Indian Journal of Extension Education
Vol. 53, No. 4, 2017 (57-65)

Herbicide Adoption Pattern of Cotton Farmers in Vidarbha

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ABSTRACT

A systematic extensive survey of 240 cotton growers on herbicide adoption was conducted in Vidarbha region of Maharashtra during 2013-2014. The study revealed that 48.17 percent cotton growers have applied herbicides during 2013-14 for control of weeds in cotton crop. Knowledge about recommended per ha doses of herbicide is not known to 62.50 per cent farmers. Overall 52.90 percent farmers have medium level of knowledge about selected 15 herbicide application practices for cotton crop. Out of the total 118 (48.17%) herbicide adopters in cotton 25 (21.18 %) farmers applied only single spray of post-emergence/selective herbicide, followed by 30.52 per cent herbicide adopter farmers applied two applications of herbicides, first applied post-emergence/selective herbicides and in second application they have used glyphosate as non-selective herbicide and remaining 48.30 per cent farmers had applied single spray of 'glyphosate' at 50 DAS in cotton.

Majority herbicides users applied the recommended dose in cotton crop. Out of the total 118 (49.17 %) herbicide adopters majority 101(85.60 %) farmers have used knapsack sprayer in cotton. Cent percent (100%) farmers has not done the calibration of sprayer pump. Out of the total 118 (49.17 %) adopters 93 (78.81%) farmers have used non-selective herbicides in cotton and out of them majority 88.17 per cent farmers used the hood for protective application. Out of total 118 (49.17%) adopters only 27.97 per cent farmers used recommended 500 liters of water /ha in cotton crop. Overall cotton farmer's choice was Pyrithiobac sodium (Hitweed) and glyphosate. Over half (62.50%) of the farmers expressed that they are not getting the proper information about herbicide applications from extension functionaries of the Government, hence the State Department of Agriculture should organize regular trainings/ workshops, demonstrations, preparation and distribution of printed material about use of herbicides before sowing season with the expertise of SAU scientists so that cotton cultivators in Vidarbha will get technical knowledge for effective use of herbicides.

Keywords: Herbicide Adoption Pattern, Knowledge, Efficacy, Recommended Dose, Time, Cotton.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a very important commercial crop of India; it sustains the cotton textile industry, which is perhaps the largest segment of organized industries in the country. Cotton is grown on an area of 115.53 lack hectares in India during 2013-14 which constitutes 27 per cent of world's area under cotton cultivation with a production of 375.00 lakh bales (Anon., 2013). Since, the crop has long growth cycle, it has to pass through various climatic conditions and thus weeds also pose a serious problem. Losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of weeds. The critical period of weed competition in cotton was found to be 15 to 60 days (Rajiv Sharma, 2008 and Prabhu G., *et al.,* 2012). Weeds primarily compete for nutrients, moisture and sunlight during the early crop growth period than at later stage that leads to reduction in yield (Azevedo *et al.,* 2000 and Punia, *et.al,* 2013).

Maharashtra ranks first in cotton with 38.72 lakh hectare area during 2013-14 (Anon., 2013). Cotton is the second major cash crop in Maharashtra after sugarcane. Anonymous (2011). Recently non availability of labourers coupled with more cost is a very severe problem with the majority of the farmers in Vidarbha (Kale, *et. al*, 2011 and Kale, *et.al,* 2013). Under such circumstances use of herbicides play important role. Recently maximum number of farmers using herbicides in cotton crop in Vidarbha.

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Sometimes, there are complaints from farmers about not gets the effective weed control by using the herbicides. So, it becomes researchable issue to access the knowledge and adoption pattern of herbicide application practices by the cotton farmers in Vidarbha and hence this systematic extensive survey of cotton growers on adoption of herbicide application practices was conducted in six district of Vidarbha with the following objectives.

1. To study the detail profile of selected cotton farmers of Vidarbha.
2. To study the knowledge of the selected cotton farmers about herbicide application practices.
3. To study the adoption of herbicide application practices by the cotton farmers in Vidarbha.

