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Population dynamics of red flour beetle on different wheat varieties at room temperature

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Abstract
The experiment comprised of eight wheat varieties under laboratory condition. The recording of observations was started on 7th April, 2016 and lasted until to 11th August, 2016. The fortnightly population of the red flour beetle *Tribolium castaneum* (Coleoptera: Tenebrionidae) fluctuated significantly ($P<0.05$) and the results indicated that at first observation (07-04-2016), the red flour beetle population was (15.00±1.73), in variety 'Sindhu', gradually increased and reaching its peak population (51.66±1.20), on the last observation (11-08-2016). The interaction of variety × observation date examined that the red flour beetle were highest (51.66±1.20) in variety Sindhu when observed on 11th August; while lowest (3.33±0.88) in variety TD-1 on 7th March. Further the minimum populations of red flour beetle (8.59±1.17 and 8.53±1.05) were equally recorded for varieties Sarsabz and Hammal at minimum-maximum temperature (20.60-38.35ºC) and relative humidity (40.70%). The ANOVA shows that there was significant ($P<0.05$) difference in population of red flour beetle between wheat varieties in all observational dates. Average maximum weight loss (96%) while the optimum was examined (85.61%). There was a positive and significant correlation in the red flour beetle population with mini-maximum and relative humidity, there is also a linear association of red flour beetles with the temperature and relative humidity.

Keywords: Population, Red flour beetle, Temperature, Wheat, Varieties

1. Introduction

Wheat is the main nutritional grain of Pakistan possessing the biggest precinct under single crop; it contributes 10.0 percent of the agriculture and 2.1 percent to the GDP. The land under wheat has diminished to 9180 thousand hectares in 2014-15 from a last year's area of 9199 thousand hectares which demonstrates a decline of 0.2 percent (Ghulam, 1996) [1]. The production of wheat remained at 25.478 million tones amid 2014-15, demonstrating a diminishing of 1.9 percent in the course of the most recent year's creation of 25.979 million tons (Pakistan Bureau of Statistics, 2015). It gives nutritious nourishment containing the essential components of a sufficient food, and also the wheat has incredible genetic qualities and is growing in differed agro eco zones (Alanko *et al.*, 2000) [2]. This grain is also subjected to harm from the time, it develops in the field until utilized by man, in storage, poor ware house and of their physical characteristic is responsible for the infestation (Syed *et al.*, 2001) [3]. Wheat grains are attacked by considerable 23 insect species in the Pakistan, and out of these, 10 species are known to harmful, attacked grains have damage from excrement, living and dead insect, egg shells, pupal cases, cocoons and webbing. Estimations of the damage are as much as 5-10% of the world production whereas in the some tropical countries these losses are as high as 30% (Lohar, 2001) [4].

Red flour *Tribolium castaneum* is one of the most harmful insect pest of the grains products, for example, flour, oats, feast, wafers, beans, flavors, pasta, cake blend, dried pet nourishment, dried blossoms, chocolate, nuts, seeds, and even the dried historical center examples (Via, 1999) [5]. This pest also found as a major pest of stored grain in the home and stores however, *T. castaneum* founds in the temperatures region and lives in the winter and secured places, particularly where there is favorable ambient (Tripathi *et al*, 2001) [6]. It lays 300 to 400 eggs at random of the grains, which hatch into worm like larvae the larvae are slim in shape whitish yellow in color, at the posterior end of larva; there are two dark pointed projections, the life cycle develops in about 5 weeks at 30ºC, while the adults are long lived and sometimes live for

a year or more (Lohar, 2001) [4]. The insect damages are ranging from 5-30% of the world's total agricultural production.

