International Journal of Scientific Research in Biological Sciences
Vol.6, Issue.6, pp.64-69, December (2019)

Research Paper

E-ISSN: 2347-7520

Population Monitoring of Diamondback Moth (*Plutella Xylostella*) and Evaluating Its Attacking Impact on Growth & Yield of Cauliflower at District Tando Allahyar

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Available online at: www.isroset.org

Received: 08/Dec/2019, Accepted: 18/Dec/2019, Online: 31/Dec/2019

Abstract—This study was intended to evaluate the population monitoring of diamondback moth and its attacking impact on growth and yield of cauliflower, at District Tando Allahyar. The experimental site is located at 25.2757^0 N and 68.42150^0 E. Two local varieties (sathri and nawri) of cauliflower were cultivated. The population of DBM was monitored for the entire crop period using direct count and light trap methods. Twenty five plants were randomly selected for direct count observations and a light trap was installed at the field. The impact of DBM attack on growth, leaf quality and yield of cauliflower was analyzed by selecting and labelling 25 plants at the time of sowing. The results indicate that, the mean values of DBM population under direct count method was ranging from 0.24 to 2.15. The maximum (2.15) and minimum (0.24) mean values were observed on 4^{th} and 12^{th} (last) week, respectively. Under light trap method, the maximum and minimum DBM population was observed on the 6^{th} and 12^{th} week, respectively. The population trend indicates a rapid increase to gradually decrease in the number of moths. Statistically, a significant difference was observed in DBM population throughout the observations. With regard to the growth and yield of cauliflower, the results indicate that, the height of leaf was reduced by 12.38, 23.19, 35.69, 41.45 and 45.72 %, weight of leaf was reduced by 12.55, 21.24, 28.98, 40.33 and 48.93 % and the average yield of flower was reduced by 9.26 %, 17.78 %, 27.41 %, 36.11 % and 46.48 %, under the DBM attack of 2, 4, 6, 8, and 10 moths, respectively. Under leaf quality assessment, the leaf was observed with one or several colors from light green, pale, light yellow, dark yellow, brown and red. From the outcomes of this study, it is recommended that, the DBM at larvae stage highly damaged the cauliflower growth rate and reduces the crop yield. Therefore, the regular scouting of pest should be carried out and the recommended application rate of pesticides should be applied for effective management of diamondback moth particularly in cauliflower.

Keywords—Diamonback Moth, Cauliflower Pest, Brassica Oleracea, Leaf Quality, and Pest Scouting

I. INTRODUCTION

Cauliflower, *Brassica Oleracea*, belongs to the Crucifer-ace family, a very diverse group that includes 350 genera and over 3,500 species of cultivated and identified as wild plants [1]. Cauliflower is basically a vegetable cultivated in cold season that has a temperature requirement for growth and which lies between 15 °C and 20 °C. Pakistan is among the top ten producing countries of this vegetable in the world [2]. The production of cauliflower has been reduced by several factors, including insect pests, such as diamondback moth (*Plutella xylostella)*, aphids (*Brevicoryne brassicae*, (Innaeus) *Lipaphis erysimi* (Kaltenbach) and Myzuspersicae (Sulzur), cabbage worms and beetles of flea (Phyllotreta.) Butterfly (*Pieris bracecae*.) and diseases such as black rot and stick root [3]. The diamondback moth is a highly destructive insect pest of *B. oleracea* throughout the world and is the parasite of most widespread insects of all insects Lepidoptera [4], [5]. *P. xylostella* is an oligophagous parasite because moths like to feed on various cruciferous crops, such as cabbage, cauliflower, broccoli, radishes, turnip and mustard [6].

Cabbage is a plant with herbaceous flowers with leaves that form a compact head. About 400 cabbage species have been documented in five groups: the first group includes round flat-leafed cabbages with the dissimilar varieties of colors like white, green or red leaves and wrinkled leaves, such as Savoy. The second group includes pointed cabbages like European spring and Chinese cabbages. The third group contains shoots with abnormally large growing stems such as Brussels sprouts. The fourth group includes shoots with curly green types, such as cabbage. The cabbage species in this group are often used as animal feed or decorations for presentation dishes. Finally, the last group includes flowing cabbages, such as cauliflower and broccoli [7].

