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Studies on Refinement of Container Size and Potting Mixture for Production of Quality Seedlings in Spruce (*Picea Smithiana* Wall. Boiss)

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Abstract

Spruce (*Picea Smithiana*) is an evergreen tree and distributed through the temperate Himalaya at the elevation of 2000 - 3500 m. Natural regeneration of spruce (*Picea smithiana*) is generally slow and almost negligible due to a number of factors e.g. presence of un decomposed raw humus on forest floor low germinative capacity of seed and infrequent good seed years. In order to supplement natural regeneration through artificial means, nursery raising assumes significance. The present study aimed at optimizing the root trainer container size and the potting mixture ingredients and their proportion for the production of quality nursery stock of *Picea smithiana*. Nine combinations of potting mixture ingredients (Forest Soil, Garden Soil, Sand, FYM and Lake weed) were tested in various ratios for the optimization of potty mixture in different root trainer sizes. Simultaneously, three different volumes (150_{cc}, 250_{cc} and 300_{cc}) of root trainers were tested for suitability of container size. Chemical and physical analysis of potting mixture ingredients was carried out for better understanding of nutrient status. The best seedling growth at seven month age in terms of height (5.53 cm), Collar diameter (1.57 mm), fresh shoot weight (0.34 g), dry shoot weight (0.10 g), fresh root weight (0.27 g) , dry root weight (0.03 g), root shoot ratio(2:52), and total fresh biomass (0.61 g) were observed when seedlings were raised in root trainer container size (300_{cc}) filled with potting mixture of (M_8) Soil:Sand:FYM (1:1:2) and the lowest growth parameters were observed in root trainer container size (150_{cc}) filled with forest soil only. Plantable quality seedlings can be recovered within a period of 7 months using potting mixture of Soil, Sand and FYM (1:1:2) and Soil, Sand and Lake weed (1:1:2) ratios in root trainer container size 300_{cc}.

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Keywords

Potting Mixture, *Picea smithiana*, Root Trainer, Lake Weed, Ingredient, Biomass

1. Introduction

The Himalayas is the home of conifers and constitutes one of the most divergent and economically important group of species. The conifer species especially Deodar (*Cedrus deodara*), Kail (*Pinus wallichiana*), Fir (*Abies pindrow*) and Spruce (*Picea smithiana*) are distributed at an altitudinal line one above the other in tiers, in pure or in mixed species combination. These species form extensive forests of economic value in Himalayas.

The Spruce (*Picea smithiana*) is an evergreen tree and distributed through the temperate Himalaya at the elevation of 2000 - 3500 m. The wood of Spruce is used in packing cases, shutters, planking, doors and window frames in wood based industries. To raise this tree species on large scale in forest and non-forest areas, quality seedlings is the pre-requisite. The natural regeneration of spruce (*Picea smithiana*) is generally slow and almost negligible due to a number of factors e.g. presence of undecomposed raw humus on forest floor low germinative capacity of seed and infrequent good seed years. The regeneration of these forests, however, is not keeping pace with the removal of tree species and this problem has resulted in the depletion of growing stock over the large area. The problem of natural regeneration in this specie has been constantly engaging the attention of foresters. Natural regeneration of spruce forests is reported to be adversely affected by the thick layer of humus in Western Himalays (Troup, 1921). In Chakarata Division of Uttar Pradesh in India, during studies on soil profile it was observed that the greater dispersion of Manganese and higher iron content in the soil also affected the natural regeneration of this species (Yadav, 1963). Debris accumulation and poor seed production heavy grazing and bad drainage also affect the regeneration, growth and development of this species (Kaushik, 1954). Besides good quality seeds, suitable root trainer (container size) potting mixture is also necessary for the production of high quality seedlings for large scale plantation programmes (Hossain, 1995). Potty mixture with excessive clay creates water logged condition while the sandy medium remains loose due to disproportionate amount of sand, which dries out readily and promotes the leaching out of the nutrients. It is imperative to determine or standardize the growing medium to provide best physio-chemical environmental attributes. On one hand the growing medium provides mechanical support and on the other hand it provides nutrients, water, oxygen for growth and development to the seedlings. Keeping in view the limitations of traditional nursery techniques and increase demand of *Picea smithiana* seedlings in afforestration programme, the present study was aimed to optimize potty mixture ingredients, their proportion and root trainer container size for quality seedlings of *Picea smithiana* in a short period.

