

Quality and Quantity Loss by Aphid Infestation in Vegetables Grown under Protected Cultivation in Ladakh Region

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ABSTRACT

During the hardly six months of suitable climatic window in summer season, many vegetable crops such as cabbage, cauliflower and radish are grown extensively in Ladakh region of India. These crops contribute significantly to the requirement of military and paramilitary troops in addition to the civil population inhabiting the region. In addition to growing these vegetable crops outdoor, some of these are grown under protective cultivation to get early and more produce, however various insect pests including aphids cause serious damage to the crops annually. The present study was undertaken to estimate the quality as well as quantity loss due to aphids infestation in three economically important crops namely cauliflower (*B. oleracea* var. *botrytis*), knol – khol (*B. caulorapa*) and radish (*R. sativus*) in the Indus valley of Ladakh region (J&K), in 2015. Results showed that there was 7.5 % to 27.5 % reduction in chlorophyll contents in the study crops while the overall yield in infested crops ranged from 35.4 in *B. caulorapa* to 41.9 % in *B. oleracea* var. *botrytis* respectively. Total chlorophyll contents were decreased statistically in radish ($p = 0.0002$; $\chi^2 \geq 17.0$), whereas the overall yield loss was statistically similar among all the three vegetable crops ($p = 0.6$). Current study is first to analyze this kind of loss in important vegetable crops in Ladakh region of India and could be used as baseline study for planning anti-aphid strategy to protect vegetable crops in Ladakh region of India.

Keywords: Ladakh; Vegetable; Aphid; Cauliflower; Knol-khol; Radish

1. INTRODUCTION

The Indian Himalayan region has a large altitudinal range and exhibit diverse ecology and physiography¹. Ladakh region (location: 32° 00' N to 80° 00' E; elevation: 2400 m to 4500 m MSL) situated in Jammu and Kashmir state of India is mostly mountainous and barren except villages and experience intense long winter season¹. The climate of Ladakh provides a narrow window of hardly six months (May-Oct) for growing vegetables and other crops. During the summer season many economically important vegetable crops such as cabbage (*Brassica oleracea* var. *capitata*), cauliflower (*Brassica oleracea* var. *botrytis*), knol – khol (*Brassica caulorapa*), radish (*Raphanus sativus*), and turnip (*Brassica rapa*) are extensively grown indigenously in the entire Ladakh region^{2,3}. Therefore these crops contribute considerably to overall requirement of local troops as well the civil population inhabiting the region. Furthermore, these crops are mostly grown on organic manures and fertilizers are used in rare cases only. To take early crop in Ladakh region, the crops are grown in green houses (protective cultivation) which provide suitable climatic conditions to the crops. However the congenial temperature and humidity in the green houses especially during the summer months also triggers out-break of insect pests specifically aphids on different vegetable crops causing untimely damage to the crops⁴.

Aphids are tiny (about 1/8"), oval to pear-shaped, soft bodied insects often known as plant lice, breed on the underside of the leaf and feed on plants sap using their needle shaped mouthparts. They have different colours such as green, yellow, orange, brown and black depending upon the species. Although most of aphid species feed on specific plants but a few may feed on different plants also. Previous studies have reported many species of aphids that damage vegetable and other crops in open cultivation⁵⁻⁷.

In the present study aphid species were collected from *B. oleracea* var. *botrytis* (cauliflower), *B. caulorapa* (knol – khol) and *R. sativus* (radish) grown in the green houses in Indus valley of Ladakh. The aphids were collected by holding a plastic tray under the affected plant and then vigorously shaking the plants with the help of stick. The specimen were stored in 70% alcohol and examined under microscope. This aphid species is green in color and feeds on plants belonging to crucifer family such as *B. oleracea* var. *capitata* (cabbage), *B. rapa* (turnips), *B. oleracea* var. *acephala* (kale), *B. oleracea* var. *italica* (broccoli), *B. oleracea* var. *botrytis* (cauliflower), *B. caulorapa* (knol – khol) and *R. sativus* (radish). The plants exhibiting the damage due to aphids display variety of symptoms including decreased growth, curled and wilted leaves, browning and yellowing of leaves which ultimately leads to severe damage in crops. The removal of phloem sap due to sucking by aphids reduces the vigour in plants and depreciates the quality and overall yield of crop due to stunted growth. This damage reduces the quality

by deforming the crop and declines its market value. Under the present study, the quality and quantity loss have been estimated in three important crops *B. oleracea* var. *botrytis* (cauliflower), *B. caulorapa* (knol – khol) and *R. sativus* (radish) grown under protective cultivation due to damage aphid infestation in Indus valley of Ladakh region (J&K) during the early summer of year 2015.

