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Effect of ground storey crop on stone weevil, *Abeus himalayanus* Voss (Coleoptera: Curculionidae) incidence in ber

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Abstract
Experiment was conducted to study the effect of ground storey intercropping of radish, mustard, coriander, marigold, and barley on stone weevil incidence with three different spacing *viz*., 16 x 4 m, 8 x 8 m and 6 x 6 m intervals. Stone weevil incidence was high in all five intercrop combinations than sole crop, irrespective of spacing environments. Maximum of 32.82% fruit damage noticed in ber + radish combination at spacing 6 x 6 m followed by ber + mustard (26.96%). Sole ber registered about 7.21 to 7.42% infestation. Among five combinations, ber + barley were better model in reducing weevil infestation with damage of 10.33-10.51%. Infestation of stone weevil was high (18.30%) with 6 x 6 m spacing and low (9.24%) with 16 x 4 m spacing. Results revealed that, irrespective of spacing, planting ground storey crop in ber-based cropping system could increase the infestation of fruit weevil.

Keywords: Stone weevil, ber based cropping, pest dynamics

1. Introduction
The ber stone weevil, *Aubeus himalayanus* Voss belongs to the insect order Coleopteran family Curculionidae is an emerging pest of ber in arid and semi-arid region of India. It was recorded as a new pest of ber for the first time from Andhra Pradesh state of India [1]. Later, from Rahuri, Maharashtra and Jobner, Rajasthan of India in 1996 [2] Karnataka state of India [3] in Bikaner district of Rajasthan, India during 2010 [4, 5]. The pest infestation occurs in all the fruit stages; however, it is prevalent in pea to pebble size fruits. Pest feeds only on the seed of developing fruit and arrests further development of infested fruit and could causes damage up to 23.63% to 43.28% [5]. Currently pest is managed mainly using synthetic insecticides and usage of bio-pesticides is also very limited. Summer ploughing, is an ecologically sound method of control that can be alternative to chemical control in minimizing the fruit weevil, which destroy the residual pupa and it is also a recommended cultural practice against tephritid flies in ber.

The intercropping of annual crops and integrating them as a groundstorey component in between perennial fruit crops is a regular practice of farming in arid region to achieve more monetary return in a unit area per time. Growing annual crops like cluster bean and green gram between the ber rows as intercrops is a common and suggested practice under arid ecosystem as it increased on an average of 10% higher monetary returns over sole ber system in a study carried out by Patel *et al*. [6]. Moreover, in this context of ecological pest management growing of non-host or pest repelling plants could be promising intervention to check the pest intensity in the main crop. Intercrop also manipulates confusing environment and acts as repellents to arthropods to find its host. This could supplement to curb the pests and boost the natural enemy populations in organic agriculture as it needs to avoid the use of synthetic pesticides [7, 8]. The possible alteration in microclimate and site-specific allelopathic interaction surrounding vegetation led the changes in incidence of insect pests and natural enemies. Though ample of work has been done on production aspects of ber based ground storey intercropping model/system no work is carried out to document the status of insect pests' ber. Since, stone weevil is an emerging pest of to hot arid ecosystem; the present study was conducted to study the status of stone weevil incidence in ber-based ground storey intercropping model under hot arid region of Bikaner, Rajasthan.

2. Materials and Methods

2.1 Study period and location

The present study was conducted in the Experimental Farm of Central Institute for Arid Horticulture, Bikaner, Rajasthan, India during August to February (2008-10), in the *rabi* season. The experimental area is situated in the hot arid region of western Rajasthan (28°06'N latitude, 73°21'E longitude and altitude of 234.84m above sea level), India. The soil of the study site is sandy, poor in fertility and water holding capacity.

