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Taxonomic studies of nodulated leguminous weeds from the flora of North Western part (Dera Ismail Khan) of Pakistan

Sarfraz Khan Marwat*, Mir Ajab Khan, Mushtaq Ahmad, Muhammad Zafar, Farooq Ahmad and Abdul Nazir

Department of Plant Sciences, Quaid-i-Azam University Islamabad, Pakistan.

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An extensive survey was carried out during 2005 - 2007 to investigate nodulated leguminous weed species which grow in agricultural and non-agricultural fields of North Western part (Dera Ismail Khan) of Pakistan. Studies revealed that 18 such weed species belonging to 10 genera are commonly found in the research area. The genera with number of species are: *Alhaji* (1 sp.), *Argyrolobium* (1 sp.), *Astragalus* (2 spp.), *Cajanus* (1 sp.), *Lathyrus* (2 spp.), *Lotus* (1 sp.), *Medicago* (5 spp.), *Melilotus* (3 spp.), *Sesbania* (1 sp.) and *Vicia* (1 sp.). Results were systematically arranged by alphabetic order of botanical names, followed by synonyms (if any), description of the plant, flowering and fruiting period, type, local and general distribution. Nodulated leguminous plant specimens were collected, identified, preserved, mounted and deposited as voucher specimens in the Department of Plant Sciences, Quaid-i-University, Islamabad, for future references.

Key words: Nodulating leguminous weeds, D. I. Khan, Pakistan.

INTRODUCTION

Dera Ismail Khan (D.I.Khan) district (7326 Km², 31°.15' - 32°.32'N and 70°.11' - 71°.20' E) is located in the extreme south of the North West Frontier Province (NWFP), Pakistan. Most of the area of the district consists of flat dry alluvial plain, commonly known as Daman which makes up more than 80% of the area where a large number of streams and hill torrents discharge 850,000 cusecs of water during peak flow. The area is gifted with diverse and unique flora, as it is adjacent to the South Waziristan Agency and Sulaiman Range in the west, Koh Sheikh Buddin in the north and Indus River in the east. The summer season is dry and hot. June is the hottest month during which the mean maximum and minimum temperatures are recorded around 42 and 27°C, respectively. December, January and February are the cold months. In January, the mean maximum and minimum temperatures are around 20 and 40°C respectively (Anonymous, 1998).

Weeds in simpler terms are plants that interfere with the healthy or normal growth and development of crops. They are now known to limit the production of crops causing serious losses in the output of grains, seeds and fruits e.t.c (Chaudhri, 1992). They belong to practically all plant families, but certain families particularly Compositae (Asteraceae), Graminae (Poaceae), Cruciferae (Brassicaceae) and Leguminosae (Fabaceae) constitute the major weed flora through out the world.

The plants of the family Leguminosae bear nodules on their root system, but not all legumes are nodulated and it is known that certain tree forms do not possess them at all. Hardly 16% of Leguminosae have so far been examined for nodulation of which 95% of Mimosoideae, 26% of Ceasalpinioideae and 90% of Papilionoideae possess root nodules (Anonymous, 2008).

In root nodules the leguminous plants host bacteria. These bacteria, known as rhizobia, have the ability to take nitrogen gas (N₂) out of the air and convert it to a form (NO₃⁻ or NH₃) of nitrogen that is usable to the host plant. This process is called nitrogen fixation. The legume, acting as a host and rhizobia, acting as a provider of usable nitrate form a symbiotic relationship. The ability of

*Corresponding author. Email: skhan.marwat@gmail.com. Tel: +92966710531. Fax: +92966719782.

Table 1. List of nodulating leguminous weeds of D. I. Khan District, NWFP, Pakistan.

