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Growth, flowering and leaf character variation of hosta

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ABSTRACT

Today many gardeners are praising the virtues of foliage and hosta is one of the best perennial plants for foliage. We conducted a pot experiment to evaluate the performance in growth and flowering through two consecutive years and variation in leaf characters of hosta taxa. We used twelve hosta taxa in the experiment coded from T1-T12. We found significant variation between the taxa for plant height, leaf numbers, single leaf area, chlorophyll content, peduncle length, floret length, and floret numbers in both the year of 2015 and 2016. All growth and flowering characters reduced on the second consecutive year. The reduction range of florets per peduncle was 21.97-36.74% and floret length was 19.89-22.16% on the second consecutive year. Vegetative growth parameters were found as negligible reduction. But, we found noticeable number of leaves reduction for three taxa and these were H. longipes var. gracillima (20.11%), H. sieboldiana (19.92%) and H. montana (16.95%). Leaf vine numbers were 19, 6, 8, 6, 12, 10, 8, 12, 12, 12, 10 and 16 for T1 to T12, respectively. Phenotypic traits variability will help to the future hosta researchers and breeders.

Key Words: *Plantain lily (Funkia), Gibosi, Asparagaceae, Leaf and Perennial*

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I. Introduction

Hosta is known as plantain lily or, funkia while Japanese called this plant as gibosi. Garden hosta was originated from Japan and China. Hosta was named by Austrian botanist Leopold Trattinnick in 1812 in honor of the another Austrian botanist Nicholas Thomas Host and Funkia were used by German botanist Christian Sprengel in honor of Heinrich Christian Funk in 1817 (Wells, 1997). This plant firstly classified in the *Liliaceae* family due to their lilioid monocots (Wells, 1997) and is currently placed in the family *Asparagaceae*. Spikes of hostas are lily shaped and leaves come in a broad range of solid and bi-colors with the heart like most common leaf shape.It is popular for it's decorative and bunch of lush green foliage. It isa long lived perennial for the shade garden and grows well under deciduous trees, in borders, and as a ground cover. There are two broad categories of reproductive

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strategies of plants: one is annuals that reproduce once and die while another is perennials that reproduce repeatedly. Annuals complete their life cycle within a single year and produce seed then complete the same life cycle in a following year. Perennial plants must survive year after year and for each of the four seasons. Perennials can produce both vegetative and reproductive structures in first year. It can repeat the life cycle similarly to annuals but unlike annuals, the vegetative structures from first year survive into second year to grow and reproduce (Friedman and Rubin, 2015). Differential behavior of meristem on a single plant is required for perennial actions so that either some meristem used for floral transition while others revert back to vegetative development meristem or remain vegetative (Amasino, 2009). Annuals are differed from perennials in several root traits important in resource uptake and conservation (Roumet et al., 2006). Perennials generally maximize resource conservation (Poorter and Garnier, 1999; Aerts and Chapin, 2000) and characterized by leaf traits associated with persistence and defense (Garnier et al., 1997). There are few perennials that are as easy to grow as Hostas. Variegation of hosta plants shows a high variability between species or, cultivars. Vegetative growth and flowering variation between varieties or, cultivars was previously evaluated in many flowering plants but there is no scientific information for hosta in this regards. Variation among hosta taxa for plant growth and flowering in consecutive year through rhizome comes from first year was addressed as the major question with the reduction percentage of their growth and flowering characteristics on the next year. The objective of this two year study was to evaluate the perennial performance of hosta with the variation among the twelve taxa.