2. Material and Method

Healthy cones of Spruce were collected in the second forth night of the September from healthy, middle aged and well developed crowned trees growing in Daksum forest area at an attitude of 2200 m amsl. Range Vailoo of Anantnag Forest Division. The collected cones were sealed in gunny bags and brought to the laboratory, dried under shade at room temperature until the opening of the cone scales. The seeds were extracted manually. The well sieved forest soil, sand, FYM and Lake weed were mixed to prepare six growing medias in the following proportions on the basis of v/v.

1) Forest soil alone;
2) Soil (Garden soil alone);
3) Soil and Sand (1:1);
4) Soil, Sand, FYM and Lake weed (1:1:1:1);
5) Soil, Sand and FYM (2:1:1);
6) Soil, Sand and Lake weed (2:1:1);
7) Soil, Sand and FYM (1:2:1);
8) Soil, Sand and FYM (1:1:2);
9) Soil, Sand and Lake weed (1:1:2).

The pointing mixture were thoroughly mixed in the desired proportion where needed and used for filling of three types of root trainers (Rc_1, 150, Rc_2 200_c and Rc_3 300_c). The containers were filled with the potting medium thoroughly giving occasional gentle lapping on the ground. The containers were kept on raised platform made up of wired frame to allow self air pruning of roots and encourage fibrous root development. Seeds of *Picea smithiana* were sown in each container in the month of February with four replications of 100 seeds each. Thus, a total of 400 seeds were evaluated in each treatment. Seed germination was recorded until it was completed, regular weeding and watering was provided to the seedlings. After one year, five seedlings from each replication were uprooted at random and measured for their seedling height (cm) and collar diameter (mm). The root and shoot proportions of each seedling were then cut and weighed (g) for fresh weight determination and placed separately in an oven at 80˚C till a constant weight was achieved. The sum of fresh shoot and root was calculated to determine the total fresh biomass (g). While the shoot and root ratio was worked out on dry weight biases by dividing the weight of dry shoot by the weight of dry root of each plant separately. The addition of root and shoot dry weight gave total seedling dry weight. The data was subjected to analysis of variance (ANOVA) to determine the critical difference (C.D). The square root transformation of percentage data was carried out before putting the data to analysis.

3. Results

3.1. Effect of Container Size

The investigation indicates that the container size exert significant influence on seedling growth parameters in the *Picea smithiana*. It is evident from the data (**Figure 1**) that maximum plant height (4.53 cm) collar diameter (1.98 mm) fresh shoot weight (0.26 g), dry shoot weight (0.06 g) fresh root weight (0.22 g), dry root weight (0.03 g), root : shoot ratio (2:15) and total biomass (0.48 g) resulted when seedlings were raised in root trainer size 300_{cc}. Recorded seedling height was 50.26% more than height recorded in 150_{cc} root trainer, Similarly collar diameter was 91.20% more over 150_{cc} root trainer.

3.2. Effect of Potting Media

The potting mixture exerts significant influence on all the seedling growth parameters in this species. The data indicates(**Figure 2**) significantly highest height of (4.50 cm), collar diameter (1.16 mm), fresh shoot weight (0.26 g), dry shoot weight (0.07 g), fresh root weight (0.19 g), dry root weight (0.03 g), root shoot ratio (2.32) and total biomass(0.45 g) when raised in (M_8) soil: sand: FYM in the ratio of 1:1:2. This represents an increase of 45,705,560 per cent of more plant height, collar diameter, root shoot ratio and total biomass respectively over the minimum obtained in M_1 (Forest Soil only).

