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Relationship between spike worm (*Raghuva albipunctella*) infestation and flowering of pearl millet, and some sources of resistance

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SUMMARY

Spike worms have recently been reported as a potential threat to millet production in the Sub-Sahelian zone of West Africa. Infestation of spike worm (*Raghuva albipunctella* de Joannis) in indigenous and exotic millet genotypes was studied during 1979-81 at Bambey, Senegal. The earliness or lateness of flowering is an important factor in host plant exposure to pest attack and subsequent pest damage. Hybrid ICH-165, synthetics ICMS-7838, ICMS-7703 and traditional varieties Souna and CIVT were found resistant to pest attack.

Additional key words : *Sahel, flowering period, resistant genotypes.*

RÉSUMÉ

*Relation entre l'infestation de la mineuse de l'épi (*Raghuva albipunctella*) et la floraison du petit mil et quelques sources de résistance.*

Les mineuses de l'épi furent considérées récemment comme fléau potentiel dans la production du mil dans la zone sous-sahélienne de l'Afrique de l'Ouest.
L'infestation de la mineuse (*Raghuva albipunctella* de Joannis) sur les génotypes indigènes et exotiques du mil a été étudiée durant 1979-81, à Bambey, Sénégal. La précocité ou le retard de floraison de la plante-hôte est un important facteur de sensibilité à l'attaque du ravageur. L'hybride ICH-165, les synthétiques ICMS-7838, ICMS-7703 et les variétés traditionnelles Souna et CIVT se sont montrées résistantes à l'attaque du ravageur.

Mots clés additionnels : *Sahel, période de floraison, génotypes résistants.*

I. INTRODUCTION

Pearl millet (*Pennisetum americanum* L.) is a major cereal food crop in Senegal. Among about 100 insect pests recorded on the millet crop (RISBEC, 1950 ; NDOYE, 1979*a*), certain lepidoptera infest the spikes during flowering and grain maturation. Among these, since the drought of 1972-74, larvae of the genera *Masalia* Moore and *Raghuva* Moore (Noctuidae) have been reported as a potential threat to millet production in the subsahelian zone of West Africa (VERCAMBRE, 1978).

Several species of *Masalia* have been identified from Africa and 7 species are present in Senegal (SEYMOUR, 1973 ; VERCAMBRE, 1979). During the last few years using light-trap and pest-rearing studies, we have identified species of *Raghuva* and *Adisura callina* Baker (LAPORTE, 1977 ; NDOYE, 1979*c*). *Raghuva albipunctella* De Joannis was the most abundant comprising 83.5 % of the moths captured in light traps and 95 % of the larval population observed on millet spikes (NDOYE, 1979*a, b*). This pest is distributed throughout millet growing-areas in the northern and south-central parts of Senegal.

Crop damage is caused by larval feeding on millet heads. Larvae of the first two instars feed on the flowers leaving behind empty glumes. Older larvae cut the floral peduncles and make their way between rachis and flowers, thereby pushing out the destroyed flowers. This results in the characteristic spiral shaped damage on the spike. As many as 51 larvae may infest a single spike and the pest may cause up to 50 % loss in grain yield (VERCAMBRE, 1978).

As control measures, deep ploughing at the end of crop season to check the population of diapausing pupae in the soil (VERCAMBRE, 1978), and the

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treatment of flowering spikes with endosulfan or chlorodimefon to kill young larvae (ANONYMOUS, 1977) have been recommended. It is realised, however, that in present peasant agriculture, pesticide applications may not be practical and economical. GAHUKAR (1981) and GUEREMONT (1982) have reported a few larval parasites from sahelian countries. However, their effectiveness in reducing crop damage and controlling pest populations is doubtful as they appear after the majority of larvae have penetrated into the soil for pupation.

While varietal resistance is an integral part of pest management strategy, little information is currently available. Thus, we studied the effect of flowering period on pest incidence and evaluated some local and introduced millet genotypes for their performance under natural pest infestation.

