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Study of morphology and outcome of various showing measures with organic nutrient application on newly introduced plant *Coptis teeta* (rare plant in earth) in Darjeeling hills

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Abstract
An experiment was carried out during the year of 2009 - 2012 at lava (2040 m asl), Darjeeling hill, under the aegis of Uttar Banga Krishi Viswavidyalaya, to evaluate the effect of various showing measures and organic nutrient application on newly introduced plant *Coptis teeta* in Darjeeling hill. Seedlings were planted in main field, to work out its morphology and other growth pattern with agronomic manipulation. Field experiment was conducted in split plot design with three replication, having four method of sowing in main plot, which includes viz. plain bed, sloppy land (terrace), furrow and undulated sowing, and four nutrient management practices in subplot viz. vermicompost (@0.50t/ha), FYM (@0 50 t/ha), leaf manure (@0 50 t/ha) and control (no nutrient). This is a small herb of 20-25 cm in hight. This has compound leaf, serrated into 3 part leaf blade ovate, triangular in shape. Root was fibrous in nature with small yellow coloured. Colour of the rhizome was golden yellow. Inflorescence includes 3-5 flowers, bract elliptic, 3 parted or pinnately divided, solitary, cymose. Rhizome weight was more found with sloppy land cultivation (3.51 g), and was at par with the ridge method of planting (2.96 g), and statistically better to rest of the imposed treatments of main plot. This treatment gave 85.75 and 56.61% more yield of rhizome compared to plain bed sowing, which gave least weight amongst all the observations under main plot. Root length was more observed with the sloppy land showing and statistically better to rest of the treatments. Rhizome weight was more found with vermicompost (@0.50t/ha), and was at par with leaf manure (@ 0.50 t/ha) and statistically better to other set of organic nutrient management. This treatment gave 102.31 and 82.11%, more rhizomes compared to control, respectively. Root length was more observed with the vermicompost (@0.50t/ha) and was statistically similar with the FYM (@0 50 t/ha). From the study, it can be conclude that sloppy land with vermicompost (@0.50t/ha), become more preferable condition for good growth of rhizome and root of *Coptis teeta*, which has high demand in domestic and international market.

Keywords: *Coptis teeta*, cultivation, nutrient management, sowing, rhizome, root

1. Introduction
Coptis teeta is a small perennial herb popularly known as *Coptis* or Mishmi tita is an important medicinal plant used for various diseases. The specific name Tita has been derived from its bitter taste. Its tenuous rhizome, known as "Yunnan goldthread" in the traditional chinese medicine system, has been used as an antibacterial and as an anti-inflammatory medicine for a long time. The root is a pungent, very bitter, cooling herb that controls bacterial and viral infections, relaxes spasms, lowers fevers and stimulates the circulation. The root contains several compounds that are effective in inhibiting various bacteria and they are a safe and effective treatment for many ailments, such as some forms of dysentery, that are caused by bacteria (http://en.wikipedia.org/wiki/Coptis_teeta). A number of factors contribute to its endangerment. It is endemic to a very small area in the eastern Himalayas where its habitat is rapidly declining, due in part to deforestation, it is over collected for medicinal use, and its reproductive success is low (Pandit and Babu, 1998; Mukherjee, 2009) [6, 4]. This is mainly used in ayurveda, unani and sidha system of medicine practitioner. This is distributed from East Asia, particularly in north China to the temperate regions of Himalayas. Few species are endemic to India recorded only in the Himalayan region across Darjeeling in the West Bengal, Sikkim and Arunachal Pradesh in an altitude range of 2500-3000 m. It has been recorded in Lohit district, Dibang Valley district, Siang and upper Subansiri districts of Arunachal Pradesh. The plant prefers light (sandy), medium (loamy) and heavy (clay) soils.

The plant prefers acid soils. It can grow in semi-shade (light woodland) or no shade. It requires moist soil. The increasing demand has resulted in commercial harvesting pressure on wild populations that were already dwindling as a result of deforestation, and wild populations are at risk of extinction. Dried root and rhizome have tremendous demand in market. Over last few years, its cultivation has been taken up by local people in Arunachal Pradesh and on a limited scale in Nagaland. The Forest Department, Arunachal Pradesh has also taken up its cultivation. It can be cultivated by seedlings raised from seed or from wildings. The plant is cultivated on a small scale in Yunnan using techniques that aim to conserve the species within its natural habitat (Huang and Chunlin, 2007) [2]. The Lisu people of the local area (in china) earn much of their income from cultivation of the plant, which they grow using traditional agroforestry methods that have little adverse impact on the ecosystem.

Till date very little work has been conducted on this plant particularly in crop production aspect. Keeping this aspect in mind, present work was undertaken to examine plant morphology and influence of various method of planting and organic nutrient management on growth and yield of *Coptis teeta*.

