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Impact of Soil Organic Amendment on The Disease Development of Potato Black Scurf Caused by Rhizoctonia Solani in Field Condition.

Tania Nuri* and Mohan Kumar Biswas[1]

[*]Department of Plant Pathology, Palli Siksha Bhavana, Visva-Bharati, Srinikrtan-231 736, West Bengal

[1] Department of Plant Pathology, Palli Siksha Bhavana, Visva-Bharati, Srinikrtan-231 736, West Bengal

Abstract

Rhizoctonia solani Kühn, a soil-borne pathogen causes potato Black scurf is a core restriction to potato (Solanum tuberosum L.) production in West Bengal, India. To address the environmental concerns related with chemical fungicides, this experiment assessed the efficacy of five organic amendments—Vermi-compost (VC), Neem Oil Cake (NOC), Farm Yard Manure (FYM), Mustard Oil Cake (MOC) and Spent Mushroom Compost (SMC)—used separately and in combination under field conditions by the 2017–18 and 2018–19 rabi seasons. The experiment was conducted in a Randomized Block Design (RBD) among eleven treatments. Results manifested that all organic amendments significantly inhibited disease growth and augmented crop productivity compared to the untreated control. Within the treatments, ***Vermi-compost @ 6q/ha*** *appeared as the most reactive, acquiring the maximum reduction in disease incidence (40.90%) and severity (59.56%), with a collective mean yield of 23.03 t/ha—a 45.76% add to over the control.* ***Neem Oil Cake @ 6q/ha*** *was the second most useful, dropping disease severity by 52.41% and yielding 22.54 t/ha. In opposition, FYM @ 5q/ha revealed the least efficacy, with only minor improvements in disease inhibition and yield. Growth parameters, with eye germination (96.76%), plant height (61.75cm), and tubers per plant (16.3) were also considerably superior in VC-amended plots. The investigations recommend that soil amendment with Vermi-compost and Neem Oil Cake gives a sustainable, eco-friendly approach for control R. solani and improving potato yields in the province.*

Keywords: *Solanum tuberosum*, *Rhizoctonia solani*, Black scurf, Organic amendments, Vermi-compost, Neem Oil Cake, Sustainable agriculture.

1. Introduction

Rhizoctonia solani causes Black scurf disease is a pivotal limitation to potato production worldwide, foremost to yield losses of 10-25% in India and up to 50% in other countries (Banville, 1989). The pathogen's soil-borne character, large host range and capability to endure in soil for extensive periods formulate management difficult (Ajayi-Oyetunde and Bradley, 2018). Chemical fungicides, however efficient, elevate ecological and health concerns and their random use has lead to the growth of resistant pathogen strains (Larkin et al., 1998).Organic amendments, for instance farmyard manure, vermin-compost and neem cake have been reported to get better soil physical condition, hold back soil-borne diseases and encourage plant growth (Hoitink and Boehm, 1999; Scheuerell et al., 2005). These amendments can modify soil physico-chemical features, encourage useful microbial populations, and bring on systemic resistance in plants, thereby dropping disease incidence and severity (Arici and Sanli, 2014). In the perspective of potato cultivation in West Bengal, India, where black scurf disease is prevalent, the use of organic amendments could offer a sustainable and ecological alternative to chemical fungicides. Though, the effectiveness of these amendments in control black scurf disease in field environment remains principally unexplored. This investigation aims to estimate the outcome of organic amendments on the progress of potato black scurf disease under field environment in West Bengal, India. Particularly, we studied the consequences of five organic amendments (vermin-compost, farmyard manure, neem cake, spent mushroom compost, and mustard oil cake) mainly on disease incidence, severity, and tuber yield. The outcomes of this experiment are predicted to put in to the progress of sustainable and eco-friendly disease management approaches for potato farming.