II. MATERIALS AND METHODS

Seven millet trials (table 1) of the millet breeding program of ICRISAT were evaluated at National Agricultural Research Center in Bambey. Date of sowing varied annually depending upon the onset of rains : 19 June 1979, 7 August 1980 and 7 July 1981.

The genetic pool consisted of traditional varieties from Senegal (Souna), Niger (CIVT-II) and Nigeria (Ex-Bornu) and introduced entries from ICRISAT program in India such as hybrids, (ICH-165, ICH-220, NBH-3), experimental varieties (WC-C-75), progeny variety (IVS-5454) and synthetics (all ICMS entries). A hybrid NHB-3 served as a check.

Plots of 18-20 m² for each entry were arranged in a completely randomized block design with 3-5 replications in rows 80 cm apart. NPK fertilizer 10.21.21 was applied at 150 kg/ha before sowing. Urea was applied twice at 50 kg/ha : at thinning (10-15 days after plant emergence) and at boot stage (40-50 days after first application).

Observations on pest damage were taken in each plot 2 weeks after 50 % flowering on 200 randomly selected spikes in the three central rows. Larval counts were made on 25 spikes. Grain yield per plot was recorded.

Data collected during the three years were statistically analysed, and simple correlations established.

III. RESULTS AND DISCUSSION

A. Pest incidence and its relation with millet flowering

The pest incidence varied considerably among years and within a year in different trials. Although larvae of both *Masalia* and *Raghuva* were present on spikes, only *Raghuva* larvae were recorded as they represented more than 85 % of the total population. Furthermore, it was observed that *R. albipunctella* was the predominant species. Correlations between pest incidence, larval numbers and grain yield were not consistent during years and therefore are not dealt with here.

1979 : The percentage of infested spikes ranged from 35 to 100 in 5 trials (table 1). In general, early flowering entries received higher pest attack but these correlations were significant (P = 0.01) only for IPMAT and WART. Mean larval number on 25 spikes varied from 5 to 34 and hybrids harboured larger population.

1980 : In the 1980 crop season, pest incidence was comparatively low. The range of percent infested spikes recorded in 6 trials was 23-72 (table 1). Entries in SRT flowered lately (52 days) and had less pest attack. The relationship between flowering time and pest infestation was significant only for PMST entries (p = 0.01, r = 0.57). Larval numbers were not always associated with flowering.

TABLEAU 1

Incidence of R. albipunctella *and period to 50 % flowering in pearl millet trials and their correlations, Bambey, 1979-81.*

Incidence de R. albipunctella *et période de 50 p. 100 floraison dans les essais de petit mil et leurs corrélations, Bambey, 1979-81.*

Year	Trial	Spikes attacked in per cent			Number of larvae/25 spikes			Days to 50 % flowering			DF	Correlations of lateness of flowering period with	
		range	mean	SEm (±)	range	mean	SEm (±)	range	mean	SEm (±)		spike attack	larval number
1979	IPMAT	45-99	92.7	9.8	2-12	7.3	5.2	41-57	46.0	5.4	22	− 0.58**	+ 0.17
	PMST	63-99	93.8	10.1	2-13	6.8	3.1	43-64	47.1	1.2	22	− 0.40	− 0.12
	PMHT	62-99	93.2	9.5	12-55	33.6	9.9	44-62	47.8	1.3	26	− 0.12	− 0.35
	WART	35-98	67.5	13.8	10-28	20.9	5.7	47-63	56.4	3.2	10	− 0.92**	− 0.80**
	EVT	65-100	93.9	10.1	1-12	5.5	3.5	43-49	46.9	4.2	26	− 0.11	+ 0.09
1980	IPMAT	32-57	44.1	5.8	1-6	4.1	1.8	42-47	44.4	1.5	19	− 0.19	+ 0.13
	PMST	23-51	37.6	6.6	1-2	1.0	0.6	43-47	44.9	1.1	18	− 0.57**	+ 0.27
	WART	29-50	38.8	6.4	1-3	0.8	0.9	46-58	50.1	1.9	23	− 0.26	− 0.39
	EVT	36-72	50.6	4.3	1-3	1.0	0.7	42-47	45.1	0.9	30	+ 0.02	− 0.12
	ELVT	44-68	56.6	6.1	1-6	3.3	1.4	42-46	44.7	1.0	30	− 0.33	+ 0.12
	SRT	26-45	33.5	6.2	1-2	1.0	0.6	43-58	52.4	1.9	14	+ 0.18	− 0.17
1981	IPMAT	9-26	15.8	5.0	5-14	10.1	3.5	48-57	51.6	1.5	19	− 0.45*	+ 0.0
	PMST	1-15	5.4	5.8	1-13	5.8	4.7	39-48	39.2	7.4	23	− 0.21	− 0.35
	PMHT	15-42	21.6	6.4	13-23	14.6	3.7	53-57	53.8	2.7	4	− 0.91*	− 0.85*
	ELVT	2-14	11.9	6.9	2-43	10.3	11.8	51-59	55.9	1.9	18	− 0.86**	− 0.43

