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Variety Registration Report

CIM-Rhoi Gold: Rhoifolin-rich, high herb-yielding variety of Ayurvedic herbal medicinal plant Prishniparni [*Uraria picta* (Jacq.) Desv. ex DC.]

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Abstract

Prishniparni [*Uraria picta* (Jacq.) Desv. ex DC.; Family: Fabaceae; 2n = 22] is a *'Dashmoola'* drug herb used in Ayurvedic herbal preparation, viz. *Dasamularishta*, *Amratarisht*, etc., to treat postnatal diseases of women, a variety of gynaecological problems, oral sores in children, general fatigue, gonorrhoea, cough, cold, fever, mental problems and fatigue. Primary and secondary biologically active metabolites, viz. fatty acids, phenolics, steroids, triterpenoids, alkaloids and flavonoids, have been reported in *U picta*. The major bioactive flavonoid rhoifolin (Apigenin-7-o-neohesperidoside) is considered a marker compound for qualitative and quantitative standardization of the herb. *U. picta* (Jacq.) Desv. was classified as Least Concern (LC) by the IUCN Red Data Book in the year 2010 (and subsequent). Despite its global "Least Concern" status, Prishniparni may be locally endangered in some regions of India due to factors like an increase in demand by the pharmaceutical/herbal drug industry and overexploitation of its wild sources. Since the WHO and Herbal Pharmacopoeia emphasize quality standardization of medicinal plants, its formulation in terms of active ingredients rhoifolin, efforts were taken towards the development of rhoifolin-rich genetically improved genotype of Prishniparni among 23 viable germplasms of the 52 collected germplasms during 2016-2017 from India. Through various evaluation trials (IET in 2020 & 2021, BST in 2022 and PST in 2023 & 2024) and morpho-chemical characterization of 23 germplasm during 2017-2019, CSIR-CIMAP has developed and released a variety of CIM-Rhoi Gold of Prishniparni, which not only produces higher herb yield (about 14 q/ha dry herb) but also has higher rhoifolin content (1.0–1.5%).

Keywords: Dashmoola, Germplasm, Prishniparni, Quality attributes, Rhoifolin, Variety, Yield

Introduction

Prishniparni [*Uraria picta* (Jacq.) Desv. ex DC.; Family: Fabaceae; 2n=22] is a *'Dashmoola*,' drug plant used in popular Ayurvedic herbal preparation, viz. *Dasamularishta*, *Amratarisht*, etc., to treat postnatal diseases of women, a variety of gynoecological problems, oral sores in children, gonorrhoea, cough, cold, fever, mental problems and fatigue. The plant is native to tropical Africa, tropical & subtropical Asia (India), and Queensland in Australia (Kirtikar & Basu, 1993; Yusuf *et al*., 1994; Kumar *et al*., 2020; Prasad *et al*., 2022; Prasad *et al*., 2022a; Kumar *et al*., 2025; Gogoi & Rana, 2022; Vats *et al*., 2024). Primary and secondary biologically active metabolites, viz. fatty acids, phenolics, steroids, triterpenoids, alkaloids and flavonoids, have been reported in *U picta* (Prasad *et al*., 2022a; Kumar *et al*., 2025; Gogoi & Rana, 2022; Vats *et al*., 2024). Flavonoids are known to exhibit analgesic, anti-inflammatory, antioxidant, aphrodisiac, and anti-hepatic properties and a vasorelaxing effect (Yang & Huang, 1981; Anand *et al*., 1998; Bhusare *et al*., 2021). Thus, the major bioactive flavonoid rhoifolin (Apigenin-7-o-neohesperidoside) is considered a marker compound for qualitative and quantitative standardization of the herb (Prasad *et al*., 2022a; Kumar *et al*., 2025; Yadav; Oyesiku *et al*., 2013). *Uraria picta* (Jacq.) Desv. was classified as least concern (LC) by the IUCN Red data book in the year 2010 (and subsequent). Despite its global "Least Concern" status, *Uraria picta* (Jacq.) Desv. ex DC. may be locally endangered in some regions of India due to factors like an increase in demand by the pharmaceutical/herbal drug industry, overexploitation from its wild

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sources, its population is diminishing from the natural habitat and the species has become threatened and categorized as endangered in India (Sharma *et al*., 2016). *U. picta* is industrially important in India and Western African countries, having the highest demand. Harvesting of prishniparni from the forest is prohibited in Uttarakhand and other parts of India (Kuniyal *et al*., 2015; Yadav *et al*., 2009). Since the WHO and the herbal Pharmacopoeia emphasize quality standardization of medicinal plants, its formulation in terms of active ingredients rhoifolin, efforts were taken towards genetic improvement of qualitative and quantitative genetic traits in Prishniparni. Survey and collection of 52 germplasms from all over India were taken for conservation and evaluation of genetic resources through identifying the diversity and variability present in the gene pool, to develop rhoifolin-rich genetically improved genotype of Prishniparni among 23 viable germplasms of the 52 collected germplasms during 2016-2027. Keeping these points in mind, development of an improved variety was taken up at *CSIR*-CIMAP that produces higher herb yield with a higher amount of rhoifolin (1.0–1.5%). The improved variety is expected to cater to the needs of the Ayurvedic and pharmaceutical industries.