2.2 Treatments

The 10 year old ber orchard of variety Gola planted at three different spacing environments *viz*., 16 x 4 m, 8 x 8 m and 6 x 6 m was taken for this study. Six intercrop combinations *viz*., T1- ber + radish, T2- ber + mustard, T3- ber + coriander, T4- ber + marigold, T5- ber + barley and T6- ber (sole crop as control) were sown as ground storey crop in a randomized block design. Each treatment had three replications. Sowing of annual crops as ground storey components was done during *rabi* season and were integrated into three different spacing environments. The recommended agronomic practices were carried out for both main crop (ber) and intercrops throughout the period of study.

2.3 Stone weevil observation

The observation of stone weevil damage in ber fruit was taken from randomly selected three branches/ treatment at fortnight interval. The data were recorded from first fortnight of October to till harvest. Ber fruits were examined for stone weevil infestation by examining for its typical damage symptoms of black ovipositional puncture mark at the fruit end as well as style end of fruit. The per cent mean damage was computed by subtracting total infested fruits with total number of fruits per branch as given in below formula.

$$\text{Damage (\%)} = \frac{\text{Nos. of weevil damaged fruits}}{\text{Total number fruits}} \times 100$$

2.4 Statistical analysis

The data on per cent damage computed and analyzed by using statistical software SPSS for analysis of variance following randomized block design (RBD) treatment means were separated by applying CD Test (critical difference) at 5% level of significance.

3. Results and Discussion

The incidence of stone weevil in five different intercrop combinations was presented in the Table 1. The significant different was observed among the different set of combination. The least incidence of stone weevil has been observed in ber where no intercrop was done and per cent damage was 7.42, 7.23, and 7.21 in 16 x 4, 8 x 8 and 6 x 6 m spacing environment, respectively. Apart from sole ber, in the plantation with 16 x 4 m spacing, ber + radish combination registered low fruit weevil incidence (7.52%) followed by ber + coriander (7.79%), ber + mustard (10.50%), ber + barley (10.51%) and ber + marigold (11.73%). At 8 x 8 m plantation least damage of weevil recorded in ber + barley (10.46%) combination followed by ber + coriander (13.22%), ber + marigold (14.80%), ber + radish (18.39 %) and maximum with ber + mustard (20.37%). At 6 x 6 m spacing the least damage of fruit weevil noticed in ber + barley (10.33%) followed by ber + marigold (12.83%), ber + coriander (19.67%), ber + mustard (26.96%) and ber + radish (32.82%). Irrespective of different planting space, the maximum infestation of 19.58% damage was recorded in ber + radish combination (Fig 1). The infestation trend was ber + radish > ber + mustard > ber + coriander > ber + marigold > ber + barley > ber (sole). Irrespective of intercrop combination, the greater incidence of stone weevil recorded with the closer planting model i.e. 6 x 6 m followed by 8 x 8 m and 12 x 4 m and mean damage was 18.30 14.07 and 9.24 per cent, respectively (Fig 2). However statistically no significant in damage level was observed between the planting system.

Intercropping affects the pests by changing microclimate through change in canopies and physical factors [9]; diverted orientation due to alteration in crop architecture [10], poly-culture create plant diversity, which affects the population dynamics of insect pests [11]. However, in the present study, the fruit weevil damage was significantly low in the ber tree where no annual crop was planted. This might be due to non availability of favorable microclimate for fruit weevil activity in and around ber tree. Moreover, leaving the land as fallow in-between ber plantation could enhance exposure of residual pest populations to various kind of predation and harsh environment, that might be a reason for least incidence of stone weevil in sole ber planted plot. Growing intercrop could have been provided favorable humidity and shade for survival and population buildup of fruit weevil. On the other hand, studies were reported that growing non host plants in between the annual crops helps in reducing the target pest, which is mainly through repellent mechanism prevails in the intercrop [6-12]. Intercropping has some suppressing effects on most of the insect pests through the changed cropping canopy and resultant change in micro-climate [14]. Moreover, study were reported that growing marigold and coriander as groundstorey crop in ber based horticulture farming found to be encouraging in reducing ber fruit fly infestation under hot arid ecosystem [5]. Similarly, studies also established that marigold repelled mexican bean beetle in bean, coriander repelled aphids in rose [12] and low stem gall incidence on cotton in combination of cotton with marigold [13]. In the present study among the five different intercrop combinations ber + barley found be better model by registering low stone weevil damage. Though, the stone weevil incidence was marginally high in this combination than sole ber, approach would be added advantage in minimizing production risk.

