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Effect of organic manure and microbial nutrient spray on yield attributes and yield of organic rice (*Oryza sativa* L.)

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Abstract
A field experiment was conducted to study the effect of organic manures and microbial nutrient spray on yield attributes and yield of organic rice, at the Northern Block Farm of Agricultural Research Station (ARS) Bhavanisagar, Tamil Nadu Agricultural University during summer 2021. The experimental field was laid out in Factorial Randomized Block Design and with treatments were replicated thrice. The experiment comprised of two factors, factor I consists of organic manures with 6 levels *viz*., farm yard manure (OM_1), enriched farm yard manure (OM_2), vermicompost (OM_3), composted poultry manure (OM_4), neem oil cake (OM_5) against absolute control (OM_6). Factor II consists of microbial nutrient spray with 3 levels *viz*., 3% panchagavya (MNS_1), 1% pink pigmented facultative methylotrophs (MNS_2) against water spray (MNS_3). From the results, higher grain yield (5236 kg/ha) and straw yield (8640 kg/ha**)** was recorded with application of vermicompost @ 2.08 t/ha (OM_3) followed by the application of neem oil cake @1.2 t/ha (OM_5) and composted poultry manure @ 3.47 t/ha (OM_4). Significantly, lower grain yield (2814 kg/ha) and straw yield (5105 kg/ha) was noted in absolute control (OM_6). The microbial nutrient spray of 3% panchagavya recorded maximum grain yield (5008 kg/ha) and straw yield (8016 kg/ha). Among nutrient sources used, vermicompost recorded maximum grain yield by increased number of productive tillers per hill and higher amount of filled grains per hill to all other nutrient source.

Keywords: Grain yield, organic manure, microbial nutrient spray, rice, straw yield

1. Introduction
Rice (*Oryza sativa* L.) is life for almost half of the global population and majority (60%) of Indian population. It is grown in more than 100 countries, especially in Asia and 90% rice is produced and consumed by Asian countries. In world, India and China accounts for half of the total area under rice cultivation. Among the rice growing countries, India ranks first in area (44.4 M ha) and second in production (121 MT), next only to China. However, the average productivity of rice in India is only 4.1 t/ha against the global average of 4.67 t/ha (FAS, 2021) [3].
The industrial revolution followed by the green revolution which fulfilled the food demands of the growing population and increased the crop productivity, at the same time it also increased the use of synthetic fertilizers. Usage of inorganic fertilizers were resulted in higher crop yield, but continuous use of them declined soil properties and degraded soils and in turn decreased yield in subsequent periods. Therefore, indiscriminate use of inorganic fertilizers in crop production deteriorates soil health, causes health hazard and insecurity of quality food.
Organic farming in recent years is gaining momentum due to realization of inherent advantages. It confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006) [7]. In world, organic agriculture is practised in 69.8 M ha. In India, total area under organic certification process is 3.56 M ha (FiBL, 2019) [4]. Balanced use of nutrients through organic sources like FYM, vermicompost, green manuring, neem cake and biofertilizers are prerequisites to sustain soil fertility, to produce maximum crop yield with optimum input level.
The use of fermented, liquid organic fertilizers, effective microorganisms (EM) as foliar spray have been introduced to modern agriculture in recent years to produce food with good quality and safety (Galindo *et al*., 2007) [5]. In the view of above facts, field experiment on "Effect of organic manure and microbial nutrient spray on yield attributes and yield of organic rice" was conducted with the following objectives.

To study the effect of organic manures and microbial nutrient spray on growth attributes and growth of organic rice and to study the effect of organic manures and microbial nutrient spray on yield attributes and yield of organic rice.

2. Materials and Methods

2.1. Experimental Location: The field experiments were directed during summer 2021 in Northern Block Farm of Agricultural Research Station (ARS) Bhavanisagar, Tamil Nadu Agricultural University, located at Western Agro-climatic zone of Tamil Nadu. The geographical location of the experimental site is 11°29' N latitude and 77°08' E longitude with an altitude of 256 m above MSL and the mean annual rainfall is 717 mm. The soil type is reddish brown belonging to the Irugur series. The texture having a neutral pH of 7.23 with low soluble salts (EC - 0.22 dS/m), high in organic carbon content (1.25 per cent), available nitrogen (251 kg/ha), high in available P (31 kg/ha), high in available K(443 kg/ha).