2. METHOD

The selected three vegetable crops namely, *B. oleracea* var. *botrytis* (cauliflower), *B. caulorapa* (knol – khol) and *R. sativus* (radish) were sown in pots containing soil, sand and compost manure in protected areas for cultivation (green houses) in Indus valley of Ladakh following randomised block study design. Indus valley of Ladakh region is strewn with many small villages and includes the Skardu region, parts of Leh district and interspersed mountaneous cold desert. The valley is strategically most important part of the region and consists of vast stretches of undulating lands. The region is characterised by very low annual rainfall, low water holding capacity in soil, intense solar radiation, low oxygen and high wind velocity^{2,8}. The valley hosts many phyto-food plants which are edible and have high food value^{2,9-11}.

The quality of each crop was ascertained by physical examination while the quantity loss in each of the crop was recorded by comparing the morphological attributes of aphids affected plants (number of leaves, leaf thickness, leaf length, leaf area, leaf width, root length, root diameter, plant height, chlorophyll contents and total yield) and quantity by total yield with the control plants of same species. The losses were determined and expressed in percent (%) as follows;

$$QL = 100 - [A \text{ (plant attribute of affected plant)} / C \text{ (plant attribute of control plant)} \times 100]$$

QL – quantity loss in %, A and C – mean value of plant attributes (affected and control)

3. RESULTS

Microscopic examination revealed that the aphid collected from all the three crops were *Brevicoryne brassicae*. *B. brassicae*, popularly known as cabbage aphid are most common aphid species that cause problems in protected vegetable cultivation (Fig. 1). The representative photographs of the aphids affected crops taken in the present study presented in Fig. 2 (a) - 2(c) show that there has been significant decrement in the quality of the crops. The quantity loss (%) in the crops has been shown in Table 1. In *B. oleracea* var. *botrytis*, there was shrinking in the leaves and leaf thickness was found to reduce by 56.3 %, while the root diameter was reduced by 37.7 % as compared to the control plant. There was 17.4 % decrease in overall chlorophyll contents in the affected plants whereas the total yield after harvest was reduced by 41.9 % (Fig. 2(a)). In *B. caulorapa*, the leaf area was found to reduce by 54.8 %, while leaf thickness and leaf length recorded a net loss of 27.3 % and 42.3 % as compared to the normal crop respectively. Although the net chlorophyll content was reduced by 7.5 %, but 35.4 % loss was recorded in the net yield (Fig. 2(b)). *R. sativus* crop showed 31.5 % loss in leaf area whereas root length was found to reduce by 23.9 % compared to the control.



Figure 1. *Brevicoryne brassicae* (cabbage aphid) as shown on the leaf of *B. oleracea* var. *botrytis* (insat), and after 100X magnification (main plate) in Ladakh (J&K), India.

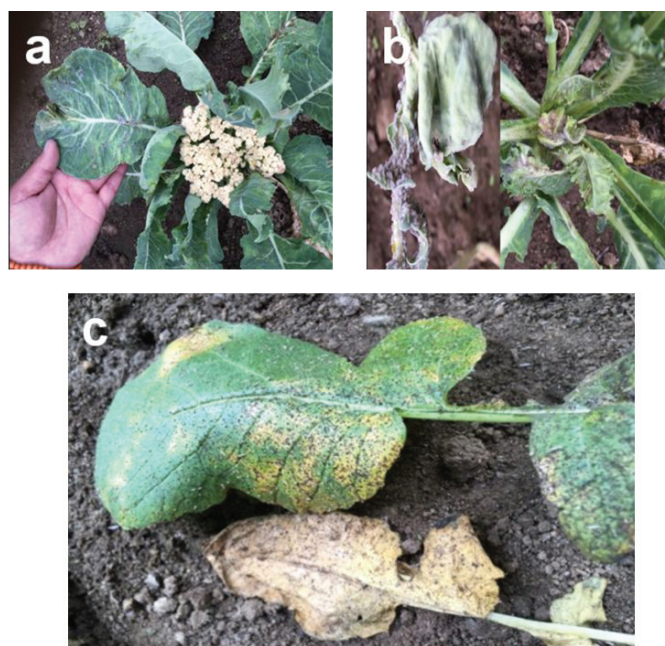


Figure 2. Vegetable crops of (a) *B. oleracea* var. *botrytis* (b) *B. caulorapa*, and (c) *R. sativus*. Damaged by aphids under protective cultivation.

The overall loss in the yield was found to be 35.7 % in the aphid affected *R. sativus* crop (Fig. 2(c)).

