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Nursery Growth Performance Of Newly Developed Superior Clones Of Poplar (*Populus deltoides* Bartr. Ex Marsh)

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ABSTRACT

New clones of poplar (*Populus deltoides*) were developed at UHF Nauni and FRI, Dehradun over the last fifteen years. Promising clones were further aimed to screen in the backdrop of two established commercial clones (G-48 and L-200/86) repeatedly for two years (2011 and 2012). Screening for growth traits revealed that 23 clones in plant height and volume index and 22 clones in basal diameter were significantly superior against check clone G-48. Check clone L-200/86 recorded at par plant height with clones 6503, 5303, T-50, T-46, and 1007, at par basal diameter with clones 6503, 1007, T-47, H-11 and T-16 at par volume index with clone 6503. The growth parameters varied significantly among clones and years, except volume index in the year 2012. The clone x year interaction was found non significant. Ranking of clones with respect to different characters changed over the years. Regression values revealed that clones 6503, L200/86 and 1007 gave consistent performance for both the years.

Key words:

Poplar, clone, volume index, regression, clone x year interaction.

INTRODUCTION

Poplars (*Populus* species) are known for their fast growth, easy vegetative propagation, capability to enrich the surface soil by adding leaf litter and high productivity (25-50 m^3 $ha^{-1}yr^{-1}$) on short rotation of 6-12 years (Tiwari, 1993). Poplars for wood production were introduced in India in 1950 in UP Terai now Uttrakhand for ply and match wood industry. Original cuttings of number of species and clones were obtained from UK, USA, France, Germany and Italy. After trial of 20 years, it was found that only *P. deltoides* clones obtained from warmer latitudes of the USA were suitable for India conditions. Initially IC clones were considered to be the best performers, but later on these clones suffered heavily from sun scorch. In 1970, G3 and G48 along with D-100, D-121 were introduced. With improvement in planting technology, these clones became very popular with farmers (Chaturvedi and Rawat 1994). Eventually G-3 clone was discontinued due to various inherent problems (Sidhu 1996). Numbers of agencies have been attempting to introduce new clones to increase the productivity of poplar plantations. In the year 1986, cuttings of 168 clones of poplars were received at Lalkuan (Haldwani, Uttrakhand) out of which S_7C_1, S_7C_2, 111828, 1467, St-72, 110702, 113324 and 64-245-1 were found to be promising (Chaturvedi and Rawat 1994). A large chunk of irrigated and fertile lands of Punjab, Haryana, Uttrakhand and Himachal Pradesh has been brought under a poplar based agroforestry system.

Presently 3,12,000 hectare area in India is under poplar cultivation (Kumar and Dhiman 2012). Now days clones like S_7C_8, S_7C_{15}, S_7C_{20}, L-49, Uday, WSL-22, WSL-27, WSL-32, have become popular. But still, more than 60 % area under poplar cultivation is of G-48 clone. Plantation of single clones on large tracts can cause disease and insect out break, which may affect the productivity of poplars in the long run (Singh and Singh 1986; Sidhu 1989). In the nineties, it was emphasized to start a coordinated performance trial so as to evolve local sustained clones from these exotic poplars. By the use of the limited number of clones, there always remained a risk of disease/pest outbreak; moreover continuous vegetative propagation also deteriorated the quality of the clones. Because of which, the new clones were continuously been introduced and old replaced by the new ones to broaden the genetic base (Khurana and Khosla, 1978; Sidhu 1994, 1996; Burfal et al. 2001). Keeping this in view, Dr Y S Parmar University of Horticulture and Forestry, Solan and Forest Research Institute, Dehradun have developed a number of clones from half sib seed collected from USA (Singh et al. 2013). The first step is to test the clones at nursery stage so that only those clones which perform better at nursery stage are sent for field testing. Various workers have tested poplar clones in nursery in different climatic zones in India (Dhanda 1983; Desraj and Cheema 1990; Sidhu 1989 and Panwar and Sharma 2001). Thus the present investigations were carried out to test the performance of poplar clones at nursery stage.

