

MORPHOLOGY AND AGRONOMICAL CHARACTERISTICS OF SOME MORNING GLORY (*Ipomoea* spp.) ACCESSIONS

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ABSTRACT

A study was conducted to characterize the variation in morphological and agronomical characteristics among 7 *Ipomoea* accessions originated from Vietnam and China. Results from the study showed that the plants were diverse in stem color, leaf shape, leaf pubescence, leaf lobing patterns, calyx, stamen, ovary, corolla shape and color, fruit and seed. These can be used as useful parameters for species identification. The results showed that 7 *Ipomoea* accessions belonged to three distinct species: (1) *Ipomoea nil* (L.) Roth (IP1, IP3, IP5, IP6); (2) *Ipomoea purpurea* (L.) Roth (IP4, IP7); (3) *Ipomoea indica* (Burm.) Merr (IP2). In addition, 7 accessions were also recorded with variation in agronomical traits such as dry matter, SPAD index, yield and yield components. Highest 1000-seed weight was obtained in IP1 (46.66 g), followed by IP3 with 46.45 g and lowest in IP2 with 32.52 g. GB2 was the one with smallest seed size. A high variation in seed yield was also recorded among 7 *Ipomoea* accessions. Seed yield varied from 11.03 g plant⁻¹ in IP7 to 19.01 g plant⁻¹ in IP2.

Keywords: *Ipomoea* spp., morphology, agronomical characteristics.

Nghiên cứu đặc điểm hình thái và nông sinh học của một số mẫu giống bim bim (*Ipomoea* spp.)

TÓM TẮT

Thí nghiệm tiến hành nghiên cứu đặc điểm hình thái và nông sinh học của 7 mẫu giống Bim bim *Ipomoea* sp. thu thập tại Việt Nam và Trung Quốc. Kết quả thí nghiệm cho thấy, các mẫu giống có sự đa dạng về màu sắc thân, hình dạng lá, mức độ lông trên lá, mức độ xê thùy của lá, hình dạng và màu sắc hoa, đặc điểm đài hoa, nhị, bầu hoa, hình dạng, màu sắc quả và hạt. Kết quả phân loại loài chỉ ra rằng 7 mẫu giống Bim bim thuộc 3 loài khác nhau: (1) *Ipomoea nil* (L.) Roth (IP1, IP3, IP5, IP6); (2) *Ipomoea purpurea* (L.) Roth (IP4, IP7); (3) *Ipomoea indica* (Burm.) Merr (IP2). Liên quan đến các chỉ tiêu nông sinh học, kết quả thí nghiệm cũng cho thấy có sự sai khác có ý nghĩa trong các chỉ tiêu như diện tích lá, khối lượng chất khô, chỉ số SPAD, các chỉ tiêu về năng suất và các yếu tố cấu thành năng suất. Năng suất hạt cả thể dao động từ 11.03g (IP7) đến 19.71g (IP2). IP1 là mẫu giống có khối lượng 1000 hạt lớn nhất (46,66 g) tiếp theo là IP3 và IP6 với 46,45 g và 45,03 g, IP2 có kích thước hạt nhỏ nhất (P1000 = 32,52g).

Từ khóa: *Ipomoea* spp., hình thái, nông sinh học.

1. INTRODUCTION

Convolvulaceae comprises approximately 60 genera and more than 1650 species (Austin & Huazman, 1996). Most of them are of ornamental, pharmaceutical importance.

Convolvulaceae includes *Calonyction*, *Merremia*, *Poramia* and *Ipomoea*. *Ipomoea* spp. belonging to *Ipomoea* genus, is one of the most common and useful plants with medicinal usage in Convolvulaceae. In Chinese traditional medicine, *Ipomoea* spp. seeds have been used as

a key medicine to get rid of edema, sputum, stasis and bloating. Seeds of *Ipomoea* spp. were also recognized with the use as purgative drug in folk medicine (Bensky and Gamble, 1993). Recent biochemical studies of this plant have revealed the existence of medicinal compounds including glycosides (Ono *et al.*, 1990), gibberellins, flavonoids, chlorogenic acid derivatives (Saito *et al.*, 1994) and anthocyanins (Saito *et al.*, 1996) in its seed and flower. In Vietnam, it has also been used in traditional medicine for a long time ago, especially in medicinal dose of treating diuretic, detoxification, diabetes, less urinating, edema.

