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Relative impact of vermiwash against phytophagous insects and growth properties of yardlong bean (*Vigna unguiculata*)

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Abstract

Due to severe insect infestation, yardlong (*Vigna unguiculata*) bean expansion and production have been declining in Sri Lanka. This experiment tested the effectiveness of several vermiwash against phytophagous insects in yardlong bean. Ten distinct types of vermiwash were generated by alternately and separately feeding exotic (*Eudriluseuginea*) and indigenous types earthworm with the specified botanicals, *viz*. onion and garlic peel, marigold and neem leaves, and the materials given for mass culturing. Eleven treatments including 10 vermiwash and untreated control and three blocks were laid on Randomized Complete Block Design. Since the third week of planting, vermiwashes have been administered to the corresponding plots at weekly intervals. Before each application of treatment, the total number of insects in each treated and untreated plot were carefully counted. ANOVA assessed treatment effects, and Duncan's Multiple Range Test compared mean separation values at 5%

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significance using SAS software. Plots treated with vermiwash made from indigenous earthworm varieties with garlic peel (1.33), exotic varieties with onion peel (2.33), and native varieties with onion peel (3.00) had the significantly similar fewest epilachna beetles. Further, vermiwash of an indigenous variety with neem leaves, where the maximum yield of yardlong beans was also discovered, had a considerably lower population of epilachna beetles. Furthermore, with the exception of the vermiwash of exotic species with onion peel, practically all treatments were less harmful to ladybird beetles. As demonstrated by this experiment, vermiwash has a beneficial effect on plant development in terms of both plant height and leaf area. Vermiwash made from combining an indigenous species of earthworm with neem leaves was potentially suggested for yardlong bean production since it was both environmentally and economically efficient.

Key words: Earthworm, Exotic, Garlic, Imdigenous, Neem

Introduction

A common ingredient in Sri Lankan cuisine is the yardlong bean (*Vigna unguiculata*), a vegetable crop. Yardlong bean cultivation has been practiced in Sri Lanka, during both the Maha and Yala seasons. Even though there were 7505.6 hectares under cultivation in 2021, the country produced 65275.9 MT, which was less than other vegetables (Department of Statistics, 2021). As a result of the market's restricted supply, consumers must pay higher prices for yardlong beans (Nijamdeen *et al*., 2016). For the cultivation of yardlong beans, the primary challenge is the severe infestation of a number of insect pests (Benchasri and Bairaman, 2010). According to previous studies, insect pests cause a 12–30% production reduction in yardlong beans which is a serious problem in yardlong bean cultivation (Hossain and Awrangzeb, 1992). In addition, Sri Lanka's growing use of chemical fertilizers and pesticides over the last several decades has led to incredibly high levels of toxic chemicals and heavy metals in the environment, which has a harmful impact on crop production and ecosystems. The unfriendly nature of these synthetic chemical pesticides has led to resistance, an increased persistence in the population of the targeted pests, and unfavourable impacts on non-target organisms. Given

all of these problems, it is essential to increase yardlong bean production while carrying out a successful organic pest management plan. Many researchers claim that extracts from indigenous plants which have medicinal properties can effectively manage insects (Muthukumar *et al.*, 2010; Samadhiya *et al.,* 2013). Though there are several methods used for biopesticides preparation, one of the greatest methods for managing organic waste and bio pesticides preparation is vermiwash. The purpose of this study was to determine the effectiveness of several vermiwash sprays over phytophagous pests on yardlong bean. Zambare *et al.* (2008) stated that vermiwash foliar spray enhances the growth, productivity, and seed germination of plants while controlling plant parasitic nematodes and arthropod pests. They also reported that vermiwash foliar application has a significant effect on plant growth and development, even though there haven't been many experimental results yet to assess the impact of such vermiwash sprays on crop cultivation.

