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Potency of Vermiwash with *Azadirachta indica* A. Juss on Yield of Gram (*Cicer arietinum*) and Infestation of *Helicoverpa armigera* (Hübner)

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Abstract: Abundant chemical fertilizers and pesticides use in agriculture for the production of huge agricultural products, which caused adverse effect on environment and human being. Animal dung and municipal solid wastes (MSW) are a problem for society, so need to it proper management. Vermicomposting is the biological process in which manages of these wastes by the help of *Eisenia fetida* and its byproducts use in agriculture. In India, Gram (*Cicer aritenum*) pulse is major sources of protein in human diet but its production decreased day to day due to a various reasons. The *Helicoverpa armigera* (Hübner) is a pest to pulse crops, which damaged pods and ultimately decrease its productivity. The vermiwash and neem based biopesticides used as alternative of chemical fertilizers and pesticides. The aim of present study was to observe the gram seed germination, growth, productivity, as well as infestation of *H. armigera* after foliar spray of liquid biofertilizer vermiwash of animal dung and MSW with combination of neem leaf (NL), bark (NB) and fruit (NF) aqueous extract. The significant germination, growth and productivity (g/m^2) was observed after the foliar spray of vermiwash with aqueous extract of neem (*Azadirachta indica* A. Juss.) leaf (NL) with respect to control. The lowest pest infestation of gram (*Cicer aritenum*) was observed after 70, 85 and 100 days sowing and foliar spray to VW+NB, VW+NF, VW+NF respectively. The foliar spray of the combination of vermiwash with aqueous extract of neem plant part is a boon for farmers because it is less expensive, easily preparable, non-hazardous to environment and human being.

Key words: Gram (Cicer Aritenum) · Helicoverpa armigera · Neem plant parts · Pest infestation · Productivity · Vermiwash

INTRODUCTION

The abundant use of chemical fertilizers and pesticides has been disturbed the soil texture, adversely affect to micro-, macro-, flora and fauna, loss of soil fertility, less agricultural productivity, deterioration of the environment, as well as affect the human health [1-3]. Nutrients like protein, amino acids, ascorbic acid etc. reduced in foodstuffs or alternate its nature by the use of chemical fertilizers and pesticides [4]. According World Health Organization (WHO) annually 200,000 peoples are killed worldwide by synthetic chemical pesticides poisoning [5]. Due to its carcinogenicity, teratogenicity, high and acute residual toxicity, ability to create hormonal imbalance, spermatotoxicity and a lot of side effects, so its use has been restricted [6-8].

The neem tree (*Azadirachta indica* A. Juss.) belongs to family Meliaceae is a tropical-subtropical evergreen tree, native to Indian subcontinent [9] and considered to its genetic diversity in India [10]. Neem is called *'arista'* in Sanskrit a word, 'Indian lilac' or 'Margosa'. All parts of this plant i.e. fruits, seeds, leaves, bark and roots contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, antiulcer and antifungal uses [11]. Neem is also used as a biocontrol agent to control many plant diseases [12]. There are an estimated 25 million trees growing all over India and maximum recorded in Uttar Pradesh (55.7%) whenever it grow all over the India [13-15]. India stands first in neem seed production and about 4,42,300 tons of seeds are produced annually yielding 88,400 tons of neem oil and 3,53,800 tons of neem cake [13].

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Gram (*Cicer arietinum*) family Leguminaceae is one of the most important pulse crops. Seed of gram contains 17.1% protein, 5.3% fats, 61.2% carbohydrates, 3.9% fibers and 2.7% minerals [16]. *Helicoverpa armigera* (Hübner) is the most serious insect pest of pulses [17]. On average about 30 to 40% pods were found to be damaged by the pod borer resulting in the yield loss of 400 kg/ha due to pod borer damage [18-19]. Due to abundant and regular use of insecticides increased resistant in some pest i.e. in *H. armigera* [20-21]. Vermiwash show the significant growth and productivity of black gram, spinch, onion and potato [22-23].

