Biological Forum – An International Journal **13(2): 133-137(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Estimation of Yield Loss Caused by *Alcidodes porrectirostris* in Walnut Growing Areas of Jammu Division (J &K)

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(Received 29 March 2021, Accepted 04 June, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Walnut (*Juglans regia* L.) is an important rainfed nut fruit grown in few states of India, preferably in the Union Territory of Jammu and Kashmir. The latter has the ascendency in producing the cherished walnuts over the years. However, in last decade or so, it has been severely infested by walnut weevil, *Alcidodes porrectirostris* Marshall (Coleoptera: Curculionidae) particularly in Bhaderwah location of Jammu province of Jammu and Kashmir. This insect-pest destroys the kernel of walnut fruits completely prematurely leading to mammoth yield loss. Since, the information on yield loss due to *A. porrectirostris* in walnut in quantitative terms is very scarce. In the backdrop of this, we took this opportunity to estimate yield loss as a function of fruit infestation due to weevil larvae and the number of healthy fruits per healthy tree.

In order to quantify the approximate yield loss, an extensive survey was conducted during 2019-2020 in walnut growing areas of Jammu. The whole yield of each plant was harvested manually from the ground, during August-September and damaged nuts by *A. porrectirostris* showing larval exit holes or still larvae were separated and summarily rejected. The relationship between the *A. porrectirostris* infestation level and the yield loss indicated that there was a significant yield reduction with increasing infestation level. The dynamics of infested fruits containing larvae revealed that mean yield loss ranged from 6.24– 25.63%. When comparing the mean yield loss across all the four areas, we observed that Bhaderwah has approximately twice as much loss (25.63%) as compared to Udhampur (12.34%) while as loss in Poonch, it is approximately twice (10.92%) that of Reasi (6.24%). The effect of site on yield loss was evident when examining data on infestation across each of the four locations.

Keywords: Walnut, *Alcidodes porrectirostris*, yield loss, kernel, survey, rainfed, infestation

INTRODUCTION

Walnut (*Juglans regia* L.) believed to have originated from ancient Persia (Mahmoodi *et al*., 2019) is an important fruit crop owing to its nutritional value. It is a rich source proteins, fat, minerals and high essential unsaturated fatty acids besides being the richest source of vitamin B6 among all nuts (Vigneshwara, 2011). It is grown in hilly regions of Arunachal Pradesh, Himachal Pradesh, Uttar Pradesh and Jammu& Kashmir underrainfed and poor soil conditions in foot-hills, abandoned places, road-sides, river-sides and marginal lands. Jammu and Kashmir is the principal walnut producing Union Territory/state in India. It has the domination of producing excellent quality walnuts contributing to more than 90% of walnut production in India.

In spite of its rich historical account, quantitative walnut production has often been a problem to mankind due to vast majority of insect-pests that has brought an enormous loss to this cherished fruit crop. Codling moth (*Cydia pomonella*), European red mite (*Panonychus ulmi*), San Jose scale (*Quadraspidiotus perniciosus*) and Walnut scale (*Quadraspidiotus juglansregiae*) are some of the important pests that are affecting walnuts all over the world (Ohlendorf and O'Neill 2009). In the plethora of insect-pests affecting the walnut crop in Jammu & Kashmir, walnut weevil, *A. porrectirostris* is regarded as one of the serious pest causing considerable loss to it (Mir and Wani 2005). It is a medium sized pest with characteristics of Mecysolobini tribe of the weevil family Curculionidae (Bhagat, 2017). As adult it feeds on the exposed aerial parts of the tree such as petioles, leaves and succulent branches while as its larva (grub) feed inside the developing walnuts destroying the kernel completely like that of pecan weevil (Boethel and Eikenbary 1979). The damage in nut fruits due to weevils is quite a serious problem and in some cases it has been reported that yield loss exceeds 90% (Caliskan *et al.*, 2020). Over a last decade or so, *A. porrectirostris* has developed as a permanent pest mostly in the walnut