2. Materials and Methods

An experiment was carried out during the year of 2009 – 2012, under the aegis of Uttar Banga Krishi Viswavidyalaya, at Lava (2040 masl) Darjeeling hill. The main objective of the study was to find out the proportion of yield of rhizome weight, because it has the main alkaloid berberine which has the medicinal value to fight malaria, indigestion, liver diseases etc. The amount of berberine will vary according to the different variable rhizome weight, girth and length. Planting materials for this experiment was collected from Arunachal Pradesh, Dibang Valley (at an altitude of 8000 ft) during November, 2009. Seedlings were planted in main field, to work out its morphology and other growth pattern with agronomic manipulation. Field experiment was conducted in split plot design with three replication, having four method of sowing in main plot, which includes viz. plain bed, sloppy land (terrace), furrow and undulated sowing, and four nutrient management practices in subplot viz. vermicompost (@0.50t/ha), FYM (@0 50 t/ha), leaf manure (@0 50 t/ha) and control (no nutrient). The irrigation was given and other recommended packages of practice were adopted during the crop growth period in both the years. Data on growth pattern was taken at 12 month after (at maximum vegetative phase) as per normal procedure. The significant differences between the treatments were compared with the critical difference (CD) at 5% level of probability (Gomez and Gomez. 1984) [1]. The soil of the experimental site was sandy loam having pH 4.8 with moderate available nitrogen, phosphorus and potassium (Jackson, 1973) [4]. Analyzed soil sample data presented in Table 1.

Table 1: Physico-chemical status of soil sample (Lava, Kalimpong Block II).

pH	ECE (inch/cm)	Available (kg/ha)			Total N (%)	Organic C (%)	Organic matter (%)	C/N ratio
		N	P_2O_5	K_2O				
4.8	0.29	318	20.1	304	16.22	3.11	2.37	13.11

3. Results and Discussion

An exploration programme was conducted during the month of November, 2009 in Arunachal Pradesh for the collection of *Coptis teeta* in Dibang Valley at an altitude of 8000 ft. The plant is locally called Mismi teeta as because local primitive inhabitants (Mismi tribes) called this medicinal plant as such from time immemorial. According to Mismi tribes and informations collected from the forest department, Govt. of Arunachal Pradesh, this plant is categorically enlisted as critically endangered plant according to Red List of International Union for Conservation of Nature and Natural resources (IUCN) list of endangered species (Mukherjee and Sharma, 2014) [3]. In Myodia (8000 ft asl) of Dibang valley, plants were collected with the help of mismi tribe person who was a forest ranger in Forest department, Govt. of Arunachal Pradesh. The collected plants were immediately planted in Lava experimental field after they were introduced in Darjeeling district.

Scientific classification

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Ranunculales
Family	:	Ranunculaceae
Genus	:	Coptis
Species	:	teeta

It is a small herb, with height of 20-25 cm. This has compound leaf, serrated into three part, leaf blade was ovate, triangular in shape. Length of the leaf varies from 6-12 cm and breadth 5-9 cm. Leaf was papery in nature. Lateral segment subsessile to petiolate, shorter than central, serrated leaf, unequally parted. Central segment petiolate, pinnately divided. Leaf margin acute apex attenuate, scales 15-25 cm tall, glabrous. Base of the leaf cordate. Adaxially sparsely puberulous (covered with minute hairs) on veins. Root is fibrous in nature with small yellow coloured. Colour of the rhizome was golden yellow. Inflorescence includes 3-5 flowers, bract elliptic, 3 parted or pinnately divided, solitary, cymose.

As it is a rare crop in earth, and till date no work has been done in its cultivation and acclimatization aspect, present field study gives glimpse of idea which may helpful for future research work and conservation programme (Table 2). Growth of *Coptis teeta* significantly influenced by various treatments under main and sub plot. Amongst various treatments in main plot, more plant height was registered with the sloppy terraced land sowing and was at par with the ridge sowing, and statistically better to rest of the treatments. Leaf length was more observed with sloppy land sowing and significantly better to rest of the treatment. Leaf breadth failed to produce any significantly response with various main plot measures, however, more of this parameter registered with the undulated land sowing. No of leaves/plant highest record with sloppy land sowing and showed parity with the ridge sowing method for improve cultivation of *Coptis teeta* in Darjeeling hill. This treatment was statistically superior to rest of the combination of core plot. Further, table 2 revealed that, petiole length was more with furrow method and showed parity with ridge sowing only, and statistically better to rest of the treatments. Number of flower and fruits were more observed with the ridge planting and significantly better to all other set of treatment in main plot. Further, table revealed that rhizome girth was more observed with sloppy land and its showed

