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Productivity Enhancement and Nematode Management Through Vermicompost and Biopesticides in Brinjal (*Solanum melongena* L.)

Gorakh Nath, D.K. Singh and Keshav Singh

Department of Zoology, D.D.U. Gorakhpur University, Gorakhpur-273009, U.P. India

Abstract: Productivity of brinjal crop is strongly destroyed by the nematode (*Meloidogyne incognita*) in the eastern Uttar Pradesh. This species is injurious to the crop and attack to the plant in rainy season i.e. August and September. Phytoparasitic nematodes are harmful to the living plants and decreased the growth and Productivity. Vermicompost containing biopesticide is a useful tool to enhance the productivity of crop and to check the infestation of nematode. Single and binary combination of vermicompost with biopesticides were used in agricultural field to control the infestation of nematode (*Meloidogyne incognita*) and their effect on growth and yield of brinjal (*Solanum melogena*). Significant decrease in nematode population was observed in the soil, when binary combination of vermicompost with neem oil (92%) and custard apple leaves (80%) were applied in the field. The combination of garlic extract with vermicompost caused 98% control of the nematode population. Vermicompost obtained from animal dung + gram bran with neem oil was also very effective against the *Meloidogyne*. The results clearly demonstrated that the use of vermicompost with biopesticide is more beneficial to organic farming. It is helpful to compensate the deficiency of nutrients in the soil as well as control of the harmful nematode pest. It is evident from the results that the vermicompost of buffalo dung + gram bran with aqueous extract of garlic bulb / neem oil were very effective against infestation of nematode (*Meloidogyne incognita*) in agricultural field which ultimately enhance the productivity of brinjal crop.

Key words: Biopesticide · Eisenia foetida · Nematodes growth · Productivity · *Solanum melogena* · Vermicomposting

INTRODUCTION

Brinjal (*Solanum melogena*) belongs to family Solanaceae and common nutritive vegetable crop. Brinjal fruit contains 93% water, 40% carbohydrates, 1.4% proteins, 0.3 fats, 0.3% minerals and 1.3% fiber. It is especially rich in potassium, sulphur, phosphorus and vitamin A and C [1]. Phytoparasitic nematodes are obligate parasite and feed only on the plant. They can be distinguished from non parasitizing forms by hearing a style which helps the nematode to puncture the protective wall of the host plant. The nematode bears a style for punctured the productivity wall of the host plant. They inject the secretion of esophageal gland which dissolved the cell wall of the host plant and ingest the cell content, which ultimately results a poor plant growth, winter injury, wilting of tree and loss of seedlings. The nematodes inject the secretion of esophageal glands containing enzymes which dissolved the cell wall, digest the plant material and prepare the cell contents suitable for ingestion. The nature of damage varies according to the species of nematodes [2]. *Pratylenchus*, *Rodopholus* and *Tylenchus* feeding on host plants cause necrosis at the site of penetration. Thus, nematode affects the growth, structure and reaction of the host tissue penetrated [2]. Phytoparasitic nematodes decrease the productivity of crops by destruction of plant [3]. The additional organic material in soil has been used in managing plant parasitic nematodes to increase the crop yield [4, 5].

Although use of chemical fertilizers and synthetic pesticide increases the productivity of the crop, yet these alter the soil texture, physico-chemical properties of soil and damage the human health and environment [6-8]. The vermicompost stimulate plant growth providing sufficient amount of nutrition (9, 10). The vermicompost contain plant growth regulator and plant growth hormones that increase the growth and yield of different crops (11). Application of vermicompost enhanced the soil fertility and improved the growth and yield of crops [12-14].

Corresponding Author: Keshav Singh, Department of Zoology, D.D.U. Gorakhpur University Gorakhpur-273009 U.P. India. Tel: 0551-2205401, Mob: 09450433313, E-mail: keshav26singh@rediffmail.com.

Gupta and Sharma, [15] reported that the garlic (*Allium sativum*) have nematicidal properties against (*Meloidogyne incognita*). He suggested that aqueous extract of garlic bulb suppressed that hatching of eggs and mortality of larvae. Taba *et al.* [16] reported that the ethanolic and aqueous leaf extract of *Bidens pilosa* was effective against *M. incognita.* Abbas *et al.* [17] have reported that aqueous bulb extract of *Allium sativum* is effective for the control of *Meloidogyne javanica.* Clove oil derived from *Syzygium acromaticum* is potent nematicide against various soil born plant parasitic nematodes [18].The aim of present study was to investigate the effect of vermicompost of different animal (cow, buffalo, sheep, goat and horse) dung and agro / kitchen wastes in binary combination with biopesticide on growth and productivity of *Solanum melongena* as well as management of harmful soil nematode *Meloidogyne incognita.*

MATERIAL AND METHODS

Collection of Wastes: Different animal dung (cow, buffalo, sheep, horse and goat), agro wastes (gram bran, straw, wheat bran, barley bran and rice bran) and vegetable wastes were collected from rural and urban parts of Gorakhpur district. The different combinations of animal dung, agro and vegetable wastes were sprayed in a layer of 1-2 feet and exposed to sun light for 5 to 10 days to removing the various harmful organism and noxious gases before use for vermicomposts bed as feed material for earthworms *Eisenia foetida* [19].