Botanical Name	Voucher no.	English name	Local/vern. name	Habit	Nodulation Frequency	Occurrence
<i>Alhaji maurorum</i>	70	Camel's Thorn	Janasa, Jawain	Under shrub	sparse	Non-Agr. And Agr. field
<i>Argyrolobium roseum</i>	155	----	----	Annual herb	Sparse	Usually in non-agr. fields
<i>Astragalus amherstianus</i>	99	Milk-vetch	Ozhai	Annual herb	Sparse	Agri. and non-agri. field
<i>Astragalus bakaliensis</i>	95	Milk-vetch	Ozhai	Annual herb	Sparse	Agri. and non-agri. field
<i>Cajanus cajan</i>	251	Pigeon pea	Arhar	Erect shrub	Moderate	Cultivated in grain crops
<i>Lathyrus aphaca</i>	289	Yellow pea	Jungli Matar,	Annual trailing or climbing herb	Moderate	Agri. and non-agri. field
<i>Lathyrus sativus</i>	288	Indian pea	Kesari dal	Annual herb	Moderate	Agri. and non-agri. field
<i>Lotus corniculatus</i>	66	Bird's-foot trefoil	----	Variable perennial herb	Moderate	Agri. and non-agri. field
<i>Medicago laciniata</i>	313	Cut-leaf medicago	----	Spreading annual herb	Moderate	Agri. and non-agri. field
<i>Medicago lupulina</i>	286	Black medicago	----	Annual or perennial herb	Abundant	Agri. and non-agri. field
<i>Medicago minima</i>	153	Small medic-grass	Maina	Annual herb	Moderate	Agri. and non-agri. field
<i>Medicago polymorpha</i>	14	California burclover	Maina	Annual spreading herb	Abundant	Agri. and non-agri. field
<i>Medicago sativa</i>	285	Lucerne or alfalfa	Vilayati Gawuth	Perennial herb	Sparse	Agri. and non-agri. field
<i>Melilotus alba</i>	23	White sweet clover	Senji	Annual erect herb	Moderate	Agri. and non-agri. field
<i>Melilotus indica</i>	15	Indian sweet clover	Banmethi, Senji	Erect annual herb	Moderate	Agri. and non-agri. field
<i>Melilotus officinalis</i>	314	Yellow sweet clover	Senji	Annual to biennial herb	Moderate	Agri. and non-agri. field
<i>Sesbania sesban</i>	205	Indian sesbania	Jaith, Jantar	shrub or soft wooded tree	Abundant	Cultivated in crop fields
<i>Vicia sativa</i>	287	Spring vetch	Rewari	Annual erect or climbing herb	Moderate	Cultivated fields

legumes to fix atmospheric nitrogen reduces fertilizer costs for farmers and gardeners who grow legumes and this means that legumes can be used in crop rotation to replenish soil that has been depleted of nitrogen. Legume seed and foliage have comparatively higher protein content than non-legume material, due to the additional nitrogen that legumes receive through the process (Anonymous, 2008a).

Leguminous plants are not bad weeds as a group, although there are certain exceptions. Under favourable conditions many species usually considered as harmless may turn into pests; difficult to eradicate. But most of them have a beneficial effect rather than injurious, due to the

presence of nitrogen fixing root nodules (Athar and Sandhu, 1992). Unfortunately, no research regarding the taxonomic studies of leguminous species has been carried out so far in D.I. Khan District. In the present investigation, nodulated leguminous weeds have been explored, examined and described.

MATERIALS AND METHODS

Frequent field trips of the area were arranged to various parts of the D. I. Khan District to collect the live specimens. A collection of nodulated leguminous weeds was made and herbarium specimens were prepared. Plants were identified with the help of available literature (Jafri, 1966; Stewart, 1972; Qurashi and Khan, 1972; Ali, 1977) and by

comparing with the already identified plant specimens of the herbarium, Quaid-i-Azam University, Islamabad. After correct identification, the plants were deposited in the Department of Plant Sciences Quaid-i-Azam University, Islamabad for future references. Only positive reports of nodulated plants were presented. Special care was taken to discriminate root nodules from other kinds of root-malformation such as caused by nematodes, insects or other root inhabiting parasitic microorganism. Plants with voucher no., English and local/ vern. names, habit, nodulating Frequency and occurrence were listed in Table 1. Phytogeography and diagnostic characters were mentioned in Table 2. to differentiate closely related taxa.

RESULT AND DISCUSSION

Studies revealed that 18 nodulated leguminous

Table 2. Phytogeography and Diagnostic characters of nodulating leguminous weeds of D. I. Khan District, NWFP, Pakistan.