MATERIALS AND METHODS

The experiment was conducted at the Naganji forest nursery of the Department of Tree Improvement and Genetic Resources, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) in the years 2011 and 2012. The nursery site is located in the north-west of Himalaya at an elevation of 1200 m above mean sea level which lies between 30°51'N latitude and 76°11'E longitude. The experimental area is hilly with a gentle slope towards the southeastern aspect. The area experiences a wide range of temperature with a minimum of 0.30°C in winters to a maximum of 32.3°C during May and June as the hottest months. The monthly rainfall ranges between 2.3-263.30 mm with maximum downpour during the monsoon season (July - September). The experiment was laid out in February in nursery in well drained, sandy loam type soil with pH 7.20, ploughed and disked properly. Shoot cuttings obtained from one year old plants were used for planting. These cuttings were 22.50 cm long and 1 cm (uniform) in thickness. The standard planting techniques were followed in Randomized Block Design. Fourteen clones developed by FRI Dehradun and 10 by UHF Nauni were selected on the basis of last two year growth performance in the germplasm nursery (Table 1). Sixteen ramets of each clone were randomly planted in three replications with two check clones (G-48 and L-200/86). The spacing between rows was 50 cm and between cuttings in a row was 40 cm in a sunken bed of size 250 cm x 150 cm under the usual nursery conditions. The observations were recorded when the saplings were nine months old i.e. in the last week of November. Height of the plant was measured to the nearest centimeter, while basal diameter was measured to the nearest mili meter 15 cm above the ground. Volume index was calculated by multiplying by the square of the diameter with height as its relative index as also used in *Populus* species (Ceulemans et al. 1992 and Li et al. 1998, Guo and Zhang 2010, Kaczmark et al. 2013) and *Salix* species (Sharma et al. 2011, 2014). The data were statistically analyzed with the statistical package for social sciences (SPSS), version 16.0.

RESULTS AND DISCUSSION

Significant variation among clones and between years was found for height, basal diameter and volume index (Table 1) except for the volume index in the year 2012. The result show that superior clones exist in the germplasm. Isik and Toplu (2004) also observed variation in growth characters among different clones of *Populus nigra*. Clone x year interaction was nonsignificant for all the characters indicated that the clones did not respond differently to changing environment (Sidhu 1996).

Plant height: Plant height varied significantly in both years. In the year 2011 maximum height (385.75 cm) was exhibited by clone T-33 followed by clone T-50 (378.00 m), 5503 (376.50 cm), 6503

(375.75cm), L-200/86 (368.00cm) and H-14 (364.3 cm). All the clones except clone T-40 were above 3 m height. In year 2012, the maximum height was recorded by clone 6503 (473.00 cm) which is at par with clones 5503 (467.75 cm), 1007 (460.38 cm), L-200/86 (455.62 cm) and T-50 (444.00 m). In the same year, 13 out of 26 clones exhibited height greater than four meters. The ranking of the clones changed in different years. Mean of both years depicted at par plant height in clones 6503 (424.37 cm), 5503 (422.12 cm), L-200/86 (411.81 cm), T-50 (411 cm), T-46 (411 cm) and 1007 (409.31 cm). However, clones 6503 and 5503 showed the same ranking (1 & 2) in the year 2012 and as well as in mean of both the years. Besides clone 6503 and 5503 were at par with clone T-33 (rank 1) and Clone T-50 (rank 2).

Basal diameter: The basal diameter in the year 2011 varied from 18.45 mm in H-14 to 22.6 mm in clone H-11. The maximum basal diameter is at par with clones 6503 (22.2 mm), L-22/86 (21.7 mm) and 8800 (21.6 mm).In the year 2012 check clone L200/86 recorded maximum basal diameter (26.5 mm) closely followed by clones T-16 (25.97 mm), T-47 (25.48 mm), 6503 (25.38 mm), T-50 (25.28 mm), 1007 (25.19 mm) and T-70 (25.04 mm). The same clones except T-50 recorded at par mean basal diameter. Clones x years were non significant. But the ranking of the clones changed in different years.

Volume index: Volume index varied significantly between years, but among clones it varied significantly only in the year 2011. Volume index varied from 1160.2 cm^3 in clone G-48 to 1861.82 cm^3 in clone 6503 in the year 2011. Clones H-11 (1848.14 cm^3) and L-200/86 (1739.48 cm^3) recorded at par volume index with clone 6503. Check clone L200/86 recorded maximum mean volume index in clone 6503 (2500.44 cm^3) followed by L-200/86 (2495.79 cm^3).