Coefficient of correlation significant at P > 0.05 (*) or P > 0.01 (**).
SEm = standard error of the mean - erreur sur la moyenne.

1981 : All trials suffered from drought during flowering and entries in synthetics and hybrids suffered the most. Percentage of infested heads was low irrespective of larval population. Of 4 trials, hybrids (PMHT) had the highest infestation rate (22 %) and larval population (15/25 spikes) (table 1). Synthetics (PMST) flowered as early as 39 days and escaped worm attack. Significant correlations were present at p = 0.01 between flowering time and pest infestation in IPMAT and PMST and at p = 0.05 in ELVT.

B. Reaction of some genotypes to pest attack

1979 : Among 17 promising genotypes, only Souna and CIVT-II had less than 45 % spikes attacked and a maximum of 97 % was found on IVS-5454 (table 2). However, CIVT-II harboured comparatively more larvae. Higher yields were obtained from Souna followed by ICMS-7838, ICMS-7816, ICMS-7819 and ICH-165. It seems that ICMS-7816 and ICH-165 could tolerate larval feeding without their grain filling being affected.

TABLEAU 2

Incidence of R. albipunctella, *period to 50 % flowering and grain yield in 17 selected genotypes of pearl millet, Bambey, 1979.*

Incidence de R. albipunctella, *période de 50 p. 100 floraison et rendement en graines dans 17 génotypes sélectionnés de petit mil, Bambey, 1979.*

Genotype	% spike attacked	Number of larvae on 25 spikes	Grain yield (kg/ha)	Days to 50 % flowering
Souna	44.7	3.7	2 993	56
ICMS-7818	85.9	10.3	1 350	44
ICH-165	94.9	12.0	2 173	50
ICMS-7703	96.9	11.0	680	42
ICM-220	99.0	3.0	406	41
WC-C-75	95.3	11.7	880	43
IVS-5454	97.1	8.7	1 240	45
CIVT-II	35.2	2.7	1 533	61
EX BORNU	72.1	23.7	1 280	48
ICMS-7838	63.4	4.0	2 376	53
ICMS-7857	95.8	2.3	2 140	46
ICMS-7806	96.7	6.7	1 753	47
ICMS-7825	96.1	7.0	2 005	49
ICMS-7835	90.0	2.3	1 686	45
ICMS-7816	96.6	11.3	2 213	46
ICMS-7819	96.8	7.3	2 211	47
NHB-3 (susceptible check)	95.5	12.7	613	41
Mean	85.4	8.2	1 619.8	47.6
CV	23.6	61.9	27.1	9.0
LSD 0.05	23.8	6.0	518	5
0.01	32.0	8.1	698	7
F Test	HS	HS	HS	HS

1980 : There was little variation in percentage spikes attacked (mean 38 %) among 16 selected entries (table 3). Entries ICMS-7838, ICH-165, CIVT-II, Souna and IVS-5454 were relatively resistant. Yield of more than 2 200 kg/ha was obtained from ICMS-7703, ICH-165 and Souna.

