POPULATION FREQUENCY AND PRE-DISPERSAL DAMAGE OF *JUNIPERUS EXCELSA* TREE BERRIES BY SEED CHALCID, *MEGASTIGMUS SPP.* (HYMENOPTERA: TORYMIDAE) IN JUNIPER FOREST TEHSIL ZIARAT, BALOCHISTAN

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ABSTRACT. *Megastigmus spp. is economically one of the important pests of Juniper excelsa tree that cause pre-dispersal seed damage. So, this research study was carried out to assess the population of Megastigmus spp. and Juniper excelsa tree berries damage in ten different locations in Juniper forest Ziarat. The study was designed in two factorial i.e. location-factor (A) and the tree positions-factor (B). The results revealed that out of total collected specimens of 679, 644 were male and 35 were female Megastigmus spp. Among the locations, Wacha ghoski exhibited greater population of male Megastigmus spp. with 20.54% occurrence and higher occurrence (45.71%) of the female Megastigmus spp was noted in Nari Sar. However, two locations viz Malikat and Sari were free from Megastigmus spp infestation. Whereas, larvae were found only in newly developed berries. Locations, tree positions and their interaction showed significant differences for predated berries, four and two hole berries, fresh weight of individual healthy and predated berry and the intensity of predation. The mean maximum predated Juniper excelsa tree berries (171.67) were observed in Wacha ghoski with higher number (156.33) of predated berries with 4 hole resulting in maximum predation intensity (68.67%) and minimum (10.88) were recorded in Walar Kanrh with greater fresh weight of 1.62 g healthy berry and 1.06 g of predated berry that reflected less predation intensity (4.36%). From this study it was inferred that the entire forest tree berries are not affected by the predation and those forest areas near permanent people settlements are severely affected by Megastigmus spp. predation*.

Key words: *Megastigmus spp.*, population, *Juniper excelsa*, berries damage,

INTRODUCTION

Juniper timberlands and the related assorted qualities of plants and creatures constitute an exceptional biological community in parched mountains with unforgiving climatic conditions in Balochistan province, Pakistan [1]. These forests are thought to be one of the universe biggest, long lived and oldest forests also termed as "Living Forest Fossils" [2]. *Juniperus excelsa* forests in Balochistan comprises of 141, 000 hectares of which 86,000 hectares are existed in area of Ziarat and Loralai. *Juniperus excelsa* actually develops as unadulterated stands and are typically open and multi-stories woods [3:4]. These woodlands are a vital resource of fuel wood for neighborhood occupants and offer insurance from soil disintegration to the local's watersheds notwithstanding give touching fields, summer amusements, bark for material, vital oils and berries. The berries are utilized for enhancing solution for kidney sicknesses. Ziarat valley stands in northern Balochistan where dry temperate *Juniperus excelsa* exists [5]. It is the 2nd largest *Juniperus excelsa* forest on earth and the first one is found in California. In Balochistan it is most established forest of the world, having life span of 2500 to 3500 years [6:7]. Phytophagous bugs known to predate berries of conifers are about 400 species that belong to seven orders including Coleoptera, Dipetera, Heteroptera, Homoptera, Lepidoptea and Thysanoptera [8:9]. Among them, Lepidoptera have higher number of species. The most important pre-dispersal seed predators are insects which predate the seeds at the time fertilization [10]. Past studies have revealed insect predation on angiosperm seeds. Natural products and additionally insect seed exchanges, ecology of insect, advancement and communication with different creatures [11:12]. Presently, there are 126 species of the genus *Megastigmus dalman* (Hymenoptera: Torymidae) and among them 1/3rd are predators of conifers berries [13: 14]. These predators are endoconophytic species [15: 16]. The available scientific information regarding internal progression of berry seed is limited and berry seed is the place where *Megastigmus spp.* lays eggs and larval and pupal phases are happened in the seed. The host range of each species is confined to single genus but seldom comprise of two genera [13: 114]. Insect change in accordance with the transient accessibility of the seed cones at two intensities. In the span of same season the insect become able to parasitize cone for development of their colony and at the stretch of two seasons the availability of resources are ensured the infested insect. Extensive studies have revealed that considerable yearly varieties in larval populations by and large reflect changes in cone plentitude [17:18:19]. The measure of cone or berries destruction depends on availability of cones that contrast to host species. An opposite association among the extent of insect formed impairment and transform in yield size happens while an expansion in the plenitude of cone overtakes enhancement in insect population resulting in cones predation [20: 19]. Seed are potentially vulnerable to predation at any time i.e. from fertilization to germination. To study see ecology it can be useful to partition the phase of the plant life at the time of seed dispersal, which occurs when the seed moves from the parent plant by the action of gravity, wind, animal activity and other agents [21. Pre-dispersal seed predation thus occurs between the time of fertilization and seed dispersal. During this time the seed may be developing or having matured, it may be independent of the parent and still awaiting dispersal. However, the interaction between dispersal seed predator and its host plant may not be limited to this particular period of time only. For example, insects