The environmental conditions during 2012 (Fig 1.) were more favorable for significantly plant height (Fig.2) and volume index growth (Fig. 3). Since the clones were raised under similar environmental conditions, the variation in growth traits may be attributed to the genetic differences (Singh and Devgiri 1997; Sharma and Khurana 2011). Similar results were obtained by Singh and Negi (1996) and Panwar and Sharma (2001) for plant height and collar diameter growth in the nursery of *Populus deltoides* clone. Significant differences were observed between the *Populus deltoides* hybrids for height, diameter and volume index in one year nursery at Izmit, Turkey (Ozel et al. 2010). Puri et al. (2002) screened *Populus deltoides* clones on the basis of nursery growth and categorize clones into vigorous, semi-vigorous, slow and very slow group.

Ranking of clones (Table 2) depicts that in the year 2011 check clone G-48 was placed on 24^{th} rank for plant height and diameter and 19^{th} rank for volume index, whereas, in 2012 it had a 19^{th} rank for plant height and volume and 20^{th} rank for diameter. Similarly, check clone L 200/86 had a 5^{th} rank for plant height, first rank for basal diameter and 3^{rd} rank for the volume index in 2011 whereas, in 2012 it was placed at 4^{th} rank plant height and the 1^{st} rank for basal diameter and volume index. Sidhu (1996) evaluated 16 poplar clones and found that year to year performance of the clones varied in the nursery.

The R^2 values for plant height, basal diameter, basal area and volume index was found to be 0.40, 0.033 and 0.169 (Table 3). The regression equation was found significant for plant height and volume index. The regression equation developed for plant height in the year 2011 and 2012 (Fig 4) revealed that clones 5503, 6503, T-50, L 200/86 and 1007 performed equally in both the years. A similar relation was observed for the volume index in the year 2011 and 2012 for clones 6503, L 200/86 and 1007 (Fig 5). Kaczmarek et al. (2013) also calculated R^2 between growth at 3 years and 10 years in *Populus* clones and found a moderately strong correlation between age 10 volume and age 3 volume indices.

Spearsman Correlation

Height growth in the years 2011 and 2012 had a positive influence on volume index (Table 4). Mean height was also significantly correlated with mean volume index (0.718). Plant diameter in the year 2011 showed significant correlations (0.559)

Table 1. Nursery growth of poplar clones in the year 2011 and 2012

			Plant Height (cm)			Basal diameter (mm)			Volume index (cm^3)		
Sr No.	**Clones**	**Developed by**	**2011**	**2012**	**Mean**	**2011**	**2012**	**Mean**	**2011**	**2012**	**Mean**
1	T-98	FRI	343.75	377.00	360.37	20.15	23.56	21.86	1401.31	2151.44	1776.38
2	T-21	FRI	309.25	397.00	353.12	20.09	24.66	22.37	1283.13	2415.93	1849.53
3	T-47	FRI	351.75	400.96	376.36	21.07	25.48	23.36	1599.1	2638.24	2118.67
4	T-33	FRI	385.75	395.12	390.44	20.93	24.33	22.63	1653.47	2374.11	2013.79
5	T-50	FRI	378.00	444.00	411.00	19.99	25.28	22.64	1517.45	2868.02	2192.73
6	T-46	FRI	354.50	382.62	411.00	20.37	23.56	21.96	1480.96	2309.63	1895.3
7	T-59	FRI	331.25	417.00	381.06	19.90	24.65	22.28	1332.77	2710.01	2021.39
8	T-16	FRI	328.00	401.83	364.92	19.81	25.97	22.89	1288.65	2764.89	2026.77
9	T-53	FRI	314.62	365.62	339.81	19.39	22.52	20.96	1198.9	1857.53	1528.22
10	T-40	FRI	261.25	326.25	293.75	21.56	22.87	22.22	1227.43	1713.03	1470.23
11	T-70	FRI	345.25	375.20	360.22	19.80	25.04	22.42	1361.28	2478.86	1920.07
12	1007	UHF	358.25	460.38	409.31	21.01	25.19	23.10	1574.21	2958.59	2266.4
13	5503	UHF	376.50	467.75	422.12	19.27	23.64	21.46	1399.58	2616.2	2007.89
14	8800	UHF	343.75	394.62	369.19	21.64	21.26	21.45	1673.29	1827.7	1750.49
15	9607	UHF	333.75	418.75	376.25	21.45	23.12	22.26	1591.26	2640.58	2115.92
16	6503	UHF	375.75	473.00	424.37	22.22	25.38	23.80	1861.82	3139.07	2500.44
17	63-N	UHF	358.00	404.50	381.25	19.33	23.86	21.60	1339.53	2376.81	1858.17
18	40-N	UHF	327.00	375.75	351.37	19.73	22.87	21.30	1293.29	2027.96	1660.63
19	PD-48	UHF	323.50	407.87	365.67	20.50	22.50	21.50	1347.25	2083.65	1715.45
20	H-11	UHF	360.25	400.62	380.44	22.64	23.56	23.10	1848.14	2226.95	2037.55
21	H-14	UHF	364.25	382.50	373.37	18.45	23.02	20.74	1259.53	2089.16	1674.34
22	G-48	USA	312.25	382.00	347.12	19.17	22.58	20.89	1160.2	2015.82	1588.01
23	H-8	UHF	323.00	370.85	346.92	20.63	22.26	21.45	1396.78	1795.74	1596.26
24	L-200/86	Forest Dept (UP)	368.00	455.62	411.81	21.70	26.49	24.09	1739.48	3252.1	2495.79
25	HYB-2	UHF	356.00	370.97	363.49	18.98	20.37	19.68	1297.76	1577.29	1437.53
26	SOLAN-1	UHF	357.00	412.75	384.87	21.07	20.99	21.03	1594.78	1834.1	1714.44
		Mean	343.85	403.29	373.57	20.42	23.65	22.04	1450.82	2336.28	1893.55
		$CD_{(0.05)}$	25.44	33.11		1.01	1.49		187.21	NS	
	$CD_{(0.05)}$	Clone		28.20			1.24			112.72	
		Year		28.79			1.27			256.60	
		Clone x Year		NS			NS			NS	