2. Materials and Methods

2.1 Isolation of *Rhizoctonian solani* from diseased potato tubers.

Infected potato tubers were gathered from distinct sources, including local farms, and markets. Sclerotia were detached from the tubers, cleaned with tap water and surface-sterilized was done for 20-30 seconds by using 0.1% mercuric chloride solution to get rid of impurities. With sterile distilled water, the sclerotia were washed for three times to abolish any residue of mercuric chloride and put to dry on blotting paper. Inside aseptic conditions in a laminar flow chamber, the sclerotia were placed on Potato Dextrose Agar (PDA) medium, which had been earlier sterilized in an autoclave at 121.6°C and 15 psi for 20 minutes. The inoculated plates were incubated for 7 days at 27 ± 2°C in a BOD incubator. The plates were regularly noticed for the presence of mycelial development of the particular fungus, *R. solani***.**

2.2 Purification and Identification of pathogen

Purification of the isolated fungus was done by transferring freshly matured hyphal tips from the Petri plates of sub-cultur into culture tubes as described by Dhingra and Sinclair (1985). The pure culture was frequently sub-cultured at 15-day intervals on PDA slants to maintain fungal capability and kept at 4-5°C for supplementary use (Kohn, 1992).The refined pathogen was mass-multiplied and inoculated into sterilized pot soil one month prior to potato seed tuber planting. Once disease symptoms appeared, infected plant parts (stem and stolon) were collected, and the causal pathogen was re-isolated. Detection of the fungus was based on cultural and morphological individuality, including radial growth on PDA plates and microscopic assessment of temporary slides stained with cotton blue and lacto-phenol. The pathogen was asured as *Rhizoctonia solani* under a compound microscope based on morphological characteristics (Parmeter, 1970; Sneh et al., 1991; Bhuiyan, 1994; Tredway and Burpee, 2001).

2.3 Preparation of spore suspension

Culture suspension of the fungus was prepared by mixing of pure culture of the fungus of 90 mm. diameter of 3 petri plates in 1 liter of sterilized water with the help of electric blender (Saleem *et. al*., 2000). Afterward, the suspension of the fungus was

altered to 1×10^{-5} to see the colony forming units (CFU)/ml using serial dilution method and that was 2.5×10^{8}/ ml.

To examine the efficacy of different organic amendments against black scurf fungus of potato, field assessment was done during two consecutive year 2017- 2018 to 2018-2019. Five organic amendments namely neem oil cake (NOC), farm yard manure (FYM), mustard oil cake (MOC), vermi-compost (VC), spent mushroom compost (SMC) were in used at different level of blending. Eleven different treatments were preferred with the combination of five amendments which are presented in (Table 2.1) and the sources of these amendments also display in Table 2.2.

Table 2.1: Treatment combination of organic amendment

S. No	Treatment	Organic Amendment
1	T_1	Neem oil cake @4 q/ha
2	T_2	Neem oil cake @ 6q/ha
3	T_3	Mustard oil cake @4q/ha
4	T_4	Mustard oil cake @ 6q/ha
5	T_5	Neem oil cake + Mustard oil cake @4q/ha
6	T_6	FYM @ 5q/ha
7	T_7	Vermi-compost @6q/ha
8	T_8	Spent mushroom compost @6q/ha
9	T_9	VC +SMC @ 5q/ha
10	T_{10}	VC+ SMC + FYM 5q/ha
11	T_{11}	Control (without any amendment)

Table 2.2: Details of organic amendments and their sources.

S. No.	Organic amendment	Source
1	Neem oil cake	Sriniketan Market
2	Mustard oil cake	Sriniketan Market
3	Vermi-compost	PSB Agriculture Farm
4	Farm Yard Manure(FYM)	PSB Agriculture Farm
5	Spent Mushroom Compost	Mushroom Unit of Plant Pathology Department of PSB

Field trial on organic amendments was completed in two consecutive years 2017-18 to 2018-19. Field was ploughed two times by tractor for building the soil suitable for potato farming. Following to the layout, Kufri Jyoti potato seed tubers were buried in different fields amended with different union of organic amendments (Table 2.1). After the use of organic amendments, small sprinkler irrigation was done for establishment of microbes into soil properly and after 15 days seed tubers were buried. With 3-4 eyes of 35-40 gm of seed tubers were planted at the distance 20 cm from plant to plant and from row to row 50-60 cm at depth 5-10 cm. Total seed tubers were treated with pathogen spore suspension of *Rhizoctonia solani* for 20 to 30 minutes. At 7^{th} day first irrigation was applied lightly after planting and at 7 -15 day interval succeeding irrigations were provided. Two earthing-up were made for this potato crop. At the 15^{th} day, first earthing-up was done when plant become 15-25 cm high and at 32^{th} day second one was done when potato started to become revealed.

