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EVALUATION OF ENTOMOPATHOGENIC FUNGI AND IMIDACLOPRID AGAINST TERMITE AS SEED TREATMENT ON CHICKPEA

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ABSTRACT

Investigations on the evaluation of entomopathogenic fungi and imidacloprid against termites as seed treatment and soil application on chickpea were carried out. Of the treatments made out of two fungi and imdacloprid relative susceptibility against termite was observed. None of the treatment was immune to the termite attack. Imidacloprid was less susceptible, seed treatment with *M. anisopliae* and *B. bassiana* followed by soil application that was rated as moderately susceptible. However, seed treatment with *M. anisopliae* and *B. bassiana* emerged highly susceptible. The minimum infestation at harvest was obtained in seed treatment with imidacloprid 70 WS followed by soil application of imidacloprid 17.8 SL (3.10%); whereas, it was maximum in seed treatment with *B. bassiana* (7.03%).The maximum seed yield was obtained in seed treatment with imidacloprid 70 WS followed by soil application of imidacloprid 17.8 SL (15.60 q/ha); whereas, it was minimum in seed treatment with *B. bassiana* (11.62 q/ha).

Key words: Evaluation, Entomopathogenic fungi, termite, chickpea, seed treatment, Imidacloprid.

INTRODUCTION

Chickpea, *Cicer arietinum* (L.) also known as gram or Bengal gram is one of the most important *rabi* season pulse crops and as considered as "king of pulses" in India. The major chickpea growing states in the country are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat and Bihar. Rajasthan is one of the major states which occupies 12.56 lakh hectares area with an annual production of 9.11 lakh tonnes (Anonymous, 2015). The gram growing districts in Rajasthan are Churu, Hanumangarh, Bikaner, Sriganganagar, Jhunjhunu, Jhalawar, Jaipur, Kota and Jodhpur.

The higher acreage and low productivity in gram depends on number of constraints, amongst them insect-pests are recognized as one of the major constraint. Around 60 insect species are known to feed on chickpea (Parsai, 2005). Major insects causing damage to the gram crop are gram pod borer, *Helicoverpa armigera* (L.), gram cut worm, *Agrotis ipsilon* (Hufnagel) and termite, *Odontotermes obesus* (Rambur).

Termites are xylophagus, considered to be a serious pest as they destroys crops and households. They are highly destructive polyphagous insect pests of crop plants, significantly reduce the yield. Termites damaged the seedling by cutting either just below or above the soil surface. In mature plants termites feed on root system and inside the stem. Severely infested plants dry up and can be easily pulled up. It inflicts heavy damage to crop cultivated in sandy loam soil from sowing till harvest. Termites are of regular occurrence mostly in tropical and sub-tropical parts of India. About 40 species of termites are known to cause damage to economic plants (Roonwal and Chhotani, 1989). In Rajasthan the situation is more alarming as the termites inflict heavy damage to the crops in sandy loam soil moisture regime (Parihar, 1981). Yield losses due to termite damage range from 50 to 100 per cent as reported by Sekamatte *et al*. (2001) and Rao and Azad (2009). In chickpea up to 46 per cent pod damage was reported by Nautiyal (2002). The initial damage to the seedlings can cause substantial seedling mortality. The chickpea roots and stems are tunnelled by termites (*Odontotermes* spp.) inside which they feed remaining under the earthen galleries (Gaur *et al*., 2010). Termites are insect pests of regional importance in particular in Rajasthan and Haryana (DPPQ&S, 2001). Economic threshold level suggested is 5 damaged plants/m^2 for *Odontotermes* species.

In order to prevent the losses caused by insects and to produce a quality crop, it is essential to manage the

pest population at appropriate time with suitable measures.

Management of termites has largely relied on broad spectrum and persistent organo-chlorine insecticides in the world (Logen *et al*., 1990). Now-a-days, most of the persistent insecticides are banned or withdrawn from the market on account of human health and environmental reasons. Thus, there are serious limitations and increasing legal restriction associated with application of persistent and deleterious insecticides, because of which the search for environmentally benign alternatives methods of termite's management has been intensified by entomologists. Among the diverse potential alternatives available for termite management, the use of entomopathogenic fungi is getting momentum (Michael, 2005).

Entomopathogenic fungi, *Metarhizium anisophilae* (Metchnikoff) and *Beauveria bassiana* (Basamo) are effective in the management of different species of termites (Milner *et al*., 1998; Milner, 2003) which may be used in different methods among which direct exposure, as soil barrier and as baits were able to achieve good control in termite colony.

