South Pacific Study Vol. 19, No. 1-2, 1999

Further Studies on Pest-host Interaction in IPM of *Mythimna separata* (Walk.)

Muhammad ASHFAQ[1], Abrar AHMAD[1]
and Ghulam Mustafa CHEEMA[2]

Abstract

The leaves of 15 selected host plants viz., 'chulai' (***Amaranthus viridis*** L.), 'dib'(***Typha angustata*** L.), garlic (***Allium sativum*** L.), gram (***Cicer aretinum*** L.), 'khabbal' grass (***Cynodon dactylon*** Pers.), 'korbooti' (***Euphorbia helioscopia*** L.), lady's finger (***Hibiscus esculentus*** L.), maize (***Zea mays*** L.), 'makoh' (***Solanum nigrum*** L.), onion (***Allium sepa*** L), potato (***Solanum tuberosum*** L.), rice (***Oryza sativa*** L.), sorghum (***Sorghum vulgare*** Pers.), sugarcane (***Saccharum officinarum*** L.) and water grass (***Phragmites karka*** L.) were offered as food to 4th instar larvae of ***Mythimna separata*** (Walk.) to find out consumption and coefficient of utilization and were correlated here with the chemical plant factors.

Keeping all the results presented here in this study in view, it is concluded that Khabbal grass (296.32 mg consumption and 66.67% coefficient of utilization) was found to be a suitable alternate host for rice crop (282.70 mgs consumption and 70.57% coefficient of utilization) whereas 'dib' was found to be a suitable (123.74 mgs consumption and 57.49% coefficient of utilization) alternate host for potato (120.79 mgs consumption and 54.33% coefficient of utilization) and Lady's finger (109.79 mg consumption and 49.28% coefficient of utilization) of all calcium, magnesium and fat contents showed negative and significant correlation both with consumption as well as coefficient of utilization values. The R^2 values were 0.852 and 0.847 for consumption and coefficient of utilization, respectively.

Key words: Pakistan, food preference, armyworm, chemical factors

Introduction

Armyworm, ***Mythimna separata*** (Walk.) is one of the most serious pest of cereals in Asia. It has been attacking plants of 33 species in 8 families resulting in heavy crop losses (SHARMA and DAVIS, 1983). Complete reliance has been made on pesticides for the control of this notorious cereal pest resulting in the disturbance of natural fauna. With the recent advances in the plant physiology, biochemistry and insects behaviour, it has become possible to determine the physiological and biochemical nature and causes of the plant immunity and resistance. A few attempts on the line by various scientists in scattered form, however, were carried out by RAMDEV and RAO (1979), BERNAYS (1982), ELAIDI and AKHTAR (1984), SURANI and ASHFAQ (1984), RAMAN and ANNADURAI (1985), BRAWER ***et al.*** (1987), HARE (1987), QAMAR (1990), CENTER and WRIGHT (1991), ALI (1993) and

1) Entomology Department, University of Agriculture, Faisalabad, Pakistan.
2) Agriculture College, Bahauddin Zikaria University, Multan, Pakistan.

VIRK (1993).

The present study was conducted to determine the role of chemical factors responsible for the acquisition of resistance against ***M. separata.***

Materials and Methods

From a screening trail, 15 plants viz., 'chulai', 'dib', garlic, gram, 'khabbal' grass, 'korbooti', lady's finger, maize, 'makoh', onion, potato, rice, sorghum, sugarcane and water grass showing the response of susceptibility/resistance and intermediate (out of 54) were selected. Fresh tender leaves weighing 40 g of each host plant were washed with distilled water to remove dust and dirt and were shade-dried for one hour. The leaves of each host plant were divided into four lots and each lot contained 10 leaves. These leaves were cut into small pieces. Ten grams leaves of each host plant were put into glass beaker and each host plant had four beakers (250 ml capacity). It was replicated four times in Completely Randomized Design. These beakers were kept into rearing room under controlled conditions. Uniform sized larvae of 4th instar were obtained from mass rearing studies and one

Table 1. Leaf consumption, coefficient of utilization, faeces and various chemical plant factors of

