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Bio-efficacy of biodynamics and botanicals against major insect pests of summer green gram and their impact on natural enemies

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Abstract
A field trial was conducted in randomized block design to evaluate the bio-efficacy of biodynamics and botanicals against major insect pests of summer green gram (var. Shikha) and its impact on their natural enemies. The experimental treatments were comprised with four biodynamics (Agniastra, Brahmastra, Dashparni ark and Neemastra) and three botanicals (Neem oil, NSKE and Tobacco leaf decoction) by taking the dose @ 5% of each treatment against the insect pests and compared with control plot. The results revealed that the most effective treatment was found to Neem oil 5% (T_5) against whitefly and jassids with the population reduction of 51.55 and 59.96%, respectively followed by NSKE 5% (T_6), Brahmastra 5% (T_2), Agniastra 5% (T_1), Tobacco leaf extract 5% (T_7), Neemastra 5% (T_4) and Dashparni ark 5% (T_3). The maximum grain yield (9.25q/ha) was recorded from the treatment of Neem oil 5% (T_5) followed by NSKE 5% (T_6) and Brahmastra 5% (T_2). The highest cost-benefit ratio for one hectare was registered from the treatment of Brahmastra 5% (T_2) with (1:8.34) followed by Agniastra 5% (1:7.18) and Neemastra 5% (1:6.03). Impact of all biodynamics and botanicals on natural enemies of insect pests were found to be safer because treatments were found to be statistically non-significant over the control.

Keywords: Biodynmics, botanicals, whitefly, aphid, summer green gram

Introduction
Pulses are grown in large area throughout the India in all seasons especially because of its high protein content, which is important in the diet of vegetarian population. Among them, green gram [*Vigna radiata* (L.) Wilczek] is a pulse crop which is native to India. Green gram is the third most important pulse crop after pigeon pea and chickpea. In India, during 2023 green gram was cultivated in total area of 55.47 Lakh ha with production of 36.76 Lakh tonnes and productivity of 663 kg/ha and in Madhya Pradesh, green gram was grown in 1218 thousand ha area with the total production and productivity of 1689.2 thousand tonnes and 1390 kg/ha, respectively during summer 2023 (Anonymous, 2023) [3]. Whitefly (*B. tabaci*), jassid (*E. kerri*) and thrips (*Caliothrips indicus*) are the major sucking pest complex in green gram during summer (Singh *et al.*, 2022) [19]. Quantitative avoidable loses in green gram due to insect pests ranged with an average of 32.97% (Duraimurugan and Tyagi 2014) [4].
In pest management, insecticides alone occupy 29.5% of total pesticide usage. Insecticides, in addition to killing target organisms, it also causes environment population like soil and water contamination, harmful to non-target organisms like human, birds, fish, natural enemies of insect pests etc. (Pathak *et al.*, 2022) [16]. The bio-dynamics and botanicals can be used as alternatives in the place of chemical insecticides for pest control. As these are safe to environment, non-target organisms and cost friendly, it is more beneficial than chemical insecticides in a long run. Among the bio-dynamics, Agniastra, Brahmastra, Dashparni ark and Neemastra have been proved to be helpful for management of various insect pests like whitefly, jassid, thrips, borers etc. in different agricultural crops (Patel *et al.*, 2017 [15] and Kumar and Sarada, 2020 [8]). On the other hand, neem-based pesticides like Neem Seed Kernel Extract and Neem oil are also very useful for the control of insect pests in green gram because azadirachtin is the main active ingredient of neem which acts as an antifeedant, repellent, prevents oviposition and disrupt growth and reproduction (Adhikari *et al.*, 2020)

[2]. Thus, neem and tobacco-based botanicals are useful for both prevention and control of insect pests.

Materials and Methods

This experiment was carried out in the field of Integrated Farming System Unit, College of Agriculture, JNKVV, Jabalpur (MP) India during the summer season, 2024. Green gram (Var. Shikha) was sown at 5th April 2024 by maintaining each plot size 4.5 m x 3 m with the distance between plants and rows were 30 and 10 cm, respectively. The experimental trial was laid out in randomized block design with eight treatments and replicated in thrice. The treatments were comprised with four biodynamics (Agniastra 5%, Brahmastra 5%, Dashparni ark 5% and Neemastra 5%) and three botanicals (Neem oil 5%, NSKE 5% and tobacco leaf decoction 5%) and one control plot.

Preparation method of bio-dynamics was followed as suggested by NITI Aayog (https://naturalfarming.niti.gov.in). To make Agniastra the ingredients taken were cow urine - 20 L, Neem leaves paste - 2 kg, tobacco and chilli paste - 0.5 kg each, garlic paste - 0.25 kg and turmeric powder - 0.2 kg. All these ingredients were mixed by stirring in the clockwise direction in earthen vessel then boiled it until the foams come out and kept it in the cool dry place for 48 hours. Stirred it twice in a day then filtered it through muslin cloth and stored it in a clean vessel. For making Brahmastra - Cow urine - 20 L, leaves of Neem, Pongamia, custard apple, castor, Datura - 2kg each. All these leaves were grinded to make it into a paste. All the ingredients were mixed by stirring in the clockwise direction in earthen vessel and boiled it until the foams come out and kept it in the cool dry place for 48 hours. Stirred it twice in a day then filtered it through muslin cloth and stored it in a clean vessel.

