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EFFECT OF VARIOUS ORGANIC AMENDMENTS ON YIELD PERFORMANCE OF MULTISPORE ISOLATES OF *PLEUROTUS* SPP.

P. Renganathan, R. Kannan, T. Suthin Raj and K. Murugavel

Department of Plant Pathology, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar-608002, Tamil Nadu

Abstract

Generally addition of organic amendments to the bed substrates enhanced the yield of all the multispore isolates and standard parent (*P. eous*) when compared to the control. The amendments *viz.,* rice bran (6 %), wheat bran (6 %), groundnut oilcake (4 %) and gingelly oilcake (2 %) were found to be effective in increasing the mushroom yield. Among these, addition of groundnut oilcake (4 %) was found to be highly superior to all other amendments tested. Addition of organic amendment *viz*., groundnut oilcake at four per cent level to paddy straw significantly increased the yield to the maximum in all the isolates. The results revealed that the addition of organic amendments to the bed substrate reduced the days taken for the first harvest and increased the yield and bio-efficiency when compared to the control. Addition of rice bran and wheat bran at six per cent, groundnut oilcake at four per cent and gingelly oilcake at two per cent level hastened the days taken for first harvest and increased the yield when compared to other treatments tested with all the isolates studied. Groundnut oilcake at four per cent was found to be superior than all other amendments tested with all the isolates studied.

Key words: *Pleurotus* spp., multispore, organic amendments, wheat bran, rice bran, groundnut oil cake and gingelly oil cake.

Introduction

Mushrooms have achieved significant importance in many countries due to their high nutritive and genuine medicinal values as well as an income generative venture. Blessed with varied agro-climates, Indian weather is aptly suitable for the cultivation of edible mushrooms. The entire coastal belts of India running in to thousands of kilometers is a potent place to produce low cost speciality mushrooms which could supplement the protein deficiency and malnutrition, besides bringing in a sky– rocketing export market of a kind which is incomparable to any single cell protein (SCP) product (Kohlii, 2000).

It is estimated that about 355 million tonnes of crop residue is generated annually and about 170 million is left out posing problems for disposal (Tewari and Pandey, 2002). Even if one per cent of this agricultural waste is used to produce mushrooms, India will soon become a major mushroom producing country in the world. Mushroom production is the only biotechnological means available to convert these agricultural wastes into highly valuable edible proteins. So far around 5658 species of mushroom in 230 genera have been recorded from all over the world; whereas from India 850 species spread over 115 genera have been reported. Of this 850 species about 20 are being commercially cultivated (Saini and Atri, 1995).

Among these, the white button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus* spp.), paddy straw mushroom (*Volvariella volvacea*) and milky mushroom (*Calocybe indica*) are popular among the commercial growers in India as the techniques for their cultivation have been well developed (Vijaya Khader *et al.,* 1998). World mushroom production at present is estimated to be around 5 million tonnes/annum and is increasing @ 7 per cent/annum. The total mushroom production in India has increased from 4000 tonnes in 1955 to 30,000 tonnes in 1995 and it is estimated to be around 50,000 tonnes/annum (Tewari, 2004).

Agaricus bisporus is highly temperature specific, and its cultivation is restricted to temperate regions. But oyster mushrooms can be cultivated easily in tropical and

Author for correspondence : E-mail : rengaabishek@yahoo.com

subtropical regions. Hence, it is rightly named as "the crop of the future". *Pleurotus* spp. has the ability to degrade most of the lignocellulosic agro wastes, thus the cultivation of this mushroom is an efficient means for the conversion of agricultural wastes in to valuable edible proteins (Deepika Sud and Sharma, 2005).

The farmers and consumers have also developed preference towards *Pleurotus* spp. in recent years because of its advantages *viz.,* high nutritive value and easiness in cultivation using the farm wastes (Eswaran, 1998). Among the thirty eight species of *Pleurotus* existing in nature, only nine species are being cultivated under artificial condition (Jandaik, 1987). Every species has its own attributes and each is known for its yield, substrate utilization and wide temp. adoption (Ravichandran, 2001). Inspite of its easy cultivation methods and adaptation to wide range of temp., the production of *Pleurotus* spp. is very less when compared to button mushroom production in India. Hence, a need was felt for up scaling the yield potential of *Pleurotus* spp. for large scale production.

