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Bio-efficacy of Biodynamic Applications against Sucking Pest of Black Gram (*Vigna mungo* L.) and Their Impact on Natural Enemies

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

An experiment was conducted at Adhartal farm, Integrated Farming System unit, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during *kharif* season 2022-23. Two spraying of brahmastra @ 45ml/L initiating on 21 DOC and repeated at 15 days interval was found to be most effective in reducing whitefly and jassid population and registered higher grain yield and also found to be most economic (1:16.53) followed by brahmastra @ 30ml/L (1:11.95), agniastra @ 45ml/L (1:9.31), agniastra @ 30ml/L (1:5.83), neemastra @ 45ml /L (1:5.39) and neemastra @ 30ml /L (1:3.45). The four biodynamics *viz.,* brahmastra, agniastra, neemastra and dashparni ark were safe for potent predators (Lady bird beetles and spider).

Keywords: Agniastra; neemastra; brahmastra; dashparni; biodynamics.

1. INTRODUCTION

Blackgram, *Vigna mungo* (Linn.) Hepper, also known as urdbean, mash, mungobean, mashkalai and black mapte etc. (Yadav *et al*., 2015). Black gram is one of the most important pulse crops in India. It is attacked by several insect pests. This manuscript determines the bio-efficacy of biodynamic practices by evaluating sustainable pest management approaches as indiscriminate use of insecticides contaminate the ecology and also leads to develop resistance in insects. Its findings can help to reframe integrated pest management strategies in improving crop yields. Moreover, the study provides insights into conserving natural enemies which are crucial in long-term pest management. It belongs to the family Leguminaceae, sub family Papilionaceae. India is the largest producer as well as consumer of black gram. It accounts for about 13% of India's total pulse production. The major black gram producing states in India are Madhya Pradesh, Rajasthan, Uttar Pradesh, Tamil Nadu, Andhra Pradesh and Maharashtra. During 2021-22, Madhya Pradesh ranked 1st both in area (17.26 lakh ha) and production (8.61 lakh tonnes) with productivity of 500 kg/ha (Anonymous, 2022).The annual yield loss due to the insect pests has been estimated at about 30 per cent in black gram (Gailce *et al*., 2015). The low crop productivity has been attributed to many factors and among them insect pest infestation is a major limiting factor. Black gram is attacked by more than 200 insect pests , belonging to 48 families from the order of Lepidoptera, Coleoptera, Hemiptera, Hymenoptera, Diptera, Orthoptera, Thysanoptera and Isoptera and 7 mites species (Acarina) were reported to inflict severe damage at different crop growth stages in different agro climatic condition (Naik *et al*., 2019). Among them the sucking pest complex includes, whitefly, Aphid, Jassid and green leaf hopper, while Grasshopper, Leaf webber, Grey weevil, Tobacco caterpillar, Bihar hairy caterpillar, Leaf miner and Epilachna beetle as foliage feeders (Kundu *et al.,* 2021). Among them whitefly is considered as the most devastating insect, it has been one of the most serious agriculture pests in many. Further this complex situation have compelled the farmers to spray various insecticides which results not only in economical losses but also produces adverse impacts both on the flora and fauna as well as on the environment (Kapoor & Shankar, 2019). Present research was undertaken to find out the relationship between pest population, natural enemies and the abiotic factors. To reduce the pesticide hazards, one of the resorts is the application of insecticides of plant and animal origin. In this context, biodynamics is being considered as environmentally safe, selective, biodegradable, economical and renewable alternative for use in Integrated Pest Management programmes.

2. MATERIALS AND METHODS

Pre-treatment observations of major insects of black gram were recorded at one day before spray and post treatment observations at 3, 7 and 10 days after each spray on randomly selected 10 plants per plot/ treatment (Singh *et al*, 2019). Jassids (nymph and adult) population were recorded on two leaves each from upper, middle and lower canopy of the plant (Kundu *et al*, 2021). Adult whitefly per plant was counted with the help of cage (Marabi *et al,* 2017).