3.3. Interaction Effect of Container Size and Potting Mixture

The container type and potting medium interaction were found to have significant influence on seedling growth parameters in the species. The data in (**Figure 3**) reveals significantly maximum plant height of (5.53 cm), collar diameter (1.57 mm) fresh shoot weight (0.34 g), dry shoot weight (0.10 g), fresh root weight (0.27 g), dry root weight (0.03 g) , root : shoot ratio (2.52) and total biomass (0.61 g) when seedling were raised in Rc_3 (300_{cc}) container size and potting mixture of M_8 filled with potting mixture of soil, sand and FYM (1:1:2), the least value of all the parameters resulted in treatment combination Rc_1M_1.

4. Discussions

The higher seedling growth parameters are attributed to higher container volume (300_{cc} Rc_3) which holds more soil nutrients and moisture than other container type. Bigger container volume enhances fibrous root development and therefore more seedling growth and development under the bigger size root trainer was observed. It has been observed that the higher growth and biomass production in lodge pole pine, white spruce and Douglus fir was achieved when seedlings were raised in large containers (Hodking & Mitchell, 1975). Similarly, while working with *Acacia catechu*, *Albizia lebbak*, *Azadirachta indica and Pinus roxburghii* maximum plant height, collar diameter and other growth parameters were recorded when improved bottom hole poly bags production system (Mounted Angle Iron Bed) was used for nursery production (Gera et al., 2003). The better growth may be ascribed to higher amount available nutrients as compared to other mixtures. The results are thus, in agreement with the work carried out on nursery and plantation technology of chir pine and in *Pinus gerardiana* seedlings where seedlings were raised in different container size and potting mixture under Solan conditions in Himachal