Materials and Methods

Preparation of vermiwash

Vermiwash was made using two different kinds of earthworms. According to this, the Ottusuttan District Agriculture Training Center is the place where the exotic species of earthworm known as *Eudriluseugeniae* was purchased. Earthworms that are native to the area were collected at Eastern University, Sri Lanka. The traditional approach was used to mass cultivate both native and exotic types at the laboratory (Hitinayake *et al*., 2018). Further, it is crucial to determine their viability for plant materials before adding earthworms to a compost bin. Plant materials were progressively added to an earthworm colony in order to study their behaviour, and it was continuously monitored. In the absence of any peculiar behaviour from earthworms, botanicals *viz*. marigold leaves, neem leaves, onion peel, and garlic peel were used to generate vermiwash. The vermiwash was prepared and collected using 10 plastic buckets, each having a 20 L capacity and a tap at the bottom. Five plastic buckets were used to collect the vermiwash for each type of earthworm. The ingredients were successively stacked in the buckets as advised by Harsita *et al.* (2019). At the bottom of each bucket, medium-sized clay bricks were placed to a height of

15 cm. Fine sand was spread up to 15 cm thick across the basement. Then, seventy-five earthworms from each earthworm species were collected from mass culture and introduced fifteen into each of the container in accordance with the treatments. Among the five buckets used for the indigenous species, each of the buckets separately combined with chopped onion peel, garlic peel, marigold leaves, and neem leaves for the height of 10 cm and one of the buckets was used as control. The buckets designated for exotic species were likewise individually filled with the chosen plant materials.

Then, to encourage the development of earthworms, organic residue and a 20 cm layer of partially decomposed cow manure were applied during the mass culturing of earthworms. Around half a litre of water was sprayed into each bucket each day to moisten the whole structure. After 30 days of execution, vermiwash from each setup was collected. Two litres of water were poured to each bucket before the vermiwash collection and left for the night. The vermiwash collected the next day was stored for later use in sealed containers at room temperature. The plant components were often put to the appropriate buckets after the collection of vermiwash to ensure the following collection.

Cultivation of yardlong bean

Yardlong bean cultivation of the bushita (Local) variety was taking place from June to September 2022, in the field of the Department of Agriculture Biology, Faculty of Agriculture, Eastern University Sri Lanka, Palacholai, situated in the Batticaloa district.

The Department of Agriculture, Sri Lanka suggested that all agronomic procedures be used to develop bushita, with the exception of nutrition and pest control. Eleven treatments were put up in 03 blocks using the Randomized Complete Block Design (RCBD).

Efficacy of vermiwash

The collected vermiwash was diluted to a ratio of 1:10 with water before using it. The vermiwash was applied to the corresponding plots three weeks following the planting. Each vermiwash was sprayed using a separate hand sprayer at a

rate of 300 ml per experimental plot. Until harvest, the vermiwash was administered on a weekly basis in the late evening.

Data collection and analysis

The overall yield per plot, the number of pests per plot, and the number of natural enemies per plot, average height of the plant and leaf area were calculated. The border effect was eliminated in order to maintain the data's effectiveness. For the number of pests and the number of natural enemies, the log 10 $^{(n+1)}$ data transformation was performed.

Using SAS software, analysis of variance (ANOVA) was used to evaluate the effects of the treatments, and Duncan's Multiple Range Test (DMRT) was used to compare mean separation values at a 5% significant level.

Results and Discussion

Number of Epilachna beetle (*Epilachnavarivestis*) on yardlong bean

Vermiwash exists in ten distinct combinations, and it was shown that each one had a significantly different impact on the pest population ($p<0.05$). The plots treated with the vermiwash of indigenous type of earthworm with garlic peel showed the lowest pest number, with a mean value of 01.33 ± 1.52 (Table 1).

Garlic peel has been shown to be very effective at warding off pests. Garlic is helpful against pests because of the phenolic compounds (Andersen, 1997). However, the significantly same results were generated from the treatments of indigenous variety of earthworm with garlic peel, exotic variety of earthworm with onion peel, and indigenous variety of earthworm with onion peel. Further, indigenous variety of earthworm with neem leaves and exotic variety of earthworm with garlic peel were the next treatments to yield the same results. Neem leaves and onion peel both showed high levels of pest control efficiency, which was also reported by Podder *et al.* (2013). The pest number was high in plants without vermiwash (+1) because, there were no pesticidal or repellent qualities.

