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RESISTANCE OF MAIZE TO FIELD INFESTATION BY SITOPHILUS ZEAMAIS MOTSCHULSKY AND SITOTROGA CEREALELLA (OLIVIER)

by J. W. TURNER, M.Agr.Sc.

SUMMARY

Levels of resistance to *Sitophilus zeamais* Motschulsky and *Sitotroga cerealella* (Olivier) in maize varieties grown in Queensland are demonstrated. A table is presented which allows comparisons to be made between varieties. A number of the current commercial varieties are shown to be more susceptible to infestation than some of the experimental varieties. Observations were made on the husk characteristics, grain moisture levels and on flowering dates of varieties, but only limited explanations are provided by these data relative to plant characteristics which confer resistance.

The increasing difficulties associated with the management of maize storage pests justifies further investigation into the economic impact of the usage of resistant varieties as part of the pest management programme.

I. INTRODUCTION

Infestation of maize in the field by the maize weevil *Sitophilus zeamais* Motschulsky and Angoumois grain moth *Sitotroga cerealella* (Olivier) is a problem of long standing. Varieties have always tended to differ in their susceptibility, and a number of workers have found significant levels of resistance to field infestation by grain pests.

Husk characteristics have been demonstrated as important in conferring resistance to *S. zeamais* (McMillan *et al.* 1968) and damage to the husk has been shown to increase susceptibility (McMillan *et al.* 1968; Floyd *et al.* 1958). Kernel characteristics have been demonstrated to confer resistance to *S. zeamais* and *S. cerealella* (Singh and McCain 1963; Villacis *et al.* 1970). Kirk and Manwiller (1964) observed a 15-fold decrease in the levels of field infestation by *S. zeamais* following widespread plantings of resistant varieties of maize in areas of the United States.

Rising world market standards for all export grains require critical re-examination of all sources of infestation commencing at the farm level. The work reported in this paper was initiated to determine whether any differences in levels of resistance were apparent in locally-grown maize varieties.

II. MATERIALS AND METHODS

The experiment was superimposed on varietal trials near Kingaroy, aimed at comparing the yield potential and regional suitability of 20 early and 18 late maturing varieties. Each variety was replicated four times and planted with a row spacing of 0·9 m and a plot size of four rows by 11 m on 3 November 1972. The middle two rows, each 10 m long, were harvested on 13 June 1973 and shelled on 19 June 1973.

Assessments were made of the percentage of cobs which were visibly infested (showing insect emergence holes) before shelling, and of the grain moisture percentage lost during oven drying at 150°C for 48 h. Aliquots of 0·6 l of grain were held at 27°C for 38 days after harvest to allow for the emergence of juvenile stages present at harvest. The numbers of adult *S. zeamais* and *S. cerealella* and the percentage of grain with emergence holes were then recorded.

A number of plant characteristics, likely to confer resistance, were assessed in the field. These were: percentage of cob ends exposed; percentage of husks with large apical apertures; percentage of husk bodies which fitted tightly over the cob; percentage of cobs with narrow husk leaves—easily removed husks.

III. RESULTS

Mean numbers of *S. zeamais* and *S. cerealella* per aliquot, of grain, mean percentage of cobs visibly infested at shelling and mean percentage of grains with emergence holes are given in table 1. The observed characteristics of the maize varieties are summarised in table 2.

IV. DISCUSSION

The data demonstrate moderate to high levels of susceptibility to infestation and consequent damage by *S. zeamais* and *S. cerealella* for locally-grown maize varieties.

Multiple linear regression and correlation analysis applied to the data from the early-maturing varieties showed no significant relationship between either the number of insects recorded per aliquot or the percentage of grain with insect emergence holes as the dependent variable and the observed plant characteristics as the independent variable.