In India, million tonnes of cattle dung, such as buffalo dung (12.20 tonnes) cow dung (11.6 tonnes) and goat dung and agro/kitchen wastes are produced annually. These wastes have noxious problems, if they are not managed properly, caused various odour and environmental problems in the surrounding area [24-28]. The large amount of sewage sludge produced in wastewater treatment plants that caused potential risks for human health and environmental problems [29]. Vermicomposting is the biological degradation and stabilization process for organic waste by earthworms and microorganisms and convert into rich nutrient for plant kingdom i.e. vermicompost [3]. *Eisenia fetida* an epigeic earthworm used in vermicomposting since last decade and also observed its little abundance in Gorakhpur district, UP, India [30]. Various studies reveal that vermicomposting accelerates organic matter stabilization, high content of microbial matter and stabilized humic substances [31-32].

Vermiwash is a liquid extract of vermicompost and earthworms, which used on various crops for enhance the productivity in agriculture and horticulture [33]. It contains micro plant nutrients, enzymes such as proteases, amylases, ureases and phosphatase and nitrogen fixing bacteria and some phosphate solublizing bacteria [34]. Vermiwash is also enriched with plant growth hormones like auxines, cytokinin, gibberellins, amino acids, vitamins that increase growth rate, high productivity and resistance against various disease for plant and also act as nematicides [35-38]. Vermiwash extracted from MSW contain high amount of organic matter, plant nutrients and soluble salts [39]. The aim of present work to observe the suitable combination of vermiwash from municipal solid wastes with neem based biopesticides for the proper germination, growth, productivity and minimization of pest infestation.

MATERIAL AND METHODS

Collection of Wastes and Experiment Set up for Vermicomposting: Municipal solid wastes and buffalo dung were collected from the local municipality and farm house of the Gorakhpur city. Vermibed were preparing from MSW and buffalo dung (in 1:1 w/w) and for pretreatment exposed to the sunlight for 8 to 10 days to remove the various harmful organism and noxious gases. After pretreated, adult earthworms *Eisenia fetida* were inoculated in each vermibed for vermicomposting. The culture of the earthworm *E. fetida* used during the experiment was procured from the Vermiculture Research Laboratory, Department of Zoology, DDU Gorakhpur University, Gorakhpur, UP, 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 (55±5% RH). After one week interval vermibed were turned manually. The tea like granules, brown color have been appearance on the upper surface of each vermibed after 90 days i.e. vermicompost collected for extraction of vermiwash [37].

Extraction of Vermiwash: Vermiwash were extracted from prepared vermiwash with earthworms by the help of vermiwash collecting device. The apparatus is made from plastic drum having capacity of two liter and an outlet 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 vermicompost with earthworms, *Eisenia fetida*. Simultaneously one liter fresh water was added in drum and after 12h open tap and allow to drops to drops in collecting beaker [37].

Extraction of Neem (*Azadirachta Indica* A. Juss.) Plant Parts: Neem leaves, bark and fruit were collected from the old tree near to Department of Zoology, DDU Gorakhpur University, Gorakhpur, India and dried in direct sunlight for two weeks, with periodic turning. The dried each 100 g leaves, barks and fruits materials were grounded and sieved through 2 mm sieve and soaked 24 h in kerosene (100 ml) then diluted by distilled water in containers of 5L capacity which further used as 5% stock solution of neem based biopesticides named NL, NB and NF respectively. Neem based bio-pesticides mixed with vermiwash (1:1 ratio) which further diluted with water (VW+NB stock solution: water :: 1:10). Prepared

vermiwash with biopesticides spread in gram crop at the interval of 15 days and first spray 10 days after showing.

Measure the Growth, Production of Gram (*Cicer aritenum*) and *Helicoverpa Armizera* Pest Infestation: For the measure of different parameters of gram (*Cicer aritenum*) variety- Gulab, showed in agricultural field of Zoology Research Building II, Department of Zoology, DDU Gorakhpur University Gorakhpur, India. In the field, randomly select six spots, each square meter area was be used for sowing the pulse crops. The effect of vermiwash with neem bio-pesticides were measured germinations on pulse crop, for this seeds soaked in different combinations for time duration 24 h and observed in per cent. For growth (cm.) of gram observation, randomly selected plant from each spot were used and by the help of Auxanometer at the interval of 15 days after 30 days of sowing. The flowering (days) of gram will be measured as 50% of gram plant flowered. The productivity will be measured as kg/m^2 of pulse crops. The different combinations of vermiwash with neem biopesticides will be sprayed over the crops after each 20 days interval for the measurement of growth whereas, at the time of starting of flowering after each 7 days interval the different combinations of vermiwash with biopesticides will be sprayed over the crops and control have no treatment.