2.2. Experimental Design

The field experiment was deliberated in Factorial Randomized Block Design (FRBD) with three replications. The experiment comprised of two factor, Factor I contained 6 treatments *viz*., Farm Yard Manure (FYM), Enriched Farm Yard Manure (EFYM), vermicompost, composted poultry manure, neem oil cake and absolute control. The Factor II contained 3 treatments *viz*., 3% panchagavya, 1% Pink Pigmented Facultative Methylotrophs (PPFM) and water spray. Based on equal N basis, required quantity of organic manures were calculated and incorporated in the soil before transplanting of rice. The microbial nutrient spray of 3% panchagavya sprayed on 15, 30 and 45 DAT and 1% PPFM sprayed on 30 and 45 DAT of rice. The organic farming responsive variety, Improved White Ponni was raised. Transplanting was done in the main field with a spacing of 20×15 cm at two seedlings/hill. Other management practices were adopted as per the recommendation of the crops.

Fig 1: Field Location

2.3. Experimental material

The enriched farm yard manure compost is prepared by using 10 kg of rock phosphate, 2 kg of biomineralizer and 10 kg of each biofertilizers *viz*., *Azospirillum*, *Azotobacter* and *Phosphobacteria* were thoroughly mixed with one ton of well decomposed and powdered FYM on dry weight basis and made into a heap like structure. Biomineralizer is used to accelerate the decomposition rate. Periodical watering should be done once in 2 days and turning should be given on 15th day of composting. The heap was kept for 30 days for composting under the shade with 60 per cent moisture.

For composted poultry manure, a known quantity of fresh poultry droppings is to be collected and mixed thoroughly with chopped rice straw (<2 cm size) @ 1:1.25 ratio so as to attain a C/N ratio of 25-30 which is considered to be optimum for composting. *Pleurotus sajor-caju* is inoculated @ 5 packets (250 g each) per tonne of substrate. The poultry waste and rice straw mix should be heaped under shade. The

moisture content to the heap should be maintained at 50-60%. Periodical watering should be done once in 2 days and turning should be given on 15th day of composting, within a period of 30 days, materials are converted to mature compost. The quantity required for the experiment was worked out based on equal N basis (Table 1).

Table 1: Nitrogen content of organic manures on dry weight basis.

Organic manures	N content (%)	Quantity applied to substitute 100% recommended N for rice (62.5 kg/ha)
Farm yard manure	0.5	12.5
Enriched farm yard manure	0.9	6.94
Vermicompost	3.0	2.08
Composted poultry manure	1.8	3.47
Neem oil cake	5.2	1.20

2.4. Biometric observation
The growth component of plants were recorded from the tagged plant of each plot at different growth stages *viz*., active tillering, panicle initiation, flowering and at harvest. Growth parameters like plant height, number of tillers per m^2, dry matter production and yield parameters like productive tillers per m^2, number of filled grains per panicle, 1000 grain weight and grain and straw yield were recorded by following standard procedure.

2.5. Statistical analysis
The data on various characters studied during the course of examination were statistically analysed for factorial randomized block design. Wherever the treatment difference were significant, critical difference were worked out at five per cent probability level. Treatment difference that were not significant denoted as "NS".

3. Result and Discussion
3.1. Influence of organic manure and microbial nutrient spray on growth attributes of organic rice
3.1.1. Plant height
Plant growth was significantly differed among the organic manures and microbial nutrient spray while their interaction remained non significant (Table 2). The influence of organic manure on plant height, the order of extent of plant height was vermicompost > neem oil cake > composted poultry manure > EFYM > FYM > Control. In the view of microbial nutrient spray the order of plant height was panchagavya > PPFM > water spray. Significantly superior plant height (138.8 cm) was obtained in plots where vermicompost @ 2.08 t/ha (OM_3) was applied. The results were followed by the application of neem oil cake @1.2 t/ha (OM_5) and composted poultry manure @ 3.47 t/ha (OM_4) (Table 2). Significantly lower plant height (128.9 cm) was noted for control. Application of 3% panchagavya showed higher plant height (138.4 cm) than PPFM and water spray. It was perceived that application of organic manure and microbial nutrient spray increased the plant height. Plant height is not a yield component particularly in grain crops but it specify the influence of various nutrient on plant metabolism. The increased plant height in response to vermicompost might be due to the presence of macro and micronutrients, which are readily available to the plant growth. Similar results were registered by Ashik Jamil Mahmud *et al*. (2016) [2] and Shaoyi Ruan *et al*. (2021) [14]. Panchagavya contains several micro and macro nutrients, beneficial microorganisms like bacteria and fungi which promote plant growth. According to Muthuvel (2002) [9] foliar spray of 3% Panchagavya obtained higher plant height and number of branches per plant in bhendi.

