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Effects of different fertilizers on growth, yield and root knot nematode Meloidogyne spp in Okra Abelmoschus esculentus under field condition in Summer Season in Chitwan, Nepal.

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ABSTRACT

An experiment was carried out at Agriculture and Forestry University, horticulture farm to determine the effects of different fertilizers on root knot nematode and yield on Okra (var. Arka Anamika) at summer season in inner terai region of Chitwan, Nepal. The treatment was carried out in the completely randomized block design (RCBD) with 7 treatments replicated 3 times. The treatment included: goat manure, sesame seed cake, mustard seed cake, poultry manure, furacron, vermicompost plus untreated control including only chemical fertilizer (NPK). All treatments were added to provide the sufficient amount of Nitrogen required for the crop as recommended by Nepal Agriculture Research Council. Remaining amount of required Phosphorous and potassium was supplied by adding Single Super Phosphate and Muriate of potash respectively. The germination percentage was found significantly superior in Furacron (93.33%) and followed by goat manure (92.67%), vermicompost (86.67%), sesame (til) seed cake (82.67%), mustard oilcake (81.67%), control i.e. NPK (76.67%) and poultry manure (61%). Similarly, In terms of number of galls , furacron (3.43) was found the most effective followed by goat manure (5.60), Poultry Manure (6.63), Mustard Seed Cake (8.47), Sesame cake (9.07), vermicompost (16.60) and control (21.96). In terms of yield, poultry manure (20mt/ha) was found superior followed by vermicompost (17.38mt/ha), goat manure (16.72 mt/ha), sesame (til) seed cake (16.62mt/ha), furacron (14.61 mt/ha), mustard oilcake (12.97 mt/ha) and control (10.51mt/ha). The highest net profit was found in case of Poultry manure while the lowest incremental cost benefit ratio was obtained in Furacron and followed by Goat Manure, Poultry manure, Vermicompost, Sesame (til) seed cake and Mustard seed cake. The highest yield (20t/ha) and nematode control was obtained in Poultry manure which is at par with Furacron treatment. This experiments suggests the use of Furacron or poultry manure will provide more economic return and also decreases the root knot nematode in okra.

Keywords: manures, galls, nematode, okra, Furacron

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INTRODUCTION

Okra (Abelmoschus esculentus L. Moench 2n=2x=130) is one of the important fruit vegetable crops of the tropical and sub-tropical regions and cultivated as summer vegetable crops in terai, inner terai and lower hills of Nepal (Acharya, 2004) .The various name of Okra in English speaking countries are ladies finger, bindi, bamia, onchro or gumbo is the flowering plant of mallow family (Khabdaker, 2017). In Nepal, it forms one of the major vegetable and is grown in different part of country mostly in Makwanpur (22.4 mt/ha), lalitpur (20mt/ha),kavre (15.6mt/ha), surkhet (15.7mt/ha), dang (14mt/ha), Taplejung (14mt/ha), bardiya (15mt/ha) Jhapa (14.5mt/ha) (MOAD, 2016/17). Occurrence of Root knot nematode in Nepal was first reported by Amatya and Shrestha in 1969 on tomato, eggplant, okra and chilly and known to more than 2000 species of plants (Kafle, 2013). Nematode is known to cause irregular growth, reduced and delayed growth with above ground chlorosis, stunting, delayed recovery with improve soil moisture condition and gall formation below ground (Noling, 2009). Affected plant becomes weak and prone to attacked by many other disease and pest (Kafle, 2013). In Chitwan district, Nematode reduce yield and quality of okra and other crops because farmers do not apply effective measure on account of their small landholding (Hogger, 1984).

Root knot nematodes can be suppressed by various ways: nematicides, soil solarization, fertilizers (Habash & Al-Banna, 2011). Some fertilizers and nematicide are known to inhibit hatching of nematode egg and cause full mortality of 2nd stage juvenile i.e. destructive phase of nematode (Habash & Al-Banna, 2011). Nematicide are mostly used and known to cause harm in the environment and human health, so effective alternatives are emphasized that do not pollute environment and effectively control nematode (Pakeerathan, K., Mikunthan, G. and Tharsani, 2009). Chicken manure is reported to decrease the number of nematodes (Kaplan & Noe, 1993). Likewise, different organic manures could be used to control nematodes and improve soil health. This study aims to study the nematode population under different fertilizers and nematicide treatments and their effect on yield of Okra.