Cauliflower, a crucified vegetable, belongs to the same family as broccoli, cabbage, cabbage and beet plants. Around the curd there are thick green wavy sheets that protect it from sunlight and prevent the development of chlorophyll. The flowers are attached to a central stem. The seeds are shaped like a head. The head of a cauliflower, also called "curd", is a group of narrow buds that have not fully developed. Sprouts are attached to fleshy stems where most nutrients are stored for growth.

The cultivation of crop varieties with insect pest resistance is one of the most effective measures to deal with insect pest infestation; since the varieties less preferred by insect pests are economically advantageous for farmers. Cultivation of insect-resistant crop varieties can suppress pest infestation and control plant-borne disease. If there are persistent viruses, the resistance of plants to their transmitters generally reduces the growth spread of the virus by slowing its replication [8]. If pest resistant varieties are used with chemical control methods, the costs of chemical control and problems related to insecticides can be reduced. As a result, the use of resistant plant varieties will play a role in reducing environmental pollution.

There are several factors that make resistant plants species of host plants unsuitable for parasites. The different parts of a plant, the age of the leaves and the hairy leaves are effective for feeding and spawning, selection and changes in the populations of jassid and whitefly. There are several defense mechanisms against parasites, such as: the number of trichomes and the type of trichoma [9]. The DBM is the major, ubiquitous, and year-round insect pest hindering the economic production of brassica crops [9], [10].

Keeping in view of the above arguments, the study was conducted to monitor the population of diamondback moth (DBM) and to evaluate its attacking impact on growth and yield of cauliflower at district Tando Allahyar (Arid to Semi-arid Climate Conditions).

Objectives

1. To monitor population of diamondback moth on cauliflower through direct count and light trap methods.
2. To analyze the effect of diamondback moth attack on growth rate, leaf quality and yield of cauliflower.

II. REVIEW OF LITERATURE

Diamondback moth (DBM) is an extremely damaging insect pest for Brassica Oleracea (Cauliflower) throughout the biosphere [11]. The population of *P. xylostella* has gradually increased during development stage of crop, where the population was 2.1 and 2.0 moths and pupae per plant in 2012 and 2013, respectively. The population increased in September to the highest number of moths and pupae per plant (8.25 and 8.4), in 2012 and 2013, respectively [12]. The diamond-coated moth, *Plutella xylostella* (L.) is the main plague of destructive brass vegetable insects worldwide. It has developed resistance to various types of insecticides. However, the current state of insecticide resistance in *P. xylostella* has not been examined in china [13]. Most of the DBM populations were sensitive to spinosad and similar to previous results, but populations in Thailand and Hawaii showed high tolerance levels. The spray tests with the recommended field rates for spinosads in broccoli plants in green house pots have confirmed that in the areas of these collections were possible failures in the field controls due to resistance [14]. In Pakistan, diamondback moth pests are highly observed in Brassica Oleracea (cauliflower) vegetables [15] and its economic damage capability has been observed with 100% [16], 90 % loss in yield has been detected in Pakistan due to DBM attack [17]. DBM is highly destructive pest for cruciferous family plants. Its superior spreading capability, lager quantity of annual generation and development of resistance to insecticides makes diamondback moth a major troubling pest [18].

III. METHODOLOGY

The study was conducted for monitoring the population of Diamondback Moth (*Plutella Xylostella)* and analyzing its attacking impact on growth and yield of two local varieties of cauliflower (Sathri and Nawri) sown using traditional methods. Following methodology was used to complete the set objectives of this study.

A. Location of Experimental Site

The Experiment was conducted at the agricultural farm of Mr. Mehmood Shah Nawaz, Taluka and District Tando Allahyar. The experimental site is located at 25.2757^0 N and 68.42150^0 E and is 17 m above the sea level). Figure 1 shows the location map of the experimental site.