Although being recognized with major benefits, *Ipomoea* species have not yet been studied extensively. Understandings of morphological characteristics among different morning glory accessions will provide precious information for classification and identification. More importantly, study on agronomical characteristics of morning glory can provide production guides for extensive cultivation of this plants in the future, and thus, achieving the sustainability of medicinal plant material production. The objectives of this research were to examine the variation in morphology of stem, leaf and flower and evaluate the difference in anatomical characteristics of root, stem, and leaf of *Ipomoea* spp.. The research also aimed at providing a biref evaluation of some agronomical characteristics *Ipomoea* accessions.

2. MATERIALS AND METHODS

2.1. Plant materials

Seven *Ipomoea* accessions collected from different regions in Viet Nam and from China were used in this study (Table 1).

2.2. Experiment design and plant maintenance

The experiment was designed following randomized complete block design with three replications. An area of 5m² was counted as one replication. Soil was plowed well, free of weed.

Table 1. Information of seven Morning Glory (*Ipomoea* spp.) accessions in the study

Accession	Origin
IP1	Phu Tho, Viet Nam
IP2	Bac Ninh, Việt Nam
IP3	Lang Son, Việt Nam
IP4	Hebei, China
IP5	Hoa Binh, Việt Nam
IP6	Hebei, China
IP7	Hebei, China

Good and uniform seeds were selected, completely dried, and treated with distilled water for 2 hours. Each plot was sown with 100 seeds. Seedlings were thinned to maintain a density of 12 plants per 1m². Fertilization was applied with 60 kg N, 120 kg P₂O₅ and 120 kg K₂O ha⁻¹. Before sowing, 100% of P₂O₅, 30 % of N, 30% of K₂O were applied (basal application). Row fertilizing was done by adding fertilizers on the plot surface, mixing them with soil. Top dressing application was divided into: (1) 50% N, 50% K₂O (1month after sowing); (2) with: 20% N, 20% K₂O (2 months after sowing).

2.3. Measurements

Mature stem color, stem description, leaf blade color, leaf margin and shape, and leaf pubescence of fully expanded leaves were recorded at 30 days after sowing (DAS). Reproductive morphology including inflorescence, calyx, corolla, stamen, ovary, fruit and seed descriptions were evaluated at peak flower stage and seed color was recorded at harvest. SPAD index was measured at 30 DAS, 60 DAS and at harvest. Yield and yield components including number of flower plant⁻¹, number or fruit plant⁻¹, mature fruit percentage plant⁻¹, seed mass fruit⁻¹, 1000 seed weight, and seed yield were measured at harvest.

Data analysis

All data collected in the study were subjected to analyse of variance using EXCEL and Cropstat 7.2.

3. RESULTS AND DISCUSSION

3.1. Vegetative morphology of 7 Morning Glory (*Ipomoea* spp.) accessions

Morphological study plays a central role in species identification and discrimination. Among morning glory species, this is based on an array of traits and characteristics such as vine production, leaf shape, leaf lobing, stem color, leaf margin and reproductive characteristics (Bryson *et al.*, 2008). Results from the study revealed the morphological variation among accessions in stem, leaf and flower (table 2). Young stems of all morning glory accessions were mostly green. However, as the plant reached its maturity, stem color varied from green to purple (Table 2 and figure 1). Mature stem color is considered a trait controlled by both genetic and environmental factors. And thus, this is not seen as a useful trait for species identification and discrimination (Bryson *et al.*, 2008). Results from the study (Table 2 and figure 1) revealed that *Ipomoea* spp. had a typical taproot system. *Ipomoea* spp. were categorized by twining stem with milky sap; stem color ranged from green to purple. Among three major parts of the plant, leaf exhibited highest level of morphological variation. Though a similarity in terms of leaf color (dark green on adaxial surface and light green on abaxial surface) and leaf margin (all entire) was recorded in all accessions, high variation was observed in leaf shape and leaf pubescence. Based on leaf shape and lobing pattern, three distinct categories were observed: (1) simple, ovate cordate, acuminate leaf (IP4, IP5 and IP7); (2) shallowly 3-lobed, acuminate leaf (IP2, IP3, IP6); and (3) deeply 3-lobed, acuminate leaf (IP1). While adaxial surface of all accessions was coarse, densely pubescent with hairs, high variation in abaxial surface description was found among the accessions. Leaf abaxial description can be identified as (1) coarse surface, densely pubescent with short and stiff hairs (IP1 and IP3); (2) coarse surface, light pubescent with short and fine hairs (IP2, IP5, IP6); and (3) fine surface (IP4, IP7).

