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AD Rojasara
Department of Entomology,
N.M. College of Agriculture,
Navsari Agricultural University,
Navsari, Gujarat, India

DR Patel
Department of Entomology,
N.M. College of Agriculture,
Navsari Agricultural University,
Navsari, Gujarat, India

DM Pathak
Department of Entomology,
N.M. College of Agriculture,
Navsari Agricultural University,
Navsari, Gujarat, India

RR Patel
Department of Entomology,
N.M. College of Agriculture,
Navsari Agricultural University,
Navsari, Gujarat, India

Correspondence
DR Patel
Department of Entomology,
N.M. College of Agriculture,
Navsari Agricultural University,
Navsari, Gujarat, India

Evaluation of different plant products against rice weevil *Sitophilus oryzae* on paddy

AD Rojasara, DR Patel, DM Pathak and RR Patel

Abstract
The experiment was carried out during the year 2018-19 at the Biological control Laboratory and P.G. Research Laboratory, Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari. Pooled data on the effect of botanicals on seed damage by *Sitophilus oryzae* showed that the neem leaf powder 5 per cent (2.47%), custard apple leaf powder 5 per cent (5.24%) and nilgiri leaf powder 5 per cent (6.99%) were found most effective treatments against rice weevil as it recorded less seed damage. While, the significant minimum weight loss was observed in the seed treated with neem leaf powder at 5 per cent (0.68%) followed by custard apple leaf powder 5 per cent (2.16%) and nilgiri leaf powder 5 per cent (4.22%). The significant highest mean per cent mortality was observed in neem leaf powder (87.08%) and it was followed by custard apple leaf powder (81.25%) and nilgiri leaf powder (61.25%).

Keywords: Rice weevil, *S. oryzae*, plant leaf powders, seed damage, weight loss, mortality

Introduction
Rice weevil, *Sitophilus oryzae* is economically important storage pest on rice and other cereals in tropical and sub tropical region of the world. Rice weevil cause heavy losses of stored food grain quantitatively and qualitatively throughout the world (Arannilewa *et al*., 2002) [3]. Among the several insect attacking stored grains *Sitophilus oryzae* has got economic importance. It is the most destructive insect pest of the stored cereal grains in the world (Champ and Dyte, 1976) [5]. *S. oryzae* is a major stored grain pest infesting many grains in storage but rice is its main target of attack (Singh *et al.*, 2017) [7]. Rice weevil mainly attacks whole grains such as wheat, corn, barley and rice and have been found actively breeding in such grains. Its host range now extended to split legumes (Deepthi and Manjunatha, 2015) [6]. The adults and larva of *S. oryzae* are internal feeder and great losses in the grain both in quality and quantity. Insect pests can be managed with the use of synthetic insecticides, but in storage, indiscriminate use of these synthetic insecticides resulted in development of resistance, residues and undesirable effect on non-target organisms, humans and environmental hazards. In view of negative effects of synthetic insecticides, substance of plant origin for the control of stored grain insects are quite promising as they are more biodegradable, less toxic to human being and safe to environment. Thus, a laboratory study was conducted to identify a plant product which prove to be effective against management of rice weevil in paddy.

Materials and methods
The experiment was carried out during the year 2018-19 at the Biological control Laboratory and P.G. Research Laboratory, Department of Agricultural Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari. Seeds were treated with nine different plant materials viz., Neem, Nilgiri, Lantana, Custard apple, Tulsi, Jatropha, Karanj, Lake and Ardushi and replicate thrice to study the reaction of pest to different plant material in Completely Randomized Design (C.R.D.). The plant materials were collecting from nearby locality as well as market. The materials were kept in oven at 55°C for 4 hour for proper drying. The dried plant materials were finally crushed in an electric grinder. Each of the crushed material or powder was mixed properly by hand mixing at the desired dosage with 100g of uninfected seeds of paddy variety in a plastic bottle of 250 g capacity. Freshly, emerged weevils were drawn from in the pure culture bottle and release at the rate of 10 pairs of adults per bottle. Bottles were covered with muslin cloth and tightly fixed with rubber band. Observations on adult mortality at 7, 14, 21 and 30 days after storage, seed damage and weight

loss was recorded periodically up to 180 days. Per cent mortality was recorded on the basis of number of dead and live insects. Per cent weight loss was worked out by using the following formula (Adams and Schulton, 1978) [1].

