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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 per cent cotton growers had 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 per cent farmers had 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 have 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%) 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 training/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: Adoption pattern, cotton, efficacy, herbicide, knowledge, recommended dose, time

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 lac 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

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weed competition in cotton was found to be 15 to 60 days (Sharma, 2008 and Prabhu *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 nonavailability 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, the use of herbicides plays important role. Recently maximum number of farmers using herbicides in cotton crop in Vidarbha is being reported on electronic and print media. Sometimes, there are complaints from farmers about not getting 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 districts of 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 was selected where cotton crop was 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 sampled randomly who were interviewed with the help of structured interview schedule. Thus this investigation was confined to a sample of 240 farmers having 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

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

Landholding: The distribution of the respondents according to land holding is presented in Table 1 which revealed that more than one third (36.67%) of the respondents were in semi-medium landholding 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 landholding 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

Holding group	Frequency	Percentage
Marginal (Up to 1.00 ha.)	16	6.66
Small (1.01 to 2.00 ha.)	64	26.67
Semi-medium (2.01 to 4.00 ha.)	88	36.67
Medium (4.01 to 10.00 ha.)	64	26.67
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 available irrigation sources

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

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

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

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

The productivity of cotton crops during 2013-14: Per ha yield of selected cotton growers in selected six districts of Vidarbha during 2013-14 is given in Table 4 as follows. 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.

***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 express 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 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**	

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

Availability of labourers	Frequency	Percentage
Abundant	13	5.41
Available to some extent	177	73.75
Not available	34	14.17
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. 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.

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

No of Bullock pair	Frequency	Percentage
Nil	96	40.00
One	132	55.00
Two	10	4.17
Three	2	0.83
Total	**240**	**100.00**

***Tractor ownership*:** Recently mechanization trend is increasing in farming hence this variable was considered for the study and data is depicted in Table 7 as follows. 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, the remaining majority (83.33%) of the farmers have no own tractor.

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

Own Tractor	Frequency	Percentage
No	200	83.33
Yes	40	16.67
Total	**240**	**100.00**

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

Use of herbicides	Frequency	Percentage
Yes	118	49.17
No	122	50.83
Total	**240**	**100.00**

Time period (In years) of herbicides use: Information on the 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 from 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 8-A: District wise herbicide adopters in cotton during 2013-2014

District	Farmers selected	Herbicide users	%
Washim	40	23	57.50
Buldana	40	12	30.00
Akola	40	5	12.50
Yavatmal	40	18	45.00
Amravati	40	23	57.50
Wardha	40	37	92.50
Total	**240**	**118**	**49.17**

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

Time Period (In years)	No (%)
5 (2009-10)	7 (2.92)
4	9 (3.75)
3	26 (10.83)
2	32 (13.33)
1 (First time-2013-14)	42 (17.50)
Not used	124 (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 bellow.

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

Own sprayer pump	No.	Percentage
Yes	227	94.58
No	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.

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

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

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 source 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.

***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 were presented in Table 11.

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

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

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

(Figures in parenthesis indicate the percentage)

glycel/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%) per cent farmers. The region behind that in study area still near about 50% 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 % and 58.33 % 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 region 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 % farmers in study area. Knowledge about calibration of spray pump was not noted in 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 was observed with majority 92.92 % farmers. Use hood while spraying non-selective herbicide in cotton this practice is known to 74.17 % farmers.

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

Knowledge index	No.	Percentage
Low (Up to 33.33)	45	18.75
Medium (33.34 to 66.66)	127	52.92
High (Above 66.66)	68	28.33
Total	**240**	**100.00**

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 districts of Vidarbha namely Akola, Buldana, Washim, Amravati, Yavatmal and Wardha out of 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% farmers used the recommended dose of various herbicides. 6.55 per cent farmers used less than recommended dose and 9.84 % 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 % farmers applied recommended dose, 32.26 % farmers used less than recommended dose and remaining 3.22 % 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 % 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 % 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 percent (100%) farmers have not done the calibration of sprayer pump in selected six districts 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 majority 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 them self 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 % farmers used 375L 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**	**% Over herbicide adotpers**	**Trade name**
	Pyrithiobac sodium +Quizalofop ethyl	12	5.00	10.17	Hitweed 10 EC @ 0.62 lit/ha 20-30 DAS + 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 20-30 DAS
	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 %**	**% over Herbicide 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	
	Total	**240**	**100.00**	100.00
10	Use of other methods of weed control in cotton	No.	Overall %	% overHerbicide users
	Hand weeding	98	40.83	83.05
	Crop rotation	118	49.17	100.00
	Herbicide not applied due to good control in previous year	0	00.00	00.00
11	Application of herbicides was done when sufficient moisture was present in soil			
	Yes	118	49.17	100.00
	Herbicide not used	122	50.83	
	Total	**240**	**100.00**	**100.00**
12	Herbicide application was not done during high speed wind & Cloudy weather			
	Yes	118	49.17	100.00
	Herbicide not used	122	50.83	
	Total	**240**	**100.00**	**100.00**
13	Clean water is used for spraying herbicide			
	Yes	118	49.17	100.00
	Herbicide not used	122	50.83	
	Total	**240**	**100.00**	**100.00**

14	Inter-cultural operations not taken up to 5-10 days after herbicide application			
	Yes	118	49.17	100.00
	Herbicide not used	122	50.83	
	Total	**240**	**100.00**	**100.00**
15	Use of separate pump for spraying herbicides			
	Yes	0	00.00	00.00
	No	240	100.00	100.00
	Total	**240**	**100.00**	**100.00**
16	Spraying of herbicides with (by mixing) pesticides			
	Yes	0	00.00	00.00
	No	240	100.00	100.00
	Total	**240**	**100.00**	**100.00**

water/ha, 8.47 % farmers used 300L of water/ha. Sizable near about one fourth (24.58 %) per cent farmers have used 250L/ha water and 31.35 % 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 farmer 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 percent (100%) 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 percent selected farmers have no separate pump for applying herbicides and no cotton farmer was observed who applied herbicide with pesticides.

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 were 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% farmers. If demand raised in market about glyphosate farmers has 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: Problems/ Constraints expressed by the selected farmers about herbicide use

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

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 a 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 percent (100%) farmers have not done the calibration of sprayer pump in selected six districts 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 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.

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