Host Plants	Consumption (mg) per 10g fresh leaves	Coefficient of utilization (%)	Dry faeces (mg) par 10g fresh leaves	Total minerals (%)	Nitrogen (%)	Protein (%)	P (%)
Chulai	192.13F	42.55G	110.34DE	6.01H	1.05I	6.57HIJ	0.28DE
Dib	123.74H	57.49D	52.63B	4.55I	0.95I	5.97IJ	0.12I
Garlic	175.82G	24.31K	133.04BC	6.55GH	0.93I	5.76J	0.28D
Gram	196.42F	31.38I	134.74BC	7.83EFG	1.36G	8.52G	0.31C
Khabbal Grass	296.32B	66.67B	98.71F	6.55GH	1.28GH	8.03GH	0.22H
Korbooti	228.03D	29.70U	160.24A	8.86DEF	1.40G	8.74FG	0.25EFG
Laby's finger	109.57I	49.28F	55.53H	7.56FGH	2.36C	14.77BC	0.45A
Maize	370.46A	69.29AB	113.26D	7.62FGH	1.66F	10.41E	0.26DEFG
Makoh	195.93F	46.79F	104.29DEF	9.22CDE	1.64F	10.23EF	0.25FG
Onion	216.13E	39.25H	131.26BC	10.69ABC	2.85A	17.78A	0.28DEF
Potato	120.79HI	54.33E	49.69H	11.87A	2.15D	13.47CD	0.37B
Rice	282.70C	70.57A	83.20G	10.04BCD	2.49B	15.53B	0.25FG
Sorghum	364.28A	62.52C	141.00B	10.86AB	2.02E	12.61D	0.26DEFG
Sugarcane	358.28A	71.06A	102.79EF	6.75GH	1.96E	13.78CD	0.25EFG
Water Grass	179.01G	27.79J	129.19C	6.14H	1.21H	7.55GHI	0.23GH

r $=0.579^{*}$
$R^2=0.336$
$R^2=0.173$
r $=0.416^{NS}$

Means sharing similar letters are not significantly different at P=0.01
r =Correlation coefficient value.
R^2 =Coefficient of determination.

larva was liberated into each beaker for feeding. The larvae were starved for 24 hours before liberation and then were allowed to feed on the experimental foods for 24 hours. At the same time an equal quantity of the leaves of the same food plant was dried in an oven at 100℃ for 24 hours to calculate dry weight of the leaves fed to the insects. Similarly, the left over leaves after 24 hours feeding in each beaker were also dried and weighed. The insects were left for further 24 hours in the same beakers (without food) to have complete collection of the faeces. The faeces thus collected were transferred to 50 ml glass beakers and were dried by putting in the oven at 100℃ for 24 hours. The dried faeces were weighed as described above. The consumption of each lot was measured by directly substracting the final dry weight of the left over leaves from the calculated mean dry weight of the initial amount of leaves provided to the insects. The percent coefficient of utilization was calculated after EVANS (1939).

$$\text{Coefficient of Utilization (\%)} = \frac{A-B}{A} \times 100$$

A = Dry weight of food consumed
B = Dry weight of faeces produced

different food plants.