Table 2 Ranking of the poplar clones in year 2011, 2012 and mean of the year for growth characters

		Plant Height (cm)			Basal diameter (mm)			Volume index (cm^3)		
Sr No.	**Clones**	**2011**	**2012**	**Mean**	**2011**	**2012**	**Mean**	**2011**	**2012**	**Mean**
1	T-98	15	20	19	14	13	15	8	16	15
2	T-21	25	14	21	15	8	10	20	10	12
3	T-47	13	12	12	7	3	3	22	8	9
4	T-33	1	15	7	10	10	8	13	13	13
5	T-50	2	5	4	16	5	7	16	4	4
6	T-46	12	17	5	13	14	14	23	14	16
7	T-59	18	7	10	17	9	11	15	6	7
8	T-16	19	11	17	18	2	6	19	5	6
9	T-53	23	25	25	21	21	23	24	21	24
10	T-40	26	26	26	5	18	13	26	25	26
11	T-70	14	22	20	19	7	9	11	11	10
12	1007	8	3	6	9	6	4	6	3	3
13	5503	3	2	2	23	12	18	9	9	8
14	8800	16	16	15	4	24	19	4	24	17
15	9607	17	6	13	6	16	12	7	7	11
16	6503	4	1	1	2	4	2	1	2	1
17	63-N	9	10	9	22	11	16	14	12	14
18	40-N	20	21	22	20	19	21	18	20	21
19	PD-48	21	9	16	12	22	17	12	18	18
20	H-11	7	13	11	1	15	5	2	15	5
21	H-14	6	18	14	26	17	25	21	17	20
22	G-48	24	19	23	24	20	24	25	19	23
23	H-8	22	24	24	11	23	20	10	23	22
24	L-200/86	5	4	3	3	1	1	3	1	2
25	HYB-2	11	23	18	25	26	26	17	26	25
26	SOLAN-1	10	8	8	8	25	22	5	22	19

Table 3. R^2 and ANOVA of regression values between traits of both the years

Source of variation	Degree of freedom	Plant Height	Basal Diameter	Volume Index
Regression	1	7974.503**	0.935NS	184747.609*
Residual	24	446.786	1.133	37879.423
R^2		0.403	0.033	0.169