3.2. Reproductive morphology of 7 *Ipomoea* accessions

Species identification of morning glory can be done by assessment of variation in reproductive traits such as inflorescence, stamen and ovary structure, calyx and corolla description (Correll and Johnson, 1970; Yatskievych, 2006). Results from this study (Table 3 and figure 2) showed that *Ipomoea* spp. have been recognized by their funnel shaped, radially symmetrical corollas with five sepals, five fused petals and five epipetalous stamens. Among reproductive traits, corolla description (color and shape) was believed to be more reliable compared to stem color and shape in species identification of *Ipomoea* sp. (Bryson *et al.*, 2008). Corolla description of 7 *Ipomoea* accessions in this study can be categorized into (1): purple or blue corolla with white center, funnel shaped (IP1, IP2, IP5); (2) white corolla, funnel shaped (IP3, IP6); (3) red corolla with white center, funnel shaped (IP4); and (4) dark purple corolla with white center, funnel shaped.

All of 7 *Ipomoea* accessions have flowers borne singly or existed in clusters of 2-3 flowers (IP1, IP3, IP7), 3-5 flowers (IP5 and IP6), and 5-7 flowers (IP2, IP4). This is in consistency with the study of 10 *Ipomoea* species of Bangladesh (Mondal *et al.*, 2009). Calyx is 5-lobed, sub-equal in all accessions. Abruptly narrowed sepals were observed in IP5 and IP6 while gradually narrowed sepals were recorded in IP4 and IP7. The most variable level in reproductive morphological features was found in corolla color. Same results were also recorded by Mondale *et al.*, (2009); Sahu and Gupta, 2014; Okereke (2015) and Hsu *et al.* (2006). Therefore, corolla color can be considered as an important criterion in identification and discrimination among *Ipomoea* species (Mondal *et al.*, 2009). Based on corolla color, 7 *Ipomoea* accessions can be classified into following groups: (1) purple or blue corolla with white center; (2) white corolla; (3) red corolla with white center; and (4) dark purple corolla with white center. A high level of similarity in terms

Table 2. Vegetative morphology of 7 *Ipomoea* accessions

Accession	Stem			Leaf		
	Root	Color	Description	Pubescence	Margin and venation	Shape and lobing pattern
IP1	Tap root yellow	Light green to purple green	Twining stem with milky sap	Densely pubescent with long and stiff hairs downward	Entire, pinnate	Deeply 3-lobed, acuminate
IP2	Tap root system, yellow	Green or purple	Twining stem with white sap	Densely pubescent with long and stiff hairs	Entire, pinnate	Shallowly 3-lobed, acuminate
IP3	Tap root system, yellow	Green or purple green	Twining stem with milky sap	Densely pubescent with long and stiff hairs downward	Entire, pinnate	Shallowly 3-lobed, acuminate
IP4	Tap root system, yellow	Green or purple green	Twining stem with milky sap	Densely pubescent with long and stiff hairs downward	Entire, pinnate	Simple, ovate cordate, acuminate
IP5	Tap root system, yellow	Green or purple green	Twining stem with milky sap	Densely pubescent with short and coarse hairs downward	Entire, pinnate	Simple, ovate cordate, acuminate
IP6	Tap root system, yellow	Light green	Twining stem with milky sap	Densely pubescent with long and stiff hairs upward	Entire, pinnate	Shallowly 3-lobed, acuminate
IP7	Tap root system, yellow	Green or purple green	Twining stem with milky sap	Densely pubescent with stiff and short hairs	Entire, pinnate	Simple, ovate cordate, acuminate

