

Full Length Research Paper

Assessment of the diversity of aggressiveness of *Striga hermonthica* ecotypes: Reactions of pearl millet cultivars (*Pennisetum glaucum*) in Niger

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***Striga* poses a serious threat to agricultural production in Niger. A mission of prospecting and collection of *Striga* ecotypes and millet varieties was carried out in the 5 regions of Niger in fields heavily infested with *Striga*. The infestation of *striga* has reached a very high level, and the parasitic situation is endemic. The objective of this study was to evaluate the aggressiveness of the five ecotypes of *Striga* in pots and identify pearl millet varieties tolerant to *Striga*. The test was carried out at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) research station in Niger. The experimental design is a complete randomized block with four replications and two factors. The appearance of *Striga* occurred on average between 30 and 45 days after sowing (DAS), and *Striga* numbers averaged between 3 and 56 *Striga* plants/pot. Considering yield as the main agronomic parameter, the VD01 varieties infested by ecotype ETI16, and VTA11 infested by ecotype EZ25, respectively, with 29 and 26 g obtained the largest seed weights. These varieties are precocious and tolerant to *Striga* attacks. The use of these tolerant varieties could be a component of the strategy to combat *Striga*.**

Key words: Pearl millet, *Striga* ecotypes, parasitic weed, *Striga hermonthica*, *Striga* severity.

INTRODUCTION

Striga species, particularly *Striga hermonthica* (Del.) Benth. and *Striga asiatica* (L.) Kuntze is among the world's most harmful and destructive weeds (Parker, 2009). They belong to the Orobanchaceae family; they are obligate root hemiparasites (Tank et al., 2006). They attach to the

roots of cereals such as millet and sorghum, depriving them of water and nutrients, which can lead to yield losses of up to 100% and affect more than 50 million ha (Gressel et al., 2004). *S. hermonthica* is now recognized as the greatest biological constraint to cereal production

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in sub-Saharan Africa (Pennisi, 2015). In Niger, a recent ethnobotanical survey conducted in the five agricultural regions revealed alarming levels of parasite infestations, with significant to very significant occurrences dominating the millet fields visited (Saidou et al., 2025a). To manage the infestation, farmers use several strategies to fight *Striga*, the most common being manual weeding and crop rotation (Hamissou et al., 2021). Although these methods have helped in reducing the impact of the parasite, but not fully addressed the *Striga* problem (Ransom, 2000).

However, *Striga* shows morphological diversity both quantitatively (length and width of flowers and leaves, plant height, and number of stems) and qualitatively (shapes, colors, and intensity of spots) (Saidou et al., 2025b). This leads to the formation of several morphologically distinct groups, contributing to exceptional adaptive ability and giving the parasite phenotypic flexibility (Saidou et al., 2025b). This remarkable capability makes the use of a single control method ineffective. Thus, the diversity of the parasite, coupled with that of production systems, has often rendered control efforts ineffective. Therefore, characterizing the aggressiveness of *Striga* ecotypes collected from different regions of Niger is necessary to develop targeted strategies. Consequently, the objective of this study is to evaluate the aggressiveness of five representative *Striga* ecotypes in pot experiments and to identify millet varieties tolerant to this parasite. This approach aims to provide a scientific basis for the selection of resistant cultivars and the development of integrated management strategies tailored to local *Striga* ecotypes, in order to sustainably address the challenge of food security in Niger.

MATERIALS AND METHODS

The pot experiment was conducted at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Niger. In Niger, ICRISAT is located in Sadoré, Say Department, in the southwestern part of the country between 13°15' North latitude and 2°18' East longitude, 40 km southeast of Niamey. It covers an area of approximately 500 ha (Sivakumar, 1986). The plant material consisted of five ecotypes of *S. hermonthica* and five millet varieties collected from the field (Table 1) and two millet varieties (controls) provided by the Millet Improvement Program at the ICRISAT Sahelian Center in Niger. These were SOSAT-C88 -P10 (*Striga*-susceptible variety) and 29AW (*Striga*-resistant variety) (Dayou et al., 2021). The experimental design was a complete randomized block design with 4 replications and two factors. The factor "millet variety" had seven levels, and the factor "*Striga* ecotypes" had 5 levels, with a spacing of 0.50 m between pots and 0.10 m between plants within pots. The blocks were 0.70 m apart. A total of 140 pots (7X5X4) were used.

Experimental procedure

On 22 August 2022, each pot was filled with a substrate composed of 70% sand, 15% clay, and 15% manure, which had been previously mixed and watered, then artificially infested with 250 mg

of *Striga* seeds. The seven millet varieties were sown after watering the pots, with four to five seeds per pot. Irrigation was provided as needed. Thinning was carried out two weeks after sowing, leaving only two plants per pot. Weed control was performed manually and regularly throughout the growing cycle. To characterize the *Striga* ecotypes according to their vigor, a score was assigned based on the height and number of *Striga* branches that appeared (Table 2). At 119 days after sowing, the harvest was done manually, the ears were harvested, then dried, weighed, and threshed.