Statistical Analysis: All the experiments were replicated six times for the purpose of obtaining consistency in the result and finding out the mean with standard error. DMRT used for determined the significance in each column as growth, flowering as well as productivity of crops [40].

RESULTS

The effect of soaking for 24 h of vermiwash and with neem based biopesticides on germination of gram (*Cicer aritenum*) plant was observed. There was significant per cent germination of gram seed in vermiwash (VW) with aqueous extract of neem plant parts 90±2.27 to 97±1.18% than control 70±2.12% (Table 1).

The data displayed in Table 1 that the foliar spray of vermiwash obtained from MSW and buffalo dung with neem plant parts were, significantly increased the growth of gram plant. There was time dependent significant

Table 1: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on growth, flowering of gram plant.

		Growth (cm) after			
Combinations	Seed Germination (%)	30 days	45 days	60 days	Flowering
Control	70±2.12^a	9.32± 0.57^a	16.13± 1.13^a	27.11± 1.08^b	32.18± 1.85^b
VW	89±1.18^b	12.21± 0.43^b	20.68± 1.25^a	31.57± 1.25^a	27. 52± 1.15^{ab}
VW +NL	98±2.27^b	13.20± 0.69^b	22.82± 1.51a	34.52± 1.27a	27.93± 1.36 ab
VW +NB	97±2.36^b	12.70± 0.76b	21.00± 1.42a	33.23± 1.54a	26.50± 1.54ab
VW +NF	96±1.25^b	12.00± 0.83b	19.27± 1.20 a	32.24± 1.25 a	24.00± 1.42a

Table 2: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on productivity of gram plant and pest infestation of *H. armigera*.

	Pod pest infestation (%) after		
Combinations	90 days	105 days	120 days
Control	2.67± 0.07^b	8.25± 0.85^b	16.59± 0.54^c
VW	1.17± 0.02^{ab}	5.83± 0.64^{ab}	10.30± 0.87b
VW +NL	0.16± 0.02a	2.12± 0.12a	0.67± 0.04a
VW +NB	0.15± 0.02a	1.72±0.11a	0.13± 0.02a
VW +NF	0.12± 0.05a	1.15±0.14a	0.12± 0.04a

Table 3: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on productivity of gram plant.

	Productivity	
Combinations	No. of pod/plant	After harvesting (g/m^2)
Control	15.32± 1.48^a	385.11± 15.01^a
VW	36.21± 2.43^b	567.57± 23.46^b
VW +NL	37.20± 2.42b	632.52± 21.47c
VW +NB	37.70± 2.65b	656.24± 21.42c
VW +NF	38.90± 2.42b	773.23± 20.64c

growth was observed after sprays of VW with different aqueous extract of neem plant parts. The maximum growth of gram 34.57±1.25 cm was observed in after 60 days by sprays of VW+NL combination (Table 1). Among all the combinations of vermiwash with neem plant parts showed significant early flowering. The earliest flowering 24.00±1.42 days was observed after sprayed of VW+NF (Table 1).

The effect of VW and with aqueous extract of neem plant parts on *Helicoverpa armigera* pest infestation (pest@100 pod) of gram (*Cicer aritenum*) plant was observed at 15 days interval (Table 2). There was significant reduction of *H. armigera* pest infestation after foliar spray of vermiwash with aqueous extract of neem plant parts. The significant lowest pest infestation of gram pod borer was observed in combination of VW with NF after 90, 105 and 120 days (Table 2).

The effect of foliar spray of vermiwash obtained from MSW and buffalo dung alone and with neem based biopesticides on the productivity of gram (*Cicer aritenum*) plant was studied. The maximum no. of pod per plant was observed 37.90±2.42 in treated with VW+NF followed 37.70±2.65 g/m^2 by VW+NB. The maximum productivity of gram plant was observed 773.23±20.64 g/m^2 in treated with VW+NF (Table 3).

Table 1: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on growth, flowering of gram plant.

Table 2: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on productivity of gram plant and pest infestation of *H. armigera*.