growing areas of Jammu region and at many places has forced the walnut growers to cut-down walnut trees thereby lowering the scope of walnut cultivation in such areas. Since, the statistical data on yield loss due to *A. porrectirostris* in walnut is very limited due to variation in tree size and cumbersomeness to distinguish between infested and uninfested fruits both on ground and on trees. Therefore, in pursuit of this, we took this opportunity to quantify for the first time the approximate yield loss caused by this weevil in the selected areas of Jammu region. There is no direct method for assessing yield loss for such big trees. Hence, in this study, yield loss was indirectly estimated as a function of fruit infestation due to weevil larvae and the number of healthy fruits per healthy tree. In order to assess the yield loss caused by this weevil an extensive survey during 2019-20 was conducted in hotspot infested areas of Jammu, J & K. The more emphasis was placed on surveying moderate to severely infested walnut trees since these are the go to candidates for forthcoming pest control. Since the data/results for the yield loss estimation with respect to walnut weevil was quite scanty and uncommon, often *ad hoc* with irregular reports, therefore a composed and meaningful survey was conducted to obtain and draw the most interpretative information with respect to yield loss estimation. Hence, the study conducted herein aimed to estimate the yield loss caused by this weevil so that it may help the growers and policy makers to use the management practices effectively thereby re-establishing the quality of this nut fruit in the affected locations.

MATERIAL AND METHODS

The present study was conducted in Bhaderwah, Reasi, Poonch and Udhampur areas of Jammu division, J & K. Routine visits were ensured to all these places from fruit initiation to harvesting for the purpose of studying the nut yield and extent of damage manifested in terms of yield loss.

A. Location of study

A preliminary list of 15 villages were screened in above mentioned areas of Jammu, J & K with on-site visits targeted at assessing tree age, growing conditions of tree and infestation level. Of the 15 initial villages surveyed and screened in each area, we selected 05 villages from each with insignificant levels of other nut pests. In line with this the survey for *A. porrectirostris* was confined to hotspot villages in Bhaderwah (Nalti, Basti, Sartingal, Sharikhi and Bruha), Reasi (Jamsalan-A, Shajroo, Bagga, Chachi and Mahore), Poonch (Rajpora, Azamabad, Seroi, Sabjian and Loran) and Udhampur (Pattangarh, Karlah, Bashat, Sudhmahadev and Bupp) respectively. In order to compute the yield loss, more emphasis was placed to hotspot locations where weevil management strategies would be applied.

B. Collection of walnut weevil infested nuts

After the exploratory survey of the walnut growing areas, well established walnut trees in the age group of (25-30 years) were selected from the hotspot villages as mentioned above. Five (05) trees in each village were marked and randomly selected hundred (100) fallen punctured fruits from each tree in each village were regularly collected and brought to laboratory for data recording. All the trees selected were of same variety (local) and no pesticide treatments were applied in the trees during the course of study. Only freshly dropped punctured fruits were selected for presence of larvae inside infested fruits and kept in suitable conditions until larvae were seen coming out on own. Due care was taken to avoid mixing of collections of fallen fruits of different trees. Collected fruits were placed in glass and clear plastic containers lined with absorbent paper and covered with fine insect netting for adequate ventilation to prevent condensation and fungal growth. Attempts were made to place nuts based on an approximate percentage of ripe fruit size (i.e. 0- 25%, 25- 40%, 40- 65% etc.) in separate containers to ensure that all stages of fruits were included and to determine the fruit size associated with the development of larvae.

C. Determination of yield loss

To assess the larval damage reflected in terms of yield loss, the whole yield of each plant was harvested manually from the ground, during August-September to estimate the average yield. The nut yield level, given in total weight of nuts was achieved and checked for consistency with interviews of the farmers and by comparing the yields with the mean yield per tree recorded in the area (personal communication with the walnut growers of respected locations). The damaged nuts by *A. porrectirostris* showing larval exit holes or still larvae were separated and summarily rejected. The percentage of weevil infestation was calculated by suitable formula.

$$\text{Per cent Infestation (PI)} = \frac{\text{Number of larvae infested nuts}}{\text{Total sample nuts observed}} \times 100$$

The yield loss was estimated from per cent infestation due to *A. porrectirostris* and the maximum yield potential of the walnut using the formula suggested by Selvakumar *et al*., (2002).

$$\text{MPYR} = \frac{\text{Per cent infestation} \times \text{maximum potential yield}}{100}$$

Where MPYR =Maximum Potential Yield Reduction

D. Statistical analysis

Data of nut weevil damage was statistically analysed by ANOVA using the SPSS version 16 and further subjected to post hoc tests for comparison of means.