Data collection

Eighteen variables were observed in this study: Date of 50% flowering (FLO_NJ); Plant height (HTR); Number of stems/plant (NST); Number of Leaves (NLE); Ear length (ELE); Number of ears per pot (NE); Weight of ears per pot (WE); Weight of 100 seeds per pot (W100); Seed weight/pot (SW); Number of days to first *Striga* emergence (DES_NJ); Number of *Striga* 64 days after sowing (DAS) (NS_64); *Striga* vigor at 64 days after sowing (VIG64); Number of *Striga* 85 DAS (NS_85); *Striga* vigor at 85 days after sowing (VIG85); Number of *Striga* 99 DAS (NS_99); *Striga* vigor at 99 days after sowing (VIG 99); Number of *Striga* 119 DAS (NS_119) and *Striga* vigor at 119 days after sowing (VIG119).

Statistical analyses

Following field data collection, all results were compiled into a Microsoft Excel 2013 spreadsheet for processing, analysis, and the generation of graphs and tables. Normality tests were performed on the quantitative variables. As the results indicated a non-normal data distribution ($p < 0.05$), the non-parametric Kruskal–Wallis test was used to compare the means among the different groups. Hierarchical cluster analysis (HCA) was subsequently applied to group individuals with similar characteristics. All analyses were conducted using RStudio version 4.4.1.

RESULTS

Striga emergence

The first *Striga* plants emerged on average between the 30 and 45 DAS. The earliest emergences were observed with the combinations VZ25_ET116 (30 DAS) and VD01_EM06 (31 DAS). All ecotypes appeared in less than 45 DAS, with the exception of ecotype EZ25 (45 DAS), which emerged on the VT06 variety (sensitive control) (Figure 1). No statistically significant differences were noted between the different ecotypes at the alpha level of 5%.

Number of *Striga* plants

Table 3 shows the averages of the different counts of *Striga* plants in the pots. On average, the number of *Striga* ranged from 3 to 56 *Striga* plants per pot. At the first count (64 DAS), on average, all *Striga* ecotypes had emerged. The period of strong *Striga* emergence corresponds to 85 DAS for most local varieties. No local variety suffered an infestation higher than that of the

Table 1. The ecotypes of *Striga hermonthica* and millet varieties and their collection sites.

Variety	Millet variety abbreviations	<i>Striga</i> ecotype abbreviations	Locality	Communes	Department	Regions	Collection date
Guéro	VD01	ED01	Bozarawa	Dogondoutchi rula	Dogondoutchi	Dosso	28/10/2021
-	VM06	EM06	Galadantchi	Giratawa	Madaroufa	Maradi	27/10/2021
Maiwa	VTa11	ETA11	Kolloma	Tahoua Commune 1	Tahoua	Tahoua	16/11/2021
Haini Kiré	VTi16	ETi16	Lossa	Kourteye	Tillabéry	Tillabéry	07/11/2021
Bandagi	VZ25	EZ25	Magarawa	Goure	Goure	Zinder	26/10/2021
SOSAT-C88-P10					ICRISAT		
29AW					ICRISAT		

Table 2. *Striga* severity scale.

Score	<i>Striga</i> height [cm]	Number of <i>Striga</i> branches
1	≥ 5	No
2	6-20	No
3	6-20	≥ 1
4	21-30	≥ 5
5	21-30	≥ 5
6	31-40	≥ 10
7	31-40	≥ 10
8	> 40	≥ 10
9	> 40	≥ 10
0	No emerged <i>Striga</i> plants	

Source: Haussmann et al. (2000).

susceptible variety VT06, except for variety VZ25 (47, 56, 55, and 55) infested by ecotype ETi16. According to the results observed, this emergence initially increases and then decreases until harvest. The results highlight significant differences between ecotypes in the initial growth stages (64 and 85 days after sowing). However, this initial heterogeneity gradually decreases, and the differences are no longer significant at the 5%

level at stages 99 and 119 days.

***Striga* plant vigor**

At the first count (64 DAS), all ecotypes had emerged on average, and vigor ranged from 1 to 7.

At the second count (85 DAS), on average, all ecotypes had reached a height between 31 and

40 cm and had fewer than 10 *Striga* branches, except for 5 ecotypes (EZ25/VT07; EM06/VM06; ED01/VD01; EM06/VTa11; and ED01/VTi16). The ecotype ETA11/VD01 showed the highest vigor score (8.5) with a plant height of over 40 cm and more than 10 *Striga* branches. *Striga* vigor increased steadily from the first to the fourth count. Statistical analyses are only significant at 64 and 85 DAS (Annex 1A to D).