Table 3. Reproductive morphology of 7 *Ipomoea* accessions

Accession	Flower				Fruit	Seed	
	Inflorescence	Calyx	Corolla	Stamen			Ovary
IP1	inflorescences 2-3 flowered, cymes, axillary	5-lobed calyx, hirsute at the base, glabrous at tip, sub-equal sepals	purple or blue corolla with white center, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color
IP2	single flowered or inflorescences 5-7 flowered, cymes, axillary	5-lobed calyx, hirsute at the base, glabrous at tip, sub-equal sepals	purple or blue corolla with white center, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color, covered with brown hairs
IP3	single flowered or inflorescences 2-3 flowered, cymes, axillary	5-lobed calyx, sub-equal sepals	white corolla, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma,	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color
IP4	single flowered or inflorescences 5-7 flowered, cymes, axillary	5-lobed calyx, sub-equal and gradually narrowed sepals	red corolla with white center, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color
IP5	single flowered or inflorescences 3-5 flowered, cymes, axillary	5-lobed calyx, sub-equal and abruptly narrowed sepals	purple or blue corolla with white center, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color
IP6	single flowered or inflorescences 3-5 flowered, cymes, axillary	5-lobed calyx, sub-equal and abruptly narrowed sepals	white corolla, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, white
IP7	single flowered or inflorescences 2-3 flowered, cymes, axillary	5-lobed calyx, sub-equal and gradually narrowed sepals	dark purple corolla with white center, funnel shaped	stamens 5, included, epipetalous at corolla base, unequal	superior ovary, 3-locular, 3-lobed stigma,	subglobose to ovoid capsule, valvate, contains 3-6 seeds	granular, dull brown to black in color

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Accession	Root	Stem	Leaf	Flower
IP1				
IP2				
IP3				
IP4				
IP5				
IP6				
IP7				

Figure 1. Vegetative morphology of 7 *Ipomoea* accessions

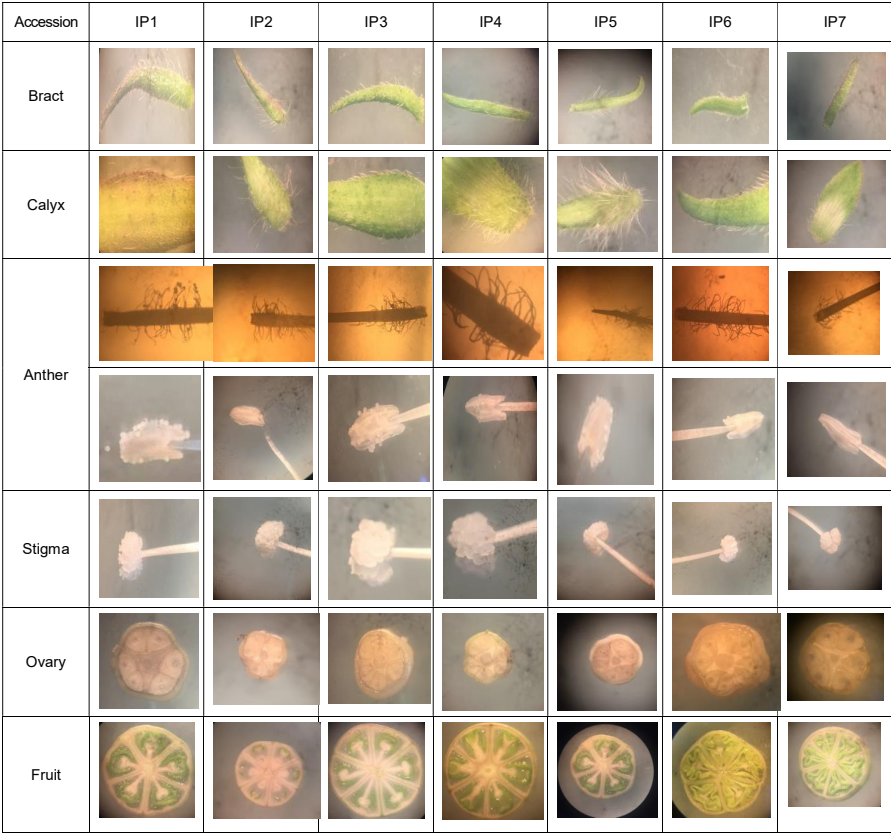


Figure 2. Reproductive morphology of 7 *Ipomoea* accessions

of fruit and seed morphology was found in all accessions of *Ipomoea* in the study. Fruit shape was seen as subglobose to ovoid capsules, valvate, having 3–6 seeds. Seed was granular, dull brown to black in color (except IP6 with white seed).