Table 1. Treatment details

Treatment	Treatments	Dose (ml/L)
T_1	*Brahmastra*	30
T_2	*Brahmastra*	45
T_3	*Agniastra*	30
T_4	*Agniastra*	45
T_5	*Neemastra*	30
T_6	*Neemastra*	45
T_7	*Dashparni ark*	30
T_8	*Dasparny ark*	45
T_9	Control	

Population of beetles and spiders were counted on per plant basis. Grain yield per plot was recorded at harvest. Bio-efficacy and economics of the treatments were worked out. Experiment was conducted of randomized block design, 8 treatment were including with control plot, 3 replications and plot size was 15 x 1.6 m. Given the insect population in the experimental location, two sprays were applied as needed. The following are treatment details.

3. RESULTS AND DISCUSSION

3.1 Whitefly

Population of whitefly in all the treatments was significantly superior than control plot (5.06 adult whitefly / plant). The lowest mean population of whitefly was recorded with brahmastra 45ml (3.87 adult whitefly / plant) which was significantly better than other treatments followed by brahmastra @ 30ml/L (3.91 adult whitefly / plant), agniastra @ 45ml/L (3.93 adult whitefly / plant), agniastra @ 30ml/L (3.96 adult whitefly / plant), neemastra @ 45ml/L (3.99 adult whitefly / plant) and neemastra @ 30ml/L (4.01 adult whitefly / plant) which were found at par with each other. The next effective treatments were dashparni ark @ 45ml/L (4.04 adult whitefly / plant) and dashparni ark @ 30ml/L (4.11 adult whitefly / plant) which were at par with each other. The present findings are in agreement with the findings of Patel *et al.,* (2017) they also reported that brahmastra @ 20% was found highly effective in suppressing the sucking pest complex of cotton *viz.,* aphid, leafhopper, thrips and whitefly and recorded highest seed cotton yield, followed by agniastra @ 20% and neemastra @ 20%, respectively. Similar findings have been documented by Negi *et al.,* (2022) and Shiwani *et al.,* (2022) that brahmastra, agniastra, neemastra were highly effective against mite , fall army worm , shoot and fruit borer and cutworm in brinjal , sorghum and brinjal, respectively.

3.2 Jassids

Population of jassids in all the treatments was significantly inferior than control (5.46 jassids / 2 leaves). The lowest mean population of jassid was recorded with brahmastra @ 45ml/L (4.33 jassids / 2 leaves), followed by brahmastra @ 30ml/L (4.38 jassids / 2 leaves) but were at par with each other. The next group of effective treatments were agniastra @ 45ml/L (4.40 jassids / 2 leaves) and agniastra @ 30ml/L (4.43 jassids / 2 leaves) but was found to be non-significant. A similar trend was also observed against jassid. At 3, 7 and 10 days after treatment, brahmastra @ 45ml/L and 30 ml /L were found to be most effective and recorded minimum jassid population. It was followed by agniastra @ 45ml/L, agniastra @ 30ml/L, neemastra @ 45ml /L and neemastra @ 30ml /L, but were found to be at par with each other. Dashparni ark @ 30 and 45 ml / L was found to be least effective against jassid. The present findings are in agreement with the findings of Patel *et al.,* (2017) they also reported that brahmastra @ 20% was found highly effective in suppressing the sucking pest complex of cotton *viz.,* aphid, leafhopper, thrips and whitefly and recorded highest seed cotton yield, followed by agniastra @ 20% and neemastra @ 20%, respectively.

Table 2. Bio-efficacy of biodynamics against major insect pest complex of black gram and their impact on natural enemies

