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SEASONAL CONSTANCY OF INTRA-POPULATION VARIATION OF HCN CONTENT OF COSTA RICAN *ACACIA FARNESIANA* FOLIAGE

D. H. JANZEN, S. T. DOERNER* and E. E. CONN*

Department of Biology, University of Pennsylvania, Philadelphia, PA 19104, U.S.A.; *Department of Biochemistry, University of California at Davis, Davis, CA 95616, U.S.A.

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Key Word Index—*Acacia farnesiana*; Leguminosae; Costa Rica; cyanogenesis; linamarin; lotaustralin; intra-population variation; seasonal variation.

Abstract—The HCN content of dried *Acacia farnesiana* foliage varies from 0.0 to 5.495 μmol/g among individuals within a population ($\bar{X}$ = 1.80, s.d. = 1.80 in wet season; $\bar{X}$ = 1.21, s.d. = 1.27 in dry season; n = 26) and increased in the wet season (average difference of 0.59 μmol/g) in Santa Rosa National Park, Guanacaste Province, Costa Rica. The correlation coefficient of HCN values for 26 bushes in the wet and the dry season was 0.898, suggesting that the seasonal change was proportional to the amount of HCN present in the foliage of each bush.

INTRODUCTION

A population of *Acacia farnesiana* (L.) Willd. in Santa Rosa National Park, Costa Rica, contains members whose foliage HCN content ranges from 0.0 to 4.5 μmol/g of dried leaves [1]. Here we ask if this inter-plant variation changes with the season at the level of the individual or population. Understanding this variation is of extreme importance in understanding a population of *A. farnesiana* as a food source for herbivorous animals, and in interpretation of chemical analyses of foliage of all species.

RESULTS AND DISCUSSION

The data in Table 1 show clearly that the foliage of a population of *Acacia farnesiana* varies strongly among individuals in dry weight HCN content. This conclusion corroborates the results reported by Seigler *et al.* [1] for a different set of 36 plants from the same population. The mean concentration of HCN content reported by Seigler *et al.* [1] was 1.56 μmol/g dry wt (s.d. = 1.51); neither this mean or standard deviation is significantly different from those of either of the data sets in the present study (wet season, $\bar{X}$ = 1.80, s.d. = 1.80; dry season $\bar{X}$ = 1.21, s.d. = 1.27; t-test). There is no doubt that the HCN content of dried *A. farnesiana* leaves varies strongly within a population (range for all samples, 0.0 to 5.495 μmol/g). Great care must be taken in interpreting quantitative chemical analyses based on samples from only a few plants. Furthermore, it is clear that inter-individual differences in extent of herbivory of *A. farnesiana* by natural populations of herbivorous insects may be due to these differences as well as those more conventionally suspected.

Does the average HCN content change with season? Two samples were taken during the wet season (June [1]; December, this study) and one during the dry season

Table 1. HCN content (μmol/g) of dried mature leaves of *Acacia farnesiana* from 26 bushes in one site in the wet and dry season (Santa Rosa National Park, Guanacaste Province, Costa Rica; wet: 10–15 December 1977; dry: 6–10 March 1978)

	Wet Season		Dry Season	
Bush No.	$\bar{X}$	s.d.	$\bar{X}$	s.d.
1	0.303	0.040	0.133	0.041
2	0.351	0.028	0.232	0.033
3	0.447	0.039	0.065	0.049
4	0.422	0.013	0.293	0.049
5	2.286	0.139	1.335	0.146
6	0.280	0.051	0.269	0.009
7	0.310	0.012	0.215	0.034
8	0.226	0.071	0.133	0.029
9	0.286	0.030	0.219	0.067
10	0.336	0.168	0.202	0.050
11	3.132	0.091	2.415	0.180
12	0.159	0.084	0.200	0.078
13	2.656	0.147	3.500	0.176
14	1.748	0.092	0.907	0.070
15	1.787	0.075	1.392	0.093
16	0.252	0.088	0.357	0.043
17	4.789	0.240	2.581	0.113
18	0.164	0.075	0.081	0.074
19	4.727	0.106	4.711	0.097
20	2.239	0.054	1.266	0.049
21	4.093	0.384	2.448	0.133
22	0.230	0.036	0.131	0.012
23	1.730	0.039	1.031	0.036
24	3.741	0.122	2.341	0.270
25	4.651	0.384	2.524	0.275
26	5.495	0.102	2.566	0.581