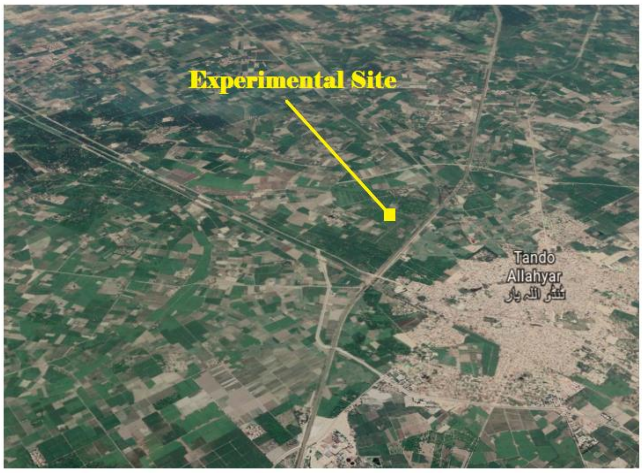

Figure 1. Location Map of the Experimental Site.

B. Population Monitoring of DBM pest

The cauliflower seed was sown on the total experimental area of about 6250 m^2. In order to monitor the population of diamondback moth (DBM) throughout the crop period, the monitoring of diamondback moth was started right from the germination till the final harvesting of the crop. The direct count (zig-zag) as well as light trap methods were used for quantifying the DBM population in study area. Twenty five plants were selected at random and were tagged for observation in each week to record population of diamondback moth on whole plant basis. The observations were carried out through weekly intervals. A light trap was installed at field for observations. Potassium cyanide was used for killing the captured moths [19]. Data was analyzed using descriptive statistics (Statix ver. 8.1).

C. Attacking Impact of DBM pest on Growth Rate, Leaf Quality and Yield of cauliflower

To assess the attacking impact of diamondback moth pest on growth rate, leaf quality and yield of cauliflower, 25 plants (of each variety) were selected and tagged at the time of sowing. For evaluating the growth rate, the leaf height and weight was measured for the damaged and undamaged plants. For quality assessment of leaf, the leaf color was physically assessed. To analyse the effect of DBM pest attack on the yield of cauliflower, the weight of flower was measured after harvesting the crop [20]. The results of damaged plants were compared with un-damaged or healthy plants.

Figure 2. Checking the leaf color of cauliflower under DBM attack.

IV. RESULTS AND DISCUSSION

The monitoring of pests was started right from the completion of germination till the final harvest. Twenty five plants were selected at random in each week to record pest population on whole plant basis. The pest monitoring was started from 1st March to 29th May, 2018. For analyzing the effect of DBM pests on growth, quality and yield, twenty five seedlings were tagged at the time of sowing. The results of growth performance, quality and yield of damaged plants were compared with unspoiled or healthier plants.

A. Population Dynamics of Diamondback Moth

1) Through Direct Count (Zig-Zag) Method

The mean values of diamondback moth population using direct count method are ranging from 0.24 to 2.15. The mean values of diamondback throughout the experiment are shown in table 1. The data indicates that, the mean value of diamondback moth was recorded maximum (2.15) on 4th observation whereas it was minimum (0.24) on 12th (last) observation. On first observation the population mean was 0.95. The trend indicates, rapid increase to gradually decrease in the population of diamondback moth. During monitoring of diamondback moth through direct count method, it was noticed that there was no any impact of temperature was found during observations. In view of the statistical outcomes, there was significant ($p<0.05$) difference in diamondback moth during different weeks. The result are in close agreement with the findings of [21].

Table 1. Mean population of diamondback moth through direct count method.

