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Propagation of some Indigenous Plant Species for Restoration of Degraded Landscapes of Cold Desert in North-west Himalaya

Indigenous species having ecological significance and multipurpose uses should be promoted in restoration of degraded landscapes of the cold deserts of North-West Himalaya. Availability of the planting stocks of indigenous species in sufficient quantity for restoration is one of the challenges in the cold deserts as it is difficult to raise the planting stocks of indigenous species easily in the nursery due to their xerophytic nature for adapting towards the harsh climatic conditions. Indigenous plant species of cold deserts of North-West Himalaya having ecological significance and multipurpose uses viz., Capparis spinosa L., Colutea nepalensis Sim, Hippophae rhamnoides subsp. turkestanica Rousi, Ribes alpestre Wall. ex Decne., and Rosa webbiana Wall. ex Royle were selected for developing propagation methods. Besides, these indigenous species, Elaeagnus angustifolia an ecologically important and sacred species reported in the cold desert was also selected for developing its propagation methods. Shoot cuttings of Elaeagnus angustifolia treated with 6000 ppm of indole-3-butyric acid (IBA) in quick dip method recorded 71.82% rooting and shoot cuttings of Hippophae rhamnoides treated with 3000 ppm of IBA recorded 85% rooting in the poly house condition in the cold deserts. Rooting in the treated cuttings was also recorded better in the open nursery conditions. Cuttings of root suckers of Rosa webbiana in pure sand medium can be used for raising the planting stocks instead of shoot cuttings. Seeds of H. rhamnoides and Colutea nepalensis need to be dipped in the hot water and left as such for 16 hrs to get the better seed germination under the nursery conditions. Seeds of Ribes alpestre, Capparis spinosa and Rosa webbiana also showed some promising results when dipped in the hot water than the untreated seeds but there is need for more research on these species to develop suitable cost-effective methods for increasing their seed germination for raising the planting stocks easily in the nursery conditions of the cold deserts.

Key words: Cold desert, Propagation, *Capparis spinosa*, *Colutea nepalensis*, *Hippophae rhamnoides*, *Ribes alpestre*, *Rosa webbiana*, *Elaeagnus angustifolia*

Indigenous species need to be promoted in restoration programmes for making cold deserts ecologically sustainable.

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Introduction

Cold desert in North-West Himalaya is situated in the rain shadow zone in the Union Territory of Ladakh and Lahaul & Spiti District, Pooh sub-division of District Kinnaur in the state of Himachal Pradesh. Rodgers and Panwar (1988) described the cold deserts as a most ecologically fragile bio-geographic zone in India. The fragile and rugged nature of cold dessert supports less vegetal cover and seems to be very poor in terms of vegetation. The short growing season with extreme climatic conditions further restricts the growth of vegetation in the cold deserts. Abiotic factors such as fast blowing winds, variations in daily and seasonal temperatures, scanty or no precipitation, infra-red and ultraviolet radiations, frozen soil moisture during early spring and low relative humidity during the growing season contribute towards the sporadic distribution of vegetation. Soil erosion is one of the serious problems in cold deserts due to poor vegetal cover and fast blowing wind. The sparse natural vegetation is under exploitation due to over grazing and over harvesting to meet fuelwood and fodder requirements of the local communities. Uprooting of the shrub's species for fuel wood was reported by Rawat (2007) and Jishtu and Goraya (2020) as a main driver for reducing the vegetal cover as well as poor the regeneration of the indigenous species in the cold deserts. Main ligneous flora of the cold deserts having direct relevance to the local communities for meeting their fodder, fuel wood and pole wood requirements are characterized by the presence of *Juniperus polycarpos, J. communis, J. recurva, Populus alba, P. euphratica, P. ciliata, P. nigra*, *Salix alba, Salix elegans*, *S. fragilis, S. sclerophylla*, *Astragalus* spp., *Artemisia* spp., *Betula utilis*, *Capparis spinosa, Caragana brevifolia*, *Caragana gerardiana, Colutea nepalensis, Ephedra gerardiana, Fraxinus xanthoxyloides, Hippophae rhamnoides, H. salicifolia, H. tibetana*, *Lonicera* spp., *Myricaria germanica, Rosa webbiana, Ribes alpestre* etc.

