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Research Article

Field Evaluation of Commercial *Metarhizium anisopliae* (Ami Meta Star) for Controlling White Grubs in Groundnut Crop

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Abstract

In India, groundnut (*Arachis hypogaea* L.) production faces significant losses due to white grub infestations annually. This research emphasizes the potential of commercial biopesticide *Metarhizium anisopliae* (Ami Meta Star) as sustainable alternatives to chemical pesticides. The study was conducted using a block-randomized design with *Metarhizium anisopliae* treatments and an untreated control group. The primary aim of the study was to evaluate the effectiveness of the biopesticide in decreasing white grub mortality rates and its impact on plant health at 15, 30, 45, and 60 days after treatment. The mean percent mortality for the treated group was 7.81% ± 1.20% at 15 days post-treatment, while the control group had a mean percent mortality of 5.12% ± 2.04%, this indicates that the white grubs treated with Ami Meta Star (*M. anisopliae*) had a higher average death rate than the untreated control group. The treatment group had a mortality rate of 5.23% at 30 days after treatment (DAT), while the untreated control group had a mortality rate of 6.91%. This indicates a substantial 24.3% decrease in white grub mortality, which can be due to the utilization of biopesticide. By 45 DAT, the treatment group showed 3.13% ± 1.36% mortality, significantly lower than the 7.54% ± 1.53% in controls, representing a 58.5% reduction. By 60 DAT, *M. anisopliae* achieved a remarkable 99.3% reduction in mortality, with the treatment group at 0.06% ± 0.02% compared to 8.97% ± 1.56% in controls. Furthermore, compared to the control group (1154 kg/ha), the treated group had a greater pod yield (1776 kg/ha), suggesting that Ami Meta Star is able to increase groundnut crop production.

Keywords: Ami Meta Star; *Arachis hypogaea L.*; Biopesticide; Mortality

Abbreviations

DAT: Days After Treatment; ITCC: Indian Type Culture Collection; DAG: Days After Germination

Introduction

The groundnut, commonly referred to as the "wonder nut", [1] occupies a notable position among food crops [2]. *Arachis hypogaea L.*, (peanuts), is one of the most significant oilseed crops in India [3] and is referred to as the "King of oilseed crops" [4]. It is ranked 5th among the main sources of dietary oil in the world [5]. It has several names, including earthnut, peanut, goober, and monkey nut [6]. It has between 48 and 50 percent oil and between 26 and 28 percent protein [7]. In Asia *Arachis hypogaea L.*, are an important oilseed and commercial crop [8]. It is a prominent member of the Leguminosae family and is grown mostly in the kharif season [9]. The states of India's northwest and south are where it is mostly grown. Ninety percent of the country's groundnut area was distributed by Gujarat, Karnataka, Tamil Nadu, Maharashtra, Madhya Pradesh, and Andhra Pradesh [10]. The initial advance estimates for the 2022–2023 period state that 487,000 tons of groundnuts were produced in India on 604,000 hectares, with a productivity of 806 kg/ha. India is one of the top three producing nations in the world for groundnuts [11]. About 15% of groundnut yield is lost annually as a result of insect infestations [12].

The most damaging soil pests that cause harm to groundnut crops and result in financial output losses in India's commercial groundnut production are white grubs, which are highly polyphagous [13]. Thus, because of several factors, including farming patterns, climate variability, and a lack of effective plant protection measures, white grubs have become a severe pest of practically all Kharif crops [14]. The larval stage of scarab beetles, which is destructive in nature, is inhibited by white grubs, which are the soil-feeding, immature stages of the insect [15]. Currently, a widely popular and extensively utilized method for managing crop pests is the application of chemical pesticides [16]. However, yearly increases in the amount and regularity of synthetic application of pesticides have led to an increase in insect resistance [17]. A biological pesticide is an environmentally acceptable substitute for chemical pesticides and it has many advantages over chemical-based pesticides, such as minimal drug resistance, a broad range of sources, low non-target toxicity, and decreased toxicity to mammals [18]. It also has significant potential for enhancement [19]. Chemical pesticides are widely used, which harms ecosystems, including water and soil, and puts both people and animals in severe danger [20]. When controlling white grubs, species of the families *Metathizium*, *Beauveria*, *Verticillium*, *Paecilomyces*, and Entomophthora have gotten the most attention and are extensively utilized [21]. Entomopathogenic fungi are often regarded as significant substitutes for pesticides, offering efficient management of a target pest, reducing production damage, and preserving agricultural systems [22]. *Metarhizium anisopliae* is a potential Entomopathogenic fungus that exhibits genetic variation and is harmful to more than 200 insect species from seven kingdoms [23].