Botanical name	Fl. and Fr. Per.	Distribution		Diagnostic characters
		Pakistan	World	
<i>Alhaji maurorum</i>	April-September	Gilgit, Khyber Agency, Jhelum District, Quetta, Urak, Pishin, Loralai, Zoob, Lahore Stadium, Surab on way to Kalat, Jacobabad, Hushab, Sukkur, Awaran, Jamshoro, Mirpur Khas, NWFP.	Pakistan; Kashmir; Iran; Afghanistan; Russia; Turkey; Iraq; Syria Palestine; Cyperus; N. Africa.	An undershrub armed with sharp thorns up to 120 cm high. Leaves simple, very variable, up to 2.5 cm long; petiole c. 2 mm. Inflor. axillary raceme, ending in spine. Flowers pink or reddish-violet, 1-8, on the thorns; 1-3 mm long; calyx teeth triangular; corolla twice or thrice as long as the calyx. Pod up to 3.5 cm long, more or less constricted between the seeds, 1-9 seeded.
<i>Argyrolobium roseum</i>	April – October	Balakot, Hazara, Waziristan, Cherat hill, Peshawar, Rawalpindi district, Murree Hills, Jhelum district, Jamu, Zoob, D.I.Khan district.	Pakistan; Kashmir; India; Persia; Afghanistan; Arabia.	Small sub erect - spreading annual herb, c. 8-16 cm long, silky hairy. Leaves 3-foliolate, petioled; leaflets obovate. Flowers yellowish rose; peduncle 1-4 flowered. Calyx glabrous. Pod 2-3 cm long, silky hairy. Seeds 8-15.
<i>Astragalus amherstianus</i>	April-June	Chitral, Chenab valley, Kashmir, Naran-Kagan, Hazara, Kagan valley, Murree Hills, Ziarat, D.I.Khan district.	Pakistan; Kashmir; India (Kumaun Tehri, Garwal, N. Punjab), 6000-13000 ft.	Annual; stem caespitose, 20-40 cm long, clothed with hairs; leaves compound, 0.3-1.7 cm long; leaflets 11-19, narrow, 3-10 x 1.5-4.5 mm hairy. Flowers 4-10, in closed racemes; calyx hairy, as long as the tube; corolla primrose-yellow. Pod linear, 0.8-1.2 x 0.3 cm broad, much recurved, rostrate, thinly pubescent, 10-12 seeded.
<i>Astragalus bakaliensis</i>	March-April	Warsak, Peshawar University, Rawalpindi district, Quetta, district, Peshin, Qila Abdullah, D.I.Khan district, Lakki Marwat district.	Pakistan; Kashmir; Persia; Afghanistan; Russia.	Annual; stem covered with hairs, up to 10 cm long; leaves pinnately compound. Inflor. An axillary raceme, peduncle 2.5 - 7 cm long, exceeding the leaves. Calyx c. 4.0 mm long, pilose. Standard broadly oval, retuse; keel longer than wings. Pod erect, sickle-shaped, pubescent, not rostrate, ventral suture obtuse. Seeds 20-30.
<i>Cajanus cajan</i>	July– August	Rawalpindi District, Faisalabad, Saikot district, Muzaffargarh District, Kalat, Nawab Shah, Karachi, Hyderabad, Tharparkar, Sangar, Mirpur Khas, D.I.Khan.	Native of tropical Africa widely cultivated.	Pubescent shrub, 1.5-4 m tall. Leaves 3-foliolate, entire; leaflets 2.5-10 x 1.5-3.5 cm, elliptic to lanceolate, soft pubescent on both surfaces; petiole 1-5 cm long. Inflor. A terminal panicle; peduncle 2-7 cm long. Calyx pubescent. Corolla bright yellow with reddish brown lines. Pod 4.5-10x 0.8-1.4 cm broad, long beaked, pubescent and glandular. Seeds 3-7, orbicular with one edge flattened, compressed.
<i>Lathyrus aphaca</i>	July– August	Chitral, Peshawar, Lower Swat, Mangora, D.I.Khan, Haripur, Attock, Rawalpindi, Jhelum District, Rawal Lake, Lahore, Karachi, Thatta.	Pakistan; Kashmir; India; Europe; N. Africa; S.W. and C. Asia; Afghanistan; Arabia.	Annual trailer or scrambler. Stem glabrous. Leaves reduced to tendrils; stipules foliaceous 5-30 mm long, broadly ovate, hestate. Inflor. 1-2 flowered, axillary raceme. Peduncle longer than stipules. Calyx teeth equal to 3 times as long as the tube. Corolla bright to pale yellow. Vexillum 7-13 mm long. Fruit 18-35 x 4-6 mm, glabrous, 4-6 seeded.

