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Evaluation of Indian pennywort (*Centella asiatica* L.) as influenced by genotypes and stage of harvest

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Abstract
The experiment "Evaluation of Indian pennywort (*Centella asiatica* L.) as influenced by genotypes and stage of harvest" was carried out to assess five different genotypes. The performance of these genotypes was observed in terms of two different stage of harvest (DAP), 90 DAP and 120 DAP. The experiment followed a Factorial Randomized Block Design with 5 cultivars, each replicated three times. The results showed that Arka Divya performed better in terms of growth characteristics, as well as fresh herbage yield, whereas Pondicherry local-1 excelled primarily in growth characteristics.

Keywords: Indian pennywort, genotypes, different stage of harvest

Introduction
Medicinal and aromatic plant species considered to be valuable treasure house of India. The Ministry of Environment and Forests has recognized and documented more than 9,500 plant species considering their importance in the pharmaceutical industry (Chowti *et al*., 2018) [2]. As global consciousness about health and wellness, intensifies, the demand for plant-based medicines is experiencing a rapid surge. The indigenous healing tradition of utilizing herbal remedies by herbal practitioners is commonly referred to as "Naatuvaidhyam" in the local language. This practice involves the use of natural herbs and plant-based preparations to treat various ailments and promote holistic well-being.

Indian Pennywort (*Centella asiatica* L.) also known as Gotu kola, is a traditional medicinal herb belongs to the family Apiaceae, it has been used in the traditional Indian Ayurvedic and Chinese medicines for many centuries (Gohil *et al*., 2010) [1] reported that the whole plant is used for medicinal purpose it has found wide usage in pharmaceutical industries because of its chemical composition, nutritive value and health benefits (Nongrum *et al*., 2020) [4]. The plant is native to India, China, Nepal, Indonesia, Sri Lanka, Australia, Madagascar and Southern and Central Africa. It flourishes well under water logged, damp and swampy areas, but also growth can be observed in sunny areas at an elevation of up to 2500 m above mean sea level although generally in climates with high humidity. *Centella asiatica* (L.) a prostrate, stoloniferous, perennial, usually creeper herb, with glabrous stem, striated and rooting at the nodes. Leaves emerge alternately in clusters at stem nodes with long petioles. The flowers are red, pink or white, which are in fascicled umbels. The fruits are oblong, dull brown, laterally compressed with hard, thickened, woody and white pericarp. (Chandrika and kumara, 2015) [3].

To reap the benefits of *Centella asiatica*'s to protect natural populations and biodiversity, farmers must cultivate it as a field crop. In commercial cultivation programmes of MAP, an in knowledge of growth and active compound is accumulated to ensure the production of medicinal plants of the best possible quality, to the best time for harvesting should be determined according to the quality and quantity of active constituents.

Materials and Methods
The study was conducted under open field environmental conditions during late winter – early summer, 2023 at Dr. YSRHU - College of Horticulture, Anantharajupeta, Annamayya district, Andhra Pradesh in the year 2022-23. The treatments comprised of 5 genotypes of Indian pennywort. These genotypes were Pondicherry local-1, Pondicherry local-2, Vallabh Medha, Arka Divya and Arka Prabhavi. The experimental layout adhered to a Factorial Randomized Block Design and replicated three times, with two factors *viz*., genotypes and different stage of harvest i.e., 90 DAP and 120 DAP.

Observations were made on various attributes, including stolon length, intermodal length No. of leaves, No. of nodes per plant and Fresh herbage yield. To facilitate this, five plants were randomly chosen from each replication for data collection.

Results and Discussion

Stolon length (cm)

Among the genotypes, Pondicherry local -1 recorded the highest stolon length (97.50 cm) followed by Arka Divya (89.67 cm), and which was statistically on par with Arka Prabhvi (83.33 cm). Whereas, the lowest was observed in Pondicherry local -2 (45.83 cm) followed by Vallabh Medha.

Different stages of harvest was significantly influence the stolon length the highest stolon length was observed in plants harvested at 120 DAP (88.80 cm) than harvested at 90 DAP (67.84 cm).

Among the treatment combinations, Pondicherry local-1 (116.44cm) harvested at 120 DAP recorded significantly higher stolon length, followed by Arka Divya (104.89 cm) harvested at 120 DAP. However, the lowest stolon length (41.22 cm) was recorded in Pondicherry local-2 harvested at 90 DAP. The data clearly indicated that stolon length varied significantly among different genotypes and increased with plant age. This variation could be attributed to a combination of genetic factors and the prevailing environmental conditions affecting plant growth. Some plant races exhibited a preference for light shade, while others thrived in open sunny conditions. In the current study, Pondichery local-1 and Arka Divya performed exceptionally well in open conditions. Similar genotype-related variations were also observed in previous studies, such as Ravi (2019) [5] in *Centella*, Roshni *et al*. (2014) [6] and Kumar (2017) [7] in Brahmi, Venkatesha *et al*. (2018) [8] in Indian oregano, and Swamy *et al*. (2015) [11] in patchouli.