MATERIALS AND METHODS

Experimental Site and design

The present experiment was carried out at the Horticultural farm of Agriculture and Forestry University on okra (var Arka Anamika) from April 7, 2018 to July 2, 2018. The experiment field was at the geographical location of 27°37′ N latitude and 84°25′ longitude at an altitude of 256 meter above sea level (Thapa & Dongol, 1988). Soil type is Sandy Loam. This variety of Okra was resistant to Yellow vein mosaic virus.

The experiment was arranged in Randomized Control Block Design (RCBD) of 7 different treatments replicated 3 times. Seeds are planted at spacing 50 cm *30 cm and 2 seeds were put per hole and later were thinned to put one after germination. The area for each plot is 2.5m *1.8m (4.5m^2) and consists of 30 plant in each plot. It was kept a wide border of 1m around the field and 75cm between the block and each treatment.

Treatment and Trial Management

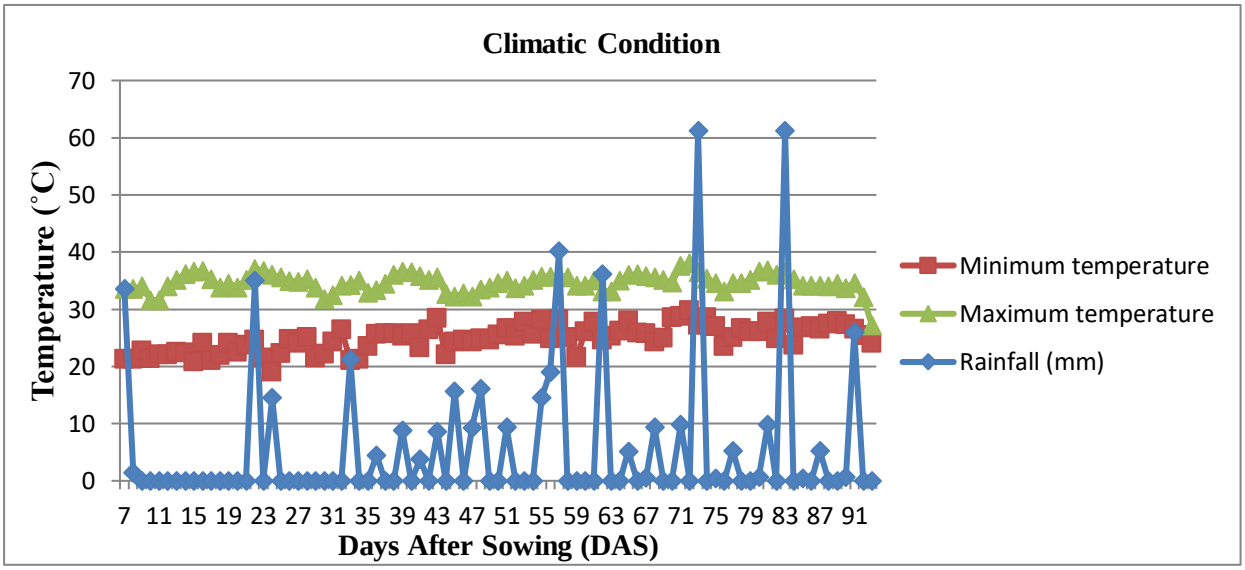
There were seven different treatment used in this experiment viz; T_1 (Goat manure), T_2 (Sesame (til) seed cake), T_3 (Mustard oil cake), T_4 (Control) i.e. NPK, T_5 (Poultry manure), T_6 (Furacron) and T_7 (Vermicompost) respectively. Seeds are planted after 5 days of fertilizer application by soaking in water for 24 hours to enhance the germination. The emergence of seed started from 3 days after sowing (DAS) and data of germination was collected from 7 days after sowing. Fertilizer was applied on the recommended dose given by Government of Nepal (Krishi Diary, 2075) i.e. 90:81:27 g NPK/4.5 m^2. Recommended dose of Nitrogen was fullfilled by respective treatments and recommended dose of Phosphorus and

Potassium was fulfilled by adding supplements of NPK fertilizers by calculations.

