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RESEARCH ARTICLE

IMPACT OF CSR BIO - AN ECO-FRIENDLY BIO-GROWTH ENHANCER ON INCREASING THE PROFITABILITY OF HORTICULTURAL CROPS TO SMALL AND MARGINAL LAND HOLDERS

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ABSTRACT

The profitability of commercial crop production system in the current agricultural scenario of developing countries is being commonly encountered with problems of increasing input cost, diminishing marginal returns and negative drift of ecological balance due to indiscriminate use of plant protection chemicals. To overcome these problems a cost effective bio-growth enhancer CSR BIO was developed under National Agricultural Innovation Project and was intervened in the Barabanki district of Uttar Pradesh which is one of the disadvantaged district designated by planning commission of India. The current study looked into the profitability of the formulation in commercial crops like tomato and banana with its impact on reducing use of chemical protection chemicals toxic to the environment. This investigation was carried out by descriptive survey from 2010 to 2013. Results showed an overall increase in yield up to 22.43 and 15.62 % in the adopters of tomato and banana which simultaneously increased the gross profitability to 20.11 and 17.39 % in banana and tomato, respectively. The study also showed the change in expenditure incurred in production and also in the use of plant protection chemicals which was 47.33 and 33.36 % lower than the non-adopters who didn't practiced the technology. The results of this study furthermore indicates that assessing the impact of the eco-friendly cost effective technologies like CSR BIO would be a critical component of agricultural research as it helps to define priorities of research and guide researchers and those involved in technology transfer to have a better understanding of the way new technologies are assimilated and diffused into farming communities.

INTRODUCTION

Outstanding agricultural technologies developed in research stations do not necessarily perform identically under farmers' fields, where there is a high variability in environmental factors which are normally beyond the control of farmers (Jayamanne *et al.*, 2002). The cultivation of high value commercial crops is now being even adopted by small land holders apart from bigger and richer farmers of developing countries (Dev and Chandrashekar, 2004). The poor households with the hope of higher income adopt cultivation of commercial crops using pesticides and chemical fertilizers indiscriminately to get immediate benefit and being unaware of the decline in the productivity and increase in the expenditure over the period of time (Damodaran *et al.*, 2011). In environmental terms, the impact of pesticide on wild life, natural enemies and pollinators is a serious problem and also the cost of pesticides increases the expenditure of small and poor landholders (Kamanula *et al.*, 2011). Keeping this in consideration an eco-friendly bio-growth enhancer was developed under a strategic research project funded by National Agricultural Innovation Project of Indian Council of Agricultural Research (ICAR) with the support of World Bank. The product is a unique of its kind produced by using consortia of microbes CSR-B-2 (*Bacillus pumilus*), CSR-B-3 (*Bacillus thuringensis*) and CSR-T-1 (*Trichoderma harzianum*) cultured on dynamic eco-friendly patented media (Damodaran *et al.*, 2013). The bio-stimulant acts as a nutrient mobilizer, soil vitalizer, plant protectant against soil born diseases and growth enhancer for crops grown in normal and alkaline soils (Damodaran *et al.*, 2013a). This technology was intervened in two blocks of Barabanki district in Uttar Pradesh, India to the small and marginal farmers through training and demonstration. Impact assessment of public agricultural research has always been considered as a primary activity to ensure accountability, maintain credibility and improve decision making process (Manyong *et al.*, 2001). Recently, more emphasize has been put on determining whether bio-formulations are environmentally better or not, while less importance has been shown to assess whether organic formulations could be economically attractive enough to trigger wide spread adoption (Nemes, 2009). Profitability of the technology is generally one of the most accepted indicators for the success of an intervention (Offermann and Nieberg, 2000). Since the intervention of this innovative technology in different crops like banana and tomato, no attempt has been made to evaluate its impact in increasing the yield, net farm income and pesticide use pattern. The main aim of the paper is to assess the change in income, expenditure on the use of pesticide / fungicide pattern of adopters and non adopters of CSR-BIO technology and to identify the social status of the adopters.