3.1.2. Number of tillers
Number of tillers per m^2 the most important component of yield. More number of tillers, especially fertile (or) productive tillers, the more will be the yield. As regards influence of organic manure on tillering, the order of extent of tillering was vermicompost > neem oil cake > composted poultry manure > EFYM > FYM > absolute Control. In the view of microbial nutrient spray on tillers production, the trend remain same as the plant height. These difference among the organic manure and microbial nutrient spray were significant while their interaction remained non significant. The variation in tillers production due to the different source of organic manure was considered to be due to variation in availability of essential nutrients (Table 2). The maximum tillering in above mentioned treatments might be attributed to the availability of more nitrogen, which played a vital role in cell division. Jeyabal and Kuppuswamy (2001) [6] who reported that application of 50% N through vermicompost integrated with 50% fertilizer N, *Azospirillum* and *phosphobacteria* gave more tillers and panicles than 100% Recommended Dose of Fertilizer (RDF) N.

Table 2: Effect of organic manure and microbial nutrient spray on plant height, number of tillers, dry matter production at harvest stage

Treatment	Plant height (cm)				Number of tillers per m^2				Dry matter production (kg/ha)			
	MNS_1	MNS_2	MNS_3	Mean	MNS_1	MNS_2	MNS_3	Mean	MNS_1	MNS_2	MNS_3	Mean
OM_1- FYM	137.6	137.0	130.0	134.8	367.3	349.0	320.3	345.3	12606	12024	11461	12030
OM_2 – EFYM	137.6	137.0	130.6	135.1	378.6	337.0	336.6	350.3	13150	12287	11736	12391
OM-Vermicom post	143.3	138.3	135.0	138.8	402.3	395.0	316.3	371.2	14859	14453	14135	14482
OM_4 – Composted PM	141.0	137.6	136.0	138.2	402.3	356.3	302.0	353.3	14492	13069	12157	13239
OM_5 – Neem oil cake	141.0	139.3	134.6	138.3	395.0	359.3	314.3	356.2	13928	13349	13141	13472
OM_6 – Absolute control	130.0	129.3	127.6	128.9	291.0	283.6	269.9	281.2	11187	10615	9986	10596
Mean	138.4	136.4	132.3	135.7	372.7	346.7	309.8	342.6	13370	12633	12103	12702
Factor	OM	MNS	OM × MNS		OM	MNS	OM × MNS		OM	MNS	OM × MNS	
SEd	2.52	1.78	4.37		17.2	12.2	29.8		344	243	596	
CD (P=0.05)	5.13	3.63	NS		35.0	24.8	NS		700	495	NS	

OM – Organic Manure; MNS - Microbial Nutrient Spray; PM – Poultry Manure; MNS_1 - 3% panchakavya; MNS_2 – 1% PPFM; MNS_3 - Water spray

3.1.3. Dry Matter Production:
The order of dry matter production was vermicompost > Neem oil cake > Composted poultry manure > EFYM > FYM > Control. In the view of microbial nutrient spray on dry matter production was panchagavya > PPFM > water spray. These difference among the organic manure and microbial nutrient spray were significant while their interaction remained non significant. Significantly higher dry matter production (14482 kg/ha) was recorded with application of vermicompost @ 2.08 t/ha (OM_3). The results were followed by the application of neem oil cake @ 1.2 t/ha and composted poultry manure @ 3.47 t/ha (Table 2). Significantly lower dry matter production (10596 kg/ha) was noted for control. The availability of macro and micronutrients is generally higher in vermicompost than in the traditional compost and inorganic fertilizer, indicating that is a better supplement to improve and stimulate plant growth. The soil treated with vermicompost showed increased availability of nutrients compared to non-ingested soil. It significantly increased the growth and yield of rice by Sudhakar *et al.* (2002) [18]. Suresh Kumar *et al*. (2011) [17] supported these findings with application of panchagavya treatment recorded the maximum plant height, number of branches per plant, dry matter production when compared with NPK and control at all the observation stage of plant growth.