Table 4 Spearsmans Rank Correlation of the characters

	Plant height 2012	Mean plant height	Basal diameter 2011	Basal diameter 2012	Mean basal diameter	Volume index 2011	Volume index 2012	Mean volume index
Plant height 2011	0.559**	0.852**	0.122	0.385	0.346	0.488*	0.453*	0.564**
Plant height 2012	1.000	0.836**	0.309	0.535**	0.543**	0.543**	0.775**	0.798**
Mean plant height		1.000	0.288	0.490*	0.490*	0.508**	0.651**	0.718**
Basal diameter 2011			1.000	0.177	0.608**	0.559**	0.195	0.383
Basal diameter 2012				1.000	0.861**	0.102	0.910**	0.841**
Mean basal diameter					1.000	0.340	0.800**	0.857**
Volume index 2011						1.000	0.285	0.532**
Volume index 2012							1.000	0.921**

with volume index, whereas no significant correlation between diameter and volume index was observed in the year. However mean basal diameter was highly correlated (0.857) with volume index. Since volume is an important parameter for yield calculation, the high and positive correlation between volume index and height or basal diameter is a good indicator of growth. Similar correlations for above characters in *Populus* clones were also calculated by Kaczmarek et al. (2013). The present findings are in agreement with earlier results of Singh et al. (2012) and Sharma et al. (2014) in *Salix* clones and Khurana et al. (1992) and Pandey et al. (1993) in *Populus* species.

CONCLUSIONS

Significant variation among clones was found for height, basal diameter and volume index. Clone x year interaction was non significant. Volume index had positive correlation with plant height and basal diameter. This character can be a good indicator of yield. Ranking of clones with respect to different characters changed over the years, but R^2 values have revealed that clones 6503, L200/86 and 1007 gave consistent performance for both the years. These clones can be recommended for field trials on the basis of their superiority and consistency.

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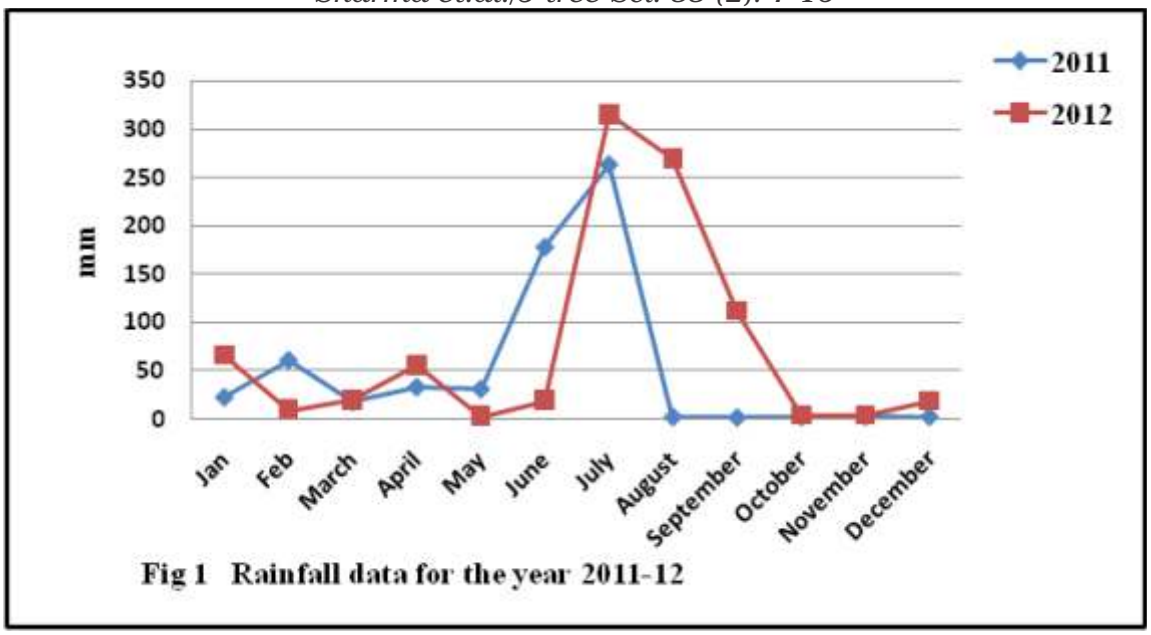