The species to be selected for restoration of degraded landscape of cold desert should have ecological significance in terms of strong soil binding capacity, be able to enrich the status of soil nutrients by adding the organic matter, fix the atmospheric nitrogen and also provide the food to the wildlife, besides their multipurpose use to the local communities Availability of the planting stock of indigenous species in sufficient quantity is the major challenge for afforestation programmes in the cold deserts. Secondly, it is not easy to propagate indigenous species easily in the nursery due to their xerophytic nature. Therefore, development of propagation methods of the indigenous species of cold deserts is of immense importance for raising the planting stocks easily in the nursery for use in restoration and plantation programme. This will also be helpful in conserving the biodiversity of the indigenous species. Earlier studies on propagation of *Capparis spinosa*, *Colutea nepalensis*, *Hippophae rhamnoides* and *Rosa webbiana* mostly in the laboratory/ controlled conditions were conducted by Singh *et al.* (1992); Singh *et al.* (1997); Prakash *et al.* (1999); Sharma *et al*. (2004); Kapoor *et al*. (2011); Raj *et al.* (2013) etc.

Material and Methods

Indigenous cold deserts species of *Capparis spinosa, Colutea nepalensis, Hippophae rhamnoides, Ribes alpestre* and *Rosa webbiana,* having ecological significance and multipurpose use, were selected for developing propagation techniques in the nursery. Another species selected was *Elaeagnus angustifolia,* which was reported as an addition to the Flora of Lahaul and Spiti by Rawat *et al.* (2007). This non-leguminous, nitrogen fixing multipurpose tree species is also having good soil binding capacity, and it can be an important species for afforestation in the cold desert.

Experimental trials for developing cost effective propagation methods were conducted at Field Research Station, Tabo (Lahaul and Spiti, Himachal Pradesh) to determine the suitable treatments for shoot/ root cuttings and seed propagation in order to raise planting stocks for restoration of degraded landscapes of cold deserts. Protocols of different doses of growth hormone indole-3-butyric acid (IBA) were applied using on the shoot cuttings (12 cm in height and about 12-16 mm in diameter) of *Elaeagnus angustifolia* and *Hippophae rhamnoides* during the month of April for developing vegetative propagation method. In case of *Ribes alpestre* rooting was not recorded in the cuttings planted in the month of April hence, cuttings were planted in the month of August to get the better results as per following details (Chart 1):

In case of *Rosa webbiana,* cuttings of root suckers were tested instead of shoot cuttings in the pure sand, and sand, soil and FYM (1:2:1) growing media with 5 replications and 25 cuttings per replication.

Pre-sowing treatments on seed germination of *Capparis spinosa, Colutea nepalensis, Hippophae rhamnoides, Rosa webbiana* and *Ribes alpestre* were

Chart-1 :

Botanical name/ Local name	Concentration of rooting hormone (IBA) used (ppm)	Growing media used inside the poly house		Growing media in open nursery conditions	Experimental design and replication	No. of ramet/ replication
Elaeagnus angustifolia/ Gandhae	1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000 and control (without rooting hormone)	Sand	Sand, soil & FYM (1:2:1)	Sand, soil & FYM (1:2:1)	Randomized block design, 3	7 cuttings in poly house and 25 cuttings in open nursery
Hippophae rhamnoides/ Chharma	1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000 and control (without rooting hormone)	Sand	Sand, soil & FYM (1:2:1)	Sand, soil & FYM (1:2:1)	Randomized block design, 3	7 cuttings in poly house and 25 cuttings in open nursery
Ribes alpestre/ Yange	1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000 and control (without rooting hormone)	-	Sand, soil & FYM (1:2:1)	-	Randomized block design, 3	10 cuttings in poly house

Chart-2 :