3.3. Species identification of 7 *Ipomoea* spp. accessions

Species identification of 7 morning glory accessions was carried out at Department of Botany, Hanoi University of Pharmacy (Tran

Van On, 2016) and was given in table 4. The results showed that 7 accessions of *Ipomoea* belonged to three distinct species: (1) *Ipomoea nil* (L.) Roth (IP1, IP3, IP5, IP6); (2) *Ipomoea purpurea* (L.) Roth (IP4, IP7); (3) *Ipomoea indica* (Burm.) Merr (IP2). The color of the seed of *Ipomoea* spp. varied with variation in flower corolla. Seed is white or yellowish white if corolla flower is white, whilst the seed is black if the corolla is red, purplish red and purple (Zhao and Xiao, 2009). However, results from the study are not in agreement with Zhao and

Table 4. Species identification of 7 *Ipomoea* accessions, adopted from On (2016)

Accession	Origin	Scientific name	Synonym	Vietnamese common name
IP1	Phú Thọ, Việt Nam	<i>Ipomoea nil</i> (L.) Roth	<i>Pharbitis nil</i> (L.) Choisy	Hắc sủu, Khiên ngư, Bim bim lam
IP2	Bắc Ninh, Việt Nam	<i>Ipomoea indica</i> (Burm.) Merr.	<i>Ipomoea congesta</i> R. Br.)	Bim Ân, Bim tím
IP3	Lạng Sơn, Việt Nam	<i>Ipomoea nil</i> (L.) Roth	<i>Pharbitis nil</i> (L.) Choisy	Hắc sủu, Khiên ngư, Bim bim lam
IP4	Hebei, China	<i>Ipomoea purpurea</i> (L.) Roth	-	Bim đỏ
IP5	Hòa Bình, Việt Nam	<i>Ipomoea nil</i> (L.) Roth	<i>Pharbitis nil</i> (L.) Choisy	Hắc sủu, Khiên ngư, Bim bim lam
IP6	Hebei, China	<i>Ipomoea nil</i> (L.) Roth	<i>Pharbitis nil</i> (L.) Choisy	Hắc sủu, Khiên ngư, Bim bim lam
IP7	Hebei, China	<i>Ipomoea purpurea</i> (L.) Roth	-	Bim tía

Xiao (2009). Plants with white corolla can produce black seed (IP3). Thus, further studies are highly recommended to investigate the correlation between corolla color and seed color

3.2. Agronomical characteristics of some morning glory accessions

3.2.2. Leaf area, SPAD index and dry weight accumulation

Data from Table 5 showed an increase in average leaf area (LAI) from 30 to 60 DAS, and a decrease in LAI was recorded at harvest. At 60 DAS, highest LAI was recorded in IP3 (6.42), followed by IP1 and IP6 with LAI of 6.39 and lowest in GB5 (3.88). High variation in LAI in all accessions in the study can be seen as one useful trait for phenotype classification and discrimination.

Chlorophyll content is an important indicator for assessing growth rate of plants. Chlorophyll content is positively correlated to leaf photosynthesis rate. SPAD index is a useful indicator for genotypic variation screening for potential photosynthetic capacity of crops (Nageswara *et al.*, 2001; Songsri *et al.*, 2008). Assessment of chlorophyll provides an estimation of crop growth status and thus, is considered an important parameter in plant production research. Results in Table 5 revealed that SPAD index gradually increased from 30 to 60 DAS and slightly decreased at harvest. Compared to LAI, SPAD index was less variable among the 7 samples of *Ipomoea* accessions. At 60 DAS, highest SPAD index was recorded in IP1 (44.68), followed by IP3 (44.0) and lowest in IP3 (27.23).

