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Original Research Article

Agro-Botanical Characterization of Different Accessions of *Mucuna Melanocarpa* Hochst A Rich

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Abstract: The phenology, morphology and biomass production of six velvet bean (*M. melanocarpa*) accession were evaluated at Bambasi Medicinal Plants Field Gen Banks. The time from seeding to first floral buds ranged from 83-135 days, to first blooms 109-149 days, and to first pods 109-160 days. The six accessions initiated blooming in a certain order, which could be described by calendar days. Five accessions had an indeterminate flowering habit, while one was determinate. Accession number DM00102, DM00103 and DM00105 produced the most biomass and accession DM00101 the least. The petiole constitutes 14% to 23% of total leaf weight. Leaf weight at bloom accounted for 81% of above-ground plant weight in indeterminate accessions, and 69% in determinate accessions. The period from first bloom to first pods spanned 8 weeks. Differences in velvet bean growth habits may be used to stag per planting dates of other crops. Growers may implement a strategy of "one time planting" of several velvet bean lines of various maturation rates each on a fraction of their acreage.

Keywords: Accession, phenology, velvet bean, morphology.

INTRODUCTION

The genus Mucuna is climbing herbs, woody lines or rarely erect shrubs of family Fabaceae. They possess trifoliate leaves (leaflets are broadly ovate, elliptic or rhomboid ovate and unequal at the base); flowers white to dark purple and hang in long clusters (pendulous racemes); pods are sigmoid, turgid and longitudinally ribbed, seeds ovoid (4-6 per pod) and black or white or brown mottling on light tan background. Mucuna pods are covered with reddish-orange hairs, which readily dislodge and cause intense skin irritation and itch due to presence of a chemical called mucunain. Some100 species were recorded in the tropics and subtropics of both hemispheres. However, only two species namely Mucuna melanocarpa Hochst.a A. Rich. and Mucuna pruriens (L.) DC.var.utilis (Wall. a Wight) Bale. exists in Ethiopia with a limited distributions in Wolega, Kefa, Harar, Arsi, Sidamo and Gojam. Moreover, the distribution of Mucuna melanocarpa species is not known elsewhere in other areas of the world (Inga Hedberg & Sue Edwards, 1989).

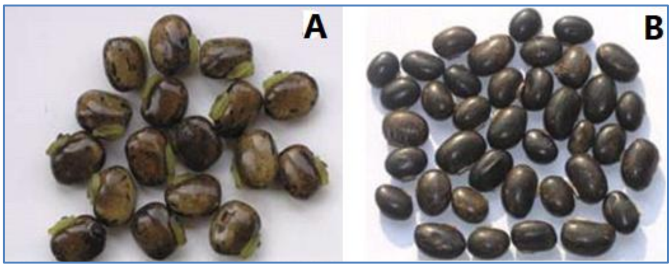

Fig-1: Seed varieties of velvet bean

All parts of Mucuna plant are known to possess high medicinal value (Caius 1989, Warrier et al. 1996). Mucuna species were known to contain several useful phytochemicals (Morris 1999). The alkaloid screening resulted in the confirmation of the presence of 5-methoxytryptamine in all the samples tested and serotonin confined to fresh leaves and stems (Szabo 2003). Various compounds present in pods, seeds, leaves and roots of Mucuna includes: bufotenine, choline, N, N-dimethyltryptomine, 5-oxyindole-3-alkylamines, indole-3-alkylamine and B-carboline (Ghosal et al. 1971). Gupta et al. (1997) reported the antiepileptic and antineoplastic activity of methanol extract of Mucuna pruriens roots. Roots of Mucuna are used in Ayurveda and in indigenous medicines to relieve constipation, nephropathy, strangury, dysmenorrhoea, amenorrhoea, elephantiasis, dropsy, neuropathy, consumption, ulcers, helminthiasis, fever and delirum. The leaves are aphrodisiac, anthelmintic and useful in treating ulcers, inflammation, helminthiasis, cephalalgia and general debility. Mucuna pod hairs are blended with honey and are used as vermifuge. The paste prepared from pod hairs are also used as stimulant and mild vesicant (Sastry and Kavathekar 1990).

Fig- 2: Pods and Flowers of velvet bean

Mucuna species are vigorous annual legume which possesses many desirable agronomic attributes. As a ground cover it re- duces erosion, fixes N (Harrison et al., 2004), suppresses weeds (Baijkya et al., 2005), reduces populations of certain plant-parasitic nematodes (Vargas-Ayala and Rodríguez-Kába- na, 2001), assimilates and sequesters left over nutrients and increases crop yields (Abdul-Baki et al., 2005). In Benishangul Gumuz Regional State the two aforementioned species grows in the rainy summer months in thickets of bamboo and within woodlands using the trees as support for the lianas in the entire three zones.

The goal of this research was to elucidate the growth habits, morphology and phenological characteristics of six accessions of M. melanocarpa in order to utilize them for bio-prospecting.

MATERIAL AND METHODS

Six accessions M. melanocarpa which were collected from Guba, Homosha and Bambasi Woredas evaluated on field during 2020 and 2021 at the Ethiopian Biodiversity Institute Assosa Center, Bambasi Medicinal Plants Field Gen Bank (Table 1).

