GROWTH OF TRIFOLIATE ORANGE (*Poncirus trifoliata* L.) SEEDLINGS AT DIFFERENT MANAGEMENT CONDITION IN NCRP, DHANKUTA.

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ABSTRACT

Citrus fruits are grafted in trifoliate orange (Poncirus trifoliate L) due to good fruit quality, dwarfness, tolerant to soil born disease, cold and hardiness. Slow growth rate of trifoliate orange is one of the serious problems of citrus nursery owners. It takes more than three year to attain the grafting requirement for sapling production. Facing this problem an experiment was conducted on trifoliate orange to accelerate the growth rate of seedlings. Seedlings are grown in different media under three different environment condition i.e. polyhouse, plastic tunnel and open field condition in NCRP, Dhankuta in Fiscal Year 2063/ 64 and 064/65. Seeds were grown in five different media (five treatments) and replicated four times. Highest seedling height (83.67 cm) and diameter (7.14 mm) was observed in polyhouse condition with vermin compost + soil mixed (1:1) treatment where as lowest height (28.20 cm) and diameter (3.58 mm) observed in open field condition in the same treatment within one year. The result shows that, highly significant effect of environmental condition on seedling growth. Seedlings height of trifoliate orange is almost three times and diameter was two times greater in polyhouse as compared to open field. Therefore, result of this experiment guided to the nurseryman's, to grow the trifoliate orange seedling in the polyhouse condition with soil and vermicompost mixed media (1:1) to accelerate growth of the seedlings and to get stander height and diameter within one-year period. This technology will be applicable to the nursery mans to improve the quality of saplings in the nursery.

Key words: Trifoliate orange, Citrus, nursery, media, polypot, seedling, rootstock, vermicompost, polyhouse.

INTRODUCTION

Grafted seedlings are widely used by the commercial fruits growers due to fruit quality, resist with soil borne diseases and hardiness. Depending on the adoptability and compatibility, many types of citrus species were used for rootstock purpose in citrus fruits. Among them, Trifoliate orange (*Poncirus trifoliata*, syn.) is widely used rootstock in most of the citrus species in Nepal. Botanical characteristic of trifoliate orange is differing from citrus fruits species. It is deciduous nature, trifoliate leaves, and pubescent (downy) presents on the fruit. Fruits are normally matured in late summer or early fall and drops soon thereafter. Seeds are brownish colour and broad end. The plant is hardy and tolerate to cold (frost and snow) and soil borne diseases. Therefore, citrus fruits grafted on trifoliate orange are usually hardier than their own roots.

Growth of Trifoliate orange seedling is one of the important parameter for nursery owners. Slow growth of trifoliate seedling is one of the limiting factors of nursery owners. Many factors are associated with seedling growth, but major factor is temperature and nutrient. In winter season seedling growth of trifoliate orange is stop about four month in a year, due to the low temperature. It takes more than three years to meet the requirement for grafting in normal condition and wait about four to five years for sapling production. It is urgent needs to generate the growth accelerated technology of seedling in the nursery to maintain the quality standard of saplings. Growth of the seedlings is influenced by environmental condition and growing media. Gautum et al (2001) reported that, to increase the trifoliate height (41.48 cm) by spraying urea at the rate of 3.5g /liter of water at one month interval and highest collar diameter (0.68 cm) was observed in 2 part soil: 1 part Farm Yard Manure: 3 part sand mixture after 6 months at 1400m elevation. Slow growth rate of trifoliate orange is due to decidious nature (October to January) and poor nutrient status in the soil. Farmers were used farm yard manure in the nursery but the amount is very low and quality also poor. The result is growth and quality of the seedling is poor and high mortality rate in the main field after transplanting and fruiting trees were suffering with soil borne diseases (Foot rot, collar rot etc). It is one of the serious problems in citrus industries of Nepal. Facing this problem an experiment was conducted at in National

Citrus Research Program (NCRP), Dhankuta, to determine the growth acceleration technology of trifoliate orange seedlings in nursery at different condition using different media.