Table 1: Incidence level of ber stone weevil, *Aubeus himalayanus* on ber based ground storey intercropping system

Treatments	% damage of stone weevil		
	16 m x 4 m	8 m x 8 m	6 m x 6 m
T1- Ber + radish	7.52 (2.43)	18.39 (3.53)	32.82 (4.61)
T2- Ber + coriander	7.79 (2.44)	13.22 (2.99)	19.67 (3.69)
T3- Ber + marigold	11.73 (2.83)	14.80 (3.21)	12.83 (3.07)
T4- Ber + mustard	10.50 (2.77)	20.37 (3.69)	26.96 (4.24)
T5- Ber +barley	10.51 (2.83)	10.46 (2.80)	10.33 (2.68)
T6- Ber (sole)	7.42 (2.20)	7.23 (2.27)	7.21 (2.40)
SEd	0.13	0.24	0.43
CD (0.05) *bt/w intercrop combinations	0.30	0.54	0.95

Figure in parenthesis are *sqrt* transformed

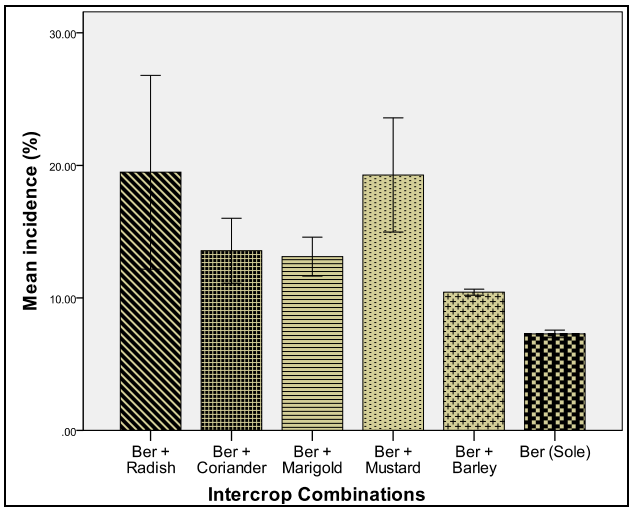

Fig 1: Incidence level of stone weevil, *Aubeus himalayanus* in different intercrop combination

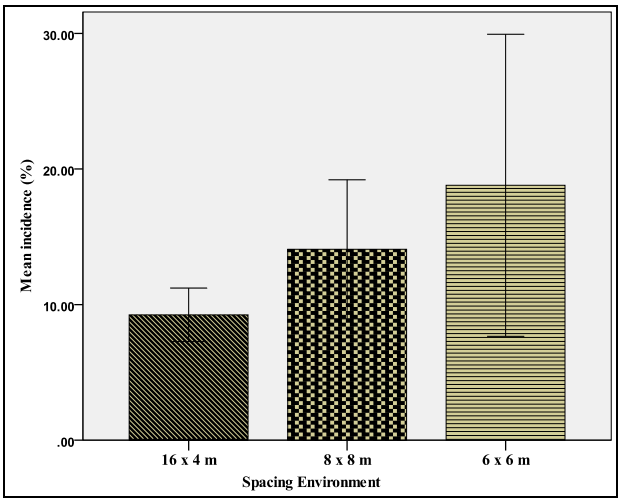

Fig 2: Incidence level of stone weevil, *Aubeus himalayanus* in different planting system

4. Conclusion

Our results conclude that, intercropping of non-host annual crops as ground storey components in ber base horticultural cropping system may add the monetary return but could facilitate the fruit weevil incidence. However, in the view of monetary return out of intercropping model, ground storey cropping model, ber + barley would be a better combination that could minimize the stone weevil incidence with addition return than other combination tried in this study.

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