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INTEGRATED PEST MANAGEMENT PRACTICES ADOPTED BY MANGO GROWERS AT MEHERPUR REGION IN BANGLADESH

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ABSTRACT

A study on integrated pest management (IPM) practices adopted by the mango growers was carried out at Mujibnagar Upazila under Meherpur district of Bangladesh during August-September 2018 using structured questionnaire. Randomly selected 112 mango growers were used for the study. Results indicated that 75.9% of the respondents were highly adopted with IPM practices during mango cultivation. According to IPM Practices Use Index (IPUI), harvesting at right stage was ranked 1st and use of sex pheromone trap was ranked 10th as commonly used IPM tactic by the growers. The use of logistic regression model in this study was identified as the significant factor of IPM adoption, explore several factors, including contact with IPM club, IFMC and Farmers Field School (FFS) and annual income from mango cultivation.

Keywords: Mango growers, Adoption, IPM practices

INTRODUCTION

Global food production is seriously affected by several biotic and abiotic factors and insect-pests and diseases are the most limiting factors for crop production (Wilson, 2001). On an average, about 32% of the world food production is lost due to insect-pests and disease infestation every year (Dhawan et al., 2010). Among all of the fruits, Mango is the king of fruits. It is very delicious and attractive fruit. Rajshahi, Satkhira, Jashore, Meherpur, Khulna are major growing areas of mango in Bangladesh. It shares about 25.22% of the garden area in Bangladesh and the total land under mango cultivation is 1,03,000 acres of and the total yearly production is about 12,88,000 metric tons (BBS 2018).

In Bangladesh, mango production is seriously decreased due to the attack of insect pests and disease organisms (MOA, 2014). Only, the mango hoppers may cause a loss of 20-100% of the inflorescence (Khan et al., 2007). As a result, to ensure desire

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production or to minimize loss due to pest infestation in mango, there is a tendency of farmers to use repeated application of toxic chemical pesticides in mango orchards across the country.

Indiscriminate use of harmful pesticides not only creates environmental and health hazards, also promotes development of pest resistance to pesticides, destroys beneficial insect, upsets the balance between the pests and their natural enemies leading to the increase in the population of the target pests and even the creation of new pest problems (Wilson and Tisdell, 2001; Caracciolo and Lombardi, 2012; Macharia et al., 2013). As well as the non-judicious use of pesticides cause environmental pollution through adulteration of soil surface, ground and surface water (Kabir and Rainis, 2012). To avoid such consequences and at the same time to increase the crop production on a sustainable basis, a viable alternative to sole dependence on chemical pesticides is integrated pest management (Zul-Ekram, 2014; Anderson et al.,1996; Migliore et al., 2012; Del Giudice et al., 2018). IPM maintain social, economical and environmental dimension of sustainability (Kabir and Rainis. 2013)

Implementation and adoption of an IPM strategy can help to reduce environmental and human health risks and pest management costs. Considering the importance of IPM practices, the present study was undertaken to focus on determining the extent of adoption of IPM practices by mango growers as well as identifying the factors that influenced the adoption of IPM practices in mango cultivation at Meherpur region in Bangladesh.

MATERIALS AND METHODS

Study area

The study was conducted during August-September 2018 at Mujibnagar Upazila under Meherpur district, Bangladesh. The total area of Mujibnagar Upazila was 112.68 square kilometers and the total population was 99,143 (BBS, 2015). There were 12 blocks with 32 villages under 4 unions of this Upazila. Out of 32 villages, 12 villages were randomly selected for the study. The map of the study area was presented in Figure 1.

Data collection procedure

Data were collected from the respondents through the personal interview schedule with Structered questioniare during August 1, 2018, to September 30, 2018. A complete list of the farmers of these villages was collected from the Upazila agriculture office. The total number of mango growers of these villages was 1218. According to Yamane's (1967) formula, 112 sample was determined randomly, in which the precision level was considered 9%. Finally data were collected from112 mango growers carefully and randomly with the help of the agricultural officer of Meherpur upazila, Bangladesh.