Materials and Methods

A survey was carried out during 2016 and 2017 to collect 52 *U. picta* germplasm from major growing regions of Uttar Pradesh, Uttarakhand, Madhya Pradesh, West Bengal, Gujarat, Karnataka, and Telangana. As part of the genetic improvement strategies of the *U. picta,* only 23 of the 52 germplasm (Table 1) that were collected were found to be viable and appropriate for further research (Figure 1: Flow diagram of Breeding Plan). Nursery was raised from the seeds of these 23 viable accessions and cultivated during 2017-2019 and the seedlings were transplanted in the experimental field of CSIR-CIMAP, Lucknow, and assessed for multiple morphometric features (Tables 2-4). During the initial yield evaluation trial (IET) of the 2020–2021 cropping season, seven accessions—UP-2, UP-11, UP-16, UP-49, UP-51, UP-52, and UP-50—were assessed using randomized block design (RBD) at the experimental farm, CSIR-CIMAP, Lucknow, with three replications. The plot measured 5.0 m × 4.0 m or 20.0 m². In the first week of July 2020 & 2021, the grown seedlings of each accession were planted 30 x 30 cm apart and uprooted in the month of October 2020 & 2021, respectively. In the 2022 cropping season bench scale yield evaluation trial (BST) was conducted on seven accessions, including UP-50 were assessed using RBD at the CSIR-CIMAP experimental farm in Lucknow. Three replications with a plot size of 30.0 m^2 (6.0 × 5.0 m) were used. In the first week of July 2022, healthy seedlings were planted 30 x 30 cm apart and harvested in the month of October 2022. In the 2023 and 2024 cropping seasons, a pilot-scale yield evaluation trial was conducted on seven accessions, including UP-50 was once more evaluated using RBD at the CSIR-CIMAP experimental farm in Lucknow. Three replications with a plot size of 50.0 m^2 (10.0 × 5.0 m) were used. In the first week of July in 2023 and 2024, healthy seedlings were planted 30 x 30 cm apart and uprooted in October 2023 & 2024, respectively. The morphometric and chemical trait includes plant height (cm), root length (cm), leaves/plant (no.), leaf length (cm), leaf width (cm), fresh aerial herb yield (kg/plot), dry aerial herb yield (kg/plot), fresh root yield (kg/plot), dry root yield (kg/plot), dry shoot: dry root ratio, rhoifolin in dry aerial part (%), rhoifolin in dry root part (%), estimated fresh aerial herb yield (q/ha), estimated dry aerial herb yield (q/ha), estimated fresh root yield (q/ha) and estimated dry root yield (q/ha). Rhoifolin content in the aerial part (%) and rhoifolin content in the root part (%) were measured, along with plant height (cm), root length (cm), inflorescence length (cm), number of leaves/plant, leaf length (cm), leaf width (cm), fresh aerial herb weight/plant (g), and root weight/plant (g).

Results and Discussion

The genotype CIMAP/UP50 (later released as variety CIM-Rhoi Gold) exhibited consistency in performance for different yield and quality attributes during the initial and pilot scale evaluations and remained stable and homogeneous for its morpho-metric and quality traits.

Initial yield evaluation trial (2020-21)

The CIMAP/UP-50 (CIM-Rhoi Gold) outperformed the other accessions in the yield assessment trial for aerial herb yield, rhoifolin content (Figure 2), number of leaves per plant, plant height, and leaf length and width (Tables 5 and 6). In terms of fresh herb yield, the percent improvement was higher by almost 49, 51, 49, and 59% in 2020 and 24, 28, 27, and 36% in 2021, respectively. Similarly, rhoifolin content in aerial part (Figure 2) was recorded as higher by 46, 51, 31, and 30% in 2020 and 59, 84, 79 and 43% in 2021, respectively.

Bench scale yield trial (2022)

Rhoifolin content in the aerial part (%) and rhoifolin content in the root part (%) were measured, along with other morphological traits. According to yield assessment trials, accession CIMAP/UP-50 (CIM-Rhoi Gold) produced more productivity than other accessions (Table 7). The strain CIMAP/UP-50 (CIM-Rhoi Gold) outperformed accessions UP-49, UP51, UP-52 and UP-2 in terms of high fresh herb yield by almost 69, 71, 70, and 75% while for rhoifolin content in aerial part was found 42, 34, 47, and 62% 2022 in 2022, respectively.

