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Evaluation of Spent Mushroom Substrate Extract as a Biofertilizer for Growth Improvement of Rice (*Oryza sativa* L)

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MUSHROOM farms started to widely establish in Egypt to partially replace animal protein. The type *Pleurotus ostreatus* is common in small farms because of the low cost production. Residues of mushroom cultivation contain highly nutritive compounds resulted from metabolic activity of the fungus. In this work, the extract of spent pleurotus mushroom was used as an organic fertilizer to enhance Sakha 106 rice cultivar growth and productivity. The chemical analysis of spent extract (SE) verified that it contains considerable amount of reducing sugars, phenolic compounds and other macro and micro elements. Tow laboratory experiments were designed to study the effect of SE on soil micro biota and cyano bacterium *Spirulina platensis*. A field experiment continued for two successive seasons 2018 and 2019 was conducted where rice grains were soaked in SE then SE was applied by three methods, spraying on rice shoot system, soil drench and combined spraying plus soil drench. Results indicated that, SE improved soil microbial activity represented by total bacterial, fungal count and dehydrogenase activity in addition to soil respiration.Results of field trial indicated that the effect ofsoaking treatment was significant in spike length, number of full and empty seeds, grain and straw yield and nitrogen percent in grains,while the most effective treatment was the combination between spraying and soil amendment where the yield of grains and straw were clearly enhanced in addition to other yield characters.

Key words: Pleurotus, Rice, Spent mushroom, Spray.

Introduction

The increase demand for agricultural products, pushes toward unsustainable fertilization practices. On the other hand, while the agriculture sector consumes large amounts of synthetic fertilizers, organic residues from crop processing and the food industry are classified as a waste, and their nutrient content is often ignored.The effect of plant residues and their extracts on the agricultural systems were reported by mini workers (Abd El-Halim, 2019a; Abd El-Halim, 2019b, Courtney and Mullen, 2008; Hackett, 2015). Spent mushroom substrate (SMS) is a substrate residue of ediblemushroom cultivation (Nakatsuka et al., 2016). The major components of SMS are lignocellulose materials, such as wood chips,sawdust, wheat, cotton, maize, rye or rice straw, and corncobs (Zhang et al. 2012 and Hackett, 2015). After harvesting of edible parts of mushroom, SMS still holds appropriatelevels of organic matter, nitrogen (N), phosphorus (P), potassium (K), and other mineral nutrients required for plant growth (Jordan et al. 2008; Roy et al.2015). About 5 kg of SMS are produced for each kg ofmushrooms produced (Medina et al., 2012).

Many proper uses of SMS have been recommended, including application as agricultural organic amendment or composts, seedling bed materials, bedding for animals,

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burning as fuels, and in the bioremediation of contaminated soils (Rinker, 2002; Zhang et al. 2012; Medina et al. 2012 and Paula et al., 2017). Many workers have shown the benefits of SMS as organic fertilizer and/or soil conditioner (Courtney and Mullen 2008; Hackett, 2015). (Siddhant and Ayodhya, 2009) used SMS of three strains of oyster mushrooms as fertilizer for improvement the growth of the plant *Spinacea oleracea*. (Sendi et al., 2013) used it as a substitution for peat moss to produce Kai-lan/Kale (*Brassica oleracea* var. alboglabra) in Malaysia. Also, SMS was used to production of tomato *Lycopersicon esculentum*. Seedling (Unal, 2015).

Ishihara et al. (2018) certified that the SMS water extract of *Le. edodes* mushroom suppressed the progress of lesions caused by *Py. oryzae*infection in rice plant and found that the SMS water extract strongly inhibited the conidial germination of *Py. Oryzae* as a result of the presence of poly phenolic compounds produced during mushroom life cycle as adegradation products of lignin.

Rice (*Oryza sativa*) is the chief food of supreme of the Egyptian's population. Rice plants consume large amounts of mineral nutrients for their growth, development and grain production. The combined use of organic materials and inorganic fertilizer considerably increased the yield and yield component characters of Egyptian rice (Mosaad 2019 and Metwally, 2015). The present study has been undertaken to evaluate the effect of spentmushroom substrate extract of pleurotus mushroom as organic fertilizer on the growth and productivity of rice *Oryza sativa*.