MATERIALS AND METHODS

An experiment was conducted on trifoliate orange; to accelerate the growth rate of seedlings at NCRP, Dhankuta in 2063/64 and 2064/65 Seedlings are grown in three-environmental condition i.e. under polyhouse, plastic tunnel and open field condition. Seedlings are raised in five different media (five treatments) i.e. (i) Compost + soil 1:1 mixture (farmer's practices) (ii) Vermin compost, (iii) Vermin compost + soil 1:1 mixture, (iv) Forest top soil and (v) Forest top soil + soil 1:1 mixture and replicate the treatments four times in each environment condition. Trifoliate seeds are grown in the nursery bed. Polybags (8x6 inch size) were filled with different media as treatment wise and transplanted the seedlings in polypot at three to five true leaf stages, than placed in the different environment conditions for evaluation. The experimental plot was designed in one square meter per treatment and total 150 seedlings (polybags) are raised in each plot. Observation was measured after 60 days where the plants are well established. All the required observations are measured from randomly selected 50 plants at 30 days interval up to one year. Height of the seedlings was measured from the base up to apical point of the seedling and diameter was measured at 5 cm above the ground level. The experiment was arranged in factorial RCBD design. The necessary data were recorded and analysed in M-stat program.

RESULTS AND DISCUSSION

Seedling Growth:

Among the three conditions (Polyhouse, Tunnel and open field) height of the trifoliate seedling was increased just double in the polyhouse in all treatments as compared with open field condition. Growth rate of the seedlings in the polyhouse is 5.99 cm per month where as in plastic tunnel 2.81 cm and open field condition 2.64 cm per month (Table 1) that may be due to the favourable environment and continuous growth of seedlings (no dormancy stage). Temperature range was observed Minimum 8.1 to 20.0^{0}C, Maximum 27.0 to 34.2^{0}C inside the polyhouse where as Minimum 6.9 to 21.1^{0}C, Maximum 19.5 to 28.5^{0}C in open field and Relative humidity (RH) was ranges 75% to 85% in polyhouse and 80% to 96% in open field condition. Rangana (1995) reported that, vegetative growth of the citrus species adversely affected below 12.5^{0}C temperature thus, in open field condition growth of seedling may be affected by low temperature. Heat unit is one of the important parameter to determines the growth of the plants and fruit quality, thus heat unit of polyhouse was observed 3590 and open field was 2373 that also supported the growth of seedlings in side the polyhouse is higher than the open field.

Highest seedling height (53.21 cm) was observed in the vermicompost + soil mixed treatment and lowest (39.25 cm) was observed in the vermicompost treatment (Table 2). Growth rate of seedlings also higher in vermicompost + soil mixed treatment (4.42 cm) as compare to other treatments but it was at par with top soil + soil mixed treatment (4.28 cm). Slow growth was observed in vermicompost treatment (2.85 cm). Lowest height and slow growth rate of seedlings in the vermin compost (sole) due to it has high organic matter rather than other nutrients and it is tight when dry. Short height of trifoliate seedling was observed in water stress and poor nutrient management condition (Subedi et al 1994). Seedlings height was lower in all treatments in open field and plastic tunnel condition as compared to poly house. Because of cold temperature in winter and growth of the trifoliate seedlings were stopped (due to dormant stage) during October to December in open condition.

The standard height of the rootstocks for grafting are recommend more than 50 cm (Anonymous 2058). Seedling grown in the polyhouse was found to meet the recommend height (>60 cm) in all treatments and can be grafted within one year. Average seedling height in the field condition was observed 32.95 cm where in the polyhouse condition was observed 71.47 cm at 360 DAS. Seedling heights were about 2.5 times greater than open field condition in all treatments due to growing environment. Most of the seedlings grown in the polyhouse were uniform and less branched. Heighest plant height was observed in the vermicompost and soil mixed treatment in all condition due to availability of nutrients and good environment condition for seedling growth. The results shows that, significant differences in the growth of trifoliate seedling within the growing media and environmental condition.

Table 1. Seedling growth of trifoliate orange grown on different environmental condition at NCRP Dhankuta (FY 2063/64 and 064/65).

Growing Environment	Seedling height (cm)			Growth rate (cm)/month
	120 DAS	240 DAS	360 DAS	
Open	11.82^{C}	19.17^{C}	32.95^{B}	2.64
Plastic Tunnel	16.38^{B}	24.93^{B}	38.83^{B}	2.80
Polyhouse	23.58^{A}	33.27^{A}	71.47^{A}	5.99
CV (%)	12.21	10.38	35.29	
F value	158.20**	140.29**	30.32**	
CD (P≤0.05)	1.631	2.072	13.04	
SEm±	0.4714	0.5986	3.769	

Table 2. Seedling growth of trifoliate orange grown on different media at NCRP Dhankuta (FY 2063/64 and 064/65).