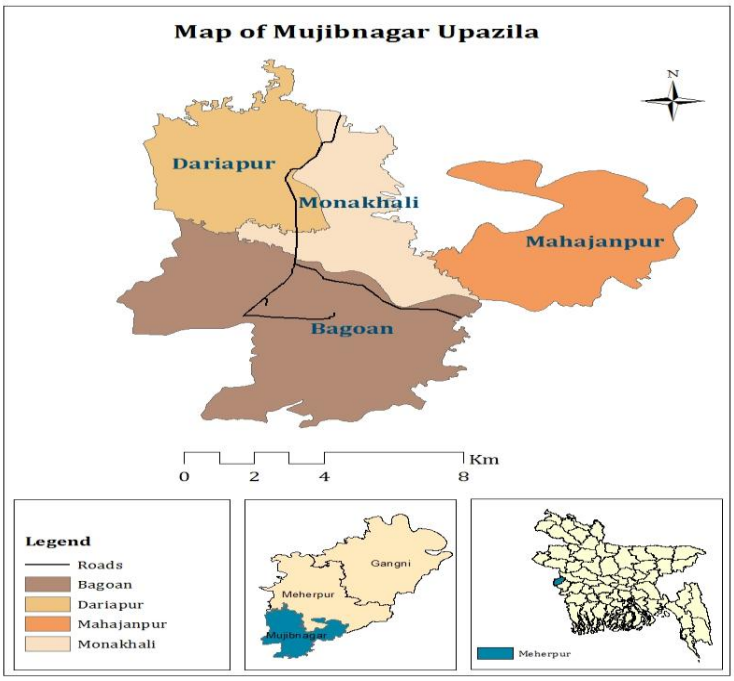

Figure 1. Map of Mujibnagar upazila under Meherpur district showing the study area

Selection of independent variables

The independent variables were some of the selected characteristics of the respondents. The characteristics were age, educational qualification, family size, farm size, land under mango cultivation, annual family income, annual income from mango cultivation, time spent in mango orchard, knowledge on IPM practices in mango cultivation, organizational participation, contact with IPM club, IFMC and FFS, cosmopolitanism, extension media exposure, training exposure, attitude towards IPM practices in mango cultivation, knowledge on pesticide application. Their adoption of IPM practices in mango cultivation constituted the dependent variable of the study.

Measurement of dependent variables

Adoption of integrated pest management (IPM) practices by the mango growers were the dependent variable of the study. The commonly used IPM practices were determined from literature and discussion with IPM experts. The respondents were asked to identify their extent of using 10 selected IPM practices in terms of 'frequently', 'occasionally', 'rarely' and 'never' and the scores assigned in these responses were 3, 2 ,1 and 0 respectively. The total score of a respondent was calculated by summing up the scores obtained from the selected practices. The score

could range from 0 to 30. To compare among selected IPM practices used by the farmers, an IPM Practices Use Index (IPUI) was calculated using the following formula (Kamal et al., 2018),

$IPUI = N_f \times 3 + N_o \times 2 + N_r \times 1 + N_n \times 0$

Where,

IPUI = IPM Practices Use Index

N_f = Number of respondents rated the extent of adoption as frequently

N_o = Number of respondents rated the extent of adoption as occasionally

N_r = Number of respondents rated the extent of adoption as rarely

N_n = Number of respondents never adopted the IPM practices

The IPUI score could range from 0 to 336 where "0" indicated no use and "336" indicate the highest use of particular IPM practice.

Chi-square test

The chi-square statistic is commonly used for testing relationships between categorical variables. It tests the weather that the distributions of categorical variables differ from each other. The test statistic is a chi-square (χ^2) random variable defined by the following equation-

$$\chi^2 = \sum \frac{(O_{r,c} - E_{r,c})^2}{E_{r,c}}$$

Where $O_{r,c}$ is the observed frequency count at level r of a variable and level C of another variable, and $E_{r,c}$ is the expected frequency count at level r of a variable and level C of another variable.

Logistic regression

Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level explanatory variables. The outcome in logistic regression analysis is coded as 0 or 1, where 1 indicates that the high adoption of IPM practices and 0 indicates that low adoption of IPM practices. The logistic regression model for identifying the influencing factors of IPM adoption is mentioned in the following:

$$\log\left[\frac{P}{1-p}\right] = XB + e$$

Where, p = Probability of the outcome, B is regression coefficient, X is independent variable, and e = random error term.

Data analysis

Data were analyzed using the concerned software Microsoft Excel and Statistical Package for Social Science (SPSS). Chi-square test was used to identify the association between independent variables with the adoption of IPM practices and logistic regression was used to determine the factors that influenced adoption of IPM practices.

RESULTS AND DISCUSSION

Adoption of IPM practices in mango cultivation

Adoption of commonly used IPM practices scores of the mango farmers ranged from 8 to 18 with an average of 11.99 with standard deviation of 2.15, respectively. According to the Adoption of commonly used IPM practices in mango cultivation, the mango farmers were classified into two categories as shown in Table 1.