II. Materials and Methods

Pot experiment was conducted at the laboratory of Vegetable and Floriculture Science, Kochi University, Japan to evaluate the variation in growth and flowering of hosta taxa in two consecutive years. We separated single rhizome from mother plants (mother plants collected from hills and riverside around Kochi prefecture) and potted in the last week of January, 2015. In the last week of January 2016, we removed the pot soil and newly produced rhizome then allowed to grow from the previously planted rhizome. All taxa grew successfully. We used twelve hosta taxa in the experiment coded from T1-T12 for *H. sieboldiana*, *H. alismifolia*, *H. sieboldii*, *H. longissima*, *H. tardiva*, *H. longipes* var. *gracillima*, *H. nakaiana*, *H. kikutii* var. *caput-avis*, *H. kikutii* var. *polyneuron*, *H. longipes* var. *caduca*, *H. kiyosumiensis,* and *H. montana*, respectively. The experiment was designed in complete randomized design (CRD) with five replicates (5 pots/taxon, a total of 60 pots). We used a year-round pot soil (Nursery earth®, Takii & Co. Ltd., Kyoto, Japan). Nursery earth® is supplemented with 320 mg/L N; 210 mg/L P and 300 mg/L K fertilizer and having mild acidity. We didn't add any other ingredients into the pot soil. We collected data on plant height, leaf numbers, single leaf area, vine numbers, chlorophyll content (CH%), peduncle length, floret length, and floret numbers. Plant height, leaf numbers, single leaf area, vine numbers and CH% were measured at the 15 weeks after rhizome plantation. CH% was measured by SPAD meter. The experimental data are represented as mean and significant differences were determined by means of Tukey's HSD test ($P < 0.05$).

III. Results and Discussion

Plant height

We found the tallest plant among these twelve taxa in *H. montana* for both of the year (Year 2015: 73.17 cm and Year 2016: 71.72 cm) which was statistically identical with *H. sieboldiana* (Year 2015: 72.76 cm and Year 2016: 70.76 cm). The minimum plant height was observed in *H. alismifolia* (Year 2015: 22.93 cm and Year 2016: 20.46 cm) which was statistically identical with T4, T10, T6, T3 and T11 in both of the year. Plant height of hosta taxa was reduced differently on the next consecutive year and the reduction was ranged from 1.98% to 10.77%. We found the maximum reduction of plant height from *H. alismifolia* (10.77%) (Table 01).

Number of leaves

Significant variation between hosta taxa was observed for the number of leaves/plant in both studied year. We found the maximum number of leaves from T8 (13.8/plant in 2015 and 12.8/plant in 2016) which were statistically identical with T7 (Year 2015: 11.96/plant and Year 2016: 11.52/plant). The minimum numbers of leaves were showed by T6 (3.78/plant in 2015 and 3.02/plant in 2016); and T6 was statistically identical with T12, T1 and T5. The percentage of the leaves number reduction was

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varied between taxa. The maximum reduction was found from *H. longipes* var. *gracillima* (20.11%) which was closely followed by *H. sieboldiana* (19.92%) and *H. montana* (16.95%) (Table 01).

Single leaf area

Maximum single leaf area was found in *H. montana* (150.80 cm^2 and 150.30 cm^2 in 2015 and 2016, respectively) which was followed by *H. sieboldiana* (135.80 cm^2 and 134.80 cm^2 in 2015 and 2016, respectively), *H. longipes* var. *gracillima* (115.10 cm^2 and 112.90 cm^2 in 2015 and 2016, respectively) and *H. kiyosumiensis* (81.50 cm^2 and 79.40 cm^2 in 2015 and 2016, respectively). We found the minimum single leaf area from *H. alismifolia* (19.54 cm^2 and 18.14 cm^2 in 2015 and 2016, respectively). The single leaf area of *H. longissima* (20.54 cm^2 and 19.04 cm^2 in 2015 and 2016, respectively) was statistically similar with *H. alismifolia*. The reduction rate of leaf area to the next year was found to be a negligible percentage for each taxon. However, the maximum leaf area reduction was found from *H. longissima* (7.30%) (Table 01).

