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Control of Codling Moth (*Cydia pomonella*) in Ladakh by different Methods to Save Fruit Industry

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ABSTRACT: The aim of the present work is to study the codling moth infestation rate and its control by using different techniques. To calculate the population of codling moth from the orchard's of Ladakh for the sake of convenience three orchards were selected from the Union territory of Ladakh. In which the delta traps were installed in Basgoo to monitor the population of codling moth and to see the effect of delta traps on the infestation caused by codling moth. Delta traps containing lures loaded with codlimone (E, E)-8, 10-doddecadien-1-ol the sex attractant which attracts male moths towards trap. Another orchard was selected from the Nurla in which 3 insecticide were sprayed. The insecticide sprayed was chlorpyriphos @1ml per 1 litre. Another orchard Nimmu was taken as control in which no chemical or matting disruption material was dropped. The three traps were also installed in all the selected orchard's to monitor the population of codling. According to the plan the visits were conducted and the result was noticed to obtain the infestation rate and to analyze the population of codling moth from the selected orchards. The orchards with heavy infestation were measured in relation to the low-infested orchards of another area containing equal number of trees. The population of the codling moth was also noticed during the three visits to these selected orchard's in which the traps were installed and finally that was calculated. The table results clearly indicated that the orchard Nimmu was heavily infested followed by Basgoo and Nurla. Finally the data taken from the orchards was correlated with the each other to see the effect of traps on the infestation rate caused by codling moth in Ladakh.

Keywords: Moths, infestation, delta traps, orchard's.

I. INTRODUCTION

Ladakh is characterized by severe and awesome climatic conditions viz; high solar intensity, low humidity and winds; hampering the quality and economic production of fruits. Ladakh is world famous for different types of fresh and dry fruits like apple, apricot, walnut etc. The fruit industry in Ladakh provides source of income for a huge section of Ladakh is and helps in maintaining their economy in this arid desert. The distribution of apple and its quality in the region is scanty low compare to apricot and wall nut due to scarcity of water and other environmental factors occurring in limiting domains. There are various doctrine commenting upon the invasion of codling moth into Ladakh however most of the workers believe that Codling moth (*Cydia pomonella*) have entered into Ladakh from Pakistan and Afghanistan (North West border) and created havoc to the apple orchard's of the region and a big menace to the growth and development of apple industry in the area. Presently this pest is the most persistent, destructive and difficult pest to control among the insect-pests of apple fruits (Pawar *et al.*, 1971). To avoid and restrain its spreads to the neighbor apple growing areas, specifically in Himachal Pradesh and Kashmir valley, the marketing and supply of apple produce from Ladakh region is restricted through various quarantine measures.

Codling moth (*Cydia pomonella*) belongs to the order Lepidoptera of family Tortricidae of class insecta. It is considered a serious pest of various agricultural crops throughout the world. In India its distribution is restricted to Ladakh newly created union territory of India. It attacks almost every variety of apples in Ladakh. Moreover its attack on apricot and walnut has also been observed. Structurally a Codling moth (*Cydia pomonella*) adult is about one inch long with a typical coppery sport on wings and has greyish brown body colour (Kumari *et al.*, 2016). The larva has three stages small larva, medium larva and large larva. It overwinters as full-grown larva within thick silken cocoon under loose scale of barks and in soil or debris around the base of the tree. The larva pupates inside their cocoon in early spring and emerges as adult moths in mid-march to early April. An adult female of codling moth lays eggs on fruits and leaf surfaces which lie in