Table 1. Distribution of the respondents according to their adoption of IPM practices

Categories & score	Respondents (N=112)		Mean	SD	Min	Max
	Number	Percent				
Low adoption (1-10)	27	24.1	11.99	2.15	8	18
High adoption (11-30)	85	75.9				
Total	112	100				

Where, SD= Standard deviation, Min= Minimum and Max= Maximum

Data presented in Table 1 revealed that 75.9% of the mango farmers had high adoption compared to low adoption 24.1%. The result indicated that the majority of the respondents had a high level of adoption of IPM practices. Kabir and Rainis (2015) conducted a study on the adoption and intensity of integrated pest management (IPM) vegetable farming in Bangladesh: an approach to sustainable agricultural development. They found that less than one-third of the farmers (30%) adopted IPM practices in vegetable cultivation. Ghimire and Kafle (2014) revealed that the majority (52.5%) of the farmers were satisfied with the IPM practice. The majority of the vegetable growers (63.7%) were falling under the medium adoption level of IPM practices (George et al., 2012). Haque et al. (2017) observed majority (61.6%) of the farmers had medium adoption of IPM practices in rice farming. About 50% of farmers' intentions to adopt integrated pest management practices in Serbia (Despotovic et al., 2019). Kamal et al. (2018) found more or less similar results in their previous study conducted to determine the adoption of IPM in vegetable cultivation. They found majority of the respondents had a medium level of adoption in commonly used IPM technology in vegetable production. The findings of the study also indicated that adoption of commonly used IPM practices by the mango growers

was considerably promising. Most of them used different practices related IPM practices frequently. It might be due to their considerable level of formal education, sound knowledge on IPM practices in mango cultivation, considerable level of cosmopolitanism, more knowledge on pesticide application which made their attitude favorable towards IPM practices. As a result, they adopted IPM practices more in mango orchard.

Comparison among adoption of the different IPM practices by the mango growers

IPM Practices Use Index (IPUI) was calculated to compare the adoption of different IPM practices in mango cultivation. The observed IPUI scores ranged from 7 to 336 where the IPUI could range from 0 to 336. Based on the calculated IPUI, it was found that harvesting at right stage was adopted by the farmers to the highest extent (336) and it was followed by the use of pesticides (300), clean cultivation/weed management (235) and use of healthy planting materials (219). On the other hands, practices like training and pruning (122) were adopted by the mango growers to moderate extent where practices like the cultivation of resistant variety (52), bagging (36), collection and destroy eggs and larvae by handpicking (25), other indigenous methods (Botanical) (11) and use sex pheromone trap (7) were adopted by them to the lowest extent.

The data indicates that people adopt harvesting at right stage at highest extent because there is a dictation by the government to harvest the mango at their attributed dateline. Though majority of the farmers are not satisfied at all on their ascribed dateline, they obliged to do this for the fear of punishment and fine by the law enforcement agencies and administration.

The second adopted practice was use of pesticides. As we know that people use mainly pesticides for insect pest control. Pesticide acts very fast against insect pests and very easy to apply. No other alternatives have the fastest capacity to control pest like pesticides. Moreover, farmers can easily manage pesticides from local market or dealer. Kamal et al. (2018) found more or less similar findings in their previous study conducted to determine the adoption of IPM in vegetable cultivation. They found that Use of pesticide adopted by the farmers at highest extent compare with other management practices. For this reason, farmers of the area adopt this practice to a high extent. Weed management is an ancient and very usual practice used by farmers in all areas. Farmers adopt this practice as it is very easy to operate and required little technical knowledge. For successful mango production, healthy planting materials are one of the basic requirements. There is no alternative to using healthy planting materials for increasing production. Farmers easily collect healthy and disease-free planting materials from the nursery and other authorized sources. For this reason, farmers adopt these practices to a high extent . Training and pruning is very effective practices to direct tree growth and minimize cutting, make the plant more productive and bear quality fruits but these practices are not performed widely because majority

of the farmers are not familiar and aware of this term. So this practice is performed in a moderate scale.