Treatments	Seedling height (cm)			Growth rate (cm)/month
	120 DAS	240 DAS	360 DAS	
FYM + Soil	15.95^{C}	25.14^{A}	44.32^{BC}	3.54
Vermi compost	16.40^{BC}	25.27^{A}	39.25^{C}	2.85
Vermi compost+ soil (1:1)	17.82^{AB}	25.64^{A}	53.21^{A}	4.42
Top soil	17.73^{AB}	25.70^{A}	49.33^{AB}	3.95
Top soil+Soil (1:1)	18.40^{A}	27.21^{A}	52.66^{A}	4.28
CV (%)	9.90	9.44	19.50	
F value	4.399**	1.382 ns	4.857**	
CD (P≤0.05)	1.415	2.016	7.711	
SEm±	0.493	0.703	2.688	

Table 3. Interaction effect of seedling growth on different media under different environmental condition.

Conditions	Treatments	Seedling height (cm)		
		120 DAS	240 DAS	360 DAS
Open	1 FYM + Soil	10.40^{F}	18.10^{E}	34.09^{EF}
	2 Vermi compost	10.68^{F}	18.00^{E}	28.20^{F}
	3 Vermi compost+ soil (1:1)	11.77^{EF}	18.95^{E}	33.91^{EF}
	4 Top soil	12.90^{DEF}	20.10^{DE}	33.72^{EF}
	5 Top soil+Soil (1:1)	13.35^{DE}	20.70^{CDE}	34.83^{EF}
Tunnel	1 FYM + Soil	15.45^{CD}	24.75^{B}	33.27^{EF}
	2 Vermi compost	15.18^{CD}	24.35^{BC}	30.11^{F}
	3 Vermi compost+ soil (1:1)	17.15^{C}	26.05^{B}	42.04^{EF}
	4 Top soil	17.13^{C}	23.70^{BCD}	41.45^{EF}
	5 Top soil+Soil (1:1)	16.97^{C}	25.83^{B}	47.30^{DE}
Polyhouse	1 FYM + Soil	22.00^{B}	32.56^{A}	65.60^{BC}
	2 Vermi compost	23.35^{AB}	33.47^{A}	59.44^{CD}
	3 Vermi compost+ soil (1:1)	24.52^{AB}	31.92^{A}	83.68^{A}
	4 Top soil	23.15^{AB}	33.30^{A}	72.80^{ABC}
	5 Top soil+Soil (1:1)	24.88^{A}	35.10^{A}	75.85^{AB}
	CV (%)	9.90	9.44	19.50
	F value	0.533 ns	0.607 ns	0.880 ns
	CD (P≤0.05)	2.450	3.492	13.36
	SEm±	0.□54	1.217	4.656

Note: SEm± = Standard error of mean difference, CV = Coefficient of variation, CD (P≤0.05) = Critical difference at probability value 0.05, Treatment means followed by common letter(s) within a column are not significantly different at 5% by DMRT, DAS=Days after sowing, ns= non significance, **= highly significance at 0.05level.

Seedling Diameter

Seedling diameter is one of the most important parameter for grafting. The requirements of seedling diameter should be more than 5 mm above 15 cm height from the ground level at the time of grafting (Anonymous 2058). Higher seedling diameter of trifoliate orange was observed in polyhouse condition (6.32 mm) followed by plastic tunnel (5.35 mm) and open field condition (4.73 mm) at 360 DAS (Table 4). The seedling diameter of polyhouse was observed (6.3mm) more than standard. It means all the seedlings were grown inside the polyhouse environment were meet the required diameter for grafting within one year, but in the open field condition could not reached standard diameter (4.2 mm) within one year. It should be wait for next year to get appropriate diameter. The increasement rate of seedling diameter is also faster in polyhouse (0.46 mm/month) than plastic tunnel (0.36 mm/month) and open field condition (0.32 mm/month).

Higher seedling diameter was observed in top soil + soil mixed treatment (5.85 mm) followed by top soil (5.76 mm) and vermicompost + soil mixed treatment (5.71 mm), however there is no significant differences between these treatments (Table 5). Lowest seedling diameter was observed in vermincompost treatment (4.80 mm). The increasement rate of seedling diameter was also higher in top soil + soil mixed treatment and vermicompost + soil mixed treatment (0.42 mm) where as slow rate was observed in vermicompost treatment (0.31 mm). Among them seedling diameter was reached to requirement level in all treatments (>5mm diameter) except vermincompost. The result shows that, there was significant effect of trifoliate seedling diameter within the growing media and environment condition.

Table 4. Seedling diameter (mm) of trifoliate orange grown on different environment condition at NCRP, Dhankuta (FY 2063/64 and 064/65).