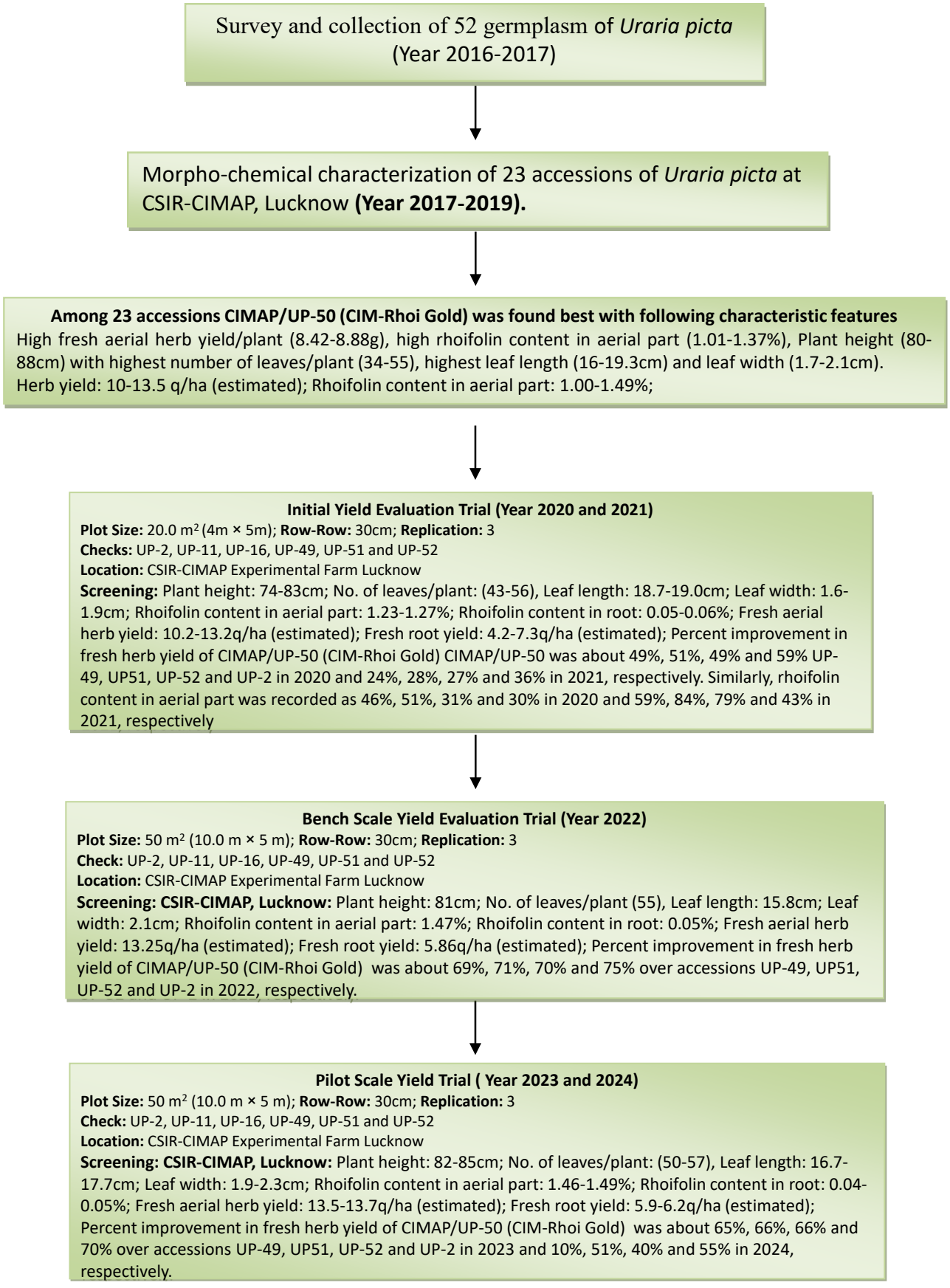


Figure 1: Flow diagram of origin and breeding of *Uraria picta* strain CIMAP/UP-50 (CIM-Rhoi Gold)

Table 1: Details of *U. picta* germplasm collected from major growing areas of the country

S. No.	*Code*	*Place of collection*	*GPS coordinates*	*Rhoifolin content (RC)/Remarks*
1	UP-01	Lucknow, UP	26°54′48′′N and 80°59′23′′E	RC in AP (0.38), RP (0.03)
2	UP-02	Dehradun, UK	30°20′30′′N and 78°01′57′′E	RC in AP (0.28), RP (0.01)
3	UP-03	Nainital, UK	29°10′25′′N and 78°39′42′′E	RC in AP (0.38), RP (0.04)/ Not Survived
4	UP-04	Nainital, UK	29°10′29′′N and 78°39′40′′E	RC in AP (0.47), RP (0.03)
5	UP-05	Nainital, UK	29°10′28′′N and 78°39′43′′E	RC in AP (0.28), RP (0.04)
6	UP-06	Nainital, UK	29°10′28′′N and 78°39′43′′E	RC in AP (0.43), RP (0.08)/Seeds not viable
7	UP-07	Nainital, UK	30°8′20′′N and 78°11′56′′E	RC in AP (0.47), RP (0.04)/Seeds not viable
8	UP-08	Chhindwara, MP	22°29′2′′ N and 78°42′2′′E	RC in AP (0.18), RP (0.01)/Not survived
9	UP-09	Chhindwara, MP	22°29′5′′ N and 78°42′5′′E	RC in AP (0.15), RP (0.01)/Died at seedling
10	UP-10	Chhindwara, MP	22°29′3′′ N and 78°42′7′′E	RC in AP (0.13), RP (ND)/Not considered
11	UP-11	Nainital, UK	30°8′34′′N and 78°12′3′′E	RC in AP (0.43), RP (0.10)
12	UP-12	Nainital, UK	30°8′42′′N and 78°11′19′′E	RC in AP (0.50), RP (0.04)
13	UP-13	Dewas, MP	22°31′27′′ N and 76°44′43′′E	RC in AP (0.12), RP (0.01)/Not survived
14	UP-14	Dewas, MP	22°31′28′′ N and 76°44′44′′E	RC in AP (0.10), RP (ND)/Not considered
15	UP-15	Dewas, MP	22°31′26′′ N and 76°44′43′′E	RC in AP (0.11), RP (0.01)/Died at seedling
16	UP-16	Nainital, UK	30°9′13′′N and 78°11′30′′E	RC in AP (0.30), RP (0.03)
17	UP-17	Nainital, UK	29°16′16′′N and 78°33′1′′E	RC in AP (0.16), RP (0.02)
18	UP-18	Hosangabad, MP	21°58′6′′ N and 80°32′3′′E	RC in AP (0.07), RP (ND)/Not considered
19	UP-19	Hosangabad, MP	21°58′9′′ N and 80°32′4′′E	RC in AP (0.05), RP (0.02)/Not considered
20	UP-20	Hosangabad, MP	21°58′8′′ N and 80°32′0′′E	RC in AP (0.05), RP (0.01)/Not considered
21	UP-21	Nainital, UK	29°16′19′′N and 78°32′54′′E	RC in AP (0.50), RP (0.09)
22	UP-22	Nainital, UK	29°16′21′′N and 78°32′53′′E	RC in AP (0.58), RP (0.05)
23	UP-23	Khandwa, MP	21°53′29′′ N and 77°51′2′′E	RC in AP (0.16), RP (ND)/Not considered
24	UP-24	Khandwa, MP	21°53′28′′ N and 77°51′1′′E	RC in AP (0.14), RP (ND)/Not considered
25	UP-25	Nainital, UK	29°16′22′′N and 78°32′51′′E	RC in AP (0.62), RP (0.03)
26	UP-26	Panna, MP	24°10′36′′ N and 80°29′5′′E	RC in AP (0.08), RP (0.02)/Seeds not viable
27	UP-27	Panna, MP	24°10′37′′ N and 80°28′59′′E	RC in AP (0.09), RP (ND)/Not considered
28	UP-28	Panna, MP	24°10′39′′ N and 80°29′0′′E	RC in AP (0.06), RP (0.01)/Not considered
29	UP-29	Nainital, UK	28°58′41′′N and 79°23′57′′E	RC in AP(0.26), RP (0.04)
30	UP-30	Nainital, UK	28°58′42′′N and 79°23′56′′E	RC in AP (0.24), RP (0.01)/Seeds not viable
31	UP-31	Nainital, UK	28°58′42′′N and 79°23′55′′E	RC in AP (0.30), RP (0.03)
32	UP-32	Sehore, MP	22°46′34′′ N and 77°37′21′′E	RC in AP (0.20), RP (0.02)/Died at seedling
33	UP-33	Sehore, MP	22°46′34′′ N and 77°37′22′′E	RC in AP (0.18), RP (0.01)/Died at seedling
34	UP-34	Nainital, UK	28°58′42′′N and 79°23′54′′E	RC in AP (0.33), RP (0.05)
35	UP-35	Seopur Kalan, MP	25°30′11′′ N and 77°7′1′′E	RC in AP (0.12), RP (0.01)/Not considered
36	UP-36	Seopur Kalan, MP	25°30′10′′ N and 77°7′1′′E	RC in AP (0.10), RP (ND)/Not considered
37	UP-37	Faizabad, UP	26°32′6′′ N and 81°50′13′′E	RC in AP (0.24), RP (0.01)/Died at seedling
38	UP-38	Nadia, WB	22°59′6′′ N and 88°26′43′′E	RC in AP (0.15), RP (0.02)/Seeds not viable
39	UP-39	Nainital, UK	29°17′18′′N and 79°32′55′′E	RC in AP (0.54), RP (0.06)
40	UP-40	Nainital, UK	29°17′19′′N and 79°32′56′′E	RC in AP (0.21), RP (0.01)/Died at seedling
41	UP-41	Nainital, UK	29°17′22′′N and 79°32′54′′E	RC in AP (0.33), RP (0.02)
42	UP-42	Bangalore, Karnataka	13°4′55′′ N and 77°35′27′′E	RC in AP (0.07), RP (0.02)/Not considered
43	UP-43	Rishikesh, UK	30°07′37′′N and 78°17′40′′E	RC in AP (0.12), RP (0.02)/Died at seedling
44	UP-44	Nainital, UK	29°17′24′′N and 79°32′54′′E	RC in AP (0.52), RP (0.02)

