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Use of botanical spray to delay application of first pesticide against sucking pests of cotton which ultimately mitigate climate change

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ABSTRACT

Cotton is a cash crop and its raw material is extremely important for use in textile industry. Pakistan comes in top exporter of cotton. Cotton crop is under different stresses during its production out of which pest pressure is most important to deal with. Rural Education & Economic Development Society (REEDS) Pakistan is working for production of better of cotton along with promotion of less pesticide use thus mitigating the environmental pollution. REEDS has established field study for use of neem extract as botanical spray against sucking pests and diseases. This experiment was done on farmer fields of Vehari and Rahim Yar Khan, Punjab and Dadu, Sindh. Botanical spray was used against sucking pests to delay the application of first pesticide for maximum number days. Which would ultimately reduce the number of pesticides applied along with less residual effects on humans and environment. The pest scouting data of trial plot clearly show the decrease in pest population after application of neem extract up to 79 days after sowing in comparison to control plot. Similarly, number of total pesticides used in trail plots were less in comparison to control plots.
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1. Introduction

Cotton is one of the major cash crops of Pakistan which occupy the largest area of cultivation as compared to other crops of country and contribute in the GDP of country. Cotton and related products of cotton shares 10% contribution in gross domestic product (GDP) while 55% in earning of foreign exchange (Economic Survey of Pakistan, 2015–16). High yield of cotton crop depends on different requirements like heavy use of inputs, chemical pesticides, synthetic fertilizers to improve soil nutrients and well-drained soil. These practices are continuously damaging the environment in multiple ways (Shafiq and Rehman, 2000, Rehman et al., 2019). Cotton crop faces many challenges like availability of quality inputs like seeds, fertilizers & pesticides and climatic factors like drought and pest pressure. To overcome the challenges of drought and use water efficiently drip and sprinkler are being used in cotton crop (Ali et al., 2020) and new drought resistance and high yielding varieties like RH-647 are being introduced in specific agroclimatic zones (Shaheen et al., 2021). Cotton crop is under attack of 145 insect pests which reduce cotton yield to 30% in Pakistan (Bo, 1992) similar percentage of 26–29% is reported in 2006 (Oerke, 2006). The pests of cotton are sucking and chewing in nature (Anees et al., 2020) while some endosymbionts are present in whitefly which play their role in transfer of Cotton Leaf Curl Virus

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(Ali et al., 2016). The Maximum of agricultural pesticides are being used against cotton pests which may results in addition of problems like development of resistance against pesticides, outbreak of secondary pest, reduction in population of beneficial insects and health issues to farmers (Bakhetia et al., 1996). The pesticides of chemical nature when used continuously adds harmful impact in human health and environment (Atreya, 2005; Soares and de Souza Porto, 2009; Fantke et al., 2012; Rehman et al., 2019). Alternate ways to control sucking pest like whitefly are by knock down of candidate genes using RNAi technique (Vyas et al., 2017) or use of biopesticides and trap crop etc (Gupta and Dikshit, 2010; Sarkar et al., 2018). Use of botanical spray against sucking pests of vegetables was well studied and analyzed to be effective in controlling population of sucking pests on brinjal. Neem (Azadirachta indica) extracts in comparison to tobacco (Nicotina tabbacium) and trooh (Citrullus collocynthus) was used to control the sucking pest population (Kunbhar et al., 2018). Different plant extracts like neem oil, garlic, eucalyptus and datura were used to control the population of sucking pests like jassid (Amrasca devastans), whitefly (*Bemisia tabaci*) and thrips (*Thrips tabaci*) on Bt cotton crop in field conditions. These plant products showed different level of toxicity against these sucking pests (Khan et al., 2013). The literature was reviewed and analyzed on the effect of diverse plant species extracts on pests of crop (Baliddawa, 1985). Another review was published in 2021 discussing the role of plant extracts which are toxic to insect pests (Tlak Gajger and Dar, 2021). Several uses of plant products in pest control have been reported (Hashmi, 2001; Mamoon-ur-Rashid et al., 2012). Neem is effective in controlling different pest, Laboratory studies were done to check the effect of neem extract on spotted bollworm Earias sp. which revealed in control of spotted bollworm at varying level for different development stages of pest (Mamoon-ur-Rashid et al., 2013). Neem is being used in stored grain as pest repellent in not only subcontinent but different parts of world too (Lale and Mustapha, 2000). A compound Azadirachtin is found in neem which has insecticidal properties (Mordue and Blackwell, 1993; Prakash and Srivastava, 2008). Not only this, other compounds like deacetylazadirachtinol, meliantriol, vepol, salannin, sulfur etc. shows varying level of insect deterrent, repellant, anti-feedant, anti-ovipositional and growth regulating properties (Atawodi and Atawodi, 2009). Neem Oil was effective treatment against sucking pests of cotton and have biopesticide value (Attri and Prasad, 1980; Ghelani et al., 2014; Vinodhini and Malaikozhundan, 2011; Mamoon-ur-Rashid et al., 2012). In a study extract of kor-tuma (Citrullus colocynthis) on mortality of fruit flies of guava by studied and found effective (ur Rehman et al., 2009; Hussain et al.). A nonprotein amino acid (Giganticine) extracted from Aksin (Calotropis gigantea) was tested successfully as antifeedant against nymphs of the desert locust (Schistocerca gregaria) (Pari et al., 1998).