Chlorophyll content

H. tardiva showed the maximum leaf chlorophyll and the contents were 75.44% and 74.14% in the year 2015 and 2016, respectively. *H. montana* (71.82% and 70.42% in the year 2015 and 2016, respectively) showed statistically identical values with *H. tardiva* for leaf chlorophyll content in both of the year. The minimum leaf chlorophyll was found in *H. longipes* var. *gracillima* in both of the year 2015 (34.89%) and 2016 (33.02%). It was found very low chlorophyll content reduction to the next year, and the reduction percentage was ranged from 1.72% to 5.36% (Table 02).

Peduncle length

H. montana had the longest peduncle among the studied taxa and the lengths were 81.10 cm and 79. 70 cm in the year 2015 and 2016, respectively. The minimum peduncle length was found in *H. longissima* (71.90 cm and 70.30 cm in the year of 2015 and 2016, respectively). The reduction percentage of the peduncle length was very low which was ranged between 1.67% to 2.27% (Table 02).

Floret length

The maximum floret length was found in T5 which was statistically identical with T7, T12, T1 and T6 whereas minimum was found from T11 in both year. The floret length of *H. tardiva*, *H. nakaiana*, *H. montana*, *H. sieboldiana*, *H. longipes* var. *gracillima* and *H. kiyosumiensis* were 7.64, 7.59, 7.59, 7.42, 7.36 and 6.86 cm respectively in 2015 while 6.10, 6.06, 6.08, 5.90, 5.88 and 5.34 cm respectively in 2016. All taxa showed a considerable percentage of reduction which was ranged from 19.89% to 22.16% (Table 03).

Number of florets

The maximum number of florets was found from *H. sieboldiana* (6.92/peduncle and 5.40/peduncle in the year of 2015 and 2016, respectively) whereas minimum was found from *H. kiyosumiensis* (4.11/peduncle and 2.60/peduncle in the year of 2015 and 2016, respectively). The reduction percentage was higher for all taxa than any other currently studied parameters. The reduction was ranged from 21.97% to 36.74% (Table 03).

Leaf characters: The vine numbers of the leaf were 19, 6, 8, 6, 12, 10, 8, 12, 12, 12, 10 and 16 for T1 to T12, respectively (Table 04). The variation of the leaf was shown in Figure 01. The leaf shape of *H. sieboldiana*, *H. longipes* var. *gracillima*, *H. kikutii* var. *polyneuron*, *H. kiyosumiensis* and *H. montana* was aristate type. *H. alismifolia, H. longissima* and *H. kikutii* var. *caput-avis were* oblong. *H. sieboldii*, *H. tardiva* and *H. nakaiana* were Lanceolate. *H. longipes* var. *caduca was* acuminate type. All taxa showed the parallel venation and undulate margin (Table 04).

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Table 01. Variation in plant height, number of leaves and leaf area of twelve hosta taxa in two consecutive year with the reduction percentage on next year

Taxa	Plant height (cm)		Reduction (%)	Number of leaves/plant		Reduction (%)	Single leaf area (cm^2)		Reduction (%)
	Year 2015	Year 2016		Year 2015	Year 2016		Year 2015	Year 2016	
T1	72.76a	70.76a	2.75	4.82d	3.86ef	19.92	135.80b	134.80b	0.74
T2	22.93d	20.46d	10.77	10.10bc	9.50c	5.94	19.54h	18.14h	7.16
T3	27.94bcd	25.84bcd	7.52	10.64b	9.92bc	6.77	31.80g	31.30g	1.57
T4	23.82d	22.02d	7.56	10.04bc	9.28cd	7.57	20.54h	19.04h	7.30
T5	32.44b	30.54b	5.86	5.40d	5.04ef	6.67	44.70ef	43.14ef	3.49
T6	25.68cd	23.58cd	8.18	3.78d	3.02f	20.11	115.10c	112.90c	1.91
T7	31.00bc	29.10bc	6.13	11.96ab	11.52ab	3.68	31.02g	29.52g	4.84
T8	30.90bc	29.00bc	6.15	13.38a	12.82a	4.19	45.38e	44.18e	2.64
T9	33.60b	31.80b	5.36	10.12b	9.68c	4.35	46.26e	44.76e	3.24
T10	23.44d	22.64d	3.41	11.36b	10.86bc	4.40	40.08f	38.78f	3.24
T11	28.28bcd	26.28bcd	7.07	8.16c	7.54d	7.60	81.50d	79.40d	2.58
T12	73.17a	71.72a	1.98	4.72d	3.92ef	16.95	150.80a	150.30a	0.33
CV (%)	*8.33*	*7.87*		*10.11*	*9.86*		*3.3*	*3.39*	