Cont....

S. No.	*Code*	*Place of collection*	*GPS coordinates*	*Rhoifolin content (RC)/Remarks*
45	UP-45	Hyderabad, Telangana	17°25′26′′ N and 78°34′39′′E	RC in AP (0.11), RP (0.01)/Died at seedling
46	UP-46	Nainital, UK	29°17′23′′N and 79°32′54′′E	RC in AP (0.38), RP (0.02)/Plant died
47	UP-47	Nainital, UK	29°17′24′′N and 79°32′52′′E	RC in AP (0.53), RP (0.11)
48	UP-48	Surat, Gujrat	20°11′28′′N and 72°48′47′′E	RC in AP (0.45), RP (0.05)
49	UP-49	Nainital, UK	29°17′24′′N and 79°32′54′′E	RC in AP (0.21), RP (0.03)
50	UP-50	Padrauna, UP	26°53′56′′N and 83°58′47′′E	RC in AP (0.88), RP (0.04)
51	UP-51	Basti, UP	26°49′32′′N and 82°45′48′′E	RC in AP (0.55), RP (0.02)
52	UP-52	Ambedkar Nagar, UP	26°28′46′′N and 82°41′10′′E	RC in AP (0.24), RP (0.02)

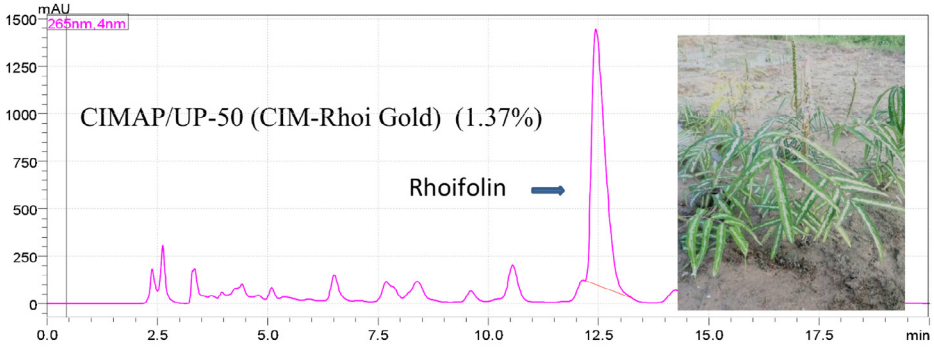
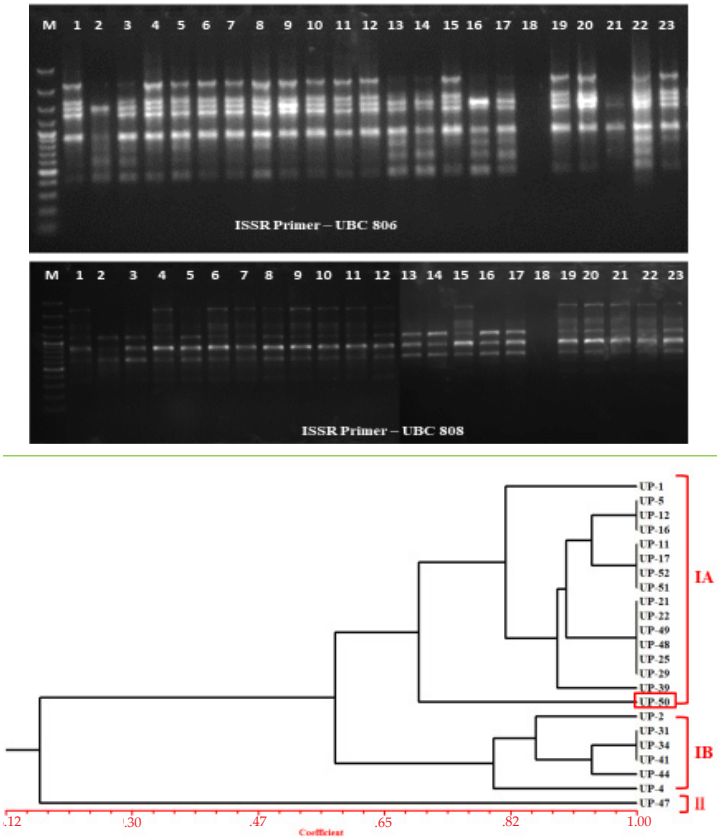


Figure 2: Chromatogram of prishniparni accession CIMAP/UP-50 (CIM-Rhoi Gold) showing the content of rhoifolin



- UPGMA clustering classified all accessions into 2 major clusters (I & II), and cluster I was again divided into 2 sub-clusters, IA & IB.
- Cluster IA has 16 accessions, Cluster IB has 6 accessions, and Cluster II has only one UP-47.
- UP-50 creates a separate identity in cluster I.