Tr. code	Insect pests						Natural enemies					
	Adult white fly / plant			Jassids/ 2 leaves			Lady bird beetle /plant			adult spider /plant		
	After 1st spray	After 2nd spray	Mean of two sprays	After 1st spray	After 2nd spray	Mean of two sprays	After 1st spray	After 2nd spray	Mean of two sprays	After 1st spray	After 2nd spray	Mean of two sprays
T_1	4.21 (2.05) ^{bc}	3.23 (1.80) ^{b}	3.91 (1.98) ^{cd}	4.46 (2.11) ^{f}	4.29 (2.07) ^{cd}	4.38 (2.09) ^{ef}	0.64 (0.80)	0.64 (0.80)	0.64 (0.80)	0.47 (0.68)	0.56 (0.75)	0.51 (0.71)
T_2	4.17 (2.04) ^{c}	3.19 (1.79) ^{b}	3.87 (1.97) ^{d}	4.40 (2.10) ^{g}	4.26 (2.06) ^{d}	4.33 (2.08) ^{f}	0.58 (0.75)	0.58 (0.77)	0.59 (0.76)	0.43 (0.64)	0.50 (0.70)	0.45 (0.66)
T_3	4.26 (2.06) ^{bc}	3.28 (1.81) ^{b}	3.96 (1.99) ^{cd}	4.52 (2.12) ^{e}	4.35 (2.08) ^{bcd}	4.43 (2.10) ^{de}	0.61 (0.78)	0.55 (0.74)	0.58 (0.76)	0.39 (0.61)	0.45 (0.65)	0.41 (0.63)
T_4	4.23 (2.05) ^{bc}	3.25 (1.80) ^{b}	3.93 (1.98) ^{cd}	4.49 (2.12) ^{e}	4.31 (2.08) ^{bcd}	4.40 (2.10) ^{de}	0.57 (0.75)	0.66 (0.81)	0.61 (0.78)	0.43 (0.65)	0.42 (0.64)	0.43 (0.65)
T_5	4.31 (2.07) ^{bc}	3.34 (1.83) ^{b}	4.01 (2.00) ^{cd}	4.57 (2.14) ^{c}	4.40 (2.10) ^{bc}	4.48 (2.12) ^{bc}	0.53 (0.73)	0.54 (0.73)	0.54 (0.73)	0.46 (0.67)	0.54 (0.73)	0.48 (0.69)
T_6	4.28 (2.06) ^{bc}	3.32 (1.82) ^{b}	3.99 (2.00) ^{cd}	4.53 (2.13) ^{d}	4.37 (2.09) ^{bcd}	4.45 (2.11) ^{cd}	0.52 (0.72)	0.62 (0.79)	0.57 (0.75)	0.45 (0.66)	0.44 (0.65)	0.44 (0.65)
T_7	4.36 (2.08) ^{b}	3.48 (1.87) ^{b}	4.11 (2.03) ^{b}	4.63 (2.15) ^{b}	4.46 (2.11) ^{b}	4.54 (2.13) ^{b}	0.56 (0.75)	0.60 (0.77)	0.58 (0.76)	0.49 (0.69)	0.47 (0.67)	0.47 (0.68)
T_8	4.33 (2.08) ^{b}	3.38 (1.84) ^{b}	4.04 (2.01) ^{bc}	4.59 (2.14) ^{c}	4.42 (2.10) ^{bc}	4.51 (2.12) ^{bc}	0.60 (0.77)	0.68 (0.82)	0.64 (0.80)	0.49 (0.69)	0.50 (0.70)	0.49 (0.69)
T_9	5.18 (2.27) ^{a}	4.50 (2.12) ^{a}	5.06 (2.26) ^{a}	5.40 (2.36) ^{a}	5.35 (2.31) ^{a}	5.46 (2.34) ^{a}	0.62 (0.78)	0.67 (0.82)	0.64 (0.80)	0.41 (0.63)	0.45 (0.66)	0.43 (0.66)
SEm±	0.01	0.02	0.009	0.002	0.01	0.005	0.02	0.02	0.02	0.01	0.03	0.02
CDat 5%	0.02	0.07	0.02	0.005	0.03	0.01	NS	NS	NS	NS	NS	NS

Figures in the parentheses are square root transformed values; NS = Non significant; DMRT test - Means followed by different letters are significantly different

Table 3. Efficacy and economics of bio-dynamics against major insect pests on black gram

Tr. code	Grain yield (Kg/ha)	Increase in yield over control (Kg/ha)	Cost of ingredients (Rs/ha)*	Cost of preparation of treatments (Rs/ha)**	Labour wage (Rs/day)#	Cost of spray(Rs/ha)			Cost of increase in yield over (Rs/ha)##	Net Profit (Rs/ha)	ICBR
						1st	2nd	Total			
T_1	915.41 ^{b}	471.09 ^{b}	-	600	600	1200	1200	2400	31091.94	28692	1:11.95
T_2	1081.62 ^{a}	637.30 ^{a}	-	600	600	1200	1200	2400	42061.80	39662	1:16.53
T_3	713.31 ^{d}	268.99 ^{d}	100	600	600	1300	1300	2600	17753.56	15154	1:5.83
T_4	850.28 ^{c}	405.96 ^{c}	100	600	600	1300	1300	2600	26793.36	24193	1:9.31
T_5	606.00 ^{f}	161.68 ^{f}	-	600	600	1200	1200	2400	10671.10	8271	1:3.45