Table 2. Contd.

<i>Lathyrus sativus</i>	March-August	Chitral, Gilgit, Peshawar, Lower Swat, Mangora, D.I.Khan, Haripur, Attock, Rawalpindi, Jhelum District, Rawal Lake, Lahore, Karachi, Thatta.	Pakistan; Kashmir; India; Europe; N. Africa; S.W. Asia; Russia.	Annual herb; stem winged; leaves pinnately compound; leaflets 2, 5-100 x 1.5-11 mm narrowly lanceolate - linear, median and upper leaves with mostly 3-sect tendrils, stipules lanceolate, semisagittate. Peduncle 1-flowered, 3-6 cm. long. Calyx tube much longer than teeth. Corolla bluish, white or red. Pod 2.5-3.5 cm long, flat, glabrous, 4-5 seeded.
<i>Lotus corniculatus</i>	April-August	Chitral, Gilgit, Mirpur, Hazara, Kalam, Kaghan, Naran and SaifulMalook, Kashmir, Waziristan, Kurram valley, Murre, Swat, D.I.Khan, Haripur, Attock, Rawalpindi, Jhelum District, Lahore, Karachi,	India; Nepal; Pakistan; Afghanistan; Iran; Syria; Lebanon; Iraq; Turkey; Palestine; Arabia. Egypt; Cyperus; Russia; Europe; Japan; Korea; China; Mongolia; Australia.	Extremely variable perennial herb, ascending or decumbent; branches glabrous to densely pilose. Leaf rachis up to 6 mm long, leaflets 3-20 x 2-10 mm. Inflorescence a 3-6-flowered axillary, pedunculate umbel; peduncle 3-12 cm long. Bracts sessile, leaf-like. Calyx c. 6 cm long, teeth unequal. Corolla yellow. Pod 12-30 x 2-3 mm cylindrical, straight.
<i>Medicago laciniata</i>	March-April	Peshawar, Kohat, Hangu, Rawalpindi Attock district, Quetta, district, Panjgoor, Peshin, D.I.Khan	Pakistan; Orient; Algeria; Tunisia; Kenya; Somalia Republic; Socotra; S. Europe.	Annual, spreading; stem glabrous. Leaves pinnately 3-foliolate; stipules laciniate; leaflets obovate-cuneate, 6-12 x 2-5 mm. truncate or retuse, pubescent on lower side only, dentate. Inflor. a 1-2 flowered raceme. Calyx narrowly turbinate. Corolla 4-5 mm long, yellow. Pod spherical or ovoid with 5-7 sharply spinous coils, 8-10 seeded.
<i>Medicago lupulina</i>	March - June	Dir, Kurram valley, Parachinar, Chitral, Abbottabad, Swat, Kalam, Kaghan, Naran, Murree, Leepa valley, Baltistan, Gilgit, Sind valley, Kashmir, Rawalpindi District, Quetta, Zairat, Shahi Bagh,	Pakistan; India; Russia; Afghanistan; Iran; Syria; Turkey; Europe; Eritarea; Ethiopia; Somali Republic; Tanganyika and Kenya.	Annual or perennial procumbent herb; stem up to 60 cm long, pubescent or glandular. Leaves pinnately 3-foliolate; petiole up to 2.5 cm long; stipules entire or faintly toothed with long acuminate tips; leaflets 5-20 x 4-8 mm. obovate, cuneate, base deltoid, entire. Inflorescence an axillary, pedunculate raceme, peduncle longer than the leaves. Flowers yellow.
<i>Medicago minima</i>	April- July	Chitral, Hazara District, Swat, D.I.Khan, Rawalpindi, Poonch,	Pakistan, Kashmir, Europe, N. Africa and Cape, Asia (except the desert areas), introduced in N. and S. America	Annual, pubescent; petiole up to 8 mm long, leaflets 6-12 x 2-7 mm distinctly toothed, obovate, pubescent on both surfaces. Inflor. A 2-6 flowered raceme, peduncle generally longer than the petiole. Flower 2-5; calyx teeth linear, as long as the tube; corolla distinctly exserted. Pod of 3-5 coils, spines variable.
<i>Medicago polymorpha</i>	March-May	Chitral, Peshawar, Rawalpindi, Hazara, Kashmir, Swat, D.I.Khan, Rawalpindi, Lahore, Karachi, Panjgoor, Khairpur, Turbat, Khairpur, Daulatpur.	Pakistan; widely distributed through out the world, except for tropical regions and desert.	Annual, glabrous or subglabrous prostrate, up to 60 cm long; leaves pinnate compound 3-oliolate; stipule laciniate; petiole 1.2-4 cm long; leaflets 10-20 x 7-15 mm. obovate to cuneate, obtuse, and truncate to retuse. Inflor. a 2-8 flowered raceme, peduncle 5-15 mm long. Flowers yellow; calyx teeth lanceolate, as long as the tube; corolla twice as long as calyx. Pod flattened to rather subglobose, of 2-4 spirals; margin with double row of spines.