Figure 3: ISSR Primers UBC 806 and UBC 808 display distinct profile of CIMAP/UP-50 (CIM-Rhoi Gold)

Table 2: Mean performance of 23 germplasm of *U. picta* grown at CIMAP, Lucknow for different morpho-metric traits during 2017

Accession no.	*Plant height (cm)*	*Root length (cm)*	*Inflorescence (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial weight/ plant (g)*	*Dry root weight /plant (g)*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*
UP 1	27	20.17	25.67	25.00	12.67	1.40	5.43	1.45	0.37	0.03
UP 2	28	20.33	31.67	25.00	12.87	1.50	5.71	2.31	0.20	0.01
UP 4	25	18.33	27.00	20.33	10.67	1.50	3.77	1.45	0.61	0.04
UP 5	25	20.17	29.00	24.67	11.33	1.33	2.17	1.36	0.32	0.06
UP 11	31	20.33	32.33	26.00	14.00	1.50	5.74	2.42	0.38	0.04
UP 12	21	19.83	20.00	16.67	11.33	1.37	3.74	1.23	0.43	0.04
UP 16	32	20.83	32.33	29.00	14.43	1.57	5.79	2.54	0.36	0.04
UP 17	26	19.17	24.33	24.67	7.63	1.17	3.55	2.10	0.09	0.02
UP 21	22	17.33	30.00	21.67	12.17	1.47	3.71	2.20	0.27	0.04
UP 22	23	16.33	30.00	19.67	12.67	1.43	2.43	1.54	0.46	0.05
UP 25	21	12.33	30.00	19.00	10.50	1.30	3.55	1.52	0.75	0.03
UP 29	23	17.83	24.33	17.00	9.60	1.33	4.69	1.37	0.32	0.03
UP 31	28	19.33	31.33	24.33	10.67	1.17	4.93	1.32	0.34	0.03
UP 34	23	17.17	27.67	22.00	9.10	1.47	1.24	1.70	0.15	0.06
UP 39	28	17.33	30.00	21.33	9.50	1.27	2.94	1.72	0.59	0.05
UP 41	20	16.33	28.33	25.33	11.83	1.37	3.16	1.66	0.21	0.04
UP 44	25	9.43	30.00	11.17	12.50	1.47	5.08	1.16	0.69	0.03
UP 47	22	12.33	16.67	22.67	8.83	1.13	2.23	1.52	0.67	0.19
UP 48	19	9.00	21.67	12.00	10.67	1.33	2.60	0.73	0.78	0.09
UP-49	65	28.33	50.33	31.33	17.17	1.67	5.29	4.53	0.24	0.05
UP-50	88	28.33	60.00	34.33	19.33	1.73	8.42	5.75	1.01	0.08
UP-51	52	21.67	33.67	29.00	14.67	1.57	5.92	2.72	0.43	0.02
UP-52	58	21.67	36.33	31.00	15.67	1.63	6.33	3.43	0.39	0.03
SEM	2.54	2.02	3.69	3.85	1.06	0.14	0.55	0.17	0.05	0.01
C.D. (5%)	5.13	4.07	7.44	7.75	2.13	0.28	1.11	0.35	0.10	0.01
CV	9.79	13.42	14.81	20.32	10.63	11.98	15.72	10.14	13.40	12.84

Table 3: Mean performance of 23 germplasm of *U. picta* grown at CIMAP, Lucknow for different morpho-metric traits during 2018.

Accession no.	*Plant height (cm)*	*Root length (cm)*	*Inflorescence (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial weight/ plant (g)*	*Dry root weight/ plant (g)*	*Rhiofolin in dry aerial part (%)*	*Rhiofoilin in dry root part (%)*
UP 1	44.33	21.67	13.33	25.00	5.93	1.43	3.06	2.54	0.40	0.01
UP 2	47.33	26.67	16.67	30.00	10.67	1.50	4.10	2.62	0.36	0.01
UP 4	39.67	22.00	13.33	23.67	6.37	1.33	1.63	1.92	0.33	0.02
UP 5	44.33	21.67	11.67	19.67	6.10	1.33	2.64	1.18	0.21	0.01
UP 11	50.33	27.67	17.00	31.00	11.00	1.50	3.82	3.08	0.47	0.02
UP 12	40.00	16.67	13.67	22.33	6.33	1.47	1.78	1.34	0.57	0.05
UP 16	51.67	28.00	17.00	31.67	11.74	1.57	4.22	3.26	0.24	0.02
UP 17	41.67	17.33	13.00	22.67	6.40	1.33	1.81	1.61	0.23	0.01
UP 21	31.67	20.67	12.33	27.33	8.00	1.37	2.37	1.66	0.73	0.03
UP 22	32.00	24.33	16.00	23.00	9.00	1.50	2.83	2.43	0.69	0.05
UP 25	38.33	21.00	15.67	17.67	9.00	1.17	2.72	1.52	0.48	0.03
UP 29	42.33	21.67	15.67	29.00	9.33	1.40	1.94	1.73	0.20	0.05
UP 31	27.67	24.33	13.67	26.33	10.00	1.33	1.62	2.00	0.27	0.02
UP 34	46.67	19.33	13.00	26.00	10.67	1.37	1.62	2.53	0.51	0.04
UP 39	40.67	22.00	11.00	26.33	8.33	1.40	2.63	1.75	0.49	0.01
UP 41	45.00	26.67	13.00	24.00	10.33	1.37	2.96	2.32	0.45	0.01
UP 44	42.33	19.33	15.67	21.67	10.67	1.33	2.53	1.98	0.34	0.02
UP 47	28.33	22.33	10.67	22.00	9.00	1.13	1.87	2.60	0.39	0.03
UP 48	31.00	25.33	14.67	22.00	9.67	1.27	2.47	2.28	0.12	0.01
UP-49	56.67	30.33	21.00	40.00	13.00	1.67	5.94	4.17	0.18	0.01
UP-50	80.00	31.33	31.67	55.00	16.00	2.10	8.88	6.60	1.37	0.05
UP-51	52.00	28.33	18.33	31.67	12.00	1.67	4.24	3.29	0.67	0.02
UP-52	53.33	28.33	19.00	35.00	12.00	1.67	4.93	3.62	0.09	0.01
SEM	6.01	3.36	2.27	3.38	0.98	0.14	0.37	0.30	0.03	0.003
C.D. (5%)	12.12	6.78	4.57	6.81	1.98	0.29	0.74	0.60	0.07	0.006
CV	16.81	17.32	17.91	15.03	12.51	12.18	14.19	14.36	9.89	14.12

Table 4: Mean performance of 23 germplasm of *U. picta* grown at CIMAP, Lucknow for different morpho-metric traits during 2019.