On the other hand, cultivation of resistant variety is an important factor for higher fruit production but unfortunately, the farmer of this are much aware of the resistant variety and also do not know where they can purchase it. Bagging is an effective practice but it is practiced by a few farmers as it involves a considerable cost. Collection and destruction of eggs and larvae by handpicking is not possible to adopt in large areas. Other indigenous methods are not so effective against aggressive insect pest and use sex pheromone trap is a fruitful method but most of the sex pheromone trap are pest specific and they require well maintenance and almost all of the farmers know nothing about the pheromone trap that is used in mango. As a result, farmers adopt these practices to a lower extent.

Status of adoption of IPM practices in mango cultivation according to selected characteristics

The chi-square statistics was mainly used for testing relationship between categorical variations. The comparisons based on the resulting probabilities for selected covariates along with p-values obtained from chi-square were presented in Table 2.

Table 2. Status of adoption of IPM practices in mango cultivation according to selected characteristics

Categories	Status of adoption of IPM practices in mango cultivation		χ^2 values	*p*-values
	Low adoption (%)	High adoption (%)		
Age (Years)				
Young (up to 35)	3 (15.8)	16 (84.2)		
Middle (36 to 50)	14 (22.2)	49 (77.8)	2.237	0.327
Old (>50)	10 (33.3)	20 (66.7)		
Educational qualification (Years of Schooling)				
Illiterate (0)	3 (23.1)	10 (76.9)		
Primary (1-5)	5 (27.8)	13 (72.2)		
Secondary (6-10)	15 (25.0)	45 (75.0)	0.460	0.928
Higher secondary or above (>10)	4 (19.0)	17 (81.0)		
Family size (No.)				
Nuclear (1-4)	17 (27.9)	44 (72.1)	1.036	0.309
Extended (>4)	10 (19.6)	41 (80.4)		
Farm Size (Ha)				
Small (Up to 1)	20 (42.6)	27 (57.4)		
Large (>1)	7 (10.8)	58 (89.2)	15.061	0.000**
Land under mango cultivation (Ha)				

Categories	Status of adoption of IPM practices in mango cultivation		χ^2 values	*p*-values
	Low adoption (%)	High adoption (%)		
Small (Up to 1)	11 (42.3)	15 (57.7)	6.131	0.013*
Large (>1)	16 (18.6)	70 (81.4)		
Annual family income (000'Tk)				
Low (Up to 300)	7 (43.8)	9 (56.3)	3.937	0.047*
High (>300	20 (20.8)	76 (79.2)		
Annual income from mango cultivation (000'Tk)				
Low (Up to 75)	22 (45.8)	26 (54.2)	21.672	0.000**
High (>75)	5 (7.8)	59 (92.2)		
Time spent in mango orchard (Hours/Day)				
Short (Up to 1.50)	21 (40.4)	31 (59.6)	14.057	0.000**
Long (>1.50)	6 (10.0)	54 (90.0)		
Knowledge on IPM practices in mango cultivation (Score)				
Low (Up to 8)	12 (33.3)	24 (66.7)	2.468	0.116
Standard (>8)	15 (19.7)	61 (80.3)		
Organizational participation				
No	5 (33.3)	10 (66.7)	2.468	0.116
Yes	22 (22.7)	75 (77.3)		
Contact with IPM club, IFMC and FFS (Score)				
Low (1-10)	23 (31.1)	51 (68.9)	5.798	0.016*
Standard (>10)	4 (10.5)	34 (89.5)		
Cosmopolitanism (Score)				
Low (1-5)	15 (35.7)	27 (64.3)	4.948	0.026*
Standard (>5)	12 (17.1)	58 (82.9)		
Extension media exposure (Score)				
Low (Up to 30)	24 (29.3)	58 (70.7)	4.457	0.035*
Standard (>30)	3 (10.0)	27 (90.0)		
Training exposure				
No	14 (34.1)	27 (65.9)	3.563	0.059
Yes	13 (18.3)	58 (81.7)		
Knowledge on pesticide application (Score)				
Low (Up to 10)	7 (35.0)	13 (65.0)	1.579	0.209
High (>10)	20 (21.7)	72 (78.3)		

** indicates the significance at 1% level of significance
* indicates the significance at 5% level of significance

Data presented in Table 2 showed the row percentage of the different categories under covariates concerning adoption of IPM practices in mango cultivation.