2. Materials and methods

2.1. Trial layout

The experiment was conducted in three climatic zones of Punjab and Sindh province of Pakistan where cotton is cultivated as major cash crop. These districts include Vehari and Rahim Yar Khan of Punjab, Pakistan while District Dadu of Sindh, Pakistan. Fifteen farmer fields from each district were selected. The variety grown on these field was same that is IUB-2013 which was selected being suitable according to climatic conditions of these districts and is being sown by farmers of these localities. To validate the results a control plot was also established adjacent to trial plot in same locality. The trial plots were kept under use of botanical spray (the procedure adopted to make botanical spray is given below) against sucking pests while the control plots were kept under use of chemical pesticides from the beginning. One acre area was selected as trial plot to use the treatment and same area for control with no treatment. To authenticate the observations and results in trail and control plots all the cultural practices of seed bed preparation were kept same, same variety sown in First week of May 2020. Following the SOPs of pest scouting both fields were monitored regularly and data was recorded from date of sowing to first pesticide application in trial plot.

2.2. Extraction of botanical spray

There are different ways of to make neem extract from different plant parts like seed, leaves etc. In our trial we have decided to use leave extract of Neem to be used against sucking pests. For making the Neem leave extract, take 5 kg of Neem (*Azadirachta indica*) leaves, 1 kg Kortuma fruit (*Citrullus colocynthis*) and 1 kgs Aaksin (*Calotropis gigantea*) plant parts which are crushed in small pieces. Boil these in 20 L of water by covering the pot with lid over it. The mixture is boiled till 10–12 L of water is remained in it. The extracted mixture is cooled down and filtered using muslin cloth.

2.2.1. Dilutions used

This extracted mixture is divided to be applied on 2.5 acres. Dilutions are made on basis of number of tanks used per acre.

2.2.2. Pest studied

Among different sucking pests only three pests namely Jassids, Thrips and Whitefly were studied in this field trial for response against use of botanical spray.

2.2.3. Data collection

Trail fields and control fields were regularly monitored for pest scouting. Pest scouting was done in early mornings. Pest count was recorded in field books. Data recorded was against days after sowing (DAS) for pest scouting and application of botanical spray & pesticide in trail plot as well as control plots. Averages of pest scouting data of sucking pest, botanical/chemical spray used at different days after sowing was taken from all the 45 trial plots and 45 control plots of Vehari, Rahim Yar Khan and Dadu. These averages were farther analyzed for delay in pesticide use and number of pesticides use in trial and control plots.

3. Results

3.1. Delay in use of first pesticide

It was found that initially the pest scouting data from trial plot and control plots was approximately similar but in our trial plot the population of sucking pest remain below ETL due to use of neem leaf extract. Pest scouting data was taken regularly and was tabulated. Averages were taken for 15 replicates from each district and then average of all 45 replicate plots was taken to conclude the number of days for which application of first pesticide was delayed and number of pesticides used in control plot in same time.

