

Effect of organic amendments on termite infestation in chickpea

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Summary

The field experiment was conducted at the Research farm, Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner, during *Rabi* season in randomized block design with nine treatments, including the control. Out of the seven organic amendments, tested against termites in chickpea, the application of neem cake recorded the lowest 9.97 per cent termite damaged plants, followed by vermicompost (10.43). The highest termite damaged plants (19.53) were observed in plots treated with FYM followed by groundnut cake treated plots (19.47). The maximum grain yield (1325 kg ha⁻¹) was obtained from the plots treated with neem cake, followed by vermicompost (1205 kg ha⁻¹). The minimum yield (1060 kg ha⁻¹) was obtained from the plots treated with FYM. The maximum profit (Rs 8790 ha⁻¹) was obtained from the treatment of vermicompost, followed by poultry manures (Rs 7010 ha⁻¹). The highest incremental cost-benefit ratio (ICBR) of 0.96 was obtained from vermicompost followed by poultry manures (0.69).

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Introduction

Pulses occupy a unique position in Indian agriculture as well as in the world but chickpea (*Cicer arietinum* L.) is considered as “king of pulses is one of the most important and remunerative pulse crops belonging to family Leguminosae. India is the largest producer of pulses in the world. In India, chickpea is cultivated in an area of 10.2 million hectares with an annual production of 9.90 million tonnes (Anonymous 2015). 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 an area of 15.36 lakh hectares with an annual production of 12.52 lakh tonnes (Anonymous, 2015b). Chickpea is nutritionally prosperous source of protein (18-22%), carbohydrate (61-63%) and fat (4-5%) and also contains calcium, phosphorus, iron, niacin, vitamin B and C. It provides a valuable protein supplement to the diet of the predominantly vegetarian human population; besides it contributes to the national income. It is also considered to have medicinal value for blood purification and is beneficial for diabetic patients

Many biotic constraints hamper chickpea production of which infestation of insect pests is a major one and attacked by 24 species of insect pests (Singh 1998). Among them, termite are the most primitive social insects in the animal kingdom belonging to the order Isoptera. Termites damage the seedlings at the soil surface and mature plants are fed from the root system and inside the stems. Severely infested plants wilt, dry up

and can be easily pulled up. It inflicts heavy damage to the cultivated crop in sandy loam soil and damages the crops from sowing till harvest. Infestation is severe in the dry season (Mehta & Verma, 1968; Haldhar & Deshwal 2017). Insecticides are evaluated as seed treatments for their efficacy.

Chemical insecticides are only the alternative that works as a frontline defence source to combat the problem of any insect pest in any crop. Some newer insecticides with different mode of action in the market are available and need to be evaluated as seed treatments for their efficacy (Bushra & Devi 2020; Haldhar & Maheshwari 2021). Since certain varieties are more preferred by a pest as compared to others or some may bear the losses caused by the pest, the study of the termite damage on different varieties of chickpea would be done to find out the least susceptible varieties. The widespread use of chemical insecticides leads to number of serious well-documented problems like pest resurgence, resistance to insecticides, a health hazard to man, domestic animals and wildlife, reduction in natural enemies of the pest, air, water and soil pollution (Haldhar et al. 2017). So, to minimize these adverse consequences of the pesticides, the use of organic amendments for the management of termite in chickpea were also included in the present study.

Material and Methods

The present study was conducted at the Research farm, Agriculture Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi* season in randomized block design with nine treatments including the control. The crop was grown in plot size 3 x 4 m, with row to row and plant-to-plant spacing of 30 and 10 cm respectively. The crop was sown on 15th

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November 2016. The crop was raised successfully by adopting standard recommended agronomical practices. Seven different organic amendments were tested to find out their effects on the management of the termite in chickpeas as soil application at the time of land preparation before sowing. For recording observations on termite incidence, infested and healthy plants were counted at ten days interval from 3m length (each of 1m) of each plot starting from 20 DAS to the harvest of the crop and transformed into % plant damage.

Avoidable losses and increase in yield

The avoidable loss and increase in grain yield over untreated check was calculated for each treatment by the following formula:

$$\text{Increase in yield} = (\%) \frac{\text{Yield in treatment} - \text{Yield in control}}{\text{Yield in control}} \times 100$$

$$\text{Avoidable loss} = (\%) \frac{\text{Highest yield in the treated plot} - \text{Yield in the treatment}}{\text{Highest yield in the treated plot}} \times 100$$

To determinate the most effective and economical treatment, the net profit and incremental benefit-cost ratio were worked out by taking the expenditure on individual insecticidal treatment and the corresponding yield into account.