METHODOLOGY

The present investigation was carried out in Akola, Buldana, Washim, Amravati, Yavatmal and Wardha districts of Vidarbha region of Maharashtra with exploratory design of social research. From each district one *Tahsil* is selected were cotton crop cultivated by the majority farmers during 2013-14. From each selected *tahsil* 4 villages were selected randomly and from each selected village 10 farmers were interviewed with the help of structured interview schedule. Thus this investigation was confined to a sample of 240 farmers of cotton crop. Data were collected by personal interview method with the help of structured interview schedule. Interview was conducted at residence of respondent as well as on the farm of the respondents.

RESULTS AND DISCUSSION

1. Profile of the selected cotton farmers

The data with respect to various characteristics/ profile of the selected cotton farmers have been furnished in subsequent Tables.

Land holding

The distribution of the respondents according to land holding is presented in Table 1 as follows.

The data regarding land holding of the selected farmers from table 1 revealed that more than one third (36.67%) respondents were observed in semi-medium land holding group. Equal percentage of respondents (26.67 %) were having land holding between 1.01 to 2.00 ha (Small) and 4.01 to 10.00 hectares (Medium). Whereas 6.66 per cent selected farmers were marginal (up to 1.00 ha.) land holders, only 3.33 per cent comes under large (above 10.00 ha.) land holding category. Thus, it is concluded that all land holding groups of the farmers have been selected for the present study. The average holding was observed 3.62 ha.

Table 1: Distribution of selected farmers according to land size

S. No.	Holding group	Frequency	Percentage
1.	Marginal (Upto 1.00 ha.)	16	6.66
2.	Small (1.01 to 2.00 ha.)	64	26.67
3.	Semi-medium (2.01 to 4.00 ha.)	88	36.67
4.	Medium (4.01 to 10.00 ha.)	64	26.67
5.	Large (Above 10 ha.)	8	3.33
	Total	240	100.00

Average land holding 3.62 Ha.

Irrigation facilities

It is observed from Table 2 that more than half (57.08%) of the selected farmers have well/tube well as a source of protective irrigation when they receive normal rainfall. Whereas 41.67 per cent farmers did not have any source to access the irrigation. They solely depended on monsoon rains and remaining 1.25 per cent have river as a source of irrigation.

Table 2: Distribution of selected farmers according to their irrigation sources

S. No.	Irrigation sources	Frequency	Percentage
1.	No source	100	41.67
2.	River	3	1.25
3.	Well/Tube well	137	57.08
	Total	240	100.00

Area under cotton crop (2013-2014)

Distribution of selected farmers according to their area under cotton crop (2013-14) has been presented in Table 3.

A majority 48.33 per cent selected farmers have up to 1ha area under cotton crop followed by 1.01 to 2 ha with 39.17 per cent farmers and 6.25 per cent each of the

Table 3: Distribution of selected farmers according to their area under cotton crop (2013-2014)

S. No.	Area in Ha.	No (%)
1	Up to 1.00	116 (48.33)
2	1.01 to 2.00	94 (39.17)
3	2.01 to 3.00	15 (6.25)
4	3.01 to 6.00	15 (6.25)
5	Above 6.00	00.00
	Total	240 (100.00)
	Average area ha	1.35

selected farmers have 2.01 to 3ha and 3.01 to 6 ha area under cotton crop, respectively.

Productivity of cotton crops during 2013-14

Per hectare yield of selected cotton growers in selected six districts of Vidarbha during 2013-14 is given in Table 4.

The average productivity of cotton was observed 21.67 quintals. The actual productivity of selected farmers in respect of cotton crop is depicted range wise in Table 4.

Table 4: Distribution of selected cotton farmers according to their productivity during 2013-14

Crops	Productivityq/ ha.	Frequency	Percentage	Averageq/ha.
Cotton	2.5 to 10	28	11.66	21.67
	10.01 to 20	84	35	
	20.01 to 30	100	41.67	
	30.01 to 40	22	9.17	
	40.01 to 62.50	6	2.5	
	Total	240	100.00	

Availability of labourers

The responses of the selected farmers regarding availability of labourers for their farming are depicted in Table 5.

Figures from Table 5 cleared that near about three fourth (73.75%) of the selected farmers expressed that labourer availability for farming is to some extent and 14.17 per cent farmers had expressed the not availability of labourer in their village these group of farmers have might be more land holding and requires more labourer. While 6.67 per cent farmers has not required any external labourer due to working of family members in own farm and remaining 5.41 per cent farmers expressed abundant availability of labourer.