Table-1: Characteristics of velvet bean (Mucuna melanocarpa) accessions tested.

No	Accession Number	Seed color	Collection area	Sources
1	DM00100	Black	Kota area (Guba Woreda)	Own collection
2	DM00101	Black	Kota area (Guba Woreda)	Own collection
3	DM00102	Brown mottling on light tan background	Anbessa Chaka (Bambasi Woreda)	Own collection
4	DM00103	Brown mottling on light tan background	Anbesa Chaka	Own collection
5	DM00104	Brown mottling on light tan background	Tsore Almetema	Own collection
6	DM00105	Brown mottling on light tan background	Tsore Almetema	Own collection

In 2020, seeds of each accession were planted in late May. A 20 cm band of organic fertilizer was applied prior to planting. Seeds treatment was not applied at the planting time. Plot size was 3x3 m. Within row spacing was 30 cm for all accessions. Spacing between rows was 60 cm. Rainfall was supplemented with overhead hand watering. In 2020, leaf and petiole weights and leaf areas from 10 leaves, total plant weight and vine weight from five plants, velvet bean coverage outside of plots, weight of 200 seeds, and above-ground biomass from one 3.4 m^2 per accession were determined. Phenological observations were made weekly until pods had become fully mature. The numbers of calendar days for each accession to reach each major phenological event were recorded. In 2021 above-ground biomass samples were col- lected from one 3.4 m^2 per accession approximately 3.5 months after planting. All plant materials were dried at 70°C for 5 days, weighed and ground.

In 2021 a field experiment was conducted at Bambasi Medicinal Field Gen Bank and was seeded at 4 kg·0.07ha-1 in four replicated plots at both sites. Seeds were planted in late May and above-ground biomass was collected, dried and weighed as before. Phenological observations were made at weekly intervals until pods had become fully mature.

Replicated data are expressed as means. Differences between accessions and locations were determined by analysis of variance, and means were compared with Tukey's adjustment for multiple comparisons ($P < 0.05$) using STATA-14.

RESULTS

The velvet bean accessions varied greatly in their phenology, morphology and biomass production. Accession number DM00102, DM00103, DM00104 and DM00105 produced the largest leaves based upon dry weight and leaf area and the remaining two accessions from Guba Woreda the smallest (Table 2). Petiole weight as percent of total leaf weight ranged from 13.9% in line 1 to 28% in accession number DM00102 and DM00103. At the time of single leaf collection, accession number DM00100 and DM00101 was the most mature with the lowest leaf moisture.

Above-ground dry weight of accession number DM00100 and DM00101 was lighter than that of all other accessions (Table 2). The ground coverage outside the plot was greatest for accessions DM00102, DM00103, DM00104 and DM00105 which did not differ statistically from accessions DM00104 and DM100105 (Table 2). The accessions from Guba area were the poorest at covering area beyond its seeding area.

There was little difference in the amount of biomass produced by each accession between years, and the relative order of biomass production among the accessions was the same in both years (Table 2).

Table-2: Leaf and petiole weights, leaf area and moisture, seed weight and biomass production by various velvet bean (M. melanocarpa) accessions

No.	Accession number	Dry wt. leaf blade (g)y	Dry wt. petiole (g)y	Total leaf weight (g)y	Leaf area (cm3)y	Leaf moisture (%)	Dry wt. whole plant (g)x	Coverage (cm)w	Biomass (Mt ha^{-1})v
1	DM00100	0.87	0.14	1.01	205.7	65.3	172	182	5.9
2	DM00101	0.84	0.19	1.03	218.0	60.8	183	163	5.6
3	DM00102	0.82	0.20	1.15	337.3	85.4	576	201	8.9
4	DM00103	0.97	0.23	1.20	327.2	81.8	578	310	7.6
5	DM00104	0.82	0.19	1.08	225.5	77.3	348	285	6.0
6	DM00105	1.02	0.22	1.10	304.7	78.8	389	316	7.0

Phenology was also influenced by year and location (Table 3). In 2019/20, 'accession number DM00100 and DM00101' matured slightly more rapidly than in 2020/21 (Table 3). The numbers of days to first floral buds and to first blooms were less at Bambasi and Homosh than at Guba, but, conversely, the number of days from first to last bloom was 5d greater at the former than at the latter site.

Differences in seed weights were used to establish seeding rates and spacing (Table 5). Accession number 3 and 4 produced the smallest seeds; hence it has the most seeds per kg. Number 1, 2, 5 and 6 had similar number of seeds required to achieve a seeding rate of 91 kg·ha-1. Accession number DM00103 and DM00104 were similar, compared to the other accessions, in number of seeds required per ha.

Table-3: Phenology of various velvet bean (M. melanocarpa) accessions.

