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Effect of Liquid Biofertilizer with Tobacco (*Nicotiana tabacum*) Extract on Productivity of *Cajanus cajan* (L.) and Infestation of *Helicoverpa armigera* (Hübner)

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Abstract: Agriculture uses a lot of chemical fertilizers and pesticides to produce more agricultural products, which has a negative impact on the environment and on humans. Animal dung and municipal solid waste (MSW) are a societal problem that requires effective treatment. With the help of the earthworm *Eisenia fetida*, vermicomposting is the useful way for managing these wastes, and the byproducts that are generated are utilized in agriculture as biofertilizers. Pigeonpea are a tropical cereal legume that is primarily farmed in India. *Helicoverpa armigera* (Hübner) is a pest of pulse crops, causing damage to pods and reduce the productivity. The vermiwash and tobacco based biopesticides are used as an alternative of chemical fertilizers and pesticides. The purpose of this study was to study pigeonpea seed germination, growth, productivity, and effect on *H. armigera* infestation after foliar application of combination of aqueous extract of tobacco leaf (TL) and liquid biofertilizer vermiwash of animal dung and MSW. The significant per cent seed germination, growth (cm) and productivity (g/m²) were observed after the foliar spray of vermiwash with aqueous extract of tobacco (*Nicotiana tabacum*) leaf (TL) with respect to control. The significant reduced pest infestation and maximum growth as well as productivity of pigeonpea (*Cajanus cajan*) was observed in foliar application of vermiwash with aqueous extract of tobacco leaf. The vermiwash with biopesticides is a boon for crops because it is an environmentally beneficial and cost-effective alternative to chemical fertilizers and synthetic pesticides.

Keywords: Municipal solid wastes (MSW), Biopesticides, *Helicoverpa armigera*, *Eisenia fetida*, Pigeonpea, *Cajanus cajan*, Pest infestation, Vermiwash

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Introduction

Chemical fertilizers are being used more frequently in agriculture these days, which is destroying soil fertility. Chemicals are being utilized in ever-increasing quantities for agricultural intensification in order to feed an

ever-increasing population. In fact, despite massive pesticide use, pest-related losses are on the rise. Fortunately, consciousness of the negative effects of these chemicals on nature and natural resources, such as pollution, pesticide

residue, and pesticide resistance, have forced many to shift their attention to more reliable, sustainable and environmentally friendly pest control agents, such as biopesticides (Kumar, 2015). The usage of organic fertilizers can help to reduce the harmful effects of chemical fertilizers.

Biofertilizers are one of the most effective current agricultural technologies. It is a gift from agricultural science today. Compost, household wastes, and green manure are used as biofertilizers in the agricultural sector to replace conventional fertilizers (Maheswari and Elakkiya, 2014). Liquid biofertilizer formulation is a new and updated technique that, despite several advantages over agrochemicals, has sparked considerable debate among farmers for a variety of reasons, the most important of which is the survivability of the organisms. As a viable alternative to chemical fertilizers and pesticides, liquid biofertilizer is becoming more commonly available. Natural enemies in various agricultural habitats were unaffected by the botanicals (Ravikumar *et al.*, 1999; Rosaiah, 2001; Tian *et al.*, 2016). A botanical pesticide is one that is taken directly from plants that contain toxic compounds and is used to control pests.

Tobacco (*Nicotiana tabacum*) is an herbaceous plant of the Solanaceae family that is farmed for its leaves. For a long time, tobacco leaves (*Nicotiana tabacum*) have been exploited as an insecticide and pesticide (Abdul-ghany *et al.*, 2011). Because it is derived from organic sources and is environmentally beneficial, tobacco extract is referred to as an ecological or green insecticide. In places where food crops such as cereals and legumes are also produced, the tobacco plant is the most agricultural product (Lisuma *et al.*, 2021).

Pigeonpea (*Cajanus cajan* L.) is a commercially significant legume that plays an essential role in the semi-arid tropics (Ngugi-Dawit *et al.*, 2021). Pigeonpea is the most widely produced and consumed legume in India. It belongs to the Leguminosae family and is also known as red

gram, arhar, and tur dal (Ghadge *et al.*, 2008). Pigeonpeas are high in nutrients, carbohydrates, B-vitamins, amino acids, calcium, fiber, and iron, making them a valuable plant-based protein for vegetarians and vegans. The seed of the plant consist of 22.3% protein, 1.7% fats, 57.2% carbohydrates and 3.6% minerals. Cajanin and concajanin are the co-important protein present in the seeds. The seeds are cheap source of protein for human diet (Nath and Singh, 2008; Nath *et al.*, 2008).

Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae), often known as cotton bollworm or pod borer, is a damaging polyphagous bug that feeds on pigeonpea (Kriticos *et al.*, 2015). *Helicoverpa armigera* (Hubner) is a cosmopolitan pest widespread in deserts including xeric shrub lands, Mediterranean scrub, temperate broad leaf and mixed forests, tropical and subtropical grasslands, savannas, and shrub lands, as well as tropical and subtropical wet deciduous forest (Wasihun, 2016). *H. armigera* causes severe damage to tomato, cotton, pigeonpea, chickpea, okra, sorghum, cowpea, and a variety of other vegetables (Anonymous, 2006). Due to its strong polyphagy, large geographical range, mobility, migratory capability, facultative diapause, and high fertility, *Helicoverpa armigera* may adapt to a variety of cropping systems (Reigada *et al.*, 2016).

Every year, India produces millions of tones of animal dung and agro-wastes (Gupta, 2005; Garg *et al.*, 2006). If adequate management and disposal procedures are not accessible, animal dung, kitchen and agro-wastes, as well as municipal solid wastes (MSW) generate major issues for society, pose environmental concerns, and have a variety of negative consequences on human life and domestic animals (Bhartiya and Singh, 2012; Chauhan and Singh, 2012; Chauhan and Singh, 2013; Nath *et al.*, 2009; Singh and Chauhan, 2015).

Vermiwash is a type of liquid manure produced from vermicomposts (Sundaravadivelan *et al.*, 2011). Before applying the vermiwash to the plants, it must be diluted. It is one of the most

cost-effective and ecologically friendly trash disposal solutions available (Jayashree, 2006). Foliar sprays of vermiwash made from vermicomposts of buffalo dung+agro/kitchen wastes has enough power to boost crop growth, flowering, production, and reduce insect infestation (Nath and Singh 2011).

The aim of the present study was to observe the effect of combination of vermiwash of municipal solid wastes and buffalo dung along with tobacco based biopesticides for the proper germination, growth, productivity and minimize the pest *Helicoverpa armigera* infestation.

Materials and Methods

Collection of Wastes and Experiment Set up for Vermicomposting:

Municipal solid wastes (MSW) and buffalo dung were collected from the local municipality and farm house of Gorakhpur city, India. Vermibeds were prepared from municipal solid wastes and buffalo dung (1:1 ratio) and for pretreatment exposed to the sunlight for 15 to 20 days to remove the various harmful organism and noxious gases. After pretreatment, adult earthworms *Eisenia fetida* were inoculated in each vermibed for vermicomposting. The culture of the earthworm *Eisenia fetida* used during the experiment was procured from the Vermibiotechnology Laboratory, Department of Zoology, D.D.U Gorakhpur University, Gorakhpur, India. The vermireactors had covered with a fine mesh screen in order to prevent the worms in bed and allow gas exchange and also moisten daily up to 40-50 days for maintaining the moisture (40% to 60% RH). After one week interval vermibed were turned manually. The tea like granules of brown color have appeared on the upper surface of each vermibed after 90 days. Fresh vermicompost was collected for extraction of vermiwash (Nath *et al.*, 2009).

Extraction of Vermiwash:

Vermiwash were extracted from prepared vermicompost of Municipal solid waste (MSW)

with buffalo dung along with earthworms by the help of Vermiwash collecting device. The apparatus is made from plastic drum having capacity of 2 L and a tap at the bottom. The drum is filled with broken bricks; about 3 cm thickened which is followed by sand layer of 2-3 cm thickness, lastly filled with 5 kg vermicompost with earthworms *Eisenia fetida* population. Simultaneously 2.5 L fresh water was added in to the drum and after 24 h opened the tap and allowed to drops to drops in collecting tea like liquid extract vermiwash in the beaker (Nath *et al.*, 2009).

Extraction of Tobacco (Nicotiana tabacum) Plant parts:

Tobacco leaves were collect from the local market. The 100 g tobacco leaves were crushed with 100 ml water, dried and then aqueous extract (w/v) was prepared. The aqueous extract of tobacco leaves was mixed with vermiwash (v/v) in 1:5 ratio and further diluted ten times with water for foliar application on experimental plants. Prepared vermiwash with biopesticides was spread in legume crop at the interval of 15 days after sowing the seeds.