Material and methods

Spent mushroom source and extraction

Spent mushroom substrateof *pleurotusostreatus* grown on rice straw resulted after thee harvesting cycles at microbiology department, soil, water and environment research institute, Sakha Agriculture Research Station, Kfrelshikh, Egypt. the obtained (SMS) was air dried in shadow for 3 days then dried in oven at 70 C until constant weight.

Extraction of SMS

Dried SMS was finely grinded and suspended in tab water at a ratio (1:10) with intermittent mixing during 48 hr then filtered through cheesecloth and used in subsequent work.

SMS analysis

Spent mushroom substrate extract (SMSE) was analyzed for its pH, EC, organic matter (Walkley and Black 1934) , and phenolic compoundscontent (Singleton et al., 1999).

Estimation of total phenolic content

The total phenolic content of spent mushroom extract was assayed using the Folin-Ciocalteure agent. One milliliter of tenfold diluted Folin Ciocalteu's phenol reagent was added to 0.5 ml of spent mushroom water extract followed by 1 ml of 7% Na_2CO_3 solution. The mixture was incubated at room temperature for 30 min. then theabsorbance was determined at 750 nm with an UV-VisSpectrophotometer using standard solution of gallic acid. Total phenolic content of extract was expressed as mg Gallic acid equivalent/100 gm dry weight extract sample. Samples weremeasured in three replicates (Elzaawely and Tawata, 2012)

Effect of (SMSE) on the microbial activity in fertile soil

To examine the response of soil microbial communities to the (SMSE), 100 gram of fertile soil obtained from the rhizosphere of rice plant was mixed with 20 ml of SMSE and incubated for 7 days at 30 ^{o}C, the same amount of soil mixed with 20 ml tap water considered as control. After incubation, the total number of bacteria, fungi, in addition to soil dehydrogenase activity and soil respiration were assayed.

Determination of soil dehydrogenaseactivity

Dehydrogenase activity was determined using the method described by Tabatabai (1982).

Measurement of respiration rate

Soil respiration was proceeded according to Jaggi (1976) as follow:10 g of soil was sited in 50 ml perforated plastic tube fitted into a Duran bottle containing 25 ml 0.05 NaOH where the plastic tube remain hanged at the neckof the Duran bottle. system without soil was used as a blank. Bottles were incubated for 72 hr at room temperature. After incubation, 5 ml of (0.5 M) barium chloride and a few drops of phenol phthalein were add to the NaOH solution, the mixture was titrated with (0.05 M) HCl until the soulution turned colorless. The rate of soil respiration was calculated according to equation: CO_2 (mg) CW/t = .CW is the soil dry weight in gram, t is incubation time (hr) V0 is volume of HCl titration of blank, V is volume of HCl titration of sample, d w is dry weight of 1g moist soil, conversion factor (1 ml 0.05 M NaOH =1.1 mg CO_2 , CO_2 (mg) 10g-172h^{-1}

Response of cyanbacteriumSpirulinaplatensis to spent mushroom extract

Zarroukbroth medium was prepared according to Zarrouk (1966) and distributed in 250 ml round flasks where each flask received 100 ml of medium, half of the flasks were supplemented with 10 ml of spent mushroom extract, another group of flasks were received 100 ml tap water containing only the same concentration of sodium bi carbonate of Zarrouk formulation, also half of this flasks were amended with spent mushroom extract but with a higher amount (50%), all flasks were inoculated with equal volumes of a well grown *Spirulina*(10^7-10^8 colony-forming units/ml). The cultures were grown under controlled laboratory conditions of 30±2°C and continuous illumination of 5500–6500.

Field experiment

A field experiment was conducted at the experimental farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during 2018 and 2019 rice growing seasons to study the performance of Sakha 106 rice cultivar as affected by different application methods of (SMSE). A field experiment was carried out as split-plot design, with three replicates.The main plots were surrounded by deep ditches to control and prevent any lateral movement of irrigation water. The experimental soil was prepared and fertilized as recommend by Rice Research and Training Center (RRTC).

