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CASE REPORT

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OKRA GROWERS' PESTICIDES USE PATTERN IN CONTROLLING INSECT-PESTS AND DISEASES IN NORTH 24 PARAGANAS DISTRICT OF WEST BENGAL

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A B S T R A C T

India is an agriculture based country. Imbalance between demand and supply of agricultural production is a major concern to feed the ever-increasing population of our country. To enhance agricultural production, there are several ways. Out of various ways, plant protection occupies prime position. Insect-pests and diseases cause enormous damage to agricultural crops, forests as well as stored agricultural commodities. Almost every economically important plant is attacked by a variety of insect-pests and diseases. Therefore, the study was concentrated on the objective- to portray the pesticides use pattern in okra cultivation in controlling insect-pests and diseases. The study was conducted in North 24 Paraganas district of West Bengal. For the selection of area and respondents, multi-stage random sampling technique and universe method were followed. The study reveals that (1) at the most 73 percent of respondents had primary level of education (2) at the most 50 percent of respondents had 1.1 to 3.0 bigha of own cultivable land(3) at the most 47 percent of respondents had upto 1 bigha (20 katha=1 bigha, 3 bihga= 1 acre, 2.5 acre=1 ha=7.5 bigha=150 katha) of land for vegetable cultivation (4) at the most 37 percent of respondents had 6-10 years of experience in vegetable cultivation (5) at the most 43 percent of respondents had 11-20 years of experience in pesticides application (6)Majority of respondents (80%) cultivated okra crop in kharif season (7)At the most 43 percent of the respondents applied pesticides on 1-3 days interval (8) all the respondents (100%) adopted spraying method for application of pesticides (9) all the respondents' (100%) main personal source of information on pesticides' use was agricultural input retailers (10) At the most 46 percent of respondents main impersonal source of information on pesticides' use was radio (11) Nearly three-fourth percent of respondents (74%) used 40-60 litres of water per bigha for spraying chemicals at seedling stage (12) at the most 66 percent of respondents used 100-120 litres of water per bigha for spraying chemicals at mature stage of the crop (13) Majority of respondents (72%) had knowledge about red sign on pesticides' containers.(14) at the most 21 percent of respondents used thimet for soil treatment (15) at the most 27 percent of respondents used Dithane M-45 for seed treatment (16) according to the report of okra growers (100%), shoot and fruit borer was the most harmful insect-pest of okra crop (17) majority of respondents (69%) reported, yellow vein mosaic disease was the most harmful disease of okra crop(18) to control the insect-pests and diseases, respondents used various pesticides with their various brands and in various doses (19) generally, farmers used more amount of chemicals than the recommended amount (dose) for controlling insect-pests and diseases(20) the study also indicated that nowadays the mixed agro-chemicals are coming in market for controlling insect-pests and diseases (21) all the respondents (100%) reported that insect-pests and diseases mainly infested the crop at mature stage. Therefore, the various public extension agencies, pesticide companies and non-government organizations should re-orient their extension programmes on the basis of the findings of the present investigation.

INTRODUCTION

India is an agricultural country and agriculture plays a vital role in the economic development of India, which provides a livelihood to millions of people. The agricultural sector encompasses crop production, animal husbandry, fisheries, agribusiness etc. Crop production depends upon crucial inputs such as seeds, fertilizers, pesticides, irrigation water, human labour, machinery and management. To maximize agricultural production, appropriate and advanced technology is essential. Indian agriculture contributes to the National Gross Domestic Product about 17.60 percent on 2011-2012 prices and 48.90 percent of workforce of India depends on agriculture directly or indirectly according to Economic Survey 2015-16

(Shanthi,2016). The rapid and continuing increase in population implies a greater demand for food and nutrition. The growth rate of food grain production decelerated to 1.2 percent during 1990-2007, lower than the population growth of 1.9 percent. The contribution of agriculture and allied sector has fallen from 61 to 17.5 percent, in the last few years. Marked deceleration in agricultural growth is certainly a cause of serious concern. With per annum population growth still over 2.1 percent, it will touch 1.4 billion by 2030 and 1.7 billion by 2050 AD, needing annually about 380 million tonnes and 480 million tonnes food grain which account about 52.6 percent and 92.7 percent increase in food production respectively. Hence the task of providing food and nutrition to our vast population poses to be really daunting (Sarkar, 2015). The production and consumption of vegetables are most important to human diet for better health, because they possess high nutritive value and are rich source of carbohydrates, proteins, vitamins and minerals. In spite of this, the vegetable production is low, because improved vegetable production technologies are not fully adopted by the farmers at their own fields (Mohan and Helen, 2014). Among the all measures to raise the productivity level, plant protection is in central position. Plant protection is a basic exercise in any crop for control of insect-pests, diseases, weeds etc. to avoid economic losses. Reports indicate these losses ranging from 20-30 percent by each of the insect-pests, diseases and weeds, but on a holistic basis about 30 percent average cumulative loss by them appears a fair estimate. This implies that suitable control measures must be followed to keep these losses to the minimum (Muthuraman and Kumar, 2013). Pesticides are the chemical substances that kill pests such as fungi, bacteria, insects, rodents, worms and nematodes etc. that cause damage to field crops. Pesticides are insecticides, fungicides, bactericides, herbicides and nematodes that are used to control or inhibit plant diseases and insect-pests. Although, application of pesticides is necessary to augment crop yields but excessive use of these chemical pesticides has lead to the buildup of pesticide residues in the soil which in term hampers the soil biological property by inducing microbial imbalance, environmental pollution and creates health hazard through bio-accumulation in the higher animals and contaminates the water resources (Patil et al., 2016). The pollution of environment, loss of biodiversity, toxic residue in food, development of pest resurgence, outbreak, hazardous to consumers and elimination of natural enemies from crop ecosystem have well illustration in the recent years. This is the fact that 1% of pesticides are reaching to the target pest and rest of 99% is reaching to the non-target sectors (Kumar *et al*. 2015a). Maintaining the productivity level in a sustainable manner considering ecological balance with sound resource management would be key issue in the coming decades (Aswal and Sha, 2011). Among the crops, it is observed that vegetable cultivation is input intensive and care intensive cultivation. Vegetables are the one of the major users of plant protection chemicals. Vegetable growers' plant protection chemicals' use behaviour is dynamic in nature which requires regular research to know their existing use pattern and their future expectations on the basis of their felt problems. Therefore, collection of reliable information and knowledge about plant protection chemicals' use pattern of the vegetable growers becomes crucial for wide range of stakeholders. Considering the importance of the study, the objective –to portray the pesticides' use pattern of okra growers in controlling insect-pests and diseases was undertaken.

