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Agro-technique of critically endangered and commercially viable medicinal plant *Inula racemosa* Hook.f. in cold desert region of Ladakh, India

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Abstract

The study has aimed to develop an agro-techniques of potential and commercially viable medicinal plant (*Inula racemosa*) in cold desert of Ladakh. It was observed that the *Inula racemosa* was easily cultivated through rootstock with easy techniques and with minimal care. Through this techniques around 98% of the plants survived and established. The two year old rootstock can yield around 580 kgs/kanal and can earn around 0.61 lakhs per kanal. Number of stem is significantly correlated with fresh weight of the root at 5% and flower head per plant is highly significant correlated with fresh weight of root at 1% and the primary root length is also highly correlated with the fresh weight of the root.

Keywords: Inula, manu-pata, cultivation, cold desert, agro techniques

1. Introduction

Inula racemosa is luxuriously found in China Europe and India. The plant grows in temperate and alpine Western Himalayas from 1300 to 4500 meters elevation. The plant is distributed in temperate alpine Himalayas at an altitude of 1,500- 4,200m from Kashmir to Kumaon, Afghanistan to Central Nepal. It occurs wild among strong alpine scrub vegetation in the cold arid habitat of NW Himalayas between 2,700-3,500 m in the eastern Ladakh (Leh) region of Kashmir. Inula is locally called Manu in Ladakh, and Manu pata in Sowa Rigpa is a medicinal plant with anti- spasmodic and hypotensive properties. It is used for the treatment of cardiovascular and liver disease. It can also be used for the treatment of respiratory tract disorders, ulcers and as an antiseptic. Manu-pata which is endemic to North West Himalaya and its neighbouring areas, predominantly in Jammu-Kashmir and Himachal Pradesh, is critically endangered plant. Three species of Inula, *I. grandiflora* Willd. *I. obtusifolia* A. Kern. (Wild Manu), and *I. racemosa* Hook. f., (Manu-pata) occurs naturally in the Lahaul-Spiti district of Himachal Pradesh, only *I. racemosa* Hook. F. was found under cultivation. Due to habitat destruction and over-utilization the density and diversity of wild Manu has drastically declined in the entire North- West Himalayan region Manu (*I. racemosa* Hook. f.) was domesticated in the Lahaul valley in the early parts of the twentieth century by progressive farmers and has been grown as a cash crop along with traditional food crops like buckwheat, maize, several varieties of pulses and medicinal plants such as *Saussurea costus*. Its cultivation flourished until the introduction of seasonal cash crops like potato and pea. Manu is currently cultivated in the Lahaul valley, at an altitude of between 2400 and 3600 meter above mean sea level (m amsl), and at a few places in the Kullu, Chamba and Kinnaur districts of Himachal Pradesh. To the best of our knowledge, there is no study has been conducted on agro-techniques on medicinal plants in cold desert of Ladakh region. Therefore the present study was carried out to study and standardized the cultivation practices and cultivation constraints in order to recommend measures to promote and cultivate this valuable medicinal plant in open field condition of cold desert.

Materials and Methods

Study site

Cultivation of *Inula racemosa* was conducted at Model herbal garden of National Research Institute for Sowa Rigpa, Leh, Ladakh, ministry of AYUSH, of cold desert in the year 2015-2018. The data recorded from the 30 beds with three individuals in each beds, eight parameters were analyze for and Pearson correlation using statistical Package for Social Sciences (SPSS) version 17.0 to correlate the different morphological parameters with respect to the yield of the root. Initially to standardization the agro-techniques of the species was conducted with different combination of soil, sand and farm yard manure in 1m² bed prepared at open condition. The standardized agro-techniques was applied again in the field described below.

Standard procedures of packages and practices

Land preparation

Since plant develop long and thick roots, which required sandy and porous soil conditions. To make the soil as per requirement, application of sand, farm yard manure (FYM) along with the well decomposed goat, poultry manure were applied to increase the growth and yield of the plant. To get maximum growth and yield standardized FYM of 6-8 t/acre was required.

Preparation of beds

Flat beds of 2 m wide and 2 m long 2m² were prepared. Irrigate by flooding immediately after preparation of beds before transplant and kept for few day as the soil remain moist during transplanting. Field was ploughed by mixing with FYM and level the beds to get uniform water supply during irrigation. Irrigate the beds with very less water after transplanting of roots followed by seven days interval at later stages and whenever required.

Propagation techniques

Inula racemosa (manu pata) is a commercially viable medicinal plant, the roots of which are the source of a drug having great demand in pharmaceutical industry. This plant is easily propagated through cutting of roots and seeds.