that consume seeds may also have consumed unpollinated flowers from the same plant [22: 23] may have hatched from eggs laid in flowers before pollination [24: 25] or may metamorphose and emerge from seeds after their dispersal from the parent plant [26]. In Juniper forest Ziarat, no comprehensive inventories have been conducted to determine the extent of losses and damage by insects and diseases particularly the *Juniperus excelsa* tree berries damage caused by *Megastigmus spp.* Therefore, reliable and comprehensive research on the occurrence of *Megastigmus spp.* population and pre-dispersal seed damage of Juniper tree berries is necessary for better understanding of the pre-dispersal seed predation intensity and chalcid attack rate. The objectives of this study were to compare seed predation intensities and *Megastigmus spp.* attack rate of Juniper tree berries as a function of tree positions and locations in juniper forest Ziarat as well as to characterize *Juniperus excelsa* tree berries under *Megastigmus spp.* predation.

MATERIALS AND METHODS

This study was conducted on Juniper forest growing on terrains at Ziarat during 2015. Ten locations were selected for surveillance of *Megastigmus spp.* population and berries sampling. Coordinates of each location in the form of latitude, longitude and elevation were recorded with the help of GPS (Table 1). From each location, 5 trees of same height and girth were chosen for sampling that were 50 Juniper trees in total. Ten locations were were included Basargi, Chawatra, Malikat, Mana Prospect Point, Wacha ghoski, Walar Kanrh, Sari, Sundamen Tangi and Zezri. For collection of the Megastigmus species, surveys were conducted in all the selected locations mostly in the months of April through October as an active period for *Megastigmus spp.* The specimens were collected by hand and aerial nets. Small specimens were collected with aspirator. Each locality was visited fortnightly or monthly depending upon the accessibility to the area. Forest data of Megastigmus was recorded. In the results of these surveys, about 563 Megastigmatus specimens were collected. In addition to this fresh collection, about 60 specimens were studiedin the insect collection of Pakistan Forest Institute, Peshawar The samplings of berries from *Juniperus excelsa* trees were carried out in the month of October and November 2015. Berries wre collected from three different positions of Juniper tree i.e. Top, middle and lower position. From each position, approximately 50 berries were collected randomly around the tree and marked as per tree's position along with the name of location and tree number. These samples were delivered to the laboratory of Zoology Department, University of Balochistan Quetta within two days. These berries were observed for the assessment of damage and for the larval population of *megastigmus spp* and other observations were assessed as per standard method.

Statistical analysis

The collected data were subjected to two way analysis of variance and least significance difference at alpha level 0.05 based on factorial arrangement in order to evaluate the significant differences in the studied parameters. All statistical analysis was computed on Statistix 8.1 software (MathSoft Inc., Cambridge, MA, USA). The correlation were established among other parameters where possible [27].