Botanical name/ Local name	Pre-seed sowing treatment	Media in open nursery conditions		Experimental design and replication	No. of seeds/ replication
Hippophae rhamnoides/ Chharma	Seeds dipped in hot water and kept as such for 16 hrs. and control without any treatment	Sand	Sand, soil & FYM (1:2:1)	Randomized block design, 6	1000
Colutea nepalensis Braa	Seeds dipped in cold water & kept as such for 16 hrs. and control without any treatment	-	Sand, soil & FYM (1:2:1)	Randomized block design, 7	450
Capparis spinosa/ Rohtokpa or Martokpa	Seeds dipped in hot water & kept as such for 16 hrs. ., seeds dipped in hot water with 200 ppm gibberellic acid & kept as such for 16 hrs. and control without any treatment	-	Sand, soil & FYM (1:2:1)	Randomized block design, 9	160
Ribes alpestre/ Yange	Seeds dipped in hot water & kept as such for 16 hrs ., seeds dipped in hot water with 200 ppm gibberellic acid & kept as such for 16 hrs. and control without any treatment	-	Sand, soil & FYM (1:2:1)	Randomized block design, 5	100
Rosa webbiana/ Siya	Seeds dipped in hot water & kept as such for 16 hrs. and control without any treatment	-	Sand, soil & FYM (1:2:1)	Randomized block design, 5	200

applied in the month of April as per following details (Chart 2):

Cuttings and seeds were irrigated at proper intervals as per the requirements. The collected data was statistically analyzed using SPSS - 20 for extracting information of the treatments on rooting and seed germination.

Results and Discussion

Effect of different doses of growth hormone indole-3-butyric acid (IBA) on rooting in shoot cuttings of *Elaeagnus angustifolia* are shown in Table 1. Maximum rooting of 71.82% in sand medium and 67.57% in a sand, soil and FYM (1:2:1) medium in poly house conditions was induced by the 6000 ppm of IBA whereas maximum rooting of 66.67% was recorded for 7000 ppm of IBA in open nursery conditions of cold desert. Effect of different doses of IBA on rooting was found significant and growing media was non-significant in poly house conditions as well as in open nursery conditions. In case of rooting the response of 5000 ppm and 6000 ppm of IBA in poly house as well as response of 6000 ppm and 7000 ppm of IBA was at par in open nursery conditions. The rooting in shoot cuttings of *E. augustifolia* shows best performance at 6000 ppm of IBA in both growing media in poly house and open nursery conditions.

The Planting stocks obtained from the shoot cuttings were planted in the cold desert of Spiti shows better performance with 80% survival in the field and about 3000 expressed gregarious growth. Local communities of the cold desert considered it as a sacred tree and offered its pleasant flowering twigs to the Lord Buddha in the monasteries. This can be one of the best species for restoration of degraded landscapes of cold deserts.

Effect of different doses of growth hormone indole-3-butyric acid (IBA) on rooting in shoot cuttings of *Hippophae rhamnoides* are depicted in Table 2. Maximum rooting of 95.24% in sand medium was induced by the 2000 ppm of IBA and 85.71% in a sand, soil & FYM (1:2:1) medium in poly house conditions was induced by the 3000 ppm of IBA whereas maximum rooting of 60% was recorded for 3000 ppm of IBA in open nursery conditions of cold desert. Effect of different doses of IBA on rooting was found significant in poly house conditions as well as in open nursery conditions. However, effect of the growing media was non-significant. The dose of 3000 ppm of IBA was recorded as a best performing treatment as far as rooting is concerned in shoot cuttings of *H. rhamnoides* in both growing media in poly house conditions and in open nursery conditions.

Table 1: Effect of IBA on rooting in shoot cuttings of *Elaeagnus angustifolia* in poly house and in open nursery conditions

Concentration of IBA (ppm)	Average rooting (%) in poly house conditions		Average rooting (%) in open nursery conditions
	Sand	Sand, soil and FYM	
1000	61.90 (±5.20)	53.99 (±2.00)	-
2000	55.24 (±2.52)	54.84 (±1.00)	43.33 (±6.11)
3000	63.97 (±1.53)	63.71 (±1.00)	52.00 (±6.93)
4000	66.80 (±1.53)	63.16 (±1.79)	40.67 (±5.77)
5000	69.03 (±1.00)	65.31 (±0.58)	38.67 (±1.15)
6000	71.82 (±1.00)	67.57 (±1.53)	66.67 (±10.06)
7000	54.06 (±1.53)	52.92 (±0.58)	68.33 (±0.58)
8000	52.96 (±1.16)	51.34 (±1.15)	-
Control	42.59 (±1.53)	42.09 (±1.50)	38.00 (±3.46)

(± Standard deviation of mean)