K (%)	Ca (%)	Mg (%)	Fe (PPM)	Mu (PPM)	Zinc (PPM)	Crude fibre (%)	CHO (%)	Fats (%)
1.91G	0.77G	0.64C	59.27D	16.48G	20.41CDE	30.83BC	50.56AB	2.63CD
1.33I	0.54H	0.36G	13.93I	20.57GH	29.59CD	37.73A	50.15AB	2.13EF
2.67E	1.16CD	0.44E	15.36I	59.00DE	23.99CDE	20.00DEF	52.25AB	2.89C
1.49HI	0.94EF	0.43E	40.02F	43.82F	11.69E	14.25F	43.56C	5.23A
2.16FG	0.38I	0.23J	35.35G	71.13D	36.39C	25.19CDE	53.90AB	0.76H
2.67E	1.12D	0.32H	26.27H	26.00GH	30.95CD	29.17BC	50.96AB	1.63FG
4.32B	1.02E	0.86A	73.11C	191.37B	75.06A	19.40EF	53.59AB	3.52B
2.68E	0.34IJ	0.18K	26.15H	140.43C	33.25CD	29.57BC	49.98AB	1.74F
3.16D	0.91F	0.52D	16.58I	68.62DE	18.25DE	30.55BC	50.44AB	2.38DE
2.66E	1.76A	0.38FG	53.16E	57.58E	13.87E	26.05CD	53.42AB	2.10EF
4.76A	1.56B	0.55D	89.94B	142.99C	30.84CD	18.38F	52.97AB	3..56B
2.24F	0.28J	0.39F	118.20A	278.48A	51.71B	25.71CDE	52.72AB	1.21GH
3.63C	0.33IJ	0.27I	43.55F	19.86GH	30.44CD	26.18CD	47.94BC	1.81F
1.63H	0.38I	0.31H	25.04H	30.89G	32.93CD	33.46AB	50.99AB	2.07EF
4.34B	1.21C	0.75B	13.95I	30.87G	55.54B	29.68BC	54.85A	1.65FG

The total minerals, nitrogen, protein, fat, crude fibre, soluble carbohydrates, magnesium, phosphorus, calcium, potassium, ferrous, manganese and zinc were determined. The data were analyzed. Means were separated by Duncan's New Multiple Range Test (DUNCAN, 1955). Simple and multiple correlations were also worked out among consumption, coefficient of utilization and chemical plant factors.

Table 2. Effect of chemical factors on the consumption (g) and utilization (%) of levels of

		Total Minerals	Nitrogen	Protein	Phoshorus	Potassium	Calcium
Consumption	r	0.157	0.156	0.156	-0.284*	-0.244*	-0.6372*
	R^2	0.017	0.029	0.043	0.083	0.077	0.425
Utilization	r	0.109	0.3590**	0.359**	-0.171	-0.158	-0.711**
	R^2	0.012	0.130	0.147	0.028	0.025	0.504

* Significant at $P \leq 0.05$
** Significant at $P \leq 0.01$
r = Correlation values
R^2 = Coefficient of Determination Values

Results and Discussion

The results (Table 1) revealed that the ranking order of host plants on the basis of consumption was maize > sorghum > sugarcane > 'khabbal' grass > rice > 'korbooti'> onion > gram > 'makoh' > 'chulai' > garlic > 'dib' > potato > lady's finger. The preference on the basis of coefficient of utilization was recorded as sugarcane > rice > maize > 'khabbal' grass > sorghum > 'dib' > potato > lady's finger > 'makoh' > 'chulai' > onion > gram > 'korbooti' > water grass > garlic. On over all basis significantly positive correlation was found to exist between food consumption and coefficient of utilization. The R^2 value was found to be 0.336.

These findings are quite in conformity with those of BAILEY (1976) who reported 51.8% coefficient of utilization on potato over the entire larval period of Bertha armyworm, Mamestra configurata Walk. Our results are also in line with those of NASIR (1979) who found that sugarcane and wheat had a very high degree of consumption and coefficient of utilization. The present findings cannot be compared with those of SURANI and ASHFAQ (1984) and MAJEED (1995) because of differences in their materials and methods.

Phosphorus, potassium, calcium, magnesium and fat contents were found to play significantly negative role for consumption. Nitrogen, protein, ferrous, crude fiber and manganese showed significantly positive correlation with coefficient of utilization, whereas, calcium and magnesium had negative effects. All other factors viz., carbohydrates, total minerals and zinc were found to be non-significant. Calcium, magnesium and fat contents were the most important chemicals which showed significant correlation with negative effects both for food consumption and coefficient of utilization. The contribution of these factors towards susceptibility/resistance was recorded as 42.5%, 51.5% and 25.6% for food consumption and 50.4%, 20.5% and 17.3% for coefficient of utilization, respectively (Table 2).

The present findings are in agreement with those of ALI (1993) regarding carbohydrates and with QAMAR (1990) regarding zinc content. However, the findings reported by Ramdev and RAO (1979), Elaidi and AKHTAR (1984), Raman and Annadurai (1985), different selected plants.