S.No	Observation Date	Mean	Temperature (^{0}C)
1	01-03-2018	0.95	29.5
2	08-03-2018	1.03	27.5
3	17-03-2018	1.45	32.0
4	25-03-2018	2.15	33.5
5	03-04-2018	1.80	43.0
6	11-04-2018	1.62	41.0
7	19-04-2018	1.18	38.5
8	27-04-2018	0.72	43.0
9	05-05-2018	0.52	43.0
10	13-05-2018	0.46	40.5
11	21-05-2018	0.42	41.0
12	29-05-2018	0.24	43.0

2) Monitoring of Diamondback Moth Through Light Trap Method

The population of diamond back moth through light trap was recorded maximum (10 moths) on 6th and 7th observations whereas it was minimum (02 moths) on 11th and 12th observation. Table 2 shows the population of moth observed throughout the experiment. The data indicates same trend of diamondback moth population was observed as of under direct method. In view of the statistical outcomes, there was significant ($p<0.05$) difference in diamondback moth during

different weeks. The results of population dynamics of DBM are in quite agreement with outcomes of [22] and [23].

Table 2. Monitoring of Diamondback Moth through Light Trap in Cauliflower from 01-03-2018 to 29-05-2018.

S.No	Observation Date	Mean	Temperature (^{0}C)
1	01-03-2018	05 f	19.5
2	08-03-2018	06 d	20.0
3	17-03-2018	05 e	24.5
4	25-03-2018	07 b	25.5
5	03-04-2018	08 a	29.3
6	11-04-2018	10 b	30.0
7	19-04-2018	10 c	28.0
8	27-04-2018	04 c	30.0
9	05-05-2018	03 d	31.5
10	13-05-2018	04 e	30.0
11	21-05-2018	02 f	29.5
12	29-05-2018	02 d	30.0

3) Severity of Pest with Reflex to Time Period

Under both methods the population dynamics was observed high during the mid of overall crop period. The results of population assessment reflects that, DBM's likes to stay and damage the young and matured plants as compared to just germinate and the plants at harvesting stage. Thus, the severity of diamondback moth with respect to crop period (time) was initiated from slightly increasing rate to high population and then at slightly declining rate. The cauliflower is one of the host crop of diamondback moth which has been observed more favorite for this pest with regard to their survival and spreading rate.

B. Effects of DBM Pest Attcvk on Growth Rate, Leaf Quality and Yield of cauliflower

The high population of diamondback moths vastly affected the growth performance, leaf quality and yield of cauliflower as compared to plants where no any attack of DBM pest was observed. Figure 2 shows the DBM larvae attack on cauliflower leaf and color appearance of leaf under DBM attack.

Figure 3. Larvae of Diamondback Moth Damaging the Cauliflower Leaf.

1) Effects on Growth rate of cauliflower

From 25 selected plants the effect of DBM pest was observed maximum under the highest attacking number of diamondback moth on cauliflower leaf. The plants having DBM attacking population of 2 (as minimum), 4, 6, 8 and 10 (as maximum) moths, were selected and compared with the plants observed without any DBM attack. Averagely, the height of leaf was affected by 12.38 %, 23.19 %, 35.69 %, 41.45 % and 45.72 % respectively under the attack of 2, 4, 6, 8, and 10 number of moths. On the average of both verities, the weight of leaf was reduced by 12.55 %, 21.24 %, 28.98 %, 40.33 % and 48.93 % under the attack of 2, 4, 6, 8 and 10 moths as compared to the pants observed without any attack of diamondback moths. Table 3 and 4 shows the height and weight of leaf of both varieties observed under different number of the DBM pest attack. The growth of cauliflower was highly affected when moths were at larvae stage. The results are resembling with the outcomes of [24].

Table 3. Growth rate of Cauliflower (Sathri variety) under DBM Attack.

S.No	No: of DBM pests observed on the plant	No: of Plants observed under DBM attack	Average Height of Leaf (feet)	Average Weight of Leaf (gram)
1	0	9	2.94	518
2	2	3	2.43	431
3	4	5	2.12	378
4	6	4	1.73	339
5	8	3	1.54	265
6	10	1	1.43	223

Table 4. Growth rate of Cauliflower (Nawri variety) under DBM Attack.