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MATERIALS AND METHODS

Study Area

The present study was carried out under World Bank funded ICAR research project of National Agricultural Innovative Project, Component- III in the Barabanki district of U.P. This district was included in the 150 disadvantaged districts of the country identified by Planning Commission of India. The district was selected based on

their poor standard of living due to limited livelihood opportunities. The present technological intervention of CSR BIO was made in banana (bio-priming in primary hardening stage; soil application at planting and 5th month after planting followed by foliar spray at 7th and 9th month after planting) and tomato (seed or corm priming; soil application at a week before first fertilization and foliar application at critical stages of the crop).

Data design

The data used in this study were collected in face-to-face interviews with adopters and non adopters of CSR-BIO in two major banana and tomato growing areas of the Barabanki district (Trivediganj and Haidergarh) during two growing seasons of the year 2011-12 and 2012-13 Fig. 1. A structured questionnaire was designed and used in the collection of data from the respondents. Data were collected from 100 adopters and 100 non-adopters of the CSR BIO technology in tomato var. Himsona (Syngenta Hybrid Seeds, India) and banana var. G-9 (Hindustan Bioenergy Ltd., India). The distribution of the respondents is furnished in Table 1.

The respondents' were selected based on the similar socio-economic conditions and land holding. The survey instruments consisted of questions where respondents were asked information about production, perceived yield losses, expenditure incurred in production (input cost, irrigation cost, labour cost including family labour, land lease cost if not cultivated and depreciation cost of farm implements and farm implements rental and repair cost), use of pesticide / fungicide and gross income obtained at the end of the growing season. The gross income was the farm gate prices that are obtained by selling the produce obtained from the individual crops during the season. The data regarding the land holding status, age and education of the adopters and non-adopters were also collected to assess the social status of the surveyed population. Survey was restricted to adopters and non-adopters who had similar land fertility status and market. Frequencies, means and standard deviation and independent T test were used for testing the significance at $P = 0.01$ between adopters and non adopters. All the analysis was carried out using SAS 9.2 software.

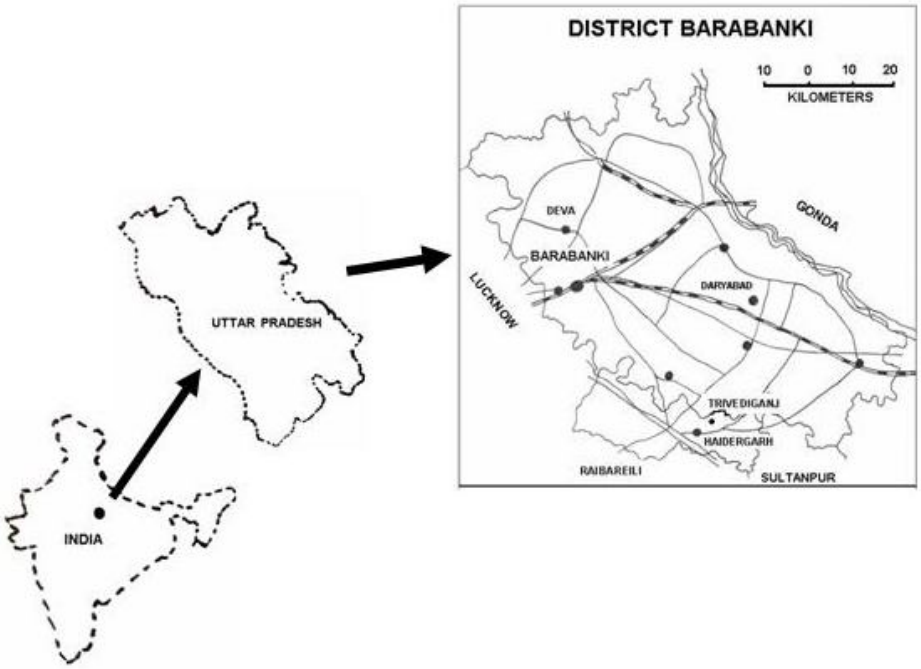

Fig. 1. Location map of the study area

Table 1. Distribution of the respondents by block

Block	Distribution of respondents for CSR BIO in tomato		Distribution of respondents for CSR BIO in banana	
	Adopters	Non Adopters	Adopters	Non Adopters
Trivediganj	58	55	52	45
Haidergarh	42	45	48	55
Total	100	100	100	100

