

Original Research Article

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Incidence of San Jose Scale, (*Quadraspidiotus perniciosus* Comstock) in Relation to Abiotic Factors on Apple Tree

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ABSTRACT

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Studies on the incidence of San Jose scale, *Quadraspidiotus perniciosus* (Comstock) was undertaken in Baramulla and Budgam districts of Kashmir valley. Highest mean per cent incidence of 32.06 was recorded in Baramulla, while as, lowest 25.65 per cent was recorded in district Budgam. Highest mean per cent incidence of 37.85 was observed in low elevation of district Baramulla followed by 31.33 per cent in low elevation of district Budgam. A positive and significant correlation was found between incidence with maximum temperature, maximum relative humidity and sunshine hours in district Baramulla and Budgam. Multiple regression analysis revealed maximum temperature contribute maximum to incidence followed by maximum relative humidity and sunshine hours in both the districts.

Introduction

Apple, *Malus domestica* (Borkh) belonging to family Rosaceae is undoubtedly the most important fruit, distributed worldwide and plays an important role in nation's economy. The area under apple cultivation in India is 311.91 thousand hectares with an annual production of 2286.37 thousand metric

tonnes; and the productivity of 7.33 metric tonnes per hectare (Anonymous, 2018). The Union Territory of Jammu and Kashmir leads both in acreage and production of apple in the country; with an area and annual production of 164.14 thousand hectares and 187.90 thousand metric tonnes, respectively, at the productivity rate of 11.44 metric tonnes per hectare. The territory has been declared as

Agro-export zone for apple production, so the priorities have to be shifted from quantity to quality and value addition aspects (Anonymous, 2019). The yield of apple, its quality as well as plant growth is influenced by many environmental factors. However, the apple quality and quantity is subjected to deterioration, which could be attributed to many factors; which among others also include insect pests and diseases. The most important insect pest infesting the apple crop is San Jose Scale, SJS (*Quadras pidiotus perniciosus* Comstock), associated with almost every apple orchard in every nook and corner of the territory (Rather and Masoodi, 1994). It is especially serious in temperate and sub-tropical regions and occurs in all the temperate fruit producing countries of the world. SJS female gives birth to living young from the eggs developed within the body of the female called immature forms, “crawlers”. Damage is caused by feeding of crawlers, which suck plant sap, weaken the plant, reduce fruit and shoot growth and desiccate foliage.

The area under the feeding site turns to characteristic purplish red color. Under high population, the crawlers may migrate from fruit spurs onto the fruit and at harvest the fruits have distinct “measles” spots on the surface and when the scale is removed from the fruit, a high coloured bull’s eye is evident (Balusu, 2017). SJS infestation on twigs and limbs can cause an overall decline in tree vigour, growth, foliage, productivity. In most cases, the scale had spread to a serious degree before it was discovered and a greater number of trees are badly injured and killed by its attack. This pest can produce several scales in one season. If uncontrolled, they can kill the tree as well as make the fruit unmarketable. Despite of, extensive work carried in India and abroad on the SJS, a thorough investigation in Kashmir division is lacking. Keeping in view the economic importance of

the pest, it is imperative to study the incidence of the pest.

Materials and Methods

Extensive field surveys were done to ascertain the incidence of SJS during the year 2018-2019 in two districts Baramulla and Budgam of Kashmir province. Each selected district was categorized in three different altitudes (high, medium and low) (Table-1); from each altitude two villages and from each village two orchards were selected. Three trees were randomly selected from each selected orchard. A total of 36 apple trees from each district was screened for the incidence of SJS.