2.4 Statistical Analysis

Randomized Block Design with 5 replications was maintained for field trial. Data on seven parameters were collected from the trial. At 30 days after plantation, eye germination was recorded. Data on plant height and stem per hill were taken at 60 days of plantation and at 90 days after planting, at the time of harvesting data on black scurf disease severity and incidence, tubers per plant and tuber yield were recorded. Collected data during the study were analyzed by means of one-way Analysis of Variance (ANOVA).

3. Result and Discussion

To see the possible efficiency of five different organic amendments *viz*. Neem Oil Cake (NOC), Farm Yard Manure (FYM), Mustard Oil Cake (MOC), Spent Mushroom Compost (SMC) and Vermi Compost (VC) were experienced individually and in combination against *Rhizoctonia solani* under field situation during two following years 2017-18 and 2018-19. The observations were recorded on eye germination %, stem per hill, plant height, number of tuber per plant, disease incidence %, disease severity % and yield. The results are displayed in Table 2.1, 2.2 and 2.3.

Vermi-compost @ 6q/ha was found the most effective regarding diminishing disease severity and incidence as well as augment the yield of tubers over control

(40.90%, 59.56% and 45.76% respectively) among the different treatments, subsequently neem oil cake @6q/ha which exhibited 35.25%, 52.41% and 42.66% respectively during 2017-18 (Table 3.1) and 2018-19 (Table 2.2). Minimum reduction in disease incidence and severity were concentrated in FYM @ 5q/ha 6.26% and 5.06% respectively and lowest rise in tuber yield 6.52% also observed during both of the year 2017-18 and 2018-19. In terms of decline in disease incidence, severity and increase in tuber yield, all the treatments differ radically over untreated control.

Within the treatments vermi-compost @ 6q/ha manifested 96.75% and 96.76% eye germination % of seed tubers followed by neem oil cake @ 6q/ha 95.49% and 95.44% correspondingly the years of 2017-18 and 2018-19. Smallest amount eye germination % was made in Farm Yard Manure @ 5q/ha treated plot with 85.66% and 85.70% correspondingly during different years measured.

Stem per hill during the period was height in the treatment of vermi-compost @ 6q/ha 7.07 and 5.52 respectively and the lowest stem per hill were observed during 2017-18 and 2018-19 in FYM 5q/ha 3.29 and 4.15 respectively.

Table 2.1: Effect of organic amendment of soil on black scurf disease of potato during 2017-18.

S.No	Treatment	*Eye germination(%)	Stem/hill	Plant height (cm)	No of tuber/plant	#Disease incidence %	#Disease severity%	Yield/ha(T)
1.	NOC 4q/ha	94.22 (76.09)	5.64	60.51	14.12	20.10 (4.54)	7.07 (2.75)	21.92
2.	NOC @ 6 q/ha	95.49 (77.74)	6.41	61.23	15.77	19.31 (4.45)	6.24 (2.60)	22.31
3.	MOC @ 4q/ha	91.24 (72.79)	4.68	58.09	11.81	22.14 (4.76)	9.09 (3.10)	19.68
4.	MOC @6q/ha	93.25 (74.94)	5.16	59.36	13.84	21.23 (4.66)	8.33 (2.97)	21.43
5.	NOC+MOC @ 4q/ha	92.71 (74.35)	4.85	58.36	12.76	21.95 (4.74)	8.17 (2.54)	20.15
6.	FYM @ 5q/ha	85.66 (67.75)	3.29	56.38	9.46	27.34 (5.28)	12.81 (3.65)	16.90
7.	VC @ 6q/ha	96.75 (79.62)	7.07	61.72	16.19	17.00 (4.18)	5.48 (2.45)	22.83
8.	SMC @ 6q/ha	87.54	3.90	56.79	9.49	26.24	11.58	17.22