RESULTS

Abundance and percent occurrence of *Megastigmus spp.*

The *Megastigmus spp.* were collected from ten different locations in Juniper forest Ziarat indicated various level of abundance of male, female and larvae of *Megastigmus spp.* The total collected specimen were 679 and among them 644 specimen were male, 35 were female and 79 were larvae (Table 2). No larva was found in predated *Juniperus excelsa* tree berries of all locations but seeds of some of the newly developed berries showed the existence of larvae. The overall population of Male *Megastigmus spp.* was ranged from 0 to 133 with mean population of 64.4 per location, while female *Megastigmus spp.* was ranged from 0 to 16 with mean population of 3.5 per location and *Megastigmus spp.* larvae was ranged from 0 to 28 with mean population of 7.9 respectively. Among the locations, Wacha ghoski exhibited greater population of male *Megastigmus spp.* with abundance of 133 and percent occurrence of 20.54% followed Nari Sar while Walar Kanrh represented minimum level (6) of male *Megastigmus spp* with percent occurrence of 0.93%. However, two locations viz Malikat and Sari did not show the existence of *Megastigmus spp.* Together with that Basargi also manifested low male *Megastigmus spp.* ercent occurrence of 3.45.7%. In case of female *Megastigmus spp.*, location 6 (Nari Sar) revealed maximum abundance (16) of female *Megastigmus spp.* with percent occurrence of 45.71% followed by Chawatra (location 2) indicating percent occurrence of 34.29% while Sundamen Tangi and Wacha ghoski indicated lower abundance level (3 and 4) of female *Megastigmus sp.* However, six locations viz Basargi, Malikat, Mana, Walar Kanrh, Sari and Zezhri did not show the existence of female *Megastigmus spp.* Among the locations, Sundamen Tangi exhibited minimum percent occurrence (8.57) of female *Megastigmus spp.* Among the locations, four locations such as Malikat, Mana, Wacha ghoski and Zezri exhibited larvae in seeds of newly developed *Juniper excelsa* tree berries and maximum abundance (28) of *Megastigmus spp.* larvae was recorded in location 6 (Wacha ghoski) with percent occurrence of 35.19%. while no occurrence of *Megastigmus spp.* larvae was examined in Basargi, Chawatra, Nari Sar, Walar Kanrh, Sari and Sundamen Tangi respectively (Table 2).

Pre-dispersal seed damage of *Juniperus excelsa* tree berries by *Megastigmus spp.*

Megastigmus spp. is an economically important pest of *Juniper excelsa* forest the world over including Pakistan. The pest lay egg at the time of fertization of *Juniper excelsa* tree and after hatching the larvae remain inside the seed for one year and feed the seed embryo along with endosperm. At maturity the adult *Megastigmus spp.* come out from the berry leaving four or two hole in the berry that resulted in pre-dispersal seed damage and the seed loss viability. Damage berries were characterized for predated berries, predated berries with four and two hole, fresh weight of individual healthy and predated berry and intensity of predation (Table 4). The analysis of variance pertaining to the above

mentioned berries characterization revealed highly significant differences for location, tree position and the interaction of location x tree position except tree position and the interaction of location x tree position for fresh weight of healthy and predated berry which were statistically at par from each other (Table 3). The overall Predated *Juniper excelsa* berries were ranged from 0 to 250 with mean value of 82.08, predated berries with four hole ranged from 0 to 243 with mean value of 60.53, predated berries with two hole ranged from 0 to 112 with the mean value of 21.54, fresh weight of healthy berry ranged from 0.43 to 1.74 g with mean value of 1.19 g, fresh weight of predated berry ranged from 0.0 to 1.28 g with mean value of 0.66 g while the intensity of predation ranged from 0 to 100% with mean intensity of 32.83% respectively. The LSD test ($p<0.05$) for comparison of mean as predicted in Table 4 exhibited that maximum predated berries (128.67), predated berries with four holes (96.19), predated berries with two holes (32.05) and intensity of predation (51.47%) in lower tree position while top tree position expressed minimum values for these berries characterization. However, fresh weight of individually healthy berry manifested statistically at par differences at lower, middle and top tree position with higher weight of 1.21 at the lower tree position. Similarly, the fresh weight of individual predated berry varied non-significantly across three tree position with higher berry of 0.68 g at middle tree position. In addition, the comparison of the fresh weight of individual healthy and predated berry showed that weight of healthy berry was greater over the weight of predated berry (Table 4). In case of locations, Wacha ghoski (location 6) revealed higher number of predated berries (171.67), predated berries with four hole (156.33) that resulted in higher intensity of predation (68.67%) while maximum number of predated berries with two hole were observed in Zezri (location 10). Together with that the fresh weight of individual healthy and predated berry varied significantly across ten locations and Walar Kanrh (location 7) expressed higher healthy berry weight (1.62 g) and predated berry (1.06 g). Out of 10 locations, Walar Kanrh showed minimum number of predated berries (10.88) with lowest intensity of predation of 4.36% indicated only predated berries with hole and no four hole predated berries was observed. However, two locations viz Malikat and Sari were found free of pre-dispersal seed damage of Juniper tree berries by *Megastigmus spp.* predation which showed healthy berries totally. The interactive of location x tree position showed significant differences for predated berries, predated berries with four and two hole, fresh weight of individual healthy and predated berries and intensity of predation. Among the berries characterization, the interactive effect of Wacha ghoski x lower tree position expressed greater number of predated berries (242.33) and predated berries with four hole that resulted into greater intensity of predation of 96.93% while maximum predated berries with two hole (71.0) was noted at the interaction of Basargi x lower tree position. In case of fresh weight of individual healthy and predated berry, the interaction of location 6 (Walar Kanrh) x lower tree position expressed higher weight of healthy berry (1.64 g) and predated berry (1.07 g) while non-significantly lower weight of healthy berry (0.53, 0.56 and 0.50 g) was observed in the interaction of location 7 (Sari) x lower, middle and top tree position respectively. However, no predated berry was examined in the interaction of Sari x lower, middle and top tree position along with Walar Karnh x middle and top tree position. In addition, location 3 (Malikat) also expressed healthy berries at all three tree positions (Table 5).

