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Capparis spinosa L. is Still a Difficult-to Propagate Crop - A Propagation Trial at Spiti Valley, India

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Abstract: *Capparis spinosa* L. (Capara or caper bush) is a perennial climber adapted naturally to the cold desert of the trans-Himalayas of Himachal Pradesh. The species is collected from the wild, holds significant cultural value and has a role in the traditional cuisine as well as the medicine system of Spitians belonging to the Bhoti ethnic community. Under the risk of developmental activities such as mountain cuttings, excavation, path broadening, etc., the climbers are always seen uprooted, strangled, hanging on the cliff near roads in Spiti Valley. In a recent scenario, these spiny-bushes are ignored by denizens on their farms and referred to as less commercial than domesticated horticultural crops. Consequently, its utilisation remains limited to household consumption with minimal attention to its commercial and ecological aspects. Hence, propagation trials on standardization of site-specific agro-techniques for multiplication and domestication of wild germplasm have been undertaken at Regional Horticultural Research Sub-Station (RHRSS) and Krishi Vigyan Kendra (KVK) Tabo, (H.P). As per previous literature studies, both sexual and asexual propagation methods have been tested using seeds and vegetative methods such as stem/root cuttings, respectively. However, consecutive three-year trials (2023-2025) of propagation methods have consistently showed poor establishment with unsuccessful results. The conducted trials indicate this medicinal plant species is still as difficult to propagate a crop in a cold desert region. With these constraints, attention must be given to strengthening in situ conservation to ensure its sustenance in natural habitats.

Key words: *Capparis spinosa* L., popagation techniques, cutting treatments, conservation.

In Spiti Valley, *Capparis spinosa* L. locally known as Roktukpa (in Bhoti) is a perennial shrubby climber belongs to family *Capparaceae or Capparidaceae*. The species occur across the dry temperate zone of Upper Kinnaur (Lippa, Pooh, Nako) extending up to alpine vegetation of Kibber, Spiti in cold desert region. Though, *Capparis spinosa* L. is native to the Mediterranean region (Moghaddasi, 2011). The species thrives under the harsh environmental conditions of the Western Himalayan cold desert, characterized by dry, stony ter rain and scant annual rainfall of less than 200 mm. In such habitats, the species exhibits a prostrate to scrambling habit by crawling

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radially up to 2 m all around the sloppy ground with spines on woody stems. It usually prefers to grow in halophytic or semi-halophytic conditions (Al-Yemeni and Zayed, 1999) and displays traits like tolerance to fire, resistance to drought and harsh winter conditions. In addition to its ecological adaptability, caper-bush possesses valuable properties such as medicinal, nutritional, culinary and ethno-pharmacological applications. Different caper-bush species such as *Capparis brevispina, C. decidua, C. grandis, C. horrida C. longispina, C. moonii, C. pedunculosa, C. rotundifolia, C. sepiaria, C. sikkimensis, C. spinosa, C. zeylanica* have been recorded across the Indian subcontinent (Maurya *et al.,* 2020), tropical to temperate climatic conditions. Plant shows frequent polymorphism with several variants all over the world (Fici, 2004) with factors such as phenotypical plasticity, eco-geographical differentiation, hybridization processes, selection of cultivated forms etc Fici, (2014).

A brief botanical description of the caper-bush has been documented by Fici, (2004); Veronesi an Montagnani, (2011); Lansky *et al.,* (2013), which describe that species bears simple leaves having oval to oblong-elliptic shape, frequently sparsely hairy at entire margin, arranged in alternate pattern with emerged tip outside or merged inside, conspicuous venations, complete edges, short petioles placed alternately on the stem. Flowers are bisexual, four white petals having long stamen shows nyctinasty movement, opening and closing in response to day-night cycle. Further, following the physiological maturity, the red caper fruit (berries) dehisces, allowing seeds dispersal upon ripening. Most of the plant leaves get powdery mildew due to fungal infection from *Leveillula taurica* with maturity.