Properties of the experimental soil

The soil of the experimental site was clayey in texture. The initial soil chemical properties at 0 - 20 cm soil depth of the experimental site were: EC 2.4, pH 8.10, organic matter (OM) 1.54%, total nitrogen 479 mg kg^{-1}, available P 11 mg kg^{-1}, available K 365 mg kg^{-1}, available Zn 0.75 mg kg^{-1}, available Fe 5.35 mg kg^{-1} and available Mn 2.85 mg kg^{-1}.

Plant and yield biometrics

Plant growth parameters as plant dry weight, height, number of branches, spike length, spike weight, full seeds, empty seeds, 1000 grain weight, grain and straw yield in addition to NPK in grain and straw.

Treatments

Statistical analysis

The field experiment was designed as split design and the collected data were subjected to statistical analysis, using the analysis of variance (ANOVA). LSD range tests were used to compare differences between the means (Steel and Torrie, 1980).

TABLE 1. Treatments of the field experiment using split design

Treatment	Details
	Grain Soaking
S_s	Grains soaked in 10% (SMSE)
S_w	Grains soaked in tap Water
	Plant treatment
P0	Plants sprayed with water
P1	Plants sprayed with 10 % (SMSE) at a rate of 10 l fed^{-1} at 40, 60 days of plant age
P2	Plants amended with 10 % (SMSE) at a rate of 10 l fed^{-1} at 40, 60 days of plant age with irrigating water
P3	Combination between P1+P2
	Interaction between grains soaking and plant treatment
T0	Ss+P0
T1	Ss+ P1
T2	Ss+ P2
T3	Ss+ P3
T4	Sw+ P0
Ts	Sw+ P1
T6	Sw+ P2
T7	Sw+ P3

Results and Discussion

Analysis of spent mushroom extract (Table 2) revealed that it contain a diverse forms of bio active compounds including sugars resulted from the action of cellulase system of mushroom and phenols which act as ideal antioxidant in addition, the pH was near neutrality in water extract with earthy smell. This unique formula is promising and expected to enhance plant growth especially for its phenolic content.

The response of soil microbial community to the addition of spent mushroom was monitored in an experiment conducted in the laboratory (Fig1). It was noticed that all microbial biometrics were affected by the addition of spent mushroom extract where total bacterial count, total fungi, dehydrogenase activity and soil respiration values were the highest in case of the presence of spent mushroom extract. This finding may be attributed to the nutritive formula of spent mushroom, it contains residues of different sugars resulted from the metabolic activity of mushroom during its life span. In addition to sugars it also contains essential elements as nitrogen, phosphorous, potassium and other microelements.

The addition of spent mushroom extract not only reflected on the activity of microbial community but also on the nature of this community. It was noticed that agar plats used in estimation of total microbial count were turned to red as a result of the activity of microbial community inhabiting the soil treated with spent mushroom extract (Fig. 2).

Cyanobacteria considered the most important biological component in rice plant ecosystem it provides it with nitrogen, oxygen and organic matter. In the current research cyanbacterium (*Spirulinaplatensis*) growth was enhanced and accelerated when spent mushroom extract was supplied to zarroukmedium also spirulina was able to grow in a medium contains tab water and spent mushroom extract in addition to sodium bi carbonate (Fig. 3).

TABLE 2. Parameters of 10 % (W/V) extract of spent mushroom

parameter	Value
pH	7.6
EC	7.4 dS m^{-1}
Color	Brown
Odor	Earthy
Reducing sugars	0.6 gl^{-1}
Organic matter	11 g kg^{-1}
Phenolic content	7 mg ml^{-1} equivalent gallic acid water extract (10 % w/v)
N	0.6 gl^{-1}
P	0.07 gl^{-1}
K	1.1 gl^{-1}