Internodal length (cm)

Various genotypes expressed significant influence on internodal length at different stage of observations. Among the genotypes, Pondicherry local-1 recorded the highest internodal length (14.81 cm) followed by Arka Prabhavi (13.43 cm) and Vallabh Medha (12.34 cm), while the lowest internodal length was recorded in Pondicherry local-2 (7.52 cm).

With respect to different stage of harvest, significant influence was observed on internodal length. The highest internodal length (12.13 cm) was noticed at 120 DAP than harvested at 90 DAP (11.14 cm).

Among the interaction effects, the data revealed that there was no significant influence of genotypes and stage of harvest on internodal length of *Centella asiatica.* However, the higher internodal length was observed in Pondicherry local -1 harvested at 120 DAP (15.28 cm) and lower value (7.33 cm) was observed in Pondicherry local -2 harvested at 90 DAP.

The data of the present experiment clearly suggested that Pondicherry local -1 produced higher intermodal length than other genotypes. The increase in intermodal length was also reflected due to stage of harvesting and highest intermodal length was recorded at 120 DAP. This may be due to the fact that upon maturity the stolon length and number of nodes had increased which ultimately led to increase in internodal length. Similar findings were observed by Nouri Nav *et al.* (2021) in Iranian *Centella asiatica.*

No. of leaves per plant

Among the genotypes, Arka Divya recorded more no of leaves (79.37) followed by Arka Prabhavi (67.89) which was statistically on par with Vallabh Medha (66.44). The least number of leaves were recorded in Pondicherry local -2 (45.89).

Different stages of harvest also, there was significant variation noticed, more number of leaves were recorded when harvested at 120 DAP (71.46) than at 90 DAP (51.49).

With respect to interaction effects between genotypes and stages of harvest. Among the treatment combinations, Arka Divya harvested at 120 DAP recorded maximum no. of leaves (98.74) followed by Vallabh Medha harvested at 120 DAP (77.56), whereas the minimum no. of leaves (38.22) was recorded in Pondicherry local^{-1} harvested at 90 DAP.

From the present study it was evident that various genotypes had a significant influence on no. of leaves produced. The highest no. of leaves was noticed in Arka Divya followed by Arka Prabhavi. This increase in number of leaves might be due to increased stolen length, prolonged days of harvest and the environmental factor that contributes to an increase in the number of leaves, when a plant matures with adequate sunlight to promotes leaf expansion and the development of leaf primordial, the plant can allocate energy and resource to produce in terms of size and increase the no.of leaves. The variations in no. of leaves among genotypes might be attributed to genetic variation in nature in a given set of environmental conditions, as the genotypes interact with the environmental conditions, especially soil moisture supply and light Similar results were reported by Ravi. (2019) [5] in *Centella asiatica*, in *Centella asiatica*.

No. of nodes per plant

Among the genotypes, Arka Divya recorded maximum no. of nodes per plant (26.22) which was comparable to Arka Prabhavi (22.16) significantly superior than Arka Prabhavi While minimum no. of nodes was recorded in Pondicherry local -2 (13.55) which was comparable to Pondicherry local -1. Among different stage of harvest. The maximum no.of nodes per plant observed when harvested at 120 DAP (22.86), which was significantly superior over 90 DAP (16.20).

Among the interaction effect, no significant effect was found between genotypes and stages of harvest. However, the maximum no. of nodes per plant was recorded in Arka Divya harvested at 120 DAP (31.56) and the minimum was noted in Pondicherry local -2 harvested at 90 DAP (11.33). The data from the experiment clearly reported that Arka Divya recorded the maximum number of nodes. The difference in the number of nodes may be attributed to the genetic makeup of the genotypes and their interactions with the environment conditions such as adequate sunlight, temperature, and soil moisture can promote vigorous growth, further contributing to the increase in the number of nodes. Comparable variations in no.of nodes in different genotypes were recorded by Singh (2017) [10] and Ravi (2019) [5] in *Centella asiatica*, Roshini *et al.* (2014) [6] in brahmi.

Fresh herbage yield (gm^{-2})

The genotype, Arka Divya recorded significantly the highest fresh herbage yield (1193.48 gm^{-2}) followed by Pondicherry local-1 (1064.45 gm^{-2}) and Arka Prabhavi (881.93 gm^{-2}) while, the minimum fresh herbage yield (299.29 gm^{-2}) was recorded in Pondicherry local-2.