Table 5: Distribution of selected farmers according to their availability of labourers

S. No.	Availability of labourers	Frequency	Percentage
1	Abundant	13	5.41
2	Available to some extent	177	73.75
3	Not available	34	14.17
4	Not required due to family labour	16	6.67
	Total	240	100.00

Bullock pairs

Distribution of the respondents according to their own bullock pair possessed has been furnished in Table 6.

Table 6: Distribution of the respondents according to the own Bullock pair

S. No.	No of Bullock pair	No.	%
1	Nil	96	40.00
2	One	132	55.00
3	Two	10	4.17
4	Three	2	0.83
	Total	240	100.00

Bullock pairs are the basic amenity for cultivating the farm, but recently the animal component is reducing day by day either due to lack of labourer/mechanization and hence this variable considered for the study. It was observed from Table.6 that more than half (55 %) of the respondents have one bullock pair and 40.00 per cent farmers have no bullock pair they totally depend on others, whereas, 4.17 per cent have two pairs and remaining two farmer (0.83%) has three bullock pairs.

Own Tractor

Recently mechanization trend is increasing in farming hence this variable was considered for the study and data is depicted in Table 7.

From the data presented in Table 7 it was observed that amongst the selected farmers 16.67 per cent have their own tractor and these are the big farmers. Whereas, remaining majority (83.33%) of the farmers have no own tractor.

Table 7: Distribution of the respondents according to the Own Tractor

S. No.	Own Tractor	No.	%
1	No	200	83.33
2	Yes	40	16.67
	Total	240	100.00

Farmers according to use of herbicides during 2013-14

Distribution of the respondents according to use of herbicides in cotton crop in selected six districts of Vidarbha has been furnished in Table 8.

Table 8: Distribution of selected cotton farmers according to use of herbicides during 2013-14

S. No.	Use of herbicides	Frequency	Percentage
1.	Yes	118	49.17
2.	No	122	50.83
	Total	240	100.00

Near about fifty (49.17%) per cent cotton farmers applied herbicide to control weeds and 50.83 per cent farmers not applied the herbicide. More than fifty per cent farmers not adopted the herbicide technology, might be due to more spacing between rows, they can control the weeds by harrowing.

The district wise users of herbicide technology have been also computed and the data is depicted in Table 8-A.

Table 8A: District wise herbicide adopters in cotton during 2013-2014

S. No.	District	Farmers selected	Herbicide users	%
1	Washim	40	23	57.50
2	Buldana	40	12	30.00
3	Akola	40	5	12.50
4	Yavatmal	40	18	45.00
5	Amravati	40	23	57.50
6	Wardha	40	37	92.50
	Total	240	118	49.17

1. Time period (In years) of herbicides use

Information on time period of herbicide use by the selected cotton farmers was collected and distribution of the farmers according to time period (In years) of herbicide use have been presented in Table 9.

Data noted that in selected six districts of Vidarbha in cotton crop very few (2.92%) farmers have applied herbicides since last 5 years, but recently increasing trend was noted. In selected districts 17.50 per cent farmers had applied herbicides first time in cotton during *kharif* season of 2013-14. However, more than half (51.67%) per cent of the cotton growers have not applied herbicides in selected districts of Vidarbha.

Table 9: Distribution of selected cotton farmers according to time period of herbicides use

S. No.	Time Period (In years)	No (%)
1	5 (2009-10)	7 (2.92)
2	4	9 (3.75)
3	3	26 (10.83)
4	2	32 (13.33)
5	1 (First time-2013-14)	42 (17.50)
6	Not used124	(51.67)
	Total	240 (100.00)

Own sprayer pump

Information regarding own sprayer pump from the selected farmers has been taken and data is presented in Table 10.

It was noted that majority (94.58%) of the selected farmers have their own sprayer pump. Type of sprayer pump with the farmers has been presented as below.