In different age group of the respondents, 84.2% of the young aged farmers highly adopt IPM practices. In the subsequent age group, adoption of IPM practices by mango grower was decreasing. Education plays an important role in adoption of IPM in mango cultivation. 72.2% of the primary passed (5 classes) farmers highly adopted IPM practices. The trends in the other categories of the educational qualification, adoption of IPM practices by mango grower was increasing. Farmer who completed higher secondary or above, 81.0% of them highly adopted IPM practices. Farmer belonged to extended family had high adoption. In case of extended family, 80.4% of the farmers highly adopt IPM practices. Mango growers belonged to large farm size had high adoption. 89.2% of farmers highly adopted IPM practices. Respondents under large land in mango cultivation had high adoption and 81.4% of the farmers of large land under mango cultivation highly adopted IPM practices. Mango growers of high annual income group (79.2%) were found to adopt and use IPM practices significantly higher than low-income groups and the alike trend was noticed for farmers with high annual income from mango cultivation accounting for 92.2%. Farmer's belonged to long time spent in the orchard had high adoption (90.0%) of IPM practices. Farmers having standard knowledge on usefulness of IPM practices in mango cultivation maximally (80.3%) adopted IPM practices to control the mango pests. 77.3% of the farmers highly adopt IPM practices who participated in different organization. 89.5% of the respondents highly adopt IPM practices that had high contact with IPM club, IFMC and FFS. For standard cosmopolitan farmers, 82.9% of the farmers highly adopt IPM practices. Farmers with standard exposure to extension media were found to adopt IPM practices greater than those with low exposure to extension. In case of training exposed farmers, 81.7% of the farmers highly adopted IPM practices. 78.3% of the farmers highly adopted IPM technology had high knowledge on pesticide application. Farm size, annual income from mango cultivation, time spent in mango orchard are significantly associated at 1% level of significance and land under mango cultivation, annual family income, contact with IPM club, IFMC and FFS, cosmopolitanism, extension media exposure, training exposure are significantly associated at 5% level of significance.

Factors influencing farmers' adoption of IPM

The most important objective in this research was to examine the adoption of IPM practices in mango cultivation. The logistic regression model was used to determine the factors that significantly influenced mango growers to adopt IPM. The degree and direction of the estimated parameters for the adoption of IPM were illustrated by this model were shown in Table 3.

According to the model, five factors negatively influenced the adoption of IPM by the other 10 factors having a positive influence. However, two of the 15 factors, namely contact with IPM club, IFMC and FFS and annual income from mango

cultivation were significant factors and had positive influences. This denoted that the higher these variables, the higher the probability of IPM adoption.

Middle-aged (OR: 0.455; 95% CI: 0.090, 2.314) and old (OR: 0.316; 95% CI.: 0.052, 1.909) people were less likely adopt of IPM compared to the young people. In educational qualification, illiterate farmer was used as the reference category for this study. Primary (OR: 0.655; 95% CI.: 0.083, 5.167) , secondary (OR: 0.330; 95% CI.: 0.051, 2.117) and higher secondary or above (OR: 0.156; 95% CI.: 0.016, 1.522) educated farmers were less likely to adopt IPM practices than illiterate farmers. It is also strictly decreasing when educational qualification is increasing. For family size, Extended family farmers (OR: 1.462; 95% CI.: 0.415, 5.157) were more likely to adopt IPM practices than nuclear family farmers. In respect of farm size, large farmers (OR: 2.170; 95% CI.: 0.354, 13.288) were more likely to adopt IPM practices than small farmers. In case of land under mango cultivation, large landholders (OR: 0.878; 95% CI.: 0.198, 3.902) were less likely to adopt IPM practices than small land holder. For annual family income, high-income farmers (OR: 1.277; 95% CI.: 0.321, 5.081) were more likely to adopt IPM practices than low-income farmers. For annual income from mango cultivation, high income is significant at 10% level of significance and high-income farmers (OR: 5.550; 95% CI.: 0.899, 34.275) were more likely to adopt IPM practices than low-income farmers. In respect of time spent in mango orchard, long time spent farmers (OR: 1.685; 95% CI.: 0.294, 9.647) were more likely to adopt IPM practices than short time spent farmers.Concerning knowledge on IPM practices in mango cultivation, low knowledge farmers (OR: 0.980; 95% CI.: 0.267, 3.600) were more likely to adopt IPM practices than high knowledge farmers. For organizational participation, participated farmers (OR: 1.878; 95% CI.: 0.431, 8.179) were more likely to adopt IPM practices than without participated farmers. In contact with IPM club, IFMC and FFS, standard contact is significant at 5% level of significance and standard contacted farmers (OR: 6.737; 95% CI.: 1.288, 35.243) were more likely to adopt IPM practices than low contacted farmers.