Therefore, the current study is aimed to determine the efficacy of entomopathogenic fungi and Imidacloprid at different concentrations by seed treatment and soil application for the management of termites.

MATERIALS AND METHODS

The experiment was carried out during 2015-16 at Research farm of College of Agriculture, SKRAU, Bikaner with ten treatments along with untreated control as detailed below, replicated thrice in Randomized Block Design (RBD).

Gram variety GNG-469 was sown on November 5, 2015 in the plots measuring 3.0 × 2.0 m^2 having row to row and plant to plant distance as 30 cm and 10 cm, respectively. The crop was raised successfully by adopting standard recommended agronomical practices.

The gram seeds were treated with respective insecticides at mentioned rates (Table 1) by using 50 ml of water before 12 hours of sowing.

Observations. Plant population counts were recorded from each plot after 15 days of sowing to know the effect of treatments on seed germination. After one month of germination plant population was recorded from each plot for recording the termite infestation. Numbers of healthy and infested plants were counted before harvesting the crop. Weight of the grain and straw yield of chickpea was recorded from each plot at harvest. The data on per cent infestation were analyzed statically after transforming them to angular value.

RESULTS AND DISCUSSION

Effect of seed treatment on seed germination. Seed treated with various bio-pesticides and chemical

Table 1. Details of treatments against termite in chickpea

S.No.	Name of bio-agent/chemical	Dose
1	Seed treatment with *Beauveria bassiana*	5 g/ kg seed
2	Seed treatment with *Beauveria bassiana*	10 g/ kg seed
3	Seed treatment with *Metarhizium anisopliae*	5 g/ kg seed
4	Seed treatment with *Metarhizium anisopliae*	10 g/ kg seed
5	Seed treatment with *Beauveria bassiana* followed by soil application	5 g/ kg seed 2 kg/ha
6	Seed treatment with *Beauveria bassiana* followed by soil application	10 g/ kg seed 2 kg/ha
7	Seed treatment with *Metarhizium anisopliae* followed by soil application	5 g/ kg seed 2 kg/ha
8	Seed treatment with *Metarhizium anisopliae* followed by soil application	10 g/ kg seed 2 kg/ha
9	Seed treatment with Imidacloprid 70 WS	2 g/ kg seed
10	Seed treatment with Imidacloprid 70 WS followed by soil application of Imidacloprid 17.8 SL	2 g/ kg seed 300 ml/ha
11	Untreated	–

insecticides were evaluated to check the adverse effect on seed germination as data of the plant population recorded at 15 days after sowing was found non significant. The plant population varied from 83.81 to 93.62 per cent in the plots treated with various insecticides. The highest plant population (93.62%) was recorded in plots where seeds were treated with imidacloprid 70 WS @ 2 g per kg seed; whereas, the lowest plant population (83.81%) was recorded in untreated (control) plots (Table 2).

Effect of seed treatment on plant population at 30 days after sowing. The data presented in Table (2) indicate that seed treatment with imidacloprid 70 WS @ 2 g/kg seed (90.51%) followed by soil application of imidacloprid 17.8 SL @ 300 ml/ha was found significantly superior in controlling termite damage over untreated control (90.92%). The lowest plant population was recorded in untreated plots (control).

Effect of seed treatment on infestation of termite at harvest. The mean data presented in Table (2) reveal that all the insecticides/bio-pesticides proved significantly superior over control in the reduction of infestation of termite in chickpea. However, significant difference existed among themselves. The seed treatment with imidacloprid 70 WS followed by soil application of imidacloprid 17.8 SL @ 300ml/ha was found most effective (9.17%). The seed treatment with *M. anisopliae* @ 5 g per kg seed proved least effective followed by seed treatment with *B. bassiana* @ 5 g per kg seed and seed treatment with *M. anisopliae* @ 10 g per kg seed.

Effect of seed treatments on the yield of chickpea. It is evident from the data presented in the Table (3) that all treatments increased yield of chickpea over control. The data indicated that maximum seed yield (13.67 q/ha) was recorded in plots where seeds were treated with imidacloprid 70 WS @ 2 g per kg seed followed by soil application of imidacloprid 17.8 SL @ 300 ml/ha followed by seed treatment with imidacloprid 70 WS @ 2 g per kg seed (11.33 q/ha). The minimum seed yield of 8.00 q/ha was recorded in seed treated with *B. bassiana* @ 5 g per kg seed followed by seed treatment with *B. bassiana* @ 10 g per kg seed (8.27 q/ha) and seed treatment with *M. anisopliae* @ 5 g per kg seed (8.33 q/ha).