Dry matter weight in plant plays a central role in determination of crop yield (Bell *et al.*,

Table 5. Leaf Area Index (LAI), SPAD index and dry weight accumulation

Accession	Leaf area index (LAI)			SPAD index			Dry weight (g/plant)		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
IP1	1.38	6.39	4.00	28.93	44.68	32.00	4.35	13.37	29.07
IP2	1.28	5.53	4.03	30.00	42.56	29.73	4.50	13.21	30.88
IP3	1.56	6.42	4.00	32.86	44.00	27.23	4.00	13.78	29.60
IP4	1.10	3.88	4.17	31.83	43.70	31.63	3.05	10.58	19.41
IP5	1.27	5.18	3.80	29.86	43.70	28.70	4.00	11.59	25.84
IP6	1.57	6.39	4.03	30.70	43.65	31.90	4.10	13.14	29.57
IP7	1.17	4.06	4.25	32.80	43.70	31.26	3.05	10.87	19.35

1994). Dry matter accumulation in plant has strong correlation with crop growth and yield. Results showed that dry weight (DW) increased in all accessions as plant age increased and was highest at harvest. A rapid growth rate was recorded in plants from 30 to 60 DAS. At 30 DAS, highest DW was measured in IP2 (4.50 g/plant), followed by IP1 (4.35 g/plant) and was lowest in IP5 and IP7 (3.05 g/plant). At harvest, highest DW was measured in IP2 (30.88 g/plant), followed by IP3 and IP6 with 29.60 and 29.57 g/plant, respectively. Lowest DW was recorded in IP4 (19.41g/plant).

3.2.3. Yield and yield components

Data regarding yield and yield components of *Ipomoea* accessions in the study were presented in table 5. Results showed a high variation in yield and yield components of *Ipomoea* accessions including number of mature fruit/plant, seed/fruit mass ratio (%), 1000 seed weight (g) and seed yield (g/plant). Among accessions, IP7 was observed with the lowest number of mature fruit/plant (96.75 fruit/plant) and IP2 was recorded with highest number of mature fruit/plant (183.06 fruit/plant). Number of mature fruit/plant in other accessions ranged from 103.08 to 135.00 fruit/plant.

Among accessions, highest seed/fruit mass ratio was recorded in IP7 (75.01 %). followed by IP4, IP5 with 73.67 (%) and 71.45 (%) respectively and was lowest in IP3 (60.23%). 1000 seed weight (P1000) is considered an important criterion in the evaluation of crop

productivity and plant breeding. P1000 is greatly influenced by genetic materials, cultural practices and environmental condition of growing areas. Highest P1000 was obtained in IP1 (46.66 g), followed by IP3 with 46.45 g and was lowest at IP2 (32.52 g). IP2 was the one with smallest seed size. A high variation in seed yield was also recorded among 7 *Ipomoea* sp. accessions. Seed yield varied from 11.03 g plant⁻¹ in IP7 to 19.71g plant⁻¹ in IP2.

4. CONCLUSIONS

A high variation in morphological characteristics was found in 7 *Ipomoea* accessions in the study. Plants existed in different stem color, leaf shape, leaf pubescence, leaf lobing patterns, and corolla color and size. Leaf shape and color were the most variable vegetative morphological trait whilst corolla color was most variable reproductive features among 7 *Ipomoea* accessions. The results showed that 7 accessions belonged to three distinct species: (1) *Ipomoea nil* (L.) Roth (IP1, IP3, IP5, IP6); (2) *Ipomoea purpurea* (L.) Roth (IP4, IP7); (3) *Ipomoea indica* (Burm.) Merr (IP2). In addition, 7 accessions were also recorded with variation in agronomical traits such as dry matter weight, SPAD index, yield and yield components. Highest P1000 was obtained in IP1 (46.66 g), followed by IP3 with 46.45 g and was lowest in IP2 (32.52 g/plant). IP2 was the one withsmallest seed size. A high variation in seed

Table 6. Yield and yield components of 7 *Ipomoea* accessions

Accession	No of mature fruit plant ⁻¹	Seed/fruit mass ratio (%)	1000 seed weight (g)	Seed yield (g plant ⁻¹)
IP1	112.16	60.29	46.66	14.93
IP2	183.06	70.53	32.52	19.71
IP3	112.15	60.23	46.45	14.83
IP4	103.08	73.63	34.54	11.73
IP5	135.00	71.45	34.15	15.76
IP6	112.87	60.23	45.03	14.95
IP7	96.75	75.01	34.52	11.03

yield was also recorded among 7 *Ipomoea* accessions. Seed yield varied from 11.03 g plant⁻¹ in IP7 to 19.71g plant⁻¹ in IP2.

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