Collection of Earthworms: Earthworm *Eisenia foetida* an epigeic species were cultured in laboratory condition, temperature (20 to 30°C) and aeration, moisture (40% to 60%) for proper growth and survival of earthworms by the method of Gupta, [6].

Preparation of Vermicomposts: Vermicomposts of different animal and agro wastes were prepared on cemented earth surface. The 35 vermibed were formed by different combinations of animal, agro / kitchen wastes in 1:1 ratio the size of each vermibed is 3m x 1m x 9cm. After formation of vermibed moist it and inoculated 2 kg cultured *Eisenia foetida* in each vermibed and covered with jute pockets and moisten daily up to 40 to 50 days for maintaining the moisture content. After one week interval vermibed was manually turned up to 3 weeks. After 50 to 60 days granular tea like vermicompost appear on the upper surface of vermibeds.

Collection and Preparation of Biopesticide:
Neem Oil: Neem oil extracted from seeds of neem (*Azadirachta indica*) which contains azadirachtine, 00.03 %; neem oil, 90.57%; hydroxy El, 05.00%; epichlorohydrine, 00.50 %; aromax, 03.9%; parched from Multiplex Agricare Pvt. Ltd, India.

Garlic Extract: Aqueous extract of Garlic (10gm/100ml) obtained from garlic (*Allium sativum*) bulb was mixed with vermicompost in 1:100 ratio.

Custard Apple: Leaves are collected from plant of Custard apple (*Annona squamosa*). Prepared aqueous extract (10gm/100ml) of leaves were mixed with vermicompost in 1:100 ratio.

Collection of Nematodes from Soil: Soil sample were collected from different experimental sites. A small amount of soil (100 cm^3) of each samples were collected from the experimental field from 20 cm depth. Nematodes were collected from soil using Cobb's Sieving and gravity methods [20].The samples were passed through sieves and the finally centrifuged for one minute at 2000g. Nematode was identified through their taxonomic character. Enumerations of nematode were performed under microscope [5].

Vermicompost obtained from different combination of animal and agro wastes in single and binary combination with biopesticide (neem oil, leaves extract of custard apple and garlic bulb extract) were mixed @ 2 kg/m^2 experimental field. Number of nematodes at pre and post mixing of vermicomposts in soil was counted with the help of microscope.

Experimental Design of Crops for Measurement of Growth, Flowering Period and Productivity: Measurement of growth, flowering period and productivity of brinjal (*Solanum melogena*) variety Pusa Kranti were performed in the experimental field of Vermiculture Research Center, Department of Zoology and D.D.U. Gorakhpur University. The 40 days old seedlings planted in the experimental field/squire meter in each. Growth of crop was measured by auxanometer after 20 days from plantation. Flowering period and productivity (kg/m^2) of brinjal was measured in each experimental field.

Chemical Analysis: For the chemical analysis of raw organic wastes and final vermicompost, the total organic carbon (TOC) was measured according the method of Nelson and Sommers, [21]. Total Kjeldahl nitrogen was determined by the method of Bremner and Mulvaney, [22].

Total available phosphorus (TAP) was determined by colorimetric method of Bansal and Kapoor, [20]. Total Potassium and Calcium were determined by flame photometer [23]. The pH and electrical conductivity (EC) were determined by with the help of pH and conductivity meter.

Statistical Analysis: The value is expressed as mean ± SE of 6 replicates. Two way analysis of variance (ANOVA) was applied to determined the significant ($P<0.05$) difference among the number of nematodes in control and treaded group. One way analysis of variance was applied to locate significant ($P<0.05$) difference between flowering and productivity of crop with respect to different formulations of vermicompost [24].

RESULTS

The binary combination of vermicompost with biopesticide viz. neem (*Azadirachta indica*) oil, aqueous extract of garlic (*Allium sativum*) bulb and leaves extract of custard apple (*Annona squamosa*) caused a significant ($P<0.05$) reduction in pest infestation and increase in plant growth, flowering and productivity of *Solanum melongena*. The significant reduction in number of nematodes population was observed in the soil mixed with vermicompost containing biopsticides (Table 1-4). The different combinationof vermicompost with garlic extract and animal dung + gram bran with neem oil have caused the complete control of soil nematodes infestation (Table 2, 3).

Table 1: Effect of vermicomposts obtain from different animal dung and agro / kitchen wastes on nematode population in soil and growth as well as growth and productivity of brinjal (Solanum melogena).

