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Nutritional indices studies of *Sitophilus oryzae* L. feeding on sorghum and split pulses

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Abstract
An experiment was carried out at the Entomology Laboratory, Horticultural College and Research Institute for Women, TNAU, Trichy in February-March 2014 to estimate the nutritional indices in *Sitophilus oryzae* L. under room temperature condition. A completely randomized design (CRD) was used with seven treatments (T1= sorghum, T2 = red gram, T3= chick pea, T4 = black gram, T5 = green gram, T6= fried gram and T7= lentil) each replicated four times. The assessed parameters were food consumption, weight gained, relative growth rate (RGR), efficiency of conversion of ingested food (ECI), efficiency of conversion of digested food (ECD), approximate digestibility (AD), consumption index and coefficient of metabolism. Among the split pulses adult weight gained (18.01), food consumption (27.82), AD (84.86), ECI (79.39) and ECD (90.05) was recorded maximum red gram followed by green gram, chick pea, black gram, fried gram and lentil. RGR was significantly maximum in redgram (50.84) followed by lentil (48.58), chick pea (47.81), black gram (47.27), green gram (47.12) and were on par with each other. Among the split pulses lowest RGR value was recorded in fried gram (45.71). In case of larva, weight gained (17.92 mg), RGR (42.51) and AD (73.75) was recorded maximum in lentil followed by other hosts. Based on the observation was made, the adult weight gained and RGR was maximum in redgram, while larva it was higher in lentil.

Keywords: Nutritional indices, *Sitophilus oryzae* L, adult and larva, split pulses

Introduction

The rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae), is one of the most destructive pest of stored cereals worldwide. It is classed as a primary pest, cosmopolitan in nature and is known to infest sound cereal seeds (Hill, 1990) [5] and causes severe loss in rice, maize, barley and wheat (Neupane, 1995) [15]. Considering the loss caused by storage insect pests, effective methods of control are of paramount importance. Control often depends on a sound knowledge of the ecology and on the effects of a multitude of environmental factors on the life history of a pest (FAO, 1968) [4].

Reports about its occurrence on legumes are scanty. Pemberton *et al* (1981) [17] studied its breeding behaviour on carob, *Ceratonia siliqua* (L.), a tree legume native to the Mediterranean region. Coombs *et al.* (1977) [1] reported the successful development by Trinidad strain of *S.oryzae* on yellow split pea. In India, the pest was recorded for the first time to feed on red gram at Coimbatore. We collected a population of rice weevil feeding on split red gram dhal was sent to IARI, identified as *Sitophilus oryzae* by Dr. V.V. Ramamoorthy, Principal Scientist, Entomology Division (Personal communication, 2011). Determining the nutritional indices of an insect is a tool for evaluating host plant resistance mechanisms that could improve pest management programs. Of the tools of pest management, host plant resistance is important in terms of being both economically and environmentally acceptable (Latha and Naganagoud, 2015) [8]. Therefore, as a method of controlling pest insects, host plant resistance is not only favorable to the environment, but also reduces expenses for growers (Li *et al*., 2004) [11]. Keeping in this view, the present study to observe and calculate the nutritional indices of pulse breeding population of *S. oryzae* were studied in comparison to normal population that occurs on sorghum.

Materials and methods

The two population of rice weevil, *S. oryzae*, was mass cultured on their respective hosts namely sorghum and red gram dhal under laboratory. The development of population reared on split pulses was studied in comparison to that of sorghum. The experiment was laid out in a completely randomized design (CRD) with seven treatments *viz.*, T1 = sorghum, T2 = split red gram, T3 = split chick pea, T4 = split black gram, T5= split green graml, T6= split fried gram and T7= split lentil and each replicated four times. The experiment was conducted under room temperature (30.5 to 35.25 ºC for 60 days period, RH range 77-84%) condition.