Consequently, there is a vast amount of information about the fungal pathogenesis of insects by *M. anisopliae,* including a variety of significant pests such as cane beetles, pasture grubs, termites, locusts, and spittle beetles [24]. Many countries and regions around the world have suffered major economic losses due to agricultural pests such as grasshoppers, termites, ticks, and locusts [25]. For the control of many insect species*, M. anisopliae* has already been included in commercial biopesticides [26].

Materials and Methods

Experimental location

The experiment was conducted at the Ami experimental farm, Ahmedabad, Gujarat, (22° 54' 57.7" 72° 32'34.3" E).

Experimental crop

During the 2020-2021 Kharif season, a research study was conducted on groundnut crops to determine the efficacy of Ami Meta Star (*Metarhizium anisopliae*) in managing white grub infestations, which are commonly damaging these crops. *Metarhizium anisopliae*, a fungus species known for its biocontrol qualities against soil-dwelling pests like white grubs [27], was collected especially from the Indian Type Culture Collection (ITCC). This set is an important resource for storing and disseminating cultures of microbial species, preserving the integrity and efficacy of fungal strains used in agro studies and applications [28].

Experimental details

The study used a single treatment in a block-randomized design in order to ensure uniform and accurate results. Plants were placed 45 cm apart inside rows and 15 cm apart between rows to enhance growing conditions and allow for regular monitoring. Each experimental plot measured 4.5 meters in length and 3.0 meters in width, with specific regions for collecting information and analysis. During the crop season, standard farming practices including soil preparation, planting, irrigation, and fertilization were carefully applied to ensure consistency across all plots. No plant measures were employed to determine the impacts of insect infestations. In this study, the soaking method was employed to determine the efficiency of several pesticide applications in targeting soil-dwelling insects, specifically white grubs. This procedure includes immersing plant roots in pesticide solutions at the beginning of a pest infestation. The insecticides examined varied in their active component ratios and dispersion rates, intending to identify the most efficient formulations for inhibiting white grub infestations while causing the least amount of damage to plants. The treatment details implemented in the experiment are mentioned in the Table 1.

Observations

This study examined plant growth and white grub damage at 15, 30, 45, and 60 days after germination. After each evaluation, the total number of plants and those affected by the white grub infestation were noted. Damaged plants were eventually removed from the field research to verify accurate mortality data and to prevent further damage to the living plants. Following each evaluation, the number of damaged plants removed relative to the beginning total plant count was used to calculate the percentage of plant death caused by white grub infestation. To determine the density

Table 1: Treatments details.

Treatment	Treatment	Formulation dose/hectare	Trade name
T1	*Metarhizium anisopliae* (Ami Meta Star) Treated	1 kg	Ami Meta Star
T2	Untreated control	-	-

and dispersion of the white grub population, it is examined in a one-square-meter area in each plot following harvest and dug to a depth of 50 cm. The purpose of this experiment was to determine the relationship between white grub populations and plant damage over time in order to bring information on how white grub infestation affects plant development and death.

Results and Discussion

Effectiveness of Ami Meta Star against white grub at 15 DAT

In comparing two treatments for suppressing white grubs, the group treated with Ami Meta Star (*M. anisopliae*) at a dose of 1 kg/acre had a mean percent mortality of 7.81% ± 1.20% at 15 days after treatment (DAT). In contrast, the untreated control group had a mean percent mortality of 5.12% ± 2.04% during the same term was shown in Figure 1. There was a 52.50% decrease compared to the control mention in Table 2. This indicates that the white grubs treated with *M. anisopliae* had a higher average death rate than the untreated control group. Additionally, the treatment's standard error (1.20%) was lower than that of the untreated control (2.04%), indicating a reduced variance in death rates. In a similar study, the white grub density decreased from 6.95 grubs/m row to 6.28 grubs/m row (15 DAT) after treatment with *Metarhizium anisopliae* [29]. Other related studies suggest that, after 12-18 days of treatment (DAT) with a commercial concentration of *Metarhizium anisopliae* at 10^7 spores/mL, the death rate of grubs was 6.67% ± 0.33% [30].

Effectiveness of Ami Meta Star against white grub at 30 DAT

The treatment group saw a death rate of 5.23% at 30 days after treatment (DAT), while the untreated control group observed a mortality rate of 6.91% demonstrate in Figure 1. This indicates a 24.3% decrease in the mortality rate of white grubs due to Ami Meta Star treatment mentioned in Table 2. In other studies, at 30 days post-treatment (30 DAT), the talc-based treatment for *Metarhizium anisopliae* produced a 7.36% clump death rate [31]. On other hands at 30 DAT, an average of 7.88 white grubs per meter row were produced by the $1x10^9$ concentration of *M. anisopliae* treatment [32].