RESULTS AND DISCUSSION

The results of mean infestation levels and nut yield loss are presented in Table 1. The relationship between the *A. porrectirostris* infestation level and the yield loss in 2019-20 indicated that there was a significant yield reduction with increasing *A. porrectirostris* infestation level (Bhaderwah, F = 11.157; df = 4, 20; P = 0.000; Reasi, F = 0 .871; df = 4, 20; P = 0.498; Poonch, F = 3.252; df = 4, 20; P = 0 .033; Udhampur, F = 2.730; df = 4, 20; P = 0.058). The mean yield loss due to *A.*

porrectirostris infestation in *Juglans regia* ranged from 6.24– 25.63%. The yield loss due to weevil infestation in nut crops often fluctuates depending upon the stage of insect -pest and intensity of damage. For example, yield loss due macadamia seed weevil *Kuschelorhynchusmacadamiae* has been reported as low as 15% (Khun *et al.* 2020) while as due to chestnut weevil (*Curculio elephas*), yield loss exceeding 90% (Caliskan *et al.*, 2020) has been reported depending upon infestation. When comparing the mean yield loss across all the four areas, we observed that Bhaderwah has approximately twice (Fig. 1) as much loss (25.63%) as compared to Udhampur (12.34 %) while as in Poonch, it is approximately twice (10.92%) that of Reasi (6.24 %). The percentage of fruit infestation kept on decreasing with the passage of time in all the four areas. The variation in above yield loss can be attributed to location/ elevation of site (Shah, 2012), differences in tree age and weather factors (Lalancette and Polk, 2000) that could have influenced infestation. Since the Bhaderwah and Poonch areas have the oldest walnut plantation in Jammu region and both possess more mean elevation (1613m and 1021 m, respectively) above sea level, it can be presumed that *A. porrectirostris* might have arrived and established here much earlier than the latter resulting in more infestation and loss. Low level of infestation in Reasi and Udhampur as compared to Bhaderwah and Poonch can be assigned to the fact that former areas relatively possess higher temperatures during the periods of oviposition (May-June) by weevil. Increased temperatures during these months may have forced the desiccation of eggs (Barker 1988) leading to low level maturation and differential growth hence less infestation. Furthermore, in addition to the above factors of yield loss, yield loss also depends upon the fecundity of females that leads to continued multiplying of the population throughout the year (Mulder *et al.*, 2012). Time of egg laying, multiple egg-laying events on individual fruit (Mulder *et al.*, 2012) and increased larval feeding corresponding with kernel formation and time spend by the larvae inside the fruit (Harris and Ring 1979) can be the additional reasons that may have caused increased loss in Bhaderwah and Poonch as compared to other areas. On an average 1-4 larvae where found in infested fruits at Bhaderwah more so in in villages Sharikhi and Basti while as only 1-2 larvae per fruit were reported in other areas. The weevil infested fruits are quite often unhealthy (Ozer, 2020) and therefore should be used for production purposes. The results of this study indicated that more damage occurred from early weevil emergence when the nut was in the water stage, resulting in premature nut drop. Hence when planning tactics for the management of walnut weevil populations, careful thought should be given to early season weevil control, especially when we evil emergence occurs while the nut is still in the water stage.

Table 1: Estimated yield loss (%) caused by *Alcidodes porrectirostris* in walnut, (*Juglans regia* L.) at different locations of Jammu division.

Location	Village	Fruit infestation (%)(Mean ± SE)	Yield loss (%) (Mean ± SE)	Mean yield loss (%)
Bhaderwah	Nalti	49.20 ± 4.21	29.52 ± 2.52^{bc}	25.63 ± 1.68^{c}
	Basti	54.00 ± 3.36	32.40 ± 2.01^{c}	
	Sartingal	40.60± 4.20	24.36 ± 2.52^{b}	
	Sharikhi	48.20± 4.21	28.92 ± 2.52^{bc}	
	Bruha	21.60± 2.89	12.96 ± 1.73^{a}	
Reasi	Jamsalan-A	10.80 ± 1.59	5.40 ± 0.79^{a}	6.24 ± 0.48^{a}
	Shajroo	10.20± 10.20	5.10 ± 1.15^{a}	
	Bagga	15.20 ± 2.15	7.60 ± 1.07^{a}	
	Chachi	13.60± 1.88	6.80 ± 0.94^{a}	
	Mahore	12.60 ± 2.80	6.30 ± 1.40^{a}	
Poonch	Rajpora	24.40 ± 3.32	14.64 ± 1.99^{b}	10.92 ± 0.69^{b}
	Azamabad	15.60 ± 1.50	9.36 ± 0.90^{a}	
	Seroi	19.80 ± 0 .86	11.88 ± 0.51^{ab}	
	Sabjian	14.40 ± 1.63	8.64 ± 0.97^{a}	
	Loran	16.80 ± 2.81	10.08 ± 1.69^{a}	
Udhampur	Pattangarh	28.00 ± 2.07	15.40 ± 1.14^{b}	12.34 ± 0.76^{b}
	Karlah	24.80 ± 2.92	13.64± 1.60^{bc}	
	Bashat	18.80 ± 2.63	10.34 ± 1.44^{a}	
	Sudhmahadev	17.00 ± 1.81	9.35 ± 0.99^{a}	
	Bupp	23.60± 3.72	12.98 ± 2.04^{bc}	

Mean ± SE followed by different letters within the same column and same location are significantly different at $p < 0.05$ level.