	No. of nematodes		Growth of brinjal (cm.) Days after planting				
Combination	Before sowing	After harvesting	20	30	40	Flowering period (Days)	Productivity (kg/m2)
Control	31.4±0.5	36.5±0.4	07.20±0.42	10.80±0.60	16.30±1.58	72.12±2.32	1.86±0.58
CowDung *	30.3±0.3	22.4±0.2	# 12.53±1.42	15.76±2.45	23.85±2.42	67.15±2.42	$ 3.86±0.23
Dung +Rice Bran	32.6±0.2	21.3±0.1	* 15.48±1.43	18.46±0.85	25.48±1.74	62.45±1.72	4.76±0.45
Dung +Wheat Bran	31.4±0.1	20.6±0.2	16.56±0.54	19.55±1.22	25.98±0.88	64.42±1.52	4.00±0.23
Dung +Straw	32.3±0.1	18.7±0.2	15.95±0.72	18.16±1.46	26.02±0.98	67.48±2.47	5.18±0.35
Dung +Vegetables	33.2±0.0	21.4±0.3	17.09±1.42	19.75±2.42	27.02±2.59	62.12±3.13	5.80±0.42
Dung +Barely Bran	30.5±0.2	22.8±0.3	15.86±0.76	18.21±0.75	25.48±2.45	63.45±3.42	3.68±0.32
Dung +Gram Bran	33.6±0.2	16.5±0.1	13.72±1.85	16.43±1.42	25.15±2.12	63.48±1.45	5.02±0.52
Buffalo							
Dung *	30.4±0.1	31.4±0.2	# 14.02±1.46	17.02±0.62	23.23±1.45	69.95±2.74	$ 3.65±0.14
Dung + Rice Bran	31.8±0.3	22.5±0.1	* 15.46±2.43	18.12±2.02	25.13±1.43	65.16±3.56	4.62±0.22
Dung + Wheat Bran	32.7±0.3	21.6±0.4	16.12±1.56	19.90±0.08	25.04±2.43	65.53±2.84	3.94±0.25
Dung + Straw	34.9±0.2	18.5±0.2	15.46±2.13	18.56±2.23	25.01±2.54	68.45±2.47	5.23±0.24
Dung + Vegetables	32.8±0.1	18.3±0.1	17.46±2.46	19.10±0.89	27.90±1.42	62.84±3.12	5.56±0.32
Dung + Barley Bran	32.4±0.2	21.6±0.0	16.56±2.76	19.44±1.53	26.20±1.34	63.75±2.46	5.02±0.52
Dung + Gram Bran	30.3±0.3	22.3±0.1	17.09±1.42	19.75±2.42	27.02±2.59	62.12±3.13	5.90±0.42
Sheep							
Dung *	32.2±0.1	22.4±0.3	# 10.53±0.29	14.74±2.12	17.45±1.56	63.45±2.78	$ 3.23±0.52
Dung +Rice Bran	33.3±0.2	21.3±0.2	* 12.12±0.43	15.13±0.76	22.41±2.75	70.64±1.75	3.60±0.36
Dung + Wheat Bran	32.2±0.2	20.7±0.3	14.13±1.46	17.15±0.46	23.15±0.78	65.48±3.72	5.21±0.24
Dung + Straw	33.4±0.1	19.9±0.1	14.47±1.13	17.51±1.45	22.98±0.75	66.42±1.89	5.50±0.38
Dung + Vegetables	30.2±0.2	18.4±0.3	14.58±1.85	17.42±1.46	23.04±2.02	67.98±3.82	3.56±0.24
Dung + Barley Bran	31.5±0.3	23.5±0.1	15.45±0.42	17.43±1.46	25.45±2.23	62.64±2.47	4.04±0.62
Dung + Gram Bran	30.6±0.1	21.2±0.2	12.46±1.45	15.45±1.43	22.43±0.86	62.75±1.84	3.57±0.42
GoatDung *	30.5±0.1	21.3±0.2	# 11.52±1.48	14.23±1.43	18.45±1.48	64.92±1.42	$ 3.12±0.40
Dung + Rice Bran	32.3±0.0	20.4±0.2	* 13.42±1.52	16.02±1.45	21.52±1.23	63.97±1.85	3.42±0.56
Dung + Wheat Bran	32.6±0.4	24.6±0.4	14.13±1.47	17.15±1.45	22.75±1.14	70.62±1.71	5.13±0.65
Dung + Straw	31.4±0.1	20.7±0.3	14.12±0.49	17.47±1.56	21.45±2.52	65.23±2.66	5.46±0.75
Dung + Vegetable	31.2±0.3	21.6±0.0	13.23±0.67	16.42±2.42	22.46±2.47	64.89±3.85	3.72±0.43
Dung + Barley Bran	31.4±0.1	22.5±0.1	14.04±1.42	17.42±0.78	22.89±0.98	63.45±2.47	3.86±0.56
Dung + Gram Bran	33.6±0.2	22.4±0.1	13.45±0.45	15.86±1.46	23.53±0.81	61.96±2.45	4.00±0.45
Horse							
Dung *	34.4±0.3	18.5±0.2	# 14.05±2.02	17.00±1.45	23.45±2.24	67.87±2.42	$ 3.65±0.13
Dung + Rice Bran	32.5±0.4	19.8±0.2	* 12.02±2.05	15.48±2.41	22.55±2.48	67.89±2.48	4.56±0.43
Dung + Wheat Bran	30.4±0.1	20.4±0.1	15.46±0.76	18.20±1.42	23.56±1.43	70.43±2.67	3.75±0.65
Dung + Straw	32.5±0.0	19.5±0.1	15.01±0.48	18.12±1.52	22.45±0.86	67.56±1.56	5.26±0.23
Dung + Vegetable	31.6±0.2	18.6±0.2	15.13±1.42	18.42±2.45	24.54±2.12	65.48±4.45	5.64±0.53
Dung + Barley Bran	30.3±0.1	23.3±0.4	14.14±0.56	17.10±2.23	23.45±0.98	67.85±2.26	3.52±0.42
Dung + Gram Bran	32.4±0.1	17.2±0.3	14.21±1.23	17.50±1.42	23.98±0.25	64.75±2.46	4.92±0.26