Apart from wild harvesting, the European countries are growing its local cultivars and ethno-varieties (Inocencio *et al*., 2006) for culinary and medicinal purpose. This medicinal plant having nutritional and ethnobotanical uses is preferred as red wild fruit called as *maarutok-pa* by denizens of Spiti Valley. Caper berries turned reddish and soft, relishes when mature during the month of July/August. Roots are deep and extensive to avoid soil erosion (Musallam *et al.,* 2011), can be used as source of salt when burn (Sher *et al.,* 2012). As per information flower buds and berries are either eaten raw or cooked as vegetable (Legua *et al*., 2013), picking for off season to preserve by pickling; seed are collected for oil extraction; green fodder for grazing; therapeutic uses such as anti-diabetic, anti-fungal, anti-leishmania, expectorant, analgesic, and anti-inflammatory.

Fu *et al*., (2007) reported various beneficial compounds as such alkaloids, lipids flavonoids, glucosinolates in its chemical study, render its role commercially for pharma sectors having antiallergic, anti-inflammatory and antioxidant effects (Ageel *et al*., 1986; Domenico *et al*., 2005). The phytochemical analysis of different parts of caper-bush with active compounds and their role in health wellbeing have been documented by Zhang and Ma, (2018). The main active chemical compounds are rutin (0.23%), kaempferol-3-glucoside (0.19%), kaempferol-3-rutinoside and kaempferol-3-rhamnorutinoside (Giuffrida *et al.,* 2002; Shahrajabian *et al.,* 2021). As a folk medicine, it has been recommended for the treatments of digestion problems, asthma, joint pain, fever, cholera, skin-infection due to therapeutic potential of presence of prominent chemical compounds such as flavonoids, polyphenols, alkaloids, glycosides. In Spiti valley, traditional oil mixture of Chuli (Apricot) and caper seeds are recommended to treat muscular discomfort and to reduce old bone/joint pain in elders (Dhiman *et al.,* 2025).

This species has a significant role in mitigating land degradation by reducing soil erosion, conserving soil moisture, and helps in reclamation of saline and calcareous soils (Scakali *et al*., 2008). The white flowers serve a good source to attract pollinators during summers and could be scope for diversification of horticultural crops in cold desert, Spiti valley. Wild green shrub is preferred by wild animals like blue sheep (*Pseudois nayaur*) and Himalayan goats (*Hemitragus jemlahicus*) for grazing and in response facilitate seed dispersal. The presence of scattered climbers on steep cliff or inaccessible slopes is due to endo-zoochorous dispersal of seeds by grazing mammals or avian species, with subsequent successful germination of various resistant wild plant species in the Spiti valley.

The locals are least aware of its commercial uses with regards to pharma industries. Since plant possess high commercial value, thus there

is a need to develop a nursery technique for its mass production. The present paper shows the efforts to propagate plants through seed and vegetative method. According to Padulosi *et al*. (2002), no propagation method has been successfully standardized to date. Previous studies have reported variable results, with success achieved primarily through laboratory-based techniques such as tissue culture and micropropagation. Various studies have recommended different conditions for successful seed germination Bhoyar *et al*. (2010). Seed leaching for 12 hours has been reported to enhance germination (Tafti *et al*., 2012). Chemical treatments, including soaking seeds in solutions of indole fatty acid, indole acetic acid, or naphthalene acetic acid (100 mL L^{-1}) for 2–3 days, have also been suggested (Gianguzzi *et al*., 2019). Cold stratification for 40–50 days has been recommended to improve germination success (Sottile *et al*., 2021). According to Sher *et al*. (2012), seeds treated and sown in November can germinate by March under favorable conditions, particularly when ambient temperatures range between 15 and 16°C and adequate soil moisture is available. In contrast, naturally sown untreated seeds generally exhibit negligible germination rates (Olmez *et al*., 2004).