The NPK content of different organic fertilizers was determined in the animal science lab of AFU. The NPK content present in Goat manure was found to be 3%, 1% and 2% respectively. Recommended level of Nitrogen was fulfilled by applying 3 Kg of Goat manure. Here, required level of Phosphorus was fulfilled by adding 318.75 gm Single Super Phosphate (SSP) and Potassium level was fulfilled by Goat manure itself. Likewise, Tilcake contains 6.61 %N, 2.1%P and 1.1%K respectively. Here, 1.361kg tilcake was used to meet the recommended level. To meet the required dose of Phosphorus and Potassium, 327.56 g and 20.03 g Single Super Phosphate (SSP) and Muriate of Potash (KCl) was used. Likewise, Mustard Seed Cake contains 4.52%N, 1.78%P and 1.4%K respectively. To meet the required dose of Phosphorus, 284.75 gm of SSP was used and Potassium was fulfilled by Mustard Seed Cake itself. Likewise, Poultry manure contains 1.2%N, 0.45%P and 0.8%K respectively. Here, 7.5 kg Poultry manure was used to meet the Nitrogen level. To meet the Phosphorus level, 295.31 gm SSP was used and Potassium level was fulfilled by Poultry manure itself. Likewise, Vermicompost contains 2.35%N, 1.6%P and 1.5%K respectively. Here, 3.829 Kg Vermicompost was used to meet the Nitrogen level. To meet the required dose of Phosphorus, 123.25gm SSP was used Potassium level was fulfilled by Vermicompost itself. Similarly, (Furacron @1kg/ 508.5 m^2+ NPK fertilizer) is used as one treatment.

Climatic condition during the Biomtric Observation

The meteorological data during the cropping period was recorded from National Maize Research Program (NMRP), Rampur, Chitwan which was 250m far from the research site. The total rainfall of 385 mm was recorded during the cropping period and the highest amount of rainfall was recorded during June (212.2mm) i.e. during the fruiting period and the least amount of rainfall was recorded during April (35.1mm) i.e. during the vegetative stage. The maximum temperature during the cropping period ranges from 27.2℃-38.1℃ and minimum temperature ranges from 19.05℃-29.8℃



Data Collection

Data was collected by taking 5 sample plants by excluding the border plants to study the growth and yield parameters

Plant height:

Height of the plant was measured from 10DAS and continued to fortnight interval. It was

measured with the help of measuring tape from the base of the plant to its tip.

Stem base diameter:

Diameter of the stem was measured from 20 DAS and continued to fortnight interval. It was measured with the help of Vernier Calliper near the base of the plant.

Leaf Number:

Fully opened leaves were counted across the whole height of plant.

Yield:

Yield was taken at 3 days interval by multiple havesting from 45DAS till 12 pickings. It was measured by the help of weighing balance

Galls Counting:

Five plants were uprooted at 60DAS, 70DAS and 80DAS respectively including the sampled plants. The total number of galls were counted in each uprooted plants.

Root Number, Root Length and Root Diameter:

These all parameters were taken during the time of uprooting. Root number includes lateral roots which was counted. Root length i.e. tap root was measured with the help of ruler. Similarly, root diameter was measured with the help of Vernier Calliper.

Statistical Analysis

The collected data were recorded by MS-excel and subjected to statistical analysis using analysis of variance (ANOVA) to determine if the treatments have any significant differences on each other. Here, the data were analyzed according to One way Anova using software R-Stat.