Each value is the mean ± SE of six replicates. Two way ANOVA: Significant ($P<0.05$) * within column, # within row.
$- Significant one way ANOVA ($P<0.05$) within row.

Table 2: Effect of combinations (1:1000) of neem oil with vermicomposts obtain from different animal dung and agro / kitchen wastes on nematode population in soil as well as growth and productivity of brinjal (S. melogena).

Combination	No. of nematodes		Growth of brinjal (cm.) Days after planting			Flowering period (Days)	Productivity (kg/m2)
	Before sowing	After harvesting	20	30	40		
Control Cow	31.4±0.5	36.5±0.4	07.20±0.42	10.80±0.60	16.30±1.58	72.12±2.32	1.86±0.58
Dung *	30.4±01	4.4±0.1	# 13.20±0.22	16.32±0.33	24.21±0.30	68.54±1.66	$ 4.06±0.21
Dung +Rice Bran	31.5±02	2.4±0.0	* 16.20±0.63	19.16±0.69	26.08±0.39	62.51±1.23	5.06±0.28
Dung +Wheat Bran	33.6±01	3.5±0.0	17.20±0.54	20.45±0.66	26.78±0.82	63.42±1.46	4.25±0.30
Dung +Straw	32.8±03	Nill	16.45±0.49	19.95±0.54	26.70±0.93	66.77±1.69	5.48±0.35
Dung +Vegetables	30.2±03	4.6±0.2	17.89±0.83	20.34±0.84	28.00±0.59	60.84±2.82	6.04±0.42
Dung +Barely Bran	33.4±01	3.6±0.1	16.30±0.72	19.99±0.49	26.01±0.66	62.91±2.93	4.08±0.23
Dung +Gram Bran	34.6±02	Nill	14.32±0.55	16.02±0.92	26.02±0.61	61.25±2.02	5.52±0.11
Buffalo							
Dung *	31.2±01	2.4±0.1	# 14.60±0.40	17.50±0.34	24.18±0.8	68.62±1.02	$ 4.07±0.14
Dung + Rice Bran	31.3±02	2.0±0.1	* 16.60±0.62	19.84±0.39	25.84±0.70	63.44±2.29	5.12±0.24
Dung + Wheat Bran	31.5±02	3.3±0.0	16.80±0.41	19.40±0.49	25.99±0.71	64.70±1.68	4.26±0.43
Dung + Straw	32.5±01	3.6±0.0	16.18±0.91	19.42±0.87	25.80±0.49	67.19±2.55	5.84±0.19
Dung + Vegetables	33.7±03	3.5±0.1	18.20±0.56	21.10±0.58	26.10±0.88	60.45±1.44	4.09±0.21
Dung + Barley Bran	30.9±03	4.2±0.1	17.21±0.73	20.04±0.50	26.00±0.91	62.40±1.84	5.52±0.43
Dung + Gram Bran	33.6±02	Nill	15.34±0.84	18.17±0.68	28.50±0.59	63.20±1.30	6.05±0.20
Sheep							
Dung *	32.6±01	2.5±0.1	# 11.20±0.09	15.24±0.31	22.06±0.26	61.89±2.97	$ 3.97±0.44
Dung +Rice Bran	31.4±03	3.4±0.0	* 12.60±0.30	15.84±0.54	23.10±0.29	69.49±2.33	4.10±0.56
Dung + Wheat Bran	30.5±02	2.5±0.1	14.80±0.82	17.92±0.83	23.85±0.73	63.84±4.56	5.80±0.10
Dung + Straw	31.9±02	Nill	15.12±0.53	18.01±0.77	22.98±0.44	64.25±1.97	6.00±0.15
Dung + Vegetables	33.8±03	Nill	15.23±0.69	18.16±0.80	23.84±0.59	66.67±2.44	4.11±0.26
Dung + Barley Bran	30.7±01	4.1±0.0	16.32±0.45	19.70±0.69	26.48±0.68	60.85±2.26	4.59±0.28
Dung + Gram Bran	33.5±02	Nill	13.20±0.78	16.99±0.91	23.70±0.87	60.79±2.20	4.03±0.23
Goat							
Dung *	33.3±02	3.5±0.1	# 12.00±0.35	15.52±0.42	24.11±0.46	63.92±2.43	$ 3.98±0.45
Dung + Rice Bran	31.5±03	1.4±0.0	* 14.10±0.49	17.60±0.54	22.11±0.98	62.57±1.64	4.00±0.56
Dung + Wheat Bran	31.4±02	3.5±0.1	14.60±0.45	17.56±0.65	23.78±0.54	69.16±2.07	5.70±0.43
Dung + Straw	30.6±00	Nill	14.93±0.75	18.14±0.55	22.40±0.49	64.38±1.66	5.00±0.26
Dung + Vegetable	32.6±01	1.5±0.1	13.83±0.94	17.40±0.85	23.49±0.78	63.51±3.43	4.22±0.32
Dung + Barley Bran	31.7±04	3.5±0.0	14.54±0.59	13.29±0.89	23.54±0.68	62.05±1.04	4.32±0.34
Dung + Gram Bran	32.2±02	Nill	13.11±0.69	16.34±0.93	23.53±0.81	60.60±1.23	4.40±0.26
Horse							
Dung *	32.3±00	2.3±0.1	# 15.85±0.89	18.98±0.73	24.80±0.70	65.77±2.99 $	4.08±0.15
Dung + Rice Bran	35.5±01	Nill	* 13.02±0.40	16.42±0.02	23.45±0.54	66.43±2.53	5.10±0.34
Dung + Wheat Bran	32.4±04	Nill	16.30±0.78	19.40±0.90	24.54±0.69	69.04±2.75	4.27±0.98
Dung + Straw	33.7±05	Nill	15.90±0.48	18.22±0.52	23.30±0.46	65.13±1.54	4.85±0.33
Dung + Vegetable	33.2±02	Nill	15.84±0.64	18.10±0.34	25.57±0.65	63.91±1.67	5.02±0.28
Dung + Barley Bran	30.8±02	3.5±0.0	14.98±0.66	18.10±0.23	24.61±0.79	66.53±2.20	4.00±0.26
Dung + Gram Bran	33.9±03	Nill	14.99±0.42	18.50±0.46	24.70±0.87	62.59±2.86	5.40±0.19