Seed and rootstock

Seeds remain dormant state during winters season. To overcome dormancy, chilling treatment is essential. Seeds sown in polyhouse in the month of November which starts germination in month of March. Nearly 65 percent germination has been observed, but in open condition the 20 percent germination was observed in 14 month. Nursery get ready for transplant in the next year in the month of May under polyhouse condition and 14 months in open condition. Thirty percent survival rate has been observed and it takes about 4-5 year to harvest of rootstock.

Through rootstock it's easy to propagate and get ready to harvest after 2-2.5 years. The 2 years old rootstock provide around 20-30 terminal buds. In open field condition around 98 percent survived and established. Since through seeds survivability is very less and required protective condition for nursery development and it will take 5 years year time to harvest of rootstock, therefore propagation through root cuttings will be recommended.

Propagation through roots

Before planting, fields should be well ploughed and are properly mixed with farmyard manure. There should be 2-2.5

ft spacing between plant to plant and row to row and the size of plots should be of 2 m². The planting materials i.e. fresh root cutting with growing apical buds, made from uprooted roots in March- April, should be planted 4-6 cm deep in the soil. The best method of propagation is by multiplying the three year old rootstock. The three years old stout rootstock is uprooted in months of March-April and made into 20-35 small pieces having terminal buds. These pieces were transplanted horizontally 3-7 cm deep in soil depending on the size of rootstock 98 percent survival rate (Fig 1 A, B) has been achieved under this standardized cultivation method.

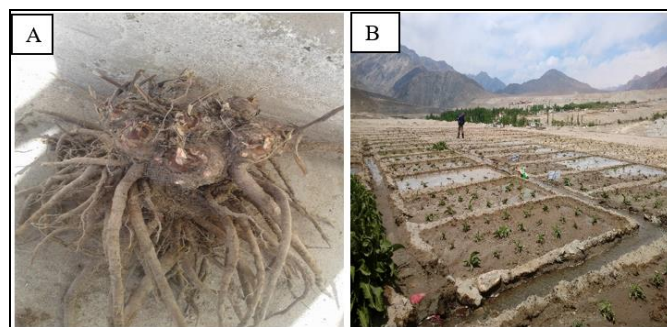


Fig 1: A) Two year root having terminal buds, B) Transplanted plants of *Inula*

Irrigation

Watering depends upon stages and growth of plant. At the time of seedlings transplantation and plantation through vegetative means, the crop requires watering twice per week during April-May. After proper establishment of plants, the crop requires watering once in a week. The crop undergoes dormant during frozen and prolonged winters (Nov-Mar) and therefore there is no requirement of watering.

Weeding

Weeds growing along with crop affect the growth and yield of the plant. To protect the plant from weeds, weeding can be done either manually or mechanically. The manual weeding is the most common and weeds are removed by frequent hoeing. The proper and regular hoeing of the fields also enhance growth and yield of the crop. No major diseases, pests or insects have been observed during life cycle of the species.

Harvest of rootstock

The data collected from experimental fields under open field conditions reveals that it is ready for harvest within 2–2.5 years, if the plant is propagated through root cuttings or it takes 4-5 years if the plant is propagated through seedlings. Roots having pharmaceutical value may be collected either in the month of March-April or in November-December at the time of senescence.

Yield

Under cultivation it has been estimated that the marketable production of roots is approximately 580 kgs/kanal in 2 years.

Cleaning and packaging

After harvesting the rootstock are immediately washed on running water to remove soil particles on it. The cleaned roots are chopped into small pieces and kept for drying under shade it will take around 15 days to 20 days complete drying. After drying the roots are properly packed in air tight containers before marketing.

Cost production and net profit of *Manu-pata*

The cost production and net profit of the species is depends on the size of the land under cultivation and the available manpower rate of the region the details of the production cost and net profit of the *Inula* is given on Table 3.

Results

Correlation among morphological parameters

Correlation were observed on various morphological characters of the *Inula* collected from Defence Institute of High-Altitude Research Leh. The morphological characters of

90 individuals (Table 1) recorded in the study showed that the correlation among morphological parameters (Table 2) number of stem is significantly correlated with fresh weight of the root at 5% and flower head per plant is highly significant correlated with fresh weight of root at 1% and the primary root length is also highly correlated with the fresh weight of the root. The mean values of PH, range from (106.3-204.9 cm), NOL (15.25-32.13), NOS (2.44-4.93), LL (24.24-57.71 cm), LW (13.23-18.64 cm), FH/P (11.54-23.4), PRL (12.72-21.92), FRW (364.6-989.92 g).