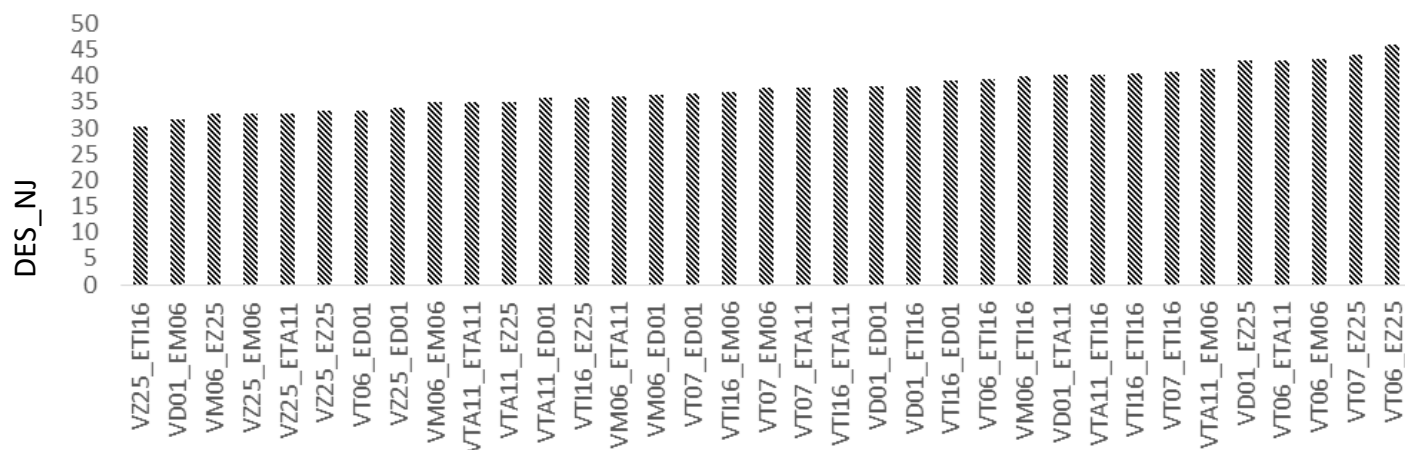


Figure 1. Number of days of *Striga* appearance by combination.

50% flowering date

The varieties flowered on average between 0 and 60 days after flowering (DAF), and the majority were early-flowering. The latest combinations were VT06_EZ25 (60 DAS), VT16_ETI16 (59 DAS), and VD01_ED01 (59 DAS). Conversely, the combinations VT06_ED01, VT06_EM06, VT06_ETA11, and VZ25_ETA11 did not reach the flowering stage (Figure 2). Statistical analysis revealed a significant difference between the varieties ($p < 0.05$).

Seed weight per plant

The average seed weight per *Striga* ecotype ranged from 0 g to 29.58 g (Figure 3). The highest seed weights were obtained with varieties VD01 infested with the ETI16 ecotype and VTA11 infested with the EZ25 ecotype, at 29.58 and 26.89 g, respectively. Conversely, yield reductions were observed with the combinations VT07_ETA11 (1.23g), VZ25_EM06 (1.37), VT07_EM06 (1.53), and VT06_ETI16 (1.6 g). All tested varieties (VD01, VM06, VTA11, and VT16), except for VZ25, exhibited the highest seed weights compared to the resistant control with all *Striga* ecotypes. The difference between the grain yields of the tested varieties was very highly significant ($P < 0.0001$).

Relationship between traits

The Pearson correlation matrix (Figure 4) shows that the strongest relationships involve the links between vegetative and yield traits on one hand, and between the number and vigor of *Striga* on the other. The most pronounced negative correlations are observed between the number of *Striga* (at 64 and 85 DAS) and phenological

and yield parameters. The strongest positive correlation ($r = 0.97$) connects the number of *Striga* at 99 and 119 DAS, whereas the strongest negative correlation ($r = -0.65$) associates the number of *Striga* at 64 DAS with the 50% flowering date. Overall, the number (64, 85, 99, and 119 DAS) and vigor of *Striga* (64 and 85 DAS) show negative correlations with all vegetative and yield traits, notably the 100-seed weight, and the number of stems, leaves, and ears per pot. Conversely, the 50% flowering date is positively correlated with vegetative and yield traits, but negatively associated with variables related to *Striga*.

Hierarchical clustering

In order to determine the nature and degree of divergence among our varieties, a principal component analysis and a hierarchical clustering of the varieties were performed on the collected data. This classification differentiates three main groups (1, 2, and 3) (Figure 5). The analysis of the 18 characteristics of millet and *Striga*, considering the varieties as a classification criterion, was performed. The first two axes of the analysis account for 92.88% of the total inertia of the dataset, which is quite representative. Group 1 brings together 18 combinations and consists of 4 varieties: VD01 (ED01, ETI16, and EZ25); VM06 (ED01, EM06, ETA11, ETI16, and EZ25); VTA11 (ED01, EM06, ETA11, ETI16, and EZ25); and VT16 (ED01, EM06, ETA11, ETI16, and EZ25). On average, it presents important vegetative parameters (number of stems, number of leaves) and yields (ear weight, 100-grain weight, grain weight, and number of ears). These varieties are characterized by a slightly later flowering compared to the other groups and low values of *Striga* numbers at 64 and 85 DAS. Group 2 brings together 11 combinations, including varieties VD01 infested by ecotypes EM06 and ETA11, VZ25 infested by

Table 3. Density of *Striga* ecotypes by combination at 64 DAS, 85 DAS, 99 DAS, and 199 DAS.