Table 2: Effect of IBA on rooting in shoot cuttings of *Hippophae rhamnoides* in poly house and in open nursery conditions

Concentration of IBA (ppm)	Average rooting (%) in poly house conditions		Average rooting (%) in open nursery conditions
	Sand	Sand, soil and FYM	
1000	76.18 (±5.77)	57.14 (±8.50)	37.33 (±2.88)
2000	95.24 (±12.70)	71.42 (±8.80)	52.00 (±2.20)
3000	80.94 (±5.77)	85.71 (±9.70)	60.00 (±2.51)
4000	66.66 (±5.19)	66.66 (±5.19)	52.00 (±0.00)
5000	52.38 (±4.62)	42.86 (±4.26)	32.00 (±3.00)
6000	47.62 (±4.62)	61.90 (±9.81)	28.00 (±2.51)
7000	33.33 (±5.19)	42.86 (±6.20)	29.33 (±1.15)
8000	28.57 (±0.00)	47.62 (±4.61)	24.00 (±1.10)
Control	19.04 (±5.77)	33.33 (±5.12)	21.33 (±1.15)

(± Standard deviation of mean)

Singh *et al.* (1997) reported about 60% rooting in the shoot cuttings of the *H. rhamnoides* under nursery conditions of the cold deserts. Prakash *et al*. (1999) reported that treatment of 100 ppm of IAA and 50 ppm of IBA for 24 hrs was most effective in inducing the rooting in the shoot cuttings of *H. rhamnoides*.

Effect of different doses of growth hormone indole-3-butyric acid (IBA) on rooting in shoot cuttings of *Ribes alpestre* in the month of August is given in Table 3. Maximum rooting of 43.33% in a sand, soil and FYM (1:2:1) medium in poly house conditions was induced by the 4000 ppm of IBA followed by 3000 ppm of IBA. Effect of different doses of IBA on rooting was found significant in poly house conditions. The rooting trial conducted in the month of April gave no results whereas the month of August shows rooting in the plant cuttings.

Singh *et al.* (1997) reported that *Rosa webbiana* can propagate very well by shoot cuttings with 70% rooting. Effect of different doses of growth hormone indole-3-butyric acid (IBA) on rooting in shoot cuttings of *R. webbiana* was tried in poly house and open nursery conditions but no rooting was recorded. Similarly, cuttings of root suckers of *Rosa webbiana* was tried in different media (sand and sand, soil and FYM) in poly house conditions without any treatment of growth hormone. Effect of different media on rooting was found significant in poly house conditions (Table 4). Maximum rooting was recorded in pure sand (68.80%) than the sand, soil and FYM medium (47.20%) in the cuttings of root suckers.

Effect of different pre-sowing treatments on seed germination of *H. rhamnoides* in different germinating media under nursery conditions of cold deserts is given in Table 5. Maximum germination of 74.61% in sand medium and 53.16% in a sand, soil and FYM (1:2:1) medium in nursery conditions was recorded for the seeds dipped in hot water. Maximum germination was recorded in sand medium for the treated and untreated seeds in comparison to the medium having sand, soil

Table 3: Effect of IBA on rooting in shoot cuttings of *Ribes alpestre* in poly house conditions.

Concentration of IBA (ppm)	Average Rooting (%) in poly house conditions
1000	26.67 (±3.46)
2000	33.33 (±3.46)
3000	40.00 (±0.00)
4000	43.33 (±3.46)
5000	30.00 (±6.00)
6000	20.00 (±0.00)
7000	20.00 (±7.55)
8000	30.00 (±0.00)
Control	13.33 (±5.19)

(± Standard deviation of mean)

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Table 4: Effect of different media on rooting of root suckers of *Rosa webbiana* in ploy house conditions

Growing media	Rooting (%)
Pure sand	68.80 (±6.05)
Sand, soil and FYM (1:2:1)	47.20 (±7.32)

(± Standard deviation of mean)

Table 5: Effect of different pre-sowing treatments on seed germination of *Hippophae rhamnoides* in different germinating media under nursery conditions of cold deserts

Pre-seed sowing treatment	Germination (%) in nursery conditions	
	Sand	Sand, soil & FYM
Seeds Dipped in Hot water	74.61 (±2.43)	53.16 (±2.50)
Control	63.68 (±2.04)	32.67 (±3.80)

(± Standard deviation of mean)

and FYM in 1:2:1. The effect of growing media on seed germination was found to be significant.