The red flour beetle is a major pest in human stored food and has been found in association with a wide range of produces including grain, flour, peas, nuts, dried fruits and spices, it also infest groundnut kernels, pods and Milled grain products remain its chosen food (Pugazhvendan and Ronald, 2009) [7]. Previous trial study exhibited that the diverse genotypes show susceptible or resistant response against infestation of red flour beetle (Weston and Rattlingourd 2000) [8]. Susceptibility index and the % mortality and developmental time while a positive relation is found in seed damage, weight loss and new F1 progeny (Abebe *et al*, 2009) [9]. Keeping in view that the significance of pests, and this study has been designed to study the population fluctuation with aims to the following objectives:- To record the resistance and susceptible varieties and weight loss due to infestation of red flour beetle in different wheat varieties.

2. Materials and Methods

2.1 Place of work

The experiment was conducted in the Department of Entomology, Faculty of crop Protection, Sindh Agriculture University Tando jam during 2016.

2.2 Collection of wheat varieties

Eight different wheat varieties; viz V1= Hammal, V2= Khurman, V3= Nia (MN1), V4= Sindhu, V5= Tj-83, V6= TD-1, V7= Inqilab, V8= Sarsabz were collected from the local market Hyderabad Sindh.

2.3 Collection of insects

The culture of *T. castaneum* was obtained from the Grain Storage Research Laboratory, Karachi University. Ten pairs of Red flour beetle were introduced in each jar having different wheat varieties. The standard weight 150gm of the each wheat variety was kept in plastic jars, cover with the muslin cloth and bound with rubber strips. To start the experiment Complete Randomized Design (CRD) experiment was followed and repeated three times.

The observations of the red flour beetle regarding the population fluctuation had been recorded at fortnightly till the culmination of the experiment. The population fluctuation of the red flour beetle on different wheat varieties was calculated with respect to the a-biotic factors (max-minimum temperature, relative humidity). The a-biotic factors were calculated with the help of hydrometer placed close to the experimental area. Thus the data was collected and was analyzed statistically

3. Results and Discussion

The particular study shown population dynamics of the red flour beetle was assessed on the wheat varieties, weight loss as well as correlation was also worked among the population of the red flour beetles and a biotic factors. According to a researcher (Shewry, 2009) [10] reported that the wheat is the leading crop in moderate temperature countries for human animal use. Its success depends partly on its adaptability and high yield potential but also decreased by the red flour beetle *T. castaneum* respectively. Whenever, the fortnightly population of the *T. castaneum* fluctuated significantly ($P<0.05$) and the results indicated in Table-1 that the red flour beetle were highest recorded (51.66±1.20) in variety Sindhu when observed on 11th August; while lowest (3.33±0.88), in variety TD-1 on 7th March. Our results are generally agreed with the (Joel and James, 2011) [11] who examined that the effects of this species are highly dispersive during the adult stage. Therefore, *T. castaneum* were recorded maximum population 53.78, at jobli-1 whereas lowest 6.46, at T91. On the other hand, (Xue, 2010) [12] argued that the starches are poor substrates for the larval survival and development and starches were as attractive as flour to adults; however, starches do not appear to be a suitable medium for egg-laying on the wheat. However, average maximum population of *T. castaneum* (27.59±4.29), were noted for V3=Nia (MN1) followed by 24.53±5.73, 20.32±3.84, 12.66±2.20, 12.46±1.87 and 9.49±0.72 respectively. While the minimum population was equally recorded for varieties V8= Sarsabz and V1= Hammal at minimum-maximum temperature (23.95-39.80ºC) and relative humidity (53.30%). Our these results are also confirmedly with (Pittendrigh *et al.*, 1997; Johnson 2004) [13, 14] whom studied that rice weevils, *Sitophilus oryzae* complete their development from egg to early adulthood inside grains of wheat, rice or maize, reared in grains held at ca. 40% RH took longer to develop from egg to pupation than those reared in grains kept at ca. 70% RH. *T castaneum* lethal exposure times for temperatures of 48, 50, and 52 °C for hemostheat-.5thorderkineticmodel. Exposures needed or 95% mortality yet 48 °C were too long to be practical (67min), but increasing treatment temperatures to 50 and 52 °C resulted in more useful exposure times of 8 and 1.3 min, respectively.

