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Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection

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ABSTRACT

Cabbage (*Brassica olearaceae* var. *capitata*) and cauliflower (*Brassica oleracea* var. *botrytis*) are two major vegetables produced and consumed in India. Over the years, they have been cultivated more intensively. This has resulted in higher rates of pest infestation, especially by the diamondback moth (*Plutella xylostella*) and higher pesticide use. This, in turn, has contributed to insecticide resistance, environmental degradation, and human health impacts, which have triggered a growing interest in alternative management techniques. There is a dearth of knowledge on current pest management practices in cabbage and crucifer. Knowledge about pest management practices is necessary to develop appropriate strategies such as Integrated Pest Management. The main purpose of this study was to obtain comprehensive information on pest management practices among farmers growing cabbage and cauliflower in India.

A survey was conducted in the states of Gujarat, West Bengal, and Karnataka from October 2006 through January 2007. Three hundred farmers were interviewed to obtain information on pesticide use in cabbage and cauliflower production, the cost of pesticide use, and socioeconomic characters that influence cabbage and cauliflower production.

Farmers relied on pesticides as the major and often exclusive crop protection strategy. Ten of the active ingredients (16.4% of all pesticides reported by all farmers in this survey) were listed as extremely or highly hazardous (classes Ia and Ib) by the World Health Organization. The results confirmed that pesticide use differs between states of India, but that location alone does not determine pesticide spraying pattern. A regression model was used to identify determinants of pesticide application frequency and pesticide cost per hectare. After controlling for location, individual level variables, such as age, education and experience, had significant effects on how often farmers sprayed. Farmers also spent more for pesticides, and sprayed more frequently on cauliflower than on cabbage and on open-pollinated varieties than on hybrid varieties.

Our findings highlight the excessive use of pesticides in cabbage and cauliflower, and the reliance on pesticides as the only pest management strategy. The results confirm the need for alternative management strategies. Bt vegetables may be one of these alternative strategies. However, it is questionable whether cultivation of Bt vegetables will reduce the strong reliance on pesticides. Small-scale farmers will need training in the identification of pests, natural enemies, basic ecology, and integrated pest management strategies to ensure sustainable and safe vegetable production.

Introduction

Cabbage (*Brassica olearaceae* var. *capitata*) and cauliflower (*Brassica oleracea* var. *botrytis*) are two major vegetables produced and consumed in India. In 2007, they accounted for 7.3% and 6.9%, respectively, of India's total vegetable production and India was the second largest producer worldwide for both of these crops (FAO, 2009). Both crops are of considerable economic importance, and are often produced under smallholder conditions. Over the years, they have been cultivated more intensively, which has resulted in high pest infestation. Diamondback moth (*Plutella xylostella*), head caterpillar (*Crocidolomia binotalis*), web worm (*Hellula undalis*), cabbage butterflies (*Pieris brassicae* and *P. rapae*), aphids (*Lipaphis erysimi* and *Brevicoryne brassicae*) and flea beetle (*Phyllotreta brassicae*) are common insect pests on vegetable brassicas in India (Chaudhuri et al., 2001; Srinivasan and Murthy, 1991). Among the plethora of insect pests, diamondback moth (DBM) is the most serious pest in India. Its preferred host plants are cabbage and cauliflower (Chelliah and Srinivasan, 1986). The yield loss caused by DBM varies from 31% to 100% (Lingappa et al., 2004).

Farmers commonly use chemical pesticides for controlling insect pests because chemicals have an immediate knock-down effect and are easily available in the local market. Spraying of inappropriate chemicals,

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Table 1
Socioeconomic profile of farmers ($n = 300$).

	Karnataka	Gujarat	West Bengal	Average	Significance
Age	42	45	38	42	0.001
% farmers with					
no formal education	9.0	5.0	22.0		0.000
primary	12.0	22.0	35.0		
secondary	13.0	46.0	32.0		
higher secondary	45.0	6.0	9.0		
college/technical	21.0	19.0	2.0		
Number of years growing crucifers	9.5	11.8	13.9		0.002
Farm size (ha)	2.5	2.6	0.9		0.000
Land under vegetables (ha)	1.3	1.9	0.4		0.000
Land under crucifers (ha)	0.5	1.4	0.2		0.000
% of farmers growing					0.000
one crucifer crop/year	52	51	95		
two crucifer crops/year	42	36	4		
three crucifer crops/year	6	13	1		
% of farmers using					0.000
local cultivar	1	11	23		
hybrid cultivar	97	89	64		
local and hybrid cultivars	0	0	13		
Don't know	2	0	0		

