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RESEARCH PAPER

Documentation of insecticide usage pattern among *Bt* cotton farmers in major cotton growing areas of Karnataka

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Abstract: Survey was carried out during 2016-17 and 2017-18 in major cotton growing districts of Karnataka *viz.,* Dharwad, Haveri, Shivamogga, Ballari and Mysuru which revealed that as many as 34 insecticides of which six commercially available combi products, nine tank mix combination of insecticides and one plant product were used by farmers for the management of insect pests on *Bt* cotton. In Ballari district, 25 different insecticides, five commercially available combination products and one neem based botanical insecticide were used by the farmers. While the Dharwad farmers used 21 different insecticides and Haveri farmers used 23 different insecticides. Shivamogga farmers used 16 different insecticides in *Bt* cotton ecosystem. The least number of 15 insecticides were used in Mysuru district. In Dharwad and Shivamogga districts, the total number of sprays ranged from one to two with a spray interval of 15 to 20 days where as Mysuru district farmers sprayed the *Bt* cotton one to two times at 20-30 days spray interval. In Haveri and Ballari, number of sprays ranged from two to three with 15-20 and three to five with 10-15 days interval, respectively during both the years. In all the districts, imidacloprid and diafenthiuron formulations were the commonly used and acephate was the primary choice of insecticide against sucking pests in all districts. In Ballari district, flonicamide and acephate + imidacloprid combi product were the major insecticide formulations used against the sucking pest in *Bt* cotton. For the application of insecticides, manual knapsack sprayers were widely used except in the irrigated cotton growing areas of Ballari district in which petrol operated knapsack power sprayers were extensively used by the farmers of Ballari district as efficient and labour saving equipment.

Key words: *Bt* cotton, Insect pest, Insecticide usage, Sprayer

Introduction

Cotton (*Gossypium* spp.) is infested by a large number of insect pests right from the sowing till harvest. The insect pests are one of the major constraints in achieving optimum yield potential. Cotton crop is found to harbour 1326 species of insects in different cotton growing areas of the world and 162 species have been reported from India (Hargreaves, 1948). It is difficult to manage insect pests and control failures have been experienced by the cotton growers due to pest outbreak in *Bt* cotton. The pesticide usage on cotton accounts 48 per cent of the total pesticide consumption.

The insecticide consumption in Karnataka has increased from 1008 metric tonnes during 2006-07 to 1444 metric tonnes during 2009-10 on *Bt* cotton. The cost of pesticides was 52 per cent higher in *Bt* cotton as compared to non-Bt cotton. Further, nearly 27 to 40 per cent of the farmers spray three or more times of pesticides against insect pests in *Bt* cotton (Anon., 2012). The consumption pattern of different insecticides belonging to different groups varies across the geographic locations primarily based on the dealer recommendations, intensity of pests, influence of peer groups, efficacy of particular insecticides, knowledge level of the farmer, availability of a particular insecticide and socioeconomic conditions of the farmer (Lingappa *et al.,* 1993).

To protect the crop from the attack of bollworms and sucking pests, farmers depend generally on the chemicals. There is a scope of utilizing the newer molecules which are required in small quantity to control the insect pests and are comparatively environmental safe and economically effective for the control of sucking pests in cotton ecosystem. The information on insecticide usage pattern in *Bt* cotton is also helpful to the policy makers. Keeping in view, the detailed survey was carried out on the usage of insecticides among the farmers against cotton insect pests in major *Bt* cotton growing districts of Karnataka.

Material and methods

Insecticide usage pattern adopted by farmers to manage cotton insect pests was collected through roving survey in different villages using a questionnaire during 2016-17 and 2017-18 from the major cotton growing districts of Karnataka *viz*., Dharwad, Haveri, Ballari, Shivamogga and Mysuru. In each district, five villages were selected. In each village, five farmers were selected for collecting the information. Totally, 25 farmers per district constituted the sample size to gather information on insecticide usage pattern.

In the cropping season, each district was visited during 2016-17 and 2017-18 and interacted with farmers with a questionnaire and recorded the information on insecticides being used, number of insecticide applications per crop, number of times a particular insecticide used, the spray interval followed and type of spray equipment for the application of insecticides. Later, the information was computed for each location and for overall cotton ecosystem.