The present study was undertaken to evaluate seed- and cutting-based propagation methods of *Capparis spinosa* L. under the cold desert conditions of Spiti Valley and to assess their suitability for the domestication, multiplication, and conservation of this ecologically and medicinally important species.

Materials and Methods

Propagation trials using both sexual and asexual methods were conducted during 2023–2025 at RHRSS and KVK, Tabo, located at 32°05.32′N and 78°23.04′E at an altitude of 3,271 m above mean sea level in the Lahaul and Spiti district of Himachal Pradesh. The experimental site is situated along the Spiti River and is flanked by east–west-oriented mountain ranges. The region experiences extremely harsh climatic conditions, with winter temperatures often falling below –25°C and a short growing season extending from May to September. Characterized as a cold arid dry-temperate zone, the area is subjected to high-intensity desiccating winds. The soils are sandy, alkaline, and low in organic carbon content and moisture-holding capacity..

Firstly, through seeds, mature seed were collected during September/October, 2023 were taken for seed germination test. Pre-treatment of seeds through water and chemical (Auxin and Gibberellic acid as per Pascual *et al*., (2004) and Koufan *et al*., (2022) for 24 hours with three replications. The treated seeds were sown in November, 2023 in poly bags of prepared different growing media *i.e.,* Soil+ FYM (2:1) and kept under polyhouse condition for germination with routine watering in a week. Same trial of seed sowing was carried out in next year with sowing seeds during active months of April and May 2024.

Secondly, a stem-cutting experiment was conducted to evaluate the influence of different growth regulators on rhizogenesis in *Capparis spinosa* L., with cuttings collected at different times of the year. As per recommended by Salem *et al.,* (2001), among all season, the caper cuttings procured during spring (April and May) are easy to handle with active sap movement, comparatively less hard and negligible spines or soft leave buds. The selected caper cuttings for trials were with length of 20 to 25 cm, having diameter 1 to 1.5 cm along with leave nodes number ranges from 6 to 8 and internode length from 3 to 5 cm were selected for dip treatment. These

Table 1. Treatment details and their impact

Months/Year	Treatments	Rhizogenesis	Status
September, October, 2023	Nil	Nil	Infested/died
April, May, June, July, August, September, October, 2024	Water (control) Indole-3-butyric acid (IBA)- (2000 ppm, 4000 ppm, 5000 ppm), 6000 ppm, 9000 ppm) Gibberellic acid (GA)- (6000 ppm & 9000 ppm)	Nil	Died on transplantation
April, May, June, July, August, September, October, 2025	As Above	A hint of root-sprout (August)	Later died

were procured from surrounding areas of Tabo and Lari villages, Spiti Valley (H.P) in different months *i.e.,* September, October of 2023 (without pre-treatment) and April, May, June, July, August, September, October 2024 (incision and treatments) *i.e.,* Cuttings Dip Treatment for rooting (CDT) with using different growth hormones in laboratory conditions. Treatments include 1) Control -Water Treatment (WT) and 2) Growth hormones (GHT) *i.e.,* T1-IBA (2000 ppm), T2-IBA (4000 ppm), T3-IBA (5000 ppm), T4-IBA (6000 ppm), T5-IBA (9000 ppm) and treatments of Gibberellic acid T6 - GA (6000 ppm) and T7 - GA (9000 ppm) with three replicates for each (for two weeks) (Ramezani-Gask *et al*., 2008).