Tr. code	Grain yield (Kg/ha)	Increase in yield over control (Kg/ha)	Cost of ingredients (Rs/ha)*	Cost of preparation of treatments (Rs/ha)**	Labour wage (Rs/day)#	Cost of spray(Rs/ha)			Cost of increase in yield over (Rs/ha)##	Net Profit (Rs/ha)	ICBR
						1st	2nd	Total			
T_6	676.59^e	232.27^e	-	600	600	1200	1200	2400	15329.82	12930	1:5.39
T_7	519.00^g	74.68^g	200	600	600	1400	1400	2800	4929.10	2129	1:0.76
T_8	576.59^f	132.27^f	200	600	600	1400	1400	2800	8729.82	5930	1:2.12
T_9	444.32^h	-	-	-	-	-	-	-	-	-	-
SEm+	12.57	10.82	-	-	-	-	-	-	-	-	-
CD at 5%	38.13	32.83	-	-	-	-	-	-	-	-	-

DMRT test - Means followed by different letters are significantly different
Cost involved during the experiment
** Tobacco leaves –Rs. 200/- per kg*
*** Two labours required for picking of leaves and preparation of various bio-dynamics included in the study in one day –Labour rate / day= Rs. 300/-*
#Two labours required for spraying 1 ha black gram crop in one day- Labour rate / day= Rs. 300/-
Cost of Blackgram Rs. 6600/- per quintal

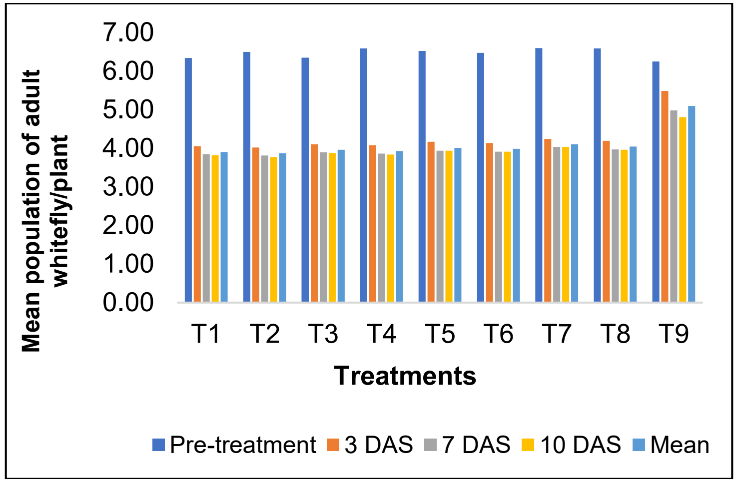

Fig. 1. Bio-efficacy of biodynamics against whitefly on black gram (Mean of two sprays)