Table 1. Insecticides used, number of sprays and spray interval followed by farmers against cotton insect pests in major cotton growing districts of Karnataka

Insecticides used during cropping season		Total number of sprays and spray interval	
2016-17	2017-18	2016-17	2017-18
1. Dharwad district Imidacloprid 17.8 SL, Imidacloprid 30.5 SC, Monocrotophos 36 SL, Profenofos 50 EC, Thiodicarb 75 SP, Acephate 75 SP, Acetamiprid 20 SP, Fenvalerate 20 EC, Diafenthiuron 50 WP, Thiamethoxam 25 WG, Dichorvos 76 EC, Dimethoate 30 EC, Chlorpyriphos 20 EC, Fenvalerate 20 EC, Cypermethrin 10 EC, Chlorantraniliprole 18.5 SC, Monocrotophos 36 SL + Acephate 75 SP Combi product: Acephate 50 SP + Imidacloprid 1.8 SP, Lamda-cyhalothrin 4.6% + Chlorantraniliprole 9.3 ZC, Neem product: Azadirachtin1500 ppmSpray equipment: lever-operated knapsack sprayers	Imidacloprid 17.8 SL, Monocrotophos 36 SL, Quinalphos 25 EC, Profenofos 50 EC, Chlorpyriphos 20 EC, Thiodicarb 75 SP, Acephate 75 SP, Acetamiprid 20 SP, Diafenthiuron 50 WP, Thiame thoxam 25 WG, Dichorvos 76 EC, Dimethoate 30 EC, Fipronil 5 SC, Chlorpyriphos 20 EC, Fenvalerate 20 EC, Cypermethrin 10 EC, Chlorantraniliprole 18.5 SC, Monocrotophos 36 SL + Acephate 75 SP Combi product: Acephate 50 SP + Imidacloprid 1.8 SP, Lamda-cyhalothrin 4.6% + Chlorantaniliprole 9.3 ZC, Neem product: Azadirachtin1500 ppm Spray equipment: lever-operated knapsack sprayers	1-2 spray and 15-20 days	1-2 spray and 15-20 days
2. Haveri district Imidacloprid 17.8 SL, Imidacloprid 30.5 SC, Profenofos 50 EC, Thiodicarb 75 SP, Monocrotophos 36 SL, Acephate 75 SP, Quinalphos 25 EC, Acetamiprid 20 SP, Dichorvos 76 EC, Diafenthiuron 50 WP, Thiamethoxam 25 WG, Fipronil 5 SC, Fenvalerate 20 EC, Cypermethrin 10 EC, Bifenthrin 10 EC, Chlorantraniliprole 18.5 SC, Chlorpyriphos 20 EC, Dimethoate 30 EC, Indoxacarb 14.5 SC, Imidacloprid 17.8 SL + Acetamiprid 20 SP, Monocrotophos 36 SL + Acephate 75 SP Combi product: Acephate 50 SP + Imidacloprid 1.8 SP Novaluron 5.25 + Indoxacarb 4.5 SC and Lamda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC Neem product: Azadirachtin1500 ppm Spray equipment: lever-operated knapsack sprayers	Imidacloprid 17.8 SL, Imidacloprid 30.5 SC, Thiodicarb 75 SP, Monocrotophos 36 SL, Acetamiprid 20 SP, Acephate 75 SP, Diafenthiuron 50 WP, Thiamethoxam 25 WG, Fenvalerate 20 EC, Cypermethrin 10 EC, Chlorpyriphos 20 EC, Chlorantraniliprole 18.5 SC, imethoate 30 EC, Bifenthrin 10 EC, Indoxacarb 14.5 SC, Imidacloprid 17.8 SL + Acetamiprid 20 SP, Monocrotophos 36 SL 1.8 SP, Novaluron 5.25 + Indoxacarb 4.5 SC and Lamda-cyhalothrin 4.6 + Chlorantraniliprole 9.3 ZC Neem product: Azadirachtin1500 ppm Spray equipment: lever-operated knapsack sprayers	2-3 spray and 15-20 days	2-3 spray and 15-20 days
3. Shivamogga district Imidacloprid 17.8 SL, Thiodicarb 75 SP, Monocrotophos 36 SL, Quinalphos 25 EC, Acephate 75 SP, Spinosad 45 SC, Acetamiprid 20 SP, Cypermethrin 10 EC, Chlorantraniliprole 18.5 SC, Dimethoate 30 EC Combi product: Chlorpyriphos 50 EC +Cypermethrin 5 EC Neem product: Azadirachtin1500 ppmSpray equipment: lever-operated knapsack sprayers	Imidacloprid 17.8 SL, Thiodicarb 75 SP, Monocrotophos 36 SL, Quinalphos 25 EC, Chlorpyriphos 20 EC, Acephate 75 SP, Spinosad 45 SC, Cypermethrin 10 EC, Lambda cyhalothrin 5 EC, Diafenthiuron 50 WP, Chlorantraniliprole 18.5 SC, Dimethoate 30 EC Combi product: Acephate 50 SP + Imidacloprid 1.8 SP and Chlorpyriphos 50 EC +Cypermethrin 5 EC Neem product: Azadirachtin 300 ppm Spray equipment: lever- operated knapsack	1-2 spray and 15-20 days	1-2 spray and 15-20 days