Effect of different pre-sowing treatments on seed germination of *Colutea nepalensis* under nursery conditions of cold deserts is given in Table 6. Maximum germination of 70.63% was recorded for the seeds dipped in hot water followed by the seeds dipped in cold water (59.84%), whereas the untreated seeds show germination in the range of 47.74%.

Singh and Jishtu (1997) reported 57.83% of germination in the seeds stored in low temperature (-5^{0}C) for first six months and stored in room temperature for next six months duration than the untreated seeds.

Effect of different pre-sowing treatments on seed germination of *Capparis spinosa* under nursery conditions of cold deserts is given in Table 7. Seeds dipped in hot water with and without gibberellic acid showed 13.89 and 13.61% germination, respectively and untreated seeds exhibited 5.62% germination. There is need to work more on this species to develop suitable methods for increasing its germination percentage.

Singh *et al*. (1992) reported 8.66% germination in the seeds of *Capparis spinosa* dipped in hot water for 90 minutes, compared to untreated seeds. Seeds of this species show dormancy to withstand the extreme environmental conditions of the cold deserts.

Table 6: Effect of different pre-sowing treatments on *Colutea nepalensis* seed germination under nursery conditions of cold deserts

Pre-seed sowing treatment	Germination (%) in nursery conditions
Seed Dipped in Hot water	70.63 (±13.35)
Seed Dipped in Cold water	59.84 (±9.57)
Control	47.74 (±5.03)

(± Standard deviation of mean)

Table 7: Effect of different pre-sowing treatments on *Capparis spinosa* seed germination under nursery conditions of cold deserts

Pre-seed sowing treatment	Germination (%) in nursery conditions
Seed Dipped in Hot water with GA 200 ppm	13.89 (±1.75)
Seed Dipped in Hot water	13.61 (±0.75)
Control	5.62 (±1.96)

(± Standard deviation of mean)

Table 8: Effect of different pre-sowing treatments on *Ribes alpestre* seed germination under nursery conditions of cold deserts

Pre-seed sowing treatment	Germination (%) in nursery conditions
	Sand, soil & FYM
Seed Dipped in Hot water with GA 200 ppm	26.80 (±3.19)
Seed Dipped in Hot water	30.60 (±3.20)
Control	18.20 (±6.45)

(± Standard deviation of mean)

Table 9: Effect of different pre-sowing treatments on *Rosa webbiana* seed germination under nursery conditions of cold deserts

Pre-seed sowing treatment	Germination (%) in nursery conditions
Seed Dipped in Hot water	16.10 (±0.83)
Control	9.60 (±1.30)

(± Standard deviation of mean)

Effect of different pre-sowing treatments on seed germination of *Ribes alpestre* under nursery conditions of cold deserts is presented in Table 8. Seeds dipped in hot water with gibberellic acid and simply in hot water showed the 26.80% and 30.60% respectively. Germination of 18.20% was recorded for untreated seeds.

Effect of different pre-sowing treatments on seed germination of *Rosa webbiana* under nursery conditions of cold deserts is reveled in Table 9. Seeds dipped in hot water showed the 16.10% germination than the untreated seeds (9.60%).

Conclusion

Indigenous species need to be used in restoration of degraded areas of the cold deserts of North West Himalaya. Availability of the planting stocks of the indigenous species is one of the major constraints for any restoration/plantation programme in the cold deserts as it is difficult to raise the planting stocks of the indigenous species easily in the nursery, due to their xerophytic nature. An attempt was made to develop the cost-effective propagation methods for *Capparis spinosa, Colutea nepalensis, Elaeagnus angustifolia*, *Hippophae rhamnoides, Ribes alpestre* and *Rosa webbiana* for raising the planting stocks in the nursery. The findings of the study concluded that dose of 6000 ppm of IBA in quick dip method was found effective for raising the shoot cuttings of *E. laeagnus angustifolia* and dose of 3000 ppm of IBA in quick dip method for the shoot cuttings of *H. rhamnoides* in the nursery conditions of the cold deserts. Cuttings of root suckers of *Rosa webbiana* should be preferred instead of shoot cuttings for raising in pure sand medium. Seeds of *H. rhamnoides* and *C. nepalensis* should be dipped in the hot water for 16 hrs to get better under nursery conditions. Seeds of *R. alpestre, C. spinosa* and *R. webbiana* treated in hot water gave encouraging results. There is a need of further research on the seeds of these species to overcome the dormancy and to develop some suitable cost-effective methods for raising their planting stocks in the nursery conditions of the cold deserts.