S.No	No: of DBM pests observed on the plant	No: of Plants observed under DBM attack	Average Height of Leaf (feet)	Average Weight of Leaf (gram)
1	0	7	3.14	645
2	2	2	2.87	586
3	4	4	2.55	538
4	6	6	2.18	487
5	8	4	2.02	429
6	10	3	1.87	371

2) Effect on Quality of Leaf

Color appearance of the cauliflower leaves under the attack of diamondback moth is illustrated in table 5. The plant leaf observed under the DBM attack were seriously damaged and were found weak and light in weight, as compared to the plants observed without any DBM attack. The color of leaf was observed as, light green, pale, light yellow, yellow, brown, dark yellow and red. The lower surface leaf area was

preferably damaged by the DBM's at larvae stage. Mostly the diamondback moths injured the leaf area between the large veins and midribs. The results of leaf quality under the DBM attack are in quite agreement with [24] and [25].

Table 5. Quality of Leaf (Color Appearance) under the Diamondback Moth Attack.

S.No	No: of DBM pests observed on the tagged plants	No: of Plants of both varieties observed under DBM attack		Color Appearance of leaves
		Sathri	Nawri	
1	0	9	7	Dark Green
2	2	3	2	Light Green & Pale
3	4	5	4	Light green, Pale & Light yellow
4	6	4	6	Light green, Pale, light yellow and brown
5	8	3	4	Light green, Light yellow, brown, dark yellow and light red.
6	10	1	3	Light green, Brown, dark yellow and red.

3) Effect on Yield of Cauliflower

The yield of cauliflower was highly affected by the extreme attack of diamondback moths observed under the high colonized flowers. Table 6 indicates the yield of cauliflower observed under the attack of diamondback moth on different population levels. The maximum weight of flower was observed for the plants where no any diamondback moth was observed. For both varieties, the average weight of flower attacked by 2, 4, 6, 8, and 10 moths was reduced by 9.26 %, 17.78 %, 27.41 %, 36.11 % and 46.48 %, respectively. The results are in favor of statement given by [18] and [20].

Table 6. Weight of flowers under Attack of the Diamondback Moth.

S.No	No: of DBM pests observed on the tagged plants	No: of Plants of both varieties observed under DBM attack		Average Weight of flower (Kg)	
		Sathri	Nawri	Sathri	Nawri
1	0	9	7	2.42	2.98
2	2	3	2	2.17	2.73
3	4	5	4	1.96	2.48
4	6	4	6	1.79	2.13
5	8	3	4	1.53	1.92
6	10	1	3	1.26	1.63

V. CONCLUSION & FUTURE SCOPE

The population diamondback moth was observed high during mid of the crop period. There was extreme effect of DBM pest attack on plant growth, leaf quality and yield of cauliflower. The attack of diamondback moth should be controlled before their larvae stage, because DBM actively damages the plants at their larvae stage. The lower leaf areas were observed with the high concentration of larvae as compared to upper leaf area, thus for selecting the application rate of pesticides the overall leaf area should me checked well. For arid to semi-arid climatic regions, if there is no any rainfall the DBM attack could not be controlled by weather conditions. Regular scouting of pest in cauliflower should be done for effective management of diamondback moth. Precautionary measures should be taken when pest population will not exceeded from economic injury level.

In future, studies should be conducted to evaluate the capability of different trap crops like; Mustard and Collard to impede the damages of Diamondback Moths (DBM) on Brassica Oleracea. The studies should also be extended to analyse the different pesticides competences to protect the plants from DBM attack.

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Author's Contribution:

H.A.M Monitored the DBM Population & Compiled the Results.
I.A.N Supervised & Designed the Project.
P.M Analyzed the effect of DBM attack on Growth of cauliflower.
N.G Analyzed the Leaf Quality.
Z.H.D Analyzed Impact of DBM Attack on Cauliflower Yield.
S.H.D Performed Statistical Analysis and Mathematical Calculations.