the close proximity of fruit. Then after 3-5 days larva emerges and starts damaging the fruits. The larva of codling moth is voracious feeder it enters into the fruit by making a tunnel inside the fruit and damages the fruit and finally moves out through another side of the fruit. After the damage on one fruits it moves towards another fruits (Zaki, 1999). It damages almost tones of fruits in the each and every year. Heavy infestation of codling moth (*Cydia pomonella*) in the orchard is reducing the yield of apple fruits. The codling moth infestation can be controlled by different techniques but the work done in this project was limited up to some of the methods like use of Traps, and Insecticide (Charles *et al.*, 2019). The work done by using these techniques was done in four sites of Leh Basgoo, Nurla, and Nimmu. In these sites different methods were used to see the control of all methods on the population of codling moth and the traps installed in all of the sites were used to monitor the population of codling moth in these sites (Hussain *et al.*, 2014). The methods used were very simple and easy so that these methods could be easily used by the farmers of Ladakh. Delta traps containing lures loaded with codlimone (E, E)-8, 10-doddecadien-1-ol the sex attractant which attracts male moths towards trap (Yamanaka *et al.*, 2000), (Coracini *et al*., 2004). The female moth releases codlimone in the air to call male moth for mating. The same pheromone is secreted by the lure in trap which attracts male moth towards trap hence male moth gets trapped (Zhang *et al.*, 2002), (Howell *et al.*, 1990). Another orchard Nurla was taken in which 3 insecticide was sprayed. The insecticide sprayed was choloropyrophas @1ml per 1 litre (Thomas *et al.*, 2005). Though it was tough to spray any insecticide in Leh due to the religious ethics. But still we were successful to motivate one of the farmers for the insecticide. Another orchard Nimmu was taken as control in which no chemical or matting disruption material was dropped. The three traps were also installed in all the selected orchard's to monitor the population of codling in the selected orchard's of Ladakh (Rather *et al*., 2016). The selected orchards were having same variety of apples Red delicious and the size of orchards was almost same. The orchards are 50 kms apart from each other on the national highway of Ladakh.

II. MATERIAL AND METHODS

The delta traps installed at the basgoo are very simple in structure and can be easily made by any of the farmer at their homes. The traps external cover was made of cardboard and inside the trap the liner and lure were present containing codlimone (E,E)-8,10-doddecadien-1-ol the sex attractant secreted by female to call males for matting when the same codlimone was secreted from the trap it which attracts male moths towards trap (Knight and Light 2005). The liner contains sticky material in which the lure was dropped. The liner and lure was changed after each visit to maintain the fluidity and the codlimone flavour. Usually the traps are being installed to monitor the population of codling moth in the orchard's were mating disruption and other chemicals will be sprayed to see the most effective one (Pitcairn *et al*., 1992). But we have taken the trap as one of the method. The ten traps installed at Basgoo were used too mass trapping of moths and their effect on the infestation of coding moth. But the three were used to monitor the population of codling moth (*Cydia pomonella*) in the orchard. The infestation measured from the orchard will be taken by using different methods like by calculating the percentage and the mean.

The rate of Infestation in each orchard was measured by means of following formula:

$$\frac{\text{Number of infected fruits}}{\text{Total number of fruits selected}} \times 100$$

For different sites the rate of infestation for different fruits was separately noticed and an average infestation was recorded. Considering the results obtained average infestation in the site was noticed. However it is worth jotted that for different fruit infestation rates were separately asserted visit wise. Then individually the average rate for the respective apple in the respective time was obtained. At the end of the project, the formula for finding mean which is given below was applied and separately for each crop viz Apple, Peach and Pear the current striking rate of the pest codling moth was obtained. The mean of all observations was taken by using the formula.

$$\frac{\text{Sum of observations}}{\text{Total number of observations}}$$

It is necessary to spray chemicals so that the orchard could not get damaged by the attack of codling moth (*Cydia pomonella*). There are different kinds of chemically used for the control of pest in different areas for different pests. But for codling moth we have only used one pesticide to see that which one is most effective. The Chemical spraying of insecticides i.e. Chlorpyriphos (Szpyrka *et al.*, 2017), as per the rate of infestation is helpful to control the codling moth insect during peak period in June and July. The dosage of these chemical depends upon the infestation caused by the codling moth in the orchard. The chemicals used are used around the world for the control of pests (Wadhi and Sethi 1975). For every insect there is separate insecticide is used like for codling moth many pesticides are used we have applied here only one. The control of codling moth by these insecticides is very high as compare to all other practices. Here we have selected only one site for the insecticides. The chemical sprayed was Chlorpyriphos of Darsiban. The control of chemical was very good as compare to all other practises. The chemical applied in the field was in the ratio of 1ml @ 1 litre (Anwar *et al.*, 2015). Every chemical was sprayed in this ratio of @ 1ml per litre. The infestation was counted by Four trees were selected randomly in each month of visit. Selected tree was divides into four quadrants and the total number of fruits in each quadrant was counted and the damaged fruit was also counted so that the infestation rate in each

orchard can be counted (Sharma, 2019). These quadrants were named as A quadrants followed by B, C and D quadrants. The damage was taken by using percentage and the mean formula.