Table 02. Variation in chlorophyll content and peduncle length of twelve hosta taxa in two consecutive year with the reduction percentage on next year

Taxa	CH (%)		Reduction (%)	Peduncle length (cm)		Reduction (%)
	Year 2015	Year 2016		Year 2015	Year 2016	
T1	43.10 f	41.80 f	3.02	80.68 ab	79.18 ab	1.86
T2	70.40 b	69.10 b	1.85	71.62 e	70.12 e	2.09
T3	65.70 c	64.10 c	2.44	78.80 abc	77.22 abc	2.01
T4	69.93 b	68.46 b	2.10	71.90 e	70.30 e	2.23
T5	75.44 a	74.14 a	1.72	73.72 de	72.12 de	2.17
T6	34.89 g	33.02 g	5.36	79.30 abc	77.50 abc	2.27
T7	57.38 d	55.88 d	2.61	78.04 bc	76.74 bc	1.67
T8	51.11 e	49.66 e	2.84	74.14 de	72.54 de	2.16
T9	41.50 f	39.90 f	3.86	72.42 e	70.92 e	2.07
T10	56.52 d	55.12 d	2.48	80.80 ab	79.10 ab	2.10
T11	39.60 f	37.86 f	4.39	76.24 cd	74.94 cd	1.71
T12	71.82 ab	70.42 ab	1.95	81.10 a	79.70 a	1.73
CV (%)	*3.18*	*3.27*		*1.72*	*1.75*	

Table 03. Variation in floret length and number of florets of twelve hosta taxa in two consecutive year with the reduction percentage on next year

Taxa	Floret length (%)		Reduction (%)	Number of florets/peduncle		Reduction (%)
	Year 2015	Year 2016		Year 2015	Year 2016	
T1	7.42 ab	5.90 ab	20.49	6.92 a	5.40 a	21.97
T2	7.04 cd	5.52 cd	21.59	5.51 bcd	4.00 bcd	27.40
T3	7.06 cd	5.58 cd	20.96	6.30 ab	4.82 ab	23.49
T4	7.04 cd	5.54 cd	21.31	4.91 def	3.41 def	30.55
T5	7.64 a	6.10 a	20.16	6.14 abc	4.59 abc	25.24
T6	7.36 ab	5.88 ab	20.11	5.11 cdef	3.60 cdef	29.55
T7	7.59 a	6.06 a	20.16	4.70 def	3.22 def	31.49
T8	6.90 d	5.40 d	21.74	5.31 bcde	3.83 bcde	27.87
T9	7.18 bc	5.70 bc	20.61	6.09 abc	4.58 abc	24.79
T10	6.90 d	5.38 d	22.03	4.89 def	3.39 def	30.67
T11	6.86 d	5.34 d	22.16	4.11 f	2.60 f	36.74
T12	7.59 a	6.08 a	19.89	4.29 ef	2.80 ef	34.73
CV (%)	*1.76*	*2.22*		*9.03*	*10.55*	

Superscript letters in the column denote mean separation by Tukey's HSD test at 5% level of significance and T1: *H. sieboldiana*, T2: *H. alismifolia*, T3: *H. sieboldii*, T4: *H. longissima*, T5: *H. tardiva*, T6: *H. longipes* var.