		(69.33)				(5.17)	(3.48)	
9.	VC+SMC @ 5q/ha	90.24 (71.79)	4.52	57.64	10.79	23.02 (4.85)	9.85 (3.22)	19.08
10.	VC+SMC+FYM @ 5q/ha	89.25 (70.86)	4.43	57.35	10.18	24.51 (5.00)	10.58 (3.33)	18.22
11.	Control	83.25 (65.84)	2.69	55.45	8.46	28.93 (5.42)	13.41 (3.73)	15.58
SE(m)± C.D C.V%		0.09 0.25 0.28	0.12 0.34 5.54	0.11 0.31 0.41	0.10 0.27 1.79	0.02 0.07 1.15	0.02 0.04 1.08	0.07 0.19 0.77

*Figures in parentheses are the arcsine √percentage transformed values

Figures in parentheses are the square root transformed values

Table 3.2: Effect of organic amendment of soil on black scurf disease of potato during 2018-19.

S.No	Treatment	*Eye germination %	Stem/hill	Plant height (cm)	No of tuber/plant	#Disease incidence %	#Disease severity%	Yield/ha (T)
1.	NOC 4q/ha	93.92(75.73)	5.16	60.44	14.69	19.64(4.49)	7.67(2.86)	21.66
2.	NOC @ 6 q/ha	95.44(77.67)	5.29	61.30	15.60	18.56(4.37)	6.59 (2.66)	22.78
3.	MOC @ 4q/ha	91.58(73.14)	4.61	58.12	11.63	22.66(4.81)	9.24(3.12)	19.78
4.	MOC @6q/ha	93.41(75.12)	5.12	59.40	13.70	20.70(4.60)	8.25(2.96)	21.13
5.	NOC+MOC @ 4q/ha	92.71(74.34)	4.76	58.41	12.48	21.59(4.70)	8.76(3.04)	20.65
6.	FYM @ 5q/ha	85.70(67.78)	4.15	56.45	9.11	27.49(5.29)	12.79(3.64)	16.76
7.	VC @ 6q/ha	96.76(79.63)	5.52	61.78	16.41	17.57(4.25)	5.42(2.43)	23.23
8.	SMC @ 6q/ha	87.54(69.33)	4.37	56.25	9.70	26.64(5.21)	11.74(3.50)	17.50
9.	VC+SMC @ 5q/ha	90.57(72.11)	4.48	57.79	10.87	23.56(4.90)	9.76(3.20)	19.20
10.	VC+SMC+FYM @ 5q/ha	89.55(71.14)	4.43	57.74	10.63	24.61(5.01)	10.66(3.34)	18.79
11.	Control	83.58(66.10)	3.97	55.22	7.96	29.57(5.48)	13.54(3.75)	16.02
SE(m)± C.D. C.V%		0.11 0.30 0.33	0.02 0.05 0.84	0.03 0.10 0.13	0.16 0.45 2.93	0.01 0.03 0.43	0.01 0.04 0.88	0.06 0.16 0.62

*Figures in parentheses are the arcsine √percentage transformed values

Figures in parentheses are the square root transformed values

In the both of years of experiment considerably greatest plant height was noted in vermi-compost @ 6q/ha amended plot of the trial field 61.72cm and 61.78cm correspondingly which vary significantly from control. On the other hand, the differences of the height of potato plant between vermi-compost 6q/h, neem oil cake @ 6q/ha and neem oil cake @ 4q/ha amended soil was not too much through copul of the rabi season.

During 2017-18 and 2018-19, the number of potato tuber production per plant was highest which was 16.19 and 16.41 correspondingly in vermi-compost @ 6q/ha amended soil and after that neem oil cake @ 6q/ha 15.77 and 15.60 respectively. But the smallest amount of potato tubers were found through two years in FYM @ 5q/ha 9.46 and 9.11 respectively.

Consideration % disease incidence through the years 2017-18 and 2018-19 observed uppermost in that plot where FYM @ 5q/ha was included 27.34% and 27.49% correspondingly. However, the slightest disease incidence was recorded from the vermi-compost @6q/ha amended soil throughout two rabi period 17.00% and 17.57% correspondingly, after that neem oil cake @6q/ha included soil 19.31% and 18.56%.