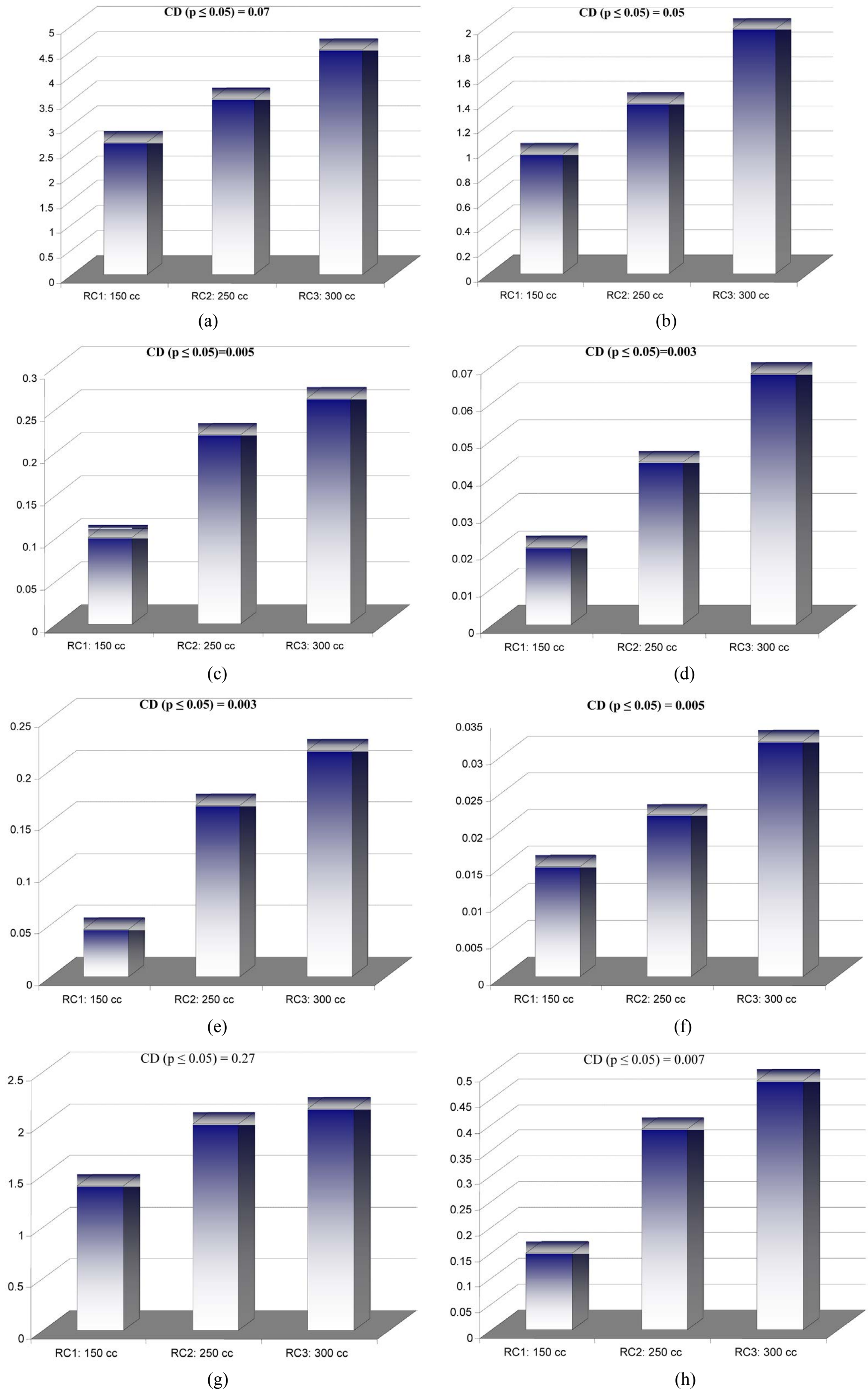

Figure 1. Effect of root trainer container size on (a) height; (b) collar diameter; (c) fresh shoot weigh; (d) dry shoot weight; (e) fresh root weight; (f) dry root weight; (g) Root shoot ratio; (h) total fresh biomass.