Notes. The Welch's *F*-ratio was used because the Levene's test of homogeneity of variances was violated.

excessive application, inappropriate timing, the wrong combination of chemicals, and spurious chemicals lead to insecticide resistance which causes farmers to spray even more pesticides. Development of insecticide resistance can occur within one or two cropping seasons after the introduction of a new chemical (Sandur, 2004).

Insecticide resistance, environmental degradation, human health impacts, resource loss, and economic concerns have thus triggered a growing interest in alternative management techniques. New technologies, such as transgenic crops, are starting to remediate the problem of resistance. However, resistance to Bt Cry toxin by *P. xylostella* populations has been reported in some locations (*i.e.* in Malaysia by Sayyed and Wright (2001). The usefulness of new approaches will depend on the availability of strategies that suit the needs of farmers and fit into their current crop protection strategies.

Knowledge of current pest management practices in cabbage and cauliflower is important to develop appropriate strategies, including different integrated pest management strategies. Surprisingly, there is a dearth of studies that examine current farmer practices in vegetable crops in India (Abhilash and Singh, 2009; Badenes-Perez and Shelton, 2006). Most studies on horticulture crops in India have focused on the effectiveness of integrated pest management practices and farmer field schools (Gururaj et al., 2004; Rajinder et al., 2007; Venkatesh Gandhi et al., 2008) or on measurements of pesticide residues in vegetables (Bhanti and Taneja, 2007; Shahi et al., 2005).

The main purpose of this study was to obtain comprehensive information on pest management practices among farmers growing cruciferous vegetables in India. This paper examines pesticide practices among small-scale farmers growing cabbage and cauliflower in India based on a survey conducted in three states of India. The objective of the survey was to (1) identify pests and diseases farmers perceive as important in cabbage and cauliflower production; (2) assess current pest management strategies; (3) identify the cost of pesticide use and factors determining pesticide use; and (4) discuss health outcomes.

Materials and methods

A survey was conducted in the states of Gujarat, West Bengal, and Karnataka from October 2006 through January 2007. These states were selected because of their intensive vegetable cultivation. The selection of districts within each state was also based on the intensity of cabbage and cauliflower cultivation. Birbhum and Murshidhabad were selected in West Bengal. Belgaum, Kolar and Rural Bangalore were selected in Karnataka, and Sabarkanta and Anand were selected in Gujarat. Villages and farmers within districts were randomly selected from a list of all cabbage and cauliflower growers and a sample of 300 farmers was drawn from 59 villages from seven districts. The sample size was predetermined to be equally large for cauliflower and cabbage growers. Thus, the sample comprised 50 cabbage growers and 50 cauliflower growers from each state.

The data generated in this study were quantitative. A pre-tested, structured questionnaire was deployed to obtain information on pesticide use in cabbage and cauliflower production, the cost of pesticide use, and socioeconomic characters that influence cabbage and cauliflower production. Local agriculture students were selected and trained to interview the farmers in local languages. Pesticide names were verified by requesting farmers to show containers. Images of insects were used to verify pest names. Questions relating to production of cabbage and cauliflower were targeted toward the last production cycle (*i.e.* after harvesting was completed).

Data from the questionnaire were encoded and entered into Microsoft Excel 2003 spreadsheets. Data were then converted into SPSS 15 and checked for consistency prior to analysis.

Results and discussion

Socioeconomic variables

Although the survey was designed to address male and female farmers, all respondents were men. This was probably because only

Table 2
Perceived importance of pests in cabbage and cauliflower.

State	Vegetable	Main pests	
		Name	Share of farmers affected (%)
Gujarat	cabbage	TFW	96
	cauliflower	DBM	90
		CAW	54
Karnataka	cabbage	DBM	100
		Blighting symptoms	76
		CAW	72
		aphids	42
	cauliflower	DBM	98
		Blighting symptoms	42
West Bengal	cabbage	TFW	90
	cauliflower	TFW	86
		DBM	82
		Blighting symptoms	80