Economics of different bio-agents/insecticides. The data presented in Table (3) indicates that maximum net profit of Rs. 38430 was calculated in seeds were treated with imidacloprid 70 WS @ 2 g per kg seed followed by soil application of imidacloprid 17.8 SL @ 300 ml/ha. The minimum net profit of 2588 per ha was recorded in seed treated with *B. bassiana* @ 5 g per kg seed followed by Rs. 4267 per ha in seed treatment with *B. bassiana* @ 10 g per kg seed. Highest incremental benefit cost ratio (B:C ratio 37.09) was computed in seeds treated with imidacloprid 70 WS @ 2 g per kg seed. The minimum B:C ratio 5.46 was obtained in seed treated with *B. bassiana* @ 5 g per kg seed followed by 6.91 in seed treatment with *B. bassiana* @ 5 g per kg seed followed by soil application @ 2 kg/ha and 7.45 in seed.

Investigations on the bio-efficacy of different biopesticides/insecticides against termite in chickpea were carried out. Meager work is available on biopesticides against termite on chickpea; however, the available literature pertaining to efficacy of biopesticides against termite is being compared and discussed. In the present investigation for the management of termite seeds of chickpea were treated with imidacloprid 70 WS @ 2 g per kg, *Beauveria bassiana* @ 5 and 10 g/kg, *Metarhizium anisopliae* @ 5 and 10 g/kg and some treatments were followed by soil application of respective insecticides.

The plant population recorded at 15 days after sowing was found non significant which indicated that there was no adverse effect of these bio-agents on seed germination. Similar results were earlier reported by Thube *et al.* (2014) who reported more than 85 per cent seed germination, where the seeds were treated with imidacloprid 600 FS. Plant population recorded after 30 days of sowing and infestation of termite at harvest indicated that seed treatment with imidacloprid 70 WS followed by soil application of imidacloprid 17.8 SL @ 300 ml/ha was found most effective followed by seed treatment with imidacloprid 70 WS @ 2g/kg seed. The present results are in agreement with those of Panigrahi (2010), Sundriya and Acharya (2012), Gadhiya and Borad (2013), Mahapatro *et al.* (2013) and Singh *et al.* (2015) who reported seed treatment and soil application of imidacloprid as most effective against termite in different crops.

The order of efficacy was seed treatment with *M. anisopliae* @ 10 g per kg seed followed by soil application @ 2 kg/ha, *B. bassiana* @ 10 g/kg seed followed by soil application @ 2 kg/ha, *M. anisopliae* @ 5 g per kg seed followed by soil application @ 2 kg/ha and seed treatment with *B. bassiana* @ 10 g per seed ranked in middle order of their efficacy whereas, the seed treatment with *M. anisopliae* @ 5 and 10 g per kg seed and *B. bassiana* @ 5 g/kg seed proved least effective. Bhat *et al*. (2010) reported 3 isolates of *B. bassiana* proved promising against the grubs of *Aeolesthes sarta* and Kapadia *et al*. (2010) reported soil drenching of *B. bassiana* @ 4 kg/ha ranked in middle order of efficacy among the different products tested, confirm present findings.

The difference in efficacy of the bio-agents/chemicals may be due to local climatic condition, season of the crop sown and difference in soil types.

Table 2. Efficacy of different bio-agents/insecticides as seed treatment against termite on chickpea during *rabi*, 2015-16

S. No.	Name of bio-agent/chemical	Dose	Plant population (%)		Percent infestation at harvest	Yield (q/ha)
			15 DAS	30 DAS		
1	Seed treatment with *Beauveria bassiana*	5 g/ kg seed	85.06 (67.45)	78.79 (62.68)	15.00 (22.78)	8.00
2	Seed treatment with *Beauveria bassiana*	10 g/ kg seed	84.74 (67.32)	80.83 (64.21)	13.33 (21.40)	8.27
3	Seed treatment with *Metarhizium anisopliae*	5 g/ kg seed	85.06 (67.44)	79.84 (63.56)	15.67 (23.31)	8.33
4	Seed treatment with *Metarhizium anisopliae*	10 g/ kg seed	84.57 (67.50)	79.10 (62.99)	14.33 (22.23)	8.50
5	Seed treatment with *Beauveria bassiana* followed by soil application	5 g/ kg seed 2 kg/ha	85.47 (72.81)	90.18 (67.81)	12.67 (20.84)	9.07
6	Seed treatment with *Beauveria bassiana* followed by soil application	10 g/ kg seed 2 kg/ha	90.10 (72.18)	85.42 (67.93)	11.00 (19.37)	9.50
7	Seed treatment with *Metarhizium anisopliae* followed by soil application	5 g/ kg seed 2 kg/ha	89.73 (71.79)	85.05 (67.41)	12.07 (20.32)	9.33
8	Seed treatment with *Metarhizium anisopliae* followed by soil application	10 g/ kg seed 2 kg/ha	90.43 (72.46)	85.21 (67.55)	11.67 (19.97)	9.67
9	Seed treatment with Imidacloprid 70 WS	2 g/ kg seed	93.62 (76.23)	90.92 (73.14)	10.07 (18.48)	11.33
10	Seed treatment with Imidacloprid 70 WS followed by soil application of Imidacloprid 17.8 SL	2 g/ kg seed 300 ml/ha	93.30 (75.51)	90.51 (73.67)	9.17 (17.62)	13.67
11	Untreated	–	83.81 (66.51)	77.11 (61.51)	18.33 (25.34)	7.53
S.Em.±		–	3.15	1.52	1.11	
C.D. (P=0.05)			NS	9.31	2.92	3.26