Economic analysis

For the economic analysis, cost of fertilizers was calculated which includes the cost of treatment i.e. cost fertilizers and their supplements if essence to fulfilled recommend dose. Cost of different fertilizers includes: Goat Manure- $0.05/kg, Tilcake:$0.25/kg, Mustard Seed Cake:$0.30/kg, Poultry Manure:$0.05/kg, Vermicompost:$0.17/kg, Urea (Nitrogen Source):$0.2/kg, DAP (Nitrogen and Phosphorus source):$0.4/kg, Muriate of Potash (Potassium source):$0.38/kg, Single Super Phosphate (Source of Phosphorus):$0.18/kg and nematicide i.e furacron:$1.6/kg and the market price of okra:$0.3/kg. Similarly, net profit was calculated separately by subtracting the cost of treatment from additional income of respective treatment. The incremental cost/benefit was calculated separately for each treatment according to the following formula:

Incremental Cost-Benefit ratio (ICBR) = Cost of treatment / Net profit (Chejara, 2013).

RESULTS AND DISCUSSIONS

Effect on seed germination

The effect of different manures on seed germination was found significant at 5% level of significance among the treatments. The seed was soaked for 24 hours and the data was taken 7 days after sowing. The effect of furacron was significantly superior over other treatments. Furacron has 21.72% more germination than that over control. Similarly, goat (20.86%), vermicompost (13.04%), tillcake (7.82%) and mustard oilcake (6.52%) more germination as compared to control. But there was considerable low germination in poultry manure (less by 20.43%) due to the high water absorbent nature causing dryness in the field.

Treatments	Number of seed germinated
	7 DAS
Furacron	93.3333 [a]
Goat manure	92.66667[ab]
Vermi compost	86.66667[ab]
Sesame (til) seed cake	82.66667[ab]
Mustard Oilcake	81.6666[ab]
Control (NPK)	76.66667[bc]
Poultry Manure	61[c]
SEM (±)	4.39
LSD (0.05)	16.4
CV	11.2

F-test	*

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. *= Significant at 5% level

Effects on number of galls formation

The effect of different types of manure and nematicide was found highly significant at 0.1% level of significance. Each individual plant was found to me infested by gall. Furacron was found superior in both 60DAS and 70 DAS. In 60 DAS, furacron was found superior compared to control (NPK). Furacron was followed by goat manure, mustard oilcake, sesame seed cake, poultry manure, vermicompost and control (NPK). Similarly in 70 DAS, furacron was found superior followed by goat manure, mustard oilcake, sesame seed cake, poultry manure, vermicompost and control (NPK). However in 80 DAS, the number of galls was found non significant as the number tends to increase and the crop life period is about to complete. After that, there is decrease in the number of galls as there is root decay and mature nematode are released from the galls.

Treatments	**Number of galls per plant**		
	60 DAS	70 DAS	80 DAS
Furacron	3.433333^{a}	10.57667^{a}	66.86667
Goat manure	5.600000^{ab}	19.58000^{ab}	71.20333
Poultry Manure	6.633333^{abc}	31.14333^{bc}	73.06667
Mustard seed cake	8.466667^{bc}	40.30333^{c}	77.93333
Sesame (til) cake	9.066667^{c}	60.59000^{d}	79.53333
Vermicompost	16.600000^{d}	107.60000^{e}	80.33333
Control (NPK)	21.966667^{e}	115.60000^{e}	108.53333
SEM (±)	1.41	8.84	7.25
LSD (0.05)	3.45	15.5	68.8
CV	18.9	15.8	48.6
F test	***	***	NS

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. ***= Significant at 0.1%level and NS=Non-Significant

Effect on the number of leaves, plant height, diameter and yield of okra

In 10, 20, 30 and 40 DAS, the data for the number of leaves was found to be non significant. In 50 DAS, the number of leaves was found to be superior in poultry manure followed by vermicompost, furacron, goat manure, sesame seed cake, mustard oilcake and control. It was found significant at 1% level of significance. In 60 DAS, the data for the number of leaves was found significant at 0.1 % level of significance. The number of leaves in plants treated with poultry manure was found superior followed by sesame seed cake, goat manure, furacron, vermicompost mustard oilcake and control (NPK).