MATERIAL AND METHOD

The study was undertaken in the State of West Bengal. Multi-stage random sampling technique and universe method were adopted for the selection of area and respondents of the present study. At the first stage of sampling, North 24 Paraganas district was selected among the 19 agricultural districts of the State purposely based on its' comparatively higher area coverage in vegetable cultivation. Out of 21 blocks of the district, one block (i.e.Habra) was randomly selected at the second stage of sampling. In the selected block (Habra) a relatively homogenous field cultivated with vegetable crops was chosen on the basis of the opinion of the local agricultural input retailers and few progressive farmers of that locality. The farmers who were growing okra in the field were selected as respondents of the present study through total enumeration. Thus total 100 okra growers ultimately considered as respondents of the study. A well-structured interview schedule was prepared. Personal interview method was followed to collect data in local language for expecting exact responses. For analysis of the data statistically, simple percentage method was used to reach at meaningful results and conclusion.

RESULTS AND DISCUSSION

The data collection was done in North 24 Paraganas district of West Bengal. The district is famous for paddy, wheat, jute, potato and oilseed cultivation. Other main crops were various vegetables cultivation. Among the vegetable crops most identifiable ones were cabbage, cauliflower, tomato, brinjal and okra.

Level of education (table-1) **:-** The study revealed that at the most 73 percent of respondents had upto primary level of education and at the lowest 5 percent of respondents had graduate and above level of education. Other levels of education were secondary level (13%) and higher secondary level (9%).

Table-1 Level of education (N=100)

Level of education	Number of respondents possessed	Percentage of respondents possessed
Primary level	73	73
Secondary Level	13	13
Higher secondary level	9	9
Graduate level and above	5	5

Own cultivable land (table-2):- The table indicates that at the most 50 percent of respondents had 1.1-3.0 bigha of own cultivable land whereas at the lowest 23 percent of respondents had 3.1-5.0 bigha of own cultivable land. The other category was upto 1.0 bigha (27%).

Table-2 Own cultivable land (N=100)

Land possessed (bigha)	Number of respondents	Percentage of respondents
Upto 1	27	27
1.1-3.0	50	50
3.1-5.0	23	23

Vegetable cultivable land (table-3):- The table indicates that at the most 47 percent of respondents had upto 1.0 bigha of

land for vegetable cultivation whereas at the lowest 20 percent of respondents had 3.1-5.0 bigha of land under vegetable cultivation. Other category was 1.1-3.0 bigha (33%). The finding reveals that day by day per capita land holding of farmers is decreasing due to population explosion.

Table-3 Vegetable cultivable land (N=100)

Land possessed (bigha)	Number of respondents	Percentage of respondents
Upto 1 bigha	47	47
1.1 to 3.0 bigha	33	33
3.1 to 5.0 bigha	20	20

Number of years cultivating vegetables (table-4) :- The table expressed that at the most 37 percent of respondents had 6-10 years of experience in vegetable cultivation whereas at the lowest 5 percent of respondents had 26-30 years of experience in vegetable cultivation. Other categories were- upto 5 years (21%), 11-15 years (10%), 16-20.years (19%) and 21-25 years (8%).

Table-4 Number of years cultivating vegetables (N=100)

Number of years cultivating vegetables	Number of respondents	Percentage of respondents
Upto 5	21	21
6-10	37	37
11-15	10	10
16-20	19	19
21-25	8	8
26-30	5	5

Number of years applying pesticides (Table-5):- The table indicates that at the most 43 percent of respondents had 11-20 years of experience in pesticides application and at the lowest 14 percent of respondents had upto 5 years of experience in pesticides application. Other categories were - 6-10 years (16%) and 21-30 years (27%). It is clear from the study that vegetable cultivation mostly depends on pesticides application to protect the crops from infestation of insect-pests and diseases.

Table-5 Number of years applying pesticides (N=100)

Number of years applying pesticides	Number of respondents	Percentage of respondents
Upto 5 years	14	14
6-10 years	16	16
11-20 years	43	43
21-30 years	27	27

Season (table-6) :- At the most 80 percent of respondents cultivated the crop in kharif season whereas 41 percent of them preferred to cultivate it in rabi season and only 30 percent of okra growers cultivated the crop in pre-kharif season. It is clear from the study that okra is a round the year crop and have market demand always.