3.2. Influence of organic manure and microbial nutrient spray on yield attributes and yield of organic rice
3.2.1. Yield Attributes: Yield is attributed to different yield components. The yield attributes (number of productive tillers per m^2, number of filled grains/panicle, 1000 grain weight), grain and straw yield of rice increased significantly over the absolute control due to the application of different source of organic manure and microbial nutrient spray.

3.2.2. Productive tillers
Application of different source of organic manure, microbial nutrient spray and their interaction significantly influenced the number of productive tillers per m^2. The treatment with application of vermicompost @ 2.08 t/ha (OM_3) recorded more number of productive tillers per m^2 (380) and was statistically superior over with other treatments *viz*., OM_5 and OM_4 (Table 3). Significantly lower number of productive tillers per m^2 (286) were recorded for control. Application of 3% panchagavya showed more number of productive tillers per m^2 (365) than PPFM and water spray. It was significantly influenced by the interaction of organic manure and microbial nutrient spray.

3.2.3. Test weight
Organic manure influenced the test weight significantly over control. Maximum 1000 grain weight was recorded (19.6 g) for the treatment in which vermicompost @ 2.08 t/ha (OM_3) was applied. Significantly lower 1000 grain weight was produced by control.

3.2.4. Number of grains per panicle
The data relevant to the number of grains per panicle against various sources of organic manure and microbial nutrient spray reveals that application of vermicompost @ 2.08 t/ha (OM_3), produced maximum number of filled grains per panicle (132.6). Significantly minimum number of filled grains (112) and more number of illfilled grain (16) was produced by control (OM_6). Muhammad Usman *et al*. (2003) [8] who reported that increased number of grains per panicle in rice might be due to better utilization phosphorus in organic manures, phosphorus as a part of DNA played a crucial role in the building of genetic parts of plants.