Pest incidence assessment

The pest incidence of SJS was recorded by randomly selecting three apple trees from each orchard as detailed in Table 1. Observations regarding the pest incidence were recorded at fortnight interval. The per cent pest incidence was calculated as the proportion of infested apple trees to the total number of trees assessed by the following formula:

$$\text{PPI} = \frac{n}{N} \times 100$$

Where,

PPI	=	Per cent Pest Incidence
n	=	Number of infested trees
N	=	Total number of assessed trees

Influence of abiotic factors on SJS

The simple correlation and multiple regression studies between pest incidence with all abiotic factors (temperature, relative humidity, rainfall and sunshine) were worked out so as to determine their impact on pest incidence on apple crop.

Results and Discussion

Location wise pest incidence

Studies conducted to ascertain the incidence at Baramulla and Budgam during 2018-2019 revealed that in all selected villages of district Baramulla, activity of SJS were observed from last week of February (8th SW). Thereafter, a increase in incidence was recorded and attained its peak in last week of July to first week of August (30th to 32nd SW) and then the incidence declined until last week of December (52nd SW). The cumulative mean incidence of SJS spanning for all 19 weeks of investigation was recorded highest as 37.85 per cent at low altitude and 27.89 per cent as lowest at high altitude; while as 30.43 per cent at medium altitude was recorded (Table 2). The present findings are in close proximity with the work of Botha (2008).

Perusal of data in Table-3 depicted that in all selected villages of district Budgam, activity of the pest was observed from last week of February (8th SW), which then increased and attained a peak incidence in second week of July to first week of September (28th to 36th SW). Thereafter, the incidence declined until last week of December (52nd SW). The cumulative mean incidence of SJS was recorded highest as 31.33 per cent at low altitude and 22.09 per cent as lowest at high altitude; while as 23.54 per cent at medium altitude was observed. The present findings are more or less supported by the work of Botha (2008).

Elevation and month wise pest incidence

The data was recorded from different elevations of district Baramulla and Budgam in different months. Perusal of data in Table-4 revealed that in district Baramulla the overall highest mean SJS incidence of 38.60 per cent

was recorded at low altitude followed by 30.96 per cent at medium altitude, while as at higher altitude it was 28.39 per cent. However, at all three altitudes, the mean pest incidence differed significantly from each other. For all three altitudes the mean per cent incidence in district Baramulla was observed as highest as 55.19 per cent in the month of August followed by 50.58 per cent in July, whereas, in February, March, April and December, the lowest mean incidence of 16.66 per cent was recorded. However, the mean pest incidence in February, March, April and December was statistically at par with each other and differed significantly from the other months. The present findings are more or less supported by the work of (Bandey *et al.*, 2008).

Perusal of data in Table-5 depicted that the mean pest incidence in district Budgam at low altitude was 31.93 per cent followed by 23.74 per cent at medium altitude, while as 22.07 per cent at higher altitude was observed. However, at all three altitudes, the mean pest incidence differed significantly from each other. For all the three altitudes the mean per cent incidence was recorded highest as 38.88 per cent in the month of August followed by 38.42 per cent in July whereas, the lowest mean incidence of 16.66 per cent was recorded in February, March, April and December.

However, the mean pest incidence in July and August was statistically at par with each other which differed significantly from remaining months. While as, in May and November the mean pest incidence was statistically at par with each other and differed significantly from remaining months. Similarly, in February, March, April and December the mean incidence was statistically at par with each other. The present findings are more or less supported by the work of (Bandey *et al.*, 2008).

Correlation and regression studies

Perusal of Table-6 indicated that in the investigation, the simple correlation between various abiotic factors with incidence of a pest revealed a positive and significant correlation between incidence with maximum temperature, maximum relative humidity and sunshine hours. The present study is in conformity with the work of (Supriadi *et al.*,

2015).

Perusal of Table-7 and 8 depicted that the multiple regression analysis between various abiotic factors with incidence of a pest revealed that maximum temperature contribute maximum to incidence followed by maximum relative humidity and sunshine hours. The present study is in conformity with the work of Supriadi *et al.*, (2015).