Table-6 Season (N=100)

Season	Number of respondent cultivated	Percentage of respondent cultivated
Kharif	80	80
Rabi	41	41
Summer	30	30

Interval of applying pesticides (table-7):-Respondents in the study area preferred to apply pesticides in the following days' interval-1-3 days (43%), 4-7 days (33%), 8-15 days (17%) and more than 15 days (7%).

Table-7 Interval of applying pesticides (N=100)

Days interval	Number of respondent applied	Percentage of respondent applied
1-3	43	43
4-7	33	33
8-15	17	17
More than 15	7	7

Methods of applying pesticides (table-8): **-**All the respondents in the study area (100%) applied pesticides mainly through spraying whereas 29 percent of okra growers followed dibbling method (digged the soil and the pesticides were inserted and filled the hole by soil again especially application of granular pesticides) and only 17 percent of selected farmers also applied the chemicals by following dusting method.

Table-8 Method of application of pesticides (N=100)

Method	Number of respondent applied	Percentage of respondent applied
Spraying	100	100
Dibbling	29	29
Dusting	17	17

Personal source of information in using pesticides (table-9): **-** At the most cent percent of respondents' (100%) main source of information in using pesticides was agricultural input retailers who provided information mainly at the time of purchasing whereas at the lowest 5 percent of respondents collected information from relatives and 9 percent of respondents collected information from experts of agricultural university when they participated any training programme at university or personally. Other categories in this regard are the followings:- Fellow farmers (23%), Neighbours (14%), Big farmers (16%), ADOs & KPS (18%), Company personnel (26%) and Agricultural fair (11%). After collecting the information from various sources, each respondent evaluated it in their level best and finally applied the suitable one. Tandel et al. (2014) reported that okra growers knowledge regarding selected scientific innovations for demonstrations was high except integrated pest management (14%).

Table-9 Personal sources of information on pesticides' use (N=100)

Personal source	No. of respondents collected	Percentage of respondents collected
Agricultural input retailers	100	100
Fellow farmers	23	23
Neighbour	14	14
Big farmers	16	16
Relatives	5	5
ADOs and KPSs	18	18
Experts of Agril. University	9	9
Company personnel,	26	26
Agricultural Fair	11	11

(ADO=Agricultural Development Officer; KPS=Krishi Prayukti Sahayak)

Impersonal sources of information on pesticides' use (table-10):- Still, Radio is playing an important role in disseminating agricultural technologies to farming communities. It is a very convenience mass media to access information compare to other impersonal media and it was reported by nearly half of respondents (46%). At the lowest 4 percent of respondents told they collected information from book. Other impersonal

sources were- T.V. (25%), Newspaper (9%), magazine (6%), internet (5%) and kisan call centre (7%)

Table-10 Impersonal sources of information on agro-chemicals' use (N=100)

Impersonal source	No. of respondents collected	Percentage of respondents collected
Radio	46	46
T.V.	25	25
Newspaper	9	9
Book	4	4
Magazine	6	6
Internet	5	5
Kisan call centre	7	7

Amount of water used for spraying (table-11):- For application of pesticides, per bigha water requirement was 40 to 60 litre at seedling stage and it was followed by majority of respondents (74%). At mature stage, water requirement for spraying was 100-120 litre per bigha and it was followed by majority of the respondents (66%).

Table-11 Amount of water used for spraying (N=100)

Crop stage	Amount of water required for spraying (per bigha)	Number of respondent followed	PRF
Seedling stage	40-60	74	74
Mature stage	100-120	66	66

(PRF= Percentage of respondent followed)

Knowledge about various sign on pesticides packets/containers (table-12):- On pesticides packets or containers, there are four signs i.e. green (Slightly toxic), blue (Moderately toxic) , yellow (Highly toxic) and red (Extremely toxic). An attempt was made to know their knowledge about these signs. It is clear from the table-12 that majority of farmers had knowledge about green sign (53%) and red sign (72%) but majority of respondents had lack of knowledge about blue sign (60%) and yellow sign (64%).

Table-12 Knowledge about various sign on pesticides packets/containers

Various signs on pesticides products	Intensity of toxicity	Known	Unknown
Green	Slightly toxic	53	47
Blue	Moderately toxic	40	60
Yellow	Highly toxic	36	64
Red	Extremely toxic	72	28

Soil treatment (table-13) :- There are many soil borne inset-pests and diseases those infest the crop. To prevent that incidence, the respondents of the study area applied various pesticides. They generally applied two chemical mainly these are –Phorate 10 G (21 percent of respondents applied @ 1-2 kg per bigha) and Carbafuran 3G (13 percent of respondents applied @ 2-5 kg per bigha).

Table-13 Soil treatment (N=100)

Name of pesticides	Commercial name	Recommended dose (per bigha)	Applied dose (per bigha)	No. of respondents applied
Phorate 10G	Thimet	1.5 kg	1-2 kg	21
Carbafuran 3G	Furadon	4 kg	2-5 kg	13

Seed treatment (table-14):- Seed treatment refers to the application of fungicides, insecticides, or a combination of both, to seeds so as to disinfect and disinfect them from seed borne pathogenic organisms and storage insects. Many diseases can be controlled by a simple chemical seed treatment. Plant disease organisms survive from season to season through spores carried on or in seeds. Some chemical seed treatments provide a protective zone around the seed through which soil-borne organisms cannot penetrate. It was seen that in study area 27 percent of respondents used Dithane M-45 @2.5-4 gm/kg of seed for seed treatment and only 18 of respondents used Bavistin @2-3 gm/kg of seed for seed treatment. Okra growers also reported information that nowadays purchased seeds are already treated by companies or sellers; therefore, there is no need to treat those seeds again. Mariselvam et al.(2012) revealed that seed biopriming with *Pseudomonas fluorescens* @ 60% for 12 hours in combination with foliar spray of *P. fluorescens* @ 2gm per litre of water on 30 and 45 days after sowing promoted the growth and early flowering , minimized the pests and diseases incidence and enhanced the seed yield of bhendi.