Results and Discussion

Termite damage

The data presented in table 1 showed that all the organic amendment treatments were found significantly superior over control till 110 days after sowing. 20 days after sowing, the lowest termite damage (0.60%) was noted in plots treated with neem cake and it was at par with vermicompost (0.83%) and cotton cake (0.97%). However, poultry manures (1.80%) were superior to mustard cake (2.03%) and it was at par with groundnut cake (2.40%). The highest termite-damaged plants were observed in plots treated with FYM (3.27%) and found to be significantly inferior to the rest of the treatments.

30 days after sowing, the lowest plant damage (0.93%) was noted in the plots treated with neem cake and it was at par with vermicompost (1.10%) and cotton cake (1.29%). The next effective treatment was poultry manures (1.87%) and mustard cake (2.17%). The highest termite damaged plants (3.50%) were observed in plots treated with FYM followed by groundnut cake (2.63%). The minimum damage (1.06%) was observed in the treatment of neem cake and it was close at par with vermicompost (1.23%) 40 days of sowing. Cotton cake (1.91%) applied plots were also found as effective as poultry manures (1.93%). The highest termite damage (3.97%) was recorded in the plots treated with FYM and it was at par with groundnut cake (3.40%). 50 days after sowing, the minimum termite damage (1.29%) was observed in the treatment of neem cake and it was close

at par with vermicompost (1.23%). Cotton cake (2.57%) applied plots were also found as effective as poultry manures (2.63%). However, it differed significantly with mustard cake (3.47%). The highest damage (4.17%) was recorded in FYM applied plots and it was at par with groundnut cake (4.03%).

60 days after sowing, the lowest termite damage (1.46%) was noted in the plots treated with neem cake and it was at par with vermicompost (1.67%). Cotton cake (3.07%) was found effective as poultry manures (3.20%). The highest termite damage (4.97%) was recorded in FYM applied plots followed by groundnut cake (4.77%) and mustard cake (4.10%). The minimum termite damage (1.83%) was observed in the treatment of neem cake and it was close at par with vermicompost

(2.27%) after 70 days of sowing. The successive effective treatments against termite were cotton cake (4.10%), poultry manures (4.33%) and mustard cake (4.97%). The highest termite damage (6.40%) was recorded in FYM applied plots and it was at par with

groundnut cake (6.33%).

The minimum termite damage (2.97%) was observed in the treatment of neem cake and it was closely at par with vermicompost (3.50%) after 80 days after sowing. Cotton cake (6.03%) applied plots were also found as effective as poultry manures (6.07%). However, it differed significantly from mustard cake (7.23%). The highest termite damage (9.40%) was recorded in FYM applied plots followed by groundnut cake (8.73%) and both were at par.

90 days after sowing, the lowest termite damage (4.17%) was recorded in the plots treated with neem cake and it was at par with vermicompost (4.67%). Cotton cake (8.40%) applied plots were also found as effective as poultry manures (8.57%) and mustard cake (10.40%). Among the evaluated amendments, the highest damage was (12.73%) noted in the plots treated with FYM and it was at par with groundnut cake (12.27%).

100 days after sowing, the lowest plant damage (7.30%) was noted in the plots treated with neem cake and it was at par with vermicompost (8.17%). Cotton cake (11.17%) applied plots were also found as effective as poultry manures (11.53%). The highest termite damage (17.40%) was recorded in FYM applied plots and it was at par with groundnut cake (17.27%) but differed significantly with mustard cake (13.37%).

110 days after sowing, the lowest termite damage (9.97%) was recorded in the plots treated with neem cake followed by vermicompost (10.43%) and both were at par. Cotton cake (12.10%), poultry manures (12.36%) and mustard cake (14.43%) were moderate against termites in chickpea. The highest termite damage (19.53%) was found in FYM applied plots and it was at par with groundnut cake (19.47%).

The present findings are supported with Gadhiya (2012) reported that the soil application of castor cake, vermicompost and neem cake @ 1 tonne/ha at the time of land preparation highly effective in suppressing the termite population in wheat. Similarly, Kumar (2013) applied eight organic amendments in soil during land preparation to know their effect on termites in wheat. The application of neem cake @ 1 tonne ha⁻¹ most effective in managing the termite damaged plant

followed by bone meal cake @ 1 tonne ha⁻¹ and vermicompost @ 1 tonne ha⁻¹ supports the present findings. Likewise, Gohil (2013) reported that the soil application of neem cake @ 1 tonne ha⁻¹, castor cake @ 1 tonne ha⁻¹ and vermicompost @ 1 tonne ha⁻¹ at the time of land preparation before sowing to be most effective in suppressing the incidence of termite in groundnut during *Kharif* season.