Table.1 Classification of villages on the basis of elevation in two different districts

District	Elevation	Villages
Baramulla	High (1700-1800m asl)	Fatehghadh
		Badmul
	Medium (1600-1700m asl)	Buran
		Yaal
	Low (1500-1600m asl)	Singpora
		Kisanbagh
Budgam	High (1800-1900 m asl)	Balpora
		Khudpora
	Medium (1700-1800 m asl)	Nambalhar
		Krimshore
	Low (1600-1700 m asl)	Bugam
		Chadoora

Table.2 Per cent incidence of San Jose scale (*Quadraspidiotus perniciosus* Comstock) on apple at different locations in district Baramulla during 2018-2019

Location	Altitude	Standard weeks																				Mean (%) ±SE	Cumulative pooled mean (%) ±SE				
		8 ^h	10 ^t _h	12 ^t _h	14 ^t _h	16 ^t _h	18 ^t _h	20 ^t _h	22 ⁿ _d	24 ^t _h	26 ^t _h	28 ^t _h	30 ^t _h	32 ⁿ _d	34 ^t _h	36 ^t _h	38 ^t _h	40 ^t _h	42 ⁿ _d	44 ^t _h	46 ^t _h			48 ^t _h	50 ^t _h	52 ⁿ _d	
FATEH GADH	(H)	16.66*	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	33.33	41.66	50.00	50.00	50.00	33.33	33.33	33.33	33.33	33.33	33.33	16.66	16.66	16.66	16.66	28.25 ±2.49	27.89±0.36
BADMUL		16.66	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	33.33	33.33	50.00	50.00	50.00	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	16.66	27.53 ±2.42		
BURAN	(M)	16.66	16.66	16.66	16.66	16.66	16.66	33.33	33.33	41.66	41.66	50.00	50.00	50.00	50.00	41.66	33.33	33.33	33.33	33.33	33.33	16.66	16.66	16.66	16.66	30.79 ±2.69	30.43±0.36
YAAL		16.66	16.66	16.66	16.66	16.66	16.66	33.33	33.33	33.33	41.66	50.00	50.00	50.00	50.00	41.66	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	16.66	30.06 ±2.65	
SINGPORA	(L)	16.66	16.66	16.66	16.66	16.66	33.33	41.66	50.00	58.33	66.66	66.66	66.66	66.66	66.66	50.00	50.00	33.33	33.33	33.33	33.33	16.66	16.66	16.66	16.66	38.40 ±4.14	37.85±0.54
KISANBAGH		16.66	16.66	16.66	16.66	16.66	33.33	33.33	50.00	58.33	58.33	66.66	66.66	66.66	58.33	50.00	50.00	33.33	33.33	33.33	33.33	16.66	16.66	16.66	16.66	37.31 ±3.95	
MEAN (%) ±SE		16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	22.21 ±3.51	31.94 ±2.56	38.88 ±3.51	43.05 ±5.00	45.83 ±5.58	51.38 ±5.44	55.55 ±3.51	55.55 ±3.51	54.16 ±2.84	41.66 ±3.04	38.88 ±3.51	33.33 ±3.18	33.33 ±3.18	31.94 ±3.38	26.38 ±3.34	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00		32.06±2.98

* Each figure is a mean of 6 observations
 * H-High altitude (1700-1800 m asl)
 * M-Medium altitude (1600-1700 m asl)
 * L-Low altitude (1500-1600 m asl)

Table.3 Per cent incidence of San Jose scale (*Quadrspidiotus perniciosus* Comstock) on apple at different locations in district Budgam during 2018-2019