Each value is the mean ± SE of six replicates. Two way ANOVA: Significant ($P<0.05$) * within column, # within row.

$- Significant one way ANOVA ($P<0.05$) within row.

Table 3: Effect of combinations (1:100) of aqueous extract of Garlic bulb with vermicomposts of different animal dung and agro / kitchen wastes on nematode population in soil as well as growth and productivity of brinjal (S. melogena).

	No. of nematodes		Growth of brinjal (cm.) Days after planting				
Combination	Before sowing	After harvesting	20	30	40	Flowering period (Days)	Productivity (kg/m2)
Control Cow	31.4±0.5	36.5±0.4	07.20±0.42	10.80±0.60	16.30±1.58	72.12±2.32	1.86±0.58
Dung *	32.3±0.3	Nill #	13.52±0.48	16.56±2.34	24.85±3.85	67.46±2.56	$ 4.13±024
Dung +Rice Bran	30.3±0.1	Nill *	16.86±1.63	19.87±1.23	26.54±2.52	61.52±2.43	5.23±0.34
Dung +Wheat Bran	33.6±0.2	3.5±0.0	17.98±2.23	20.92±0.66	26.45±2.85	62.42±3.46	4.46±0.43
Dung +Straw	30.7±0.1	3.2±0.1	16.98±1.42	20.12±2.14	27.12±3.52	65.23±2.69	5.76±0.45
Dung +Vegetables	32.4±0.2	Nill	18.23±2.12	21.85±1.45	28.54±4.12	60.04±2.82	6.03±0.23
Dung +Barely Bran	33.3±0.2	1.2±0.1	16.97±2.16	20.13±2.24	26.75±3.12	62.75±2.45	4.46±0.48
Dung +Gram Bran	32.4±0.1	Nill	15.02±2.63	18.56±2.17	26.48±2.61	61.45±2.42	5.89±0.26
Buffalo							
Dung *	31.6±0.3	Nill #	15.24±1.52	18.96±1.52	24.75±3.12	67.46±2.47	$ 4.27±0.24
Dung + Rice Bran	32.3±0.3	1.2±0.0 *	17.13±0.96	20.84±2.23	26.14±3.15	62.42±3.43	5.56±0.48
Dung + Wheat Bran	30.2±0.1	Nill	17.42±2.46	20.85±2.42	26.23±4.17	61.28±2.76	4.76±0.73
Dung + Straw	33.3±0.2	Nill	16.86±2.23	20.22±0.84	26.13±2.28	66.43±2.46	6.14±0.23
Dung + Vegetables	30.4±0.1	Nill	18.78±3.02	19.16±1.34	26.72±3.45	60.00±2.42	4.46±0.62
Dung + Barley Bran	32.6±0.2	2.3±0.1	17.86±1.45	21.42±2.26	26.72±0.91	61.84±4.47	5.90±0.64
Dung + Gram Bran	33.5±0.2	Nill	16.00±0.68	22.23±2.25	28.86±3.29	62.23±4.04	6.46±0.45
Sheep							
Dung *	31.4±0.3	Nill	# 11.76±2.09	14.15±2.35	22.46±3.45	60.56±3.43	$ 4.16±0.54
Dung +Rice Bran	32.5±0.0	Nill	*13.00±2.32	16.64±1.65	23.46±4.12	68.76±3.76	4.46±0.27