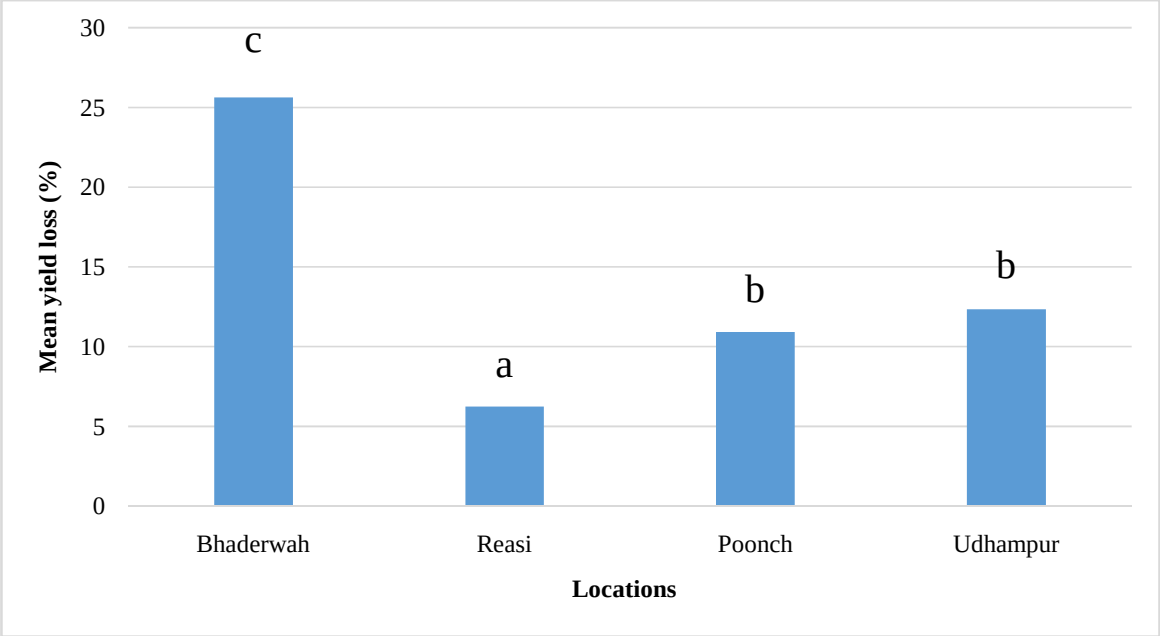

Fig. 1. Estimated yield loss (%) caused by weevil, *Alcidodes porrectirostris* in walnut, *Juglans regia* at different locations of Jammu division.

CONCLUSIONS

Juglans regia is an important nut fruit crop with more than 90% production in the state/UT of Jammu and Kashmir. It is a valuable fruit crop in terms of its nutritional value, wood products and rural development. Of late, this fruit crop has been attacked by several insect- pests. Our results and observations show that the quantity of fruit loss due to *A. porrectirostris* has increased over recent decades. While quantifying the yield loss, we found that it has caused more harm in Bhaderwah area than the rest of places studied. Therefore, it is quite essential that necessary management practices may be employed at appropriate time so that we may be able to save this cherished fruit from weevil attack.

Acknowledgements. The authors are highly thankful to the Department of Horticulture for their cooperation and help during the survey. We sincerely thank the anonymous reviewers for their valuable comments and suggestions which improved the paper.

Conflict of interest. The authors declare that they have no conflict of interest**.**

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How to cite this article: Guroo, M.A., Ahmad, H., Gupta, R.K., Gani, M., Bali, K., Mir, M. and Jamwal, S.S. (2021). Estimation of Yield Loss Caused by *Alcidodes porrectirostris* in Walnut Growing Areas of Jammu Division (J &K). *Biological Forum – An International Journal, 13*(2): 133-137.