Table 2. Impact of CSR BIO on profitability and environment among the adopters and non-adopters in banana (N=100)

Parameters	*Group	Mean	Standard Deviation (SD)	Significance ($P = 0.05$)	Standard Error Difference (SED)
Yield	1	31.533	4.612	0.030	1.867
	2	27.266	5.574	0.030	1.867
Expenditure	1	0.647	5.522	0.006	2.026
	2	0.707	5.574	0.006	2.026
Income	1	2.782	0.393	0.013	0.157
	2	2.366	0.464	0.013	0.157
Pesticide	1	7.333	1.195	0.004	0.658
	2	11.067	2.250	0.005	0.658

*1= adopters; 2= non adopters

RESULTS

Banana

The findings of the survey data analyzed using Independent T test indicated existence of significant differences between adopters and non adopters with respect to yield of banana (Table 2**)** obtained due to intervention, expenditure incurred in production of the crop, income obtained and chemical pesticide / fungicide used during the cropping period as plant protection measures. The mean bunch yield of 31.53 kg was obtained with adopters while the non-adopters obtained a mean bunch yield of 27.27 kg. The mean expenditure incurred in production was Rs. 0.64 lakhs among the adopters while among the non-adopters the mean expenditure was Rs. 0.70 lakhs. Adopters gained an average gross income of Rs. 2.78 lakhs from one acre while the non adopters obtained a gross profit of Rs. 2.36 lakhs from one acre of crop. Adopters sprayed their crops with pesticide / fungicide combination for 7.333 times while the non adopters used chemical sprays for 11.067 times.

Tomato

There is clearly a pronounced effect by the use of CSR-BIO on the yield, expenditure, income and pesticide use in tomato (Table 3) crop. There existed significant difference between the adopters and non-adopters with respect to the yield obtained from the crop, expenditure incurred in production and gross income obtained from the adopters and non- adopters of the technology. The adopters obtained a mean yield of 19.64 tonnes / acre while the non-adopters obtained 16.05 tonnes / acre. The mean expenditure incurred in production was Rs. 37,000/- among adopters while the non adopters incurred Rs. 41,000/-. The gross return obtained was Rs. 2.21 and Rs. 1.84 lakhs between adopters and non-adopters respectively. An average of 6.533 sprays was given to the crop during its growing period by the adopters while the mean spray used by non adopters was 12.400 times.

Table 3. Impact of CSR BIO on profitability and environment among the adopters and non-adopters in tomato (N=100)
***1= adopters; 2= non adopters**

Parameters	*Group	Mean	Standard Deviation (SD)	Significance (P = 0.05)	Standard Error Difference (SED)
Yield	1	19.640	4.079	0.004	1.137
	2	16.053	1.663	0.005	1.137
Expenditure	1	0.378	4.224	0.026	1.414
	2	0.412	3.489	0.026	1.414
Income	1	2.216	0.448	0.008	0.130
	2	1.845	0.229	0.010	0.130
Pesticide	1	6.533	1.567	0.001	0.569
	2	12.400	1.549	0.001	0.569

Social status

The social status analysis (Table 4) of the adopters showed that 77 % of banana and 82 % of tomato farmers were small land holders with an average land holding < 1 ha / family. Among the adopters 52 % of banana and 48 % of tomato respondents were in the age group of 30 – 50 years old. Similarly, 83 % of banana and 68 % of tomato adopters were literate up to secondary school and above while the rest were educated up to primary level.

Table 4. Personal and Social Characteristics of CSR BIO adopters (N = 100 for each tomato and banana)

Characteristics group	Adopters of banana (%)	Adopters of tomato (%)
Age:		
(20-30 years)	14	17
(30-40 years)	52	48
(40-50 years)	23	19
(50-60 years)	11	16
Land holding:		
< 1 ha	77	82
> 1 ha	23	18
Educational status:		
Primary level education	27	32
Secondary level and above	83	68

