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RESEARCH ARTICLE

ECONOMIC ASSESSMENT OF THE USE OF MICROBIAL INOCULANTS IN BLACK PEPPER (PIPER NIGRUM L.) IN IDUKKI DISTRICT

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ABSTRACT

The research entitled 'Economic assessment of the use of microbial inoculants in black pepper (Piper nigrum L.) in Idukki district was conducted with the objectives of quantifying the extent of use of microbial inoculants (MI) used in black pepper, to assess the economics of microbial inoculants (MI) application and to identify the constraints of microbial inoculants adoption in pepper cultivation. Present research revealed that by using MI, farmers could reduce the use of chemical fertilizers and pesticides; thereby they could reduce the cost of cultivation and increase profitability. 3Excess adoption of MI was prominent among the users and proper guidance is required to the farmers on the application of recommended dose of microbial inoculants along with adequate availability of all types of microbial inoculants.

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INTRODUCTION

The continued and indiscriminate use of chemical fertilizers and pesticides for enhanced soil fertility and crop productivity resulted in unexpected harmful environmental effects. In order to maintain agricultural productivity along with sustainable ecosystem, integrated management for nutrients, diseases and pests can be advocated. The advent of intensive farming and its prevalence in Kerala for the past 50 years have resulted in the decline in beneficial micro-organism, loss of soil fertility and vitality, collapse of the sustainable agricultural system, soaring of cost of cultivation, health hazards and challenged food security and food safety. Recently the farmers of Idukki district are switching in favour of organic pepper production. The importance of organic farming and residue free commodities would certainly warrant increased adoption of the microbial inoculants. Black pepper renowned as the 'King of Spices' and also termed as 'Black gold' is one of the most important spices contributing to commerce and trade in India since pre-historic period. Kerala accounts for 80-90% of the total black pepper production in the country. Idukki and Wayanad are the two major pepper producing districts in Kerala. Microbial inoculants (MI) are plant growth promoting beneficial endophytes (microbes) that can be used as agricultural amendments. Microbial inoculants offer a biological protective covering capable of mobilizing nutrients from unavailable form to available form. The production of bio-inoculants in India was reported as 20,040.35 tons in 2009-10 and Kerala is the third major producer with a share less than 10 per cent (Devi 2014). The MI used in the study area were *Pseudomonas, Trichoderma*, *Beauveria, Lecanicillium, Paecilomyces,* PGPRs (Plant growth promoting Rhizobacteria) and PSB (Phosphorous Solubilizing Bacteria).

Jerome (1991) analyzed that the growth performance of area under black pepper in Kerala was characterized by swinging and stagnations. Lack of institutional support, traditional methods of cultivation, pests and disease attacks were the core reasons for the stagnant yield. Analysis pointed out trends in farm, wholesale and export prices of pepper showed high degree of instability and year-to-year fluctuations. The study stressed the importance of intensive cultivation of pepper in future rather than extensive one. Black pepper when treated with the Plant Growth Promoting Rhizhobacteria (PGPRs) showed enhanced nutrient mobilization in the rhizhosphere and it exhibited significant uptake of Nitrogen (N) and Phosphorous (P) that resulted in improved plant growth and better root proliferation (Diby *et al*., 2005). Supanjani*et al.* (2006) reported that mineral availability, mineral uptake and plant growth of black pepper and cucumber were increased by the application of *Bacillus megatherium var phosphaticum*and potassium solubilizing bacteria *Bacillus mucilaginosus* to nutrient limited soil. The major restraints in adoption of biological practices were lack of knowledge and skill for determining Economic Threshold Level (ETL) (89%), non-availability of bio-control agents and bio fertilizers (91%), lack of knowledge about bio fertilizers (73%), lack of knowledge about untoward effect of chemical pesticides (32%) (Verma, 2006) The economicsand yield parameters of *Withaniasomnifera*(Ashwagandha) using dual inoculation of *Azotobacter chroococcum* and *Pseudomonas putida*was studied byKumar *et al.* (2008). The crop with the inoculants obtained a root yield of 1185.6 kg per ha. Cost of cultivation was calculated as Rs. 54,500 per ha and the gross returns estimated was 1, 45,000 per ha. Rosli *et al*. (2009) studied that pepper farms in Sarawak, Malaysia were technically inefficient due to the mean of technical efficiency of pepper farms were low. The study observed that misallocation of farm resources and inappropriate farm management practices were the reasons for inefficient production. Hence they did not minimize cost and maximize profit, this inefficient pepper farms could not produce pepper yield at maximum level. In a study on influence of microbial inoculants on black pepper cultivation under organic conditions by Vlahova (2013) revealed that the use of bio inoculants led to increase in yield of the black pepper by 8% to 39%. According to Nair (2014) *Trichoderma* spp. *and Pseudomonas fluorescens*, which were antagonistic microbes, assisted in decreasing *Phytophthora* foot rot of black pepper. Application of *Trichoderma harzianum* around the base of the vine at the rate of 50g / vine had the capacity to reduce the disease incidence.