In terms of % disease severity, highest was found in FYM @ 5q/ha amended field, 12.81% and 12.79% correspondingly, after that spent mushroom compost @ 6q/h 11.58% and 11.74% correspondingly. However least amount disease severity was recordeded in vermi-compost @ 6q/ha included space during couple of the rabi season 5.48%, 5.42% correspondingly.

It is approved from the Table 3.3 that all ten combinations of soil amendments had a considerable outcome on yield with association to control. The maximum yield was found during 2017-18 and 2018-19, the vermi-compost @ 6q/ha which gave 22.83 tone/ha and 23.23 tone/ha correspondingly, after that neem oil cake @ 6q/h, 22.31 tone/ha and 22.78 tone/ha correspondingly. The smallest tuber yield was taken during couple the year 2017-18 and 2018-19 were 16.90 tone/ha and 16.76 tone/ha correspondingly with FYM @ 5q/ha. The collective represent data of the couple of the years (2017-18 and 2018-19) also manifested that soil included with vermi-compost @6q/ha was considerably higher effective than other treatments which brought about least disease incidence and disease severity of 17.29% and 5.45%

correspondingly and highest yield 23.03 tone/ha. (Table 3.3). After that neem oil cake @6q/ha, had the effectiveness to diminish the disease incidence and severity of 18.94 and 6.42% correspondingly and maximize the yield of 22.54 tone/ha.

Table 3.3: Effect of organic amendment of soil on black scurf disease of potato under field condition during 2017-18 to 2018-19 through pooled.

Treatment	#Disease incidence%				#Disease severity%				Yield / ha (T)			
	2017-18	2018-19	Pooled	Decrease over control	2017-18	2018-19	Pooled	Decrease over control	2017-18	2018-19	Pooled	Increase over control
NOC 4q/ha	20.10 (4.54)	19.64 (4.49)	19.87 (66.41)	32.06	7.07 (2.75)	7.67 (2.86)	7.37 (41.94)	45.30	21.92	21.66	21.79	37.91
NOC @ 6 q/ha	19.31 (4.45)	18.56 (4.37)	18.94 (63.06)	35.25	6.24 (2.60)	6.59 (2.66)	6.42 (36.45)	52.41	22.31	22.78	22.54	42.66
MOC @ 4q/ha	22.14 (4.76)	22.66 (4.81)	22.40 (75.65)	23.42	9.09 (3.10)	9.24 (3.12)	9.17 (52.01)	32.00	19.68	19.78	19.73	24.87
MOC @6q/ha	21.23 (4.66)	20.70 (4.60)	20.97 (70.03)	28.32	8.33 (2.97)	8.25 (2.96)	8.29 (47.00)	38.50	21.43	21.13	21.28	34.68
NOC+MOC @ 4q/ha	21.95 (4.74)	21.59 (4.70)	21.77 (72.88)	25.56	8.17 (2.54)	8.76 (3.04)	8.46 (48.12)	37.21	20.15	20.65	20.40	29.11
FYM @ 5q/ha	27.34 (5.28)	27.49 (5.29)	27.42 (92.23)	6.26	12.81 (3.65)	12.79 (3.64)	12.80 (72.58)	5.06	16.90	16.76	16.83	6.52
VC @ 6q/ha	17.00 (4.18)	17.57 (4.25)	17.29 (58.51)	40.90	5.48 (2.45)	5.42 (2.43)	5.45 (30.90)	59.56	22.83	23.23	23.03	45.76
SMC @ 6q/ha	26.24 (5.17)	26.64 (5.21)	26.44 (89.12)	9.62	11.58 (3.48)	11.74 (3.50)	11.66 (66.16)	13.49	17.22	17.50	17.36	9.87
VC+SMC @ 5q/ha	23.02 (4.85)	23.56 (4.90)	23.29 (78.65)	20.38	9.85 (3.22)	9.76 (3.20)	9.81 (55.59)	27.26	19.08	19.20	19.14	21.14
VC+SMC+FYM @ 5q/ha	24.51 (5.00)	24.61 (5.01)	24.56 (82.60)	16.03	10.58 (3.33)	10.66 (3.34)	10.62 (60.24)	21.22	18.22	18.79	18.50	17.09
Control	28.93 (5.42)	29.57 (5.48)	29.25 (98.76)	-	13.41 (3.73)	13.54 (3.75)	13.48 (76.44)	0.04	15.58	16.02	15.80	-
SEm± CD CV%	0.24 0.69 2.36	0.09 0.26 0.89	0.45 0.89 1.30		0.08 0.24 2.03	0.07 0.21 1.74	0.45 0.89 1.87		0.07 0.19 0.77	0.06 0.16 0.62	0.45 0.89 0.69	