$$\frac{\text{Number of infected fruits}}{\text{Total number of fruits selected}} \times 100$$

$$\frac{\text{Sum of observations}}{\text{Total number of observations}}$$

The orchard at Nimmu was used to see the control of Traps and insecticide on the infestation of codling moth at Basgoo and Nurla. The orchard at Nimmu was regularly visited to calculate the infestation rate caused by codling moth. Three traps were only installed in the orchard at Nimmu to monitor the population of codling moth in the orchard. The total number of moths trapped in regular visit was calculated and was correlated with the trapped and sprayed orchard. The calculation of infestation rate formula was same in this orchard as like orchard in which traps were installed and the orchard in which 3 insecticides were sprayed. The damage and moth catch in this orchard will give show us the exact result of traps and 3 sprays.

III. RESULT AND DISCUSSION

The three sites in Leh district were selected to control the infestation caused by codling moth (*Cydia pomonella*). The three sites were selected from three different locations. The first site selected was Basgoo, another site was Nurla and the third site selected was Nimmu. In basgoo the 10 traps were installed and in 1 hector of orchards and three traps were installed to monitor the population of codling moth in the orchards under examination. And three sprays of chlorpyriphos insecticide was sprayed @1 ml for 1 litre in the orchard under examination at Nurla and three traps were installed to monitor the population of codling moth in the same orchard. The orchard of Nimmu was used to see the control of codling moth infestation and three traps were installed to monitor the population of codling moth. The Traps were installed before the first flight of codling moth (Pitcairn *et al.,* 1990) so that it can affect the moth population which directly reduces infestation rate (Youm *et al.,* 1997). The lures were continuously changes after 1 month to maintain the validity of the traps and the liners were also change after 1 month to maintain the fluidity of trap (Jaffe *et al* 2018). The insecticide chlorpyriphos was first sprayed at petal fall and then regularly after 1 month. Hence in six months of codling moth (*Cydia pomonella*) bloom the insecticide was sprayed in three times.

The results were taken from these Orchard's regularly in 3 visits. The data taken from these orchard's was tabulated in simple manner so that we can easily calculate the most effective method for the control of codling moth infestation (Nissar *et al.,* 2018). The data taken from three visits clearly shows us that the orchard at Nurla were the traps and three 3 insecticide were applied was least damaged and was seen very effective in the field followed by the orchard Basgoo were the traps were installed and the most damaged orchard was seen Nimmu were no insecticide or trap was installed.

Fruit injuries caused by Larva of Codling Moth

Traps Installed and Trap Catch

Spray of Insecticide and the Fruits after Spray


Fruit Damage at Basgoo/Trap.

Visit 1	Plants	No. of Fruits	Infested Fruits	Percentage
R1	4 Plants	230	24	10.43
R2	4 Plants	237	22	10.12
R3	4 Plants	233	28	12.01
R4	4 Plants	160	18	11.25
Visit 2				
R1	4	233	47	20.17
R2	4	240	56	23.33
R3	4	183	32	17.48
R4	4	330	71	21.51
Visit 3				
R1	4	155	43	27.74
R2	4	254	80	32.25
R3	4	237	87	36.70
R4	4	155	59	38.06

Fruit Damage at Nurla Trap+ 3 Insecticides.

Visit 1	Plants	No. of Fruits	Infested Fruits	Percentage
R1	4	181	3	1.65
R2	4	329	3	0.91
R3	4	229	1	0.43
R4	4	305	4	1.31
Visit 2				
R1	4	185	4	2.16
R2	4	359	8	2.22
R3	4	311	7	2.25
R4	4	222	8	2.70
Visit 3				
R1	4	318	17	5.43
R2	4	302	12	3.97
R3	4	278	12	4.31
R4	4	187	9	4.81

Fruit Damage at Nimmu/Control.