Table 3: Effect of different combinations of vermiwash of municipal solid wastes and neem plant parts biopesticide on productivity of gram plant.

DISCUSSION

The vermiwash with aqueous extract of neem plant parts showed significant germination of gram (*Cicer aritenum*) plant may be due to presence of different plant hormones and micro-macro nutrients in vermiwash. Vermiwash of different wastes are rich source of enzymes, vitamins, plant growth hormones (such as IAA, gibberellins, cytokines) and also provide nutrients (such as phosphorus, potassium, calcium etc.) [38, 41-44]. The significantly increased the growth of gram plants was observed due to foliar spray of vermiwash and neem based biopesticides. Zambare *et al*. [34] have observed that vermiwash supplemented with enzyme of proteases, amylases, urease, phosphatases, nitrogen fixing bacteria like *Azotobacter* sp, *Agrobacterium* species and *Rhizobium* sp which may be important of gram growth. In this study it was observed that no major role of neem based biopesticides on the growth of gram plant because there was no significant growth in treatment with VW and with different part of neem based biopesticides. Nath and Singh [43] observed the significant growth of cauliflower after foliar spray of vermiwash of animal dung with agro and kitchen wastes. The effect of vermiwash and different neem based biopesticides were observed in the flowering of gram plant may be due to the presence of important inorganic and organic nutrient for flowering present in vermiwash. The hormones auxines promotes the plant growth and gibberellins stimulate the early flowering in long photo-period plant [24, 45,46].

The effect of foliar spray of vermiwash obtained from municipal solid wastes and buffalo dung with neem based biopesticides showed significant productivity of gram plant may be due to vermiwash and neem based biopesticides which also protect the pod/grains. The maximum no. of pod per plant was observed in treated with VW+NF > VW+NB showed that neem based fruit biopesticides were more protective than bark. Large amount of humic acids was produced during vermicomposting and extracted in vermiwash [2, 47]. The highest no. of seed per pod was observed in VW > BF which reviled that vermiwash was responsible for no. of grain in gram pod. There was no significant difference of fresh seed weight because in control even small no. of pod and or grain observed but it size and weigh large. According to Astaraei and Ivani [48] increased the number of leaves after foliar spray and leaves become thicker and dark green which important for growth and productivity of crops. Presence of essential nutrients which were absorbed by plants and increase metabolic rate and enhance the crop productivity [48-49].

There was significant pest infestation in control >VW after 100 days, this observation showed effect of neem based biopesticides. The significant low pest infestation of gram pest was observed 100 days by treatment with VW+BF which showed the maximum use fruit as pesticides. Ponnusamy [50] reported that the reduction in bug population by application of neem based biopesticides on rice crop. Nath *et al.* [51] recorded that significant reduction in the population of *Helicoverpa armigera* larvae after spray of vermiwash with neem

based pesticides on the *Cajanus cajan* crop. Wondafrash *et al.* [52] was also observed that the water extract obtained from neem leaf extract caused significant decrease in feeding and survival behavior of insect pest. Biswas *et al.* [53] reported that the nimbidin has anti-inflammatory, antiarthritic, antipyretic, hypoglycaemic, antigastric ulcer, spermicidal, antifungal, antibacterial, diuretic whereas, nimbin has spermicidal, nimbolide- ntibacterial, antimalarial, antifungal, antimalarial. The active component azadirachtin reduced the feeding behavior of larvae of various lepidopterous insects. Oligophagous species were more sensitive than polyphagous ones [54]. The volatiles of neem seed kernel prevented contract and repelled the moths *H. armigera* [55]. Heyde *et al*. [56] demonstrated that the spraying of 1-50% emulsion of neem oil significantly reduced the food intake of homopterous insects.

CONCLUSION

The present study is information about the management of MSW and production of vermiwash as well as plant product biopesticides for better growth, flowering and productivity as well as reduction pest infestation on gram (*Cicer aritenum*) plant. The used of vermiwash and neem based biopesticides have significant per cent germination of seed, growth, early flowering, productivity and reduced the reduced the *H. armizera* pest infestation. Thus vermiwash used be a better technology for pest infestation and used as organic farming. The use of vermiwash and biopesticides are less expensive, non hazardous and eco-friendly for human as well as animal health.

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