Table 2. Contd.

<i>Medicago sativa</i>	March June	–	Chitral, Gilgit, Kalam, Swat, Hazara, Kashmir, Sind valley, Baltistan, Kaghan, Quetta, Zoob, Makran, Hyderabad,	Pakistan; India; Central Asia to Europe, Orient and N. Africa; widely cultivated.	Annual or perennial herb, up to 90 cm tall; leaflets 5-20 x 3-10 mm. obovate to sublinear, dentate at apex, appressed pubescent. Inflor. Raceme; peduncle much longer than petiole. Flowers violet or bluish; calyx teeth as long as the tube; corolla exserted. Pod slightly pubescent with 2-3 spiral coils, 10-20 seeded.
<i>Melilotus alba</i>	March June	–	Kagan, Kashmir, Hazara District, Muzaffarabad, Scardu, Ladkh, Murree, Nathia, Poonch, Lahore, Panjgur, Sukkur, Nawabshah, Larkana, Karachi, Tando Muhammad Khan, Mirpur Khas Hyderabad.	Pakistan; India; Tibet; Persia; Afghanistan; Central Asia; Turkey; Arabia; Europe; introduced in America and Australia.	Annual, erect, glabrous or finely pubescent above, 30-150 cm high. Leaflets narrowly or broadly oblong, denticulate, obtuse or emarginated. Flowers in 4-10 cm long raceme, white, honey sweet; pedicel short. Calyx teeth lanceolate, shorter than the tube. Corolla exceeding calyx. Pod small, usually 2-seeded, slightly reticulate.
<i>Melilotus indica</i>	March– August		Chitral, Waziristan, D.I.Khan, Swat, Islamabad, Attock District, Lahore, D.G.Khan, Hazara, Kashmir, Sind valley, Baltistan, Kaghan, Quetta, Zoob, Mirpur Khas, Makran, Panjgur, Nawabshah, Karachi, Hyderabad.	Pakistan; India; Orient; Europe; introduced in warm temperate regions.	Annual, erect herb, 15 – 90 cm high, stem pubescent. Stipules linear, acuminate; leaflets 1.5-2.5 cm long, 5-10 mm broad, oblong or lanceolate, dentate, retuse or emarginated. Inflorescence 10-16 flowered raceme. Peduncle up to 3 cm long. Flowers yellow; calyx c. 1.5 mm long; corolla 2-3 mm long. Pod small, nearly globose, turgid, irregularly reticulate, 1-seeded.
<i>Melilotus officinalis</i>	September		Chitral, Kurram to Alikhel, Drosh, Kashmir, Ladakh, Scardu, Baltistan, Hushe valley, D.I.Khan.	Kashmir; India (N. Punjab) Tibet; Russia; China; Persia; Turkey; Middle and Southern Europe; introduced in America and Tropical Asia.	Annual to biennial, erect or decumbent plant, 30-250 cm tall, glabrous or slightly pubescent above. Leaves pinnately 3-foliolate. Leaflets obovate or oblanceolate, 12-25 mm. long, rounded at apex, denticulate nearly all round. Inflor. A 4-10 cm long raceme. Flowers yellow; calyx teeth lanceolate, as long as the tube; corolla linear usually three times as long as calyx, wings and vexillum equal or longer than the keel. Pod distinctly stipitate, usually 1-seeded.
<i>Vicia sativa</i>	July August	–	Chitral, Peshawar, Swat, Abbottabad, Muzaffarabad, District, Rawalpindi, Baltistan, Kashmir, Kotli, Mirpur, Murree hills, Poonch, Sargodaha, Quetta, Loralai District, Panjgur, Dadu District, Hyderabad, Karachi, D.I.Khan, Khairpur.	Pakistan; India; Orient; Europe; Russia; Far East.	Annual climbing herb, 5-8 cm high, pubescent. Leaves pinnate; leaflets 4-18, the terminal represented by a tendril, linear to lanceolate-oblong, acute, obtuse or emarginated; stipules semisagittate, dentate; tendril generally branched. Flowers 1-2 rarely 3, axillary; pedicel short; calyx pubescent, subequal; corolla pale pink, purplish violet, rarely white. Pod 2.3-6.5 cm long, narrowly oblong, 6-12 seeded.