Multiple linear regression and correlation analysis of the data from the late maturing varieties demonstrated significant ($p = 0{\cdot}05$) positive correlation for the number of *S. cerealella* per aliquot of grain both with exposure of the cob end ($r = 0{\cdot}56$) and presence of a loosely fitting husk body ($r = 0{\cdot}49$). No significant relationships were apparent for either the percentage of grain with emergence holes after storage or the number of *S. zeamais* per aliquot of grain with the observed plant characteristics. Regression analysis demonstrated that 32% of the variation in the numbers of *S. cerealella* per aliquot of grain could be explained by the exposure of the cob end alone ($Y = 30{\cdot}28 + 0{\cdot}3058\ X$).

TABLE 1

Levels of Damage and Infestation of Maize in the Field by *S. zeamais* and *S. cerealella*

Factors A—Percentage of grain with emergence holes after storage
Factors B—Number *S. zeamais* per aliquot of grain after storage
C—Number *S. cerealella* per aliquot of grain after storage
D—Percentage of cobs visibly infested at harvest

Early Maturing					Late Maturing				
Variety	A	B	C	D	Variety	A	B	C	D
*XT664	44·5	120·00	186·00^{d†}	97·17^{ef†}	*GH390	14·0^{abc†}	40·00	37·25	75·80^{bc†}
DS456W	37·0	148·75	40·50^{ab}	96·87^{ef}	*GH128	11·0^{ab}	37·00	34·00	82·82^{bcd}
PX50	28·0	123·50	66·0^{abc}	92·47^{cdef}	QK217	10·5^{ab}	20·75	21·00	52·25^{a}
*DX2005	18·5	35·50	26·50^{a}	95·22^{def}	*GM211	16·5^{bc}	37·25	29·00	88·70^{cd}
DSE64	37·5	83·50	25·25^{a}	99·40^{f}	*Q692	30·0^{d}	33·00	43·50	89·52^{cd}
DSE32	28·5	97·50	42·75^{ab}	95·60^{ef}	KTW232	7·5^{ab}	21·00	15·25	65·55^{ab}
PQ300	18·5	56·00	95·00^{bc}	81·70^{ab}	*Q1280	11·5^{ab}	24·75	42·25	78·47^{bcd}
*DX2000	27·0	119·50	40·25^{ab}	92·85^{cdef}	*XL389	9·5^{ab}	25·50	54·25	83·79^{cd}
DC1247	23·5	48·50	80·75^{abc}	88·72^{bcd}	GH417	17·5^{bcd}	45·00	43·50	78·70^{bcd}
PQ301	32·0	81·50	25·75^{a}	87·52^{abcd}	T66	18·0^{bcd}	29·75	57·50	79·85^{bcd}
PX616	22·5	34·00	30·50^{ab}	91·65^{cdef}	*PQ500	17·0^{bc}	29·50	45·50	80·02^{bcd}
*XL361	27·5	64·25	47·75^{ab}	90·42^{cde}	KTW227	14·0^{abc}	69·50	35·50	79·65^{bcd}
DC1260	35·5	91·25	37·50^{ab}	92·60^{cdef}	KTW221	6·0^{ab}	28·00	23·50	74·72^{bc}
*DS805A	45·0	102·25	38·25^{ab}	99·42^{f}	DC1223	8·5^{ab}	42·25	30·50	74·97^{bc}
DSE65	23·0	66·25	36·25^{ab}	86·40^{abc}	DC1225	10·0^{ab}	24·75	65·75	85·17^{cd}
*Q739	36·5	127·75	14·50^{a}	91·70^{cdef}	GH401	12·0^{ab}	55·00	29·50	95·50^{d}
*XL81	25·5	74·00	132·50^{cd}	87·65^{abcd}	*QK218	3·5^{a}	6·50	12·50	73·05^{bc}
DSE66	15·5	46·00	54·25	79·95^{a}	DSF4	25·5^{cd}	29·00	53·25	94·82^{d}
DSE63	37·5	104·50	16·75^{a}	93·25^{cdef}					
PX52	27·0	45·75	19·00^{a}	96·17^{ef}					
F	1·66 (N.S.)	1·35 (N.S.)	3·26	3·77		2·20	1·37 (N.S.)	0·90 (N.S.)	2·80
Nec. Diff.	5%		66·90	7·78		12·63			17·33
	1%		89·03	10·35		16·84			23·10

† Means followed by the same letter do not differ significantly at the 0·05 significance level.
* Present commercial varieties grown in Queensland.