DAS = days after sowing, NS=Non Significant

Table 3. Comparative economics and incremental B: C ratio of different treatments against termite on chickpea during *rabi*, 2015-16

S.No.	Name of bio-agent/chemical	Dose	Mean yield (q/ha)	Total increase in yield over control (q/ha)	Income of increased yield (Rs.*)	Total cost of protection (Rs. ha^{-1})**	Increase net profit	Incremental B:C ratio
1	Seed treatment with *Beauveria bassiana*	5 g/ kg seed	8.00	0.47	3062	474	2588	5.46
2	Seed treatment with *Beauveria bassiana*	10 g/ kg seed	8.27	0.74	4821	554	4267	7.70
3	Seed treatment with *Metarhizium anisopliae*	5 g/ kg seed	8.33	0.8	5212	494	4718	9.55
4	Seed treatment with *Metarhizium anisopliae*	10 g/ kg seed	8.50	0.97	6320	594	5726	9.64
5	Seed treatment with *Beauveria bassiana* followed by soil application	5 g/ kg seed 2 kg/ha	9.07	1.54	10033	1268	8765	6.91
6	Seed treatment with *Beauveria bassiana* followed by soil application	10 g/ kg seed 2 kg/ha	9.50	1.97	12835	1348	11487	8.52
7	Seed treatment with *Metarhizium anisopliae* followed by soil application	5 g/ kg seed 2 kg/ha	9.33	1.8	11727	1388	10339	7.45
8	Seed treatment with *Metarhizium anisopliae* followed by soil application	10 g/ kg seed 2 kg/ha	9.67	2.14	13942	1488	12454	8.37
9	Seed treatment with Imidacloprid 70 WS	2 g/ kg seed	11.33	3.8	24757	650	24107	37.09
10	Seed treatment with Imidacloprid 70 WS followed by soil application of Imidacloprid 17.8 SL	2 g/ kg seed 300 ml/ha	13.67	6.14	40002	1572	38430	24.45
11	Untreated	–	7.53	–	–	–	–	–

*Cost of seed grains of chickpea at current season was Rs. = 6515 per quintal; **Includes cost of insecticides and labour involved in application; Number of man days/ha/application = 2; Labour charges @ Rs. 197/man

The data reveal that all the biopesticides/insecticides increased the yield of chickpea significantly over control. The maximum yield (13.67 q/ha) was recorded in the plots where seed were treated with imidacloprid 70 WS @ 2 g/kg seed followed by soil application of imidacloprid 17.8 SL @ 300 ml/ha followed by seed treatment with imidacloprid 70 WS @ 2 g/kg seed (11.33 q/ha). The present results are in conformity with those of Singh *et al.* (2004), Mishra *et al.* (2007), Panigarhi (2010), Mahapatro *et al.* (2013) and Singh *et al.* (2015) who reported significantly superior mean yield over control due to the seed treatment and soil application of imidacloprid.

In the present studies minimum seed yield 8.00 q/ha was recorded in seed treated with *B. bassiana* @ 5 g/kg seed followed by seed treatment with *B. bassiana* @ 10 g/kg seed (8.27 q/ha) and seed treatment with *M. anisopliae* @ 5 g/kg seed (8.33 q/ha). No work is available on the impact of *B. bassiana* and *M. anisopliae* on seed yield of chickpea hence these could not be compared and discussed.

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REFERENCES

Anonymous, 2015. Reports of Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India. 03 pp

Bhat, J.A., Wani, N.A., Mohi- ud-din, S., Lone, G.M. and Pukhta, M.S. 2010. Relative virulence of local entomopathogenic fungal isolates infecting apple stem borer, *Aeolesthes sarta* Solsky. *Annals of Plant Protection Sciences,* **18**: 153-155.