Correlation

The extent of relationship between number of predated *Juniperus excelsa* tree berries and number of berries with 4 holes was positive and highly significant ($r = 0.947$). It demonstrates that variation in number of berries with 4 holes is due to its association with number of predated berries with coefficient of determination (R^2) of 89%. Regression coefficient (b) showed that a unit increase in number of predated berries will correspondingly increased number 4 hole berries by 0.82. while the correlation between other studied parameters were found non-significant (Fig. 1). The T-test was performed on the dependent variable (number of berries with 4 hole) and independent variable (Number of predated berries) where the calculated T value was 27.67 which was higher than book value as calculated at 5% probability level indicating that the correlation is highly significant.

DISCUSSION

Juniper forest Ziarat Balochistan is one of the oldest forest and world important biological heritages and is called living fossil because of its longevity with 2500 years life span or more [3]. But unfortunately, this highly prestigious heritage has not been protected significantly as it could be. However, Juniper forest is yielded to many degradation processes including indiscriminate cutting by local people and adoption of continuous grazing system by nomads has comulatively deteriorated the ground flora that accelerated soil erosion leading to loss of surface fertile soil and loss of many highly valuable plant species [4]. In addition to that, the Juniper forest trees are also succumbed to many insect pest infestation, parasite and disease attack. Among the insect pests, *Megastigmus spp.* is economically one of the important pests of *Juniperus excelsa* tree that cause pre-dispersal seed damage due to which seeds become unable to regenerate. So, this research study was carried out to assess the population of *Megastigmus spp.* and *Juniperus excelsa* tree berries damage in ten different locations in Juniper forest Ziarat. As regard to the population of *Megastigmus spp.* in various locations at *Juniperus excelsa* forest Ziarat, the results showed great fluctuation in abundance and percent of occurrence of sex ratios of *Megastigmus spp.* As compared to female *Megastigmus spp.* Male *Megastigmus spp.* was dominant and larvae were found only in some of newly developed berries. All the locations were not infested with this pest but some of them were completely free from the existence of *Megastigmus spp.* Among the locations, the most infested *Juniperus excelsa* trees were found in location 6 (Wacha ghoski) in respect of male *Megastigmus spp.* while higher female percent occurrence of *Megagstigmatus spp.* was observed in location 5 (Prospect point). The reasons behind