Combinaton	<i>Striga</i> plant density per combination at 64 DAS	<i>Striga</i> plant density per combination at 85 DAS	<i>Striga</i> plant density per combination at 99 DAS	<i>Striga</i> plant density per combination at 119 DAS
VD01_ED01	17.00 ^{ab}	20.5 ^{ab}	20.25 ^a	17.25 ^a
VD01_EM06	19.00 ^{ab}	24 ^{ab}	21.5 ^a	18.75 ^a
VD01_ETA11	25.00 ^{ab}	27 ^{ab}	26 ^a	23 ^a
VD01_ETI16	23.75 ^{ab}	27.75 ^{ab}	26.5 ^a	24.5 ^a
VD01_EZ25	15.00 ^{ab}	15 ^{ab}	17 ^a	14.25 ^a
VM06_ED01	29.75 ^{ab}	32.25 ^{ab}	35.5 ^a	28.75 ^a
VM06_EM06	12.25 ^{ab}	13.75 ^{ab}	16.25 ^a	13.25 ^a
VM06_ETA11	24.0 ^{ab}	25.5 ^{ab}	23.5 ^a	23.25 ^a
VM06_ETI16	31.00 ^{ab}	41 ^{ab}	29.5 ^a	31.5 ^a
VM06_EZ25	24.50 ^{ab}	26.5 ^{ab}	26.75 ^a	26.25 ^a
VTA11_ED01	23.00 ^{ab}	20 ^{ab}	18.25 ^a	20.25 ^a
VTA11_EM06	7.75 ^{ab}	13 ^{ab}	14.25 ^a	16.25 ^a
VTA11_ETA11	24.75 ^{ab}	24.25 ^{ab}	26.25 ^a	22 ^a
VTA11_ETI16	27.25 ^{ab}	35.5 ^{ab}	36.75 ^a	33.5 ^a
VTA11_EZ25	12.50 ^{ab}	17 ^{ab}	17.75 ^a	14.75 ^a
VTI16_ED01	4.00 ^{ab}	3.5 ^b	18.5 ^a	17.75 ^a
VTI16_EM06	21.50 ^{ab}	21.75 ^{ab}	24 ^a	23.5 ^a
VTI16_ETA11	16.00 ^{ab}	13 ^{ab}	13 ^a	13.25 ^a
VTI16_ETI16	19.00 ^{ab}	19 ^{ab}	20.5 ^a	20 ^a
VTI16_EZ25	21.75 ^{ab}	24.75 ^{ab}	25.25 ^a	22.25 ^a
VZ25_ED01	29.25 ^{ab}	22.25 ^{ab}	23.75 ^a	21.75 ^a
VZ25_EM06	25.75 ^{ab}	39.5 ^{ab}	24.25 ^a	24.75 ^a
VZ25_ETA11	27.00 ^{ab}	25.5 ^{ab}	22.25 ^a	17.75 ^a
VZ25_ETI16	55.25 ^a	56 ^a	55.25 ^a	47.5 ^a
VZ25_EZ25	19.00 ^{ab}	21.5 ^{ab}	21 ^a	18 ^a
VT06_ED01	44.00 ^{ab}	40.5 ^{ab}	39.5 ^a	35 ^a
VT06_EM06	41.75 ^{ab}	41.75 ^{ab}	29.75 ^a	25.75 ^a
VT06_ETA11	44.00 ^{ab}	35.75 ^{ab}	39.5 ^a	35.5 ^a
VT06_ETI16	34.50 ^{ab}	28 ^{ab}	30.5 ^a	27.25 ^a
VT06_EZ25	25.50 ^{ab}	30 ^{ab}	27.5 ^a	18.5 ^a
VT07_ED01	10.00 ^{ab}	13.5 ^{ab}	13.5 ^a	12.25 ^a
VT07_EM06	14.00 ^{ab}	14.5 ^{ab}	13.75 ^a	11 ^a
VT07_ETA11	13.25 ^{ab}	14.75 ^{ab}	15.25 ^a	13.75 ^a
VT07_ETI16	12.75 ^{ab}	16.5 ^{ab}	16 ^a	13.75 ^a
VT07_EZ25	3.50 ^b	5.25 ^b	5 ^a	3.75 ^a
Mean	22.81	24.29	23.83	21.44
CV	0.50	0.46	0.40	0.39
<i>p-value</i>	0.03	0.04	0.28	0.19

Values followed by the same letter do not differ significantly from each other ($p > 0.05$).

ecotypes ED01, EM06, ETA11, and EZ25, and finally VT07 (susceptible control) infested by ecotypes ED01, EM06, ETA11, ETI16, and EZ25. These are medium-sized varieties with medium-sized ears. This group is characterized by low yields (grain weight and ear weight) at harvest. Group 3 is composed of two varieties: VZ25 and VT06 (susceptible control). Variety VZ25 is infested by ETI16, and VT06 is infested by ecotypes ED01, EM06,

ETA11, ETI16, and EZ25. This group is characterized by a late appearance of *Striga* and strong *Striga* emergence at 64 and 85 DAS. They are distinguished by their small sizes with a low number of stems, ears, and leaves. Floral initiation occurred early. They also have short ears and low yields (100-grain weight, grain weight, and ear weight). Each of the variables indicates significant differences between groups ($P\text{-value} < 0.05$) except for