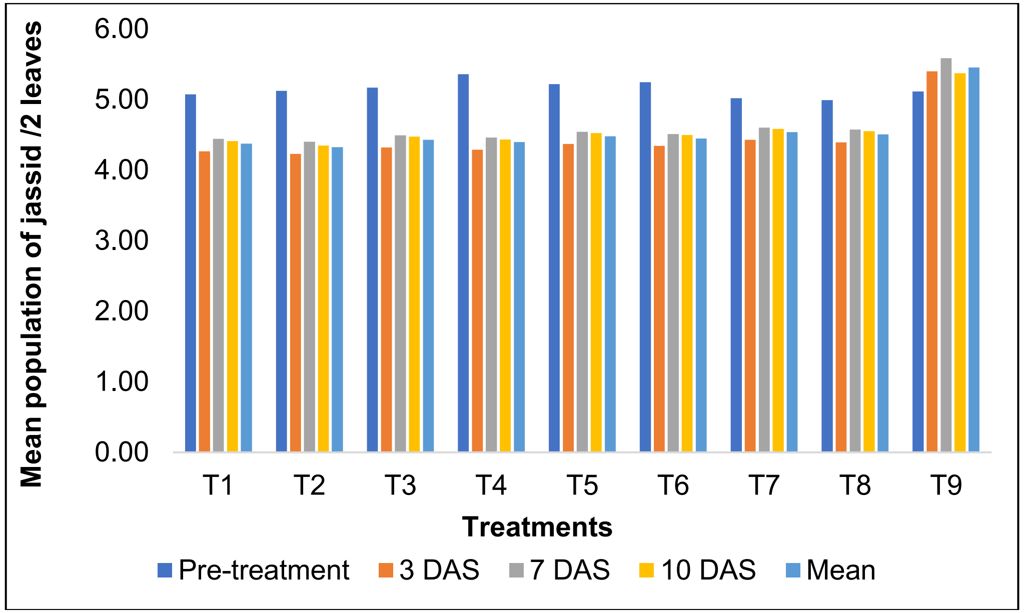

Fig. 2. Bio-efficacy of biodynamics against jassid on black gram (Mean of two sprays)

3.3 Lady Bird Beetle

The mean population of the ladybird beetle at over all mean of the two sprays ranged from 0.64 to 0.54 beetle / plant, respectively, but all were found to be non-significant. It confirms the findings of Mounika *et al*., (2019) and Kumar and Sarada (2020) as they also claimed that brahmastra, agniastra and neemastra had no adverse effects on the natural enemies in cotton, paddy, okra and castor ecosystem, respectively.

3.4 Spiders

The mean population of spiders at over all mean of two sprays varied from 0.51 to 0.41 spiders / plant, respectively and the differences among the treatments were found to be non-significant. It confirms the findings of Patel *et al.* (2017), Gaikwad *et al*., (2020) as they also claimed that brahmastra, agniastra and neemastra had no adverse effects on the natural enemies in cotton, paddy, okra and castor ecosystem, respectively.

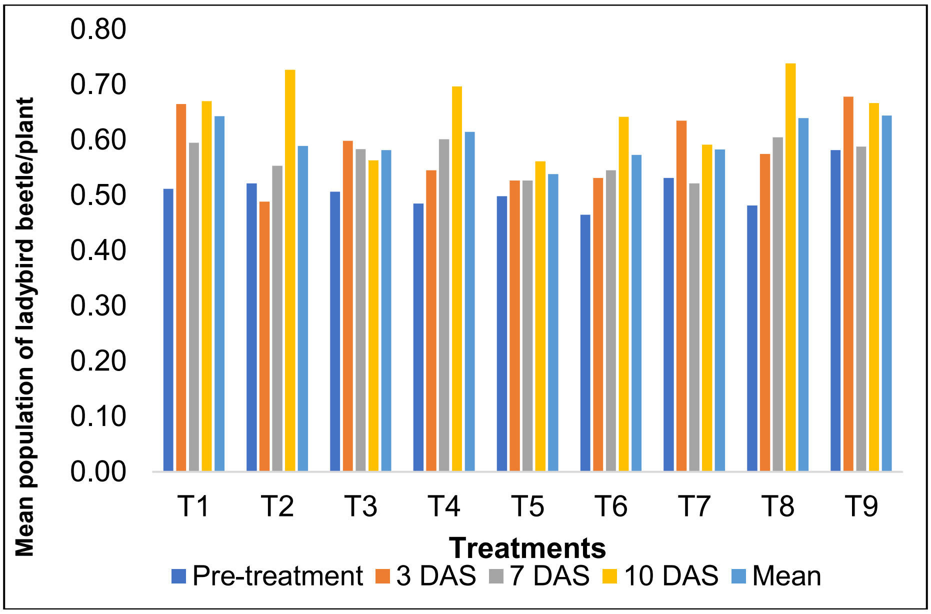

Fig. 3. Impact of biodynamics on ladybird beetle in black gram (Mean of two sprays)