Location	Altitude	Standard weeks																				Mean (%) ±SE	Cumulative pooled mean (%) ±SE			
		8 th	10 th	12 th	14 th	16 th	18 th	20 th	22 nd	24 th	26 th	28 th	30 th	32 nd	34 th	36 th	38 th	40 th	42 nd	44 th	46 th			48 th	50 th	52 nd
BALPORA	(H)	16.66*	16.66	16.66	16.66	16.66	16.66	16.66	24.99	24.99	33.33	33.33	33.33	33.33	33.33	33.33	33.33	16.66	16.66	16.66	16.66	16.66	16.66	16.66	22.45 ±1.60	22.09±0.36
KHUDPORA		16.66	16.66	16.66	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	16.66	16.66	16.66	16.66	21.73 ±1.54	
NAMBALHAR	(M)	16.66	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	16.66	16.66	16.66	23.90 ±1.68	23.54±0.36
KRIMSHORE		16.66	16.66	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	33.33	33.33	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	16.66	16.66	16.66	23.18 ±1.65	
BUGAM	(L)	16.66	16.66	16.66	16.66	16.66	24.99	33.33	33.33	41.66	50.00	50.00	50.00	50.00	50.00	50.00	41.66	33.33	33.33	33.33	24.99	16.66	16.66	16.66	31.88 ±2.85	31.33±0.54
CHADOORA		16.66	16.66	16.66	16.66	16.66	33.33	33.33	41.66	41.66	50.00	50.00	50.00	50.00	50.00	33.33	33.33	33.33	33.33	24.99	16.66	16.66	16.66	30.79 ±2.79		
MEAN (%) ±SE		16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00	18.04 ±1.38	23.60 ±3.34	27.77 ±2.77	33.33 ±3.04	37.49 ±2.84	38.88 ±3.51	38.88 ±3.51	38.88 ±3.51	38.88 ±3.51	38.88 ±3.51	33.33 ±2.15	24.99 ±3.04	22.21 ±3.51	22.21 ±3.51	19.43 ±1.75	16.66 ±0.00	16.66 ±0.00	16.66 ±0.00		25.65±2.86

* Each figure is a mean of 6 observations
 * H-High altitude(1800-1900 m asl)
 *M-Medium altitude (1700-1800 m asl)
 *L-Low altitude(1600-1700 m asl)

Table.4 Per cent incidence of San Jose scale (*Quadrspidiotus perniciosus* Comstock) at different altitudes on apple in district Baramulla during 2018-2019

Month	Per cent incidence			Mean per cent incidence
	High altitude	Medium altitude	Low altitude	
February	16.66(4.08)*	16.66(4.08)	16.66(4.08)	16.66(4.08) ^h
March	16.66(4.08)	16.66(4.08)	16.66(4.08)	16.66(4.08) ^h
April	16.66(4.08)	16.66(4.08)	16.66(4.08)	16.66(4.08) ^h
May	20.82(4.56)	24.99(4.99)	35.41(5.94)	27.07(5.17) ^g
June	33.33(5.77)	35.41(5.95)	50.00(7.07)	40.27(6.26) ^d
July	40.27(6.34)	47.22(6.87)	64.27(8.07)	50.58(7.09) ^b
August	50.00(7.07)	50.00(7.07)	65.57(8.03)	55.19(7.39) ^a

CD (P=0.05)
Month (A) : (0.121)
Elevation (B) : (0.070)
Month × Elevation (A×B) : (0.191)

Figure in parentheses are square root transformed values
 Values superscripted by same letter (s) are statistically identical

Table.5 Per cent incidence of San Jose scale (*Quadraspidiotus perniciosus* Comstock) at different altitudes on apple in district Budgam during 2018-2019