Table-14 Chemicals used for seed treatment (N=100)

Name of pesticides	Commercial name	Recommended dose (per kg seed)	Applied dose (per kg seed)	No. of respondents applied
Mancozeb 75% WP	Dithane M-45	3 gm	2.5-4 gm	27
Carbendazim 50% WP	Bavistin	2 gm	2-3 gm	18

Major insect-pests of okra:- (table-15):- There are several insect-pests of okra crop i.e. shoot and fruit borer, green jassids or leaf hoppers, white fly, red spider mite, red cotton bug (*Dysdercus cingulatus*), leaf roller (*Sylepta derogata*), pink boll worm (*Pectinophora gossypiella*), grey weevils (*Myllocerus spp.)* etc. Out of these, four insect-pests were identified as most harmful in the study area. Shoot and fruit borer was one of most harmful insect-pests of okra and it was reported by cent percent of respondents (100%) in the study area. Leaf hopper, white fly, and red spider mite were other prominent insect-pests in the study area and it was reported by 49 percent, 41 percent and 37 percent of respondents respectively. Joshi and Ghadage (2011) reported that okra is a popular vegetable grown all over India and the crop is attacked by several insect-pests causing considerable damage. Among which shoot and fruit borer, *Earias vittella* is the most important polyphagous pest causing direct damage to marketable fruits with 80 percent net yield loss in okra. Jakhar (2014) reported that need based application of Azadirachtin@ 3 ml/litre, need based application of Profenophos 50EC @ 2.5ml/litre, need based application of Thiamethoxam 25% WG @ 0.5gm/litre, need based application of Propergite 57% EC @ 20ml/10 litre of water and need based application of Indoxacarb 14.5% EC @ 4.5ml /10 litre of water were the effective treatments against the major pests of okra. Rawal et al.(2011) conducted a study and the result of the study indicated that 65.83 percent of respondents possessed medium level of pesticides use behaviour whereas 20.00 and 14.17 percent okra growers had low and high level of pesticides use behaviour. It was further observed that pesticides namely, Malathion 50 EC, Phorate 10G and Imidacloprid 200 SL were mostly used by majority of the okra growers for controlling insect-pests of okra. Likewise, Bavistin, Rogor,Thiram, Malathion 50 EC were also using commonly for controlling diseases in okra. It was also observed that there was no

significant difference in pesticide use behaviour among the okra growers of selected villages

Table-15 Major insect-pests of okra (N=100)

Name of insect-pest	Number of respondents reported	Percentage of respondents reported
Shoot and Fruit borer	100	100
Leaf hopper	49	49
White fly	41	41
Red spider mite	37	37

Shoot and fruit borer (Earias fabia) (Table-16) : - The larvae bore into the shoots, flower buds, flowers and fruits and cause severe shedding of the fruits or killing the plants. The affected fruits become distorted and unfit for human consumption. The moth has a yellowish head and thorax. The forewings are pale white and have a broad, wedge-shaped, greenish band in the middle. The chemicals used for controlling the insect-pest, their doses and percent of respondents reported were the following: Ostaad @2.0ml/litre of water (28%), Metacid @1.0ml/litre of water (26%), Monocil @2.5ml/litre of water (9%), Rogor @1.5 ml/litre of water (13%), Ekalux @1.5 ml/litre of water (16%), Tarjan @ 2.0 ml/litre of water (19%), Coragen@1ml/5litre of water (8%) and Fame @1ml/5litre of water (11%). Katti and Surpur (2015) reported that among the newer insecticide molecules evaluated, flubendiamide 480 SC @ 60g a.i. /ha and flubendiamide 480 SC @ 48g a.i. /ha were superior in recording less shoot damage (8.7% and 10%), lower fruit damage (5.7% and 9%) and higher fruit yield (113q/ha and 104q/ha), followed by Cypermethrin 10EC @ 50g a.i. /ha.

Table-16 Shoot & fruit borer of okra and doses of various chemicals used to control (N=100)

Name of pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose (per litre of water)	PRA
Cypermethrin 10 % EC	Ostaad	1.0ml	2.0ml	28
Methyl Parathion 50% EC	Metacid	1.0ml	1.0ml	26
Monocrotophos 36 % EC	Monocil	1.5ml	2.5ml	9
Dimethoate 30 % EC	Rogor	2.0ml	1.5ml	13
Quinalphos 25 % EC	Ekalux	2.0ml	1.5ml	16
Triazophos 20 % EC	Tarjan	1.0ml	2.0ml	19
Chlorantraniliprole 18.5 SC	Coragen	1ml/5litre	1ml/5litre	8
Flubendiamide 39.80 SC	Fame	1ml/5litre	1ml/5litre	11

(PRA=Percentage of Respondents Applied)

***Leaf hopper (Amrasca biguttula biguttula) (table-17)*: -**Both the nymphs and adults suck sap from the leaves and tender plant parts and secrete some toxic material. The leaves turn pale and curl upward. The leaves exhibit a burnt appearance and fall down in case of severe infestation. The adult hoppers are greenish yellow during summer while reddish in winter. They are wedge-shaped.