For Dashparni ark ingredients were water - 200 litres, cow urine - 20 litres, cow dung - 2 kg. 10 types of leaves: Neem leaves - 3 kg and leaves of Pongamia, custard apple, castor, Datura, guava, pomegranate, Calotropis, bitter gourd, papaya - 2 kg each. Ginger paste - 200g tobacco powder - 1 kg, asafoetida - 10g, green chilli paste - 2 kg, turmeric powder and garlic paste - 0.5 kg each. For this water, cow urine and cow dung was mixed in a drum and then covered it with the gunny bag and kept it aside for 2 hours. Then turmeric powder, ginger paste has to be added into the mixture by stirring it in the clockwise direction and kept aside overnight. Next morning, tobacco powder and green chilli paste were added into it then left it for 24 hours under shade. Then paste of 10 leaves were added to the mixture by stirring then covered it with the gunny bag and kept it for 30-40 days for fermentation. The content was filtered through muslin cloth and stored it in a clean vessel. Neemastra was derived from water - 200 L, cow urine - 10 litre, cow dung - 2 kg and Neem leaves with tender stems - 10 kg. To prepare this first neem leaves and tender stem were grinded to make a paste. All the ingredients were mixed into the plastic drum by stirring it in clockwise direction then covered it with a gunny bag. Contents of the drum were stirred twice in a day for 2 days and then filtered it through muslin cloth and stored it in clean vessel. NSKE (Neem seed kernel extract) 5% comprised from 500g of neem seed kernels (shade dried) were grinded to make it into a powder. The powder was soaked in 10 L of water overnight. Then filtered the content using muslin cloth and store it in a plastic vessel (iimr.icar.gov.in). Tobacco leaf decoction 5% was prepared by taking 500g of dried tobacco leaf waste was grinded to make powder form and soaked it in 10 L of water for an overnight. Next day it was boiled for 30 minutes. Then it was stirred and filtered through muslin cloth store it in a plastic vessel.

A total of three sprays was done in the field trial. The first spray was given when the crop age was 14 days old, second spray after 15 days of first spray and third spray was done after 15 days of second spray (Singh *et al.,* 2019) [18]. The observations of major insect pests and their natural enemies were recorded from 10 randomly selected plants from each plot. Pre-treatment observations were recorded one day before the spray and post-treatment observation was recorded on 3, 7 and 10 days after each spray. The population of whitefly (adult/cage/plant) was recorded using a caging method (Marabi *et al.,* 2017) [11]. Jassid population was counted from 6 leaves per plant each 2 from top, middle and bottom (Ojha *et al.,* 2022) [13]. White spotted leaf beetle count was taken on the basis of adult beetle per plant (Sujatha and Bharpoda, 2017) [20]. Lady bird beetles were recorded on the basis of no. of grub and adult per plant (Sujatha and Bharpoda, 2017) [20] and rove beetle count was taken on the basis no. of beetle/plant (Nayak, 2022) [12].

The data of insect population of each treatment were converted into square root transformed values for the purpose of analysis. ROC (Reduction over control) formula was used for computing the reduction of insect population for each treatment compared to untreated control (Abbott's, 1925) [1]. ROC values were turned into Arc sin transformed values after calculation to determine the significance level. The cost-benefit ratio was computed for each treatment to find the most efficient and economical treatment for the management of major insect pests. Critical difference (C.D.) test was used to identify the significance of different treatment means at 5% level of significance (Gomez and Gomez 1984) [5]. Duncan's Multiple Range Test (DMRT) test was used to evaluate the significance of different treatment means to know whether there is a significant difference between them (Thumar *et al.,* 2020) [21].

Results and Discussion

1. Whitefly (*Bemisia tabaci* Gennadius)

The whitefly population of all the treatments were significantly lower than the control plot (6.79 adult whiteflies /cage). The lowest population of whitefly was observed in Neem oil 5% (3.29 adult whiteflies /cage) which is at par with NSKE 5% (3.57 adult whiteflies /cage), Brahmastra 5% (3.84 adult whiteflies /cage), which was further at par with Agniastra (4.13 adult whiteflies /cage), tobacco leaf decoction 5% (4.16 adult whiteflies /cage), Neemastra 5% (4.24 adult whiteflies /cage) and the last best treatment was Dashparni ark 5% (4.48 adult whiteflies /cage) (Table 1). These results are in linked with Logeswaran *et al.* (2023) [10] who revealed that Neem oil 3% was the best treatment for the control of whitefly (*Bemisia tabaci*) followed by NSKE 5%, pongamia oil, garlic oil, garlic chilli kerosene extract 5%, Brahmastra 5% and Agniastra 3%. Randhawa *et al.* (2018) [17] and Lodhi (2021) [9] reported that Neem oil 2% was superior to NSKE 5% for the control of whitefly in green gram. Sujatha and Bharpoda (2017) [20] found that tobacco decoction 2% was an effective treatment for the control of whitefly. Parmar (2023) [14] found that Brahmastra 4.5% was the most effective treatment for controlling whitefly population in green gram

followed by Brahmastra 3.0%, Dasparni ark 4.5%, Dasparni ark 3.0%, Neemastra 4.5%, Neemastra 3.0%, Agniastra 4.5% and Agniastra 3.0%.

