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Appraising the Changes in the Nutritional Value of Stored Wheat, *Triticum aestivum* L. Infested with Acarid Mite, *Rhizoglyphus tritici* (Acari: Acaridae)

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Abstract.- Storage mites are considered to be detrimental to grain fitness and commonly cause a change in the chemical composition of the stored wheat. The present study showed the changes in nutritional value of the wheat grains of variety Lasani-08 when subjected to infestation with varying population levels of the acarid mite, *Rhizoglyphus tritici* (Acari: Acaridae) for one month and three months. Maximum moisture contents were 17.06 and 17.73% in infested grains as compared to 16.10 and 16.36% for control after one and three months of storage, respectively. The protein contents were lowest (12.66%) after three months of storage with highest level of mite infestation. Also, there was a significant effect of mite population on fat contents. Maximum decrease in fat contents was recorded after three months, which was from 1.28 and 0.93% for control and infested wheat with 20 pairs of mites, respectively. The fiber contents increased significantly in infested grains compared to control which was 1.03% to 1.72% and from 1.07 to 1.99 after one and three months interval, respectively. The ash contents increased in treated grains (2.03%) compared to control (1.23%) after three months of storage. Starch contents decreased after three months of storage with mite infestation. Although the ash and fiber increased with storage and mite infestation, the increase due to depletion of protein, fat and carbohydrate. It can be concluded that mites are responsible for nutrient depletion of wheat during storage

Key Words: *Triticum aestivum*, acarid, mites, nutritional losses.

INTRODUCTION

More than 70% of the population is engaged with agriculture for its livelihood. Wheat is the main staple food and largest grain crop of the country (Gulzar *et al*., 2010). It contributes 13.1% to agriculture and 2.8% to GDP. Area and production of wheat for the year 2009-10 was 9046 thousand hectares and 24 million tons, respectively (GOP, 2009-10).

Cereals are principal food sources around the world that provide more nutrients than any other single food source. Wheat is one of the most important cereal grains worldwide, in terms of production and utilization (Nadeem *et al*., 2010). It is a major source of nutrients in many regions. Its grains provide 60% of the calories and proteins daily required for the Pakistani people. Although seen primarily as a source of carbohydrates; these foods are also a substantive source of protein, vitamins and minerals when consumed as a major component of diet. Wheat is one of the cereals used extensively in many parts of the world for the preparation of many bakery products like bread (Hoseney *et al*., 1988).

Wheat is the basic and most important concern of the human being in Pakistan. The mites are important pests of wheat during its storage and accountable of both the qualitative and quantitative losses (Mahmood *et al*., 2011). The wheat grain includes three distinct parts, the bran (12 to 14%), the germ (2 to 4%) and the endosperm that is 82 to 83% (Posner, 2000). Most of the nutrients in the wheat grain with the exception of starch are congregated in the germ. It is an excellent source of vitamins, minerals, dietary fiber, calories, proteins and some functional micronutrients (Shurpalekar and Rao, 1977). Mites preferably feed on germ and demolish its contents; mites also consume the other parts of the grain but to a smaller extent. The wheat

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germ flakes are consumed more rapidly than grain itself under optimum infestation (Soloman, 1946). During varied storage conditions, several insect pests attack cereal grains and weight losses are accrued to the extent of 23% in India (Swaminathan, 1977). Among insect pests the khapra beetle (*Trogoderma granarium* Everts) and the lesser grain borer (*Rhizopertha dominica* Fabricius) cause major storage losses in cereals in India (Girish *et al*., 1975) and several other tropical and sub-tropical regions of the world (Salunkhe *et al*., 1985). Protein and starch digestibility of wheat, maize and sorghum grains having 25, 50 and 75% grain infestation caused by *T. granarium* Everts and *R. dominica* Fabricius separately and in mixed form were affected significantly (Jood and Kapoor, 1992). Although infestation of these pests has been reported to decrease carbohydrates and proteins in various stored food grains (Girish *et al*., 1975; Swaminathan, 1977), information is still lacking on the effect of mite infestations and storage periods on the nutritional decline in wheat that led to the present investigation.

MATERIALS AND METHODS

Procurement of raw material

Wheat variety Lasani-08, commonly grown in Pakistan, was collected from Ayub Agricultural Research Institute, Faisalabad. The present appraisal was carried out in Acarology Research Laboratory of Department of Agricultural Entomology, University of Agriculture, Faisalabad. Biochemical and nutritional changes in the infested grains induced by infestation of mites were studied at Cereal Lab, Wheat Research Institute, Ayub Agricultural Research Institute, Faisalabad. The experiments were conducted in CRD with three replications.

