

Global Variation in velvetleaf (*Abutilon theophrasti*)

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Summary

Genetic variation among populations of the widespread weed velvetleaf (*Abutilon theophrasti*) was investigated using polyacrylamide gel electrophoresis to characterise alloenzyme patterns for five enzyme systems. Seeds were obtained from field populations in India, China, Israel, Italy, Canada and the United States of America and propagated to yield single-plant accessions. Only one of the 38 accessions tested displayed any variation in alloenzyme pattern; this accession, from Wuhan, Hubei Province, China, is believed to be a variety of velvetleaf previously cultivated as a fibre crop. The genetic uniformity of the weedy forms of velvetleaf is probably attributable to its hexaploid genome.

Introduction

Velvetleaf, *Abutilon theophrasti* Medik. (Malvaceae), was introduced into North America prior to 1750 as a potential fibre crop for ropemaking and is now a major weed of row crops in the eastern United States (11). Chemical control is difficult and expensive as velvetleaf is tolerant to several common herbicides (11, 12, 14), and biological control methods are under active investigation (8, 15).

Although originally considered to be a native of China (11), velvetleaf is now believed to have originated elsewhere (S Y Hu, personal communication), possibly in the Middle East. Its present distribution is virtually world-wide. While there is considerable phenotypic variation among North American populations in morphology, resource allocation and phenology (2, 13), levels of allozyme variation are very low (13). This paper describes the results of an electrophoretic survey of five enzyme systems using 38 single-plant accessions derived from populations within the present range, to investigate the extent and pattern of global variation within the species and the possible location of its centre of origin.

Materials and methods

Locations of accessions are shown in Table 1; seed numbers were increased by one or two generations of glasshouse culture. Mature plants were generally similar in appearance, with the exception of accessions 43 (purple pigmentation of the leaf pulvinus) and 40 (larger plants, purple pigmentation of stem, light brown fruits). Accession 39 was derived from an atrazine-tolerant population (1, 9).

For each accession a composite extract was prepared from six seedlings (3-4 weeks old). Extracts were also prepared from individual seedlings of two accessions to verify the genetic uniformity of plants within accessions. The extraction buffer consisted of 0.1M MES, pH 6.8, to which were added 0.1M sucrose, 15% ethylene glycol and 2% 2-mercaptoethanol. Approximately 1g plant tissue was ground with 4mL buffer, 20mg PVP and 80mL PMSF in a chilled container, and after centrifugation at 10,000rpm for 20 minutes the supernatant was decanted and used immediately or

Table 1 Collection locations for velvetleaf accessions. All degrees and minutes are north latitude.

| Accession number | Country | Nearby town or city | Latitude deg min | Accession number | Country | Nearby town or city | Latitude deg min |
|------------------|---------|---------------------|------------------|------------------|---------|---------------------|------------------|
| 1 | USA | Stoneville, MS | 33 25 | 21 | USA | Greenfield, IN | 39 48 |
| 2 | USA | Merigold, MS | 33 50 | 22 | Israel | Ein-Shemer | 32 00 |
| 3 | USA | Fayetteville, AR | 36 04 | 23 | Israel | Atlith | 32 41 |
| 4 | USA | Columbia, MO | 38 58 | 24 | China | Fushun | 41 57 |
| 5 | USA | Urbana, IL | 40 07 | 25 | India | Srinagar | 34 04 |
| 6 | USA | Urbana, IL | 40 07 | 26 | China | Beijing | 39 55 |
| 7 | USA | Lincoln, NE | 40 50 | 27 | China | Beijing | 40 00 |
| 8 | USA | Kelley, IA | 42 00 | 29 | China | Nanjing | 32 00 |
| 9 | Canada | Ridgetown, Ont | 42 26 | 31 | China | Nanjing | 32 00 |
| 10 | USA | Madison, WI | 43 05 | 32 | USA | Bridgetown, NJ | 39 26 |
| 11 | Canada | Guelph, Ont | 43 32 | 33 | USA | Shafter, CA | 35 30 |
| 12 | USA | Lemond, MN | 44 00 | 34 | India | Coimbatore | 11 00 |
| 13 | USA | Waseca, MN | 44 05 | 35 | China | Beijing | 39 55 |
| 14 | USA | Rosemount, MN | 44 43 | 36 | Italy | Padova | 45 24 |
| 15 | USA | Manhattan, KS | 39 12 | 38 | India | Bangalore | 13 03 |
| 16 | USA | Wolverton, MN | 46 34 | 39 | USA | Westminster, MD | 39 35 |
| 18 | USA | Benton Harbor, MI | 42 06 | 40 | China | Wuhan | 30 40 |
| 19 | USA | East Lansing, MI | 42 44 | 42 | China | Nanjing | 32 00 |
| 20 | USA | Lexington, KY | 38 02 | 43 | China | Huhehot | 40 50 |

