Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 483-486

Received: 19-07-2020
Accepted: 30-08-2020

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Efficacy of biorationals and Chlorantraniliprole against coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.)

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Abstract
A novel botanical cake and paste developed by ICAR-CPCRI, neem cake admixed with sand, naphthalene balls and chlorantraniliprole sachets were evaluated against coconut rhinoceros beetle (*Oryctes rhinoceros*) on a three-year old juvenile palms (GBGD variety) at Ratnagiri during 2016-2019. Leaf damage by the pest during pre-treatment observation ranged from 10.2% to 16.2%. Palms treated with chlorantraniliprole (0.4%) GR @ 6g per palm and botanical cake and paste @ 15 g palm^{-1} registered lowest leaf damage of 7.0% and 8.5%, respectively. With respect to spear leaf, chlorantraniliprole and botanical cake and paste-treated palms recorded least damage of 8.3% and 12.2%, respectively. The study revealed supremacy of botanical cake and paste in the suppression of coconut rhinoceros beetle and is comparable with chlorantraniliprole treatment.

Keywords: Black beetle, botanical cake, eco-friendly pest management, naphthalene balls, neem cake

Introduction
Coconut (*Cocos nucifera* Linn.) is an important plantation crop grown in Konkan region of Maharashtra cultivated in a traditional manner with local varieties utilizing limited available resources. It has great socio–economic significance fostering livelihood security to more than 12 million marginal and small farmers globally. It provides basic needs such as food, drink, shelter, fuel, furniture, medicine, decorative materials to mankind [10]. Though, aptly eulogized as *Kalpavriksha*, it is depredated by a wide array of insect pests cussing severe crop loss. Coconut rhinoceros beetle (*Oryctes rhinoceros* Linn.) is a ubiquitous and cosmopolitan pest which causes tremendous damage to spear leaf and ultimately affect the palm health and nut yield. The adult beetles feed on the soft tissues of the growing region and make burrow holes on unopened fronds. The opened leaves show a characteristic 'V' shaped geometric cut and of late the pest incidence is quite severe on juvenile palms impairing good establishment during initial phase [7, 9]. Furthermore, attack on juvenile palms resulted in stunted growth and delayed flowering [5, 11]. A loss in yield of 5.5–9.1% due to beetle attack was estimated in Kerala, India [12]. Damage to spathe further cause reduction in coconut yield up to 10% in India [8]. The rhinoceros beetle attack leads to the secondary attack by red palm weevil and other pathogens which causes more severe damages or eventually leads to death of palm [1]. Since the initial establishment of juvenile palms is very critical for timely flowering and attaining good yield, the present investigation was carried out to evaluate different biorationals and chlorantraniliprole against rhinoceros beetle.

Materials and Methods
A field experiment was conducted at RCRS, Bhatye, Dist. Ratnagiri (M.S.) during 2016-19 to evaluate different biorationals and chlorantraniliprole against coconut rhinoceros beetle infesting juvenile palms. A total of 100 palms of three year old GBGD variety were selected for the experiment. Five treatments with four replication were imposed *viz.*, T1-Botanical cake (June, Oct and Feb) + paste (August, December and April) @ 15g/palm, T2-Neem cake + sand (150 g each) to be filled in the innermost leaf axils - once in 4 months (June, Oct, Feb), T3-placement of naphthalene balls on the innermost leaf axils @ 12g/palm once in 2 months (June, Aug, Oct, Dec, Feb, April), T4-placement of chlorantraniliprole (0.4%) GR in perforated sachets in the innermost leaf axils @ 6g per palm once in 4 months (June, Oct, Feb)

and T5-untreated control in randomized block design. The observations on rhinoceros beetle incidence in term of leaf (Infested leaf x100/ total leaf) and spindle damage (Infested spindle x100/ total palm spindle) were recorded one day before as pre-treatment observations. The post-treatment observations were observed in the month of June, September, December and March at every year. The generated data were subjected to ANOVA and means are separated by Least Significant Difference.