Table-17 Leaf hopper insect-pest of okra and doses of various chemicals used to control (N=100)

Name of pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose per litre of water	PRA
Cartaf Hydrochloride 50% S.P.	Kritaf	1.0 gm	1.0 gm	25
(Deltamethrin 1% EC+Triazophos 35%) EC	Spark	1.5 ml	1.5 ml	9
Cypermethrin 10% EC	Ostaad	1.0 ml	1.5 ml	22
Phosphamidon 40% EC	Sumidon	1.5 ml	2.0 ml	21
Quinalphos 25% EC	Suquin	2.0 ml	1.0 ml	18
Imidachloprid 17.8 SL	Confidor	3ml/5litre of water	3ml/5litre of water	5

(PRA=Percentage of Respondents Applied)

The pest was controlled by applying the following insecticides, their doses and percent of respondents reported were also given with it, Kritaf @ 1.0gm per litre of water (25%), Spark @ 1.5ml/litre of water (9%). Ostaad @ 1.5ml/litre of water (22%). Sumidon @ 2.0ml/litre of water (21%), Suquin @ 1.0ml/litre of water (18%) and Imidachloprid 17.8 SL @ 3ml/5 litre of water (5%). Habil and Kumar (2014) revealed that from the nine different chemical insecticides [Imidacloprid 17.08 SL (0.04%), Acephate 75 SP (0.15%), Chlorpyriphos 20 EC (0.1%), Cypermethrin 25 EC (0.03%), Malathion 50 EC (0.05%), Spinosad 45 EC (0.01%), Methyl dematon 25 EC (0.05%), Indoxacarb 14.5 SC (0.01%) and Quinalphos 25 EC (0.05%)], Imidacloprid 17.08 SL at 0.04% was most effective against jassid on okra. The next best treatment was Cypermethrin 25 EC at 0.03%.

White fly (Bemisia tabaci) (table-18):- The adults suck the sap of the leaves and transmit the yellow vein mosaic virus. The viral disease spreads too many plants if this vector is not controlled. The insect-pest was controlled by applying the following insecticides, their doses and percent of respondents reported were also given with it: Rogor @ 2.0ml/litre of water (12%), Kritaf @2.0gm/litre of water (41%), Cyperin @1.0ml/litre of water (5%), Sumidon @1.0ml/litre of water (3%) and Imidachloprid17.8 SL @ 3ml/5 litre of water (3%). Venkataravanappa et al. (2011) reported that the seed treatment with Imidacloprid FS (5g/kg) and 4 spraying of Imidacloprid SL (0.5ml/litre) combination with neem oil 0.03 EC (2.0ml/litre) at 15 days interval starting two weeks after germination had significant effect on reduction of white fly population, spread of bhendi yellow vein mosaic virus (BYVMV) and increased the bhendi yield.

Dave et al. (2011) reported that regarding the component of insect and pest control it was found that participants were facing the problem of white fly insect and they were using Rogor along with its recommended quantity for protection of plant from insects. In case of disease control, participants are using improved varieties of seeds therefore, it reduces the problem of plant disease, 18.8 percent of respondents had problem of yellow vein mosaic disease in their crop, out of which 13.3 percent had cured the disease by using 0.52-1 litre / ha of Rogor pesticides, other disease was not found in their

area. In respect of seed treatment, it was seen that more than half of the participants were using Phorate 10G but the quantity was insufficient.

The characteristic symptoms of the disease are a homogeneous interwoven network of yellow veins enclosing islands of green tissues.

Table-18 White fly insect-pest of okra and doses of various chemicals used to control (N=100)

Name of pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose (per litre of water)	PRA
Dimethoate 30% EC	Rogor	2.0 ml	2.0 ml	12
Cartaf Hydrochloride 50% SP	Kritaf	1.0 gm	2.0 gm	41
Cypermethrin 10% EC	Cyperin	1.0 ml	1.0 ml	5
Phosphamidon 40% EC	Sumidon	1.5 ml	1.0 ml	3
Imidachloprid 17.8 SL	Confidor	3ml/5litre of water	3ml/5litre of water	3

(PRA=Percentage of Respondents Applied)

Red spider mite (Tetranychus cinnabarinus) (table-19) :-The nymphs and adults suck the sap from the leaves and other tender parts. The infested leaves fall down and cause defoliation. The agro-chemicals used by the farmers for controlling the pest, their doses and percent of respondents reported were as follows:- Colonel-S@ 2.0ml/litre of water (59%), Metasystox @ 3.0 ml/litre of water (23%), Rogor @ 2.0ml/litre of water (9%), Thiodan @ 2.0 ml/litre of water (5%) and Sumidon@ 1.5 ml/litre of water (4%).

Initially infected leaves exhibit only yellow coloured veins but in the later stages, the entire leaf turns completely yellow. In extreme cases, the infected leaf becomes totally light yellow or cream coloured and there is no trace of green colour. At times, enations (raised structures) are observed on the under surface of infected leaf. Plants infected in the early stages remain stunted. The fruits of the infected plants exhibit pale yellow colour, deformed, small and tough in texture.