Table 10: Distribution of the respondents according to Own sprayer pump

S. No.	Own sprayer pump	No.	Percentage
1	Yes	227	94.58
2	No	13	5.42
	Total	240	100.00

Table 10-A: Distribution of the respondents according to types of sprayer pump

S. No.	Types of sprayer pump	No.	Percentage
1.	Only knapsack	128	53.33
2.	Knapsack + Power sprayer	59	24.58
3.	Only power sprayer	26	10.83
4.	Knapsack + Power sprayer + Battery sprayer	9	3.76
5.	Knapsack + Power sprayer + Boom sprayer	5	2.08
6.	Don't have own pump	13	5.42
	Total	240	100.00

Types of sprayer pump with the farmers

In selected six districts of Vidarbha more than fifty (53.33%) per cent selected farmers have only knapsack sprayer, followed by knapsack + power sprayer (24.58%), only power sprayer (10.83%), knapsack + power sprayer + battery operated sprayer was observed with 3.76 per cent farmers and remaining 2.08 per cent have knapsack + power sprayer + boom sprayer. While 5.42 per cent farmers don't have own sprayer, they depend on others.

Information sources used for spraying of herbicides

Herbicides use is very complex issue at farmers level due to lack of detail knowledge about proper application. Hence, an information sources used by the farmers for herbicide application is important variable in this study. Hence, the information is collected from selected farmers about use of information sources and data clears that cent percent herbicide adopters have used the proprietor of *Krishi Seva Kendras* as source of information.

2. Knowledge of cotton farmers about herbicide application practices

Total 15 important practices given in Table 11 were considered for accessing the knowledge of cotton farmers about herbicide application practices in selected six district namely Akola, Buldana, Washim, Amravati, Yavatmal and Wardha of Vidarbha. The results about the knowledge are presented in Table 11.

It was observed from Table 11 that 66.67 per cent cotton farmers have a knowledge about name of recommended (Any one) herbicides for cotton. They mostly know the trade name namely hitweed and glycel/

Table 11: Distribution of cotton farmers according to the knowledge of herbicide application practices in Vidarbha

S. No.	Herbicide application practices	Knowledge (N=240)	
		Yes	No
1.	Knowledge about any name of recommended herbicides for cotton.	160 (66.67)	80 (33.33)
2.	Knowledge about recommended per ha. dose of any herbicide.	90 (37.50)	150 (62.50)
3.	Knowledge about appropriate time of application of pre-emergence herbicides	24 (10.00)	216 (90.00)
4.	Name of pre- emergence herbicides for cotton	24(10.00)	216 (90.00)
5.	Knowledge about appropriate time of application of post-emergence herbicides	137 (57.08)	103 (42.92)
6.	Name of post-emergence herbicide for cotton	140 (58.33)	100 (41.67)
7.	It is necessary to have sufficient moisture in soil during application of herbicides	230 (95.83)	10 (4.17)
8.	Avoid herbicide spray during high speed wind & Cloudy weather	228 (95.00)	12 (5.00)
9.	Power spray is never used for spraying of herbicides	168 (70.00)	72 (30.00)
10.	Knowledge about calibration of spray pump (10x10 m =100 sqm : 5 lit for 1 ha: 500 lit.)	6 (2.50)	234 (97.50)
11.	Muddy water is never used for spraying herbicide	231 (96.25)	9 (3.75)
12.	Flat fan or flood jet type of nozzle should be used while spraying herbicides in cotton crop	168 (70.00)	72 (30.00)
13.	Quantity of water used for herbicide spray (500 L/ha)	51 (21.25)	189 (78.75)
14.	Not take any inter-cultural operation up to 5-10 days after herbicide application	223 (92.92)	17 (7.08)
15.	Use hood while spraying non-selective herbicide in cotton	178 (74.17)	62 (25.83)

(Figures in parenthesis indicate the percentage)

round up. Knowledge about recommended dose of any herbicide/ha for cotton is known to 37.50 per cent farmers.

Knowledge about appropriate time of application of pre-emergence herbicides and name of pre-emergence herbicides for cotton were not known to majority (90%) of farmers. The reason behind that in study area still near about 50 per cent farmers not applying any herbicides in cotton and the adopters use mostly post-emergence/ selective and non-selective herbicide, hence they have no knowledge about pre-emergence herbicide's name and application time.