In case of cosmopolitanism, standard cosmopolitan farmers (OR: 2.249; 95% CI.: 0.722, 6.999) were more likely to adopt IPM practices than low cosmopolitan farmers. For media exposure, standard media exposed farmers (OR: 1.209; 95% CI.: 0.207, 7.058) were more likely to adopt IPM practices than low media exposed farmers. Trained farmers (OR: 1.187; 95% CI.: 0.261, 5.406) were more likely to adopt IPM practices than without trained farmers. Lastly, for knowledge on pesticide application, high knowledge farmers (OR: 0.760; 95% CI.: 0.153, 3.764) were less likely to adopt IPM practices than low knowledge farmers.

Table 3. Logistic Regression estimates of different categorical variables for adoption of IPM practices in mango cultivation

Factors	Coefficient (β)	S.E. (β)	Wald	P values	Odds ratio, Exp (β)	95.0% C.I. for EXP (β)	
						Lower	Upper
Age (Years)							
Young (up to 35) (ref)			1.580	.454	1.000		
Middle (36 to 50)	-.787	.830	.900	.343	.455	.090	2.314
Old (>50)	-1.151	.917	1.575	.209	.316	.052	1.909
Educational qualification (Years of Schooling)							
Illiterate (0) (ref)			2.851	.415	1.000		
Primary (1-5)	-.423	1.054	.161	.688	.655	.083	5.167
Secondary (6-10)	-1.109	.948	1.367	.242	.330	.051	2.117
Higher secondary or above (>10)	-1.860	1.163	2.556	.110	.156	.016	1.522
Family size (No.)							
Nuclear (1-4) (ref)					1.000		
Extended (>4)	.380	.643	.349	.554	1.462	.415	5.157
Farm Size (Ha)							
Small (Up to 1) (ref)					1.000		
Large (>1)	.775	.925	.702	.402	2.170	.354	13.288
Land under mango cultivation (Ha)							
Small (Up to 1) (ref)					1.000		
Large (>1)	-.130	.761	.029	.864	.878	.198	3.902
Annual family income (000'Tk)							
Low (Up to 300) (ref)					1.000		
High (>300)	.244	.705	.120	.729	1.277	.321	5.081
Annual income from mango cultivation (000'Tk)							
Low (Up to 75) (ref)					1.000		
High (>75)	1.714	.929	3.403	.065	5.550	.899	34.275
Time spent in mango orchard (Hours/Day)							
Short (Up to 1.50) (ref)					1.000		
Long (>1.50)	.522	.890	.343	.558	1.685	.294	9.647
Knowledge on IPM practices in mango cultivation (Score)							
Low (Up to 8) (ref)					1.000		

Factors	Coefficient (β)	S.E. (β)	Wald	P values	Odds ratio, Exp (β)	95.0% C.I. for EXP (β)	
						Lower	Upper
Standard (>8)	-.020	.664	.001	.975	.980	.267	3.600
Organizational participation							
No (ref)					1.000		
Yes	.630	.751	.704	.401	1.878	.431	8.179
Contact with IPM club, IFMC and FFS (Score)							
Low (1-10) (ref)					1.000		
Standard (>10)	1.908	.844	5.105	.024	6.737	1.288	35.243
Cosmopolitanism (Score)							
Low (1-5) (ref)					1.000		
Standard (>5)	.810	.579	1.956	.162	2.249	.722	6.999
Extension media exposure (Score)							
Low (Up to 30) (ref)					1.000		
Standard (>30)	.190	.900	.045	.833	1.209	.207	7.058
Training exposure							
No (ref)					1.000		
Yes	.171	.774	.049	.825	1.187	.261	5.406
Knowledge on pesticide application (Score)							
Low (Up to 10) (ref)					1.000		
High (>10)	-.274	.816	.113	.737	.760	.153	3.764

[Abbreviations: SE: Standard error; CI: Confidence Interval; Ref: reference Category.]

CONCLUSION

From the findings, it was evident that the adoption of IPM practices by mango growers was in satisfactory level. The IPUI index underlined that mango growers are used pesticides at high level from early stage of flowering to fruit maturity for controling the insect-pests and diseases with minimal use of other ecofriendly management tools. The adoption of IPM practices was influenced by several key factors, including contact with IPM club, IFMC, FFS and annual income from mango cultivation. Overall, it is worth mentioning that the initiatives to increase these facilities to cover a larger part of the mango growers could play an important role to increase the adoption of IPM practices.

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