Fig 1 Rainfall data for the year 2011-12

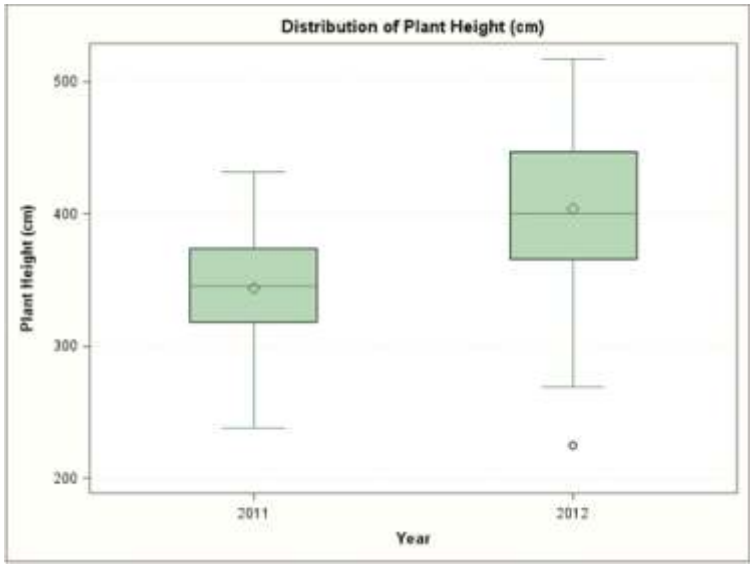

Fig.2 Plant height in the year 2011 and 2012

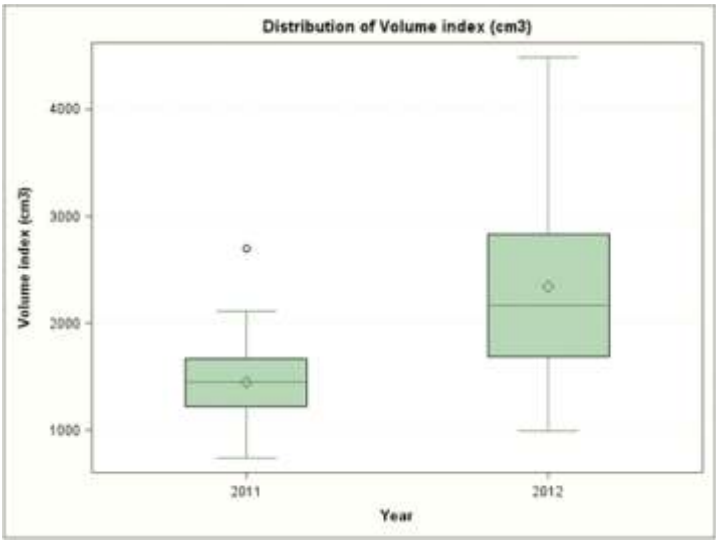

Fig. 3 Volume index in the year 2011 and 2012