Knowledge about appropriate time of application of post-emergence herbicides and name of post-emergence herbicide for cotton is known to 57.08 per cent and 58.33 per cent farmers, respectively. Application of herbicide is done when sufficient moisture in soil and avoid herbicide spray during high speed wind & cloudy weather were known to majority farmers (95.83 % & 95 % farmers, respectively). The reason behind that most of the cotton growers also cultivating soybean crop in this region and they applying herbicide for soybean crop.

Power spray is never used for spraying of herbicides is known to 70 per cent farmers in study area. Knowledge about calibration of spray pump was not noted by majority (97.50 %) farmers.

Muddy water is never used for spraying herbicide this practice is known to majority (96.25%) farmers. Flat fan or flood jet type of nozzle should be used while applying herbicides in cotton crop is not known to 30.00 per cent farmers. Use of 500 L water per ha for herbicide application in cotton crop is not known to more than three fourth (78.75 %) per cent cotton farmers. Not take any inter-cultural operation up to 5-10 days after herbicide application, the knowledge about this practice were observed with 92.92 per cent farmers. Use of hood while spraying non-selective herbicide in cotton this practice is known to 74.17 per cent farmers.

3. Overall knowledge level of cotton growers about selected herbicide application practices

Overall knowledge level of cotton growers about selected 15 herbicide application practices has been computed in the form of index and respondents has been distributed in three categories by equal distribution method as given in Table 12.

It was observed from Table 12 that over half (52.90 %) farmers have medium level of knowledge about all selected 15 herbicide application practices for cotton crop. More than one fourth (28.33 %) per cent farmers have observed in high level category of knowledge and remaining sizable 18.75 per cent farmers noted in low level knowledge category. This group of farmers still not applying herbicides in cotton crop.

Table 12: Distribution of cotton farmers according to the overall knowledge level of selected herbicide application practices

S. No.	Knowledge index	No.	%
1.	Low (Up to 33.33)	45	18.75
2.	Medium (33.34 to 66.66)	127	52.92
3.	High (Above 66.66)	68	28.33
	Total	240	100.00

4. Adoption of herbicide application practices by the cotton farmers

Adoption of recommended herbicide application practices by the cotton farmers in selected six districts of Vidarbha have been studied and results in detail presented in Table 13.

In selected six district of Vidarbha namely Akola, Buldana, Washim, Amravati, Yavatmal and Wardha out of

Table 13: Adoption of Herbicide application practices by the cotton farmers in Vidarbha