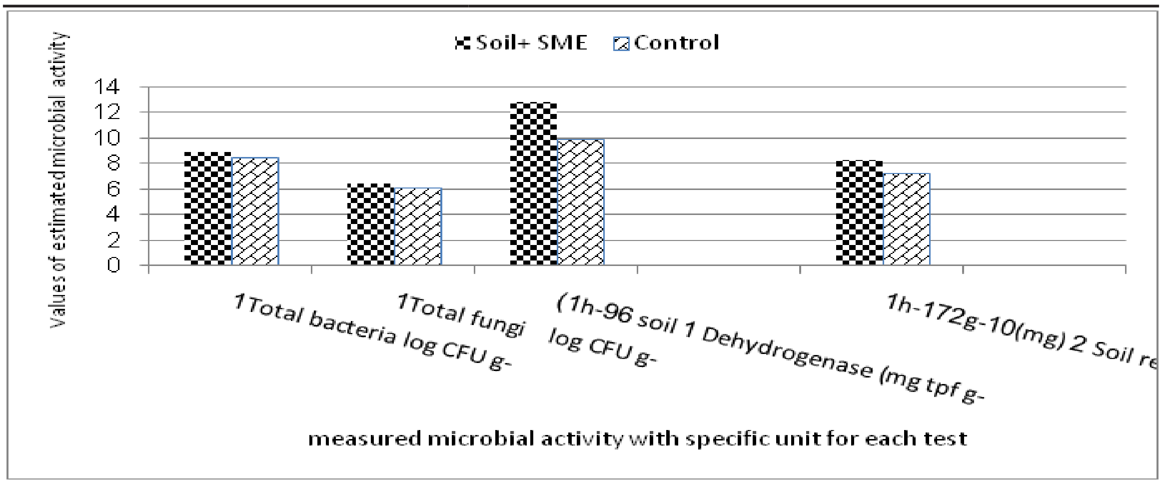

Fig. 1. Effect of spent mushroom extract as a potential stimulant for soil micro biota

Fig. 2. change in color of agar plats as a result of spent mushroom extract amendment to the experimental soil

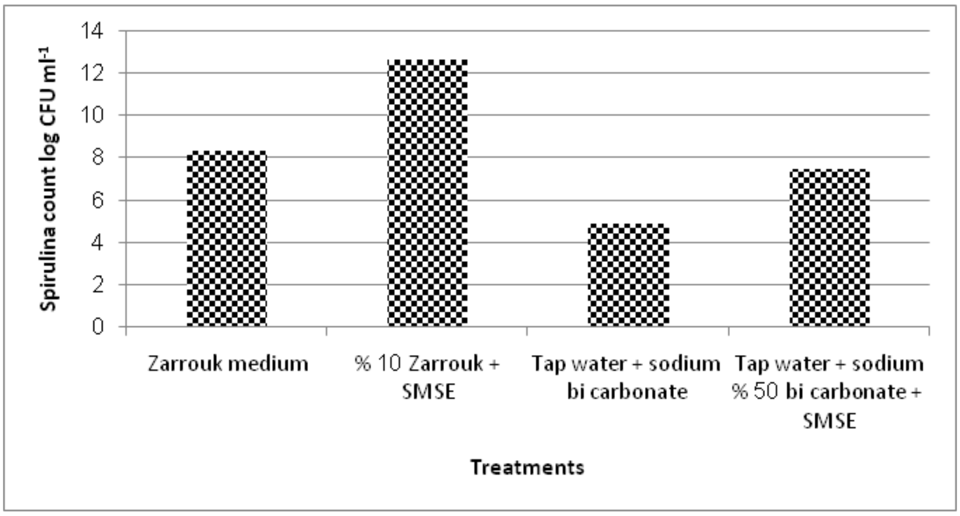

Fig. 3. Effect of spent mushroom extract as a potential stimulant for cyanobacteria (Spirulinaplatensis)

Spent mushroom substrate (SMS) contains growing fungal mycelia and elevated levels of bioactive molecules, including polysaccharides, polypeptides/proteins and phenolic compounds (Lakhanpal and Rana 2005). The enzymatic activity during mushroom life span increase crude protein and fat content of lignocellulose substratemore than twice, while cellulose, lignin and gossypol decrease about 50%,30% and 60% respectively. Meanwhile, the activity of fungal enzymesgenerates polysaccharides, vitamins, and liberatetrace elements such as Fe, Ca, Zn and Mg (Medina et al. 2009;Paredes et al. 2009).So the extraction of bioactive components from SMS may thus be an efficient alternative for resource recovery.

Lignocellulosic material of rice straw (which considers the main substrate for oyster mushroom production) contains about 32-47% cellulose, 19-27% hemicellulose, and 5-24% lignin (Binod et al. 2010). Lignins are combined with phenolic compoundsAkpinar et al.(2010); therefore, there is a demand for hydrolysis to free soluble phenolic compounds from its bound form (Jung et al. 2015). These phenolic compounds possess high antioxidant potential(Pouteau et al. 2003;Boeriu et al. 2004). So the enzymatic hydrolysis of rice straw by oyster mushroom releases such components.