Grain infestation

Grains were fumigated with aluminum phosphide tablets to nullify the possibility of previous infestation. The grains were cleaned by sieving through 3/8, 3/16, 1/8, 1/12 inch mesh sieves as described by Proctor (1994). One kg wheat grain samples were taken into glass jars. Mixed age mites were introduced in each jar from the culture being reared in Acarology Research Laboratory, Department of Agricultural Entomology, University of Agriculture Faisalabad without any exposure to pesticides. All the jars were covered with lid having fine mesh of size 400µm. These jars incubated at 25±2°C, 70±5% R.H. Following treatments were applied; 05 pairs of mites per Kg (T_1), 10 pairs of mites per Kg (T_2), 20 pairs of mites per Kg (T_3) and Control with no mite (T_0). Jars without mite served as control. The results were calculated after one and three months of storage.

Milling of wheat grains

The whole meal wheat flour of wheat grains was prepared by grinding the wheat grains through Udy Cyclone Sample Mill (Seedburo Equipment Co., IL) fitted with 0.5 mm sieve.

Chemical characteristics of wheat

The whole wheat flour of variety was evaluated for proximate composition *i.e.* moisture, crude protein, crude fat, crude fiber, ash and starch content according to the procedure described in AACC (2000), methods # 44-15A, 46-10, 30-25, 32-10 and 08-01, respectively. The NFE or the starch was calculated according to the following expression:

NFE = 100 – (% moisture + % crude protein + % crude fat + %crude fiber + % ash)

RESULTS

There was a non-significant change in all the parameters in control but there was a significant change in those having different levels of mites after 30 and 90 days. There was a significant increase in mite population, moisture and ash of the grains having different levels of mite populations. Mite population significantly increased after 30 days of storage (df, 3,8; f ratio, 1319; $P \leq 0.0000$), showing 796, 973 and 2226 mites in T_1, T_2 and T_3 respectively (Table I). There was also a significant increase in mite population after 90 days of storage, (df, 3,8; f ratio, 1071; $P \leq 0.0000$) having 1575, 2163 and 5146 mites in the treatments having 5, 10 and 20 pairs of mites, respectively. t-test values showed that there was a significant change in the treatments having five, ten and twenty pairs of mites

Table I.- Effect of storage of wheat infested with mites for 30 and 90 days on mite population and various nutritional parameters of wheat (Means ± S.E)

Level infestation	Mites population	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)	Starch (%)
Storage for 30 days							
Control (T_0)	0d	16.10±0.82 a	13.90±0.10 a	1.29±0.5 a	1.03±0.11 b	1.24±0.04 c	66.43±0.25 a
05 Pairs (T_1)	796±45 c	16.43±0.12 a	13.63±0.15 a	1.26±0.06 a	1.14±0.18 b	1.30±0.02 b	66.21±0.17 ab
10 pairs (T_2)	973±35 b	16.83±0.60 a	13.53±0.06 b	1.22±0.04 a	1.61±0.17a	1.39±0.01 a	65.40±0.43 bc
20 Pairs (T_3)	2226±25 a	17.06±0.57 a	13.50±0.10 b	1.07±0.02 b	1.72±0.02a	1.42±0.03 a	65.21±0.46 c
Storage for 90 days							
Control (T_0)	0d	16.36±0.12 d	13.86±0.06 a	1.28±0.03 a	1.07±0.02 d	1.23±0.03 d	66.18±0.21 a
05 Pairs (T_1)	1575±22 c	16.76±0.15 c	13.36±0.15 b	1.23±0.02 b	1.35±0.05 c	1.55±0.05 c	65.73±0.14 b
10 pairs (T_2)	2163±37 b	17.13±0.15b	13.06±0.06 c	1.15±0.01 c	1.76±0.06 b	1.75±0.05 b	65.13±0.15 c
20 Pairs (T_3)	5146±56 a	17.73±0.06 a	12.66±0.15 d	0.93±0.03 d	1.99±0.10 a	2.03±0.06 a	64.64±0.31 d

Means sharing similar letters are not significantly different by LSD Test at p = 0.05

at both the intervals t_{cal} = 26.52, 25.63 and 81.33, respectively.

Moisture increased but statistically it was the same in all the treatments after 30 days of storage. Maximum moisture was found in the treatment having 20 pairs of mites that was 17.06% (Table I). After 90 days of storage moisture was significantly increased in all the treatments with different levels of mite infestation (df, 3,8; f ratio, 63.9; P ≤0.0000). Maximum moisture was found in the treatment having 20 pairs of mites that was 17.73% (Table I). t-test between the moisture of 30 days and 90 days of storage showed a significant change in the treatments having 10 and 20 pairs of mites t_{cal} = 3.015 and 2.42, respectively.