1	**Use of different herbicides**				
A	**Only single spray of Post-emergence/selective herbicide**	**No. of farmers**	**Overall %N=240**	**% Overherbicide adotpers**	**Trade name**
	Pyrithiobac sodium +Quizalofop ethyl	12	5.00	10.17	Hitweed 10 EC @ 0.62 lit/ha 20-30DAS + Targa Super 5%EC @ 1.00 lit/ha 30-40 DAS
	Quizalofop ethyl	5	2.08	4.24	Targa Super 5%EC @ 1.00 lit/ha 30-40 DAS
	Propaquizofop	3	1.25	2.54	Ajil 10EC @ 0.750 lit/ha 15-20 DAS
	Fenoxyprop ethyl	3	1.25	2.54	Vip Super 10% EC @ 1.00 lit/ha 30-40 DAS
	Pyrithiobac sodium	2	0.83	1.69	Hitweed 10 EC @ 0.62 lit/ha 20-30DAS
	Total	**25**	**10.41**	**21.18**	
B	**Two spray** (First- selective & Second – non-selective)				
	First selective	**Second non-selective**			
	Pyrithiobac sodium	Glyphosate	17	7.08	14.41
	Pyrithiobac sodium + Quizalofop ethyl	Glyphosate	16	6.67	13.56
	Propaquizofop	Glyphosate	3	1.25	2.55
		Total	**36**	**15.00**	**30.52**
C	**Only single spray of non-selective herbicide**				
		Glyphosate	55	22.92	46.61
		Gramoxone	02	0.84	1.69
		Total	**57**	**23.76**	**48.30**
		A + B + C (Herbicide used)	**118**	**49.17**	100.00
D	Herbicide not applied	122	50.83		
	Total (A+B+C+D)	240	100.00		
2	**Application of recommended herbicide dose**				
A	**For post-emergence-selective** N=61 (51.69%)				
i	At recommended dose	51	21.5	83.61	
Ii	Less than recommended dose	4	1.67	6.55	
iii	Higher than recommended dose	6	2.5	9.84	
	Total	**61**		**100.00**	
B	**For non-selective herbicides** N= 93 (78.81%)				
i	At recommended dose	60	22.5	64.52	
ii	Less than recommended dose	30	12.5	32.26	
iii	Higher than recommended dose	3	1.25	3.22	
	Total	**93**		**100.00**	
	Not applied	122	50.83		
3	**Application time**				
A	**For post-emergence selective** N=61 (51.69%)	**No.**	**Overall %**	**% overHerbicide users**	
i	Application of herbicide at recommended at recommended time	50	20.83	81.97	
ii	Application of herbicide after recommended time	11	4.58	18.03	
	Total	**61**		**100.00**	
B	**For non-selective herbicides** N= 93 (78.81%)				
i	Application of herbicide at recommended	33	13.76	35.48	
ii	Application of herbicide after recommended time	60	25.00	64.52	
	Total	**93**		**100.00**	
	Not applied	122	50.83		
4	**Herbicide use frequency**				
A	**For selective herbicides** N=61 (51.69%)				
i	Once in crop duration	61	25.42	100.00	
B	**For non-selective herbicides** N= 93 (78.81%)				
i	Once in crop duration	57	23.75	61.29	
ii	Twice in crop duration	36	15.00	38.71	
	Total	**93**		**100.00**	
5	**Sprayer pump used**				
	Knapsack	101	42.08	85.60	
	Power sprayer	17	7.09	14.40	
	Herbicide not used	122	50.83		
	Total	**240**	**100.00**	**100.00**	

6	**Type of nozzle used**			
	Flat fan	75	31.25	63.56
	Hollow cone	21	8.76	17.80
	Flood jet	5	2.08	4.24
	Power sprayer	17	7.08	14.40
	Herbicide not applied	122	50.83	
	Total	**240**	**100.00**	100.00
7	**Calibration of spray pump**			
	Yes	0	00.00	
	No	240	100.00	100.00
	Total	**240**	**100.00**	
8	**Use hood while spraying non-selective herbicide (N=93)**			
	Yes	82	34.17	88.17
	No	11	4.58	11.83
	Total	**93**		**100.00**
9	**Use of water for herbicide spray in cotton**			
	500 L/ha	33	13.75	27.97
	375 L/ha	9	3.75	7.63
	300 L/ha	10	4.17	8.47
	250 L/ha	29	12.08	24.58
	150 L/ha	37	15.42	31.35
	Herbicide not applied	122	50.83	

240 selected farmers 118 (49.17 %) farmers applied herbicide in cotton crop to control weeds and remaining 50.83 per cent farmers have not use the herbicide, they still doing hand weeding and intercultural operations. Out of the total 118 (48.17%) herbicide adopters in cotton 21.18 per cent farmers applied only single spray of Post-emergence/selective herbicide. Herbicides used by 21.18 per cent farmers in single application are Pyrithiobac sodium + Quizalofop ethyl by 10.17 % farmers, Quizalofop ethyl by 4.24 % farmers, Propaquizofop and Fenoxyprop ethyl used by each 2.54 per cent farmers, and 1.69 per cent farmers used Pyrithiobac sodium in cotton.

Among the total 48.17 per cent herbicides adopters in cotton sizable group of 30.52 per cent farmers applied two applications of herbicides, first applied post-emergence/ selective herbicides (Pyrithiobac sodium by 14.41% & Pyrithiobac sodium + Quizalofop ethyl by 13.56% farmers) and in second application they have used glyphosate as non-selective herbicide. In study area researcher also observed that out of the total adopters 48.30 per cent farmers had used only 'glyphosate' at 50 DAS as single application.

While considering the application of recommended herbicide doses in cotton, it was observed that out of total 118 (49.17 %) adopters in cotton 61 (51.69 %) farmers applied post-emergence/selective herbicides, out of them 83.61 per cent farmers used the recommended dose of various herbicides. 6.55 per cent farmers used less than recommended dose and 9.84 per cent farmers applied higher than recommended dose of herbicide for weed control in cotton in selected six districts of Vidarbha.