The unique solid state fermentation occurred during development of mushroom mycelium make the residual substrate rich with organic matter, mineral nutrients andnear neutral pH make SMS as a suitable organic material forapplication as organic fertilizer for crops production.

Field experiment

Spent mushroom substrate extract of Oyster mushroom was tested for their effect on growth promotion of rice (*Oriza sativa*) under field conditions. Spent mushroom substrates extract was prepared and applied as mentioned earlier. Growth promotion in terms of height, number of branches, spike length, spike weight, full grains, empty grains, 1000 grain weight, grain and strew yield in addition to NPK in grain and straw were evaluated. Soaking treatment showed significant effect in spike length, number of full and empty seeds, grain and straw yield and nitrogen percent in grains while the other parameters did not response significantly to the soaking treatment. On the other hand the treatment of growing plants with spent extract enhanced significantly rice growth and yield parameters in both seasons exceptplant height, flag leaf area, number of branches, spike weight and 1000 grain weight in the second season.

Among the compounds with antioxidant activity, polyphenols are important. These are found in a great variety of foods, such as apples, mulberries, cherries, grapes, raspberries, citric fruits, onions, spinach, peppers, oat, wheat, black tea, wine and chocolate, among others (Holden et al. 2005 and Dimitrios, 2006). These compounds have demonstrated higher *in vitro* antioxidant capacity than other antioxidants, such as ascorbic acid and α-tocopherol (Pulido et al. 2000) emphasizing the importance of polyphenols as antioxidants in the diet.

The combined use of both spraying and soil amendment of spent mushroom extract had the greatest effect on number of branches where treatment P3 (Spaying + soil treatment) recorded the highest value compared to other treatments and presents about 16.8 % and 13.5 % increase over control. The effect of different treatments was not significant in case of plant height in the second season and the effect was significant but with little variation in the first season where the T4 (plants without spraying, soil amendment or seed soaking) presented the lowest plant height values. Also the effect of treatments was significant in the first season only in case of flag leave area (Table 3).

Roy et al. (2015) studied thepotential of spent mushroom substrate (SMS) of oyster mushroom on the improvement of growth of *Capsicum annuum*L. the analysis of growth parameters in terms of height, yield, no of branches and no of leaf drop shown that the use of (SMS) of oyster mushroom had a positive effect on the overall growth of the tested plants.

Data presented in Table 4 show that the effect of soaking rice grains in spent mushroom extract on spike weight was not significant but the effect of spraying or soil amendment was significant in the first season and the highest values were recorded by T3 followed by T7 treatments. In case

TABLE 3. Response of rice vegetative parameters;number of branches, plant height and flag leaf area to different treatments with spent mushroom extract

Treatments	No.branches		plant height		flag leave	
	1 st Season	2 nd Season	1 st Season	2 nd Season	1 st Season	2 nd Season
Ss	18.45	18.47	85.77	84.94	17.95	18.13
Sw	18.14	18.33	84.70	84.51	17.78	18.06
L.S.D.0.05	n.s	n.s	0.36**	n.s	n.s	n.s
Sub main						
P0	17.01	17.27	83.43	83.63	17.25	17.74
P1	18.13	18.28	85.39	85.04	17.95	18.21
P2	17.62	17.89	84.58	84.67	17.84	18.04
P3	20.44	20.16	87.53	85.57	18.43	18.41
L.S.D.0.05	0.48**	0.38**	1.19**	n.s	0.02**	n.s
interaction						
T0	17.07	17.30	84.05	84.07	17.51	17.84
T1	17.90	18.30	85.19	85.22	17.78	18.12
T2	18.12	17.96	84.73	84.70	17.74	18.08
T3	20.73	20.31	89.11	85.78	18.78	18.50
T4	16.96	17.23	82.81	83.19	16.98	17.63
T5	18.36	18.26	85.60	84.87	18.12	18.31
T6	17.11	17.81	84.43	84.63	17.93	17.99
T7	20.14	20.00	85.95	85.36	18.08	18.31
L.S.D.0.05	0.69**	0.47**	1.23**	n.s	0.036***	n.s

All abbreviations are listed in Table 1.