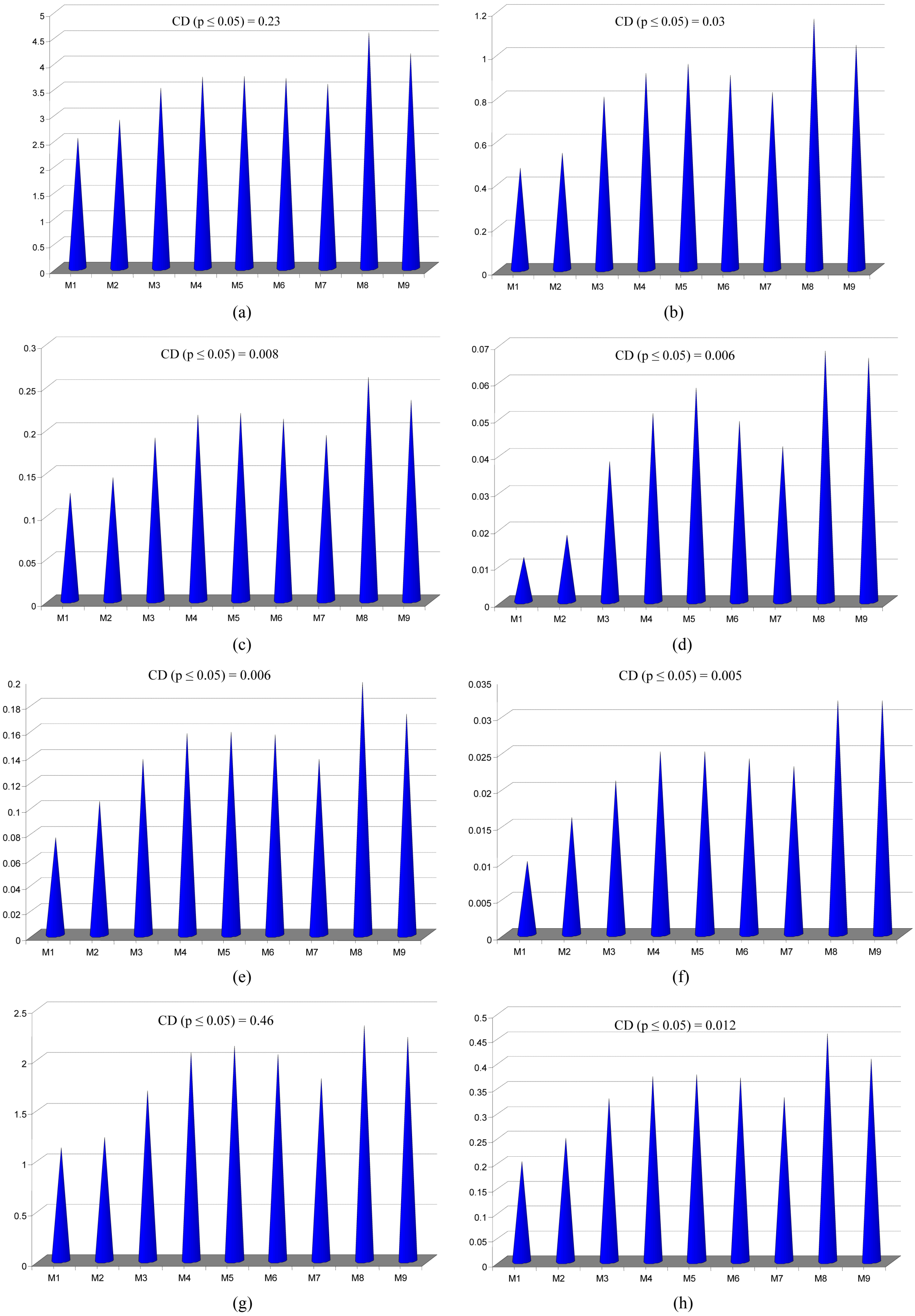

Figure 2. Effect of potting mixture on (a) height; (b) collar diameter; (c) fresh shoot weight; (d) dry shoot weight; (e) fresh root weight; (f) dry root weight; (g) root shoot ratio; (h) total fresh biomass.