$$\text{Per cent weight loss} = \frac{(UND) - (DNU)}{U\ (ND + NU)} \times 100$$

Where,
U - Weight of uninfested seeds (g)
NU - Number of uninfested seeds
D - Weight of infested seeds (g)
ND - Number of infested seeds

Results and Discussion

Per cent paddy seed damage due to *S. oryzae* treated with plant leaf powders

Pooled data (Table 1) on the effect of botanicals on seed damage by S. *oryzae* at 30, 60, 90,120, 150 and 180 DAT showed that the all the treatments were found significant superior then untreated control. However lowest per cent seed damage was recorded in seed treated with neem leaf powder (2.47%). The order of effectiveness based on per cent seed damage was neem leaf powder (2.47%) < custard apple leaf powder (5.24%) < nilgiri leaf powder (6.99%), < lake leaf powder (7.37%) < ardushi leaf powder (7.52%) < lantana leaf powder (8.31%) < karanj leaf powder (10.77%) < tulsi leaf powder (13.63%) < jatropha leaf powder (15.67%).

Per cent paddy weight loss due to *S. oryzae* treated with plant leaf powders

The pooled data (Table 2) of weight loss at 30, 60, 90, 120, 150 and 180 days after seed treatments revealed that the all the treatments were found significantly superior over untreated control. The significant minimum weight loss was observed in the seed treated with neem leaf powder at 5 per cent (0.68%). In the remaining treatments, the weight loss ranged from 2.16 to 8.89 per cent while, the highest weight loss 10.34 per cent was recorded in untreated control. The order of per cent weight loss in different treatments was neem leaf powder (0.68%) < custard apple leaf powder (2.16%) < nilgiri leaf powder (4.22%) < lake leaf powder (4.90%) < ardushi leaf powder (5.11%) < lantana leaf powder (5.13%) < karanj leaf powder (5.91%) < tulsi leaf powder (6.44%) < jatropha leaf powder (8.89%). Thus on the bases of per cent weight loss paddy treated with neem leaf powder, custard apple leaf powder and nilgiri leaf powder at 5 per cent recorded significantly less per cent weight loss by *S. oryzae.*

Per cent mortality of *S. oryzae* in paddy treated with various plants leaf powder

The pooled data of per cent mortality of rice weevil (Table 3) revealed that all treatments found significantly superior over control. The significant highest per cent mortality was observed in neem leaf powder (87.08%) and it was followed by custard apple leaf powder (81.25%) and nilgiri leaf powder (61.25%). Thus paddy seed treated with neem leaf powder, custard apple leaf powder and nilgiri leaf powder at 5 per cent found most effective as recorded more per cent mortality of rice weevil.

The present findings show that among the different plant powders, treatments of neem leaf powder, custard apple leaf powder and nilgiri leaf powder against rice weevil, *S. oryzae* was found effective by showing highest per cent mortality, least grain damage and weight loss. The insecticidal activity of these botanicals may possible due to the different factors such as the presence of bioactive chemicals with diverse activity. The present findings are in accordance with the reports Bhanderi *et al.* (2015) [4] who recorded that the sweet flag powder, custard apple seed powder and neem seed kernel powder were the most effective in controlling rice weevil, *S. oryzae* as they render no damage and least weight loss. Akter and Akter (2016) [2] revealed that neem leaf powder posses very high insecticidal effect on *S. oryzae* adults and recorded highest per cent mortality of *S. oryzae* on wheat. According to Singh *et al.* (2017) [7] neem kernel at 2 per cent was more effective against *S. oryzae* as if wheat added with neem kernel powder recorded minimum grain damage (3.84%), weight loss (1.15%), adult emergence (16.17) and highest inhibition rate (92.58%) followed by dharek kernel powder, neem leaf powder, dharek leaf powder, castor kernel powder and castor leaf powder.