Growing Environment	Seedling diameter (mm)			Increase rate
	120 DAS	240 DAS	360 DAS	(mm) /month
Open	2.10^{C}	3.62	4.73^{C}	0.32
Plastic Tunnel	2.45^{B}	4.30^{B}	5.35^{B}	0.36
Polyhouse	2.68^{A}	4.53^{A}	6.32^{A}	0.46
CV (%)	6.29	5.75	10.91	
F value	74.473**	78.904**	36.032**	
CD (P≤0.05)	0.1173	0.1847	0.4617	
SEm±	0.0339	0.0533	0.1334	

Table 5. Seedling diameter (mm) of trifoliate orange grown on different media at NCRP, Dhankuta (FY 2063/64 and 064/65).

Treatments	Seedling diameter (mm)			Increase rate
	120 DAS	240 DAS	360 DAS	(mm)/month
FYM + Soil	2.35^{B}	4.05^{BC}	5.19^{B}	0.35
Vermi compost	2.32^{B}	3.97^{C}	4.80^{C}	0.31
Vermi compost+ soil (1:1)	2.38^{B}	4.17^{AB}	5.71^{A}	0.42
Top soil	2.47^{A}	4.26^{A}	5.76^{A}	0.41
Top soil+Soil (1:1)	2.51^{A}	4.29^{A}	5.85^{A}	0.42
CV (%)	4.02	4.44	6.37	
F value	8.438**	6.599**	20.228**	
CD (P≤0.05)	0.07855	0.1527	0.2880	
SEm±	0.0273	0.0532	0.1004	

Note: SEm± = Standard error of mean difference, CV = Coefficient of variation, CD (P≤0.05) = Critical difference at probability value 0.05, Treatment means followed by common letter(s) within a column are not significantly different at 5% by DMRT, DAS=Days after sowing, ns= non significance, **= highly significance at 0.05level.

Table 6. Interaction effect of seedling diameter on different media under different environment condition.

Conditions	Treatments	Seedling diameter (mm)		
		120 DAS	240 DAS	360 DAS
Open	1 FYM + Soil	1.95^{H}	3.65^{E}	4.85^{DE}
	2 Vermi compost	1.97^{GH}	3.52^{E}	4.58^{E}
	3 Vermi compost+ soil (1:1)	2.09^{FG}	3.60^{E}	4.78^{E}
	4 Top soil	2.22^{EF}	3.67^{E}	4.60^{E}
	5 Top soil+Soil (1:1ratio)	2.27^{DE}	3.65^{E}	4.83^{DE}
Tunnel	1 FYM + Soil	2.40^{CD}	4.10^{D}	4.76^{E}
	2 Vermi compost	2.37^{D}	4.10^{D}	4.51^{E}
	3 Vermi compost+ soil (1:1)	2.40^{CD}	4.40^{BC}	5.52^{BC}
	4 Top soil	2.52^{BC}	4.45^{BC}	5.92^{B}
	5 Top soil+Soil (1:1ratio)	2.55^{B}	4.47^{ABC}	6.04^{B}
Polyhouse	1 FYM + Soil	2.72^{A}	4.40^{BC}	5.97^{B}
	2 Vermi compost	2.62^{AB}	4.30^{CD}	5.32^{CD}
	3 Vermi compost+ soil (1:1)	2.65^{AB}	4.52^{ABC}	6.84^{A}
	4 Top soil	2.67^{AB}	4.67^{AB}	6.77^{A}
	5 Top soil+Soil (1:1)	2.72^{A}	4.75^{A}	6.69^{A}
CV (%)		4.02	4.44	6.37
F value		2.123 ns	1.053ns	5.103**
CD ($P \leq 0.05$)		0.136	0.264	0.498
SEm±		0.047	0.092	0.173

Number of Leaf

Leaf is the most important part of the plant which is the factory of food processing. Higher the leaf number indicates vigorous growth of the plant. Highest leaf number was observed in the polyhouse (24) followed by the plastic tunnel (21) and open field condition (17) at 360 DAS (Table 7). Statistically there was no variation of number of leaf between the polyhouse and plastic tunnel conduction but, significant effect was observed among the environment condition at 0.5 levels. However, continuous flushing was observed inside the polyhouse where as leaves was dropped in the winter season and growth of the seedlings was stopped in open field condition.

Seedling growth may be influenced by number of leaf. Highest leaf number was observed in top soil + soil mixed treatment (23) followed by top soil (22) and vermicompost + soil mixed treatment (21) at 360 DAS (Table 8). The leaf number was shows better performance in the polyhouse condition than others. The result shows that, there was significant effect of trifoliate leaf number within the growing media and environment.

Table 7. Leaf number of trifoliate orange grown on different environment condition at NCRP, Dhankuta (FY 2063/64 and 064/65).