उत्तर-पश्चिम हिमालय में शीत मरुस्थल के क्षरित भूदृश्य के पुनरूद्धार की बहाली के लिए कुछ स्वदेशी पौधों की प्रजातियों का प्रचार

आर.एस. रावत और के.एस. कपूर

सारांश

उत्तर–पश्चिम हिमालय के शीत मरुस्थलों के क्षरित भूदृश्यों की पुनरूद्धार में पारिस्थितिक महत्व और बहुउद्देशीय उपयोग वाली स्वदेशी प्रजातियों को बढ़ावा देने की आवश्यकता है। शीत मरुस्थलों में बहाली के लिए पर्याप्त मात्रा में स्वदेशी प्रजातियों के रोपण स्टॉक की उपलब्धता एक चुनौती है क्योंकि कठोर जलवायु परिस्थितियों के अनुकूल होने के लिए उनकी जेरोफाइटिक प्रकृति के कारण नर्सरी में स्वदेशी प्रजातियों के रोपण स्टॉक को आसानी से उगाना मुश्किल है। उत्तर–पश्चिम हिमालय के शीत मरुस्थलों की स्वदेशी पौधों की प्रजातियाँ जिनका पारिस्थितिक महत्व और बहुउद्देशीय उपयोग है, जैसे *कैपेरिस स्पिनोसा* लिन, *कोलुटिया नेपालेंसिस* सिम, *हिप्पोफे रमनोइड्स* उप प्रजाति *टर्केस्टेनिका रूसी, रायब्स एल्पेस्ट्रे* वालिच एक्स डेकेन और रोजा वेबबियाना वालिच एक्स डेक्ने प्रसार विधियों के विकास के लिए चयनित किये गये। इन स्वदेशी प्रजातियों के अलावा, *इलियाग्नस एंजस्टिफोलिया* शीत मरुस्थलों में रिपोर्ट की गई पारिस्थितिक रूप से महत्वपूर्ण और पवित्र प्रजाति को भी इसके प्रसार विधियों को विकसित करने के लिए चुना गया। इण्डोल–3–ब्यूटिरिक एसिड के 6000 पीपीएम से क्विक डिप मेथड से ट्रीट किए गए *इलियाग्नस एंजुस्टिफोलिया* की शूट कटिंग में 71.82% रूटिंग दर्ज की गई और इण्डोल–3–ब्यूटिरिक एसिड के 3000 पीपीएम से ट्रीट किए गए *हिप्पोफे रमनाइड्स* की शूट कटिंग को शीत मरुस्थलों में पॉली हाउस की स्थिति में 85% रूटिंग दर्ज की गई। खुली नर्सरी स्थितियों में उपचारित कलमों में जड़ें भी बेहतर दर्ज की गई। शुद्ध बालू माध्यम में *रोजा वेबबियाना* के रूट सकर की कटिंग को शूट कटिंग के बजाय रोपण स्टॉक को बढ़ाने के लिए उपयोग करने की आवश्यकता है। नर्सरी परिस्थितियों में बेहतर बीज अंकुरण प्राप्त करने के लिए *हिप्पोफे रम्नोइड्स* और *कोलुटिया नेपालेंसिस* के बीजों को गर्म पानी में डुबोया जाना चाहिए और 16 घंटे के लिए छोड़ देना चाहिए। *रिब्स एल्पेस्ट्रे, कैपेरिस स्पिनोसा* और *रोजा वेबबियाना* के बीजों ने भी अनुपचारित बीजों की तुलना में गर्म पानी में डुबोने पर कुछ आशाजनक परिणाम दिखाए लेकिन अभी भी इन प्रजातियों पर अधिक शोध करने की आवश्यकता है ताकि उनके बीज अंकुरण को बढ़ाने के लिए कम लागत वाले प्रभावी तरीके विकसित किए जा सकें।

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