The experiment was conducted in order to determine the different nutritional indices of adult and larvae of *S. oryzae* based on consumption and utilization of food. The pre weighed grains (sorghum and split pulses) were placed in separate plastic containers (4.0cm height and 4.0 cm dia.) along with 10 pair of adults. Observations on quantity of food consumed, excreta voided and the weight gained by the adult were recorded daily to a maximum of 2l days feeding period.

In order to estimate the larval nutritional indices 20 infested grains were taken and observed to a maximum of 22 days feeding period. Each host was considered as a treatment and replicated four times. Using the observed values the following nutritional indices were calculated as described by Waldbauer (1968) [22], Slansky and Scriber (1985) [21] and Deml *et al*. (1999) [2].

1. Consumption (C) = Initial fresh weight of food – Final fresh weight of food
2. Production (P) = Final fresh weight of adult- Initial fresh weight of adult
3. Assimilation (A) = Fresh weight of food ingested- Fresh weight of faeces

4. $$\text{Relative Growth Rate (RGR)} = \frac{\text{Fresh weight of adult /larva}}{\text{Duration of feeding period (Days) X Mean fresh weight of adult during feeding period}}$$

5. $$\text{Approximate Digestibility (AD)} = \frac{\text{Weight of food ingested- Fresh weight of faeces}}{\text{Weight of food ingested}} \text{ X 100}$$

6. $$\text{Efficiency of Conversion of Ingested food (ECI)} = \frac{\text{Weight gained}}{\text{Fresh weight of food ingested}} \text{ X100}$$

7. $$\text{Efficiency of Conversion of Digested food (ECD)} = \frac{\text{Weight gained}}{\text{Fresh weight of food ingested- Fresh weight of faeces}} \text{ X100}$$

8. $$\text{Consumption Index (CI)} = \frac{\text{Fresh weight of food consumed}}{\text{Mean fresh weight of adult during feeding period X Duration of feeding period (days)}}$$

9. $$\text{Coefficient of Metabolism (COM)} = \frac{\text{Fresh weight of digested food- increase in weight of larva}}{\text{Fresh weight of digested food}}$$

Results and discussion

Adult

At room temperature the adult weight gained was higher in redgram (18.01 mg) followed by other hosts. The food consumption was significantly higher in redgram (27.82 mg) followed by chick pea (25.17 mg) and was on par with green gram (25.02 mg) respectively. Assimilation rate was 9.83 g in fried gram followed by other hosts (Table 15). A legumes used in the present study were comparatively rich in proteins. But the deviation in present results is might be due to presence of some food attractants in redgram (Scriber and Slansky, 1981) [20].

RGR was significantly maximum in redgram (50.84) followed by other hosts. Among the split pulses lowest RGR value was recorded in fried gram (45.71). Hwang *et al.* (2008) [6] reported that when insect feed on high nutrient food growth and development were increased. Lower fitness of hosts might be due to the presence of some secondary phytochemicals in these food grains or absence of primary nutrients necessary for growth and development. The values of AD was maximum in redgram (84.86) followed by other hosts. AD depends on a number of factors like quantity of food intake, retention time in the mid gut, nature and efficiency of digestive enzymes and digestibility of the complex nutritive components in the diet (Sabhat *et al*., 2011) [18].

ECI and ECD values in adult was significantly higher in redgram (79.39 and 90.05) followed by lentil (58.73 and 64.88) and green gram (47.50 and 75.48) respectively. It might be due to the imbalance of proteins, amino acids and fibres (Haylett *et al.,* 1971). CI was 42.05 in redgram followed by lentil (38.03) and chick pea (37.08). COM was significantly maximum in green gram (0.97) followed by other hosts (Table 1). Analysis of nutritional indices can lead to understanding of the behavioral and physiological basis of insect response to food grains (Lazervic and Peric-Mataruga, 2003) [9].