Accession no.	*Plant height (cm)*	*Root length (cm)*	*Inflorescence (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial weight/ plant (g)*	*Dry root weight/ plant (g)*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*
UP 1	44	21.43	24.67	32.33	8.94	1.25	2.48	2.46	0.56	0.03
UP 2	46	22.23	26.21	39.33	9.77	1.35	2.87	2.66	0.76	0.02
UP 4	32	18.17	18.00	37.00	8.96	1.22	1.54	1.83	0.59	0.01
UP 5	36	20.83	18.00	35.00	7.83	0.97	2.02	1.70	0.35	0.01
UP 11	39	23.07	26.30	42.33	10.53	1.38	3.42	3.15	0.77	0.01
UP 12	27	17.50	21.00	35.00	6.45	1.34	2.38	1.91	0.59	0.02
UP 16	36	23.70	26.39	42.33	11.51	1.40	3.49	3.18	0.47	0.01
UP 17	43	17.93	18.07	34.33	4.22	0.77	1.16	1.88	0.52	0.02
UP 21	34	20.00	18.03	36.67	6.52	0.67	2.17	2.29	0.63	0.03
UP 22	32	20.03	21.35	35.00	8.75	0.99	2.04	1.75	0.50	0.01
UP 25	26	22.33	22.77	24.33	5.29	1.07	1.87	2.46	0.68	0.01
UP 29	35	19.10	18.33	32.33	9.22	1.05	1.25	1.95	0.40	0.01
UP 31	34	22.67	20.67	35.33	7.48	0.86	1.92	1.43	0.79	0.01
UP 34	37	17.80	15.33	33.67	8.69	1.09	2.15	1.42	0.35	0.02
UP 39	26	12.60	15.27	31.00	3.61	0.89	1.18	1.31	0.35	0.01
UP 41	33	13.83	22.87	32.33	3.65	1.11	1.67	1.49	0.73	0.02
UP 44	38	18.67	20.00	31.33	7.62	1.30	1.56	1.51	0.61	0.01
UP 47	35	14.20	16.87	30.00	6.45	1.13	1.31	1.81	0.37	0.03
UP 48	27	15.13	23.23	30.00	6.69	1.31	2.59	2.09	0.51	0.01
UP-49	54	25.63	32.07	45.33	14.32	1.71	3.87	3.96	0.48	0.03
UP-50	85	26.33	33.67	55.00	15.08	1.93	8.66	5.94	1.21	0.04
UP-51	45	25.10	26.83	43.67	11.97	1.41	3.61	3.38	0.24	0.01
UP-52	44	25.33	28.00	44.67	13.47	1.59	3.67	3.78	0.49	0.03
SEM	2.79	1.99	1.82	3.01	1.16	0.18	0.29	0.31	0.05	0.002
C.D. (5%)	5.63	4.02	3.67	6.06	2.34	0.36	0.58	0.63	0.10	0.005
CV	8.87	12.11	9.99	10.11	16.57	18.35	13.70	15.94	10.68	9.61

Table 5: Mean Performance of different *Uraria picta* germplasm in Initial Yield Evaluation Trial (IET) at Lucknow during 2020

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial herb yield (kg/20 m^2)*	*Dry root yield (kg/20 m^2)*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	36	22.6	34.3	14.3	1.3	0.83	0.61	0.86	0.05	4.14	3.03
UP 11	36	22.7	34.7	14.3	1.4	0.84	0.61	0.91	0.02	4.22	3.03
UP 16	37	22.9	34.7	14.7	1.4	0.92	0.65	0.82	0.02	4.59	3.26
UP 49	50	23.6	36.3	16.3	1.5	1.12	0.73	0.66	0.01	5.59	3.65
UP-50	74	24.6	42.7	18.7	1.9	2.04	1.45	1.23	0.06	10.18	7.27
UP-51	43	23.1	34.7	15.1	1.4	0.99	0.67	0.60	0.06	4.96	3.33
UP-52	47	23.1	35.3	15.4	1.5	1.04	0.67	0.85	0.03	5.18	3.33
SEM	2.35	1.78	2.56	1.19	0.28	0.10	0.09	0.07	0.003	0.51	0.44
C.D. (5%)	5.10	3.85	5.55	2.57	0.61	0.22	0.19	0.15	0.006	1.10	0.95
CV	6.23	9.35	8.68	9.34	23.18	11.20	13.96	10.14	9.93	11.20	13.96

*Plot size: 20m^2 (5m×4m); Replication: Three; Spacing: 30cm×30cm

Table 6: Mean Performance of different *Uraria picta* germplasm in Initial Yield Evaluation Trial (IET) at Lucknow during 2021

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial herb yield (kg/20 m^2)*	*Dry root yield (kg/20 m^2)*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	68	15.7	35.7	14.1	1.4	1.67	0.48	0.72	0.02	8.33	2.42
UP 11	68	15.7	39.7	14.3	1.4	1.68	0.52	0.24	0.06	8.38	2.59
UP 16	71	16.0	40.7	14.7	1.4	1.86	0.54	0.45	0.07	9.30	2.69
UP 49	81	20.7	44.0	18.7	1.5	2.00	0.63	0.52	0.02	10.02	3.14
UP-50	83	28.3	56.0	19.0	1.6	2.64	0.84	1.27	0.06	13.19	4.19
UP-51	72	18.3	42.3	16.3	1.5	1.89	0.54	0.20	0.02	9.46	2.72
UP-52	72	20.3	42.7	16.6	1.5	1.91	0.57	0.26	0.07	9.57	2.87
SEM	10.56	3.38	3.24	1.45	0.24	0.08	0.07	0.04	0.003	0.42	0.37
C.D.(5%)	22.91	7.34	7.02	3.14	0.52	0.18	0.16	0.09	0.006	0.92	0.80
CV	17.56	21.48	9.22	10.91	20.01	5.32	15.27	9.97	6.88	5.32	15.27