Materials and methods

organism

The pure culture of *Pleurotus* spp. (*Pleurotus citrinopileatus* (Fr.) Singer, *P. djamor* (Rumph.) Boedijn, *P. eous* (Berk) Sacc*, P. flabellatus* (Berk and Br.) Sacc., *P. florida* (Eger) and *P. ostreatus* (Jacq.Fr.) Kummer) were obtained from National Centre for Mushroom Research (NCMR) Chambaghat, Solan, Himachal Pradesh. The sub cultures were maintained on oat meal agar (OMA) medium.

Pc- Pleurotus citrinopileatus

Pd- Pleurotus djamor

Pe- Pleurotus eous

Pf- Pleurotus flabellatus

Pfl- Pleurotus florida

Po- Pleurotus ostreatus

Preparation of mushroom bed

Cultivation of *Pleurotus* was carried out in transparent polythene bags of 60×30 cm size and thickness of 100 gauges. Cylindrical beds were prepared using 0.5 kg of paddy straw on dry weight basis, following the method described by Eswaran (1998). The unchopped whole straw was made into coils and used. A layer of coiled paddy straw was placed at the bottom of polythene bag. Over this, a layer of spawn was placed. In this manner five layers of coiled paddy straw and four layers of spawn were placed in the polythene bag and then the bag was tied at the top. The mushroom beds were hung from the ceiling by means of ropes ("Uri" method) instead of the usual method of keeping them in tiers made of bamboo or casuarina stacks (Plate 2). Two holes were made in the polythene bags and the beds were kept in cropping room, where the temp. was maintained between 23 to 28^{0}C and relative humidity between 80 to 90 per cent. Water was sprinkled regularly to maintain adequate moisture and relative humidity. The following yield parameters were studied in all the experiments.

Spawn run

Number of days taken for 100 per cent colonization/ mycelial coverage on the substrate was recorded as spawn run period.

Time taken for first harvest

The number of days required for first harvest of the sporophores from the date of spawning of the bed was recorded.

Weight of sporophores

The sporophores were weighted after harvest and yield per bed in g. was recorded.

Biological efficiency

The biological efficiency of *Pleurotus* spp. was calculated by

$$Biological\,efficiency\,(\%) = \frac{Fresh\,weight\,of\,the\,mushrooms\,/\,bed}{Dry\,weight\,of\,the\,substrate\,/\,bed} \times 100$$

Effect of addition of organic amendments to the bed substrate on the sporophore yield

Organic amendments *viz*., rice bran, wheat bran at four, six and eight per cent levels, groundnut oilcake and gingelly oilcake at two, four and six per cent levels were added on dry weight basis of the substrate to study their effect on the yield performance of *Pc × Pe, Pc × Pfl, Pe × Po, Pf × Po* and *P. eous.* All the amendments were powdered and sterilized at 15 psi. for 1 h. The amendments were thoroughly mixed with the paddy straw substrate before spawning. Suitable control without any supplementation was also maintained. All the observations on the yield attributes were recorded as already described.

Results

Addition of organic amendments on bed substrates

Effect of addition of organic amendments on the yield of multispore isolates of *Pleurotus* spp.

The results presented in tables 24 to 28 revealed that the addition of organic amendments to the bed substrate reduced the days taken for the first harvest and increased

Table 1: Effect of organic amendments on yield performance of *Pc* × *Pe*

S. No	Amendments	Conc. (% Dry weight basis)	Days for first harvest	Yield (g/bed)	Bio-efficiency (%)
1.	Rice bran	4	11.55	620.36	124.07
		6	11.45	626.76	125.35
		8	11.60	620.14	124.03
2.	Wheat bran	4	11.80	614.95	122.99
		6	11.65	621.38	124.27
		8	11.45	616.25	123.25
3.	Groundnut oil cake	2	11.00	620.36	124.07
		4	10.85	660.45	132.09
		6	11.33	639.38	127.88
4.	Gingelly oil cake	2	11.33	633.43	126.68
		4	11.45	629.45	125.89
		6	11.67	621.00	124.42
5.	Control		12.00	614.15	122.83
	SED		0.023	0.228	
	CD (P = 0.05)		0.047	0.477	