Table 1: Per cent paddy seed damage due to *S. oryzae* treated with plant leaf powders at 5 per cent

Sr. No.	Treatments	Per cent seed damage						Pooled Data
		30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT	
1.	Neem leaf powder	8.85 (2.37)	8.86 (2.38)	8.92 (2.41)	9.04 (2.47)	9.17 (2.54)	9.35 (2.64)	9.03 (2.47)
2.	Nilgiri leaf powder	13.01 (5.08)	14.57 (6.34)	15.79 (7.41)	15.93 (7.54)	16.15 (7.75)	16.24 (7.83)	15.28 (6.99)
3.	Lantana leaf Powder	14.90 (6.62)	15.52 (7.17)	17.39 (8.95)	17.39 (8.95)	17.45 (9.01)	17.60 (9.16)	16.71 (8.31)
4.	Custard apple leaf powder	12.55 (4.73)	12.57 (4.74)	13.01 (5.08)	13.50 (5.46)	13.63 (5.56)	13.96 (5.84)	13.21 (5.24)
5.	Tulsi leaf powder	16.40 (7.99)	18.05 (9.62)	22.28 (14.41)	23.94 (16.48)	24.02 (16.59)	24.11 (16.71)	21.48 (13.63)
6.	Jatropha leaf powder	16.67 (8.24)	21.75 (13.76)	24.06 (16.64)	25.25 (18.22)	25.34 (18.34)	25.71 (18.84)	23.13 (15.67)
7.	Karanj leaf powder	16.17 (7.78)	17.63 (9.18)	19.47 (11.13)	20.21 (11.94)	20.45 (12.22)	20.59 (12.38)	19.09 (10.77)
8.	Lake leaf powder	14.20 (6.04)	15.09 (6.79)	16.05 (7.65)	16.21 (7.80)	16.23 (7.82)	16.52 (8.12)	15.72 (7.37)
9.	Ardushi leaf powder	14.53 (6.30)	15.28 (6.96)	16.10 (7.70)	16.39 (7.97)	16.42 (8.00)	16.59 (8.17)	15.88 (7.52)
10.	Untreated control	20.55 (12.33)	26.08 (19.35)	33.45 (30.40)	36.28 (35.05)	37.87 (37.72)	40.66 (42.49)	32.48 (29.56)

S.Em.±	T	0.36	0.40	0.42	0.38	0.47	0.42	0.93
	Y*T	-	-	-	-	-	-	0.41
CD at 5%	T	1.05	1.18	1.25	1.11	1.38	1.23	2.65
	Y*T	-	-	-	-	-	-	1.14
CV%		4.17	4.18	3.95	3.36	4.13	3.59	3.89

Figures in the parentheses are original values and those outside the parentheses are arcsine transformed values. DAT-Days after treatments, Y-Time period, T-Treatments

Table 2: Per cent paddy weight loss due to *S. oryzae* treated with various plant leaf powders at 5 per cent