Significant variation in terms of fresh herbage yield was observed at different stage of harvest. The maximum fresh herbage yield (1068.83 gm^{-2}) was observed when harvested at 120 DAP and the minimum fresh herbage yield (626.01gm^{-2}) was observed at 90 DAP.

Among the various treatment combinations, the maximum fresh herbage yield (1596.21 gm^{-2}) was obtained from Arka Divya harvested at 120 DAP and was found to be superior over all other genotypes, followed by Pondicherry local-1 (1314.54 gm^{-2}) and Arka Prabhavi (1119.9854 gm^{-2}) harvested at 120 DAP. However, the minimum fresh herbage yield (278.81 gm^{-2}) was recorded in Pondicherry local -2 harvested at 90 DAP.

Arka Divya recorded the maximum fresh herbage yield, followed by Pondicherry local-1. The Biomass production greatly influenced by the respective genotypes and environmental interaction mainly due to genetic variations, which in turn to increases vegetative growth leading to synthesis of more carbohydrate and their utilization for food production and effective absorption of nutrients resulting in increased yield in terms of vigorous growth, quick ground cover, more stolons and nodes, and medium to long petioles. Also, this might be due to the increased vegetative growth during crop duration as referred by Nandakumar *et al*., 2018. Whereas, the lowest fresh herbage yield was observed in Pondicherry local -2 because of the fact that this genotype was prostate in growth habit, weak in development in terms of non-vigorous growth, poor ground cover, medium to poor regenerability and inadequate ground cover. The results are in agreement with the findings made by Prasad *et al*. (2014) [14], Lal *et al*. (2017) [13], Singh (2017) [10], Ravi (2019) [5] and Nanditha (2022) in *Centella*, Venugopal *et al*. (2021) [9] in ashwagandha, Venkatesha *et al*. (2018) [8] in Indian oregano.

Table 1: Stolon length, internodal length, No. of leaves per plant of Centella asiatica as influenced by genotypes and stage of harvest at 90 120 DAP

Genotypes	Stolon length (cm)			Internodal length (cm)			No. of leaves per plant		
	Stage of harvest			Stage of harvest			Stage of harvest		
	90 DAP	120 DAP	Mean	90 DAP	120 DAP	Mean	90 DAP	120 DAP	Mean
Pondicherry local -1	78.56	116.44	97.50	14.34	15.28	14.81	38.22	57.33	47.78
Pondicherry local -2	41.22	50.44	45.83	7.33	7.71	7.52	41.44	50.33	45.89
Vallabh Medha	68.56	82.00	75.28	11.56	13.12	12.34	55.33	77.56	66.44
Arka Divya	74.44	104.89	89.67	9.42	10.72	10.07	60.00	98.74	79.37
Arka Prabhavi	76.44	90.22	83.33	13.04	13.82	13.43	62.44	73.33	67.89
Mean	67.84	88.80		11.14	12.13		51.49	71.46	
	S.Em±	C.D@ 5%		S.Em±	C.D@ 5%		S.Em±	C.D@ 5%	
Genotypes	2.38	7.06		0.27	0.79		2.62	7.77	
Stage of harvest	1.50	4.47		0.17	0.50		1.65	4.92	
Genotypes x stage of harvest	3.36	9.99		0.38	NS		3.70	10.99	

Table 2: No. of nodes per plant, Fresh herbage yield of Centella asiatica as influenced by genotypes and stage of harvest at 90 120 DAP

Genotypes	No. of nodes per plant			Fresh herbage yield (gm^{-2})		
	Stage of harvest			Stage of harvest		
	90 DAP	120 DAP	Mean	90 DAP	120 DAP	Mean
Pondicherry local -1	13.89	16.44	15.17	814.37	1314.54	1064.45
Pondicherry local -2	11.33	15.78	13.55	278.81	319.77	299.29
Vallabh Medha	17.56	23.52	20.54	602.25	993.67	797.96
Arka Divya	20.89	31.56	26.22	790.75	1596.21	1193.48
Arka Prabhavi	17.33	26.99	22.16	643.87	1119.98	881.93
Mean	16.20	22.86		626.01	1068.83	
	S.Em±	C.D@ 5%		S.Em±	C.D@ 5%	
Genotypes	1.30	3.87		32.00	95.08	
Stage of harvest	0.82	2.45		20.24	60.13	
Genotypes x stage of harvest	1.84	NS		45.26	134.46	

Conclusions

In the current study, notable variations were observed among the different genotypes Pondicherry local -1 performed better for the phenotypic characters, with respect to the stolon length, internodal length, However, Arka Divya recorded the maximum no. of leaves per plant, no. of nodes per plant. Regarding the fresh herbage yield Arka Divya recorded the maximum followed by Arka Prabhavi being the second-highest performer.

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