this higher population of both sexes in these two locations are due to the increased human activities. It means that permanent settlements in the area have disturbed the ecosystem by clearing the ground flora for domestic uses and left no alternate source for the insect pest like *Megastigmus spp.* to feed upon. Because in other locations where human interference was limited showed no pest infestation or very rare infestation. It is further evidenced from the location like Sari which showed no existence of *Megastigmus spp.* where human settlement is limited. Similar study of population assessment of *Megastigmus spp.* was conducted by Mailleux *et al.* [28] who reported that in the forest of *Pseudotsuga menziesii* at North America *Megastigmus spp.* was found as major pest seed. In location like Walar Kanrh revealed minimum level of *Megastigmus spp.* abundance and percent occurrence because in this area shrub such as *Berbaris balochistanica* is flourishing and working as alternate source for *Megastigmus spp.* Because the shrub population of *Berbaris balochistanica* was also higher in Sari area of the Juniper forest Ziarat. *Juniperus excelsa* tree berries were collected from randomly selected five trees in each location with three tree positions (i.e. lower, middle and top) and then these berries were cutted into two equal halves to expose seeds for the existence of larvae of *Megastigmus spp.* No larva was found in predated *Juniperus excelsa* tree berries of all locations but seeds of some of the newly developed berries showed the existence of larvae. It means that the existence of larvae in newly developed berries indicates that the infestation of *Megastigmus spp.* is increasing and these larvae will be transformed in to adult ready to come out from the berries and accelerated the process of predation. The scientists like Aderkas *et al.* [29] also reported that in Douglas fir forest tree berfore the occurrence of fertilization the *Megastigmus spp.* lay eggs in the ovule and the larvae remain in the seed for long period and ovules provide food for these larvae. As regard to predated *Juniperus excelsa*tree berries and intensity of predation, the obtained results indicated that the number of predated berries its and intensity of predation varied significantly across location, tree position and the interaction of location x tree position. The mean higher number of predated berries was recorded in location 6 (Wacha ghoski) which showed 68.67% intensity of predation and at lower tree position with 51.47% intensity of predation along with the interactive effect of location 6 (Wacha ghoski) x lower tree position which exhibited 96.93% intensity of predation. While the berries in other two lications viz Malikat and Sari were not affected by the predation of *Megastigmus spp.* because in these two areas no *Megastigmus spp.* was collected. This fluctuation of berries damage revealed that in areas where anthropogenic activities are low or very limited like Malikat and Sari less berries damage and less intensity of predation was observed. Together with that the existence of higher shrub population of *Berbaris balochistanica* in area like Sari, Walar Kanrh depicted healthy berries or very limited number berries damaged. The study of Roques and Skrzypczyn [14] can be considered in the support of this study. The data regarding predated *Juniperus excelsa* tree berries with 4 and 2 hole indicate that in the study area the majority of predated berries showed 4 holes per berry which means that all the seeds in the berry has been damaged. In

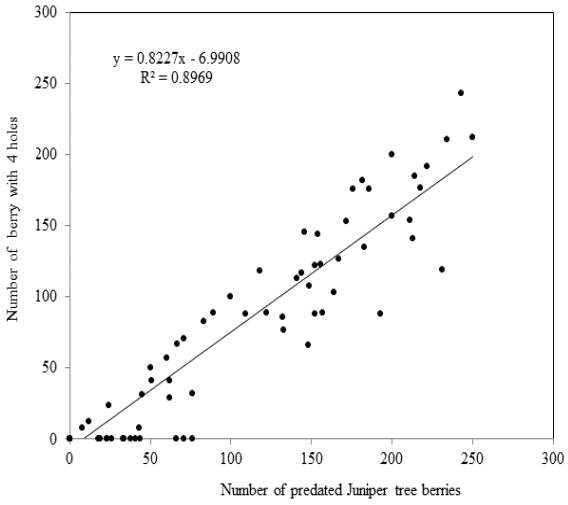

Fig. 1. Linear correlation between number of predated Juniper tree berries and number of berries with

contrast, the two hole berry revealed that two seeds were damaged and two were intact. So, the predated berries with 2 holes will be considered as partial damage because the two intact seeds when dispersed by any means can be regenerated when favourable conditions become available to them. In case of fresh weight of individual healthy and predated *Juniperus excelsa* tree berries, the rusltes exhibited that in all locations healthy berries were weighted than predated berry. It means that on predation by *Megastigmus spp.* the weight of berries is decreased. As regard to the correlation analysis, it was observed that during predation of Juniper tree berries by *Megastigmus spp.* mostly all seeds in the berry are damaged and the predated berry indicate four hole. Because the extent of relationship between number of predated berries and predated berry with 4 holes were positive and highly significant.

CONCLUSION

From this study it was inferred that the predated *Juniperus excelsa* tree berries by *Megastigmus spp.* were fluctuated across different locations in Juniper forest Ziarat but the entire forest tree berries are not affected by the predation and those forest areas near permanent people settlements were severly affected by *Megastigmus spp.* predation. The factorial analysis confirm that the lower tree position showed higher predated berry and wacha goski was found with more male *Megastigamus spp.* infestation and more predated berries and predation intensity. So, it is suggested that the Juniper forest where anthropogenic activities are limited and where the population of *Berbaris balichistanica* is higher than there would be less chances of *Megastigmus spp.* infestation.