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gracillima, T7: *H. nakaiana*,T8: *H. kikutii* var. *caput-avis*,T9: *H. kikutii* var. *polyneuron*, T10: *H. longipes* var. *caduca*, T11: *H. kiyosumiensis,* and T12: *H. montana*

Table 04. Variation in vine numbers and leaf shape for the twelve hosta taxa

Taxa	VN	LS	Vn	Mn
T1	19	Aristate (with a spine like tip)		
T2	6	Oblong (elongated, non-lobed)		
T3	8	Lanceolate (pointed at the both end)		
T4	6	Oblong (elongated, non-lobed)		
T5	12	Lanceolate (pointed at the both end)	Parallel (arranged axially and not intersected)	Undulate (widely wavy, shallower than sinuate)
T6	10	Aristate (with a spine like tip)		
T7	8	Lanceolate (pointed at the both end)		
T8	12	Oblong (elongated, non-lobed)		
T9	12	Aristate (with a spine like tip)		
T10	12	Acuminate (tapering to along point)		
T11	10	Aristate (with a spine like tip)		
T12	16	Aristate (with a spine like tip)		

VN: Vine number; LS: Leaf shape; Vn: Venation; Mn: Margin and, T1-T12 (Figure 01)


H. sieboldiana (T1)


H. alismifolia (T2)


H. sieboldii (T3)


H. longissima (T4)


H. tardiva (T5)


H. longipes var. gracillima (T6)


H. nakaiana (T7)


H. kikutii var. caput-avis (T8)


H. kikutii var. polyneuron (T9)


H. longipes var. caduca (T10)


H. kiyosumiensis (T11)


H. montana (T12)

Figure 01. Pictorial presentation of leaves of the *Hosta* taxa

Discussion

A significant variation observed among the hosta taxa for all studied parameters in both of the year which might be occurred as a genetically controlled factor (Vikas et al., 2011; Baskaran et al., 2010). Variation in growth and flowering between species were studied in different flowering plants (Kim et al., 2014; Ramzan et al.,2014; Gharge et al., 2009; Mantur et al., 2005; Shiragur et al., 2004; Shafique et al., 2011; Reddy et al. 2003). *Hosta* species are generally propagated by lateral shoot division but it can also be propagated by tissue culture (Feng et al., 2009; Wilson and Rajapakse, 2000). Rhizomes are modified stem tissue which moves out from the plant underground. Hostas are generally multiplied by rhizomes and are, therefore, properly known as rhizomatous. In our study, we removed the new rhizomes from the plant to grow in next year. The results of our study noticed that all of the hosta taxa performed very well as perennials, though their growth and flowering traits reduced. We found the higher reduction in peduncle length, floret length and number of florets i.e., flowering characters reduced noticeably. Hosta generally use for its attractive leaves, and flowers are mostly ignored. So we can skip the reduction percentage of flowering traits. We found different percentage of plant height reduction (1.98% to 10.77%) on the second year. Hosta plant leaf characters are the key factors for the growers and breeders. We found the number of leaves reduction 20.11%, 19.92% and 16.95% for *H. longipes* var. *gracillima*, *H. sieboldiana* and *H. montana*, respectively while other taxa showed very lower reduction to the next year. On the other hand, leaf area reduced negligibly in next year for each taxon. The very low percentage of the growth parameters suggested the perennial habit of hosta plant and can be grown without changing the rhizomes. A gardener generally doesn't remove the new rhizomes from the plant. Hosta can produce single plant from each of new rhizomes. Division of the clump will improve the plant's appearance but frequent division will restrict plant and leaf size, and keep it from developing to its desirable mature features.

IV. Conclusion

Hosta plant can grows from the rhizomes of the previous year. It is the natures of the perennials that it can survive each season of a year and grow year after year. In the second consecutive year, all parameters showed the reduction and their percentage was negligible for growth but noticeable for flowering. Growth charcters are mostly important for hosta because it generally grows for its foliage. The significant variability among the hosta taxa we studied can give a general idea to the hosta grower. Further study recommended on various aspects such as green house cultivation, plant generation from seed or tissue culture to improve the hosta plant.

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Conflicts of Interest

Authors reported no conflict of interest.

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APA (American Psychological Association)

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