Table 1. Effect of organic amendments on termite infestation in chickpea

S No	Treatment	Termite damaged plants (%) day after sowing									
		20	30	40	50	60	70	80	90	100	110
1.	Cotton cake	0.97 (5.64)*	1.29 (6.52)	1.91 (7.93)	2.57 (9.21)	3.07 (10.08)	4.10 (11.68)	6.03 (14.22)	8.40 (16.85)	11.17 (19.52)	12.10 (20.36)
2.	vermi-compost	0.83 (5.23)	1.20 (6.25)	1.23 (6.35)	1.43 (6.83)	1.67 (7.39)	2.27 (8.57)	3.50 (10.70)	4.67 (12.42)	8.17 (16.59)	10.43 (18.80)
3.	Mustard cake	2.03 (8.19)	2.17 (8.45)	2.53 (9.12)	3.47 (10.72)	4.10 (11.68)	4.97 (12.88)	7.23 (15.60)	10.40 (18.81)	13.37 (21.43)	14.43 (22.32)
4.	Neem cake	0.60 (4.43)	0.93 (5.52)	1.06 (5.91)	1.29 (6.51)	1.46 (6.91)	1.83 (7.77)	2.97 (9.91)	4.17 (11.77)	7.30 (15.67)	9.97 (18.40)
5.	FYM	3.27 (10.41)	3.50 (10.77)	3.97 (11.49)	4.17 (11.77)	4.97 (12.87)	6.40 (14.65)	9.40 (17.85)	12.73 (20.91)	17.40 (24.65)	19.53 (26.23)
6.	Groundnut cake	2.40 (8.90)	2.63 (9.53)	3.38 (10.59)	4.03 (11.58)	4.77 (12.61)	6.33 (14.57)	8.73 (17.19)	12.27 (20.50)	17.27 (24.55)	19.47 (26.23)
7.	Poultry manures	1.84 (7.80)	1.87 (7.85)	1.93 (7.98)	2.63 (9.33)	3.20 (10.30)	4.33 (12.01)	6.07 (14.26)	8.57 (17.02)	11.53 (19.85)	12.63 (20.82)
8.	Control	4.43 (12.04)	4.50 (12.16)	6.10 (14.30)	7.17 (15.52)	7.97 (16.39)	10.20 (18.62)	16.37 (23.86)	24.50 (29.67)	30.33 (33.42)	34.73 (36.11)
S. Em. ±		0.45	0.37	0.29	0.30	0.28	0.32	0.32	0.30	0.32	0.33
CD at 5%		1.36	1.11	0.83	0.91	0.84	0.98	0.96	0.92	0.97	0.99

* Figures in parentheses are arcsine value.

Grain yield, Avoidable losses and Economics

Data on grain yield, avoidable losses and economics are presented in Table 2 and 3.

Grain yield

The organic amendment applied plots produced significantly higher yield over control (Table 2). The maximum (1325 kg ha⁻¹) grain yield was obtained from the plots treated with neem cake and it was at par with vermicompost (1305 kg ha⁻¹), poultry manures (1290 kg ha⁻¹) and cotton cake (1255 kg ha⁻¹). Among the evaluated organic amendments, the minimum (1060 kg ha⁻¹) yield was obtained from the plots treated with FYM and it was at par with groundnut cake (1170 kg ha⁻¹) and mustard cake (1190 kg ha⁻¹).

However, Singh et al. (2010) reported that using dry powder of immature neem kernels and leaves @ 50 kg ha⁻¹ in the integration of plant nutrients gave wheat a significantly higher economic return by 45.80 q ha⁻¹ and checked the incidence of termites. Similarly, Gohil (2013) obtained the maximum pod yield (2411 kg ha⁻¹) from the plot treated with neem cake followed by castor cake (2223 kg ha⁻¹) and vermicompost (2141 kg ha⁻¹) during *Kharif* season support the present findings.

Avoidable losses and increase in yield over control

The per cent increase in grain yield of chickpea over control was also worked out and presented in table 4.7. The maximum grain yield (38.02%) was increased in the

plots treated with neem cake followed by vermicompost (35.94%) and poultry manure (34.38%). The increase in yield over control was (23.96%) and (30.73%) in mustard cake and cotton cake applied plots respectively. The minimum increase in yield over control was (10.42%) in plots treated with FYM followed by groundnut cake (21.88%).

The data showed in table 2 indicated that the avoidable losses in grain yield of chickpea varied from 1.51 to 20.00 per cent in different treatments, considering the maximum (1325 kg ha⁻¹) yield of neem cake taken as base. The avoidable loss was 1.51 and 2.64 per cent in vermicompost and poultry manure treatments, respectively. It varied from 5.28 to 11.70 per cent in cotton cake, mustard cake and groundnut cake. The avoidable loss was highest (20%) in the treatments of FYM.