Table 2: Effect of organic amendments on yield performance of *Pc* × *Pfl*

S. No	Amendments	Conc. (% Dry weight basis)	Days for first harvest	Yield (g/bed)	Bio-efficiency (%)
1.	Rice bran	4	12.25	615.36	123.07
		6	12.05	620.76	124.15
		8	12.67	605.28	121.05
2.	Wheat bran	4	12.45	610.35	122.07
		6	12.25	617.78	123.55
		8	12.45	606.25	121.25
3.	Groundnut oil cake	2	12.00	630.00	126.00
		4	11.33	650.15	130.03
		6	11.82	620.27	124.05
4.	Gingelly oil cake	2	11.67	625.38	125.07
		4	11.85	615.47	123.09
		6	12.00	608.27	121.65
5.	Control		12.90	603.33	120.66
	SED		0.091	0.456	
	CD (P = 0.05)		0.191	0.953	

the yield and bio-efficiency when compared to the control. Addition of rice bran and wheat bran at six per cent, groundnut oilcake at four per cent and gingelly oilcake at two per cent level hastened the days taken for first harvest and increased the yield when compared to other

Table 3: Effect of organic amendments on yield performance of *Pe* × *Po*

S. No	Amendments	Conc. (% Dry weight basis)	Days for first harvest	Yield (g/bed)	Bio-efficiency (%)
1.	Rice bran	4	10.77	640.28	128.06
		6	10.67	645.76	129.15
		8	10.72	634.57	126.91
2.	Wheat bran	4	10.90	638.67	127.73
		6	10.87	641.37	128.27
		8	10.95	635.57	127.11
3.	Groundnut oil cake	2	10.55	658.00	131.60
		4	10.45	670.15	134.03
		6	10.55	645.05	129.01
4.	Gingelly oil cake	2	10.57	655.15	131.03
		4	10.87	640.27	128.05
		6	10.96	635.55	127.11
5.	Control		11.13	633.67	126.73
	SED		0.027	0.366	
	CD (P = 0.05)		0.057	0.763	

Table 4: Effect of organic amendments on yield performance of *Pf* × *Po*

S. No	Amendments	Conc. (% Dry weight basis)	Days for first harvest	Yield (g/bed)	Bio-efficiency (%)
1.	Rice bran	4	12.67	600.73	120.14
		6	12.33	615.15	123.03
		8	12.47	602.28	120.45
2.	Wheat bran	4	12.87	598.36	119.67
		6	12.67	611.15	122.23
		8	12.55	601.67	120.33
3.	Groundnut oil cake	2	11.87	620.00	124.00
		4	11.67	642.00	128.40
		6	12.00	618.33	123.66
4.	Gingelly oil cake	2	12.00	622.33	124.46
		4	12.15	615.67	123.13
		6	12.45	608.25	121.65
5.	Control		13.45	593.25	118.65
	SED		0.137	0.548	
	CD (P = 0.05)		0.285	1.144	

treatments tested with all the isolates studied. Groundnut oilcake at four per cent was found to be superior than all other amendments tested with all the isolates studied.

The results presented in table 1 revealed that addition of groundnut cake at 4 per cent conc. hastened the time

Table 5: Effect of organic amendments on yield performance of *P. eous (Pe)*

S. No	Amendments	Conc. (% Dry weight basis)	Days for first harvest	Yield (g/bed)	Bio-efficiency (%)
1.	Rice bran	4	12.67	583.78	116.75
		6	12.33	590.67	118.13
		8	12.49	575.25	115.05
2.	Wheat bran	4	12.49	575.25	115.05
		6	12.69	585.25	117.05
		8	12.65	557.47	111.49
3.	Groundnut oil cake	2	11.89	600.67	120.13
		4	11.69	625.76	125.15
		6	12.00	601.47	120.29
4.	Gingelly oil cake	2	12.00	595.25	119.05
		4	12.15	560.15	112.03
		6	12.47	559.27	111.85
5.	Control		13.47	555.17	111.03
	SED		0.005	0.366	
	CD (P = 0.05)		0.010	0.763	

taken for the first harvest of sporophore (10.85 days) and increased the yield of *Pc* × *Pe* (660.45 g/bed) and bio-efficiency (132.09 %) to the maximum which was followed by gingelly oilcake at 2 per cent (633.43 g/bed and 126.68 %). The minimum yield was obtained with wheat bran at 4 per cent level (614.95 g/bed) further which delayed the days (11.80) required for the first harvest.