Magnesium	ferrus	Manganeze	Zinc	Crude fibre	Carbohydrates	fats
-0.718**	-0.038	-0.004	-0.0095	0.235	-0.145	-0.506**
0.515	0.009	0.00	0.009	0.055	0.021	0.256
-0.452**	0.321**	0.406**	0.234	0.278**	0.125	-0.417**
0.205	0.103	0.166	0.043	0.077	0.002	0.1773

Table 3. Multiple effects of chemical factors on consumption and coefficient of utilization (%) of different food plants plants.

S. O. V.		D. F.	M. S.	F. RATIO	R^2
Regressoion	Consumption	13	26176.34795	19. 37*	0.846
	Utilization		1006.63484	19. 55*	0.847
Error	Consumption	46	1351.67699		
	Utillization		51.50124		

* Signiffcant at P≤0.01.

REGRESSION EQUATION FOR CONSUMPTION

$Y=603.1079-9.8832\,X1-3417.6\,X2+554.99\,X3+496.43\,X4+26.232\,X5-114.94\,X6-162.28\,X7-0.17631\,X8-0.14336\,X9-1.9940\,X10-1.4412\,X11-3.7465\,X12-46.227\,X13$

REGRESSION EQUATION FOR UTILIZATION

$Y=-20.25535-1.3585\,X1+166.45\,X2-24.548\,X3+0.9117\,X4+4.9710\,X5-27.549\,X6-28.333\,X7+0.07904\,X8+0.021883\,X9-0.14523\,X10+0.67758\,X11+1.0355\,X12+3.7883\,X13$

The adjusted R^2 value for consumption = 0.803
The adjusted R^2 value for utilization = 0.802
Where: X1 = Totarl Mineral
X2 = Nitrogen
X3 = Protein
X4 = Phosphorus
X5 = Potassium
X6 = Calcium
X7 = Magnesium
X8 = Ferrous
X9 = Manganese
X10 = Zinc
X11 = Crude Fibers
X12 = Carbohydrates
X13 = FAT

HARE (1987). CENTER and WRIGHT (1992), SURANI and ASHFAQ (1984) are contradictory to the present ones which might be due to differences in test materials. The present findings also can not be compared with those of ALI (1993) who found non-significant correlation between protein, potassium and phosphorus contents and coefficient of utilization of different food plants offered to ***M. separata.*** He further reported non-significant effects of manganese, zinc and ferrous on the coefficient of utilization. In the present studies zinc contents showed non-significant response but manganese and ferrous showed a significantly positive correlation.

Linear Multiple Regression Analysis of Variance revealed significant effects of chemical factors on food consumption and coefficient of utilization. The 100 R^2 values were 84.6% and 84.7% for consumption and coefficient of utilization, respectively. The regression equations were found to be fitted good (Table 3). According to THORSTEINSON (1960) nutritive substances were responsible for attraction of the polyphagous insects and similar conclusion has also been drawn during the present dissertation.

Keeping all the results presented here in this study in view, it is concluded that Khabbal grass (296.32 mg consumption and 66.67% coefficient of utilization) was found to be a suitable alternate host for rice crop (282.70 mg consumption and 70.57% coefficient of utilization) whereas 'dib' was found to be a suitable (123.74 mg consumption and 57.49% coefficient of utilization) alternate host for potato (120.79 mg consumption and 54.33% coefficient of utilization) and Lady's finger (109.79 mg consumption and 49.28% coefficient of utilization) of all calcium, magnesium and fat contents showed negative and significant correlation both with consumption as well as coefficient of utilization values. The R^2 values were 0.852 and 0.847 for consumption and coefficient of utilization, respectively.

References

ALI, S. 1993. Physico-chemical factors affecting the consumption and utilization of different food plants by ***Mythimna separata*** Walk. M.Sc. Thesis, Dept. Agri. Entomol., Univ. Agri., Faisalabad.

BAILEY, C. G. 1976. A quantitative study of consumption and utilization of various diets in the bertha armyworm (***Mamestra conficureta*** Walk. Dept: Noctuidae). Gen. Entomol. 108, 1319-1326.