Dung + Wheat Bran	31.5±0.1	Nill	15.32±1.85	18.87±2.23	24.23±2.45	62.48±3.12	4.12±0.25
Dung + Straw	33.7±0.2	1.2±0.0	15.87±1.52	19.45±1.45	23.32±1.23	63.43±4.86	4.23±0.24
Dung + Vegetables	31.8±0.1	2.5±0.1	15.86±2.64	19.12±2.52	24.24±3.42	65.45±3.24	4.45±0.28
Dung + Barley Bran	32.8±0.3	Nill	16.98±2.32	20.76±2.46	26.87±4.46	60.12±3.45	4.96±0.46
Dung + Gram Bran	32.7±0.1	Nill	13.76±2.12	17.98±2.62	24.02±1.34	60.06±3.12	4.50±0.24
Goat							
Dung *	32.8±0.1	Nill	# 12.56±1.23	15.52±1.46	24.58±3.54	62.22±3.42	$ 4.26±0.34
Dung + Rice Bran	33.9±0.1	2.4±0.1 *	14.85±2.14	17.42±2.35	22.45±2.34	62.12±2.43	4.25±0.43
Dung + Wheat Bran	32.7±0.3	Nill	15.06±3.12	18.56±1.42	24.02±2.54	68.56±3.15	5.42±0.42
Dung + Straw	32.3±0.3	1.2±0.0	15.33±1.56	18.46±3.46	22.86±3.45	63.48±2.43	5.76±0.54
Dung + Vegetable	30.2±0.4	Nill	14.54±2.28	18.48±2.45	23.98±2.48	63.00±3.42	4.83±0.43
Dung + Barley Bran	30.4±0.2	2.2±0.1	15.07±1.27	18.45±3.45	24.00±1.23	61.05±2.04	4.76±0.24
Dung + Gram Bran	31.2±0.0	Nill	13.46±2.25	17.48±2.18	23.89±2.42	60.02±2.23	4.86±0.52
Horse							
Dung *	31.3±0.3	Nill	# 16.34±3.25	19.95±0.89	25.23±3.46	65.16±3.43	$ 4.46±0.50
Dung + Rice Bran	32.2±0.0	2.0±0.1 *	13.76±2.26	17.46±3.21	23.97±3.15	66.02±3.26	5.45±0.43
Dung + Wheat Bran	34.4±0.1	Nill	16.80±1.42	17.72±1.46	24.95±2.12	69.04±1.46	4.58±0.34
Dung + Straw	33.6±0.2	1.2±0.0	16.34±1.25	19.54±2.28	23.56±3.15	64.73±1.54	5.12±0.43
Dung + Vegetable	31.5±0.1	Nill	16.25±2.26	19.42±2.81	25.98±2.35	63.28±3.42	5.46±0.24
Dung + Barley Bran	32.5±0.3	Nill	15.45±3.52	18.45±2.42	24.90±2.24	66.13±2.42	4.46±0.48
Dung + Gram Bran	32.2±0.1	Nill	15.45±2.26	16.46±1.15	25.05±2.35	62.09±3.17	5.96±0.26

Each value is the mean ± SE of six replicates.

Two way ANOVA: Significant ($P<0.05$) * within column, # within row.

$- Significant one way ANOVA ($P<0.05$) within row.

Table 4: Effect of combinations (1:100) of aqueous leaf extract of Custard apple (Annona squamosa) with vermicomposts of different animal dung and agro kitchen wastes on nematode population in soil as well as growth and productivity of brinjal (S .melogena).