Directorate of Plant Protection, Quarantine & Storage. 2001. IPM programme for groundnut. (www.ppqs.gov.in accessed on14/01/2018).

Gadhiya, V.C. and Borad, P.K. 2013. Effects of insecticidal seed treatments on reduction of termite damage and increase in wheat yield. *Pesticide Research Journal*, **25** : 87-89.

Gaur, P.M., Tripathi, S., Gowda, C.L.L., Ranga Rao, G.V., Sharma, H.C., Pande, S. and Sharma, M. 2010. *Chickpea seed production manual*. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp.

Kapadia, M.N., Butani, P.G., Jethva, D.M., Virani, V.R. and Beria, N.N. 2010. Management of white grub, *Apogonia rauca* (Feb.) in groundnut. *Annals of Plant Protection Sciences,* **18** : 86-89.

Logan, J.W.M., Cowie, R.H. and Wood, T.G. 1990. Termite (Isoptera) control in agricultural and forestry by non-chemical methods: A review. *Bulletin of Entomological Research*, **80:** 309-330.

Mahapatro, G.K., Das, T.K., Mukherjee, I. and Gajbhiye, V.T. 2013. Biorational termite management in wheat agro system. *Indian Journal of Entomology*, **75**: 336-361.

Michael, L. 2005. Biocontrol control in termite management: the potential of nematodes and fungal pathogen. Proc. 5th Internat. Conf. on urban pests, July 11-13.

Milner, R.J. 2003. Application of biological control agents in mound building termites (Isoptera: Termitidae): Experience with *Metarhizium* in Australia. *Sociobiology*, **41:** 419-428.

Milner, R.J, Staples, J.A. and Lutton, G.G. 1998. The selection of an isolates of the Hyphomycete fungus, *Metarhizium anisopliae,* for control of termites in Australia. *Biological Control*, **11**:240-247.

Mishra, D.N., Yadav, V. and Chandrapal. 2007. Effect of seed treatment with different insecticides against field termites, *Odontotermes obesus* Rampur and *Microtermes obesi* holmgren damage in wheat (*Triticum aestivum*) under mid-western plain zone of UP. *Environmental Ecology,* **25** : 943-944.

Nautiyal, P.C. 2002. Groundnut: post-harvest operations. (Eds. AGSI/FAO: Danilo Mejia, Beverly Lewis). 126 pp.

Panigrah, D. 2010. Chemical seed treatment for management of termite in chickpea. *Annals of Plant Protection Sciences*, **18** : 90-93.

Parihar, D.R. 1981. Termite pest of vegetation in Rajasthan and their management. Central Arid Zone Research Institute, Monograph No. 16:31.

Parsai, S.K. 2005. Damage by pod borer, *H. armigera* (Hub.) to different varieties of chickpea. *Food legumes*, **21** (2): 135-136.

Rao, K.R. and Azad, T.N.S. 2009. Seed treatment and intercrop systems for the management of leaf floder (*Nacoleia vulgalis*) and stem fly (*Ophiomyia phaseoli*) in soybean (*Glycine max*). *Indian Journal of Agricultural Sciences*, **79**: 662-665.

Roonwal, M.L. and Chhotani, O.B. 1989. Fauna of India-Isoptera (Termites). Zoological Survey of India, I: 672-672.

Sekamatte, M.B., Latigo, M.W.O. and Smith, A.R. 2001. Evaluation of plant protectants on damage and yield of rainfed maize by termites. *Pesticide Research Journal*, **15**:36-39.

Singh, R., Bhatnagar, A. and Singh, D.V. 2015. Management of termite, *Odontotermes obesus* in chickpea. *Annals of Plant Protection Sciences,* **23**: 158-199.

Singh, S, Choudhary, D.P. and Jat, K.L. 2004. Management of termite *Odontotermes obesus* Rubs. in pearl millet. *Indian Journal of Entomology,* **66**: 148-150.

Sundriya, M.M. and Acharya, V.S. 2012. Eco-friendly management of termites in wheat. Paper presented in *National seminar on emerging pest problems and their bio-rational management,* held at department of Entomology, Rajasthan College of Agriculture, MPUAT, Udaipur, pp. 170-171.

Thube, S.H., Mahapatro, G.K. and Arunkumar, M.B. 2014. In vitro evaluation of insecticidal seed treatments in wheat. *Indian Journal of Entomology,* **76**: 215-218.

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