Table 1. Cumulative Pest Number, Ladybird Beetle, and Yield

Treatment	Pest number / plot	Number of ladybird beetles / plot	Total Yield (Kg/ha)
Exotic earthworm + onion peel	02.3 ± 2.3 cd	2.0 ± 0.0 b	4041.7 ± 126.6 a
Exotic earthworm + garlic peel	04.3 ± 2.5 bc	5.0 ± 1.7 ab	3511.9 ± 412.4 abc
Exotic earthworm + marigold leaves	10.3 ± 5.5 b	6.0 ± 1.0 ab	3095.2 ± 491.7 bcd
Exotic earthworm + neem leaves	10.0 ± 1.0 b	8.0 ± 7.0 ab	3214.3 ± 154.6 bcd
Exotic earthworm	25.7 ± 3.8 a	7.6 ± 1.5 a	3333.3 ± 412.4 abcd
Indigenous earthworm + onion peel	03.0 ± 1.7 cd	8.0 ± 4.4 a	3601.2 ± 313.5 ab
Indigenous earthworm + garlic peel	01.33 ± 1.52 d	5.66 ± 2.08 ab	2827.4 ± 272.7 cd
Indigenous earthworm + marigold leaves	11.66 ± 7.09 b	6.00 ± 1.73 ab	3184.5 ± 360.8 bcd
Indigenous earthworm + neem leaves	05.00 ± 2.00 bc	9.33 ± 0.57 a	3720.2 ± 272.8 ab
Indigenous earthworm	32.33 ± 8.62 a	9.33 ± 6.02 a	3154.7 ± 507.6 bcd
Control	35.33 ± 5.50 a	7.66 ± 3.51 a	2589.3 ± 557.5 d

Each value represents the mean value of three replicates ± standard deviation. Means followed by same alphabet don't vary significantly at p<0.05 based on DMRT.

However, tests using an indigenous and an exotic variety of earthworm did not significantly vary from controls, indicating that the pest population was high in these treatments because there were no selected botanicals present. Additionally, the use of several earthworm types both exotic and indigenous showed that there were no notable variations among them in the way they broke down the plant materials and that native earthworm kinds could also be used to make efficient vermiwash.

Effectiveness of vermiwash on ladybird beetle

The quantity of ladybird beetles (*Coccinellaseptempunctata*) was shown to significantly ($P<0.05$) vary across treatments (Table 1). The highest number of ladybird beetles were found in indigenous earthworm treated with neem leaves and indigenous earthworm treated with untreated botanicals. It was discovered that treating indigenous earthworms with neem leaves significantly increased the presence of ladybird beetles. According to Hwang-In-Cheon *et al.* (2007), the spectrum of toxicity of the neem-based insecticide against natural enemies was extremely low. Except for the exotic species of earthworm with onion peel, which demonstrated the least toxicity of the chosen plant materials against ladybird beetles, statistically equivalent results were discovered for all other treatments. In general, the usage of synthetic chemical pesticides had a big impact on how often diseases, pests, and especially natural enemies were present.

Although the exotic earthworm species with onion peel showed outstanding pesticide efficiency, it could not be suggested as a good pesticide since it was detrimental to ladybird beetles. The indigenous species of earthworm with neem leaf treatmentt was found in the current research to promote ladybird beetles while also being effective against pests. Therefore, an indigenous earthworm type with neem leaves might be suggested as a secure and efficient pesticide against the pests of yardlong bean.

Yield

According to Table 1, the output of plants treated with onion peel with exotic varieties of earthworm was greater, with a mean value of 4041.7 kg/ha. The study found no significant variations between the treatments, which included

exotic variety of earthworm with onion peel, exotic variety of earthworm with garlic peel, vermiwash made up of exotic variety of earthworm without selected plant materials, indigenous variety of earthworm with onion peel, and indigenous variety of earthworm with neem leaves. It was evident that these treatments had statistically equivalent yields overall, with the exception of the exotic earthworm type treated with neem leaves considering there were the presence of pests. In their examination into the efficacy of onion extract against cowpea pests, Baba *et al.* (2019) discovered that it boosts cowpea production by reducing insect infestation. This conclusion fits well with the findings of the current study. It was further supported by the correlation study, where a negative correlation ($r = -0.55$) between insect infestation and yield was found.

Average height of the plant

Table 2 displays the average heights of plants receiving various treatments from the first to the fourth week after treatment application. No discernible variation in plant height was seen between treatments during the first week after treatment application. It is probable that all plants received an equal share of the nutrients present in the soil prior to the treatment application. Afterwards, it began to differ significantly between treatments. Vermiwash has a beneficial effect on plant development, as evidenced by the fact that the untreated plant very slightly increased in height while other plants saw weekly increases in height. After the second week of treatment application, Table 2 demonstrates a substantial change ($P<0.05$) between treatments. The plants treated with an indigenous kind of earthworm combined with neem leaves showed the highest plant height. Similar findings were made by Moyin-Jesu *et al.* (2012), who discovered that the modified neem leaf extract increased tomato plant height by 2%.