Visit 1	Plants	No. of Fruits	Infested Fruits	Percentage
R1	4	191	30	15.70
R2	4	305	39	12.78
R3	4	139	21	14.38
R4	4	217	33	15.20
Visit 2				
R1	4	156	40	25.64
R2	4	265	61	23.01
R3	4	333	78	23.42
R4	4	180	45	25.00
Visit 3				
R1	4	180	120	65.93
R2	4	246	121	49.18
R3	4	123	73	59.34
R4	4	289	166	57.43

Infestation caused by Codling Moth.

Visits	Mean Pest Infestation (%)		
Test Sites	**Basgoo/Traps**	**Nurla/Trap + 3 insecticides**	**Nimmu/Control**
Visit 1	10.95	1.07	14.51
Visit 2	20.62	2.33	24.26
Visit 3	33.68	4.63	57.43
Sub Mean	65.25	8.05	96.2
Total Mean	56.5		

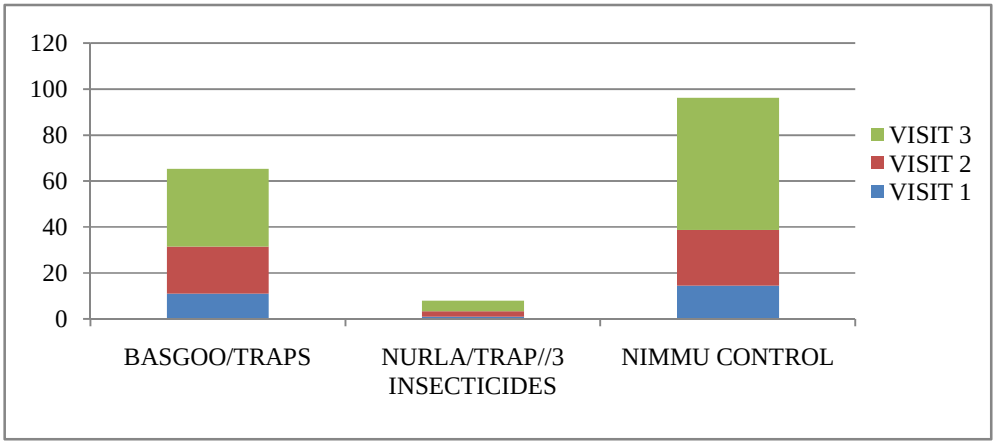

Fig. 1.

Trap Catch from the Orchard's in Three Visits.

Visits 1 to 3 Basgoo	No. of Traps	No. of catches found per trap	Average
R1	3	13	4.3
R2	3	24	11.33
R3	3	53	17.66
Visit 1 to 3 Nurla			
R1	3	1	0.33
R2	3	3	1
R3	3	7	2.33
Visit 1 to 3 Nimmu			
R1	3	18	6.00
R2	3	45	15.00
R3	3	85	28.33

Number of moths trapped from orchard's under examination in 3 visits.

Visits	Basgoo /Traps	Nurla/Traps/Splat/3 Insecticides	Nimmu/Control
Visit 1	4.33	0.33	6.00
Visit 2	11.33	1.00	15.00
Visit 3	17.66	2.33	28.33
Sub Mean	33.32	3.66	49.33
Mean	28.77		

The Nimmu was taken to see the control traps and insecticides. The three traps were also installed at each location to see the most codling moth orchard. The highest trap catch was seen at Nimmu were only three traps were installed to monitor the population of codling moth the least catch of codling moth was seen at the Nurla were traps and insecticides were sprayed. The data taken by from selected orchards was taken randomly from the orchard's from orchard four Replicates or trees were selected.