weed species were common in agricultural and non-agricultural fields. The plants examined included *Alhaji*

maurorum Medic, *Argyrobium roseum* (Camb.) Jaub and Sapach, *Astragalus amherstianus* Royle ex Benth.,

A. bakaliensis Bunge, *Cajanus cajan* (L.) Millsp. *Lathyrus aphaca* Linn, *Lathyrus sativus* Linn, *Lotus corniculatus* Linn, *Medicago laciniata* (L.) Mill, *Medicago lupulina* L., *Medicago minima* (L.) Grufb. *Medicago polymorpha* L., *Medicago sativa* L., *Melilotus alba* Desr. *Melilotus indica* (L.) All *Melilotus officinalis* (L.) Pall *Sesbania sesban* (L.) Merrill and *Vicia sativa* L. These are herbs, climbers and undershrubs. *Sesbania sp.* and *C. cajan* are agricultural crops. Results were systematically arranged in Tables 1 and 2.

Leguminous plants only grow vigorously if they have functioning nodules and this depends upon their roots encountering the appropriate bacteria strains in the soil. Bacteria involved in nodule formation and symbiotic N-fixation belong to the genera *Rhizobium* and *Bradyrhizobium*. *Rhizobium* species are fast growing, acid producing N-fixing bacteria. *Bradyrhizobium* species are slower growing, alkaline producing bacteria (Adjei et al., 2008).

A. maurorum species has a symbiotic relationship with certain soil bacteria. These bacteria form nodules on the roots and fix atmospheric nitrogen. Some of this nitrogen is utilized by the growing plant but some can also be used by other plants growing nearby (Anonymous, 2008b). *C. cajan* is nodulated with *Rhizobium* of the cowpea type and is an effective green manure crop (Anonymous, 1988). Being a legume, *L. aphaca* enriches soil through symbiotic nitrogen fixation. *L. sativus* has an extensive root system and fixes atmospheric nitrogen through bacteria that live on the roots. It makes a good soil-enriching green manure crop or can be planted for erosion control (Anonymous, 2008a).

The plant *Lotus carnicultus* can fix nitrogen from the air courtesy of their root nodules, making it useful as a cover crop. The nodulating symbionts are *Bradyrhizobium* bacteria. *M. laciniata* forms a symbiotic relationship with the bacterium *Sinorhizobium milloti* which is capable of nitrogen fixation. *M. lupulina* is a summer annual-perennial plant sometimes considered a weed. As with other legumes, nitrogen fixing bacteria, known as *Rhizobia*, are found in nodules on the roots. *M. minima* forms a symbiotic relationship with the bacterium *Sinorhizobium meliloti*, which is capable of nitrogen fixation. *M. polymorpha* forms a symbiotic relationship with the bacterium *Sinorhizobium medicae*, which is capable of nitrogen fixation. The root nodules of *M. sativa* contain bacteria, *Sinorhizobium meliloti*, with the ability to fix nitrogen, producing a high protein feed regardless of available nitrogen in the soil. Its nitrogen-fixing abilities (which increases soil nitrogen) and use as animal feed greatly improves agricultural efficiency. *M. albus* is a major source of nectar. It is nonetheless favoured for honey production and for its nitrogen fixing ability in preparing agricultural soil for future crops. Other *Melilotus* spp. possess mode-rate nodulation. *S. sesban* is a culti-

vated nitrogen fixing leguminous plant which has abundant nodulation. It is considered to be a weed when found growing in cultivated cropfields. *V. sativa* L. is also a nitrogen fixing leguminous plant. Although considered a weed when found growing in a cultivated grainfield, this hardy plant is often grown as green manure or livestock fodder (Anonymous, 2008a).

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