2. Jassids (*Empoasca kerri* Pruthi)

The overall mean of all three sprays data in Table 2 clearly indicated that the jassids population of all the treatments were significantly lower than the control plot (4.82 nymph and adult / 6 leaves /plant). The lowest jassids population was observed in Neem oil 5% (1.93 nymph and adult / 6 leaves /plant) followed by NSKE 5% (2.25 nymph and adult /6 leaves /plant) which was significantly at par with Brahmastra 5% (2.34 nymph and adult /6 leaves /plant). The next best treatment was Agniastra 5% (2.64 nymph and adult /6 leaves /plant) which was at par with tobacco leaf decoction 5% (2.71 nymph and adult /6 leaves /plant), Neemastra 5% (3.09 nymph and adult /6 leaves / plant) and Dashparni ark 5% (3.12 nymph and adult / 6 leaves / plant) were found to be significantly at par with each other. Further, Kumar *et al.* (2022) [7] also revealed that Azadirachtin 5% was the most effective treatment for the reduction of jassids population. Sujatha and Bharpoda (2017) [20] found that tobacco leaf decoction 2% was an effective treatment for the control of jassids. While, Parmar (2023) [14] revealed that for the control of jassids in green gram, Brahmastra4.5% was the best treatment followed by Brahmastra 3.0%, Dasparni ark 4.5%, Dasparni ark 3.0%, Neemastra 4.5%, Neemastra 3.0%, Agniastra 4.5% and Agniastra 3.0%.

The perusal of data presented in Table 3 depicted that the highest cost-benefit ratio for one hectare was registered in Brahmastra 5% with (1:8.34) followed by Agniastra 5% (1:7.18), Neemastra 5% (1:6.03), NSKE 5% (1:5.65) and Dashparni ark 5% (1:4.68) which was significantly at par with Neem oil 5% (1:4.57), while the lowest cost-benefit ratio was recorded in tobacco leaf decoction 5% (1:1.60). For this study, the included expenses incurred for biodynamics apart from tobacco leaf, all leaves were available in field itself. Some ingredients were purchased from the market i.e., Tobacco leaves @ Rs. 150/- per kg, Neem seed kernel @ Rs. 50/- per kg and Neem oil @ Rs. 100/- per L. Two labours were required for preparation of all bio-dynamics and spraying for one ha while one labour for preparation of NSKE and tobacco leaf decoction (labour charge/day @ Rs. 385/-). The market rate of green gram was Rs. 8682 per quintal for the computation of cost benefit ratio.

3. Impact of biodynamics and botanicals on natural enemies

The overall mean of third spray revealed that the rove beetle population was uniformly spread across the experimental field with the range varied from 1.35 to 1.47beetle/ plant and the differences of different treatment were found to be statistically non-significant. These results are in line with the results of Nayak (2022) [12] who revealed that Neem oil 5% and NSKE 5% were found to be safe for rove beetle. Similarly, Parmar (2023) [14] also found that Brahmastra, Agniastra, Neemastra and Dasparni extract at 4.5% didn't affect the population of rove beetle as their effect on the population of rove beetle was statistically non-significant.

The overall mean of all two sprays (during first spray lady bird beetle population was absent) revealed that the lady bird beetle population was uniformly distributed throughout the field with the range varied from 0.76 to 0.94 grub and adult/ plant and the differences of different treatment were found to be statistically non-significant. This finding is in accordance with the findings of Nayak (2022) [12] who revealed that Neem oil 5% and NSKE 5% were found to be safe for lady bird beetle population, as their effect was statistically non-significant. Parmar (2023) [14] also revealed that Brahmastra, Agniastra, Neemastra and Dasparni extract at 4.5% concentration didn't affect the population of lady bird beetle. Kambrekar *et al.* (2022) [6] found that Azadirachtin didn't have a significant effect on non-target organisms.

Conclusion

The present results revealed that Neem oil @ 5% was recorded the most effective treatment against whitefly and jassids followed by NSKE @ 5%, Brahmastra @ 5%, Agniastra @ 5%, Tobacco leaf extract @ 5%, Neemastra @ 5% and Dashparni ark @ 5% in green gram crop during summer season. The highest and lowest cost-benefit ratio was registered in Brahmastra 5% and tobacco leaf decoction @ 5%, respectively. The impacts of all biodynamics and botanicals treatments on natural enemies of insect pests in green gram were found to be safer and eco-friendly.

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