Treatments	**Number of leaves**					
	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Vermicompost	3.066667	5.600000	8.666667	17.46667	24.93333^{a}	31.73333^{bc}
Sesame (Til) cake	3.000000	5.266667	7.466667	14.80000	19.73333^{bcd}	35.66667^{b}
Control (NPK)	3.000000	5.600000	8.333333	14.20000	15.60000^{d}	25.40000^{d}
Goat manure	2.933333	5.466667	8.466667	15.00000	22.06667^{abc}	34.86667^{bc}
Mustard oilcake	2.933333	5.400000	7.466667	15.53333	18.80000^{cd}	29.60000^{cd}
Poultry manure	2.933333	5.866667	8.666667	17.13333	26.73333^{a}	44.60000^{a}
Furacron	2.933333	5.866667	8.133333	18.93333	23.66667^{ab}	31.80000^{bc}
SEM (±)	0.02	0.1	0.2	0.8	0.97	1.43
LSD (0.05)	0.162	0.907	1.62	6.46	4.73	5.48
CV	3.06	9.14	11.2	22.5	12.3	9.23

F test	NS	NS	NS	NS	**	***

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. NS= Non-Significant **= Significant at 1%level *= Significant at 5%level

Similarly, for the plant height, in 10, 20, 30 and 40 DAS, there were not any significant differences between the treatments. In 50 DAS, poultry manure, furacron, vermicompost and goat manure was found superior followed by sesame seed cake, mustard oilcake and control at 1% level of significance. In 60 DAS, poultry manure and furacron was found superior followed by sesame seed cake, vermicompost, goat manure, mustard oilcake and control (NPK) at 5% level of significance.

Treatments	**Plant height (cm)**					
	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Goat manure	7.300000	14.20000	26.26667	60.2000	84.66667^{a}	109.3333^{bc}
Furacron	7.300000	14.23333	27.06667	56.46667	87.46667^{a}	119.8667^{a}
Sesame (til) cake	6.800000	13.10000	26.13333	61.4000	84.20000^{ab}	117.7333^{ab}
Vermicompost	6.733333	13.06667	25.13333	53.66667	87.13333^{a}	111.6667^{abc}
Poultry manure	6.600000	12.23333	24.90000	59.20000	88.73333^{a}	119.9333^{a}
Control (NPK)	6.400000	13.70000	26.93333	60.86667	74.53333^{c}	102.5333^{c}
Mustard Oilcake	6.333333	14.73333	26.93333	55.33333	77.46667^{bc}	107.1333^{c}
SEM (±)	0.16	0.38	0.52	1.26	1.32	1.83
LSD (0.05)	1.14	2.53	4.73	11.3	6.79	10.5
CV	9.49	10.4	10.1	10.9	4.57	5.24
F test	NS	NS	NS	NS	**	*

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. NS=Non-significant **= Significant at 1%level *= Significant at 5%level

In 20, 30 and 40 DAS, the data for the plant diameter was found to be non significant. In 50 DAS, poultry manure was found to be superior followed by vermicompost, sesame seed cake, furacron, goat manure, mustard oilcake and control at 5% level of significance. In 60 DAS, poultry manure was found superior followed by goat manure, vermicompost, sesame seed cake, mustard oilcake, furacron and control (NPK) at 5% level of significance.

Treatments	Plant diameter (cm)				
	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
Goat manure	0.5400000	0.6133333	1.240000	1.586667^{ab}	1.936667^{ab}
Furacron	0.5666667	0.6833333	1.206667	1.673333^{ab}	1.700000^{bc}
Sesame (til) cake	0.5500000	0.6800000	1.280000	1.746667^{ab}	1.773333^{b}
Vermicompost	0.5133333	0.6066667	1.193333	1.833333^{ab}	1.846667^{b}
Poultry manure	0.5666667	0.7000000	1.273333	1.960000^{a}	2.200000^{a}
Control (NPK)	0.6133333	0.7066667	1.280000	1.193333^{c}	1.406667^{c}
Mustard seed cake	0.5866667	0.7266667	1.266667	1.500000^{bc}	1.740000^{bc}
SEM (±)	0.01	0.02	0.03	0.07	0.06
LSD (0.05)	0.0961	0.15	0.223	0.377	0.341
CV	9.6	12.5	10	12.9	10.7
F test	NS	NS	NS	*	*

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. NS=Non-significant **= Significant at 1%level

The data for the plot treated with poultry manure was found superior followed by vermicompost, goat manure, sesame seed cake, furacron, mustard oilcake and control (NPK) at 0.1 % level of significance.