	No. of nematodes		Growth of brinjal (cm.) Days after planting				
Combination	Before sowing	After harvesting	20	30	40	Flowering period (Days)	Productivity (kg/m2)
Control Cow	31.4±0.5	36.5±0.4	07.20±0.42	10.80±0.60	16.30±1.58	72.12±2.32	1.86±0.58
Dung *	32.4±0.3	8.2±0.7	# 12.85±2.72	16.12±1.42	24.13±3.42	67.02±3.47	$ 3.95±0.35
Dung +Rice Bran	31.4±0.2	7.9±0.9	* 15.85±0.42	18.95±0.75	25.89±1.76	62.24±0.47	4.85±0.25
Dung +Wheat Bran	33.2±0.5	6.3±0.7	16.95±0.43	19.94±2.75	26.25±2.43	64.23±0.25	4.12±0.75
Dung +Straw	33.3±0.7	7.2±0.7	16.15±0.25	18.75±0.65	26.54±3.73	67.12±2.45	5.24±0.47
Dung +Vegetables	31.5±0.4	6.7±0.7	17.45±2.43	20.12±0.75	27.65±0.77	62.00±0.47	5.86±0.65
Dung +Barely Bran	30.4±0.2	7.9±0.3	15.86±0.42	18.67±0.95	25.98±3.44	63.24±3.78	3.72±0.75
Dung +Gram Bran	32.4±0.4	5.6±0.4	14.23±3.12	16.75±3.58	25.75±2.12	63.12±3.89	5.10±0.45
Buffalo							
Dung *	31.2±0.3	4.5±0.9	# 14.46±1.12	17.75±2.57	23.78±2.14	69.42±2.47	$ 3.72±0.78
Dung + Rice Bran	32.4±0.4	7.9±0.8	* 15.84±0.78	18.49±0.14	25.76±0.15	65.01±3.78	4.70±0.75
Dung + Wheat Bran	30.6±0.3	7.8±0.7	16.56±1.58	20.12±0.15	25.45±0.45	65.42±3.25	4.00±0.45
Dung + Straw	33.6±0.8	7.8±0.4	15.76±0.47	19.21±0.47	25.46±0.42	68.15±0.25	5.32±0.34
Dung + Vegetables	33.7±0.4	7.6±0.3	17.95±2.48	19.76±0.89	27.12±3.43	62.72±3.14	5.65±0.24
Dung + Barley Bran	31.5±0.3	4.6±0.2	16.95±0.96	19.86±1.46	26.84±2.20	63.45±2.17	5.12±0.75
Dung + Gram Bran	32.6±0.2	2.3±0.7	17.75±1.35	20.12±3.24	28.12±2.24	62.00±0.45	5.96±0.75
Sheep							
Dung *	31.6±0.4	4.7±0.4	# 10.95±3.24	15.32±0.47	17.75±1.14	63.24±2.14	$ 3.32±0.46
Dung +Rice Bran	32.2±0.6	7.6±0.4	* 12.46±0.24	15.75±0.64	22.75±3.52	70.23±2.48	3.72±0.74
Dung + Wheat Bran	30.7±0.4	4.6±0.5	14.75±2.24	17.85±2.24	23.72±0.42	65.32±3.40	5.32±0.45
Dung + Straw	31.6±0.7	4.6±0.7	14.76±1.13	18.12±0.17	23.34±3.45	66.21±8.51	5.56±0.85
Dung + Vegetables	31.3±0.6	7.3±0.7	14.95±1.18	17.85±0.47	23.45±2.24	67.45±2.45	3.65±0.48
Dung + Barley Bran	30.4±0.7	4.8±0.9	15.76±0.48	17.96±1.57	25.76±3.34	62.24±3.48	4.12±0.56
Dung + Gram Bran	32.3±0.4	7.3±0.8	12.95±2.45	15.78±2.58	22.85±3.75	62.34±3.45	3.67±0.45
Goat							
Dung *	32.6±0.6	7.5±0.7	# 11.96±2.29	14.75±3.12	18.94±0.23	64.24±4.45	$ 3.22±0.25
Dung + Rice Bran	30.8±0.7	4.5±0.7	* 13.97±1.24	16.59±1.48	21.96±3.27	63.45±5.48	3.56±0.89
Dung + Wheat Bran	31.7±0.8	6.5±0.3	14.79±1.75	17.64±2.49	23.12±2.48	70.42±0.15	5.25±0.78
Dung + Straw	32.9±0.4	7.6±0.2	14.75±0.48	17.86±0.27	21.85±1.24	65.02±0.45	5.55±0.56
Dung + Vegetable	30.5±0.5	6.4±0.7	13.96±0.47	16.76±2.48	22.87±2.46	64.45±2.48	3.85±0.78
Dung + Barley Bran	31.4±0.5	7.2±0.6	14.47±1.49	17.84±0.22	23.32±1.47	63.24±5.65	3.96±0.28
Dung + Gram Bran	32.6±0.6	4.7±0.5	13.47±0.24	16.25±3.18	23.98±2.65	61.75±2.47	4.12±0.47
Horse							
Dung *	31.6±0.3	5.2±0.8	# 14.46±1.02	17.52±0.24	23.89±2.47	67.45±4.17	$ 3.75±0.58
Dung + Rice Bran	32.3±0.4	5.2±0.7	* 12.47±2.15	15.85±2.45	22.96±0.45	67.14±2.49	4.65±0.96
Dung + Wheat Bran	31.2±0.8	6.4±0.4	15.49±0.21	18.90±2.28	23.98±1.48	70.45±2.45	3.87±0.78
Dung + Straw	33.2±0.8	5.3±0.7	15.75±2.27	18.91±1.18	22.85±2.24	67.45±3.48	5.36±0.78
Dung + Vegetable	30.2±0.4	4.7±0.7	15.46±1.48	18.76±3.37	24.86±2.56	65.15±3.49	5.76±0.75
Dung + Barley Bran	32.4±0.5	6.4±0.5	14.75±0.14	17.75±2.18	23.98±2.24	67.14±2.34	3.85±0.45
Dung + Gram Bran	30.2±0.4	4.8±0.4	14.95±2.18	18.12±3.18	24.25±1.28	64.34±4.48	5.00±0.25

Each value is the mean ± SE of six replicates.