	Days from seeding to			Days from 1st to last blooms	Flowering Habit
	1st Floral buds	1st Blooms	1st Pods		
Accession 1	83	103	112	16	Indeterminate
Accession 2	95	122	109	39	Indeterminate
Accession 3	110	138	141	65	Determinate
Accession 4	100	146	153	79	Indeterminate
Accession 5	112	149	160	60	Indeterminate
Accession 6	135	142	160	65	Indeterminate

Table-4: Seed attributes of velvet bean (M. melanocarpa) accessions

Accession number	Seed wt. (g) y	Number seeds kg^{-1}	Seeds required ha^{-1}	Seed spacing (cm)
DM00100	137.0	1258	111,930	24
DM00101	135.0	1372	125,120	22
DM00102	160.3	1196	100,160	34
DM00103	150.0	1179	98,215	33
DM00104	144.1	1188	101,980	33
DM00105	179.4	1215	114,775	28

DISCUSSION

One of the most important morphological attributes of the velvet bean plant is the high proportion of leaf to total above-ground weight. Leaf weight to above-ground plant weight ratio in most indeterminate lines at the time of bloom was about 62%, whereas in the determinate lines it ranged up to 81%. In comparison, leaf to above-ground plant ratio in sunn hemp at the time of bloom is only 37% (Abdul-Baki et al., 2005), and the rest of the plant consists of a stem high in cellulose and low in N. The higher percent of leaf tissue in vel- vetbean compared to sunn hemp allows more immediate re- lease of N for use by the subsequent crop.

Additionally, a valuable morphological attribute of velvet- bean is its large petiole. Petioles in grapevine leaves normally have concentrations of nutrients about 3 times greater than in the leaf blade (Reuter and Robinson, 1986); and this is like- ly to be the case in velvetbean. Petiole extracts are also much more toxic to the root knot nematode than other plant parts (Zasada et al., 2006).

Biomass production reported here was significantly lower than reported previously (Abdul-Baki et al., 2005; White bread et al., 2004), because the plants were not terminated at optimal times. Biomass measurements of all lines on the same date did not accurately represent the relative performance of the lines due to differences in maturity. Therefore biomass should be measured at the time of terminating the cover crop and incorporating the cover crop into the soil. By that time the cover crop should have attained maximum biomass and high N content.

During the whole period of bud formation through seed development and maturation, demand for nutrients by the reproductive tissue is high because of the need for synthesis and storage of proteins. During seed maturation and plant senescence, the available N diminishes in the leaves, and the quality of the plant as a cover crop is reduced. Furthermore, as the seeds reach a stage in their development that allows them to germinate, incorporating then into the soil will give them a chance to germinate and serve as weeds competing with the subsequent cash crop. Therefore, it is recommended that the velvet bean line be terminated and soil incorporated no later than two weeks after the first blooms.

Differences in growth habits of the tested lines offer a unique advantage to vegetable growers in south Florida. The common practice among large- and small-scale growers is to do more than one planting for each kind of vegetable crop per season and to stagger these plantings over several months. This practice allows them to provide the market with the quantities that can be consumed for a longer duration in- stead of over-saturating the market for a short duration. For example, in Miami-Dade County the fresh-market tomato planting season begins in late September to early October (for early yield) and ends in January (for late yield). Plantings are staggered at 2- to 3-week intervals to ensure steady and continuous supply. Differences among velvet bean lines to reach the optimal growth stage before termination offer an opportunity in this production system. Since the period between April and Sept. is an off-season for growing vegetables in south Florida the growers can implement a strategy of "one-time-planting" of velvet bean in fallow fields. In that "one-time-planting", they can seed short-, intermediate-, and long-growing season lines. The short growing season lines will mature early and will be ready to terminate and use as cover crops for early vegetable plantings whereas the late maturing lines will be terminated at a later date for late tomato planting dates. This strategy saves time by planting once instead of numerous times; planting is done at a time to make full use of the rainy summer season; and the cover crop protects the soil during the hurricane season.

From a pest management perspective, knowledge of velvet bean morphology, phenology and biomass production is also important. Zasada et al. (2006) found that velvet bean ex- tracts suppress root-knot nematode development, and growth of the tomato and lettuce hypocotyls. For root-knot nematode, extracts from the above-ground portion of the plant are much more toxic than from the roots. Leaf blades, petioles, and vines have similar toxicities to the root-knot nematode. Therefore, from a nematode management perspective, lines which produce large amounts of biomass should be selected for maximum nematode suppression.

Velvet bean has been shown to suppress some weed species in tropical production systems (Baijukya et al., 2005). Competition for light and nutrients, as well as allelopathic compounds such as L-dopa (Fuji, 1999), play an important role in the ability of velvet bean to suppress weeds. Line 5 may be able to shade out weeds more effectively than the vineless accession by virtue of better ground cover; however this deficiency can be compensated by increasing the plant density of the vineless accessions. The suppressive action on nematodes and weeds will be related to the amount of biomass produced.

Velvet bean, along with other cover crops, should be considered in the development of best management practices (BMPs) to protect water quality. The selection of an appropriate velvet bean line will also depend upon the length of time between cash crops, biomass production, N return and economics.

In summary the high proportion of leaf tissue rich in nutrients together with high biomass production and low susceptibility to pathogens should make the velvet bean plant a major component of sustainability of vegetable production in tropical and subtropical areas.

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