Table-19 Red spider mite of okra and doses of various chemicals used to control (N=100)

Name of pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose (per litre of water)	PRA
Dicofal 18.5 % EC	Colonel-S	1.5ml	2.0ml	59
Methyl Demeton 25% EC	Metasystox	2.0ml	3.0ml	23
Dimethoate 30% EC	Rogor	2.0ml	2.0ml	9
Endosulfan 35% EC	Thiodan	2.0ml	2.0ml	5
Phosphamidon 40% EC	Sumidon	1.5 ml	1.5 ml	4

(PRA=Percentage of Respondents Applied)

Major diseases of okra (table-20):- There are several diseases of okra i. e. damping off, Fusarium wilt (*Fusarium oxysporum*), leaf spot, powdery mildew, yellow vein mosaic, root knot nematode (*Meloidogyne incognita*), dry root rot (*Macrophomina phaseoli*). Out of these, four diseases were identified most harmful in the present study area. At the most 69 percent of respondents reported that they had the problem due to infestation of yellow vein mosaic disease which was generally known as "Saheb Rog" whereas 35 percent of respondents had the problem of powdery mildew disease of okra, 28 percent of respondents had Cercospora leaf spot disease and at the lowest 14 percent of respondents had damping-off disease in okra crop. Singh et al. (2014) reported that the important insect-pests of okra are jassids, fruit and shoot borer and root knot nematode whereas important disease is yellow vein mosaic. Jakhar (2014) reported that seed treatment with Imidacloprid 70 WS @ 5g/kg seed, mechanical collection and destruction of the infected fruits of *Earias* larvae, installation of yellow sticky traps for jassids and white flies @ 5/ha, need based application of Azadirechtin@ 3ml/litre and need based application of Profenophos 50%EC @ 2.5ml/litre of water were the most effective and economical (ICBR 1:11.4) treatment against shoot and fruit borer (*Earias vittella* F.), Yellow vein mosaic virus, white fly (*Bemisia tabaci* Genn.), leaf hopper (*Amrasca biguttula biguttula)* and red spider mite (*Tetranychus cinnabarinus*, Boisd.).

Yellow vein mosaic disease (Yellow vein mosaic virus**)** (**table-21**): **-**This is the most important and destructive viral disease in bhindi. The disease infects at all the stages of crop growth and severely reduces growth and yield. The disease is transmitted by white fly.

General recommendations to prevent these disease are (1) removal and destruction of virus affected plants (2) planting of disease resistant varieties reduces the disease incidence (3) controlling the white fly population minimizes the incidence of YVMV. Maurya (2015) reported that yellow vein mosaic disease is the most serious disease of okra. Removal of weeds susceptible to mosaic from nearby fields, control of white fly by uprooting and burning of affected plants from field and spray Rogor @ 5ml in 10 litre of water or Methyl Demeton @ 10ml in 10 litre of water at 7-10 days interval. Adjusting the time of sowing and cultivation of resistant varieties like Arka Anamika, Arka Abhay, Susthira etc. are recommended for raising a disease free crop. Jaiganesh and Eswaran (2013) reported that yellow vein mosaic is the most serious disease of bhendi. Also, this is the main limiting factor in cultivation of bhendi. Whenever, this crop is grown in India, the virus disease is prevalent especially in the rainy season crop. Jaiganesh and Eswaran (2013) expressed that ways to manage bhendi yellow vein mosaic. According to them considerations are –(1) diseased plants should be rouged and destroyed (2) the wild weed hosts should be eradicated (3) crop rotation should be followed (4) the varieties-Arka Abhay, Arka Anamika, Parbhani Kranti are highly resistant (5) spraying with insecticides Follidol (0.3%) reduces the spread of the disease (6) soil application of Carbofuran 3G @ 1.5kg a.i. /ha at the time of sowing followed by 4 or 5 foliar sprays of Methyl Demeton@ 0.02%

Table-20 Major diseases of okra (N=100)

Name of disease	Number of respondents reported	Percentage of respondents reported
Yellow vein mosaic	69	69
Powdery mildew	35	35
Leaf spot	28	28
Damping-off	14	14

to manage the vector (7) sowing of 4 lines of either sorghum or pearl millet or maize all round the main bhendi plots to reduce the disease incidence. The table- 21 indicates that at the most 45 percent of farmers sprayed Dithane M-45 @ 2.50-3.00 g/litre of water for controlling the disease whereas other chemicals were- Bavistin @1.0 g/litre of water (15%), Furadon @ 1kg a.i. /ha (9%), Rogor@ 2.00ml/litre (28%), Metasystox@ 2.00ml/litre (20%) and Nuvacron @ 1.50-2.00ml/litre (13%). Most of the respondents told that the disease was a non-curable disease and finally they uprooted the plants. The information provided by them was true because yellow vein mosaic disease is a viral disease and controlling viral disease is quite difficult. The study obviously opened the matter that farmers had lack of knowledge to identify the real cause of happening of this disease.

infected leaves become yellow, then become dry and brown. Extensive premature defoliation of the older leaves can ensue if the disease is not controlled. Healthy, vigorous leaves and stems are less prone to infection. Plants under nutritional stress in most cases will develop powdery mildew much sooner than plants the same age grown under a good nutritional programme. Hence the plant should be well manured and application of fertilizers should be done on the basis of standard recommendations.

The severely affected leaves turn yellow and drop off. The chemicals used by the respondents, their doses and percentage of respondents applied were – Bavistin @1.0gm/litre of water (7%), Indofil M-45 @2.5-3.0gm/litre of water (16%), Thiovit @2.0-3.0 g/litre of water(28%) and Theme@ 1.00gm/litre of water (15%).

