (12.08%). which was at par with Cymoxanil 8% + Mancozeb 64% WP @ 0.2% (12.26%), Metiram 55% + Pyraclostrobin 5% WG @ 0.2% (14.27%) and Chlorothalonil 75% WP @ 0.2% (15.99%) (Table 1).

After the second spray similar trend was observed and the Metalaxyl 8% + Mancozeb 64% WP @ 0.2% was found significantly superior with the minimum disease intensity (12.44%), which was at par with Fosetyl-Al 80% WP @ 0.1%, Azoxystrobin 23% SC @ 0.1% and Cymoxanil 8% + Mancozeb 64% WP @ 0.2% with disease intensity 12.78%, 13.47% and 14.71% respectively. The rest of the fungicides viz., Metiram 55% + Pyraclostrobin 5% WG and Chlorothalonil 75% WP, were found least effective with 16.21% and 26.28% disease intensity, respectively (Table 1).

After the third spray, Metalaxyl 8% + Mancozeb 64% WP @ 0.2% was found significantly superior with least disease intensity (15.62%), which was at par with Fosetyl-Al 80% WP @ 0.1%, Azoxystrobin 23% SC @ 0.1% and

Cymoxanil 8% + Mancozeb 64% WP @ 0.2% with disease intensity of 15.66%, 17.04% and 18.47% respectively. This was followed by Metiram 55% + Pyraclostrobin 5% WG @

0.2% (27.21%) and Chlorothalonil 75% WP @ 0.2% (44.36%) (Table 1).

Table 1: Efficacy of fungicides against downy mildew of ridge gourd

Tr. No	Treatment details	Conc. (%)	PDI before spray	PDI after spray			Mean	PDC
				I	II	III		
T ₁	Metalaxyl 8% + Mancozeb 64% WP	0.2	5.91 (2.43)*	8.41 (2.90)	12.44 (20.53)	15.62 (23.24)	12.16	75.75
T ₂	Cymoxanil 8% + Mancozeb 64% WP	0.2	5.75 (2.40)	12.26 (3.49)	14.71 (22.53)	18.47 (25.41)	14.73	70.35
T ₃	Metiram 55% + Pyraclostrobin 5% WG	0.2	5.51 (2.35)	14.27 (3.77)	16.21 (23.74)	27.21 (31.43)	19.23	61.66
T ₄	Fosetyl-AL 80% WP	0.1	5.87 (2.42)	10.14 (3.17)	12.78 (20.93)	15.66 (23.24)	12.86	74.36
T ₅	Azoxystrobin 23% SC	0.1	5.41 (2.33)	12.08 (3.47)	13.47 (21.54)	17.04 (24.30)	14.61	70.87
T ₆	Chlorothalonil 75% WP	0.2	5.72 (2.39)	15.99 (4.00)	26.28 (30.83)	44.36 (41.76)	28.88	42.41
T ₇	Control	-	6.11 (2.47)	21.36 (4.71)	46.07 (42.75)	83.01 (65.68)	50.15	-
F test			NS	Sig	Sig	Sig		
S.E (m) $\pm$				0.13	0.64	1.27		
C.D at 5%				0.39	1.98	3.91		

*Figures in parenthesis are angular transformed value

These results support the findings of Sharma *et al.* (2003) [13] who reported that among eight fungicides tested against *Pseudoperonospora cubensis* under *in vitro* conditions, Ridomil-MZ proved most effective at all concentrations. Sharma *et al.* (2003) [13] who founded Ridomil MZ as most effective at all concentrations and reduced sporangia production by 87.2 percent.

Gupta *et al.* (1993) [7], Reddy *et al.* (2012) [12] was evaluated the efficacy of nine fungicides against downy mildew of gherkin out of these Sectin (Fenamidone + Mancozeb) was found very effective in reducing disease severity followed by Ridomil (Metalaxyl + Mancozeb) and Amistar (Azoxystrobin). Chaudhari *et al.* (2008) [16] conducted a field experiment to evaluate the performance of different fungicides against downy mildew on ridge gourd. In this study minimum disease incidence was recorded by spraying Success (9%), Ridomil (9%) and Alliet (11%) compared

with control (78%). Devappa *et al.* (2006) [17] recorded Curzate M-8 @ 8 g/l significantly, lower percent disease index (13.48%) which was on par with Ridomil MZ @ 3 g/l recorded PDI (15.45%) and highest percent disease index (47.60%) were found in untreated control.

3.2 Percent disease control (PDC)

Among all the treatments, percent disease reduction over control (PDC) was highest in the spraying of Metalaxyl 8% + Mancozeb 64% WP (75.75%) which was at par with Fosetyl AL-80% WP (74.36%). This was followed by Azoxystrobin 23% SC (70.87%), which was at par with Cymoxanil 8% + Mancozeb 64% WP (70.35%) and Metiram 55% + Pyraclostrobin 5% WG (61.66%). The lowest percent disease control was observed in Chlorothalonil 75% WP (42.41%).