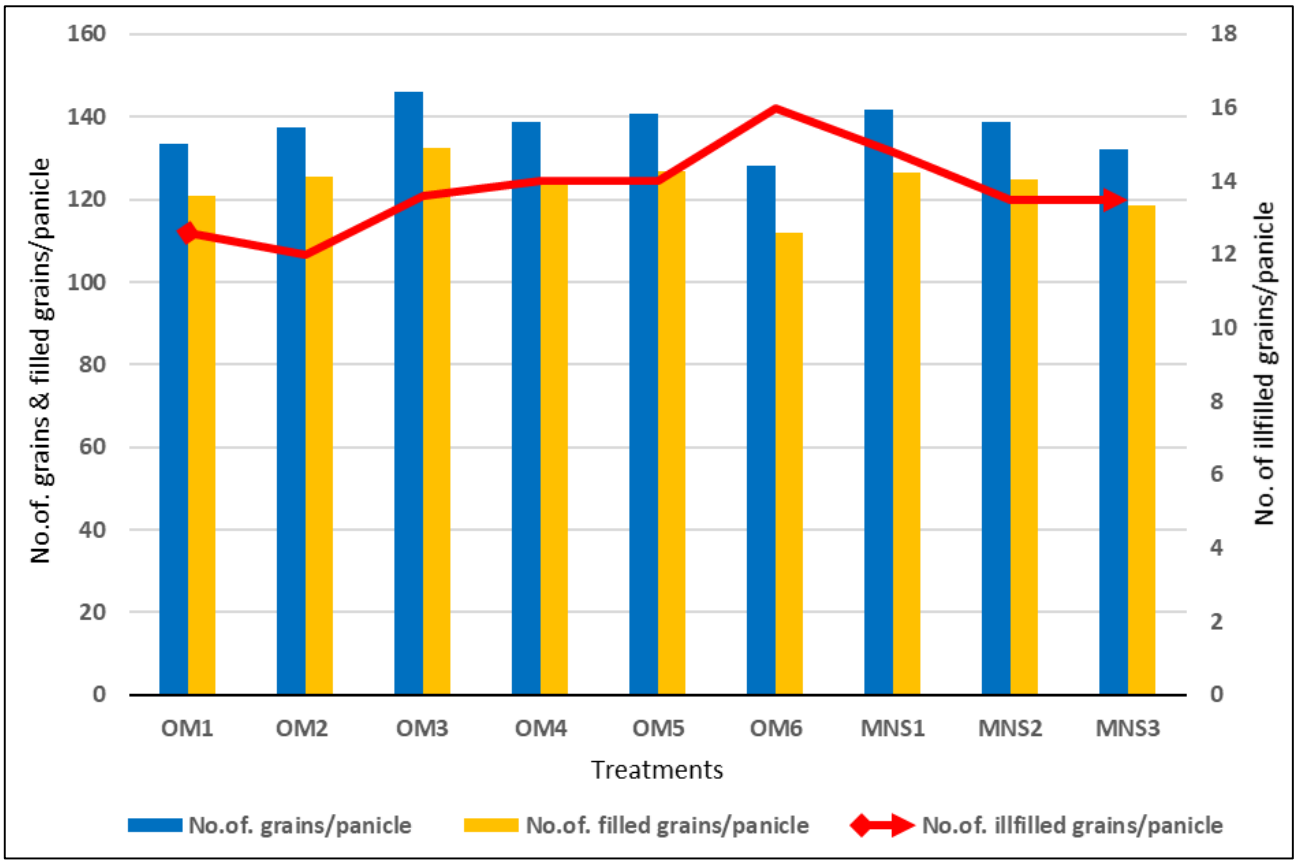

Fig 2: Effect of organic manure and microbial nutrient spray on number of grains/panicle

Table 3: Effect of organic manure and microbial nutrient spray on number of productive tillers and test weight of organic rice

Treatment	Number of productive tillers per m^2				Test weight (g)			
	MNS_1	**MNS_2**	**MNS_3**	**Mean**	**MNS_1**	**MNS_2**	**MNS_3**	**Mean**
OM_1- FYM	356	327	325	336	19.2	18.4	18.3	18.6
OM_2 – EFYM	359	356	327	347	19.6	18.6	18.1	18.8
OM_3 - Vermicompost	398	385	358	380	20.1	20.0	18.7	19.6
OM_4 – Composted PM	361	342	321	341	19.8	19.5	18.8	19.4
OM_5 – Neem oil cake	416	355	316	362	20.5	18.9	19.1	19.5
OM_6 – Absolute control	305	294	261	286	18.1	18.2	17.5	17.9
Mean	365	343	318	342	19.5	18.9	18.4	19.0
Factor	OM	MNS	OM × MNS		OM	MNS	OM × MNS	
SEd	5.4	3.8	9.3		0.50	0.35	0.87	
CD (P=0.05)	11	7.7	19		1.02	0.72	NS	

OM – Organic Manure; **MNS** - Microbial Nutrient Spray; **PM** – Poultry Manure; **MNS_1** - 3% panchakavya; **MNS_2** – 1% PPFM; **MNS_3** - water spray