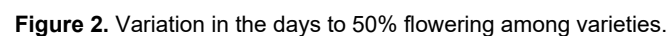
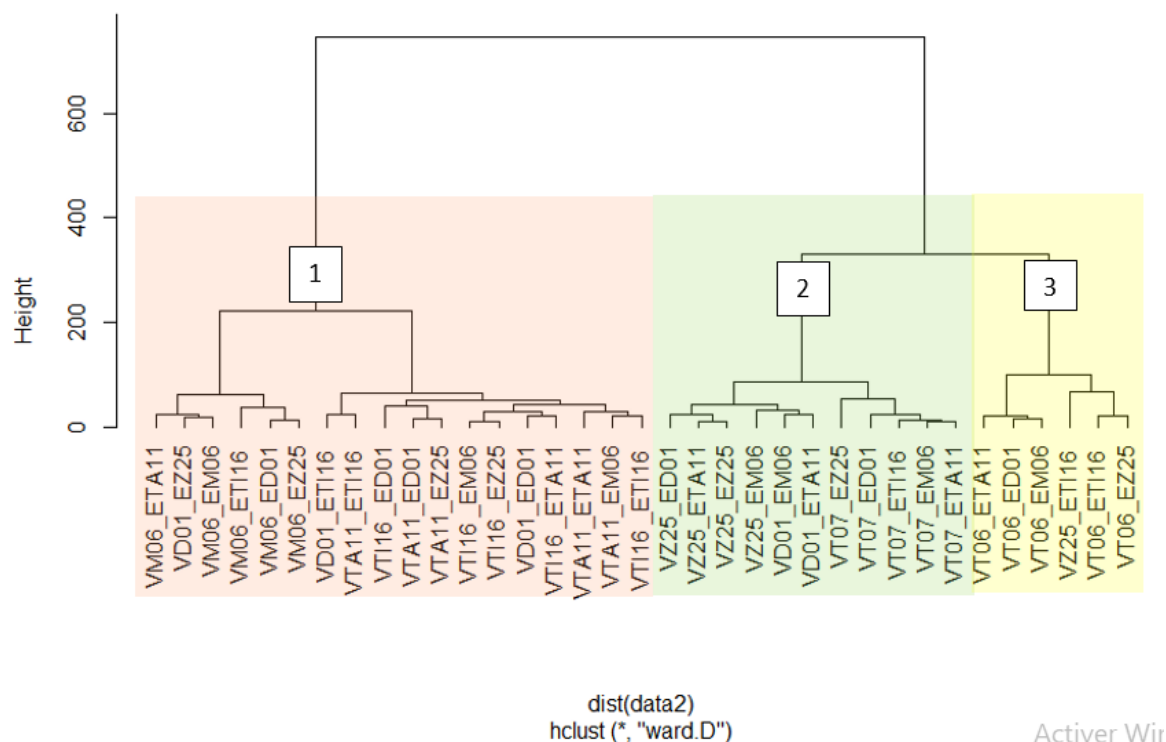


Table 4. Characteristics of each group.

Group	Group 1		Group 2		Group 3		R-squared	p-value
	Moy	sd	Moy	sd	Moy	sd		
WE	37.53	10.04	13.03	5.73	4.33	4.10	0.75	8.36E-11
DES_NJ	37.26	3.88	36.73	4.90	44.29	3.90	0.27	0.002
FLO_NJ	51.07	5.32	43.61	10.60	13.67	11.57	0.71	5.76E-10
HTR	154.76	23.90	105.20	11.22	60.88	23.43	0.75	8.31E-11
NST	6.17	1.53	4.27	1.05	2.04	0.33	0.59	2.40E-07
NE	2.10	0.42	1.55	0.67	0.46	0.43	0.56	5.81E-07
ELE	46.42	7.12	25.64	5.79	8.21	6.92	0.82	1.89E-13
SW	14.42	5.42	3.88	2.57	1.72	1.97	0.63	3.15E-08
W100	1.02	0.12	0.65	0.27	0.28	0.25	0.66	8.60E-09
NE	2.10	0.42	1.55	0.67	0.46	0.43	0.56	5.81E-07
VIG_64	3.99	0.97	4.41	1.33	5.04	1.54	0.04	0.1777
VIG_85	6.58	1.00	6.98	1.22	7.17	0.80	-0.005	0.4132
VIG_99	7.89	0.81	7.70	1.11	7.79	0.99	-0.05	0.8762
VIG_199	8.26	0.82	8.07	1.05	8.25	0.47	-0.04	0.8272
NJ_64	19.71	7.39	18.05	8.12	40.83	10.04	0.5	5.38E-06
NJ_85	21.89	9.04	20.39	9.01	38.67	10.11	0.31	0.0008311
NJ_99	22.76	6.74	18.39	6.27	37.00	10.30	0.41	7.01E-05
NJ_199	21.25	6.10	16.23	6.10	31.58	10.04	0.33	0.0005023

**Figure 5.** Dendrogram of the 35 combinations.

Striga vigor at 64, 85, 99, and 119 DAS. The highest coefficients of determination were obtained for the variables: ear length (0.82), grain weight (0.75), and plant

height (0.75) (Table 4). The projection of the three groups composed of local millet varieties infested by the 5 *Striga* ecotypes onto the plane defined by axes 1 and 2 showed