Out of the total 118 (49.17 %) adopters 93 (78.81%) farmers have used non-selective herbicides and out of them 64.52 per cent farmers applied recommended dose, 32.26 per cent farmers used less than recommended dose and remaining 3.22 per cent farmers applied the higher than recommended dose of non-selective herbicide in cotton.

Regarding application of herbicides at recommended time in cotton, it was observed that out of total 118 (49.17 %) adopters in cotton 61 (51.69 %) farmers applied post-emergence herbicides, out of them majority 81.97 per cent farmers applied at recommended time and 18.03 per cent farmers applied after recommended time.

While considering the 93 (78.81%) farmers who have applied non-selective herbicides in cotton out of them 35.48 per cent farmers applied at recommended time and 64.52 % farmers applied after recommended time (150DAS) when harrowing operations were close. Information on frequency of herbicide use have been collected from the cotton farmers, it was observed that in case of post-emergence/selective herbicides out of total 61 (51.69%) adopters cent per cent (100%) applied once in crop duration. Whereas non-selective herbicide was applied by 93 (78.81%) farmers out of them 61.29 per cent farmers applied once in crop duration and 38.71 per cent applied twice in a crop duration.

While considering the sprayer pump used for applying herbicides by cotton farmers it was observed that out of the total 118 (49.17 %) adopters majority 101(85.60 %) farmers have used knapsack sprayer and 17 (14.40%)

farmers applied selective herbicides by power sprayer in cotton.

Results about the nozzle used by the cotton farmers for application of herbicides revealed that majority 63.56 per cent farmers used flat fan nozzle, followed by 17.80 per cent farmers used hollow cone nozzle and 14.40 per cent have used power sprayer. Hollow cone and power sprayer are not recommended for application of herbicides by DWSR and Dr.PDKV, Akola. Remaining 12.92 per cent farmers used hollow cone nozzle which is also not recommended for application of herbicides by DWSR and Dr.PDKV, Akola. In study area these both (Use of power sprayer and use of hollow cone nozzle) may be the reason for poor efficacy/ results of herbicides at farmers field. Cent per cent (100%) farmers has not done the calibration of sprayer pump in selected six district of Vidarbha in cotton crop.

Out of the total 118 (49.17 %) adopters 93 (78.81%) farmers have used non-selective herbicides in cotton and out of them 88.17 per cent farmers used the hood for protective application and remaining 11.63 per cent farmers had not used hood while applying non-selective herbicides. Probably these are the small farmers and doing the application operation themselves very carefully.

The results about the use of recommended quantity (500L/ha) of water for herbicide spray in cotton crop clears that (Table 13) out of total 118 (49.17%) adopters 27.97 per cent farmers used recommended 500 liters of water /ha, 7.63 per cent farmers used 375L of water/ha, 8.47 per cent farmers used 300L of water/ha. Sizable near about one fourth (24.58 %) per cent farmers have used 250L/ha water and 31.35 per cent farmers used 150 L/ha water. It was observed that some farmers applying non-selective herbicides on only weed affected areas and between plants to plant in high density planting pattern of cotton on drip irrigation in study area. Hence, their per ha water quantity is low.

While considering other methods of weed control, it was observed that out of total 118 (49.17%) adopters majority (83.05 %) farmers have done hand weeding and crop rotation (100%) in study area. Not a single farmers was observed who have applied herbicide in previous year but due to good control he has not applied herbicide in next (current) year.

Out of the total adopters in cotton cent per cent (100%) farmers applied herbicides when sufficient moisture was present in soil, not applied herbicides during high speed wind & in cloudy weather, used clean water and not taken inter-cultural operations up to 5-10 days after herbicide application. It was also observed that cent per cent selected farmers have no separate pump for applying herbicides and no cotton farmer was observed who applied herbicide with pesticides.

5. Problems/ Constraints expressed by the selected farmers about herbicide use

Information about problems faced by the farmers in use of herbicides have been collected and findings are depicted in Table 14.