Protein contents of the grains after 90 days of storage significantly decreased in the infested grains (df, 3,8; f ratio, 57.6; P ≤0.0000). Protein contents after 90 days of storage in T_0, T_1, T_2 and T_3 were 13.86, 13.36, 13.06 and 12.66% (Table I). There was a significant change in protein contents after both the intervals in the treatments having 10 pairs and 20 pairs of mites t_{cal} = 9.89 and 7.93, respectively.

Fat contents significantly decreased in the only treatment having twenty pairs of mites after 30 days of storage that was 1.07% (Table I), while after 90 days of storage fat contents significantly decreased in all the treatments (df, 3,8; f ratio, 165; P ≤0.0000) showing 1.28, 1.23, 1.15 and 0.93% in T_0, T_1, T_2 and T_3 (Table I). t-test showed a significant change in the treatments having ten pairs and twenty pairs of mites after both the intervals t_{cal} = 2.85 and 7.37, respectively.

Fiber contents significantly increased but statistically similar in the treatments having ten pairs and twenty pairs of mites after 30 days of storage that was 1.61 and 1.72%, respectively (Table I). Fiber contents after 90 days of storage in all the treatments showed a significant increase in the fiber contents (df, 3,8; f ratio, 125; P ≤0.0000). Maximum fiber contents (1.99%) after 90 days were found in the treatment having 20 pairs of mites (Table I). t-test between the treatment having twenty pairs of mites after 30 and 90 days of storage showed a significant change (t_{cal} = 4.63).

Ash contents also significantly increased after 30 days and 90 days of storage. After 30 days maximum ash contents (1.42%) were found in the treatment having 20 pairs of mites that was statistically similar with the treatment having 10 pairs of mites (1.39%) (Table I). After 90 days of storage ash contents were significantly increased in all the treatments (df, 3,8; f ratio, 148; P ≤0.0000), treatment with 20 pairs of mites showed maximum ash contents having 2.03% (Table I). t-test showed a significant change between 30 days and 90 days storage interval in the treatments having five, ten and twenty pairs of mites t_{cal} = 8.06, 12.03 and 15.90, respectively.

Starch contents significantly decreased after 90 days of storage in the infested gains (df, 3,8; f ratio, 30.1; P ≤0.0001). Minimum starch (64.64%) after 90 days was found in the treatment having 20 pairs of mites (Table I). t-test showed a significant change between 30 days and 90 days interval in the only treatment having twenty pairs of mites (t_{cal} = 2.768).

Correlation

The results (Table II) showed the effect of mites on moisture, protein, fat, fiber, ash and starch after 30 and 90 days of storage. The results of protein, fat and starch showed significant negative correlation. The effect of mites on the moisture, fiber and ash showed significant positive correlation.

Table II.- Correlation between mite population and different quality parameters.

Parameters (%)	After 30 days	After 90 days
Moisture	0.93	0.98
Crude protein	-0.85	-0.96
Crude fat	-0.96	-0.98
Crude fiber	0.86	0.93
Ash	0.90	0.97
Starch	-0.86	-0.95

DISCUSSION

Findings of the current investigations have disclosed significant changes in nutritional composition of wheat grains of Lasani-08 when subjected to artificial mite infestation. It is realized that there is negative relation between mite levels and the protein, fat and starch contents of wheat kernels. Literature has revealed that storage mites infest, cause weight losses and germination losses in the stored grains (Soloman, 1946; Ashfaq *et al*., 1995; Franz *et al.*, 1997; Zdarkova, 1998; Stejskal *et al*., 2003; Mahmood *et al*., 2012). The present findings can be compared with those of Sinha and Wallace (1966), Tabassum and Ahmed (1989) and White and Jayas (1993) who reported the increase in moisture content due to mite infestation. These results are also in accordance with those of Cook *et al,* (2004) and Hubert *et al,* (2010) who reported that higher moisture favours the increase in mite population in stored grains. Results regarding decrease in protein and fat content can be compared with those of Hughes (1976) and Parkinson (1990) who reported that mites prefer to feed on commodities with high protein and fat content. These findings are also in accordance with those of Jood *et al,* (1995) and Ahmedani *et al,* (2009) who found the decrease in protein and fat content while a percent increase in ash and fiber content of stored wheat infested by various insect pest. Mite infested grains undergo a series of changes in their chemical composition and affecting the germination capacity flour prepared from contaminated grains is more acidic, has fusty smell and bitter in taste (Stejskal *et al*., 2002). It may be inferred from the present investigation that nutritional value of wheat grains during storage are affected by mite. Infestation at different levels caused significant reductions and the adverse effects were related to feeding habits of the mites.

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