The selected tree was divides into four quadrants and the total number of fruits in each quadrant was counted and the damaged fruit was also counted so that the infestation rate in each orchard can be counted. These quadrants were named as A quadrants followed by B, C and D quadrants. Then the number of fruits was counted from different quadrants and the damaged one were also counted to calculate the fruit damage. The result taken from the orchards of the different sites was tabulated.

The data clearly shows that the Nurla site was least infected and the trap catch at Nurla was very low followed by the Basgoo were only traps were installed to see the effect of traps on the infestation rate of codling moth sites. The site Nimmu was highest infected site and the trap catch at the Nimmu site which was used to see the control was highly infected.

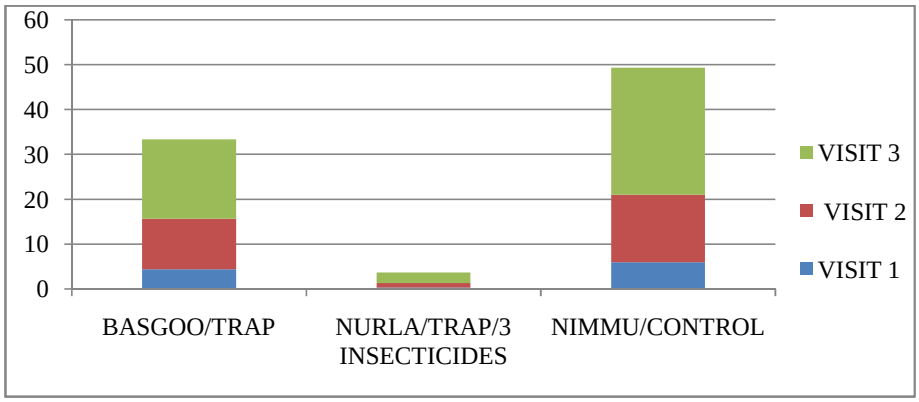

Fig. 2.

IV. CONCLUSION

The work was completed in 6 months of season in which the codling moth is at bloom. It was concluded that the codling moth (*Cydia pomonella*) the most dangerous pest of apple fruit can be controlled by many methods but the most appropriate one is the use of trap+3 insecticides. The Traps were used to control the codling moth population by means of mass trapping in Basgoo. The three insecticide sprays were applied to the site Nurla @ 1ml/litre these three sprays were sprayed month after moth .Three traps were also installed at every location to see effect of TRAP, 3 INSECTCIDES on the population of codling moth. The data taken was very fruitful in which we see the orchard Nurla was with Trap + 3 Insecticides was least infected followed by Basgoo in which only traps were installed was more effected than the Nurla. The orchard Nimmu which was taken as untreated was very highly affected and the trap catch in this orchard was very high. The lowest rap catch was at Nurla were traps + 3 insecticides were applied. This study is very useful and will provide an edge to the farmers of Ladakh and in feature it will serve the purpose of researchers for decades.

V. FUTURE SCOPE

The Union territory of Ladakh holds a peak spot in Indian fruit industry. It produces most diverse type of fruits from edible soft cover to hard jacketed dry fruits. Among the various varieties produced Apple, Apricot and Walnut are well received worldwide. All these fruits are unfortunately susceptible to pest attack. Among various pests Codling moth acts as a key pest in almost all the apple growing areas. Contrary to other pests it directly effects the shape of fruits. This study alarms it danger and can be considered as a red signal for Ladakh fruit industry. As per the results asserted we have reasons to believe that it could be still threatening and cannot ignore its tackling. Though we have a bad weather this year that has escalated its rate of infestation but we need to develop new methodologies that could be incorporated in checking it, even during bad weather. Codling moth one of the very early know pest probably has been studied very well. In Ladakh it is being controlled by using common pesticides like choloropyrop has, Cypermethin, Quinalphos etc. Despite the usage, pest is taking sharp peaks and time has come to introduce its biologically controlling agents here. Recently Trichogramma embryophagum, Delta Traps and SPLAT (Specialized pheromone lure application technology) has been proven effective in checking codling moth. This research will aid workers in better understanding of biological agents to curb damage. It is also hoped that the results obtained will prove a reference for further analysis. It is hopeful to serve the purpose of researchers in the field of Entomology.

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