DISCUSSION

Impact of agricultural research technology in field conditions is a continuous process (Mayong *et al*., 2001). Success or failure of any technology is mainly attributed to its economic feasibility and economic profitability (Canavari *et al*., 2007). The technology that sustains the economic profitability will change the poverty status of the region if backed with strong eco-friendly scientific principle (Nemes, 2009). Ex-post impact assessment is usually conducted to evaluate the impact of the technology on the farm income after its adoption over a wider area (Bantilan and Dar, 2001). The current study is one such kind where the economic feasibility and profitability along with impact on environment was assessed to one of the unique and a novel bio-formulation CSR-BIO which was developed using a consortia of dynamic microbes (Damodaran *et al*., 2013b) cultured in an dynamic organic growth media modeled to increase the substrate dynamism when integrated with the soil in cultivation of commercial crops. The present study indicated 22.43 % and 15.62 % increase in yield of tomato and banana respectively, for the adopters of CSR-BIO technology. Application of selected antagonist and PGPR agents either individually or in combination significantly increased the yield of tomato (Niknejad *et al*., 2000; Zaghloul *et al*., 2007). The increase in yield resulted in the increase of gross income of the adopters to 20.11 % and 17.39 % in tomato and banana respectively over non-adopters (Fig. 2). Earlier, increase in gross income of small land holdings due to intervention of *Trichoderma* was observed by Truc *et al*. (2012). The increase in yield witnessed is basically due to increase in nutrient mobilization of the crop from the rhizosphere soil which has been enabled by the inoculated microbial consortia present in CSR-BIO to harness the nutrients from various soil strata. The treatments with growth promoting bacteria enhance the uptake of nutrients through biological processes (Hanafy-Ahmed *et al*., 1995). In the present study, it was observed that the expenditure incurred in crop production has been reduced with the use of CSR-BIO among the adopters to about 9.76 % in tomato and 8.45 % in banana. The reduction in the input cost was witnessed due to the reduced fertilizer and plant protection applications in the crop. Similar reports were evidenced in organic system when compared with existing system

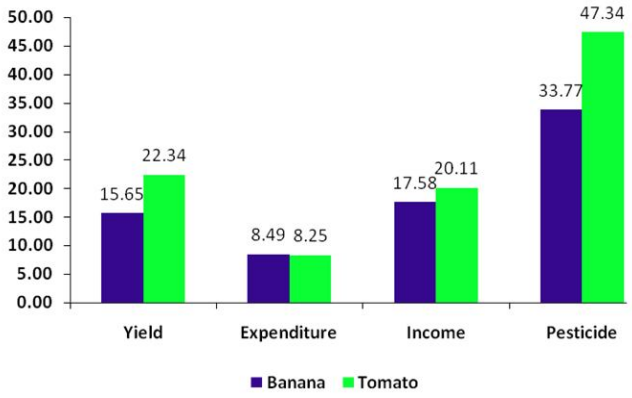

Fig. 2. Percent change in profitability and pesticide use of adopters over non-adopters in banana and tomato

where the low input cost compensated the yield loss in organic system (Chase *et al*., 2008). It was observed in the current study that there was a reduction in the use of pesticide / fungicide to about 47.34 % in tomato and to about 33.77 % in banana. The reduction in use of pesticide / fungicide was due to the bio-control potential of the microbial consortia in the soil and foliar parts of the respective crops. Use of *Trichoderma harzsianum* as a biocontrol agent reduces the use of fungicide and protects the environment from exposure to harmful chemicals (Sharma, 2011; John *et al*., 2010). Technologies reducing the use of chemical insecticides and fungicides protects the environment from the toxic chemicals thereby reducing the risk of dreadful disease like cancer and diseases relating to central nervous system failure Spraying on bananas plantations with chlordecone in French Carribean islands initially led to higher crop yields but later as a consequence, this tropical paradise with about 800,000 inhabitants now faces an environmental disaster with far-reaching ecological, economical and social impacts (Coat *et al*., 2006). The technology had attributed in saving of expenditure incurred in crop production and simultaneously it has also helped in protecting the environment and the end users from residual toxicity effects of the chemicals used as plant proctectants. The reduction in spray of pesticides / fungicides helped in harbouring more predators' population in the eco-system which may enable the functioning of normal bio-cycle in nature. The social status analysis of the adopters showed that the small landholder in the age group of 30-40 with secondary level and above education got motivated which helped them to harness the maximum economic returns with the adoption of cost effective CSR-BIO technology.

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