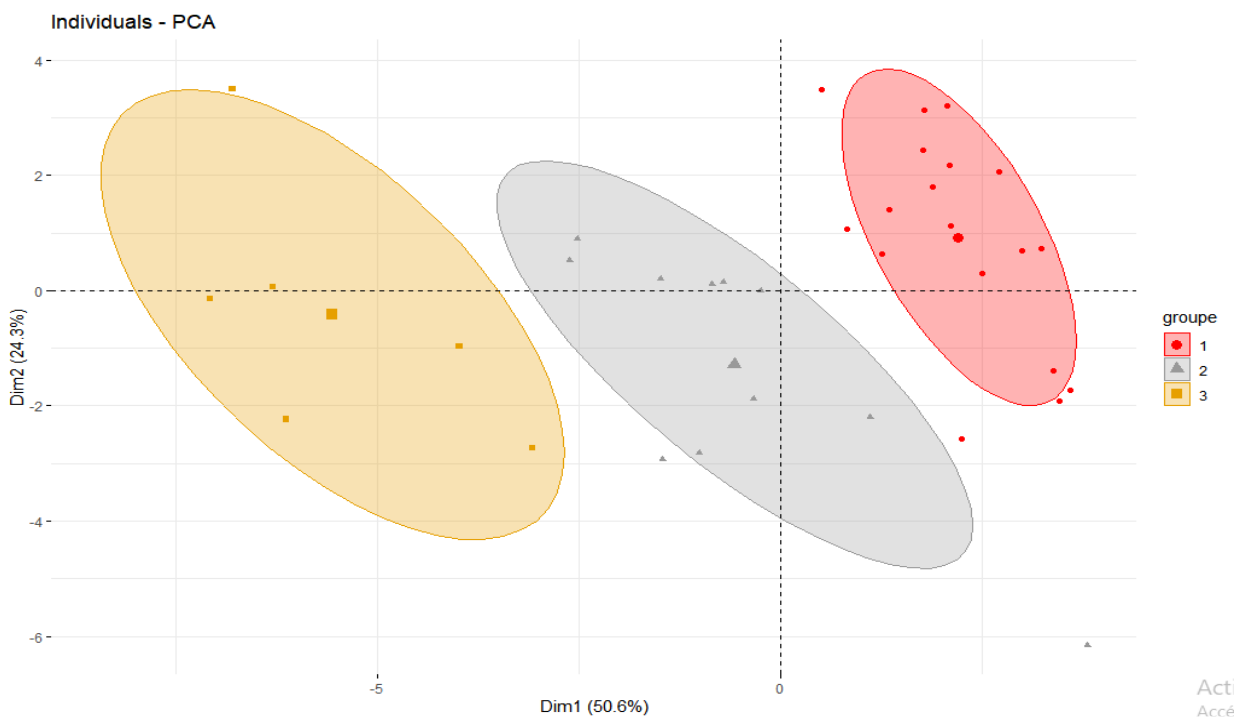


Figure 6. Projection of the three groups in the plane formed by axes 1 and 2.

a great diversity for the studied variables (Figure 6). The first axis accounts for 50.6% of the total variance, while the second axis accounts for 24.3% of the total variance. The inertia carried by these two axes represents 74.9% of the total variance. A clear opposition was observed between the varieties of group G1 and those of group G3. As for the varieties of G2, they occupy an intermediate position between G1 and G3.

DISCUSSION

Emergence dynamics of *Striga*

The results obtained reveal a particularly early emergence of *Striga*, observed as early as 30 days after sowing for the VZ25_ET116 combination. For all the varieties evaluated, the appearance of the first individuals occurred before 45 days. This earliness contrasts with the data from Lawane et al. (2010), who reported emergence around the sixth week, and with the later observations of Naitormmbaide et al. (2015), which were between 52 and 58 days after sowing. This discrepancy highlights the high sensitivity of the experimental system used in the present study and underscores the temporal variability of the parasite's emergence cycle depending on environmental and experimental conditions. Several factors could explain the earlier emergence of *Striga* observed in this study. First of all, it is established that *Striga* seeds remain dormant for a long period and only

germinate after exposure to warm and humid conditions, followed by the perception of germination stimulants derived from the host, mainly strigolactones (Al-Babili and Bouwmeester, 2015). The imposed artificial dormancy period of 9 months for the seeds significantly exceeded the typically observed natural dormancy period of 4 to 8 months (Andrianaivo, 1998). Moreover, the storage conditions of the seeds in a greenhouse, with temperatures reaching up to 50°C, may have favored the breaking of seed dormancy. Second, the experimental substrate consisted of a sandy soil poor in organic matter. *Striga* development is generally observed in poor soils (Dembélé et al., 2009).

Differential varietal responses and ecotype aggressiveness

Each millet variety tested during this experiment showed different behaviors depending on the origin of the parasite seed ecotypes. The differential responses of the local millet varieties tested confirm the existence of divergence in aggressiveness among the tested *Striga* ecotypes. Although the timing of *Striga* emergence may vary depending on the ecotype-variety combinations, the results did not reveal statistically significant differences between the different ecotypes tested. This uniformity could be explained by a similar germination potential among the studied ecotypes, which may have limited the observed variability. At the first count (64 days), on

average, all *Striga* ecotypes had emerged. The number of *Striga* plants ranged from an average of 3 to 55 per combination. These varieties showed high susceptibility. Results on the average number of emerged *Striga* plants showed that variety VZ25 infested by ecotype ETI16 had high emergence rates of the parasitic plant compared to the susceptible control VT06. In general, this high rate can be explained by a significant secretion of strigolactone by the roots of the host plant VZ25, which promoted the germination of *Striga* seeds.