MATERIALS AND METHODS

The study was conducted in Idukki district which is the major producer of black pepper. Two development blocks in the district Kattappana and Nedumkandam with maximum area under pepper cultivation were selected for the study. From each Panchayath, 15 farmers adopting microbial inoculants in black pepper cultivation and 15 farmers following conventional pepper farming were selected randomly. Thus the total sample size was 60 (30 adopting and 30 non adopting farmers).

A B C Cost Concept

The Cost A_1 includes

- Cost of hired labour
- Cost of manures, fertilizers and soil ameliorants
- Cost of microbial inoculants
- Cost of plant protection chemicals
- Cost of tying and shading material
- Land revenue
- Depreciation
- Maintenance cost of equipment and machineries
- Interest on working capital
- Miscellaneous cost

Cost A_1
Cost A_1 + rent paid for leased-in land.
Cost B
Cost A_2 + rental value of owned land & interest on owned fixed capital excluding land.
Cost C
Cost B + imputed value of family labour.
(CSO, 2008)

Resource Use Efficiency: Cobb-Douglas production function has been fitted to the collected data in order to describe the relationship between the output and various inputs used in production. From the production function, elasticities of production of inputs were worked out.

$$Y= a\prod_{i=1}^{5}(X_i^{b_i})e$$

The algebraic form of Cobb- Douglas production function is

$$Y= \log Y = \log a + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + b_4\log X_4 + b_5\log X_5 + \log e$$

Where,

Y = Quantity of output (kg / ha)
X_1 = Number of bearing vines / ha
X_2 = Hired labour / ha
X_3 = Family labour / ha
X_4 = Quantity of MI (kg/ha for MI using)/ quantity of plant protection chemicals (For conventional)
X_5 = Quantity of manures (kg/ha)
a = Intercept
$b_1 \ldots b_5$ = Regression coefficients of explanatory variables.

Constraint analysis-Garret's Ranking Technique

Per cent position = 100 x (R_{ij} - 0.5) / N_j
R_{ij} = Rank given for i^{th} factor by j^{th} farmer.
N_j = Number of factors ranked by the j^{th} farmer (Garret, 1969)

RESULTS AND DISCUSSION

The average adoption of the different MIs per vine was worked and compared the same with the recommendation of KAU (Table 1). In the case of black pepper, for pepper vine pretreatment, *Pseudomonas* (375g/vine) was used above recommended rate of 250 g/vine and *Trichoderma* 2kg/vine, which was used less than recommended rate,5 kg/ vine. PGPR I and II, *L. lecani, B. bassiana, P. lilacinus*were used over the recommended rate. It was observed that all the microbial inoculants for all the treatments like Pre - vine treatment, soil application and foliar application were used over recommended rate except *T. viridae.*From the table 1, it can be seen that the farmers are wasting MI and money by applying large quantity of MI to the soil. This shows the necessity of more extension activities among farmers for the proper adoption of MI.

Table 1. Average adoption of MI

Particulars	Recommendation for black pepper			Adoption by pepper farmers		
	Pre - vine treatment	Soil application	Foliar application	Pre - vine treatment	Soil application	Foliar application
P. flourescens	250g/ vine	20g / vine drenching	20g/ l	375 g /vine	45 g/ vine	40g/l
T. viridae	-	5 kg/vine	-	-	2 kg/vine	-
PGPR I & II	-	2 g/ l per vine	-	-	5g/l per vine (5%)	-
L. lecani	-	-	10g / l	-	-	30 g/l
B. bassiana	-	-	10g / l	-		40 g/l
P. lilacinus	-	20g/vine	-	-	50g/vine	-

(KAU, 2011)