1981 : The check entry NHB-3 had the highest spike infestation (27 %) whereas synthetics ICMS-7914, ICMS-7903 and ICMS-7908 were resistant to worm attack (table 4). ICH-220 yielded 771 kg/ha as it flowered early (43 days) and escaped from moth flights and severe drought during flowering.

Many factors may be involved in the millet-worm relationship, such as between floral density and egg laying, between density, length and orientation of awn

TABLEAU 3

Incidence of R. albipunctella, *period to 50 % flowering and grain yield in 16 selected genotypes of pearl millet, Bambey, 1980.*

Incidence de R. albipunctella, *période de 50 p. 100 floraison et rendement en graines dans 16 génotypes sélectionnés de petit mil, Bambey, 1980.*

Genotype	% spike attacked	Number of larvae on 25 spikes	Grain yield (kg/ha)	Days to 50 % flowering
Souna	32.0	6.0	2 288	43
ICMS-7818	40.0	4.3	1 719	48
ICH-165	34.0	4.0	2 654	45
ICMS-7703	40.6	3.6	2 385	43
ICH-220	42.0	3.6	2 108	42
WC-C-75	52.6	3.6	1 696	44
IVS-5454	34.6	5.6	1 779	45
CIVT-II	34.7	0.3	2 089	50
ICMS-7838	24.6	1.0	2 045	45
ICMS-7857	34.0	1.0	1 718	46
ICMS-7825	36.6	1.0	1 786	45
ICMS-7835	44.0	1.3	1 890	45
ICMS-7816	40.0	1.0	1 831	44
ICMS-7819	41.3	1.6	1 406	45
EX BORNU	36.0	2.3	1 852	51
NHB-3 (susceptible check)	41.3	3.0	584	44
Mean	38.0	2.7	1 864	45.6
CV	33.3	80.7	25.4	5.3
LSD 0.05	—	—	560	3
0.01	—	—	755	4
F Test	NS	NS	HS	HS

TABLEAU 4

Incidence of R. albipunctella, *period to 50 % flowering and grain yield in 12 selected genotypes of pearl millet, Bambey, 1981.*

Incidence de R. albipunctella, *période de 50 p. 100 floraison et rendement en graines dans 12 génotypes sélectionnés de petit mil, Bambey, 1981.*

Genotype	% spike attacked	Number of larvae on 25 spikes	Grain yield (kg/ha)	Days to 50 % flowering
Souna	9.5	12.0	662	56
ICH-165	17.0	8.5	633	53
ICMS-7703	10.5	12.5	697	53
ICH-220	18.2	13.0	771	43
WC-C-75	17.7	9.5	632	51
ICMS-7914	3.2	5.0	542	59
ICMS-7903	0.5	3.5	246	60
ICMS-7918	7.2	12.2	598	62
ICMS-7908	0.7	1.5	282	72
ICMS-7916	22.0	13.0	696	64
ICMS-7806	6.7	12.0	566	59
NHB-3 (susceptible check)	27.5	16.0	673	49
Mean	11.7	9.9	583	56.9
CV	48.7	64.4	22.5	13.0
LSD 0.05	8.9	—	204	—
0.01	12.6	—	—	—
F Test	HS	NS	S	NS

and oviposition preference and between spike compactness and antibiosis effect on larval population. Of these, only the first aspect has been studied, by VERCAMBRE (1978) and GUEREMONT (1982) showing a negative relationship. Based on evaluation of 3 years' data of the present study, 3 entries from introduced material (ICMS-7703, ICMS-7838 and ICH-165) and 2 traditional varieties (Souna and CIVT-II) are selected as resistant for their earliness or lateness of flowering that escape exposure to pest attack. Other factors such as mentioned above may also be involved and need further study.

Large scale cultivation of hybrids and synthetics under present farming conditions in Senegal may not be feasible because of lack of seed and fertiliser. Therefore, it may be appropriate to incorporate the suitable characters of resistance and yield potentiality in introduced genotypes into existing local millets.

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