TABLE 4. Response of rice yield parameters; spike weight, spike length and straw yield to different treatments with spent mushroom extract

Treatments	No.branches		spike weight (gm/ plant)		spike length (cm)		straw	
	1 st Season	2 ndSeason	1 st Season	2 ndSeason	1 st Season	2 ndSeason	1 st Season	2 ndSeason
Ss	8.99	8.92	2.61	2.68	19.13	19.11	10.51	10.60
Sw	8.75	8.76	2.65	2.59	18.57	18.83	10.18	10.24
L.S.D.0.05	n.s	n.s	n.s	n.s	0.18**	0.25*	0.28**	0.06**
Sub main								
P0	8.55	8.53	2.45	2.46	18.02	18.35	9.06	9.06
P1	9.05	8.92	2.61	2.67	18.88	19.11	10.35	10.39
P2	8.67	8.67	2.53	2.62	18.64	18.70	9.70	9.78
P3	9.21	9.23	2.93	2.78	19.86	19.72	12.28	12.44
L.S.D.0.05	0.36**	n.s	0.19*	n.s	0.48**	0.48**	0.3**	0.38**
Interaction								
T0	8.74	8.60	2.50	2.51	18.52	18.50	9.36	9.58
T1	9.22	9.10	2.51	2.71	19.00	19.23	10.49	10.46
T2	8.76	8.70	2.46	2.68	18.94	18.77	9.74	9.80
T3	9.22	9.27	2.98	2.81	20.05	19.93	12.45	12.55
T4	8.37	8.47	2.41	2.42	17.52	18.20	8.76	8.54
T5	8.88	8.73	2.71	2.63	18.75	18.98	10.21	10.32
T6	8.57	8.63	2.60	2.57	18.33	18.63	9.65	9.76
T7	9.20	9.20	2.88	2.75	19.67	19.50	12.11	12.33
L.S.D.0.05	0.58**	n.s	0.23**	n.s	0.98**	0.56**	0.49**	0.54**

All abbreviations are listed in Table 1.

of spike length and straw yield, the response to all treatments including soaking were significant at both seasons.

The seed parameters are important in evaluation of fertilization efficiency. It affected by many factors as pollination efficiency and the availability of macro and micro elements in addition to biotic and a biotic stresses. The treatment with spent mushroom extracts enhanced rice seed properties (Table 5) where the percent of full seeds increased 10 .5 and 11 % over control in first and second seasons respectively in case of dual application with spray and soil amendment. While empty grains decreased about 29, 31 % under the previous treatment at first and second seasons respectively.

Tuhy et al. (2015) studied the use of spent mushroom substrate (SMS) of *Agaricusbisporous* as adsobant material for micronutrients to improve yield component of maize plant, he found that grain yield of maize treated with micronutrients delivered with (SMS) was higher than the traditional treatment.

Ashrafi et al. (2015) established that the application ofSMS compost at a rate of 2.5 t ha^{-1} along with recommended dose of mineral fertilizer showed the best performance for fruits number, fruit yield, fruit quality (total protein, total sugar, vitamin C, reducing sugar) in addition to nutrient uptake bytomato.

The accumulation of macro elements as NPK in rice seeds is a good sign for the successful crop management, it also reflected on seeds nutritive value. The use of spent mushroom extract improves the accumulation of such elements in rice seeds especially when treated by spraying plus soil amendment. Grains soaking prior sawing was not significant in case of phosphorous and potassium percent but was significant in case of nitrogen percent (Table 6).