Contd……

Insecticides used during cropping season		Total number of sprays and spray interval	
2016-17	2017-18	2016-17	2017-18
4. Ballari district			
Imidacloprid 17.8 SL, Acetamiprid 20 SP, Flonicamide 50 EC, Thiamethoxam 25 WG, Profenofos 50 EC, Quinalphos 25 EC, Monocrotophos 36 SL, Acephate 75 SP, Dimethoate 30 EC, Indoxacarb 14.5 SC, Spinosad 45 SC, Diafenthiuron 50 WP, Bifenthrin 10 EC and Phenthoate 50EC, Fipronil 5 SC, Phosphamidon 40 SL, Buprofezin 25 EC, Imidacloprid 17.8 SL + Acetamiprid 20 SP, Imidacloprid 17.8 SL + Acephate 75 SP, Imidacloprid 30.5 SC + Acephate 75 SP, Acetamiprid 20 SP + Acephate 75 SP, Monocrotophos 36 SL + Acetamiprid 20 SP, Monocrotophos 36 SL + Acephate 75 SP, Bifenthrin 10 EC + Acetamiprid 20 SPCombi product: Acephate 50 SP + Imidacloprid 1.8 SP, Novaluron 5.25 + Indoxacarb 4.5 SC, Chlorantraniliprole 9.3 + Lamda-cyhalothrin 4.6 ZC, Deltamethrin 1.0 EC + Triazophos 40 EC and Profenofos 40 EC + Cypermethrin 4 EC Neem product: Azadirachtin1500 ppm Spray equipment: Petrol operated knapsack power sprayers	Imidacloprid 17.8 SL, Acetamiprid 20 SP, Flonicamide 50 EC, Thiamethoxam 25 WG, Profenofos 50 EC, Monocrotophos 36 SL, Acephate 75 SP, Dimethoate 30 EC, Indoxacarb 14.5 SC, Lambda cyhalothrin 5 EC, Fipronil 5 SC, Spinosad 45 SC, Diafenthiuron 50 WP, Bifenthrin 10 EC, Imidacloprid 17.8 SL + Acetamiprid 20 SP, Imidacloprid 17.8 SL + Acephate 75 SP, Imidacloprid 30.5 SC + Acephate 75 SP, Acetamiprid 20 SP + Acephate 75 SP, Monocrotophos 36 SL + Acetamiprid 20 SP, Monocrotophos 36 SL + Acephate 75 SP, Bifenthrin 10 EC + Acetamiprid 20 SPCombi product: Acephate 50 SP + Imidacloprid 1.8 SP, Novaluron 5.25 + indoxacarb 4.5 SC, Chlorantraniliprole 9.3 + Lamda-cyhalothrin 4.6 ZC, Deltamethrin 1.0 EC + Triazophos 40 EC and Profenofos 40 EC + Cypermethrin 4 EC Spray equipment: Petrol operated knapsack power sprayers	3-5 spray and 10-15 days	3-5 spray and 10-15 days
5. Mysuru district			
Imidacloprid 17.8 SL, Imidacloprid 70 WG, Quinalphos 25 EC, Monocrotophos 36 SL, Profenofos 50 EC, Dimethoate 30 EC, Acephate 75 SP, Chlorpyriphos 20 EC, Fipronil 5 SC, Thiamethoxam 25 WG, Chlorpyriphos 20 EC, + Acephate 75 SP Combi product: Chlorpyriphos 50 EC +Cypermethrin 5 EC and Profenofos 40 + Cypermethrin 4 EC Spray equipment: Petrol operated knapsack power sprayers	Imidacloprid 17.8 SL, Quinalphos 25 EC, Acephate 75 SP, Chlorpyriphos 20 EC, Dimethoate 30 EC, Thiamethoxam 25 WG, Diafenthiuron 50 WP, Lambda cyhalothrin 5 EC, Indoxacarb 14.5 SC, Acetamiprid 20 SP Imidacloprid 17.8 SL + Acetamiprid 20 SP Combi product: Chlorpyriphos 50 EC +Cypermethrin 5 EC and Profenofos 40 + Cypermethrin 4 EC Spray equipment: Petrol operated knapsack power sprayers	1-2 spray and 20-30 days	1-2 spray and 20-30 days