It was found that on an average first chemical-based pesticide was delayed up to 81.38 days when we are using botanical spray against sucking pests in comparison to control plots where first pesticide was applied after 52.73 days of sowing and second pesticide was used after 55.42 days post sowing while third pesticide against sucking pest was used at 72.17 days post sowing as shown in Table 1 and Table 2.

From this we can clearly depict that by using botanical spray we not only delay the use of chemical-based pesticide on cotton crop

Table 1
Application of pesticide on trial & control plots (days after sowing) for each replicate.

	R-1	R-2	R-3	R-4	R-5	R-6	R-7	R-8	R-9	R-10	R-11	R-12	R-13	R-14	R-15	Average
Vehari Trial	81	79	78	80	79	82	78	81	79	80	83	80	78	81	77	79.73
Vehari Control	48	48	47	48	47	50	48	47	48	56	47	47	53	51	47	48.8
RYK Trail	79	83	77	80	81	79	82	77	80	83	81	78	78	80	79	79.8
RYK Control	51	50	51	58	50	52	50	51	57	50	52	50	50	51	54	51.8
Dadu Trial	86	80	83	83	86	85	83	84	86	84	89	87	84	83	86	84.6
Dadu Control	59	58	59	57	66	56	60	59	67	50	54	54	53	54	58	57.6

Table 2
Averages DAY for First, Second and Third application of botanical spray / pesticide on Trial or Control plots.

District	Trial Plot	Control		
	First Pesticide (DAS)	First Pesticide (DAS)	Second Pesticide (DAS)	Third Pesticide (DAS)
Vehari	79.73	48.8	53.2	68.8
RYK	79.8	51.8	53.6	71.13
Dadu	84.6	57.6	59.46	76.58
Averages	81.37666667	52.73333333	55.42	72.17

for up to 80–85 days but also reduce the input cost by substituting three pesticides. The lesser number of pesticides will also add to reduction in harmful residual effects of pesticides and ultimately will play role in climate mitigation. Maximum average of 84.6 days post sowing pesticide was delayed in trial plots of District Dadu, 79.73 in District Vehari and minimum average of 79.8 days in trial plots of Districts of Rahim Yar Khan as shown in Table 1 & Table 2.

3.2. Cost effectiveness

It was found that initially the pest scouting data from trial plot and control plot was approximately similar but in our trial plot the population of sucking pest remain below ETL by use of neem extract in two repeats. On the other hand, in control plots three pesticides were used in same duration. Looking into input cost for both plots for pesticide application up to observed days (till first pesticide applied) we found that Rs. 600 was spent on extraction and spray application of botanical spray while Rs. 3600 was spent on purchase of chemicals against sucking pests (The cost will go higher if the farmer purchases chemicals of Multinational Brands). This way the botanical spray is very useful for farmer in reducing the production cost of trial plots. The pest scouting data of trial plot clearly show the decrease in pest population after application of botanical spray extract in comparison to trial plots. This way we find a clear difference of Rs. 3000/- on an average in input cost comparison of both plots. So botanical based spray is not only an environment friendly technique but also is cost effective and have least harmful residual effects of human health.

4. Discussion

Botanical spray is tested by different scientist for repelling the sucking pest of cotton (Vinodhini and Malaikozhundan, 2011b; Khan et al., 2013; Jat and Jeyakumar, 2006) and different vegetables like brinjal (Azad et al., 2013; Kunbhar et al., 2018), capsicum (Kaur and Singh, 2013), Okra (Moawad and Ebadah, 2019). There is always a risk of health issue of farm working males and females who are involved in application of pesticides (Ali et al., 2008; Mancini et al., 2005). REEDS have already conducted a study to analyze the harmful effect of pesticide on farm worker by testing the residual effects in blood samples of farm workers males and female. This study has clearly shown the delay of application of first pesticide and it will ultimately reduce the residual effects. Techniques like use of pheromone traps, Sticky Cards, trap crops, border crops and botanical spray can reduce the number of pesticides used against pests of cotton and will ultimately paly role in climate mitigation.

5. Conclusion

Alternate ways to pesticide application for controlling pests of crop can reduce the number of pesticides applied to crops like cotton. Less use of pesticide will lower input cost and residual effects of pesticides. The health of male and female farm worker will be improved and will also support in climate mitigation by least addition of chemical to soil, water and environment.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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