Gadhiya (2012) calculated maximum net realization (Rs 54773.19 ha⁻¹) in wheat from the treatment of castor cake. It was Rs 46828.74 ha⁻¹ and Rs 41720.5 ha⁻¹ in vermicompost and neem cake treatments, respectively partially support the present findings. Similarly, Kumar (2013) obtained the maximum net realization Rs 24703 ha⁻¹ from the treatment of neem cake followed by bone meal (Rs 18275 ha⁻¹) and vermicompost (Rs 15783 ha⁻¹) in wheat infested by termite. Likewise, Gohil (2013) calculated maximum net realization Rs 75867 ha⁻¹ in

neem cake followed by castor cake (Rs 64783 ha⁻¹) and vermicompost (Rs 59682 ha⁻¹) in groundnut infested by termite during kharif season support the present findings.

Economics

The economics of different organic amendments used for managing termite infestation in chickpea crop presented in table 3 showed that maximum net realization (Rs 8790 ha⁻¹) in the treatment of vermicompost whereas it was 7010 and 830 Rs. ha⁻¹ in poultry manure and neem cake treatments, respectively. The cotton cake, mustard cake, groundnut cake and FYM applied plots resulted the net realization of -7810, -8190, -10230 and -14950 Rs. ha⁻¹ respectively. Looking to the

ICBR, the highest 0.96 return was obtained with vermicompost treatment. The ICBR of poultry manures and neem cake was 0.69 and 0.05 respectively. The treatments of cotton cake, mustard cake, groundnut cake and FYM gave negative ICBR ranged from -0.34 to -0.74.

These results are agreement with the findings of Gadhiya (2013) who reported the highest ICBR (30.42) with the treatment of poultry manure. Similarly, Kumar (2013) recorded highest ICBR (8.84) from the treatment of poultry manures (1 tonne/ha) followed by neem cake (1.00). Likewise, Gohil (2013) computed highest ICBR (56.61) from the treatment of poultry manures (1 tonne/ha) in groundnut infested by termite during Kharif season.

Table 2. Assessment of losses caused by termite in chickpea during rabi season

Treatments	Dose (t/ha)	Yield (kg ha ⁻¹)	Total avoidable losses (kg ha ⁻¹)	Avoidable losses (%)	Total Increase in yield over Control (kg ha ⁻¹)	Increase in yield over Control (%)
Cotton cake	1.0	1255	70	5.28	295	30.73
Vermi-compost	1.0	1305	20	1.51	345	35.94
Mustard cake	1.0	1190	135	10.19	230	23.96
Neem cake	1.0	1325	00	0.00	365	38.02
Groundnut cake	1.0	1170	155	11.70	210	21.88
FYM	10.0	1060	265	20.00	100	10.42
Poultry manures	1.0	1290	35	2.64	330	34.38
Control	-	960	365	27.55	00	0.00
S. Em.±	-	39	-	-	-	-
CD at 5%	-	119	-	-	-	-

* Highest yield among the treatments.

Table 3. Comparative economics of organic amendments against termite in chickpea during rabi season

S. No.	Treatments	Conc./ Dose (t/ha)	Mean yield (kg ha ⁻¹)	Increase in yield over control (kg ha ⁻¹)	Cost of increased yield *(Rs. ha ⁻¹)	Total expenditure **(Rs. ha ⁻¹)	Net profit (Rs. ha ⁻¹)	ICBR
1	Cotton cake	1.0	1255	295	15340	23150	-7810	-0.34
2	Vermi-compost	1.0	1305	345	17940	9150	8790	0.96
3	Mustard cake	1.0	1190	230	11960	20150	-8190	-0.41
4	Neem cake	1.0	1325	365	18980	18150	830	0.05
5	Groundnut cake	1.0	1170	210	10920	21150	-10230	-0.48
6	FYM	10.0	1060	100	5200	20150	-14950	-0.74
7	Poultry manures	1.0	1290	330	17160	10150	7010	0.69
8	Control	-	960	00	0.00	0.00	0.00	0.00

* Cost of gram at current season was 5200/- per quintal.

** Included the cost of organic amendments and labour involved.

Conclusion

Seven different organic amendments were tested as a soil application to know their effects on termite management in chickpea. The application of neem cake (1 tonne ha⁻¹) was found to be most effective, followed by vermicompost (1 tonne ha⁻¹). The maximum grain yield (1325 Kg ha⁻¹) was recorded from the neem cake (1 tonne ha⁻¹). However, maximum profit (Rs 8790 ha⁻¹) and incremental cost-benefit ratio of 0.96 was obtained from vermicompost treatment (1 tonne ha⁻¹).

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Conflict of interest

The authors of this research paper, "Effect of organic amendments on termite infestation in chickpea," declare that no competing interests could influence the objectivity, integrity, or validity of the research findings presented in this paper.

Declaration of interests

The authors have no conflict of interest to declare.

Data Sharing

All relevant data are within the manuscript.

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