Results and discussion

Variations in the number of insecticides used, total number of sprays and spray interval across major cotton growing districts are presented in Table 1. Survey conducted during 2016-17 and 2017-18 in major cotton growing districts of Karnataka *viz.,* Dharwad, Haveri, Shivamogga, Ballari and Mysuru revealed that as many as 34 insecticides were used for the control of bollworms and sucking pests in *Bt* cotton, of which six commercially available combi products (acephate 50 % + imidacloprid 1.8 % SP, novaluron 5.25 % + indaxacarb 4.5 % SC, lamda-cyhalothrin 4.6 % + chlorantaniliprole 9.3% ZC, chlorpyriphos 50 EC + cypermethrin 5 EC, deltamethrin 1.0 % + triazophos 58.3 % and profenofos 40 % + cypermethrin 4 % EC), nine tank mix combination of insecticides and one plant product (azadirachtin 1500 ppm) were used by the farmers. In all major cotton growing districts, monocrotophos, imidacloprid, diafenthiuron and acephate formulations were the commonly used against sucking pests in all districts, whereas flonicamide and one combi-product (acephate + imidacloprid) were the major insecticides used against the cotton sucking pests in Ballari district.

The highest numbers of 25 different insecticides were used in Ballari district alone, along with five commercially available combination products and one neem based botanical insecticide. Dharwad farmers used 21 different insecticides and Haveri farmers used 22 different insecticides. Shivamogga farmers used 16 different insecticides in *Bt* cotton ecosystem. The least number of insecticides were used in the Mysuru district of Karnataka.

Sagar *et al*. (2013) reported that in cotton growing areas of Karnataka as many as 27 insecticides, of which two are commercially available combi-products and one plant product were used by the farmers for management of insect pests on *Bt* cotton. Monocrotophos was the most common insecticide used in all major cotton growing districts of Karnataka but in Haveri and Belagavi, imidacloprid

formulations were the commonly used insecticides, while in Mysuru dimethoate was the most commonly used insecticide. Fakrudin *et al.* (2003) reported that monocrotophos was the most commonly used insecticide in all the locations of South India for the management of bollworms in cotton. This clearly indicates that farmers are using newer molecules in addition to conventional insecticides as a practice of insecticide resistant management. Farmers in the Mysuru region used 15 different insecticides, which was least in Karnataka in the present study. Fakrudin *et al.* (2003) also opined that Mysuru farmers were using least number of insecticides compared to other districts.

In Dharwad and Shivamogga districts the total number of sprays ranged from one to two with a spray interval of 15-20 days while, in Mysuru it ranged from one to two sprays with 20-30 days spray interval and recorded minimum insecticide sprays. Whereas, in Haveri and Ballari, number of sprays ranged from two to three with 15-20 and three to five with 10 to 15 days interval, respectively during both the years. Total number of sprays and spray interval remained almost similar during both the years. But, number of insecticides used was varied between two years. Present results are in accordance with the reports of Sagar *et al*. (2013) who reported that the total number of insecticide sprays ranged between one to three with spray interval of 15-20 days in Dharwad, Belagavi and Haveri districts while, in Mysuru it ranged between one to two sprays with 20-30 days spray interval. Dhawan *et al.* (2011) reported that the average number of sprays for sucking pests was 5.20 and 5.16 in *Bt* cotton during 2008 and 2009, respectively.

Based on the number of insecticides used, number of sprays and spray interval, the major *Bt* cotton growing districts of Karnataka could be categorized as high insecticide usage area which included Ballari, Haveri and Dharwad districts, medium insecticide usage area comprised of Shivamogga district, while low insecticide usage area comprised of Mysuru district. Sagar *et al*. (2013) categorized as high insecticide usage area comprising of Raichur, Yadgir districts, medium insecticide usage area comprising of Haveri, Dharwad and Belagavi districts, while low insecticide usage area comprising of Mysuru district. This little variation in the grouping of insecticide usage area may be due to variation in the cotton growing area covered.

In the present survey it was observed that manual knapsack sprayers were the most widely used type of spray equipment by the farmers except in the irrigated areas of Ballari, where there was scarcity of labourers and petrol operated knapsack power sprayers were extensively used by the farmers as efficient and labour saving equipment. The present findings also in complete corroboration with the findings of Matthews *et al.* (2003) who conducted survey in Cameroon revealed that lever-operated knapsack sprayers are the most widely used type of spray equipment, but in the drier areas where water supplies are less readily available, CDA (control droplet applicator) rotary atomizer sprayers are used for spraying in cotton.

The results of the present study indicated that insecticide usage pattern in all locations followed a typical cocktail system with a greater variability in the nature of insecticides, number of insecticides used and frequency of application with different spray equipments. Such indiscriminate use of insecticides might aggravate the resistance problem making pest problems more complex in addition to insecticide residues and resurgence of minor pests. The information generated is helpful to the plant protection experts and policy maker to delay insecticide resistance and ensure effective control of target pests.

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