The NPK percent in straw did not affected with soaking treatment although it affected greatly by post treatments including spraying and soil supplement with spent mushroom extract (Table 7), the general observations from the all previous results indicated that, the soaking of rice seeds in the extract of spent

TABLE 5. Response of rice yield parameters; full and empty grains, 1000-grains weight (gm) and harvest to different treatments with spent mushroom extract

Treatments	full		empty		1000-grain weight (gm)		Grain yield t ha^{-1}	
	1 st Season	2 ndSeason	1 st Season	2 ndSeason	1 st Season	2 ndSeason	1 st Season	2 ndSeason
Ss	82.33	82.33	6.73	6.73	29.33	29.72	9.19	9.17
Sw	80.52	80.51	7.28	7.28	29.17	29.49	8.88	8.87
L.S.D.0.05	0.87*	0.69*	0.81*	0.45*	n.s	n.s	0.03*	0.13**
Sub main								
P0	77.70	77.22	8.10	8.12	28.83	28.92	8.08	8.00
P1	82.50	82.63	6.83	6.70	29.33	29.68	9.42	9.41
P2	78.63	78.96	7.53	7.61	29.17	29.65	8.64	8.50
P3	86.87	86.85	5.57	5.59	29.67	30.15	10.01	10.18
L.S.D.0.05	2.65**	1.8**	1.24**	0.64**	n.s	0.86*	0.26**	0.37**
interaction								
T0	78.00	77.60	8.00	7.77	29.00	29.23	8.13	8.28
T1	84.80	84.85	6.67	6.59	29.33	29.53	9.68	9.63
T2	78.93	79.65	7.20	7.60	29.33	29.90	8.85	8.56
T3	87.60	87.21	5.07	4.95	29.67	30.20	10.10	10.19
T4	77.40	76.84	8.20	8.47	28.67	28.61	8.02	7.71
T5	80.20	80.42	7.00	6.80	29.33	29.83	9.15	9.19
T6	78.33	78.27	7.87	7.61	29.00	29.40	8.42	8.43
T7	86.13	86.49	6.07	6.22	29.67	30.10	9.93	10.16
L.S.D.0.05	3.02**	2.23**	1.85*	0.81**	n.s	0.95**	0.33**	0.45**

All abbreviations are listed in Table 1.

TABLE 6. Response of rice grainchemical estimations; N%, P% and K% to different treatments with spent mushroom extract

Treatments	N (%) in grains		P (%) in grains		K (%) in grains	
	1 st Season	2 ndSeason	1 st Season	2 ndSeason	1 st Season	2 ndSeason
Ss	1.08	1.08	0.20	0.21	0.28	0.28
Sw	0.97	0.96	0.20	0.20	0.27	0.28
L.S.D.0.05	0.007**	0.006*	n.s	n.s	n.s	n.s
Sub main						
P0	0.88	0.89	0.18	0.18	0.24	0.26
P1	0.96	0.97	0.19	0.19	0.26	0.26
P2	1.04	1.05	0.19	0.20	0.28	0.29
P3	1.22	1.17	0.24	0.25	0.32	0.34
L.S.D.0.05	0.04**	0.051*	0.027**	0.01*	0.01**	0.02**
interaction						
T0	0.93	0.93	0.18	0.18	0.24	0.26
T1	1.03	1.04	0.19	0.19	0.26	0.26
T2	1.11	1.11	0.19	0.21	0.27	0.27
T3	1.25	1.22	0.25	0.26	0.33	0.34
T4	0.84	0.85	0.18	0.18	0.24	0.25
T5	0.89	0.90	0.20	0.19	0.25	0.26
T6	0.97	0.98	0.18	0.20	0.28	0.30
T7	1.19	1.12	0.24	0.24	0.31	0.33
L.S.D.0.05	0.095**	0.06**	0.032**	0.09*	0.02**	0.022*

All abbreviations are listed in table 1.

TABLE 7. Response of rice straw chemical estimations; N%, P% and K% to different treatments with spent mushroom extract.

Treatments	N (%) in straw		P (%) in straw		K (%) in straw	
	1 st Season	2 nd Season	1 st Season	2 nd Season	1 st Season	2 nd Season
Ss	0.55	0.55	0.08	0.08	1.15	1.15
Sw	0.56	0.54	0.08	0.08	1.11	1.11
L.S.D.0.05	n.s	n.s	n.s	n.s	n.s	0.01*
Sub main						
P0	0.48	0.46	0.06	0.06	0.94	0.96
P1	0.51	0.50	0.07	0.07	1.02	1.03
P2	0.57	0.57	0.08	0.08	1.14	1.10
P3	0.66	0.65	0.11	0.11	1.43	1.43
L.S.D.0.05	0.02**	0.03**	0.01**	0.01**	0.11**	0.08**
Interaction						
T0	0.49	0.46	0.06	0.07	0.96	0.97
T1	0.51	0.51	0.07	0.07	1.02	1.05
T2	0.54	0.55	0.07	0.07	1.16	1.11
T3	0.66	0.66	0.12	0.11	1.47	1.46
T4	0.47	0.45	0.05	0.06	0.91	0.94
T5	0.51	0.50	0.07	0.06	1.03	1.01
T6	0.61	0.58	0.08	0.08	1.11	1.09
T7	0.65	0.63	0.11	0.11	1.38	1.40
L.S.D.0.05	0.03**	0.04**	0.014**	0.01*	0.14	0.1*