3.2.5. Grain yield

Grain yield was significantly differed among the organic manures and microbial nutrient spray while their interaction were remained non significant (Table 4). The order of grain yield was vermicompost > neem oil cake > composted poultry manure > EFYM > FYM > Control. Significantly higher grain yield (5236 kg/ha) was obtained in plots where vermicompost @ 2.08 t/ha (OM_3) was applied. The next in order was application of neem oil cake @ 1.2 t/ha (OM_5) and composted poultry manure @ 3.47 t/ha (OM_4) (Table 4). Significantly lower grain yield (2814 kg/ha) was noted for absolute control (OM_6). While the application of microbial nutrient spray, 3% panchagavya recorded highest grain yield (5008 kg/ha) against water spray. vermicompost contains high level of plant growth hormones and soil enzymes, while enhancing the microbial population in soil and retaining its nutrients over a longer period of time without having an adverse effect on environment. The highest grain yield might be due to the availability of all essential. nutrient in soil enriched with vermicompost. Application of NPK 50% + vermicompost + panchagavya 3% + jeevamrutha 5% gave the significantly higher grain yield in rice by Shardha and Sujathamma (2018) [13]. These findings also supported by Amitava *et al.* (2008) [1] who reported that treatment with vermicompost imparted maximum grain yield compared to all other treatment. The results are in line with the observations of Sailajakumari and Ushakumari (2002) [11] and Vasanthi and Kumarasami (1999) [19] who found increased rice yield after treatment with vermicompost plus NPK and enhanced nutrient uptake and yield by cowpea after application of vermicompost enriched rock phosphate. Selvaraj (2003) [12] also observed that french bean was increased 36 per cent with application of vermicompost + panchakavya. Jeyabal and Kuppuswamy (2001) [6] reported that integrated nutrition comprising vermicompost, fertilizer N and biofertilizers could be applied to rice – legume cropping system to achieve higher yields and sustain soil health. Su lin lim *et al.* (2014) [16] found that vermicompost should be applied at moderate concentrations in order to obtain maximum plant yield.

Table 4: Effect of organic manure and microbial nutrient spray on grain yield and straw yield of organic rice

Treatment	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	MNS_1	**MNS_2**	**MNS_3**	**Mean**	**MNS_1**	**MNS_2**	**MNS_3**	**Mean**
OM_1- FYM	5016	4620	4135	4590	8035	7531	7094	7553
OM_2 – EFYM	5086	4621	4165	4624	8064	7534	7193	7596
OM_3 – Vermicompost	5715	5230	4765	5236	9144	8643	8135	8640
OM_4 – Composted PM	5385	4827	4363	4858	8543	8173	7645	8120
OM_5 – Neem oil cake	5598	5056	4635	5096	8894	8013	7427	8111
OM_6 – Absolute control	3250	2835	2357	2814	5417	5175	4723	5105
Mean	5008	4531	4070	4536	8016	7511	7036	7521
Factor	OM	MNS	OM × MNS		OM	MNS	OM × MNS	
SEd	169	119	293		239	169	415	
CD (P=0.05)	344	243	NS		487	344	NS	

OM – Organic Manure; **MNS** - Microbial Nutrient Spray; **PM** – Poultry Manure; **MNS_1** - 3% panchakavya; **MNS_2** – 1% PPFM; **MNS_3** - Water spray

3.2.6. Straw yield: There was significant difference in the straw yield among the organic manure, microbial nutrient spray and their interaction remained non significant. The order of straw yield was Vermicompost > neem oil cake >Composted poultry manure > EFYM > FYM > Control. Significantly higher straw yield (8640 kg/ha) was obtained in plots where vermicompost @ 2.08 t/ha (OM_3) was applied. The next in order was application of neem oil cake @1.2 t/ha (OM_5) (Table 4). Significantly lower straw yield (5105 kg/ha) recorded for control. Application of 3% panchakavya recorded higher straw yield (8016 kg/ha**)** than PPFM and water spray. Vermicompost has nitrogen, potassium, phosphorus and other micro and macronutrients, so that the plants are fed continuously. This also improves the fertility of soil in which crops are planted. The higher the straw yield was might be due to continuous availability of macro and micronutrients. Shardha and Sujathamma (2018) [13] reviewed that application of 50% NPK + vermicompost + 3% panchagavya + 5% jeevamrutha recorded significantly higher straw yield. Suchitra Rakesh *et al.* (2017) [15] showed that increase in growth and yield parameter at 3% foliar spray of panchagavya. Application of panchagavya enhance the biological efficiency and it ultimately Increased yield of crop plants by Natarajan (2002) [10].

4. Conclusion

The study could be concluded that the application of vermicompost on equal N basis (2.08 t/ha) recorded higher yield attributes such as number of productive tillers per hill and number of filled grains per hill and grain yield of rice. The vermicompost increased grain yield by 86 per cent over absolute control. Among microbial nutrient spray 3% panchagavya recorded maximum yield. Therefore vermicompost and panchagavya is advisable to get maximum yield and also sustain the soil productivity compared to all other compost.

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