parity with all other treatment except plain bed and undulated sowing method. Rhizome length was more found with the sloppy land sowing and was closely followed by ridge and undulated land sowing methods. These treatments were at par to each other and significantly better to rest of the treatments in main plot. Rhizome weight was more found with sloppy land cultivation (3.51 g), and was at par with the ridge method of planting (2.96 g), and statistically better to rest of the imposed treatments of main plot. This treatment gave 85.75 and 56.61% more yield of rhizome compared to plain bed sowing, which gave least weight amongst all the observations under main plot. Root length was more observed with the sloppy land showing and statistically better to rest of the treatments. Various sub plot treatments show significant response except number of number of flower /plant. Plant height was more with vermicompost (@0.50t/ha), and statistically more to rest of the treatments. Leaf length was more observed with vermicompost (@0.50t/ha), and was followed by leaf manure (@ 0.50 t/ha), and considerably better to other treatments. Leaf breadth was more with leaf manure (@ 0.50 t/ha), and gave notably reply compare to other application of organic nutrient supply. More number of leaves/plant record with vermicompost (@ 0.50 t/ha), and was statistically similar in response with leaf manure (@ 0.50 t/ha). Highest petiole length was observed with FYM (@0 50 t/ha), and was at par with vermicompost (@0.50t/ha). Number of flower /plant was more with the FYM (@0 50 t/ha), however it failed to produce any statistical difference. More flower number registered with the FYM (@0 50 t/ha), and failed to produce any statistical disparity. Number of fruits/plant, were more observed with the FYM (@0 50 t/ha), and significantly better to rest of the subplot treatments. With the perusal of table 1 revealed that, rhizome girth was more observed with FYM (@0 50 t/ha), and its showed parity with all other treatment except control plot. Rhizome length and its girth, was more found with the leaf manure (@0 50 t/ha), and showed parity with the FYM (@0 50 t/ha), and significantly better to other nutrient incorporation. Rhizome weight was more found with vermicompost (@0.50t/ha), and was at par with leaf manure (@ 0.50 t/ha) and statistically better to other set of organic nutrient management. This treatment gave 102.31 and 82.11 %, more rhizomes compared to control, respectively. Root length was more observed with the vermicompost (@0.50t/ha) and was statistically similar with the FYM (@0 50 t/ha).

Table 2: Effect of various treatments on plant growth and yield characters of *Coptis teeta* in Darjeeling hills.

Treatments	Plant height (cm)	Leaf length (cm) (compound leaf)	Leaf breadth (cm)	No of leaves/plant	Petiole length (cm)	No. of flowers/ plant	No of fruits/plant (follicle)	Rhizome girth (cm)	Rhizome length cm	Rhizome weight (g)	Root length (Fibrous root) (cm)
Methods of planting											
Plain bed sowing	10.02	7.11	5.63	6.33	8.01	4.33	3.02	1.59	2.04	1.89	4.31
Sloppy land sowing	15.54	9.02	4.29	8.21	9.89	3.78	3.33	2.71	3.91	3.51	6.94
Furrow sowing	10.21	5.29	4.54	5.56	10.04	2.89	2.91	1.73	2.32	2.44	4.96
Ridge sowing	14.36	6.51	5.53	7.35	10.51	5.66	4.66	2.64	3.63	2.96	5.82
Undulated land	11.01	6.38	5.74	5.12	7.52	4.33	2.78	2.54	3.02	2.15	5.61
SEm±	0.80	0.34	0.65	0.63	0.51	0.09	0.21	0.32	0.44	0.22	0.29
CD (*p*=0.05)	2.01	1.11	NS	1.89	1.23	0.30	0.63	0.94	1.02	0.63	0.72
Organic nutrient management											
Control	10.08	6.11	3.02	9.02	8.10	3.01	2.02	1.61	1.18	1.98	5.21
Vermicompost (@0.50t/ha)	18.21	9.15	4.45	14.32	12.14	3.11	3.35	2.21	2.12	4.01	8.73
FYM (@0 50 t/ha)	14.33	5.16	4.12	10.78	13.15	3.31	5.25	2.36	2.84	3.23	7.94
Leaf manure (@ 0.50 t/ha)	16.15	8.90	5.04	13.22	10.13	3.01	4.15	2.24	2.96	3.61	6.95
SEm±	0.19	0.33	0.13	0.55	0.75	0.44	0.21	0.09	0.15	0.26	0.56
CD (*p*=0.05)	0.52	1.06	0.52	1.36	2.13	NS	0.69	0.28	0.46	0.70	1.54
CV	10.69	14.11	11.33	10.89	12.01	11.16	15.16	10.11	13.33	12.54	9.87

NS = Non-significant.

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