Over half (62.50%) of the farmers expressed that they are not getting the proper information about herbicide applications from extension functionaries, this was followed by lack of labourers for herbicide application mentioned by 41.67 per cent farmers. If demand raised in market about glyphosate, farmers have to pay more is expressed by 22.92 per cent farmers. If rains after herbicide application not gets the effective results were mentioned by 20.83 per cent farmers and long gap in monsoon leads to delayed application of herbicide were expressed by 12.50 per cent farmers.

Table 14: Constraints expressed by the selected farmers about herbicide use

S. No.	Constraints Faced by farmers	No	%
1	Lack of proper information about herbicide applications from extension functionaries	150	62.50
2	Lack of labourers for herbicide application	100	41.67
3	Considering the demand of glyphosate farmers has to pay more	55	22.92
4	If rains after spray not gets the effective results	50	20.83
5	Long gap in monsoon leads to delayed application	30	12.50

6. Suggestions given by the farmers

Extension functionaries should organize the workshop on use of herbicide for detail information was the suggestion given by half (50%) of the respondents.

CONCLUSION

Out of the total 118 (48.17%) herbicide adopters in cotton 25 (21.18 %) farmers applied only single spray of post-emergence/selective herbicide. Followed by 30.52 per cent herbicide adopter farmers applied two applications of herbicides, first applied post-emergence/selective herbicides and in second application they have used glyphosate as non-selective herbicide. Out of the total adopters of herbicides 48.30 per cent farmers had applied only ‘glyphosate’ at 50 DAS in cotton.

Majority herbicides users applied the recommended dose in cotton crop. Out of the total 118 (49.17 %) herbicide adopters majority 101(85.60 %) farmers have used knapsack sprayer in cotton. Cent per cent (100%) farmers have not done the calibration of sprayer pump in selected six district of Vidarbha. Out of the total 118 (49.17 %) adopters 93 (78.81%) farmers have used non-selective herbicides in cotton and out of them majority (88.17%) farmers used the hood for protective application. Out of total 118 (49.17%) adopters only 27.97 per cent farmers used recommended 500 liters of water /ha in cotton crop. Overall cotton farmer's choice was Pyrithiobac sodium (Hitweed) and glyphosate.

Over half (62.50%) of the farmers expressed that they are not getting the proper information about herbicide applications from extension functionaries. Hence, for avoiding the poor efficacy of herbicide technology on farmers' field, it is recommended that the State Department of Agriculture should organize regular trainings/workshops, demonstrations preparation and distribution of printed material about use of herbicides before sowing season with the expertise of SAU scientists so that cotton cultivators in Vidarbha will get technical knowledge for effective use of herbicides.

REFERENCES

Anonymous 2011. Weeds threaten cotton crop in Maha Cos work on resistant seeds. Available at http://www.cottonmarket.in/

Anonymous 2013. The current cotton scenario. The cotton corporation of India Ltd, New Mumbai. Available at http://www.cotcorp. gov.in

Azevedo, D. M., Nobrega, L. B., Vieria, D. J., Bezera, J. R. C. and Alves, I. 2000. The effect of herbicides mixtures on weed control in irrigated cotton. *Crop Sci.,* 43: 16-17.

Kale,N.M., Wankhade, P.P. and Gopal Jadhao 2011. Factors affecting Agrarian Distress Proneness in Western Vidarbha. *J. of Agricultural Extension Management* (MANAGE, Hyderabad) XII (2) July-Dec 2011: 61-68.

Kale, N.M., D.M. Mankar and P.P. Wankhade 2013. Factors affecting Agrarian Distress Proneness in Vidarbha. Research Review Committee Project submitted to Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during 2012-13.

Prabhu, G., A. S. Halepyati, B. T. Pujari and B. K. Desai 2012. Weed management in Bt cotton (Gossypium hirsutum L.) under irrigation. *Karnataka J. Agric. Sci.,* 25 (2), (183-186).

Punia, S.S., Dharamvir Yadav and Anil Dhun 2013. Herbicide adoption pattern in rice and wheat among Haryana farmers. *Indian J. of Weed Science* 45(3), 175-178.

Rajiv Sharma 2008. Integrated weed management in field crops. *Crop Care,* 35 (4), 41-46.