TABLE 2

Observed Characteristics of the Maize Varieties

A—Days from 50% silking to harvest
B—Moisture % of grain at harvest
C—% cob ends exposed
D—% husks with large apical apertures
E—% cobs with loose husk bodies
F—% cobs with easily removed husks

Early Maturing

Variety		A	B	C	D	E	F
XT664		143·75^{abc}†	11·67	50	100	100	100
DS456W		141·75^{a}	10·90	100	100	100	100
PX50		153·25^{e}	11·35	60	100	30	100
DS2005		144·25^{abc}	11·40	70	100	100	100
DSE64		143·00^{ab}	11·28	100	100	100	100
DSE32		146·75^{cd}	11·70	50	100	100	100
PQ300		145·50^{bcd}	12·40	50	100	100	100
DX2000		142·64^{ab}	11·43	80	100	100	100
DC1247		143·00^{ab}	11·85	10	10	30	50
PQ301		145·00^{abcd}	11·26	50	100	100	100
PX616		145·75^{bcd}	11·05	80	80	100	100
XL361		148·00de	11·20	50	70	60	100
DC1260		144·75^{abcd}	11·12	0	100	70	100
DS805A		145·50^{bcd}	11·42	50	100	100	100
DSE65		142·50^{ab}	11·32	0	100	100	100
Q739		142·25^{ab}	11·65	40	100	100	100
XL81		145·25^{abcd}	11·42	0	0	50	50
DSE66		143·00^{ab}	11·65	0	50	50	100
DSE63		142·50^{ab}	11·50	0	70	100	100
PX52		151·00de	11·35	30	100	100	100
F		7·62**	1·53 (N.S.)				
Nec.	5%	3·64					
Diff.	1%	4·04					

Late Maturing

Variety		A	B	C	D	E	F
GH390		138·50^{hi}†	11·53	0	100	0	0
GH128		135·50^{cdef}	11·32	0	30	0	0
QK217		133·75^{abcd}	11·40	0	70	0	20
GH211		141·00^{jk}	11·17	30	90	100	90
Q692		138·50^{hi}	11·45	50	80	100	80
KTW232		133·25^{abc}	11·45	0	100	0	0
Q1280		135·75^{def}	11·25	60	60	50	50
XL389		142·00^{k}	11·28	70	80	100	100
GH417		137·75^{fgh}	11·50	0	50	50	0
T66		131·50^{a}	11·18	30	80	0	0
PQ500		134·00^{bcd}	11·60	0	50	50	50
KTW227		132·75^{ab}	11·70	0	50	0	0
KTW221		133·75^{abcd}	11·20	10	10	0	0
DC1223		136·50^{efg}	11·95	10	50	60	90
DC1225		137·25^{efgh}	12·20	80	100	100	100
GH401		139·50^{hij}	11·28	50	60	80	100
QK218		135·25^{cde}	11·79	10	10	20	10
DSF4		140·75^{ijk}	11·65	20	100	100	90
F		12·51**	1·12 (N.S.)				
Nec.	5%	2·48					
Diff.	1%	3·30					

† Means followed by the same letter do not differ significantly at the 0·05 significance level.

Thus, in both early and late maturing varieties, a large part of the variability in levels of susceptibility remains unexplained in terms of the characters assessed.

The current commercial varieties used in Queensland (marked by an asterisk in table 1) were not screened during development for resistance to these storage pests and are more susceptible than many of the non-commercial varieties.

The increasing difficulties associated with the management of maize storage pests justifies future investigation of the economic impact of the usage of resistant varieties as a part of the pest management programme.

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The author is an officer of Entomology Branch, Queensland Department of Primary Industries, and is stationed at Kingaroy.