Month	Per cent incidence			Mean per cent incidence
	High altitude	Medium altitude	Low altitude	
February	16.66(4.08)*	16.66(4.08)	16.66(4.08)	16.66(4.08) ^f
March	16.66(4.08)	16.66(4.08)	16.66(4.08)	16.66(4.08) ^f
April	16.66(4.08)	16.66(4.08)	16.66(4.08)	16.66(4.08) ^f
May	16.66(4.08)	18.74(4.32)	27.07(5.19)	20.82(4.53) ^c
June	22.91(4.78)	31.24(5.58)	37.49(6.12)	30.54(5.49) ^c
July	33.33(5.77)	33.33(5.77)	48.61(6.97)	38.42(6.17) ^a
August	33.33(5.77)	33.33(5.77)	50.00(7.07)	38.88(6.20)^a
September	31.24(5.58)	33.33(5.77)	43.74(6.61)	36.10(5.99) ^b
October	16.66(4.08)	20.82(4.56)	33.33(5.77)	23.60(4.80) ^d
November	16.66(4.08)	16.66(4.08)	29.16(5.40)	20.82(4.52) ^c
December	16.66(4.08)	16.66(4.08)	16.66(4.08)	16.66(4.08) ^f
Mean	22.07(4.69) ^C	23.74(4.87) ^B	31.93(5.65) ^A	

CD (P=0.05)

Month (A) : (0.142)

Elevation (B) : (0.082)

Month × Elevation (A×B) : (0.224)

Figure in parentheses are square root transformed values

Values superscripted by same letter (s) are statistically identical

Table.6 Correlation between incidence of San Jose scale (*Quadraspidiotus pernisiocus*) and weather parameters during 2018-2019

Weather parameters	Baramulla	Budgam
	Incidence	Incidence
Maximum temperature	0.757**	0.732**
Minimum temperature	-0.202	-0.072
Rainfall	0.156	0.112
Relative humidity morning	0.752**	0.730**
Relative humidity evening	-0.250	-0.292
Sunshine hour	0.571*	0.506*

Table.7 Regression coefficient (R^2) between incidence of San Jose scale (*Quadraspidiotus pernisiocus*) and weather parameters along with coefficient of Determination in district Baramulla during 2018-2019

Regression equation	R^2	100 R^2	Difference
$Y = 6.078 + 1.260 X_1$	0.5659	56.59	56.59
$Y = 33.218 - 0.941X_1 + 2.702X_2$	0.5668	56.68	0.09
$Y = 53.186 - 2.128X_1 + 4.050X_2 - 1.559X_3$	0.5830	58.30	1.62
$Y = -75.978 + 0.354X_1 + 1.957X_2 + 0.127X_3 + 1.056X_4$	0.8131	81.31	23.01
$Y = -174.730 + 2.205X_1 + 0.823X_2 - 1.851X_3 + 0.800X_4 + 1.628X_5$	0.8236	82.36	1.05
$Y = -166.330 + 2.718X_1 + 0.608X_2 - 1.914X_3 + 0.693X_4 + 1.609X_5 - 1.460X_6$	0.9909	99.09	16.73

X1= maximum temperature, X2= minimum temperature, X3= rainfall, X4= relative humidity morning , X5= relative humidity evening , X6= sunshine hour.

Table.8 Regression coefficient (R^2) between incidence of San Jose scale (*Quadraspidiotus pernisiocus*) and weather parameter along with coefficient of Determination in district Budgam during 2018-2019

Regression equation	R^2	100 R^2	Difference
$Y = 6.719 + 0.899X_1$	0.6376	63.76	63.76
$Y = 21.662 - 0.312X_1 + 1.487X_2$	0.6471	64.71	0.95
$Y = 48.377 - 1.901X_1 + 3.291X_2 - 2.086X_3$	0.6643	66.43	1.72
$Y = -24.378 - 0.502X_1 + 2.113X_2 - 1.135X_3 + 0.595X_4$	0.8407	84.07	17.64
$Y = -63.942 + 0.238X_1 + 1.658X_2 - 1.928X_3 + 0.492X_4 + 0.652X_5$	0.8472	84.72	0.65
$Y = -28.613 + 2.397X_1 + 0.752X_2 - 2.192X_3 + 0.0419X_4 + 0.572X_5 - 6.142X_6$	0.9791	97.91	13.19

X1= maximum temperature, X2= minimum temperature, X3= rainfall, X4= relative humidity morning , X5= relative humidity evening , X6= sunshine hour.

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