Results and Discussion

Sexual method (Through seeds): In the case of seed germination of *Capparis spinosa* L., replicated trials using treated seeds yielded unsatisfactory results, corroborating the findings of previous studies by Barbera (1991), Ramezani-Gask *et al*. (2008), and Sozzi *et al*. (2012). The treated seeds were sown during the winter of 2023; however, no signs of germination were observed even up to April 2024. This shows seeds possess the physiological dormancy (Witztum *et al.,* 1969) till April and May. Similarly, stored seeds sown during the active growing season in April and May 2024 also exhibited negligible germination. The poor germination response may be attributed to seed dormancy imposed by the hard seed coat, which contains fatty compounds such as linoleic acid ($C_{17}H_{31}COOH$) and linolenic acid ($C_{17}H_{29}COOH$), known to hinder water uptake and delay germination (Asatov *et al*., 2021). *Propagation through Vegetative method:* For vegetative propagation, mature stem cuttings collected during September and October 2023 were subjected to a simple water treatment for 48 hours before planting. The cuttings were planted in polybags and covered with polyethylene sheets to minimize soil moisture loss. However, the cuttings began to desiccate within a month of planting and gradually turned black due to fungal infestation. The onset of winter dormancy and declining temperatures further adversely affected their survival, resulting in the failure of rooting and establishment.

The treated stem cuttings collected during April, May, June, July, August, September, and October of 2024 and 2025 also failed to exhibit satisfactory rhizogenesis. Despite the application of various growth regulator treatments, rooting response remained poor, and no significant root development was observed under the prevailing environmental conditions. However, the cuttings collected in August (2025) and treated with IBA (9000 ppm) with basal incision showed a hint of root bud development, however these cuttings dried later and failed on transplantation. After two weeks, all the treated cuttings were transferred to standardized growing medium under both open-field and polyhouse conditions. The woody cutting procured in autumn remains green with retained foliage up to November (2025) and subsequently dry to enter dormancy. Nevertheless, no successful establishment as well as survival of any treated cuttings was recorded using different treatments (Fig 1).

The poor performance of conventional vegetative propagation observed in caper suggests that the species possesses a low capacity for rooting and establishment through stem cuttings, making large-scale propagation difficult (Elmaghrabi *et al*., 2017; Ullo, 2024). Similar constraints have been reported in previous studies, which indicate that conventional methods alone are often inadequate for the multiplication of this species. Consequently, considerable attention has been directed towards in vitro propagation techniques as an alternative approach for successful plant regeneration.

Several studies have demonstrated the effectiveness of tissue culture methods for caper propagation. Successful regeneration has been achieved from floral explants, including stigma, anthers, and unfertilized ovules of unopened flowers, using Murashige and Skoog (MS) medium supplemented with 3% sucrose and 6-benzylaminopurine (BAP) (Carra *et al*., 2007). Likewise, Musallam *et al*. (2011) reported approximately 80% success in shoot proliferation using MS and Woody Plant Medium (WPM) supplemented with 0.8 mg L^{-1} kinetin, 0.05 mg L^{-1} indole-3-butyric acid (IBA), and 0.1 mg L^{-1} gibberellic acid (GA_3). Elmaghrabi *et al*. (2017) obtained more than 80% rooting in micropropagated plants derived from wild leaf explants cultured on MS medium containing 2