In the present study, the percent loss in number of leaves was not determined for cauliflower, however both the remaining crops knol-khol and radish were equally affected as the % loss of leaf number did not show variation ($p = 0.3$; $\chi^2 = 1.9$; OR = 1.3; RR = 1.1) (Table 1). The leaf thickness was significantly reduced in cauliflower followed by knol-khol ($p < 0.0001$; $\chi^2 = 45.1$). Similarly, the mean curd diameter and overall plant height were also found statistically reduced in cauliflower as compared to the other two crops (was also $p \leq 0.03$; $\chi^2 \geq 7.3$). On the other hand leaf area and length were found significantly reduced in knol-khol than the others ($p < 0.0001$; $\chi^2 \geq 28.2$), whereas total chlorophyll contents were found to be decreased statistically in radish ($p = 0.0002$; $\chi^2 \geq 17.0$). The overall yield

Table 1. Quantity loss (%) in different vegetable crops under protected cultivation in Indus valley of Ladakh (J&K), India

Attributes	Vegetable crops			p(χ^2)
	Cauliflower % of loss	Knol-khol % of loss	Radish % of loss	
No. of leaves	ND	9.7	8.6	0.3 (1.9)
Leaf thickness	56.3	27.3	12.5	<0.0001 (45.1)
Leaf area	18.8	54.8	31.5	<0.0001 (28.2)
Leaf length	6.8	42.3	11.3	<0.0001 (50.1)
Leaf width	2.1	5.7	1.2	0.03 (7.0)
Root length	ND	ND	23.9	ND
Curd/Knob/Root diameter	37.7	25.2	11.4	<0.0001 (22.2)
Plant height	18.2	14.5	6.8	0.03 (7.3)
Chlorophyll content*	17.4	7.5	27.5	0.0002 (17.0)
Yield (quantity)	41.9	35.4	35.7	0.6 (0.9)

*Soil-Plant Analyses Development (SPAD) unit; p – significant at 95% CI; χ^2 - Chi square, ND – not done.

loss (range: 35.4 % - 41.9 %) was statistically similar among all the three vegetable crops (p = 0.6).

4. DISCUSSION

Insect pests cause serious damage to the commercial as well as domestic horticulture, agriculture and floriculture in cold desert area of Ladakh region. In the recent years many insect pests such as codling moth, cutworm, weevils, maggots and many moth species have gained entry into the region deteriorated the quality and quantity of the locally grown vegetable and fruit crops^{1,5-7,9,12}.

Studies have reported that many important vegetable crops belonging to *Apiaceae*, *Brassicaceae*, *Cucurbitaceae*, *Fabaceae*, *Polygonaceae* and *Solanaceae* are infested by aphid species in Ladakh region of India. Altogether, 31 aphid species corresponding to 21 genera have shown wide occurrence in different cultivated crops and reported to cause sizeable economic damage to the crops every year^{6,7,13,14}. Species *Acyrtosiphon pisum* and *A. rubi* have been potentially responsible for damaging garden pea and wild blackberry respectively. However two important aphid species *Brevicoryne brassicae* and *Hyadaphis erysimi* have emerged as major aphid pests in the region during the recent years and known to cause severe damage to *B. oleracea* and its varieties, viz. cauliflower, cabbage, knol-khol and radish, etc.^{6,7}. These aphid pests causes damage to both sides of leaves and significantly reduce the economic value of host crops. Presently studied three important vegetable crops have shown considerable damage due to aphid infestation in Ladakh region of India. The damage was observed in overall size, shape and color of the fruit, therefore the quality was significantly poor as compared to the control crop. The overall yield of all the three vegetable crops was reduced significantly⁷.

In the current study, although there has been considerable loss in the different vegetable attributes, the unaffordable overall reduction observed in the yield among all the study crops was more of concern. Previous studies have suggested

that some other insect pests were also prevalent in the region but caused limited damage mainly to the vegetable crops only^{6,12}. This study suggests that the aphid pests severely damage economically important vegetable crops grown under protective cultivation in the Ladakh region of India than thought previously. It is well known that only few crops can grow in cold-arid Ladakh region which provides a few months cultivation season during the summer months only. The study emphasizes that aphids should be considered as a serious pest problem not only in the open cultivation but also in protective green houses, since during the recent years different green house technologies have revolutionised the vegetable production in Ladakh region^{9-11,15}. Therefore region specific management and appropriate control measures need to be devised to interrupt the aphid infestation to the studied vegetable crops as well as other economically important crops grown in the region under protective cultivation.

5. CONCLUSIONS

To our knowledge, this study is the first attempt to estimate the economic loss due to aphid infestation in some commercially grown vegetable crops under protected cultivation to augment the requirement of locals as well as the troops posted in the Ladakh region. Study highlights the damage caused to economically important vegetable crops grown under protective cultivation by comparatively less popular entomological pest of Ladakh region. This effort of assessing economical loss to the three major vegetable crops can be extended to other economically important crops of the region. Considering the seriousness of the issue, effective and timely insect pest management focusing on aphid pests by LAHDC, DIHAR (DRDO) and other related institutions by involving local NGO's, self help groups (SHG's), civilian as well as military and paramilitary is warranted.

COMPETING INTERESTS

The authors declare no competing interest.

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He was involved in designing the study, conducting field experiments and recording observations in the present study.

Dr Sunil Dhiman is Scientist 'D', presently posted at DRDO-Defence R&D Establishment, Gwalior. He has worked in border areas of another strategically important north-east region of India. His subject of expertise is entomology and worked in the management of insect vectors in north-eastern region. Presently he was involved in data analysis, compilation of results and structuring & writing of the manuscript.