Phenological and yield performance of varieties

The flowering of the tested millet varieties occurred over a period ranging from 43 to 60 days after sowing, with the majority of varieties flowering before 55 days. However, strong *Striga* emergence was observed from the 85th day after sowing. Thus, all varieties were able to flower and produce seeds before being subjected to severe *Striga* infestation. This early flowering is a definite advantage as it allows the host plant to gain a growth advantage over the parasite. These results are in agreement with those of Naitormmbaide et al. (2015) obtained with maize varieties. Despite the yield reduction, the tested varieties VD01, VM06, VTA11, and VTI16 showed higher seed weights compared to the resistant millet control with all tested *Striga* ecotypes. Surprisingly, the resistant millet VT07, which was used for its resistance to the parasite, appeared moderately susceptible to *Striga* attack. This result can be explained by the very aggressive effect of these tested *Striga* ecotypes.

Relationships between infestation levels and agro-morphological traits

Statistical analyses did not reveal significant links between the parasitic pressure exerted by *Striga* at phenological stages 99 and 199 DAS and the main agro-morphological characteristics of millet. However, a negative relationship was established between *Striga* abundance at stage 99 DAS and the number of ears per pot as well as flowering duration. These results can be explained by the strong infestations observed at stages 64 and 85 DAS, which may have induced sufficiently high stress to affect the production and development of the host plant, even if the effects of these attacks attenuated subsequently. The 50% flowering date is highly positively correlated with agro-morphological characteristics, indicating that varieties with a longer development cycle generally have better vegetative vigor and higher yield. In parallel, this phenological variable is negatively correlated in a significant manner with the different indices of *Striga* infestation. These results suggest that late-flowering varieties are better adapted to cope with *Striga* infestation, probably thanks to a better ability to compensate for the

negative effects of the parasite. Correlation analyses revealed strong links between different morphological and agronomic traits. Thus, taller varieties generally had more developed vegetation. Regarding yield components, 100-grain weight was highly positively correlated with ear length, ear weight per pot, total grain weight per plot, and number of ears per pot (ranging from 0.70 to 0.87). These results indicate that varieties producing larger seeds tend to have longer, heavier, and more numerous ears.

Conclusion

The results of this study highlight the complexity of the interactions between the five *Striga* ecotypes and the different millet varieties. While none of the tested varieties proved to be totally resistant to the parasite, two showed interesting tolerance, notably varieties VD01 and VM06. The results of the study made it possible to identify the best varieties that can be used in the fight against *Striga*. Considering yield as the main agronomic parameter, the use of these early and tolerant varieties could be an effective strategy to control *Striga*. These results highlight a significant advance in the understanding of the relationship between the host plant and the parasite, opening up new strategies for sustainable management of the parasite in Niger.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

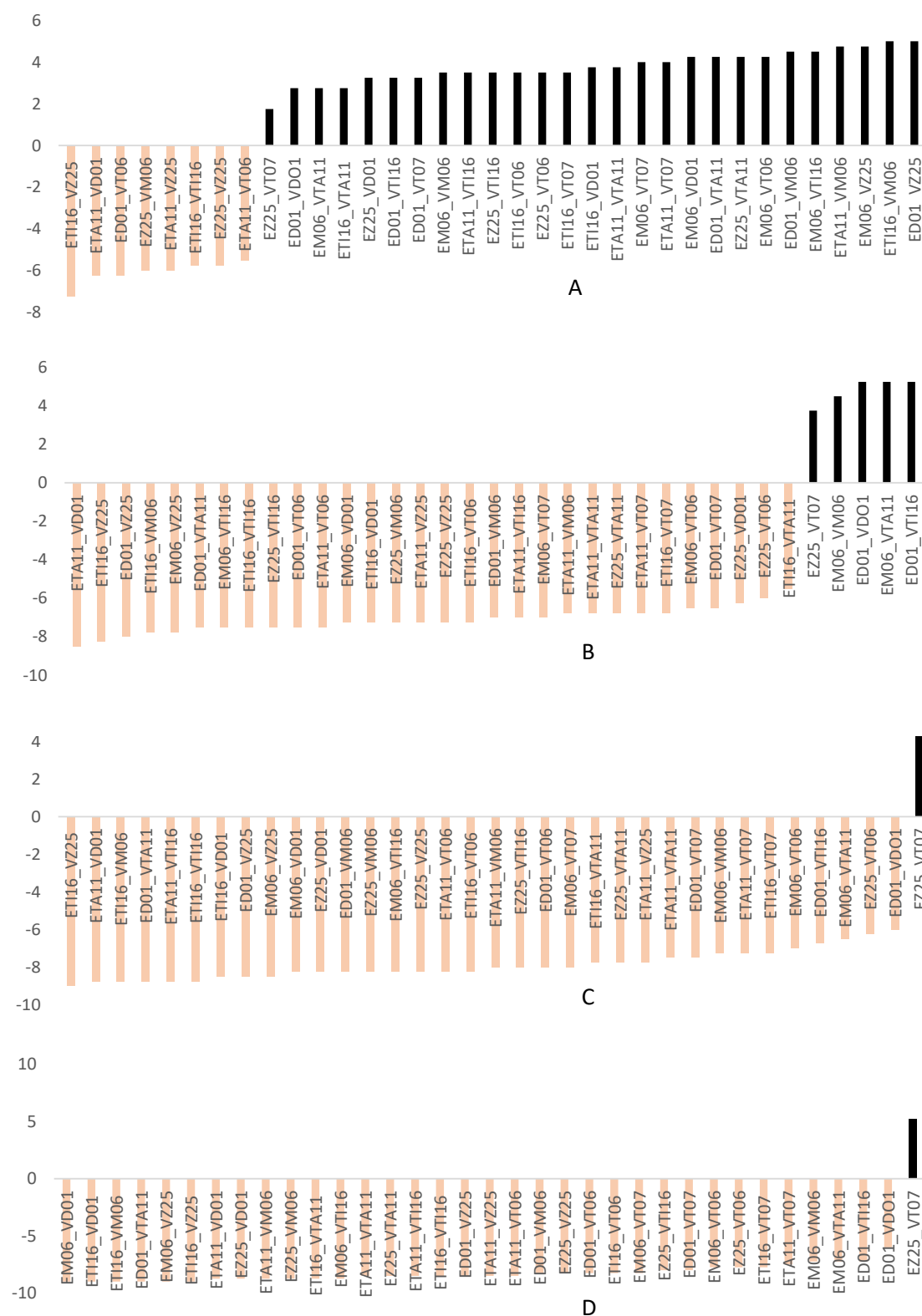
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REFERENCES