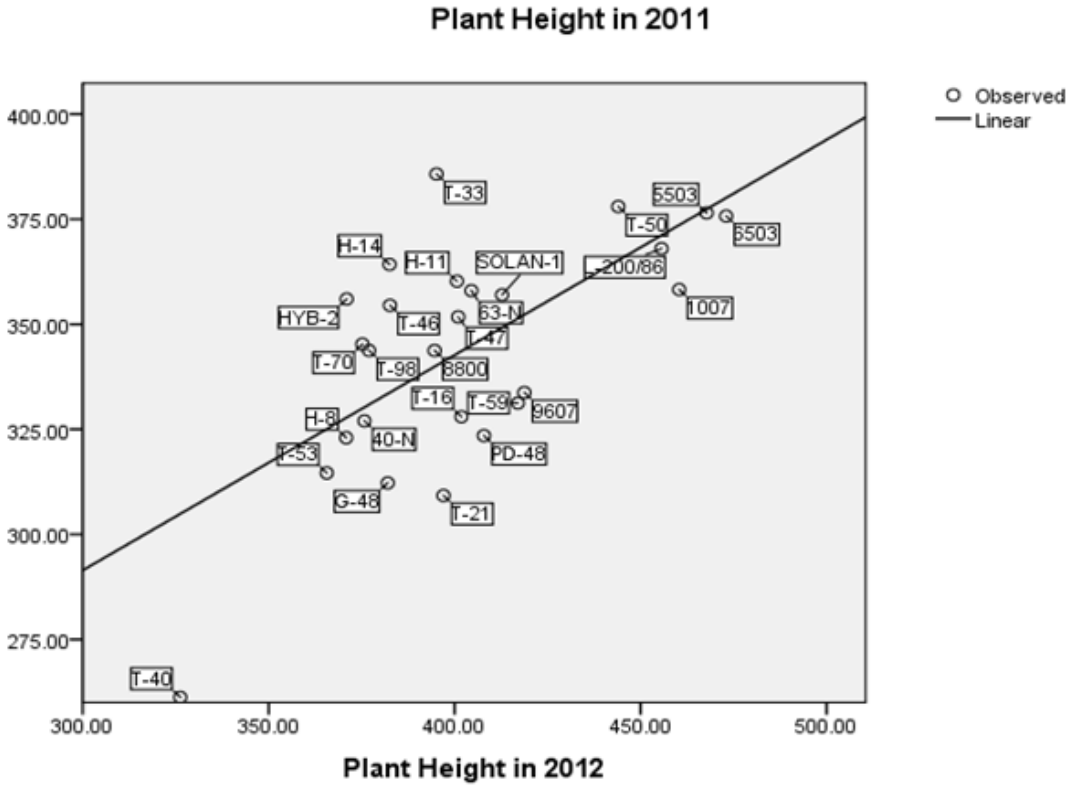

Fig. 4. Plant Height Performance of clones and regression

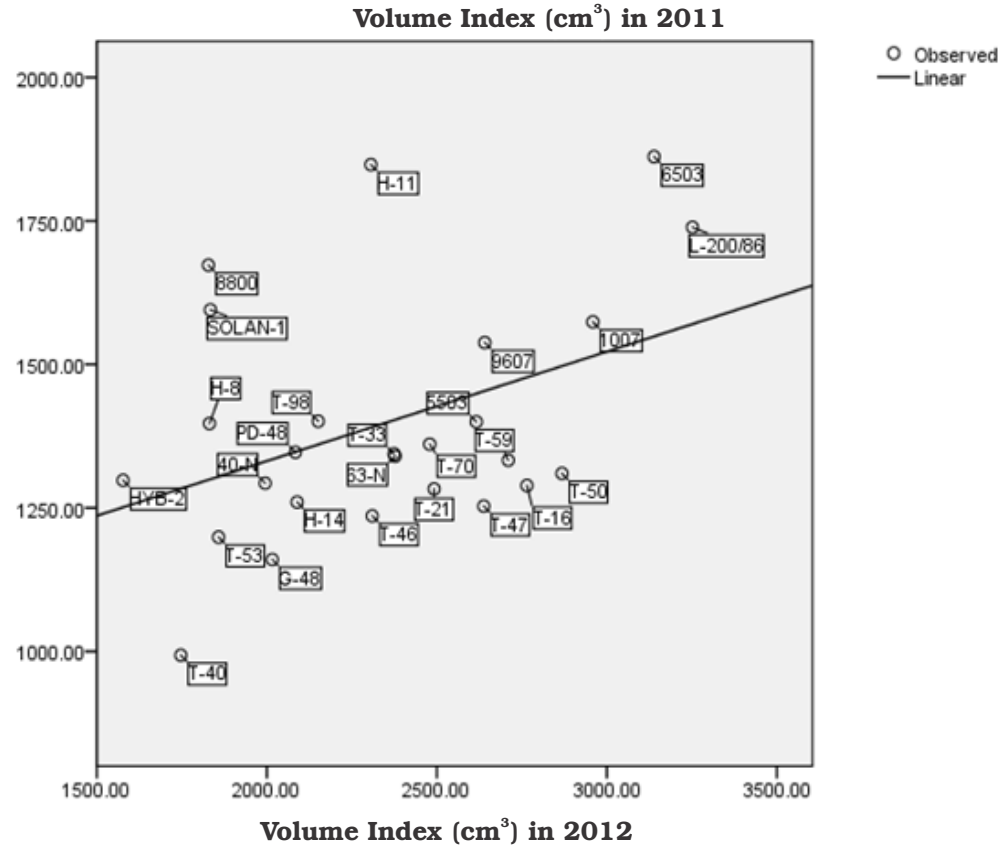

Fig. 5. Volume Index Performance of clones and regression

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