BERNAYS, E.A. 1982. The insect on the planta closer look. Proc. 5th Intern. Symp. on insect plant relationship, Wageningen, The Netherlands 1-4 March, 1982. 3-17 Centre for overseas pest research, London, UK. (Rev. Appl. Entomol. (A), 71, 3969, 1983).

BRAWER, J. W., O'NEIL, K.M., and DESHON, R.E. Jr. 1987. Effects of artificially altered foliar nitrogen levels on development and survival of young instars of Western spruce budworm, ***Choristoneura occidentalis*** Freeman. J. Appl. Entomol., 104, 121-130 (Rev. Appl.Entomol., (A); 76, 8070, 1988).

CENTER, T.D. and WRIGHT, A.D. 1991. Age and phytochemical composition of water hyacinth (Pontederiaceae) leaves, determine their acceptability to ***Neochetina eichhorniae*** (Coleoptera; Curculionidae). Envirn. Entomol., 20 ,323-334.

DUNCAN, D.B. 1955. Multiple range and multiple F tests. Biometrics 11: 1-42.

ELAIDI, G. M. I. and AKHTAR, M. 1984. Factors affecting consumption and utilization of different plants by ***Agrotis ipsilon*** (Rott.). Pak. J. Entomol., 6, 105-110.

EVANS, A. C. 1939. The utilization of food by certain Lepidopterous larvae. Trans. Roy. Entomol., Soc., 89, 13-22.

HARE, J.D. 1987. Growth of ***Leptinotarsa decemlineata*** larvae in response to simultaneous variation in protein and glyco-alkaloid concentration. J. Chem. Ecol., 13, 39-46. (Rev. Appl. Entomol. (A), 75, 5240, 1987).

MAJEED, M. A. 1995. Consumption and utilization of different plants by rice grasshopper, ***Hieroglyphus banian*** (F.) (Acrididae: Orthoptera). M.Sc. thesis, Dept. Agri. Entomol., Univ. Agri., Faisalabad, Pakistan.

NASIR, M. S. 1979. Food preference and utilization of food plants by armyworm, ***Cirphis unipuncta*** (Haw.). M.Sc. thesis, Dept. Entomol., Univ. Agri., Faisalabad.

QAMAR, S. 1990. The impact of some factors on the utilization of food by certain lepidopterous larvae. Trans. Roy. Entomol. Soc., 89, 13-22.

RAMAN, K. and ANNADURAI, R.S. 1985. Host selection and food utilization of pumpkin beetle, ***Raphidophora foveicollis*** (Lucas). (Coleoptera: Chrysomelidae). Proc. Indian Acad. Sci., 94,547-556. (Rev. Appl. Entomol., (A); 73, 5833, 1988).

RAMDEV, Y.P. and RAO J.P. 1979. Consumption and utilization of dietary constituents of Castor, ***Ricinus communis*** Linn. by castor semilooper, ***Acheata janata*** Linn. Indian J. Expt. Biol., 17, 1154-1156 (Rev. Appl. Entomol., (A); 69 , 1394. 1981.

SHARMA, H. and DAVIS, J.C. 1983. The oriental armyworm, Mythimna ***separata*** (Walk.). Distribution, biology and control: a literature review. Miscellaneous Report, Centre Overseas Pest Res., 59, 24pp (Rev. Appl. Entomol., 71, 3342, 1983).

SURANI, I. R. and ASHFAQ, M. 1984. Studies on some physio-chemical factors influencing the host preference in ***Chrotogonus Trachypterus*** Balanchard. Pak. J. Entomol., 6, 15-20.

THORSTEINSON, A.J. 1960. Host plant selection by polyphagous. Ann. Rev. Entomol., 5, 193-218.

VIRK, E. A., 1993. Physico-chemical factors affecting the consumption and utilization of different food plants by ***Aiolopus tamulus*** F. M.Sc. Thesis, Dept. Agri. Entomol., Univ. Agri., Faisalabad.

(Accepted 21 December, 1998)