Table 1. Coordinates of sampling points

S.No.	Name of location	Latitude	Longitude	Elevation
1	Basargi	30°24.755'N	067°42.004'E	2377 m
2	Chawatra	30°23.695'N	067°43.604'E	2456 m
3	Malikat	30°22.395'N	067°47.4.93'E	2755 m
4	Mana	30°23.908'N	067°43.894'E	2500 m
5	Prospect Point	30°21.071'N	067°44.545'E	2697 m
6	Wacha ghoski	30°23.112'N	067°45.503'E	2524 m
7	Walar Kanrh	30°19.947"N	067°42.908'E	2761 m
8	Sari	30°26.918'N	067°25.120'E	2311 m
9	Sundamen Tangi	30°23.964'N	067°43.764'E	2468 m
10	Zezri	30°19.259'N	067° 42.679'E	2603 m

Table 2. Abundance and percent occurrence of *Megastigmus spp.* in different locations at Juniper forest Ziarat

S.No.	Locations	Abundance			Percent occurrence		
		Male	Female	Larvae	Male	Female	Larvae
1	Basargi	23	0	0	3.57	0.00	0.00
2	Chawatra	87	12	0	13.51	34.29	0.00
3	Malikat	0	0	19	0	0	24.05
4	Mana	57	0	20	8.85	0.00	25.32
5	Nari Sar	128	16	0	19.88	45.71	0.00
6	Wacha ghoski	133	4	28	20.65	11.43	35.44
7	Walar Kanrh	6	0	0	0.93	0.00	0.00
8	Sarri	0	0	0	0	0	0
9	Sundamen Tangi	117	3	0	18.17	8.57	0.00
10	Zezri	93	0	12	14.44	0.00	15.19
Total		644	35	79	**100.00**	**100.00**	**100.00**

Table 3. Mean square values of predated berries, four hole and two hole predated berries, fresh weight of individual healthy and predated berry and intensity of predation by *Megastigmus spp.*

Source of variance	Predated berries	Predated berries with four hole	Predated berries with two hole	Fresh weight of individual berry (g)		Intensity of predation
				Healthy berry	Predated berry	
Replication	907.8	1262.6	39.41	0.03747	0.07544	145.5
Location	38452.4**	28497.9**	3425.37**	1.12940**	1.29760**	6152.4**
Tree position	76349.2**	46210.9**	3792.58**	0.01269NS	0.01522NS	12215.9**
Location x tree position	3915.3**	3684.2**	610.49**	0.00624NS	0.00250NS	626.4**
Error	93.2	297.4	232.40	0.01478	0.00753	14.9
CV	**11.76**	**28.49**	**70.76**	**10.22**	**13.10**	**11.76**

Table 4. Predated berries, predated berries with four hole and two hole, fresh weight of individual healthy and predated berry and intensity of predation as affected by tree position and location (n = 250 berries from tree position)

Source of variance	Predated berries	Predated berries	Predated berries	Fresh weight of individual berry (g)		Intensity of predation
		Four hole	Two hole	Healthy berry	Predated berry	
Tree position						
Lower	128.67 a	96.19 a	32.50 a	1.21 a	0.67 a	**51.47 a**
Middle	89.07 b	66.97 b	22.10 b	1.18 a	0.68 a	**35.63 b**
Top	28.50 c	18.46 c	10.03 c	1.17 a	0.63 a	**11.40 c**
SE±	2.49	4.45	3.94	0.031	0.022	0.99
LSD (p<0.05)	4.98	8.91	7.87	0.063	0.045	1.99
Location						
Basargi	30.33 f	0.00 e	30.33 c	0.87 d	0.63 d	12.13 f
Chawatra	109.33 d	77.22 d	32.11 bc	1.15 c	0.87 b	43.73 d
Malikat	0.00 h	0.00 e	0.00 f	1.58 b	0.00 e	0.00 h
Mana	95.00 e	95.00 bc	0.00 f	0.84 d	0.56 d	38.00 e

Nari Sar	129.20 d	102.69 b	26.44 cd	1.14 c	0.77 c	51.73 c
Wacha ghoski	171.67 a	156.33 a	15.33 de	1.41 b	0.90 b	68.67 a
Walar Kanrh	10.88 g	0.00 e	10.89 ef	1.62 a	1.06 a	4.36 g
Sarri	0.00 h	0.00 e	0.00 f	0.53 e	0.00 e	0.00 h
Sundamen Tangi	135.22 bc	85.88 bcd	46.31 ab	1.36 b	0.98 b	54.19 bc
Zezri	139.0 b	85.00 cd	54.00 a	1.40 b	0.84 bc	55.60 b
SE±	4.55	8.13	7.18	0.057	0.041	1.82
LSD (p<0.05)	9.108	16.27	14.38	0.114	0.082	3.64