Table 1: Mean values of morphological parameters of 90 individuals of *Inula racemosa*

Inula	PH (cm)	NOL	NOS	LL (cm)	LW (cm)	FH/P	PRL (cm)	FRW (g)
P1	167.3	23.14	3.12	44.89	14.64	15.95	13.13	434.61
P2	177.4	27.32	3.16	45.96	14.92	16.43	18.93	775.3
P3	203.2	32.13	4.84	39.26	17.85	23.11	21.92	989.92
P4	106.3	15.25	2.72	57.71	13.23	13.78	19.86	918.5
P5	195.5	29.43	4.93	40.14	18.64	15.14	18.12	659.3
P6	115.9	19.34	2.95	24.24	17.37	11.54	15.73	459.5
P7	144.2	20.98	2.44	45.23	14.99	15.21	16.32	364.6
P8	177.4	27.32	3.16	45.96	14.92	16.43	18.93	775.3
P9	167.3	23.14	3.12	44.89	14.64	15.95	13.13	434.61
P10	106.3	15.25	2.72	57.71	13.23	13.78	19.86	918.5
P11	115.9	19.34	2.95	24.24	17.37	11.54	15.73	459.5
P12	167.3	23.14	3.12	44.89	14.64	15.95	13.13	434.61
P13	115.9	19.34	2.95	24.24	17.37	11.54	15.73	459.5
P14	204.9	32.13	4.84	39.26	17.85	23.11	21.92	989.92
P15	144.7	20.98	2.44	45.23	14.99	15.21	16.32	364.6
P16	106.3	15.25	2.72	57.71	13.23	13.78	19.86	918.5
P17	167.3	23.14	3.12	44.89	14.64	15.95	13.13	434.61
P18	177.4	27.32	3.16	45.96	14.92	16.43	18.93	775.3
P19	155.1	20.21	3.25	47.67	14.72	12.62	12.72	370.2
P20	106.3	15.25	2.72	57.71	13.23	13.78	19.86	918.5
P21	144.7	20.98	2.44	45.23	14.99	15.21	16.32	364.6
P22	195.5	29.43	4.93	40.14	18.64	15.14	18.12	659.3
P24	144.7	20.98	2.44	45.23	14.99	15.21	16.32	364.6
P25	155.1	20.21	3.25	47.67	14.72	12.62	12.72	370.2
P26	204.5	32.13	4.84	39.26	17.85	23.11	21.92	989.92
P27	195.5	29.43	4.93	40.14	18.64	15.14	18.12	659.3
P28	195.5	29.43	4.93	40.14	18.64	15.14	18.12	659.3
P29	155.1	20.21	3.25	47.67	14.72	12.62	12.72	370.2
P30	167.3	23.14	3.12	44.89	14.64	15.95	13.13	434.61

Abbreviations: PH=plant height, NOL=number of leaf per plant, NOS= number of stem per plant, LL= Leaf length, LW= leaf width, FH/P=flower heads per plant, PRL= primary root length, FRW=fresh root weight.

Table 2: Pearson correlation among different morphological parameters

Correlations								
	PH	NOL	NOS	LL	LB	FHB	PRL	FRW
PH	1	.958**	.782**	-.184	.575**	.704**	.166	.162
NOL		1	.816**	-.338	.700**	.738**	.351	.293
NOS			1	-.295	.808**	.542**	.394*	.413*
LL				1	-.752**	.018	.124	.285
LB					1	.292	.250	.086
FHB						1	.543**	.535**
PRL							1	.906**
FRW								1
** . Correlation is significant at the 0.01 level (2-tailed).								
* . Correlation is significant at the 0.05 level (2-tailed).								

Table 3: Cost of production of *Inula* in Ladakh region

Items	Details	Rate (Rs)	Amount (Rs)
Land preparation	2 ploughing (March)	800/plough	1600.00
Manures FYM	1ton	1200/ton	1200.00
Cost of planting material	1875 plants/kanal	3/plant	5625.00
Transplanting	30 man/days	200	6000.00
Irrigation	40 Nos	200	8000.00
Weeding	20 man/days	200	4000.00
Harvesting of roots	40 man/days	200	8000.00
Sorting/cleaning	40 man/days	200	8000.00
Drying (under shed) for 15 days	20 man/days	300	6000.00
Total Cost Production			48,425.00

Raw material (Dry) production/ kanal	Cost for raw material/ kgs	Total amount earned (Rs)
580 kgs	Rs. 190/kgs	1,10,200/-
Total cost for production		48,425/-
Net profit		61,775/-

Note: The rate of the daily wedgers as per available in the region.

Conclusion

The study confirmed that, *Manu-Pata* can be cultivated easily with minimal care in the cold desert region of Ladakh condition. With the help of high yield contributing characters high yielding germplasm can be selected for further cultivation. The germplasm of the plant with highest number of stem, flower head and primary root length can be select for higher yield.

Farmers can adopt *Manu-Pata*, for high economic returns. This study will provide the base to encourage the cultivation of this endangered medicinal plant and other available medicinal plants of the region. Substantial efforts need to be made to provide technical support, establish value-addition centers and strengthen the market. To promote the cultivation of medicinal plants and strengthen the economics of the farmers of the region of can be achieved by the support of the local administration of the region.

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