Sr. No.	Treatments	Per cent weight loss						Pooled Data
		30 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT	
1.	Neem leaf powder	4.49 (0.61)	4.59 (0.64)	4.68 (0.67)	4.74 (0.68)	4.79 (0.70)	4.98 (0.76)	4.71 (0.68)
2.	Nilgiri leaf powder	9.43 (2.69)	10.53 (3.36)	12.44 (4.65)	12.50 (4.69)	12.63 (4.79)	13.06 (5.14)	11.76 (4.22)
3.	Lantana leaf powder	11.13 (3.73)	12.44 (4.65)	13.76 (5.66)	13.05 (5.11)	13.87 (5.75)	13.99 (5.85)	13.04 (5.13)
4.	Custard apple leaf powder	8.16 (2.02)	8.18 (2.03)	8.20 (2.04)	8.59 (2.24)	8.66 (2.27)	8.85 (2.37)	8.44 (2.16)
5.	Tulsi leaf powder	12.61 (4.78)	14.19 (6.02)	14.97 (6.68)	15.31 (6.98)	15.41 (7.07)	15.43 (7.09)	14.65 (6.44)
6.	Jatropha leaf powder	12.65 (4.81)	14.42 (6.21)	18.25 (9.84)	19.11 (10.74)	19.11 (10.75)	19.35 (11.00)	17.15 (8.89)
7.	Karanj leaf powder	11.83 (4.21)	13.32 (5.32)	14.47 (6.26)	14.66 (6.41)	14.83 (6.56)	14.98 (6.69)	14.01 (5.91)
8.	Lake leaf powder	10.98 (3.64)	11.78 (4.17)	13.04 (5.10)	13.71 (5.63)	13.15 (5.19)	13.73 (5.67)	12.73 (4.90)
9.	Ardushi leaf powder	11.07 (3.69)	11.79 (4.18)	13.67 (5.59)	13.81 (5.70)	13.75 (5.66)	13.97 (5.84)	13.00 (5.11)
10.	Untreated control	18.75 (10.34)	24.56 (17.30)	28.18 (22.32)	30.45 (25.70)	31.57 (27.43)	33.57 (30.60)	27.85 (22.28)
S.Em.±	T	0.28	0.29	0.30	0.31	0.34	0.44	0.64
	Y*T	-	-	-	-	-	-	0.33
CD at 5%	T	0.82	0.85	0.90	0.93	0.99	1.29	1.82
	Y*T	-	-	-	-	-	-	0.93
CV%		4.36	3.98	3.71	3.73	3.94	4.99	4.17

Figures in the parentheses are original values and those outside the parentheses are arcsine transformed values. DAT- Days after treatments, Y-Time period, T-Treatments

Table 3: Per cent mortality of *S. oryzae* in paddy treated with various plants leaf powders at 5 per cent

Sr. No.	Treatments	Per cent mortality				Pooled Data
		7 DAT	14 DAT	21 DAT	30 DAT	
1.	Neem leaves powder	57.84 (71.67)	65.93 (83.33)	75.21 (93.33)	89.32 (100.00)	72.07 (87.08)
2.	Nilgiri leaves powder	44.02 (48.33)	48.82 (56.67)	52.72 (63.33)	61.12 (76.67)	51.67 (61.25)
3.	Lantana leaves powder	43.07 (46.67)	46.89 (53.33)	51.73 (61.67)	57.84 (71.67)	49.88 (58.34)
4.	Custard apple leaves powder	52.72 (63.33)	62.26 (78.33)	65.73 (83.33)	89.32 (100.00)	67.56 (81.25)
5.	Tulsi leaves powder	38.23 (38.33)	45.94 (51.67)	49.78 (58.33)	55.75 (68.33)	47.42 (54.17)
6.	Jatropha leaves powder	37.24 (36.67)	45.94 (51.67)	51.73 (61.67)	55.75 (68.33)	47.66 (54.59)
7.	Karanj leaves powder	42.11 (45.00)	46.89 (53.33)	51.73 (61.67)	55.75 (68.33)	49.12 (57.08)
8.	Lake leaves powder	43.07 (46.67)	48.82 (56.67)	52.72 (63.33)	57.84 (71.67)	50.61 (59.59)
9.	Ardushi leaves powder	43.07 (46.67)	48.82 (56.67)	52.72 (63.33)	57.84 (71.67)	50.61 (59.59)
10.	Untreated Control	0.64 (0.00)	12.92 (5.00)	16.59 (8.33)	21.33 (13.33)	12.87 (6.67)
S.Em.±	T	0.88	0.97	1.23	0.99	1.84
	Y*T	-	-	-	-	1.02
CD at 5%	T	2.59	2.85	3.62	2.94	5.35
	Y*T	-	-	-	-	2.89
CV%		3.79	3.54	4.09	2.87	3.56

Figures in the parentheses are original values and those outside the parentheses are arcsine transformed values.

Conclusion

Studies on evaluation of different plant products against rice weevil *S. oryzae* on paddy indicated that, among different plant powders, seed treatment with neem leaf powder, custard apple leaf powder and nilgiri leaf powder at 5 per cent against rice weevil, *S. oryzae* found effective by showing highest per cent mortality, least grain damage and weight loss.

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