Measure the per cent germination, growth and production of Pigeonpea (Cajanus cajan) and Helicoverpa armigera pest infestation:

The seeds of pigeonpea (Narendra Arhar-2 variety) were sowed in agricultural field of Zoology Research Building II Department of Zoology, DDU Gorakhpur University, Gorakhpur, India. Before the sowing, per 100 g seeds of pigeonpea were treated for soaking for 24 h with combination of 5 ml of aqueous extract of tobacco leaf with 10 ml of vermiwash of MSW and buffalo dung. The seeds of *Cajanus cajan* were sowed in month of July in the field and six different areas of *Cajanus cajan* crop of size 5m×5m were selected for treatment of each combination. Vermiwash (VW) of combination of Municipal Solid Waste (MSW) and buffalo dung mixed with aqueous extract of tobacco leaf (TL) was sprayed over the crops after 15 days intervals. The growth of

pigeonpea plant was observed from August to January in each month. After starting of flowering at the end of January, then observed the per cent pod pest infestation of *Helicoverpa armigera* and finally, calculate the productivity of the crops after harvesting (Nath *et al.*, 2008). The control group received no treatment.

Statistical Analysis:

All data are presented as mean $\pm$ SE of 6 replicates. Student 't' test was applied to determine the significant ($P<0.05$) difference between treated and control group (Sokal and Rohlf, 1973).

Results

The significant effect of seed treatment (soaking) for 24 h with vermiwash and aqueous extract of tobacco leaf on seed germination of pigeonpea (*Cajanus cajan*) was observed. The maximum significant per cent germination of pigeonpea seed was observed (94.15 ± 1.8) after seed treatment of combination of vermiwash of MSW with buffalo dung and aqueous extract of tobacco leaf (Table 1).

The foliar spray of vermiwash obtained from MSW and buffalo dung with aqueous extract of tobacco leaf significantly increased the growth of pigeonpea plant. Time-dependent significant growth after spray of vermiwash (VW) with aqueous extract of tobacco leaf was obtained in all the treatments with respect to control group. The maximum growth 245.6 ± 4.2 was observed in month of January after the foliar application of vermiwash with aqueous extract of tobacco leaf in ratio 1:5 as compared to the control and vermiwash alone (Table 1). Among all the treatment of vermiwash with aqueous extract of tobacco leaf, significant reduction was noticed in per cent pod pest infestation of *Helicoverpa armigera* and productivity of (pigeonpea) *Cajanus cajan* (Table 2). The significant per cent pod pest infestation 03.00 ± 0.5 of *Helicoverpa armigera* was obtained after third foliar spray of vermiwash with aqueous extract of tobacco leaf after 15 days intervals (Table 2). After the harvesting, the

significant maximum productivity 221.5 ± 21 was observed after the foliar application of combination of vermiwash with aqueous extract of tobacco leaf after 15 days intervals after starting of flowering (Table 2).

Discussion

The significant effect of seed treatment (soaking) for 24 h and foliar application of vermiwash with aqueous extract of tobacco leaf on seed germination, growth, per cent pod infestation of *Helicoverpa armigera* and productivity was observed. Vermiwash increased plant growth and nutrition by containing a high concentration of important accessible elements. Vermiwash appeared to have an inherent property that operated as a liquid organic fertilizer and mild biocide, and it was shown to make a significant contribution to organic agriculture, soil health, disease management, and long-term crop productivity (Das *et al.*, 2014; Tripathi *et al.*, 2005; Nath *et al.*, 2008; Nath and Singh, 2008). The presence of several plant hormones and micro- and macro-nutrients in vermiwash resulted in considerable germination of pigeonpea (*Cajanus cajan*) plants. Many nutrients, vitamins, and growth hormones are found in vermiwash/vermicompost, which function as disease and pest suppressants (MacHfudz *et al.*, 2020). The more it is liquefied the more bioavailable and easily absorbed it became by plants for disease suppression. The use of vermiwash in combination with other plant-based pest management methods resulted in a synergetic effect that reduced insect infestations such as thrips and mites while also producing a significant number of healthy pods to boost yield (Mishra *et al.*, 2013). The use of foliar sprays of vermiwash and tobacco-based biopesticides significantly increased the development of pigeonpea plants.

Tobacco leaves, powder, extracts, or fumigants (*Nicotiana* spp.) have been employed to control agricultural pests or parasites of medical and veterinary relevance for centuries (McIndoo,

Table 1: Effect of combinations of vermiwash of municipal solid wastes and buffalo dung with aqueous extract of tobacco leaf (biopesticides) on growth (cm), of pigeonpea plant (*Cajanus cajan*)

Treatment	% Germination (July)	Growth (cm)					
		August	September	October	November	December	January
Control	61.2±2.1	59.2±1.5	85.44±1.4	100.4±1.7	120.5±1.6	148.5±1.8	162.5±1.5
VW	80.2±1.6*	81.6±4.4*	81.5±4.7*	121.5±7.2*	164.5±8.1*	197.5±6.6*	227.5±4.1*
VW+TL	94.15±1.8*	95.2±2.8*	83.6±2.4*	127.4±3.6*	167.2±6.2*	207.05±5.2*	245.6±4.2*

VW= Vermiwash, TL= Tobacco leaf. Each value represents mean±SE of 6 replicates.