Results and Discussions

The data presented in Table 1 revealed that the pre-treatment observation on leaf damage in different treatments ranged from 10.1% to 16.2%. During March 2017, the minimum leaf damage was observed in palms treated with botanical cake with paste (6%) followed by T4 chlorantraniliprole-treated palms (7.2%) which was significantly superior to other treatments. Placement of two tablet shaped botanical cakes on the top most leaf axils reduced leaf damage by 54 per cent and was found superior to chlorantraniliprole sachets (34%)-treated palms in subduing rhinoceros beetle attack in Kerala. The botanical cake and paste swiped on the spear leaf @ 10g/palm was found to safeguard juvenile palms for about two months from rhinoceros beetle attack [3]. All the treatments registered non-significant pest reduction during June 2017. Palms treated with chlorantraniliprole recorded minimum leaf damage (8.9%) and was found significantly superior over control (27.6%). However, it was on par with placement of botanical cake and smearing of paste (9.8%), followed by naphthalene balls (14.41%) and neem cake (21.1%) noticed in September, 2017. Observations recorded during December, 2017 indicated that chlorantraniliprole-treated palms showed 8.3 per cent leaf followed by botanical cake and paste (15.9%). The naphthalene balls and neem cake-treated palms recorded 16.9 and 22.8 per cent leaf damage, respectively. During March, 2018, palms treated with chlorantraniliprole registered the least leaf damage (5.8%) which was significantly superior over control (10.6%) and on par with botanical cake and paste (7.3%), neem cake (8.5%) and naphthalene balls (8.8%). Similar trends of effectiveness of treatments were noticed during June, September, December 2018 and March, 2019. The overall mean data of three year indicated that the palms treated with chlorantraniliprole registered the least leaf damage (6.9%). This agrees with the findings that placement of chlorantraniliprole 0.4% GR insecticides admixed with 100-150g sand registered least leaf and spindle damage in coconut [6]. It was also found significantly superior over neem cake + sand (12.9%) and untreated control (17.8%) and on par with botanical cake and paste (8.4%) and naphthalene balls (11.2%). The high rate of mortality of the rhinoceros grubs was recorded in neem cake followed by *A. squamosa* powder under semi field condition [18]. The next effective treatment was found as botanical cake + paste (8.4%) which was significantly superior over untreated control (17.8%). Among the different insecticides tested in farmers fields, chlorpyriphos (1.5%) DP and chlorantraniliprole (0.4%) GR insecticides along with 100-150 gram of sand were found effective in reducing the leaf and spindle damage and comparable with phorate 10 G insecticide [16]. Palms treated with naphthalene balls and neem cake with sand recorded 11.2 and 12.9 per cent leaf damage. It was further indicated that significant control of rhinoceros beetle was observed on palms when five naphthalene balls were placed in top most leaf axils [15]. Placement of naphthalene balls @ 10 to 12 g per palm in the innermost leaf axil once in 45 days could manage the rhinoceros beetle damage successfully [17].

Table 1: Effect of biorationals with Chlorantraniliprole for the Management of Coconut Rhinoceros beetle in Maharashtra during 2016-19

Treatments	Leaf Damage (%) by rhinoceros beetle										
	Dec. 2016 (PTC)	**March 2017 (3 MAT)**	**June 2017 (6 MAT)**	**Sept. 2017 (9 MAT)**	**Dec. 2017 (12 MAT)**	**March 2018 (15 MAT)**	**June, 2018 (21 MAT)**	**Sept, 2018 (24 MAT)**	**Dec, 2018 (27 MAT)**	**March, 2019 (30 MAT)**	**Mean**
T1 - Botanical cake 2-3 + paste@ 15g each/palm	10.2 (18.5)	6.0 (12.1)	15.6 (22.1)	9.8 (17.3)	15.9 (23.3)	7.3 (15.7)	8.3 (15.9)	6.4 (14.3)	3.7 (10.7)	3.2 (10.3)	8.4 (15.7)
T2 - Neem cake+ sand @150 g each/ palm	12.2 (20.4)	11.7 (18.9)	24.1 (28.0)	21.1 (26.9)	22.8 (28.4)	8.5 (16.9)	12.5 (20.2)	7.0 (15.3)	4.3 (11.9)	4.7 (12.4)	12.9 (19.8)
T3 -Naphthalene balls @12g/palm	16.2 (23.7)	10.4 (17.8)	25.5 (29.7)	14.41 (21.0)	16.9 (23.8)	8.8 (16.7)	10.1 (17.2)	6.9 (15.2)	3.7 (11.1)	4.5 (12.2)	11.2 (18.3)
T4 -Chlorantraniliprole 0.4GR @ 6g/palm	11.8 (20.0)	7.2 (13.1)	15.3 (22.9)	8.9 (15.8)	8.3 (11.8)	5.8 (13.8)	8.2 (14.2)	4.0 (11.4)	2.8 (8.3)	2.3 (8.6)	6.9 (13.3)
T5 – Control	12.4 (20.5)	13.1 (20.4)	30.7 (33.5)	27.6 (31.6)	25.6 (30.1)	10.6 (19.0)	15.3 (23.0)	11.7 (19.9)	13.0 (21.3)	13.4 (21.1)	17.8 (24.4)
S.E ±	2.23	4.1	4.32	3.6	3.7	1.59	3.50	1.12	1.6	0.97	2.06
CD at 5%	N.S.	N.S.	N.S.	11.07	11.20	4.92	N.S.	3.47	5.02	3.00	6.41

(Figures in parenthesis are arc sine transformed value)