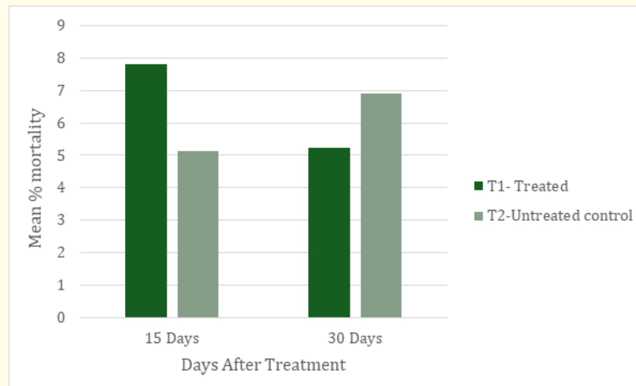

Figure 1: Efficacy of Ami Meta Star against groundnut infestations by white grubs.

Table 2: Mean mortality decrease in percent at different intervals.

Time Days after treatment (DAT)	%Decrease (Treatment vs Control)
15 DAT	-52.50%
30 DAT	24.30%
45 DAT	58.50%
60 DAT	99.30%

Effectiveness of Ami Meta Star against white grub at 45 DAT

In the treatment group, the death rate at 45 days after treatment (DAT) was 3.13% ± 1.36%, while the untreated control group had a mortality rate of 7.54% ± 1.53% illustrated in Figure 2. Compared to the control, this indicates a significant 58.5% decrease in white grub mortality with the biopesticide treatment shown in Table 2. In additional research, the treatment showed a plant mortality of 17.87% (±9.42) at 50 days after germination (DAG) and a grub density of 1.69 per square meter (±2.86) [33]. In other studies at 45 days after treatment, the white grub population was decreased to 1.1 per 10-meter row [34].

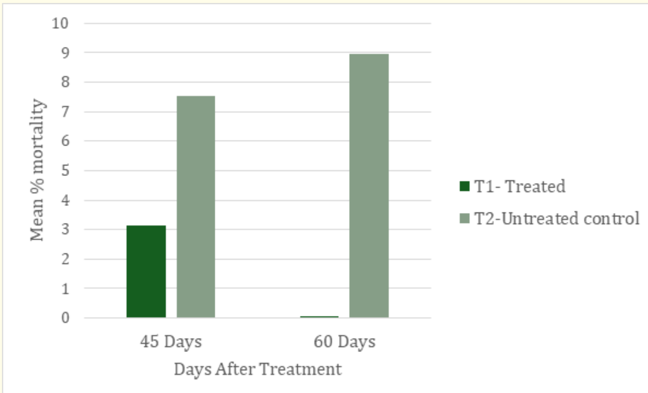

Figure 2: Efficacy of Ami Meta Star against groundnut infestations by white grubs.

Effectiveness of Ami Meta Star against white grub at 60 DAT

The treatment group showed a significantly decreased mortality rate (0.06% ± 0.02%) at 60 days after treatment (DAT) compared to the untreated control group (8.97% ± 1.56%) shown in Figure 2. When compared to the control, the use of bio pesticide decreased white grub mortality by 99.3% depicted in Table 2. In additional research *Metarhizium anisopliae* treatment proved effective for groundnuts; the pretreatment plant population was 8.54 per square meter, At 60 days post-sowing , 3.65% ± 9.47% of the plants were infected with white grubs [35]. Also similar research reported, the average death rate of white grubs was 6.67% ± 3.33% eight weeks after using *M. anisopliae* [36].

Pod yield

Applying *Metarhizium anisopliae* powder at a dose of 1 kg per acre and a concentration of 1×10^8 CFU/g has demonstrated significant agricultural effectiveness. Pod production increased significantly with this treatment, obtaining 1776 kg/ha and the pod yield of untreated control was just 1154 kg/ha shown in Table 3. This indicates that *M. anisopliae* is effective in improving the yield of crops.

Table 3: Average pod yield in kg/ha.

Sr. No.	Treatments	Dosage	Pod yield (kg/ha)
1	*M. anisopliae* @1×10^8 (powder)	2.471 kg/ha	1776
2	Untreated control	-	1154

Conclusion

This study evaluates commercial *Metarhizium anisopliae* efficiency as a biopesticide for controlling white grub infestations in groundnut crops. The results demonstrate that *M. anisopliae* is beneficial in controlling white grub populations, indicating a potential solution to the current challenges faced by Indian farmers. Furthermore, the considerable improvement in pod output caused by *M. anisopliae* treatment indicates its commercial value. The use of this biopesticide promotes organic farming, aids in environmental preservation, and may improve soil health by decreasing reliance on chemical pesticides. These results suggest the use of biopesticides such as *M. anisopliae* into agricultural management systems, therefore enhancing the sustainability and profitability of groundnut farming while protecting environmental health for future generations. Enhanced pest management with biopesticides can also help to improve food security and agricultural system resistance to evolving pest challenges.

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