*Significant (P<0.05) 't' test between treated and control group.

Table 2: Effect of combinations of vermiwash of municipal solid wastes and buffalo dung with aqueous extract of tobacco leaf (biopesticides) on pest infestation of *Helicoverpa armigera* and productivity of pigeonpea (*Cajanus cajan*)

Treatment	% Pest Infestation after 15 days interval of starting of flowering			Productivity (gm/m ²)
	I Foliar spray	II Foliar spray	III Foliar spray	
Control	91.01±2.5	94.4±2.5	96.03±2.0	0.87±16
VW	40.02±1.7*	30.15±2.6*	21.21±2.5*	165±17*
VW+TL	03.5±1.0*	03.3±0.5*	03.00±0.5*	221.5±21*

VW= Vermiwash, TL= Tobacco leaf. Each value represents mean±SE of 6 replicates.

*Significant (P<0.05) 't' test between treated and control group.

1943). Tobacco is frequently recognized as an excellent pesticide and is also used as an insect or tick repellent to prevent vector-borne infections in traditional pharmacopoeia (Jufri *et al.*, 2016; Pavela *et al.*, 2016).

Tobacco leaves are made up of around 4,000 different components, and crude leaf methanolic extracts are extremely complex combinations (Eich, 2008; Leffingwell, 1999; Rodgman and Perfetti, 2013). Tobacco extracts have been used to control insect pests for ages (Bradbury, 2008). Tobacco quality is mostly determined by the key chemical components of tobacco leaves, such as nicotine, protein, and carbohydrates. Vermiwash with various biopesticides such as neem (*Azadirachta indica*) oil, aqueous extract of garlic (*Allium sativum*) bulb, and leaf extract of custard apple (*Annona squamosa*) resulted in a significant reduction in economically harmful insect pests from various agricultural crops, resulting in

improved gram crop growth, early flowering, and productivity (Rajput *et al.*, 2003; Nath *et al.*, 2011; Nath and Singh, 2011).

Vermiwash contains protease, amylase, urease, and phosphatase enzyme cocktail, as well as nitrogen-fixing bacteria such *Azotobacter* sp., *Agrobacterium* sp., and *Rhizobium* sp., as well as some phosphate-solubilizing bacteria (Zambare *et al.*, 2008). Foliar application of vermiwash enhanced disease resistance power in the crops. Tobacco extracts are insecticides with a wide range of applications. They work as insecticides, nematocides, and fungicides, as well as having antibacterial effects. Tobacco leaves have been used as a pesticide for centuries. Nicotine, the principal component, is effective against most insects (neurotoxic). Kanmani *et al.* (2021) reported that the poisonous effect of tobacco *Nicotiana tabacum* Linnaeus (Solanaceae) leaf extracts is very beneficial in the control of the rice

weevil *Sitophilus oryzae*. This natural pesticide is not toxic in small amounts and is quickly metabolized (hydrolysed and photolysed). More mineral nutrients were converted into more plant accessible forms, which helped the plant recover from the larvae's damage, but adding vermiwash extract to these botanicals helped the plant consistently increase the early start of flowering, much more than could be achieved by more mineral nutrients being converted into more plant accessible forms. After spraying vermiwash with neem-based pesticides on *Cajanus cajan* crop, Nath *et al.* (2008) found a substantial reduction in the number of *Helicoverpa armigera* larvae. Amoabeng *et al.* (2013) reported that *N. tabacum* extract reduced the number of *Plutella xylostella* in a cabbage field by 93.0 %. *Nicotiana tabacum* extract has been shown to be an appropriate control agent for *Grapholita molesta* (Sarker and Lim, 2018).

Conclusion

The present study focuses on MSW management and vermiwash generation, as well as plant product biopesticides for improved growth, flowering, and productivity, as well as pest infestation reduction on the pigeonpea (*Cajanus cajan*) plant. The combination of vermiwash and tobacco-based biopesticides resulted in considerable increase in seed germination, growth and productivity, as well as a reduction in the *Helicoverpa armigera* pest infestation. So we can say that vermibiotechnology is a tool for waste management through vermicomposting and liquid biofertilizer vermiwash has become a more effective solution for pest infestation and organic farming. For both human and animal health, vermiwash and biopesticides are less expensive, non-hazardous, and environmentally acceptable.

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