Leaf spot (table-23):- Causal organism –*Cercospora abelmoschi.* The fungus grows as a shooty mould on the lower surface of the leaves. Badly affected leaves roll, wilt and fall down. The disease causes severe defoliation during humid seasons. General recommendation to prevent the disease is removal and destruction of diseased plant materials. The fungi survive through the conidia and stromata on the diseased plant debris in the soil.

Table-21 Yellow vein mosaic disease of okra and doses of various pesticides used to control (N=100)

Name of the pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose (per litre of water)	PRA
Carbofuran 3G	Furadon	1 kg a.i. /ha	1 kg a.i. /ha	9
Dimethoate 30% EC	Rogor	2.00 ml	2.00 ml	28
Oxydemeton Methyl 25% EC	Metasystox	2.00 ml	2.00 ml	20
Monocrotophos 36% EC	Nuvacron	1.50 ml	1.50-2.00 ml	13
Mancozeb 75% WP	Dithane M-45	2.50 gm	2.50-3.00 gm	45
Carbendazim 50% WP	Bavistin	1.00 gm	1.00 gm	15

(PRA= Percentage of respondents applied)

Powdery mildew (*Erysiphe cichoracearum*)**(table-22**): **-** The disease is found mainly on the older leaves and stems of plants. Yields of many of the infected vegetables are reduced due to premature foliage loss. Increased humidity can increase the severity of the disease, and infection is enhanced during periods of heavy dew. The disease symptoms appear as subtle, small, round, whitish spots on leaves and sometimes stems. The spots enlarge and coalesce rapidly and a white mass resembling talcum powder becomes evident on the upper surface of older leaves or other plant parts. Young leaves are almost immune. A large part of the talc-like powder on the leaf surface is composed of spores. These spores are easily blown by winds to nearby susceptible plants. Heavily

The pesticides used by the farmers for controlling the disease, their doses and percent of respondents applied were as follows:- Blitox-50 @4.0gm/litre of water (24%), Indofil Z-78 @ 2.50-3.00 gm/litre (7%), Bavistin @1.0 gm/litre of water (2%), Captan @2.50-3.00 gm /litre of water (6%) and SAAF @ 2.00gm/litre of water (4%). Kumar *et al*. (2015b) reported that among the 13 fungicides, only three fungicide viz. Tebuconazole, Propiconazole and Bavistin had 100 percent radial growth of cercospora leaf spot and proved to be the most effective as they have inhibited the fungus growth. In field conditions maximum seed germination (98.33%), minimum disease incidence (0.17%) and maximum fruit yield

Table-22 Powdery mildew disease of bhindi and doses of various chemicals used to control (N=100)

Name of the pesticides	Commercial name	Recommended dose (per litre of water)	Applied dose (per litre of water)	Percentage of respondents applied
Carbendazim 50% WP	Bavistin	1.00 gm	1.00 gm	7
Mancozeb 75%WP	Indofil M-45	2.50 gm	2.50-3.00 gm	16
Sulphur 80%WP	Thiovit	3.00 gm	2.00-3.00 gm	28
Thiophanate Methyl 70% WP	Theme	1.00gm	1.00gm	15

Table-23 Leaf spot disease of okra and doses of various pesticides used to control (N=100)

Name of the pesticides	Commercial name	Recommended dose per litre of water	Applied dose per litre of water	PRA
Copper oxychloride 50% WDP	Blitox-50	4.00 gm	4.00 gm	24
Zineb 75%WP	Indofil Z-78	2.50 gm	2.50-3.00 gm	7
Carbendazim 50% WP	Bavistin	1.00 gm	1.00 gm	2
Captan 50% WP	Captan	2.50 gm	2.50-3.00 gm	6
Carbendazim 12%+Mancozeb 63%	SAAF	2.00gm	2.00gm	4

(PRA= Percentage of respondents applied)

145.16q/ha was recorded in treatment of three foliar spray of the Tebuconazole (0.1%).

Damping off *(Pythium aphanidermatum)* **(table-24):-** Cool, cloudy weather, high humidity, wet soils, compacted soil, and overcrowding especially favour development of damping-off. Damping–off kills seedlings before or soon after they emerge. Infection before seedling emergence results in poor germination. If the decay is after seedlings emergence, they fall over or die which is referred to as "damp-off." The destructiveness of the disease depends on the amount of pathogen in the soil and on environmental conditions. Seedlings that emerge develop a lesion near where the tender stem contacts the soil surface. The tissues beneath the lesion become soft due to which the seedlings collapse. General recommendations for this disease are – (1) excess irrigation should be avoided to reduce humidity around the plant (2) the field should be regularly inspected for the disease-affected seedlings. Such seedlings should be removed and destroyed. The disease was controlled by applying the following fungicides, their doses and percentage of respondents applied were also given with it, Agrosan@2.0gm/kg of seed (6%), Thirax @ 3.0gm/kg of seed (3%), Captan @ 3.0gm/kg of seed (5%) and Trichoderma@ 3-4g/kg of seed (4%), Dithane M-45 @ 0.2% (3%) and Bavistin @ 0.1% (3%) for soil drenching.

Sometimes few farmers tried to blend chemicals by mixing two or three chemicals together (7) Farmers have the common tendency to use more amounts of chemicals over the recommended one (8) Pesticides products have two names- one is technical name or chemical name and other is commercial name or trade name or brand name. Commercial names are changed year after year or various pesticides companies have their own commercial name. Due to lack of this knowledge, farmers considered any new commercial name as new pesticide (9) The agricultural personnel or extension personnel who will visit a village for his purpose must have sound knowledge about plant protection aspects because; farmers generally ask several questions on this aspect (10) It is seen from the study that farmers were applying lot of chemicals to control insect-pests and diseases, but it is partially true. Actually one application of one pesticide for any insect-pest and disease sometimes affects on other insect-pests and diseases also. Therefore, practically farmers were using limited numbers of pesticides (11) Farmers /respondents in the study area were not following various precautions in pesticides use properly.