With regard to the yield performance of *Pc* × *Pfl* (Table 2), minimum days for the first harvest (11.33 days) and a maximum sporophore yield of 650.15 g/bed and was obtained in the treatment with addition of groundnut oilcake at 4 per cent followed by gingelly oilcake at 2 per cent (625.38 g/bed). Among the additives tested, rice bran at 8 per cent recorded the maximum days for first harvest (12.67) and minimum yield (605.28 g/bed).

The isolate *Pe* × *Po* recorded the minimum 10.45 days required for the first harvest and maximum yield of 670.15 g/bed when paddy straw was supplemented with 4 per cent groundnut oilcake. The addition of rice bran at eight per cent level recorded the lowest yield among the additives tested (Table 3).

The results presented in table 4 revealed that the addition of groundnut oilcake 4 per cent increased the yield of *Pf* × *Po* to a maximum of 642.00 g/bed and also reduced the days (11.67) required for the first harvest. This was followed by gingelly oilcake at 2 per cent (622.33 g/bed) and rice bran at six per cent (615.15 g/bed).

P. eous recorded the maximum yield of 625.76 g/ bed when paddy straw substrate was supplemented with 4 per cent groundnut oilcake and also significantly reduced the days (11.69) required for the first harvest. Supplementation with gingelly oilcake @ 2 per cent ranked next and recording a yield of 595.25 g/bed. It is also noted that the supplementation of wheat bran generally reduced the yield and increased the days taken for the first harvest when compared to other additives tested (Table 5).

Discussion

Addition of organic amendments increased the yield of multispore isolates. In the present study, groundnut oilcake at 4 per cent and gingelly oilcake at 2 per cent increased the yield of all the multispore isolates. Rice bran (6 %) and wheat bran (6 %) also increased the yield of all the multispore isolates (Table 1 to 5). These findings are in conformity with that of Bahram (1989) and Jandaik (1989), who obtained increased yield of *Pleurotus* spp. by the supplementation of organic amendment (wheat bran) to paddy straw.

Ross (1968) reported that these organic additives were more constant and safe to be used for increasing mushroom yields. The supremacy of horsegram flour due to induction of cellulase was one of the critical factors responsible for increased yield (Ramasamy and Kandasamy, 1976). Neemcake as well as rice bran at 5 per cent hastened the spawn run, maturity of sporophore and increased the yield of *P. citrinopileatus, P. platypus* and *P. sajor-caju* (Marimuthu *et al.,* 1994). Supplementation with pigeonpea dhal powder at 5 % on dry weight basis during spawning gave the highest number of sporophores and yielded maximum biological efficiency in *P. sajor-caju, P. flabellatus. P. ostreatus* and *P. cystidiosus* (Dubey, 1999).

An excellent performance of neemcake as additive was reported by Marimuthu *et al.,* (1994). Paddy straw substrate supplemented with wheat bran and rice bran have also recorded higher yield of mushroom (Hazarika, 1998). Likewise, various workers have reported increased mushroom yield due to addition of organic substances to the substrate (Eswaramurthy *et al.,* 1983; Sivaprakasam, 1986; El-kattan *et al.,* 1991; Srivastava and Singh, 1999). All these reports add value to the present findings. Perhaps the level of nitrogen content might be one of the most important craterous to decide the positive effect of these organic additives in improving the yield of oyster mushrooms as observed by Marimuthu *et al.* (1991).

Conclusion

In the present study, groundnut oilcake at 4 per cent and gingelly oilcake at 2 per cent increased the yield of all the multispore isolates. Rice bran (6 %) and wheat bran (6 %) also increased the yield of all the multispore isolates. The oyster mushroom grew profusely in different substrates supplemented with various organic additives which could be due to the presence of more natural and homologous materials.

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