With regard to spindle damage, the pre- treatment observation ranged from 30 to 40 per cent among different treatments. During March, 2017, the lowest spindle damage was observed with chlorantraniliprole-treated palms (20%), followed by botanical cake with paste (25%), neem cake (30%) and naphthalene balls (35%). Maximum spindle damage was noticed in control (40%). There was no significant difference among the treatments in June, 2017. The minimum spindle damage (5%) was observed in chlorantraniliprole treated palms which was found to be significantly superior over neem cake (25%) and untreated control (35%). The next effective treatments were botanical cake with paste and naphthalene balls which recorded 10% and 15% spindle damage, respectively in September 2017. The application of oil cakes of neem (*Azadirachta indica*, Meliaceae) or marotti (*Hydnocarpus wightiana*, Bixaceae) in powder form @ 250 g mixed with equal volume of sand, thrice a year to the base of the spindle leaf of coconut palm is an effective prophylactic method against rhinoceros beetle and red palm weevil [4]. Mixture of either neem seed powder + sand (1:2) at 150 g per palm or neem seed kernel powder + sand (1:2) at 150 g per palm applied in the base of three innermost leaves in the crown effectively controlled RB damage [13]. During December, 2017, the lowest spindle damage (5%) was

recorded in chlorantraniliprole sachet treated palms which was on par with botanical cake and paste (10%) and neem cake (15%). Palms treated with naphthalene balls recorded 25 per cent spindle damage. All the treatments were significantly superior over untreated control (35%). The palms treated with chlorantraniliprole recorded minimum spindle damage (5%) followed by botanical cake with paste (10%), naphthalene balls (15%) and neem cake (25%). Similar trends of effectiveness of treatments were noticed during June, September, December 2018 and March, 2019. The overall mean data of three years revealed that the chlorantraniliprole treated palms registered the least spindle damage (8.3%) which was significantly superior over control (32.7%). It was at par with botanical cake + paste (12.2%), naphthalene balls (18.8%) and neem cake (20.5%). The repellant action of naphthalene balls was significantly superior over conventional insecticides such as HCH (10%), Carbofuran or Phorate [14]. Chlorantraniliprole was reported as an effective component of integrated pest and pollinator management programs on woody ornamentals [2].

Table 2: Effect of biorationals with Chlorantraniliprole for the Management of Coconut Rhinoceros beetle in Maharashtra during 2016-19

Treatments	Spear leaf damage (%) by rhinoceros beetle										
	Dec. 2016 (PTC)	**March 2017 (3 MAT)**	**June 2017 (6 MAT)**	**Sept. 2017 (9 MAT)**	**Dec. 2017 (12 MAT)**	**March 2018 (15 MAT)**	**June, 2018 (21 MAT)**	**Sept, 2018 (24 MAT)**	**Dec, 2018 (27 MAT)**	**March, 2019 (30 MAT)**	**Mean**
T1 - Botanical cake 2-3 + paste@ 15g each/palm	35.0 (35.7)	25.0 (29.1)	10.0 (13.2)	10.0 (9.8)	10.0 (13.2)	15.0 (19.1)	10.0 (9.8)	15.0 (16.4)	10.0 (13.2)	5.0 (6.6)	12.2 (14.4)
T2 - Neem cake+ sand @150 g each/ palm	30.0 (32.6)	30.0 (32.9)	15.0 (19.9)	25.0 (25.9)	15.0 (19.9)	25.0 (25.9)	20.0 (23.0)	25.0 (26.2)	20.0 (23.0)	10.0 (13.2)	20.5 (23.3)
T3 -Naphthalene balls @12g/palm	40.0 (39.2)	35.0 (36.0)	10.0 (13.2)	15.0 (19.9)	25.0 (29.7)	15.0 (16.4)	20.0 (23.0)	20.0 (23.0)	15.0 (19.9)	15.0 (16.4)	18.8 (22.0)
T4 -Chlorantraniliprole 0.4GR @ 6g/palm	30.0 (32.9)	20.0 (26.5)	5.0 (6.6)	5.0 (6.6)	5.0 (6.6)	5.0 (6.6)	15.0 (16.4)	5.0 (6.6)	10.0 (13.2)	5.0 (6.6)	8.3 (10.6)
T5 – Control	35.0 (35.7)	40.0 (39.2)	20.0 (23.0)	35.0 (32.3)	35.0 (35.7)	35.0 (32.3)	30.0 (32.9)	40.0 (38.9)	30.0 (29.1)	30.0 (32.9)	32.7 (32.9)
S.E ±	2.7	2.5	7.6	5.8	4.4	7.8	6.0	8.5	9.0	7.7	6.1
CD at 5%	N.S.	7.5	N.S.	17.0	13.2	24.0	18.3	26.1	N.S.	23.2	18.4

(Figures in parenthesis are arc sine transformed value)

Conclusion

Among the treatments, palms treated with chlorantraniliprole was found to be most effective in reducing leaf and spindle damage by coconut rhinoceros beetle. However, among the biorationals attempted in the study, botanical cake and paste treated palms was found to be effective in pest suppression which is also an eco-friendly alternative for the prophylactic management of the rhinoceros beetle in coconut.

Acknowledgement

The authors are thankful to ICAR-AICRP (Palms) and ICAR-CPCRI, Kasaragod for providing funds, technical help and timely guidance for conduct of experiment.

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