In case of sorghum the values of adult weight gained (16.48mg), food consumption (24.49mg), assimilation rate (2.78g) was significantly minimum feeding by the respective population when compared to redgram population feeding on split pulses. The lowest RGR value was recorded in sorghum (40.62) feeding by the respective population when compared to redgram population. ECI and ECD values were minimum in sorghum (70.26 and 84.76) as compared to redgram feeding by the respective population. In case of sorghum AD and CI values was 79.90 and 33.30 feeding by the respective population and COM was 0.92 (Table 1).

Larva

Under room temperature the larval weight gained was significantly higher in lentil (17.90 mg) and redgram (16.00mg) followed by other hosts. The food consumption was maximum in chick pea (357.75 mg) followed by lentil (328.00 mg), red gram (327.50mg) and were on par with each other (Table 16). Among the split pulses the lowest food consumption was recorded in fried gram (185.75 mg). According to Ernst (1992) [3] the amount of food consumed by the larva of bruchid-*Specularius Impressi thorax* L. ranged between 15.1 and 48.7 mg while feeding on redgram. The assimilation rate was higher in fried gram (1.97g) followed by chick pea (1.45g), lentil (0.86g) and redgram (0.76g) respectively.

The RGR was significantly higher in lentil (42.51) followed by grains of redgram (38.70) chick pea, green gram and fried gram on par with each other. Kotkar *et al.* (2009) [7] reported that legumes such as redgram, chickpea, and pea had the highest protein content and were favourable for insect growth and development. The difference in survival, growth and development of insects on different hosts might have been caused by antibiotic effects, poor nutritional quality of the food and secondary metabolites (Samraj and David, 1988) [19].

The values of AD was maximum in lentil (73.75) followed by other hosts. ECI was maximum in green gram (36.56) followed by black gram and redgram and it was recorded minimum in fried gram. Among the split pulses ECD in larva was 82.70 in green gram followed by redgram (50.34) and black gram (38.25) respectively. The higher ECD values of green gram suggest higher food efficiency and low cost maintenance. The low ECI and ECD values of fried gram might be due to some physiological adoptions to overcome nutritional imbalance at the time of feeding. The changes of ECI and ECD value might be due to depend on the level of digestive enzymes of insects (Patankar *et al.,* 2001) [16]. ECI and ECD values, of *S. oryzae* reared on different food grains were significantly different, suggesting that the various host had different nutritional values (Naseri *et al.,* 2010) [13]. ECI is a general index of an insects ability to use the food consumed for the growth and development and ECD is an index of the efficiency of conversion of digested food into growth (Nathan *et al.,* 2005) [14].

CI was 44.73 in lentil followed by redgram (43.44) and was on par with chick pea (42.91) followed by other hosts. COM was maximum in grains of chick pea (0.73) and were on par with green gram (0.71) followed by redgram (0.65) respectively (Table 2). Consumption Index was higher in sorghum followed by redgram and chick pea. Coefficient of Metabolism (COM) was maximum in chick pea followed by sorghum, respectively. According to Munro (1996) [12] the food type and content of nutrient affect the biological parameters of stored product insects. Lecato and Flaherty (1973) [10] showed the quantity and quality of food media of are capable of affecting the life cycle of an insect.

Food consumption was maximum (356.25 mg) in sorghum grains feeding by the respective population when compared to redgram population feeding on split pulses. In case of sorghum grains the larval weight gained was 16.30 mg as compared to lentil (17.92mg) feeding by the respective population. Assimilation rate was 0.56 g in sorghum grains feeding by the respective population. In case of sorghum RGR was minimum (31.92) feeding by the respective population when compared to redgram population. AD value in sorghum (81.67) was significantly superior to all the treatments feeding by the respective population. ECI values of sorghum population while feeding on sorghum was 27.08 as compared to redgram population feeding on green gram (36.56). The ECD and CI values in sorghum (86.81 and 46.56) were significantly superior to all the treatments feeding by the respective population. COM was 0.72 in sorghum as compared to chick pea (0.73) feeding by the respective population (Table 2).

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