The further data revealed that the wheat varieties Sarsabz and Hammal were relatively resistance against red flour beetle as compared to the rest of the wheat varieties. The ANOVA shows that there was significant ($P<0.05$) difference in population of red flour beetle between the wheat varieties in all observational dates. Similarly to the present results (Ajayi and Rahman, 2006; Astuti *et al*., 2013) [15, 16] examined that the *T. castaneum* adults developed in wheat, more Significantly ($P\leq0.05$), with susceptibility of 8.65, 6, 26, 4.46 and 3.19, respectively. While, the rice cultivars grain borer against Intani-2, and IR-64, found that there was a significant difference in number of eggs and weight loss percentage between cultivars.

Furthermore! The data examined in Table-2 that there was a positive and significant correlation for red flour beetle *T. castaneum* population with mini-maximum and relative humidity, respectively. The present findings indicate that there is a linear association of red flour beetles with the temperature and relative humidity, as the temperature increases and relative humidity decreases simultaneously population of the red flour beetle increases. This investigation is also well matching with (Rustamani *et al.*, 2014) [17] whom concluded that *T. castaneum* caused heavy losses in stored grain food with maximum (272.25 beetles) population in stored grain followed by (65.88 beetles) in semolina, (8.5 beetles) in corn flakes and (6.16 beetles) in biscuits. There was positive and significant correlation of abiotic factors with pest population. In that order, two other scientist (Pugazhvendan and Ronald, 2009) [18] studied on the food grains face severe damage due to infestation by insects. The insect damages are ranging from 5-30% of the world's total agricultural production. The red flour beetle, *T. castaneum* is a major pest Thus powders of *T. purpurea* may prove to be a novel bio-treatment to protect the grains from the damages caused by *T. castaneum.* Different parameter of correlation of red flour beetle and wheat were significant and positive.

Table 1: Fortnightly population fluctuation of red flour beetle on different varieties of wheat from 07-04-2016 to 11-08-2016

Obs. date	Varieties								Temperature		R.H %
	V1	V2	V3	V4	V5	V6	V7	V8	Mini	Maxi	
07-04-16	7.33± 1.20	11.33± 1.45	12.00± 2.88	15.00± 1.73	11.33± 1.76	3.33± 0.88	7.66± 0.66	4.33± 0.88	18.0	38.0	50
21-04-16	8.33± 1.33	10.66± 1.20	11.00± 1.52	13.33± 2.18	12.33± 0.88	5.00± 0.57	8.00± 0.57	5.00± 0.57	20.0	40.5	46
05-05-16	2.33± 0.88	4.33± 0.33	9.66± 3.48	10.00± 1.00	16.00± 3.05	6.00± 1.15	7.33± 0.88	5.66± 1.76	19.5	38.5	44
19-05-16	6.00± 1.15	25.00± 4.72	25.66± 10.58	9.33± 0.88	8.33± 1.45	16.00± 3.05	7.33± 0.88	5.66± 1.76	25.0	46.0	50
02-06-16	7.33± 0.88	8.33± 1.20	32.00± 3.46	5.33± 0.88	9.33± 0.88	21.33± 3.17	9.66± 1.76	9.00± 1.52	25.5	41.0	52
16-06-16	10.00± 1.52	12.66± 0.88	37.00± 3.21	14.33± 1.76	12.66± 0.88	24.66± 2.33	11.66± 1.76	14.66± 1.45	26.5	39.5	52
30-06-16	14.33± 2.40	12.00± 0.57	21.33± 1.85	32.66± 3.38	23.66± 0.88	15.00± 1.73	14.33± 0.88	13.66± 2.02	24.0	36.5	73
14-07-16	11.66± 0.88	12.66± 1.20	39.66± 2.18	42.66± 3.52	31.33± 1.76	14.33± 3.52	11.33± 1.45	12.00± 1.15	26.0	38.5	70
28-07-16	10.66± 0.88	19.66± 0.88	44.00± 5.29	51.00± 2.88	40.66± 1.76	10.00± 2.51	8.66± 1.20	9.00± 1.15	30.0	41.0	52
11-08-16	7.33± 1.45	8.00± 1.73	43.66± 3.17	51.66± 1.20	37.66± 1.20	11.00± 1.15	9.00± 0.57	7.00± 0.57	25.0	38.5	44
Mean ± SE	8.53± 1.05 C	12.46 ± 1.87 bc	27.59± 4.29 A	24.53± 5.73 a	20.32± 3.84 ab	12.66± 2.20 bc	9.49± 0.72 c	8.59± 1.17 c	23.95 ± 1.16	39.80 ± 0.82	53.30 ± 3.19