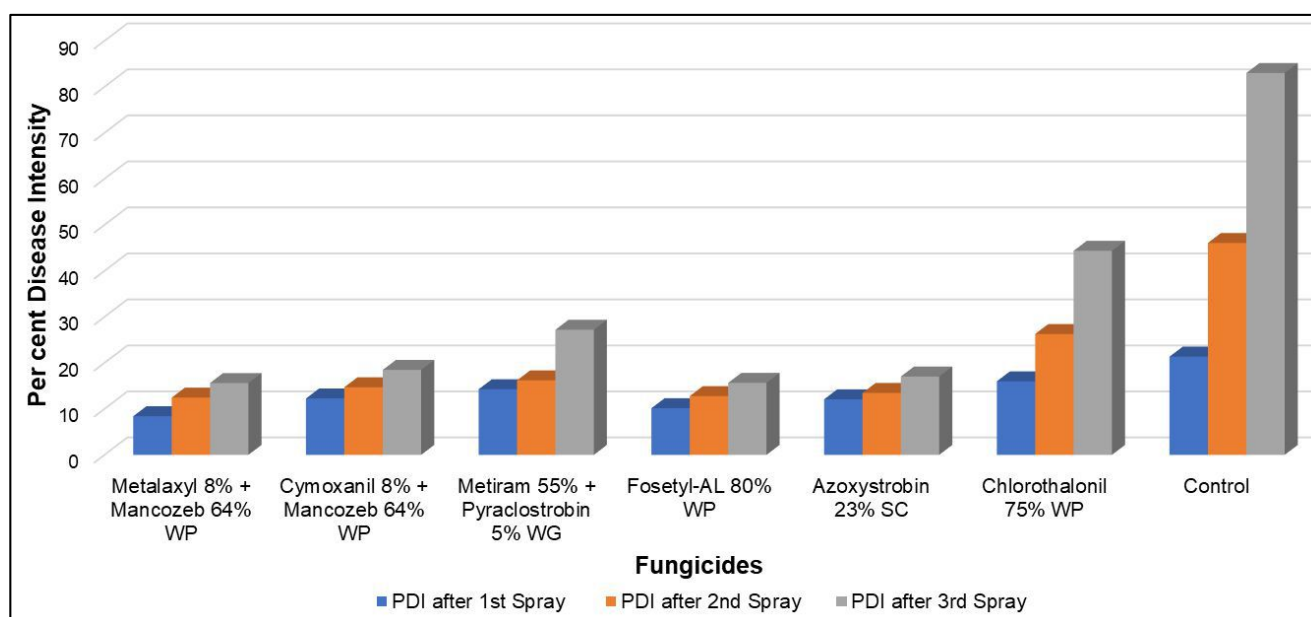


Fig 1: Effect of fungicides spraying on percent disease intensity of downy mildew

Similar results of percent disease control were obtained by Vyavhare (2020) ^[14] who found Metalaxyl + Mancozeb @ 0.2 had 81.60 percent disease control followed by Fosetyl-Al @ 0.2% (80.90%), Azoxystrobin @ 0.1% (77.60%), Cymoxanil + Mancozeb @ 0.2% (76.40%), Metiram+ Pyraclostrobin @ 0.2% (71.10%), Copper oxychloride @ 0.25% (61.30%) and Chlorothalonil @ 0.2% (50.20%). Deadman (2002) ^[18] suggested that Fosetyl-Al and Chlorothalonil can provide effective control of downy mildew, even though Gupta and Shyam (1993) ^[7] have previously reported that Chlorothalonil was the least effective of the fungicides tested against downy mildew on cucurbits.

3.3 Effect of fungicides on yield of ridge gourd

Plot-wise yield of marketable ridge gourd fruits was weighted and presented in quintal/ hectare (Table 2). Yield value showed variation due to the effect of different fungicide treatments.

The yield value ranged from 62.43 q/ha to 75.45 q/ha. Maximum yield of 75.45 q/ha was recorded in plants sprayed with Metalaxyl 8% + Mancozeb 64% WP @ 0.2% which was at par with Fosetyl-Al 80% WP 0.1% (73.16) and Azoxystrobin 0.1% (72.14) was followed by Cymoxanil + Mancozeb 0.2% (71.63), Metiram+ Pyraclostrobin 0.2% (65.32 q/ha) and the lowest yield was recorded in plants sprayed with Chlorothalonil 75% WP 0.2% (62.43 q/ha), which was significantly least effective in comparison to all the fungicides but minimum yield was achieved in control (45.52 q/ha).