*Plot size: 20m^2 (5m×4m); Replication: Three; Spacing: 30cm×30cm

Table 7: Mean Performance of different *Uraria picta* germplasm in Bench Scale Yield Evaluation Trial (PST) at Lucknow during 2022

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Dry aerial herb yield (kg/30 m^2)*	*Dry root yield (kg/30 m^2)*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	39	23.0	36.7	12.3	1.3	0.98	0.88	0.56	0.02	3.26	2.95
UP 11	40	23.3	39.3	12.6	1.4	0.98	0.94	0.96	0.06	3.27	3.13
UP 16	42	23.5	42.3	13.2	1.4	1.05	1.01	0.70	0.01	3.52	3.38
UP 49	50	24.6	45.3	14.2	1.5	1.20	1.21	0.84	0.03	4.00	4.02
UP-50	81	25.3	55.0	15.8	2.1	3.97	1.76	1.47	0.05	13.25	5.86
UP-51	45	23.9	42.3	13.3	1.4	1.15	1.04	0.96	0.06	3.82	3.46
UP-52	45	24.0	43.7	14.0	1.5	1.19	1.06	0.78	0.03	3.96	3.53
SEM	3.22	2.03	3.14	1.02	0.26	0.19	0.10	0.05	0.002	0.62	0.35
C.D. (5%)	6.99	4.41	6.81	2.22	0.57	0.41	0.23	0.10	0.004	1.35	0.76
CV	8.07	10.40	8.83	9.20	21.34	15.25	11.34	6.25	5.80	15.25	11.34

* Plot size: 30m^2 (6m×5m); Replication: Three; Spacing: 30cm×30cm.

Table 8: Mean Performance of different *Uraria picta* germplasm in Pilot Scale Yield Evaluation Trial (PST) at Lucknow during 2023

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Fresh aerial herb yield (kg/50 m^2)*	*Dry aerial herb yield (kg/50 m^2)*	*Fresh root yield (kg/50 m^2)*	*Dry root yield (kg/50 m^2)*	*Dry shoot: dry root ratio*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated fresh aerial herb yield (q/ha)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated fresh root yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	39	23.4	35.3	11.9	1.3	5.44	1.93	3.27	1.49	1.53	0.61	0.02	10.87	3.85	6.54	2.98
UP 11	40	23.8	35.7	12.1	1.4	5.91	2.09	3.28	1.49	1.52	0.44	0.05	11.81	4.19	6.55	2.98
UP 16	42	23.9	39.7	13.0	1.4	6.17	2.19	3.35	1.52	1.71	0.39	0.02	12.33	4.37	6.69	3.05
UP 49	50	25.2	45.7	13.6	1.5	6.69	2.37	4.11	1.87	1.27	0.93	0.03	13.38	4.74	8.22	3.74
UP-50	82	25.8	50.3	16.7	1.9	19.08	6.76	6.86	3.12	2.17	1.49	0.05	38.15	13.53	13.72	6.25
UP-51	43	24.0	40.7	13.4	1.4	6.38	2.26	3.58	1.63	1.40	0.40	0.04	12.75	4.52	7.16	3.26
UP-52	45	24.6	41.7	13.5	1.5	6.48	2.30	4.01	1.83	1.35	0.50	0.05	12.96	4.60	8.03	3.65
SEM	3.5	1.8	2.87	1.10	0.16	1.17	0.41	0.93	0.16	0.48	0.04	0.0006	2.34	0.83	1.87	0.31
C.D. (5%)	7.64	3.93	6.23	2.38	0.35	2.53	0.90	2.03	0.34	1.03	0.10	0.0013	5.07	1.80	4.05	0.68
CV	8.84	9.10	8.52	9.97	13.35	17.84	17.84	28.12	10.32	37.36	7.90	2.00	17.84	17.84	28.12	10.32

* Plot size: 50m^2 (10m×5m); Replication: Three; Spacing: 30cm×30cm.

Table 9: Mean Performance of different *Uraria picta* germplasm in Pilot Scale Yield Evaluation Trial (PST) at Lucknow during 2024

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Fresh aerial herb yield (kg/50 m^2)*	*Dry aerial herb yield (kg/50 m^2)*	*Fresh root yield (kg/50 m^2)*	*Dry root yield (kg/50 m^2)*	*Dry shoot: dry root ratio*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated fresh aerial herb yield (q/ha)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated fresh root yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	42	18.3	31.0	13.2	1.5	8.61	3.05	3.18	1.45	2.14	0.28	0.05	17.22	6.10	6.36	2.89
UP 11	42	19.3	31.3	13.7	1.5	8.76	3.11	3.46	1.58	2.02	0.31	0.02	17.53	6.22	6.92	3.15
UP 16	42	19.3	31.7	13.8	1.5	9.03	3.20	3.62	1.65	1.94	0.26	0.02	18.05	6.40	7.24	3.30
UP 49	47	20.7	41.7	15.5	1.6	17.35	6.15	5.35	2.44	2.55	0.87	0.02	34.70	12.31	10.70	4.87
UP-50	85	24.3	57.0	17.7	2.3	19.34	6.86	6.88	2.95	2.19	1.46	0.04	38.68	13.71	13.76	5.89
UP-51	46	19.7	32.3	14.1	1.5	9.36	3.32	4.75	2.16	1.57	0.71	0.06	18.71	6.63	9.50	4.33
UP-52	47	20.0	34.7	14.5	1.5	11.52	4.08	5.01	2.28	1.79	0.75	0.03	23.04	8.17	10.01	4.56
SEM	5.7	2.5	31.0	0.8	0.2	0.85	0.30	0.45	0.21	0.24	0.06	0.002	1.69	0.60	0.90	0.42
C.D. (5%)	12.31	5.33	31.33	1.75	0.54	1.84	0.65	0.98	0.46	0.52	0.14	0.004	3.67	1.30	1.95	0.91
CV	13.83	14.88	31.67	6.74	18.78	8.64	8.64	11.95	12.41	14.52	11.57	6.45	8.64	8.64	11.95	12.41

* Plot size: 50m^2 (10m×5m); Replication: Three; Spacing: 30cm×30cm.