Treatments	Number of Leaf per plant		
	120 DAS	240 DAS	360 DAS
Open	7.35^{C}	17.34^{B}	16.79^{B}
Plastic Tunnel	11.04^{B}	21.78^{A}	20.55^{A}
Polyhouse	13.62^{A}	24.51^{A}	23.85^{A}
CV (%)	19.02	23.22	21.91
F value	48.182**	10.799*	12.487**
CD (P≤0.05)	1.569	3.811	3.458
SEm±	0.453	1.101	0.999

Table 8. Leaf number of trifoliate orange grown on different media at NCRP, Dhankuta (FY 2063/64 and 064/65).

Treatments	Number of Leaf per plant		
	120 DAS	240 DAS	360 DAS
1 FYM + Soil	10.16^{B}	21.09^{B}	18.57^{B}
2 Vermi compost	10.16^{B}	19.27^{C}	17.32^{B}
3 Vermi compost+ soil (1:1ratio)	10.71^{AB}	21.54^{AB}	21.31^{A}
4 Top soil	10.98^{A}	21.73^{AB}	22.11^{A}
5 Top soil+Soil (1:1ratio)	11.35^{A}	22.43^{A}	22.67^{A}
CV (%)	7.77	6.54	14.53
F value	4.692**	8.794**	7.449**
CD (P≤0.05)	0.686	1.148	2.453
SEm±	0.239	0.400	0.855

Table 8. Interaction effect of seedling diameter on different media under different environment condition.

Conditions	Treatments	Leaf number		
		120 DAS	240 DAS	360 DAS
Open	1 FYM + Soil	6.787^{F}	16.84^{E}	15.60^{CD}
	2 Vermi compost	7.275^{EF}	17.75^{E}	17.89^{CD}
	3 Vermi compost+ soil (1:1ratio)	7.213^{EF}	16.85^{E}	15.19^{D}
	4 Top soil	7.325^{EF}	16.70^{E}	16.75^{CD}
	5 Top soil+Soil (1:1ratio)	8.163^{E}	18.58^{E}	18.53^{CD}
Tunnel	1 FYM + Soil	10.24^{D}	20.77^{D}	16.03^{CD}
	2 Vermi compost	10.19^{D}	18.30^{E}	13.99^{D}
	3 Vermi compost+ soil (1:1ratio)	11.22^{CD}	23.02^{BC}	24.86^{AB}
	4 Top soil	11.52^{C}	23.00^{BC}	23.63^{AB}
	5 Top soil+Soil (1:1ratio)	12.02^{BC}	23.83^{ABC}	24.26^{AB}
Polyhouse	1 FYM + Soil	13.46^{A}	25.65^{A}	24.08^{AB}
	2 Vermi compost	13.00^{AB}	21.77^{CD}	20.08^{BC}
	3 Vermi compost+ soil (1:1ratio)	13.70^{A}	24.75^{AB}	23.89^{AB}
	4 Top soil	14.10^{A}	25.50^{A}	25.96^{A}
	5 Top soil+Soil (1:1ratio)	14.2^{A}	24.90^{AB}	25.24^{A}
	\CV (%)	7.77	6.54	14.53
	F value	0.770 ns	4.154**	3.915**
	CD (P≤0.05)	1.189	1.989	4.249
	SEm±	0.414	0.693	1.481

Note: SEm± = Standard error of mean difference, CV = Coefficient of variation, CD (P≤0.05) = Critical difference at probability value 0.05, Treatment means followed by common letter(s) within a column are not significantly different at 5% by DMRT, DAS=Days after sowing, ns= non significance, **= highly significance at 0.05%.

CONCLUSIONS

Result of the experiment show that, height and diameter of the trifoliate seedlings grown in the polyhouse condition was satisfactory stage for grafting in all treatments. There was significant effect of seedling growth at different environment condition. Growth rate was two times greater in polyhouse than open field condition. Seedlings growth was just double in vermicompost + soil mixture media than vermin compost treatment, but no significant effect was observed in seedling diameter between the top soil and vermin compost + soil mixed treatment. Therefore the experiment conclude that, growth and diameter of the trifoliate seedlings was faster in soil mixed vermicompost and topsoil used treatments in the poly house condition. Growth and diameter of seedlings can be accelerated at recommended level for grafting in the polyhouse condition within one year. Seedlings grown in the polyhouse was straight and no more branching as compared to open condition and plastic tunnel. Generated technology of this study is highly applicable and fruitful to the nursery owners for sapling production. They can produce standard size saplings within one and half year period in the polyhouse condition.

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