Table 2. Distribution of respondents based on dosage of MI used

Particulars	*P. flourescens*	*T. viridae*	*B. bassiana*	*L. lecani*	*P. lilacinus*	PGPR I&II	Total
Below recommended dose	1 (7.7)	8 (100)	0	0	0	0	9(30)
Recommended dose	2(15.4)	0	0	0	0	0	2(7)
Above recommended dose	10 (77)	0	4 (100)	2 (100)	1 (100)	2 (100)	19(63)
Total	13 (43)	8 (27)	4 (13)	2 (7)	1(3)	2 (7)	30(100)

Table 3. Annual maintenance cost of black pepper using MI and conventional – a comparison

Particulars	MI using pepper Cost (Rs/ha)	Conventional pepper Cost (Rs/ha)
Cost A_1	133797.24	155720.64
Cost A_2	164938.79	191359.53
Cost B	262495.13	383659.87
Cost C	295050.13	439399.87

Table 4. BC Ratio

Particulars	MI using	Conventional
Cost A_1	3.97	3.47
Cost A_2	3.22	2.82
Cost B	2.02	1.40
Cost C	1.80	1.23

Table 5. Production constraints of MI using farmers

Constraints	Garret's score	Rank
Less availability of microbial inoculants other than *Pseudomonas* and *Trichoderma*	63.41	2
Difficulty in proper identification of pests and diseases	70.36	1
Gall wasp attack of standards	51.68	5
Climate change	53.30	4
High cost of PP chemicals	46.98	7
Lack of support from agricultural institutions	47.96	6
Difficulty in availing institutional credit	37.95	8
Difficulty in intercultural operations	34.41	9
High price of MI	30.71	10
Lack of knowledge about correct dose, method and time of application of MI	60.54	3

Table 6. Technological constraints

Constraints	MI using		Conventional	
	Garret's score	Rank	Garret's score	Rank
Late adoption of new generation chemicals	-	-	63.15	1
Lack of knowledge about MI	49.75	3	-	-
Lack of awareness about practical utility of novel technologies	63.71	1	-	-
Lack of technical expertise on MI	57.71	2	-	-

It was observed from table 2 that 63 per cent of adopters used MI above the recommended dose and 30 per cent used below recommended dose. Only7 per cent adopters used it in recommended dose. It was clear from the table that except *T. viridae* all other MI were used over than recommendation. *T. viridae*was used 100 per cent below recommended rate. As shown in table 3, Cost A_1 of conventional farmers was Rs. 21923.4 ha^{-1} higher than that of MI users. Major portion of Cost A_1 was contributedby cost of hired labour and cost of manures, fertilizers and plant protection chemicals. For conventional farmers cost of hired labour, manures and fertilizers were comparatively high when compared to MI users. Cost C of conventional farmers was Rs. 144349.74 more than MI users. Returns generated per rupee invested were found slightly more (3.97) for MI using farmers and it was 3.47 for conventional farmers on cost A_1 basis (table 4). This slight change was due to a low cost A_1 owing to the maximum usage of manures and no use of chemicals such as fertilizers and plant protections. The higher price recovered by MI using farmers was also contributed to a large benefit cost ratio when compared to conventional farmers. However the benefit cost ratio on cost C basis was more than one for both the categories of farmers. There was not much variation observed in the establishment cost between MI using and conventional farmers.

The major production constraint faced by MI users was difficulty in proper identification of pests and diseases followed by less availability of microbial inoculants other than *Pseudomonas* and *Trichoderma* and lack of knowledge about correct dose, method and time of application of MI. climate change and gall wasp attack on standards were also important challenges faced by MI using pepper farmers (table 5). As shown in table 6 lack of awareness about practical utility of novel technologies and lack of technical expertise on MI were the two major technological constraints of MI using farmers. Lack of proper knowledge about MI was also a challenge. Late adoption of new generation chemicals was the serious technological constraint faced by conventional pepper growers.

CONCLUSION

Present research revealed that by using MI, farmers could reduce the use of chemical fertilizers and pesticides; thereby they could reduce the cost of cultivation and increase profitability. From this study it was obvious that KAU technologies should propel more and cover large area, and then only it becomes a success. Mere adoption does not give 100 percent success and profit. Whenever a technology becomes a habit to farmer, there lies its potential. Excess adoption of MI was prominent among the users and proper guidance is required to the farmers on the application of recommended dose of microbial inoculants along with adequate availability of all types of microbial inoculants

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