*Figures in parentheses are the arcsine √percentage transformed values

Figures in parentheses are the square root transformed values

A detailed analysis of Fig. 3.1 also exposed that within all soil amendments, vermi-compost was the most proficient organic material succeeded by neem oil cake and mustard oil cake in conditions of decline in severity and incidence of black scurf of

potato and moreover in augmentation of mounting the yield of potato tuber through couple of the rabi seasons under field circumstances.

As a result, it is clear from this present experiment that among all tested soil amendments, vermi-compost gave utmost decline in disease incidence and severity and an increase in potato tuber harvest. The detailing data also carry the views of Manoj Kumar and Anil Kumar (2018) who reported in earlier period that among different organic amendments as Farm Yard Manure (FYM), Neem cake, Vermi-compost, Mustard cake, Mushroom spent compost, Cotton cake, @ 10gm and 20 gm/kg soil/pot, Vermi-compost amended soil could control ailment, subsequently *Neem* cake and mustard cake, while slightest ailment reduction was found by spent mushroom compost and farmyard manure, correspondingly compared to the control. S. N. Rahul et, al. (2016) also opined that the same, equally neem cake and vermi-compost were established to be the most efficient in dropping the black scurf disease index (BSDI). Whereas FYM was not as much of effective in falling black scurf, stolon and stem canker of potato.

From many of the researcher, it is sound acknowledged that, the application of composts has cut the inhabitants of numerous soil-borne pathogens together with *R. solani* and *Fusarium* spp. (Bonanomi *et. al*., 2020; Escuadra and Amemiya, 2008) and improves soil richness according to the nature of used organic material (Kallah and Adamu, 1998). S. N. Rahul *et, al*. (2016), Rahman *et, al* (2016) momentous influence of organic amendment had in disease incidence, yield quality and quantity of potato. Soil which is included with compost is measured as suppressor of many soil borne fungi, even if its expertise depends on its old age. Young favorable compost might help in increasing of diseases (Tuitert *et, al.* 1998). The plant growth is favored by vermi-compost and neem cake also. For sinking soil born disease of crop, application of organic amendments in soil may a good move toward which can diminish the population of soil borne pathogens in biodegradable manner.