Table-24 Damping off disease of okra and doses of various pesticides used to control (N=100)

Name of the pesticides	Commercial name	Recommended dose	Applied dose	PRA
Phenyl mercury acetate + Ethyl mercury chloride	Agrosan GN	2.0gm/kg of seed for seed treatment	2.0gm/kg of seed	6
Thiram	Thirax	3.0gm/kg of seed for seed treatment	3.0gm/kg of seed	3
Captan 50% WP	Captan	3.0gm/kg of seed for seed treatment	3.0gm/kg of seed	5
Trichoderma viride	Trichoderma	3-4g/kg of seed for seed treatment	3-4g/kg of seed	4
Mancozeb 75%WP	Dithane M-45	0.2% for soil drenching	0.2%	3
Carbendazim 50% WP	Bavistin	0.1% for soil drenching	0.1%	3

(PRA= Percentage of respondents applied)

Insect-pests and diseases and their infestation stage (table-25):-All the respondents in the study area (100%) reported that Insect-pests and diseases mainly infested at mature stage of the crop.

Considerations emerged from the present investigation: - (1) more emphasis should be given on education (2) majority of the farmers are small and marginal farmers in the study area

Table-25 Crop stage of infestation (N=100)

Name of insect-pest	Crop stage of infestation	Name of disease	Crop stage of infestation
Shoot and Fruit borer	Early to mature stage	Yellow vein mosaic	Mature stage
Leaf hopper	Early to mature stage	Powdery mildew	Mature stage
White fly	All the stages	Leaf spot	Mature stage
Red spider mite	Mature stage	Damping off	Seedling stage

Few of observations in the present study: - (1) A certain percentage of farmers were applying pesticides in morning and harvesting the crop in afternoon (2) A certain percentage of farmers applied pesticides before appearance of insect-pests and diseases. According to their view, it will protect the crop from infestation of insect-pests and diseases in a better way (3) A certain percentage of farmers reported that for their home consumption, they cultivated vegetables in a small piece of land and there they never applied pesticides, but for commercial purpose they applied pesticides (4) Sometimes agricultural input retailers sold expired pesticides products to farmers by convincing them intensely (5) Among the three types of pesticide products i.e. liquid, dust and granular, liquid chemicals provide comparatively better result (6) (3) experience of the farmers should be up-to-dated by providing new information, new technology as well as short-term training on various aspects of cultivation as well as plant protection aspects (4) okra crop can be cultivated round the year though the farmers mainly cultivated in kharif season due to lack of irrigation water. Therefore, in vegetable cultivation irrigation water is an important basic input (5) okra growers interval of pesticides use pattern obviously indicates that they are not following precautions properly in pesticides application (6) all the farmers preferred spraying method for pesticide application means liquid pesticides are more effective than granules and dust pesticides (7) agricultural input retailers still playing a major role in providing information to farmers regarding pesticides use (8) radio is

still playing a major role for mass awareness regarding various aspects of cultivation in rural areas (9) there is difference in using amount of water for spraying chemicals at seedling stage and mature stage of the crop (10) according to nature of insect-pests and diseases, soil treatment should also be considered as an important starting point of plant protection measures (11) seed treatment should be considered as an essential activity of cultivation (12) at mature stage of the crop, farmers should be more careful to protect the crop from insect-pests and diseases (13) integrated approach is needed to control shoot and fruit borer of okra (14) integrated approach is needed to control yellow vein mosaic disease of okra (15) it is observed that farmers are using various brands of a particular chemical considering those as different chemicals. It obviously indicates that farmers have insufficient knowledge regarding various brands of chemicals. (16) farmers are not applying recommended doses of pesticides, therefore, it is an important focus area of extension activities (17) mixed agro-chemicals are gaining popularity day by day due to their effectiveness. (18) pesticides should be available in small packets or containers, therefore, it will be highly useful for marginal and small farmers.

CONCLUSION

Cultivation of high yielding varieties is an input intensive technology. Therefore, more fertilizers, pesticides, herbicides, irrigation water etc. were applied to field. Initial years of green revolution, it was not a problem, but gradually, it had become a great problem. Among the several activities to grow a crop (package of practices), farmers are confident enough all these activities (upto a certain extent or according to their level best) except plant protection activities. Application of plant protection measures is a complex technology where farmers' lack of proper understanding (knowledge) make the matter more complex as well as brings psychological disappointment in the mind of farmers. The outcomes thus, suggest that the extension personnel are required to strengthen their efforts to educate the okra growers on various aspects of pesticides use. There is also need to give regular exposure through mass media to the okra growers on the latest scientific information regarding plant protection aspects in general and pesticides use in particular and the extension agency needs to follow a systematic, well-planned and co-ordinated approach for improving the knowledge status of okra growers regarding proper pesticides use. In developed countries, especially U.S.A. and U.K. only 2 percent of population of their countries are managing agriculture, but in our country 64 percent of populations are involved in agriculture though, they are unable to manage agriculture properly. The central cause is lack of education in our countrymen. Therefore, first and foremost, our government must have strict measures to educate all the countrymen, because, education trains one to think clearly and act rightly.

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