All abbreviations are listed in Table 1.

mushroom is not effective alone in most cases an should be combined with post sawing treatments including spraying and/or soil amendment.

The spraying of the SMS extracts on rice clearly suppressed the development of lesions caused by *Py. oryzae*infection.The accumulation of phytoalexinsmomilactones A and B, oryzalexin A, andsakuranetin was markedly induced by the spraying of extracts(Ishihara et al. 2019)**.** The protective effect of SMS treatment was attributed to the induction of systemicacquired resistance (SAR).

Conclusion

Extracting of plourotus spent mushroom with water is an efficient way to obtain highly nutritive organic fertilizers acting to improve rice growth and yield parameters, the most effective application method is the dual use of spraying and amendment with irrigation water. More research is needed to evaluate the role of spent mushroom extract from different sources in saving mineral fertilizers in addition the demand to optimize extraction process.

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تقييم إستخدام مستخلص متبقيات زراعة عيش الغراب كسماد حيوي لتحسين نمو نبات الأرز

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لقد أصبح من الملاحظ في الأونة الأخيرة زيادة الأتجاه إلي زراعة المشروم كبديل للبروتين الحيواني و يكثر استخدام المشروم من النوع المحاري (بليوروتس اوستراتس) في المزارع الصغيرة لإنخفاض تكلفة إنتاجة. تحتوي متبقيات زراعة المشروم من هذا النوع وغيره علي العديد من المغذيات المتبقية من نشاط الفطر علي بيئته الغذائيةأثناء فترة النمو. في هذه الدراسة تم استخدام مستخلص متبقيات زراعة المشروم من النوع المحاري (بليوروتس اوستراتس) كمخصب لنبات الأرز وقد أوضح تحليل هذا المستخلص إحتوائه علي نسبة من السكريات المختزلة والفينولات بالإضافة إلي العديد من العناصر الغذائية الكبري والصغري. لتحديد مدي فاعلية وتأثير هذا المستخلص علي إثراء المكون الحيوي للتربة تم إجراء تجربتين معمليتين لدراسة استجابة ميكروبات التربة عموما و سبيرولينا بلاتينيسيس علي وجه الخصوص لهذا المستخلص. تم أيضا إجراء تجربتين حقليتين لدراسة فاعلية المستخلص في زيادة نمو وإنتاج نبات الأرز صنف سخا ١٠٦ خلال موسمي ٢٠١٨- ٢٠١٩ حيث احتوت المعاملات علي نقع حبوب الأرز قبل الزراعة و والرش بالمستخلص والإضافة الأرضية خلال فترة النمو وقد أظهرت النتائج ان إضافة المستخلص إلي التربة في التجربة المعملية أدي إلي تشجيع نشاط الميكروبات متمثلا في زيادة العد الكلي للفطريات والبكتريا وزيادة نشاط إنزيم ديهيدروجيناز و أيضا زيادة تنفس التربة. كما أدي إضافته إلي بيئة سبيرولينا بلاتينسيس إلي تشجيع نموها مقارنة بالمعاملة المرجعية الحاكمة .أوضحت نتائج التجربة الحقلية خلال الموسمين أن تأثير نقع الحبوب في المستخلص كان معنويا بالنسبة لطول السنبلة وعدد الحبوب الممتلئة والفارغة ومحصول الحبوب والقش. كما أظهرت النتائج تفوق المعاملات المشتركة بين الرش بالمستخلص مع الإضافة الأرضية علي باقي المعاملات حيث أظهرت هذه المعاملات زيادة في إنتاجية الحبوب والقش مقارنة بالمعاملات الأخري.