Table 10: Mean Performance of different *Uraria picta* germplasm in Pilot Scale Yield Evaluation Trial (PST) at Lucknow during 2023 and 2024

Accession no.	*Plant height (cm)*	*Root length (cm)*	*No. of leaves/ plant*	*Leaf length (cm)*	*Leaf width (cm)*	*Fresh aerial herb yield (kg/50 m^2)*	*Dry aerial herb yield (kg/50 m^2)*	*Fresh root yield (kg/50 m^2)*	*Dry root yield (kg/50 m^2)*	*Dry shoot: dry root ratio*	*Rhiofolin in dry aerial part (%)*	*Rhiofolin in dry root part (%)*	*Estimated fresh aerial herb yield (q/ha)*	*Estimated dry aerial herb yield (q/ha)*	*Estimated fresh root yield (q/ha)*	*Estimated dry root yield (q/ha)*
UP 2	41	20.9	33.2	12.5	1.4	7.02	2.49	3.22	1.47	1.83	0.45	0.03	14.04	4.98	6.45	2.94
UP 11	41	21.6	33.5	12.9	1.4	7.34	2.60	3.37	1.53	1.77	0.38	0.03	14.67	5.20	6.74	3.07
UP 16	42	21.6	35.7	13.4	1.4	7.60	2.69	3.48	1.59	1.83	0.33	0.02	15.19	5.39	6.97	3.17
UP 49	49	22.9	43.7	14.5	1.5	12.02	4.26	4.73	2.15	1.91	0.90	0.02	24.04	8.53	9.46	4.31
UP-50	84	25.1	53.7	17.2	2.1	19.21	6.81	6.87	3.04	2.18	1.48	0.05	38.41	13.62	13.74	6.07
UP-51	44	21.8	36.5	13.8	1.5	7.87	2.79	4.17	1.90	1.48	0.56	0.05	15.73	5.58	8.33	3.79
UP-52	46	22.3	38.2	14.0	1.5	9.00	3.19	4.51	2.05	1.57	0.62	0.04	18.00	6.38	9.02	4.11
SEM	4.60	2.13	2.45	0.95	0.21	1.01	0.36	0.69	0.18	0.36	0.05	0.001	2.01	0.71	1.38	0.37
C.D. (5%)	9.98	4.63	5.32	2.06	0.45	2.18	0.77	1.50	0.40	0.78	0.12	0.003	4.37	1.55	3.00	0.79
CV	11.34	11.99	7.62	8.36	16.06	13.24	13.24	20.04	11.36	25.94	9.74	4.23	13.24	13.24	20.04	11.36

* Plot size: 50m^2 (10m×5m); Replication: Three; Spacing: 30cm×30cm.

Table 11: Description of accession/variety

S. No.	*Plant characteristic*	*CIM-Rhoi Gold*
1	Growth habit	Erect, Branched
2.	Appearance	Light green
3	Shape of canopy	Symmetrical
4.	Plant height	75–85 cm
5.	Leaf length	14.5–19.3 cm
6.	Leaf width	1.6–2.1cm
7.	Stem	Cylindrical, purple to purplish green
8.	Leaf	Unipinnate, imparipinnate, leaflets 4 pairs with 1 odd as terminal, Lanceolate, dark green, obtuse to acute at apex, rounded at base, blotches along the mid vein on the upper surface
9.	Inflorescence	Pink
10.	Propagation	Through seeds
11.	Estimated Herb yield (q/ha)	12–14
12.	Rhoifolin content in aerial part (%)	1.01–1.49
13.	Estimated root yield (q/ha)	5–6
14.	Rhoifolin content in the root part (%)	0.04–0.06

Pilot scale yield trial (2023 And 2024)

As per yield assessment trials, accession CIMAP/UP-50 (CIM-Rhoi Gold) outperformed other accessions for evaluated traits (Tables 8-9). The strain CIMAP/UP-50 (CIM-Rhoi Gold) outperformed accessions UP-49, UP-51, UP-52 and UP-2in terms of fresh herb yield by almost 65, 66, 66, and 70% in 2023 and 10, 51, 40 and 55% in 2024, respectively. Similarly, for rhofolin content in the aerial part was out outperformed the other accessions by 37, 73, 66, and 59% in 2023 and 40, 51, 48, and 80% in 2024, respectively.

During the 2023 & 2024 cropping season, accession CIMAP/UP-50 (CIM-Rhoi Gold) outyielded other accessions, viz. UP-2, UP-11, UP-16, UP-49, UP-51 and UP-52 for fresh herb yield by 63, 62, 60, 37, 59, and 53%, fresh root yield by 51, 49, 48, 29, 74 and 32% and rhoifolin content in aerial part by 69, 74, 77, 39, 62, and 58%, respectively (Table 10).

Molecular profile

ISSR markers UBC-806 and UBC-808 were used to evaluate the genetic composition of 23 accessions and CIMAP/UP-50 (CIM-Rhoi Gold) displayed a distinct profile in comparison to other accessions and it as further displayed by the UPGMA dendrogram (Figure 3).

Stability and tield assessment

During its preliminary and pilot-scale evaluation yield trials, strain CIMAP/UP-50 (CIM-Rhoi Gold) demonstrated consistency in performance for a variety of yield and quality parameters and remained stable and homogeneous for its morphometric attributes.

Statement of distinction

The proposed strain CIMAP/UP-50 (CIM-Rhoi Gold) is distinguished by its highest herb yield, number of leaves per plant, leaf length, leaf width, height, and high aerial rhoifolin concentration. Its characterization based on DUS attributes is shown in Table 11.

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Conflict of Interest

The authors declare no conflict of interest.

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