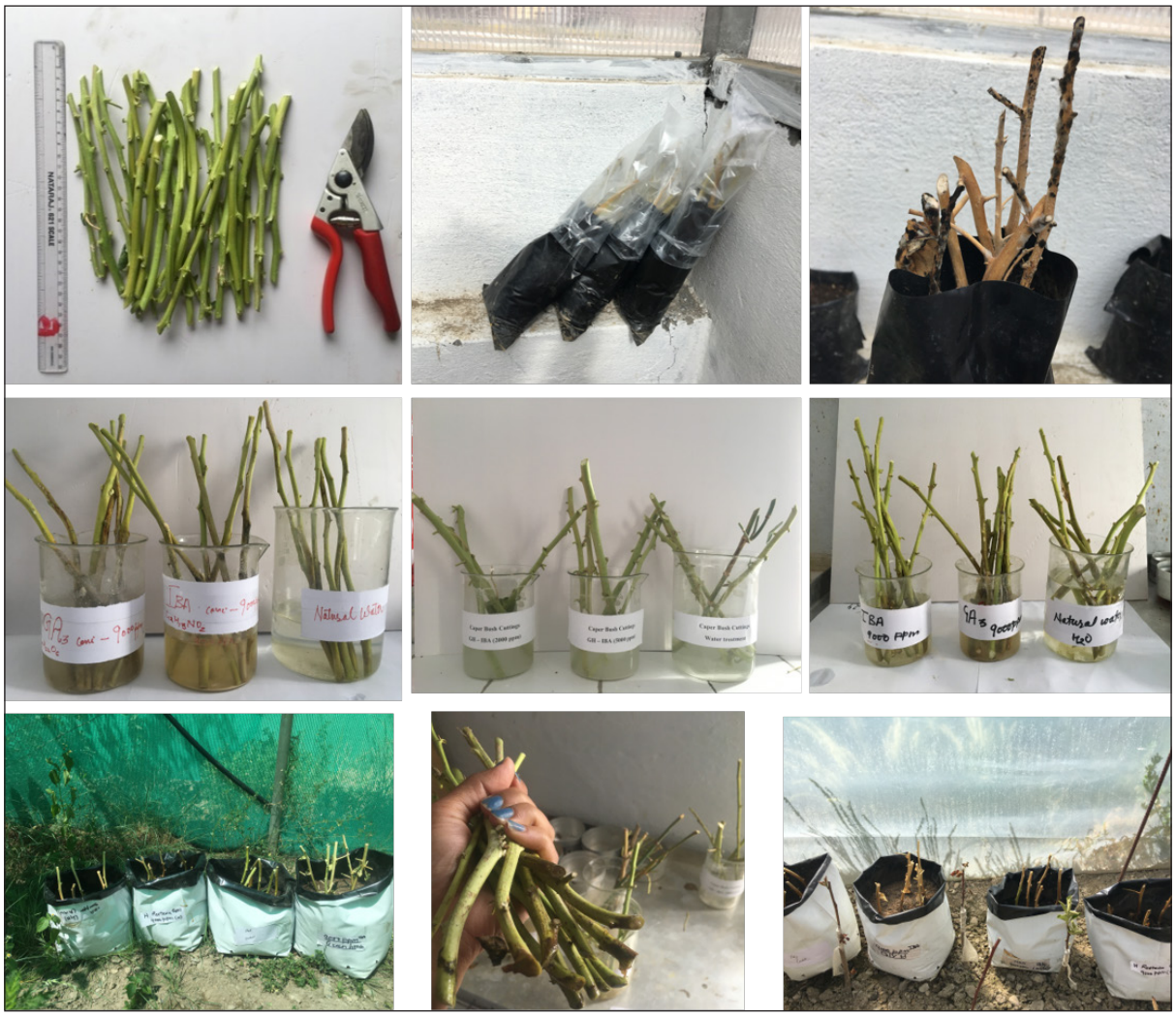

Fig 1. Trial images on Cutting propagations using treatments on Capparis spinosa L.

mg L^{-1} BAP. Furthermore, successful in vitro rooting of *Capparis spinosa* L. has been achieved using various auxin treatments, including NAA, IBA, and IAA at concentrations of 1–2 mg L^{-1}, as well as a combination of NAA (0.75 mg L^{-1}) and IBA (0.25 mg L^{-1}) (Gianguzzi *et al*., 2020).

The recalcitrant nature of caper to conventional vegetative propagation may be associated with its inherent hardiness and adaptation to harsh environments. Earlier observations by Thimann and Delisle (1939) indicated that highly resistant plant species are often difficult to propagate through cuttings, even when treated with auxin-based rooting hormones. The present findings are consistent with this view and further support the need for developing efficient in vitro propagation protocols for large-scale multiplication and conservation of caper.

Conclusion

As it is difficult to propagate at site simply using seeds and cutting methods, plant need attention for its conservation to avoid germplasm erosion. In wild habitat, the scattered patches are grazed by wildlife and livestock. The plant still lacks a general or specified site specific agro-technique; hence government should give attention on conservation of this wild plant of Spiti valley.

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Competing Interests

The authors declare no competing interests.

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