- Al-Babili S, Bouwmeester HJ (2015). Les strigolactones, une nouvelle hormone végétale dérivée des caroténoïdes. *Annual Review of Plant Biology* 66:161-186.
- Andrianaivo AP, Kachelriess S, Kroschel J, Zehrer W (1998). Biologie et gestion du *Striga* à Madagascar. FOFIFA, DPV, GTZ 3p.
- Dembélé B, Sidibé A (2009). Guide de formation en lutte participative contre le *Striga* dans le système de culture à base de sorgho. IER,

- USAID, CORAF/WE CARD 27p. <https://mashamba.org/s/bibnum-enabel/item/10893>
- Dayou O, Kibet W, Ojola P, Gangashetty PI, Wicke S, Runo S (2021). Two-tier witchweed (*Striga hermonthica*) resistance in wild pearl millet (*Pennisetum glaucum*) 29AW. *Weed Science* 69:300-306. <https://doi.org/10.1017/wsc.2021.12>
- Gressel J, Hanafi A, Head G, Marasas W, Obilana B, Ochanda J (2004). Major heretofore intractable biotic constraints to African food security that may be amenable to novel biotechnological solutions. *Crop Protection* 23:661-689.
- Hamissou AM, Hamissou Z, Ibrahim AA, Hadizatou A (2021). État de lieu de connaissances des producteurs de mil et de niébé sur *Striga hermonthica* et *Striga gesnerioïdes* dans cinq (5) communes rurales au Niger. *International Journal of Innovation and Applied Studies* 33(4):687-695.
- Hausmann BIG, Hess DE, Welz HG, Geiger HH (2000). Improved methodologies for breeding *Striga*-resistant sorghums. *Field Crops Research* 66:195-211.
- Lawane G, Djimasbeye N, Ndoutamia G, Lawane G (2010). Efficacité de l'association des céréales et du niébé pour la production de grains et la lutte contre *Striga hermonthica* (Del). HAL Id: Cirad-00471450.
- Naitormbaide M, Djondang K, Mama VJ, Koussou M (2015). Criblage de quelques variétés de maïs (*Zea mays* L.) pour la résistance au *Striga hermonthica* (Del.) Benth dans les savanes tchadiennes. *Journal of Animal and Plant Sciences* 24(1):3722-3732.
- Parker C (2009). Observations on the current status of *Orobancha* and *Striga* problems worldwide. *Pest Management Science* 65:453-459.
- Pennisi E (2015). How crop-killing witchweed senses its victims. *Science* 350:146-147.
- Ransom JK (2000). Long-term approaches for the control of *Striga* in cereals: Field management options. *Crop Protection* 19:759-763.
- Saidou SS, Maina F, Mohammed R, Amadou HI, Bakasso Y (2025b). Morphological diversity of 23 ecotypes of *Striga hermonthica* collected in the 5 regions of Niger. *Journal of Experimental Agriculture International* 47(9):222-233.
- Saidou SS, Maina F, Soulé M, Ali Koura A, Mohammed R, Amadou HI, Yacoubou B (2025a). Prospection and collection of *Striga hermonthica* ecotypes and cultivated millet in Niger: Towards improved control strategies. *Journal of Applied Life Sciences International* 28(5):88-97.
- Sivakumar MVK (1986). Climat de Niamey. Programme exploitation des ressources. *Compte Rendu des Travaux* 1p.
- Tank DC, Beardsley PM, Kelchner SA, Olmstead RG (2006). Review of the systematics of Scrophulariaceae and their current disposition. *Australian Systematic Botany* 19:289-307.



Annex 1. *Striga* plant vigor at (A) 64 DAS, (B) 85 DAS, (C) 99 DAS, and (D) 119 DAS.