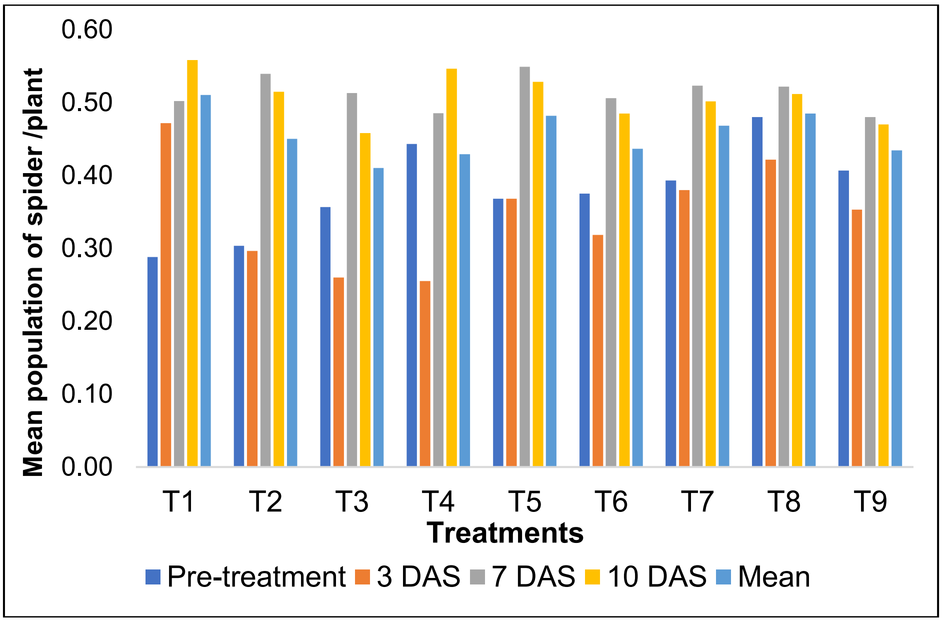

Fig. 4. Impact of biodynamics on spiders in black gram (Mean of two sprays)

3.5 Efficacy and Economics of Biodynamics on Black Gram Grain Yield

Highest increase in grain yield over control was recorded in brahmastra @ 45ml/L (637.30kg/ha), followed by brahmastra @ 30ml/L (471.09 kg/ha), agniastra @ 45ml/L (405.96kg/ha), agniastra @ 30ml/L (268.99 kg/ha) and neemastra @ 45ml/L (232.27 kg/ha). The next group of effective treatments were neemastra @ 30ml/L (161.68 kg/ha) and dashparni ark @ 45ml/L (132.27 kg/ha) which were at par with each other. Minimum increase in yield over control was registered in dashparni ark @ 30ml/L (74.68 kg/ha). The present findings are in conformity with the findings of Patel *et al.* (2017), as they also claimed that highest seed cotton yield (27.74 q/ ha) was recorded in plots treated with brahmastra @ 20%, followed by agniastra @ 20% (25.12 q/ha) and neemastra @ 20% (23.99 q/ha), respectively. Similar findings have been documented by Sreekanth and Ramana (2020) against pod borer complex in pigeonpea. However maximum cost benefit ratio was obtained in brahmastra @ 45ml/L (1:16.53). It was followed by brahmastra @ 30 ml/L (1:11.95), agniastra @ 45ml/L (1:9.31), agniastra @ 30ml/L (1:5.83), neemastra @ 45ml/L (1:5.39), neemastra @ 30ml/L (1:3.45), dashparni ark @ 45ml/L (1:2.12) and minimum in dashparni 30ml/L (1:0.76). Besides, pest population there may be a number of factors such as location, soil type, variety of the crop, fertilize used *etc.* which may determine the grain yield at a time. Further, the losses in terms of rupees and the benefit accrued due to the use of insecticide may depend upon market price of the grain, plant protection inputs and labour cost which are likely to vary from year to year and place to place. These in turn are responsible for variation in losses caused due to pest incidence and the benefit obtained by the pest control.

4. CONCLUSION

Among two spraying of brahmastra @ 45ml/L initiating on 21 days old crop and repeated at 15 days interval was found to be most effective in reducing whitefly and jassid population and registered higher grain yield and also found to be most economic (1:16.53) followed by brahmastra @ 30ml/L (1:11.95), agniastra @ 45ml/L (1:9.31), agniastra @ 30ml/L (1:5.83), neemastra @ 45ml /L (1:5.39) and neemastra @ 30ml /L (1:3.45). The four biodynamics *viz.,* brahmastra, agniastra, neemastra and dashparni ark were safe for potent predators (Lady bird beetles and spider).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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