(March, this study). As mentioned in the previous paragraph, there is no significant difference among the means and standard deviations for each of these three samples, appearing to imply that the HCN content of *A. farnesiana* mature foliage does not change through the year (though no statement can be made about very young leaves, irrespective of the time of year that they are produced). However, the HCN content recorded for the dry season samples is lower than that recorded for the wet season for 23 of the 26 bushes. There is an average difference of 0.59 μmol/g of dried leaves for the 26 plants. A paired *t*-test of the values in Table 1 shows a highly significant difference between the wet and dry season values ($t = 3.45$, $n = 26$, $P < 0.01$). In short, there is so much variation among bushes that it obscures the seasonal change which is readily visible if each rainy season sample is compared with a dry season sample from the same bush. There is a correlation coefficient of 0.898 between the two columns of means in Table 1 (24 d.f., $P < 0.01$, highly significantly different from 0). Bushes that have a high HCN content stay high and those that are low stay low through the late wet and dry season. Additionally, the change from wet to dry season is proportional to the amount of HCN contained, which produces the differences shown with the paired *t*-test above.

These results allow the possibility that plants that are heavily attacked at one time owing to poor chemical defenses may be subject to repeated attack in other seasons and other years. On the other hand, the seasonal change suggests that for a HCN-sensitive herbivore, the dry season may be the season when the plants are most available. The high correlation between the two columns in Table 1 is consistent with the speculation that the inter-individual differences in HCN content are directly genetic, but does not allow the rejection of the hypothesis that the differences are based on differences in health, micro-site or age of plant. In summary, the HCN profile of this *Acacia farnesiana* population may be viewed as highly undulating with the peaks and troughs remaining fixed in location through the year but the average height rising in the rainy season and falling in the dry season.

EXPERIMENTAL

Adult bushes of *Acacia farnesiana* were selected haphazardly in brushy, old, abandoned pasture near the campground and headquarters area of Santa Rosa National Park, Guanacaste Province, Costa Rica (300 m elevation). These plants are indigenous and the site was orginally covered with deciduous forest. There are no other plants at this site that can be confused with *A. farnesiana* and voucher specimens from this population have been deposited in the Missouri Botanical Garden Herbarium. Each plant was identified with a numbered AL tag. Leaves were collected by stripping all the mature leaves from a branch into a plastic bag. The sample was then spread on newspaper to air-dry in shade for 1–2 days, after which it was quickly dried in an oven for 10–15 min at about 100°; this treatment left the sample brittle and greenish-brown. The plants produced a second set of foliage within several weeks after being defoliated in December; the March leaves were therefore ca 10 weeks old at the time of collection. Initially 40 bushes were tagged but 14 were lost through labelling errors, road construction or overheating in the oven.

The HCN content of each sample was determined by the methods outlined in ref. [1]. Three subsamples of each sample were analysed, and the values reported in Table 1 are the means and standard deviations of these samples. In 15 samples scattered through those from both seasons, the analyses were duplicated. There is a correlation coefficient of 0.96 between the first and second of these determinations. Only the first of them is reported in Table 1. There is no reason to suspect that either of the absolute values reported here are far from reality. However, if they are off, it should not affect the relative statements since all samples were treated in the same manner. The HCN is present as linamarin and lotaustralin [1] and the values for μmol HCN/g dry wt tissue can be converted to per cent by multiplying by 0.0027.

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