Results of increased yield over control (%) are presented in Table 5. Among all treatments increase yield was highest in spraying of Metalaxyl 8% + Mancozeb 64% WP (65.75%), followed by Fosetyl AL-80% WP (60.72%), Azoxystrobin 23% SC (58.47%), Cymoxanil 8% + Mancozeb 64% WP (57.35%), Metiram 55% + Pyraclostrobin 5% WG (43.50%) and Chlorothalonil 75% WP (37.14%).

Table 2: Effect of fungicides on yield of ridge gourd

Tr. No	Treatment	Con. (%)	Yield (q/ha)	Increase yield over control (%)
T ₁	Metalaxyl 8% + Mancozeb 64% WP	0.2	75.45	65.75
T ₂	Cymoxanil 8% + Mancozeb 64% WP	0.2	71.63	57.35
T ₃	Metiram 55% + Pyraclostrobin 5% WG	0.2	65.32	43.50
T ₄	Fosetyl AL-80% WP	0.1	73.16	60.72
T ₅	Azoxystrobin 23% SC	0.1	72.14	58.47
T ₆	Chlorothalonil 75% WP	0.2	62.43	37.14
T ₇	Control	-	45.52	-
F' test			Sig	
S.E (m)±			1.50	
C.D at 5%			4.60	

3.4 In vivo evaluation of plant extracts against downy mildew of ridge gourd

The result obtained after the first spray indicated that all the treatments were significantly effective over the untreated control. Garlic extract @ 10% was found significantly superior with the least disease intensity (13.48%), which was at par with Nilgiri @ 10% (14.61%), this was followed by Neem @ 10%, Onion extract @ 10% and Pongamia leaf extract @ 10% with disease intensity 19.33%, 22.26% and 23.40% respectively. Tulsi @ 10% found least effective in which highest percent disease intensity was found (75.05%) (Table 3 and Fig.2).

After the second spray similar trend was observed as Garlic extract @ 10% was found significantly superior with the least disease intensity (33.97%), which was at par with Nilgiri @ 10% (35.50%) and Neem @ 10% (35.83%) this was followed by Onion extract @ 10% (40.69%), Pongamia leaf extract @ 10% (41.68%) and Tulsi leaf extract @ 10% (43.96%), were found least effective in controlling downy mildew disease on ridge gourd

After the third spray Garlic extract @ 10% was found significantly superior with the least disease intensity (62.70%), which was at par with Nilgiri @ 10% (63.12%), this was followed by Neem @ 10% (66.70%) and Onion extract @ 10% (69.83%). However, Pongamia leaf extract @ 10% (70.79%). Tulsi @ 10% (75.05%) were found least

effective in managing downy mildew disease on ridge gourd.

The present investigation is in accordance with the earlier reports made by researchers. In the present investigation, Garlic @ 10% was found best in reducing the severity of downy mildew followed by Nilgiri @ 10% and Neem @ 10%. The volatile antimicrobial substance allicin (diallylthiosulphinate) is produced in garlic when the tissues are damaged and the substrate allicin (Sallyl-L-cysteine sulfoxide) mixes with the enzyme alliin-lyase. Allicin undergoes thioldisulphide exchange reactions with free thiol groups in proteins and it is thought that this is the basis of its antimicrobial action. These observations are supported by the findings of Portz *et al.* (2008) ^[9] that the volatile antimicrobial substance allicin (Diallyl thiosulphate) from garlic (*Allium sativum*) at concentrations 50-100 µg/ml reduced the severity of *P. cubensis* on cucumber by approximately 50-100 percent. Rajeshwari *et al.* (2007) ^[10] tested a large number of plant extracts among them Neem seed kernel extract 5 percent significantly inhibited the sporangial germination of *Plasmopora viticola*. Reddy *et al.* (2012) ^[12] evaluated the efficacy of five plant extract and two organic products against downy mildew of gherkin out of these (Garlic @ 10%) was found effective in reducing disease severity followed by Pongamia leaf extracts @ 10%.