frozen at -80°C until use. Slab gels for discontinuous native polyacrylamide gel electrophoresis (PAGE) were used with 5% running gels (5), and ethylene glycol was added to the stacking gel (5%) and running gel (10%). Malate dehydrogenase (MDH, 1.1.1.37), glutamate dehydrogenase (GDH, 1.4.1.2), aspartate aminotransferase (AAT, 2.6.1.1) and phosphoglucosmutase (PGM, 5.4.2.2) were stained by the methods of Shaw and Prasad (10). The staining method used for arylesterase (EST, 3.1.1.2) was modified from Arulsekhar and Parfitt (3) using α -naphthyl butyrate as substrate.

Results and Discussion

Of the 38 accessions tested, 37 had identical banding patterns for all five enzymes, while accession 40 differed in pattern for EST, AAT and MDH (Figure 1). The complex pattern observed for EST (up to six separate bands, although only three could be scored reliably) is indicative of the non-specific nature of the staining reaction for aryl esterases (4); the diffuse-staining region centred on 0.55 may represent a multiple banding pattern but these bands could not be resolved.

The banding patterns for GDH, PGM and MDH are consistent with previous observations of velvetleaf from Canada and USA (13). PAGE revealed more bands for AAT than were observed previously (13), suggesting that PAGE has superior resolving power when compared with starch gel electrophoresis (7).

With the exception of accession 40, there appears to be little allozyme variation among this widespread sampling of velvetleaf. Polyploid species are characterised by fixed heterozygosity (6), that is relative genetic uniformity among individuals but high diversity within the genome, and hexaploid velvetleaf appears to

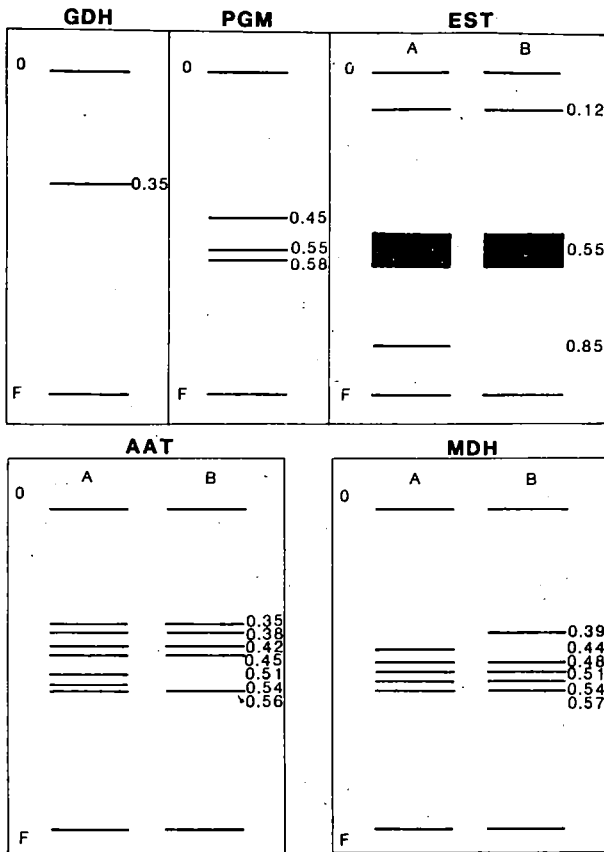


Figure 1

Electrophoretic patterns of five enzyme systems in velvetleaf.

All accessions exhibited the same pattern for GDH and PGM. For EST, AAT and MDH accession 40 exhibited the pattern labelled B; all other accessions displayed the pattern labelled A.

O = origin; F = dye front; R_f values are indicated for each band.

be no exception. Accession 40 resembles one of the regional cultivars of velvetleaf selected for fibre production (S Y Hu, personal communication) and is the most distinct form morphologically. The uniformity of pattern among the other "weedy" accessions sheds no further light on the centre of origin of the species.

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