Table 2. Average height of the plant in each treatment and leaf area

Treatment	Average plant height (cm)				Leaf area (cm ^{2})
	1st WTA	2nd WTA	3rd WTA	4th WTA	
Exotic earthworm + onion peel	17.15^{a}	23.24^{abc}	37.83^{a}	44.75^{a}	51.05 ± 1.69 ^{c}
Exotic earthworm + garlic peel	18.03^{a}	26.17^{ab}	36.54^{a}	42.91^{a}	43.34 ± 0.74 ^{e}
Exotic earthworm + marigold leaves	16.66^{a}	21.94^{bc}	30.03^{b}	35.08^{a}	46.10 ± 0.64 ^{d}
Exotic earthworm + neem leaves	16.62^{a}	25.49^{ab}	33.35^{ab}	40.33^{a}	46.34 ± 0.89 ^{d}
Exotic earthworm	15.19^{a}	21.66^{bc}	29.79^{b}	34.66^{b}	37.01 ± 1.05 ^{f}
Indigenous earthworm + onion peel	16.41^{a}	24.83^{ab}	37.57^{a}	44.00^{a}	56.91 ± 0.45 ^{b}
Indigenous earthworm + garlic peel	16.29^{a}	24.33^{ab}	35.11^{a}	42.33^{a}	43.22 ± 1.26 ^{e}
Indigenous earthworm + marigold leaves	17.08^{a}	23.16^{abc}	28.50^{b}	31.75^{b}	49.55 ± 0.89 ^{c}
Indigenous earthworm + neem leaves	18.37^{a}	26.86^{a}	36.43^{a}	46.00^{a}	59.41 ± 0.35 ^{a}
Indigenous earthworm	18.77^{a}	23.45^{abc}	28.78^{b}	34.16^{b}	35.63 ± 1.01 ^{f}
Control	15.95^{a}	18.73^{c}	22.54^{c}	26.12^{c}	22.06 ± 2.23 ^{g}

Each value represents the mean value of three replicates ± standard deviation. Standard deviation followed by same letter in each don't have any significant difference statistically at p<0.05 based on DMRT.

Leaf area

The use of different kinds of vermiwash had a considerable impact on the overall leaf area. Table 2 illustrates significant ($p<0.05$) differences between the treatments. The vermiwash indigenous variety of earthworm with neem leaves, which was made from neem leaves and indigenous earthworms, provided the noticeably highest leaf area. This observation might be the result of vermiwash's fast availability of nutrients. The correlation analysis showed a strong positive relationship between leaf area and yield ($r=0.99$). Seyedbagheri (1999) revealed that an increased nitrogen uptake increases leaf area, which in turn increases yield, which is evident in the findings of present study. The indigenous variety of earthworm with onion peel and exotic variety of earthworm with onion peel were the treatments that came to the place 2nd and 3rd having higher leaf area. In contrast among vermiwashes, in indigenous variety of earthworm with onion peel and exotic variety of earthworm with onion peel, statistically higher leaf area was noted. It may be due to the overriding ability of the pest damage, where a negative correlation ($r = -0.61$) was observed between pest infestation and leaf area. Due to the lack of additional nutrient support like vermiwash, untreated control treatment had the lowest leaf area (22.06 cm^2).

Conclusion

The study endorsed the effectiveness of vermiwashes made with indigenous earthworm varieties with garlic peel and onion peel, and exotic varieties with onion peel in reducing the number of epilachna beetles. Indigenous earthworm varieties with neem leaves and exotic varieties with garlic peel came in second and third places, respectively. Although the indigenous earthworm variety's vermiwash with neem leaves was statistically categorized into the second group in reducing the number of epilachna beetles, the highest yields of yard long beans and the greatest numbers of ladybird beetles were observed in such treatment-treated plots. The study also confirmed that, native earthworm varieties are more effective than exotic ones, as evidenced by the fact that vermiwash made from native earthworms outperformed vermiwash made from exotic earthworms in controlling insects.

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