Table 5. Interactive effect of location x tree position on predated berries, predated berries with four hole and two hole, fresh weight of individual healthy and predated berry and intensity of predation (n = 250 berries from tree position)

Interaction		Predated berries	Predated berries	Predated berries	Fresh weight of individual berry (g)		Intensity of predation
Location x tree position			Four hole	Two hole	Healthy berry	Predated berry	
Basargi	Lower	71.00 i	0.00 j	71.00 a	0.88 h	0.66 i	28.40 i
	Middle	20.00 mn	0.00 j	20.00 cd	0.84 h	0.66 i	8.00 mn
	Top	0.00 o	0.00 j	0.00 d	0.88 h	0.58 i	0.00 o
Chawatra	Lower	157.33 de	119.33 de	38.00 bc	1.14 g	0.88 cdef	62.93 de
	Middle	131.67 g	96.00 efgh	35.70 bc	1.13 g	0.86 def	52.67 g
	Top	39.01 kl	16.34 ij	22.71 cd	1.17 efg	0.87 def	15.60 kl
Malikat	Lower	0.00 o	0.00 j	0.00 d	1.60 ab	0.00 j	0.00 o
	Middle	0.00 o	0.00 j	0.00 d	1.59 ab	0.00 j	0.00 o
	Top	0.00 o	0.00 j	0.00 d	1.54 abc	0.00 j	0.00 o
Mana	Lower	168.00 d	168.00 bc	0.00 d	0.86 h	0.56 i	67.20 d
	Middle	102.33 h	102.33 efg	0.00 d	0.84 h	0.56 i	40.93 h
	Top	14.66 no	14.66 ij	0.00 d	0.81 h	0.56 i	5.87 no
Nari sar	Lower	189.67 c	161.00 bc	28.66 c	1.16 fg	0.76 fgh	75.87 c
	Middle	138.33 fg	118.00 def	20.30 cd	1.16 fg	0.85 def	55.33 fg
	Top	60.00 ij	29.67 i	30.33 c	1.11 g	0.69 ghi	24.00 ij
Wacha ghoski	Lower	242.33 a	222.00 a	20.33 cd	1.54 abc	0.95 a-e	96.93 a
	Middle	199.00 c	173.33 b	25.70 c	1.44 bcd	0.91 bcde	79.60 c
	Top	73.71 i	73.70 h	0.00 d	1.28 defg	0.84 def	29.46 i
Walar Kanrh	Lower	32.66 lm	0.00 j	32.67 c	1.64 a	1.07 a	13.07 lm
	Middle	0.00 o	0.00 j	0.00 d	1.61 ab	1.08 a	0.00 o
	Top	0.00 o	0.00 j	0.00 d	1.62 ab	1.03 abc	0.00 o
Sari	Lower	0.00 o	0.00 j	0.00 d	0.53 i	0.00 j	0.00 o
	Middle	0.00 o	0.00 j	0.00 d	0.56 i	0.00 j	0.00 o
	Top	0.00 o	0.00 j	0.00 d	0.50 i	0.00 j	0.00 o
Sundamen Tangi	Lower	203.67 c	140.67 cd	63.00 a	1.36 cde	0.98 abcd	81.46 c
	Middle	149.70 ef	89.33 gh	60.31 ab	1.34 cdef	1.01 abc	59.87 ef
	Top	52.34 jk	36.71 i	15.67 cd	1.37 cd	0.96 a-e	20.93 jk
Zezri	Lower	222.33 b	150.67 bc	71.33 a	1.39 cd	0.84 def	88.80 b
	Middle	149.00 ef	90.67 fgh	59.00 ab	1.38 cd	0.86 def	59.87 ef
	Top	45.33 jkl	13.66 ij	31.70 c	1.43 bcd	0.83 efg	18.13 jkl
SE±		7.88	14.08	12.45	0.099	0.071	3.15
LSD (p<0.05)		15.77	28.18	24.92	0.198	0.142	6.31

Mean bearing the same letters are statistically at par

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