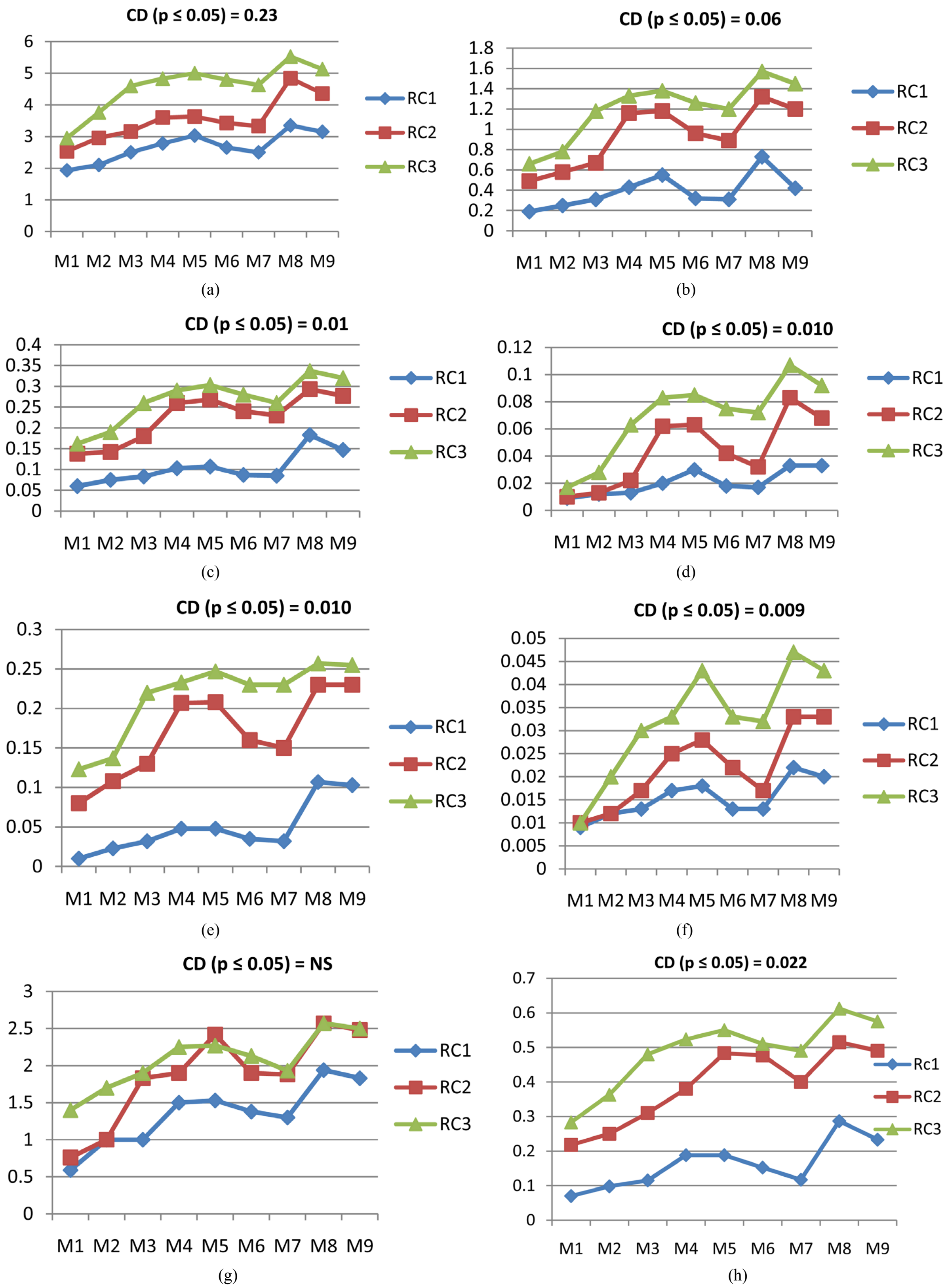

Figure 3. Interaction effect of container size and potting mixture on (a) height; (b) collar diameter; (c) fresh shoot weight; (d) dry shoot weight; (e) fresh root weight; (f) dry root weight; (g) root shoot ratio; (h) total fresh biomass.

Pradesh (Bhardwaj et al., 1986; Malik & Shamet, 2009). Size of container has significant role in carrying capacity of potting mixture, which supports the growth and development of seedlings at nursery stage. Large the size of container, more the availability of nutrient for longer period and more the surface area to hold water and space for root development resulting in better growth of seedlings. The major constrain of large size (Volume) container is production cost , as large container requires more potting mixture and long growing period for seedling root system for plug formation (Sharma, 1996). Requirement of optimum container size depends on factors like species, growing density, type of potting mixture length of growing season and size of seedling desired for planting (Jinks, 1994). The higher the volume, better the seedling growth was observed in this experiment. Similarly, it is reported that increasing the container size result in better growth in seedlings of *Pinus contorta* (Endean & Carlson, 1975). However, plug formation was comparatively better in Rc_3 and Rc_2 as compared to Rc_1. This may be due to more volume of potting mixture and the root system could not occupy the container as compared to Rc_2 and Rc_3. In *Picea smithiana* plantable seedlings of 5 cm in height can be produced in seven month period in 300_{cc} root trainer. However based on the nursery gestation period and requirement of seedling size container size can be determined. In other words for producing seedlings in seven month period it is advisable to use 300_{cc} and 200_{cc} root trainers for planting at stress sites which requires seedling bigger volume containers can be utilized.

5. Conclusion

Nine combinations of potting mixture ingredients (Forest soil, Garden soil, Sand, FYM and Lake weed) were tested in various ratios for the optimization of potty mixture in different root trainer sizes. Simultaneously, three different volumes (150_{cc}, 250_{cc} and 300_{cc}) of root trainers were tested for suitability of container size. It is concluded from the present study that the potting mixture, its proportion and the root trainer container size have significant effects on the seedling growth. Plantable quality seedlings can be recovered within a period of 7 months using potting mixture of Soil, Sand and FYM (1:1:2) and Soil, Sand and Lake weed (1:1:2) ratios in root trainer container size 300_{cc} (Rc_3).

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