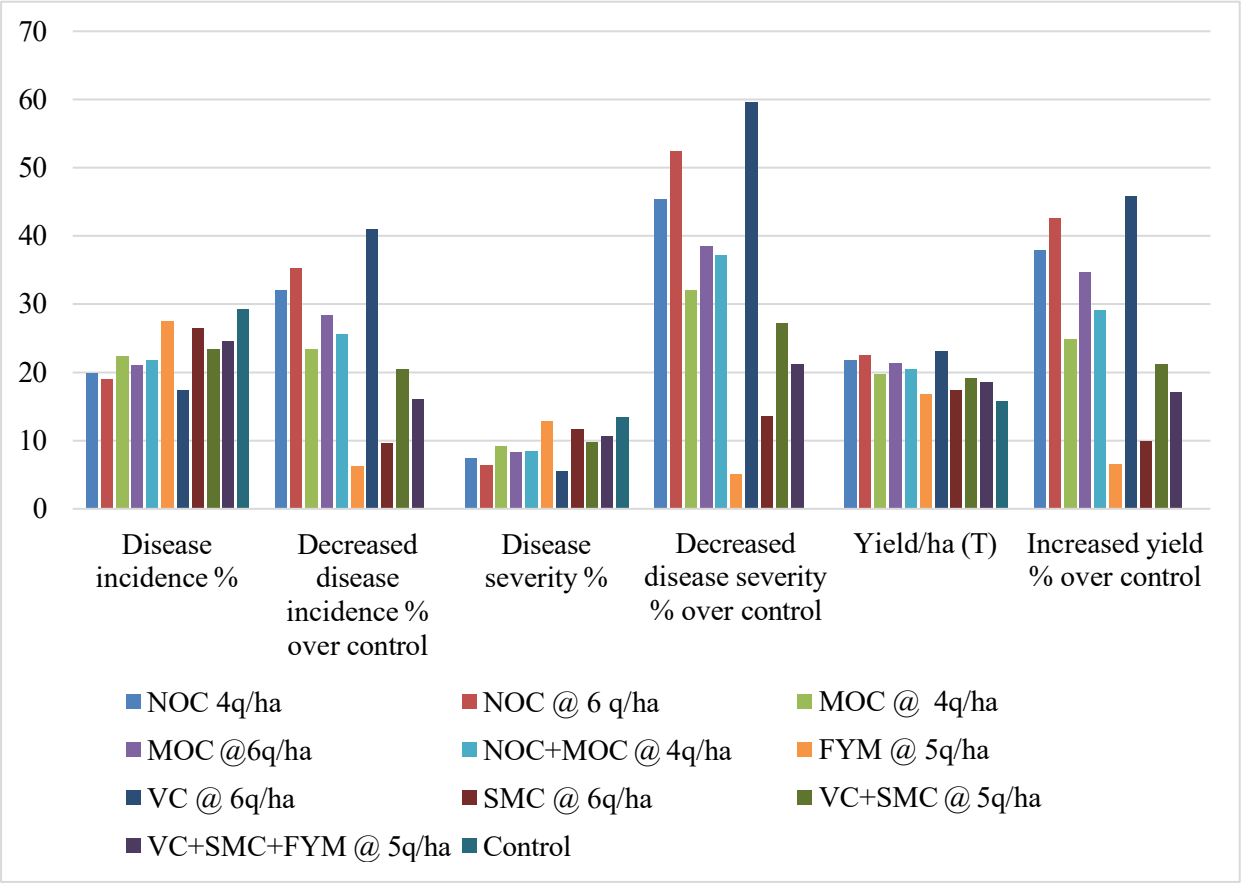

Fig. 3.1: Effect of organic amendment of soil on black scurf disease of potato under field condition (Average 2017-18 and 2018-19)

Based on numerous studies it has established that, organic amendments are efficient for controlling soil fungal pathogens of plant, together with *Rhizoctonia* spp. Amadioha (2003) assured that organic alterations of soil can rapidly degraded into related form and also pollution-free. They do not leave any harmful residues behind; equally they are not as much of costly as well as not harmful to alive organisms. In all instances, those resources are included to the soil in fresh and dry condition (Sikora and Fernàndez, 2005). From vast range of research it has validated that the amalgamation of particular organic amendments in addition to bio-control treatments enhanced the capacity of hindering those bio-control agents (Scheuerell *et al*., 2005; Pugliese *et al.*, 2011). A narrow number of soil microorganisms normalize the *Rhizoctonia* disease fungus (Hoitink and Boehm, 1999). So variation into organic matter helps wipe out these pathogens if in soil they aid maintain populations of oppressive species which are already found, or strains those are supplement together with the amendment (Sanli and Arici, 2014).

4. Conclusion

The experiment assessed the consequence of five organic amendments—Neem oil cake, Mustard oil cake, Farm Yard Manure, Spent Mushroom compost and Vermi-compost—used singly and in combination on potato black scurf disease under field circumstances during 2017-18 and 2018-19. Vermi-compost at 6 q ha^{-1} constantly excelled than other treatments, enhancing growth parameters (eye germination: 96.75%, stems/hill: 7.07, plant height: 61.72 cm, tubers/plant: 16.19, yield: 22.83 t ha^{-1} in 2017-18) and reducing disease incidence (17.00%) and severity (5.48%) in 2017-18, with similar results in 2018-19. Pooled analysis revealed Vermi-compost diminished disease incidence and severity by 40.90% and 59.56%, correspondingly, and encourageted yield by 45.76% over control, afterwards Neem oil cake (35.25%, 52.41%, and 42.66% correspondingly). Farm Yard Manure at 5 q ha^{-1} showed negligible influence.

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