Two way ANOVA: Significant ($P<0.05$) * within column, # within row.

$- Significant one way ANOVA ($P<0.05$) within row.

Growth of brinjal in control group was 7.20, 10.80 and 16.30 cm. at 20, 30 and 40 days after plantation, respectively. Combination of different animal dung agro/kitchen wastes with biopesticide in the soil caused significant increase in the growth of plant height. Vermicompost of buffalo dung +gram bran with different biopesticide shows significant ($P<0.05$) growth of brinjal plant (Table 1-4). The highest growth of brinjal (28.86 cm) was observed in soil mixed with vermicompost of buffalo dung + gram bran + garlic extract followed by vermicompost of buffalo dung + vegetable wastes with aqueous extract of garlic bulb (Table 2). Vermicompost of buffalo dung + gram bran with neem oil and leaf extract of custard apple (*Annona squamosa*) shows a significant growth i.e. 28.50 and 28.12 cm, respectively (Table 3, 4).

The flowering period of brinjal in control was 70.12 days. The significant early flowering was observed in all combination of vermicompost of different animal dung + agro/ kitchen wastes singly, as well as binary combination with different biopesticide. The earliest flowering period of brinjal was 60.00 and 62.00 days was observed, when combination of vermicompost of buffalo/goat dung+ gram bran with garlic extract (Table 3).

The significant increase in productivity of brinjal was observed in all the combinations of vermicomposts obtained from different animal dung + agro/ kitchen wastes singly and in binary combination with different biopesticide. The combination of buffalo dung +gram bran with aqueous extract of garlic has maximum productivity of brinjal (6.46 kg/m^2) in comparison to all other biopesticide (Table 2, 3).

DISCUSSION

It is evident from result section that the use of vermicompost obtained from different combinations of animal and agro/kitchen wastes singly as well as in binary combination with different biopesticides like neem (*Azadirachta indica*- Azadiractine) oil, aqueous extract of garlic (*Allium sativum* - Allicine) bulb and leaf extract of custard apple (*Annona squamosa*) caused significant reduction in plant parasitic nematodes infestation in the soil [5, 15, 25], which ultimately enhances the growth, early flowering and productivity of brinjal crop. Vermicompost of different animal-agro wastes have significant amount of nitrogen, phosphorus, Ca^{++}, K^+ vitamins, enzyme, plant hormones etc. [26-28] and plant pesticide viz neem aqueous extract of garlic and leaf extract of custard apple (*Annona squamosa*) have toxic effect against nematode infestation [5, 15, 25]. Akhtar and Mahmood, [5] reported that addition of nitrogen based supplement along with organic amendments alter the soil texture, consequently number of nematodes in soil significantly reduced. Earthworms feed on the egg and larvae of soil nematode pest which ultimately reduced the soil nematode population [6, 18, 29]. Musabyimana and Saxena, [30] reported that garlic and neem seed derivatives were very effective against plant parasitic nematode (*Pratylenchus dunesis*). Neem, garlic and custard apple are potent nematicide against different nematodes [4, 15].

The different combination of vermicompost obtained from different animal agro/kitchen wastes with garlic extract and vermicompost obtain from different animal dung +gram bran with neem oil shows total control of soil nematode pest. Content by the plant extract had the ability to affect the nervous system by inhibiting the activity of acetylcholinestrase in nematodes [31-33].

There was significant start early flowering of brinjal of all the combination of vermicomposts of different animal and agro wastes +neem oil/garlic/custard apple extract in comparison to untreated control plants The combination of vermicompost with biopesticide caused early flowering of tomato plants, possibly due to the presence of TKN, TP in the vermicompost which stimulate the early flowering of crop [9, 34-37]. The rich amount of TKN and TP stimulate the early flowering period of *Daucus carota* and tomato [38, 39].

The combination of buffalo dung +gram bran with aqueous extract of garlic and neem oil shows significant maximum productivity of brinjal. It is due to the presence of essential nutrients in vermicompost which increased the metabolic activity of plant as well as garlic extract check the infestation of nematodes [40, 41]. Large amount of humic acid were produced during vermicomposting which lowers the pH of soil and ultimately affect the productivity of plant [6]. Reduction of plant parasitic nematodes directly affected the productivity of crops [6, 30].

CONCLUSION

It is evident from the present study that different combinations of vermicompost obtain from buffalo dung + gram bran with different biopesticides have significant effect on control of parasitic nematodes. Simultaneously, it also increases the growth, started early flowering and enhanced the productivity of *Solanum melongena*.

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