SE± = 4.4055 LSD 0.05= 8.7823

Table 2: Correlation between population fluctuations of red flour beetle with a-biotic factor on different varieties of wheat

Varieties	Mini	Maxi	R.H
V1	0.7411*	0.2976*	0.8279
V2	0.6028**	0.3597**	0.7553**
V3	0.8246**	0.3079**	0.6093**
V4	0.7708*	0.2537*	0.6317*
V5	0.9391*	0.5579*	0.9992*
V6	0.4595**	0.2598**	0.5677**
V7	0.742*	0.3272*	0.6039*
V8	0.7595**	0.899**	0.8233**

3.1 Weight loss %

The finalized results are shown in Fig-1 that average maximum weight loss (96.00%) were noted for V1= Hammal followed by 93.33, 92.51, 90.67, 87.83 and 85.61% for varieties V8=, V2=, V7=, V6=, V5= and V4=. These results are clearly confirmed by (Lale *et al*., 2000; Khair, 2015) [19, 20] whom investigated that the damages of *T. castaneum* on grains. Their findings indicated that beetle caused weight loss (99.7, 92.3 and 77.7%) in GB8735, Gwagwa and Ex-borno. Considering weight loss as the main indication of susceptibility, rice appeared to be the least susceptible (lowest total percentage of weight loss), while wheat and millet flours were the most susceptible (highest total percentage of weight losses) respectively. While the minimum weight loss (80.01%) were recorded for variety V3= (MN1). The experiment of some other authors (Shafique *et al.*, 2006; Bodroza *et al*., 2012) [21, 22] recorded the maximum weight loss was in grade-l (3.41%) and the lowest in dry wheat (0.41%) caused by larval development. Whenever, quality attributes of wheat against *S. oryzae*. The findings indicates that the pest damaged (8.3%) in whole crop during the entire experimental period. They also recommended that integrated pest management program should be developed for the control of these serious pests and prevent the field crop losses.

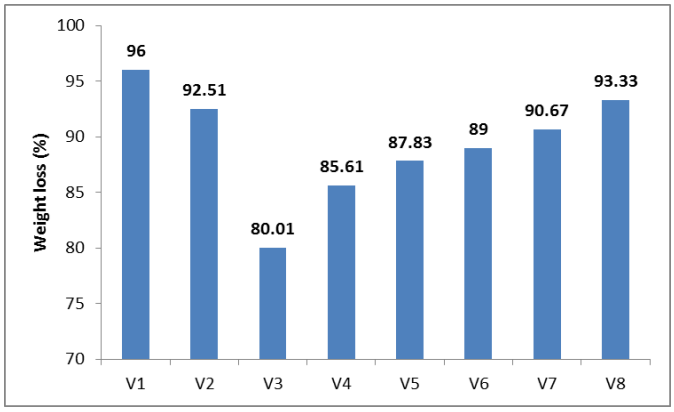

Fig 1: Weight loss on different varieties of wheat infected by red flour beetle from 07-04-2016 to 11-08-2016

4. Conclusions

It was concluded that wheat varieties Sarsabz and Hammal were relative resistance against red flour beetle as compared to rest of the wheat varieties.

5. Suggestions

Farmers have to use resistant varieties 'Sarsabz and Hammal' for the growth of the wheat and also avoid the pest infestation.

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