Table 3: Efficacy of plant extracts against downy mildew of ridge gourd

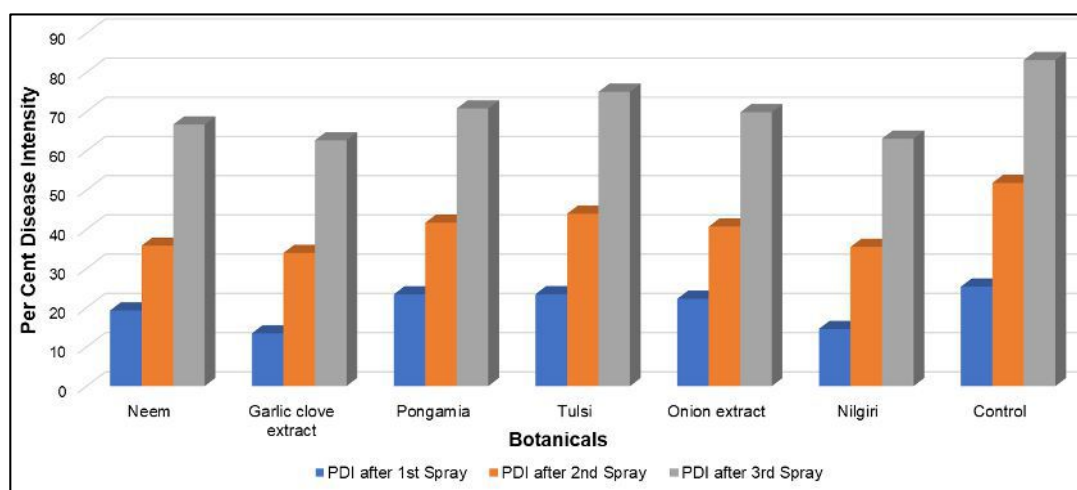
Tr. No	Treatments	Con (%)	PDI before spray	PDI after spray			Mean	PDC
				I	II	III		
T ₁	Neem	10	5.91 (2.43)*	19.33 (4.40)	35.83 (36.76)	66.70 (54.76)	40.62	23.98
T ₂	Garlic extract	10	5.75 (2.40)	13.48 (3.67)	33.97 (35.63)	62.70 (54.36)	36.71	31.30
T ₃	Pongamia	10	5.51 (2.35)	23.40 (4.83)	41.68 (41.53)	70.79 (57.28)	45.29	15.25
T ₄	Tulsi	10	5.87 (2.42)	23.46 (4.84)	43.96 (40.21)	75.05 (60.05)	47.49	11.13
T ₅	Onion extract	10	5.41 (2.33)	22.26 (4.72)	40.69 (39.63)	69.83 (56.68)	44.26	17.17
T ₆	Nilgiri	10	5.72 (2.39)	14.61 (3.82)	35.50 (36.56)	63.12 (52.61)	37.74	29.37
T ₇	Control	-	6.11 (2.47)	25.37 (5.04)	51.79 (46.03)	83.17 (65.82)	53.44	-
F' test			NS	Sig.	Sig.	Sig.		
S.E (m)±			-	0.10	0.75	0.78		
C.D at 5%			-	0.32	2.32	2.42		

*Figures in parenthesis are angular transformed value

3.5 Percent disease control (PDC)

Among all treatments, percent disease reduction over control (PDC) was highest in the spraying of garlic extract @ 10% (31.30%) which was at par with Nilgiri extract @

10% (29.37) and was followed by Neem leaf extract @ 10% (23.98%), Onion pulp extract @ 10% (17.17%) and Pongamia leaf extract @ 10% (15.25%). The lowest percent disease control was observed in Tulsi @ 10% (11.13%).

**Fig 2:** Effect of botanicals spraying on percent disease intensity of downy mildew

3.6 Effect of plant extract on yield of ridge gourd

Plot-wise yield of marketable fruits of ridge gourd was weighted and is presented in quintal/hectare (Table 4). Yield value showed variation due to the effect of different plant extract treatments.

The yield value ranged from 40.50 to 56.36 q/ha among the plant extract. Maximum yield of 56.36 q/ha was recorded in plants sprayed with Garlic which was at par with Nilgiri leaf extract (55.38 q/ha) and Neem extract (54.45 q/ha). The lowest yield was obtained in Pongamia leaf extract (46.80 q/ha) and Tulsi (43.76 q/ha).

Table 4: Effect of plant extract on yield of ridge gourd

Tr. No	Treatments	Con. (%)	Yield (q/ha)	Increase yield over control (%)
T ₁	Neem	10	54.45	34.44
T ₂	Garlic clove extract	10	56.36	39.16
T ₃	Pongamia	10	46.80	15.55
T ₄	Tulsi	10	43.76	08.04
T ₅	Onion pulp extract	10	50.22	24.00
T ₆	Nilgiri	10	55.38	36.74
T ₇	Control	-	40.50	-
F' test			Sig	-
S.E (m)±			1.13	-
C.D at 5%			3.94	-

Results of increased yield was presented in Table 4. Among all treatments increase yield over control (39.16%) was highest in spraying of garlic extract @ 10% (39.16%), followed by Nilgiri @ 10% (36.74 q/ha), Neem leaf extract 10% (34.44 q/ha), Onion pulp extract @ 10% (24.00 q/ha), with Pongamia leaf extract @ 10% (15.55 q/ha) and Tulsi @ 10% (8.04 q/ha).

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