Treatments	Average Yield (mt/ha)
Poultry manure	20.00000[a]
Vermicompost	17.38667[ab]
Goat manure	16.72889[b]
Sesame (til) cake	16.62222[b]
Furacron	14.61333[bc]
Mustard oilcake	12.97778[cd]
Control (NPK)	10.50667[d]
SEM (±)	0.72
LSD (0.05)	3.2
CV	11.6
F test	***

Means with the same letter do not differ significantly at p= 0.05 by DMRT. CV = Coefficient of variation. LSD= least significant difference, SEM= Standard error of mean. ***= Significant at 0.1%level

Above results show, poultry manure was available in the best form for easy absorption of the roots. Thus, it boosts up the morphological growth of the plants. The above results will agree with the findings of (Aniefiok, Idorenyin, & John, 2013) for okra production. This will enhance the vegetative growth of plants by easy solubilization effect (Tswanya, Isah, Ahmed, Yisa, & Lile, 2017) and finally increases the yield . Poultry manure was found superior in almost all parameters. Poultry manure has very high nitrogenous contents and it leads to the formation of ammonia gas which contains nematicidal properties (Rodry guez- Ka bana, 1986). This ammonia gas is toxic to root knot nematodes.

On using of organic manures as a source of fertilizers , it enhances the microbial activities in soil and finally reduces the nematode population by antibiosis properties.

Economics of different fertilizers

Amongst all the fertilizers treatment, the highest net profit of $1407.92 was found in case of Poultry manure was followed by Goat manure ($1077.5), Furacron ($742.67), Vermicompost ($216.96), Sesame (til) cake (-$152.62), and mustard seed cake (-$874.6). Among the fertilizers treatment, lowest incremental cost/benefit ratio was obtained in Furacron (1:2.63) followed by Goat manure (1:2.26), Poultry manure (1:1.5), Vermicompost (1:0.14), Sesame (til) seed cake (-1:0.09) and Mustard seed cake (-1:0.58)

S.No	Treatments	Cost of Treatments ($/ha)	Yield (Mt/ha)	Average yield of Produce ($/ha)	Gross return Over control ($/ha)	Net Profit over control ($/ha)	ICBR
1.	Goat Manure+Supplements	333.33+ 141.67= 475	16.72	4180	1552.5	1077.5	1:2.26
2.	Sesame (Til Cake)+ Supplements	1548.56+ 126.56= 1675.12	16.62	4150	1522	-152.62	-1:0.09
3.	Mustard Seed Cake+ Supplements	1326.67+ 162.44= 1489.10	12.97	3242	614.5	-874.6	-1:0.58
4.	Poultry Manure+ Supplements	833.33+ 131.25= 964.58	20	5000	2372.5	1407.92	1:1.5
5.	Furacron+ NPK	32+250.33= 282.33	14.61	3652.50	1025	742.67	1:2.63
6.	Vermicompost+ Supplements	1445.76+ 54.78= 1500.54	17.38	4345	1717.5	216.96	1:0.14
7.	Control(NPK)i.e.RDF	250.33	10.51	2627.50	-	-	-

Note: Negative sign(-) indicates loss

CONCLUSION

Okra responds well to the different organic manures in terms of nematode conrol. But, the poultry manure was found superior than other methods excluding germination and incremental cost benefit ratio (ICBR) . The yield attributing character and yield was found superior in the poultry manure treated plot than the plot treated with synthetic fertilizers

RECOMMENDATION

If the poultry manure is used, than the proper soaking of the manure in water should be carried out to enhance the germination. Further research should be carried out to demonstrate the suitable dose of fertilizers for increased production.

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