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THE INVESTIGATION ON EFFECT OF WEATHER CONDITIONS ON SURVIVAL AND ESTABLISHMENT OF TREES IN GOREWADA ZOO, NAGPUR (MAHARASHTRA)

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ABSTRACT
Tree transplanting is herculean task trees in arid and semi-arid regions due to higher mortality and slower rate of establishment. The success of tree transplanting has been largely depends up on several antedal evidence. The present investigation was conducted to assess the effect of species, tree size and time of planting on survival and establishment of transplanted trees in the International Gorewada Zoo and Wildlife Rescue Centre, Nagpur, Maharashtra. A total of 177 whole-trees belonging to 19 species were up-rooted and transplanted with help of Tree Planter Machine (Volva Trucks Pvt.) during the month of November and December, 2017. Survival and establishment status of transplants were surveyed 6-months after transplanting. The data revealed that type of species and weather conditions of planting time had significant effect in survival and establishment of transplanted trees. Among 177 transplants, *Gmelina arborea, Choloroxylon swieteinia, Grewia tilifolia, Gardenia resinifera, Flacourtia ramonchii, Lagerstroemia parviflora, Phoenix sylrestris* and *Anogeissus latifolia* were shown 100% survival and establishment. None of *Buchanania lanzan, Tamarindus india, Belerica india, Hardwickia binnata, Ailanhus excelsa,* and *Albizia odoratissima* species were survived due to transplanting shock and unfavorable weather of the planting day. The size of transplants and weather conditions of planting time did not have influence on survival and establishment of *Phoenix sylvestris, Gmelina arborea, Grewia tilifolia* and *Lagerstroemia parviflora.* Since the success of transplants depend upon several factors, detailed species specific– and site-specific studies are required for tree cover retention and saving urban trees.

KEY WORDS: tree, transplantation, survival, green cover, species.

INTRODUCTION

The country's economic growth and development depends upon development of infrastructure facilities. A large track of forest areas are being cleared for want of infrastructure development of the country, leading to concerns around the loss or cut off a multitude of mature trees present. Tree transplanting is the method of choice to counter this loss and to preserve trees of ecological, social and cultural values, since planting seedlings and nurturing them to such a matured trees require substantial time, effort and cost. The benefits of matured trees can be reaped immediately, without impacting the ecological balance with tree transplanting. Tree transplantation is a relatively new concept in India and faces some specific challenges. In fact, mature trees cannot easily re-establish in arid and semiarid areas due to adverse weather conditions such as high temperature, high evapotranspiration, and moisture deficit (Zhang *et al*., 2002). It is reported that mortality rate is up to 50% among newly transplanted trees in these areas (Hiron and Percival, 2012), which increase the expenses associated with maintenance and replacement of failed trees (Etemadi *et al*., 2013). Experimental studies have been recently started to identify causal factors for the failure. A few studies revealed that smaller sized transplants become quickly established and outgrow than large sized transplants (Watson, 1985). Other studies do not agree these results and propose that several factors should be considered when comparing success of transplants. The present study was aimed to examine the effect of tree size, species and time of transplanting on survival and establishment of transplants in Gorewada Zoo, Nagpur (Maharashtra).

MATERIALS AND METHODS

Study area

The present was conducted in International Zoo and Rescue Centre (IZRC) at Gorewada, Nagpur (21.198392 N; 78.999585E). The Government of Maharashtra (GoM) is currently developing this Zoo in 1939.57 ha land, of which 25.57 ha non-forest government land and rest is forest land. To create wildlife habitat in the said-zoo and to save mature trees, the GoM was up-rooted 200 trees of different species from the adjoining forest area and transplanted the same in the proposed zoo site with help M/S. Volva Trucks Pvt., during month of November and December, 2017. The study area is falls under tropical climate. The Köppen-Geiger climate classification is Aw. The mean annual temperature is 26.9 °C. The mean annual precipitation of study area is about 1092mm and altitude is 312.42m.

Up-rooting and transplanting of trees

The tree donor-site and receiving site were identified and site matching was done before uprooting trees. The girth at breast height (gbh) of all transplantable trees were measured and marked. Circular pits *(i.e*. cone shape) with

top diameter 8-feet and bottom diameter 2-feet were digged out in transplants receiving site with help of Tree Trans-planter machine (Volva Trucks Pvt.) before re-planting. The Maharashtra State Forest Department was marked transplantable trees in donor-site. Trees which had straight stem and girth of 30- 85cm were up-rooted and transported the same with intact root ball to receiving site using Tree Trans-planter machine (TTM). The distance between up-rooted site and receiving site is about 5km.

Before planting, about 25-30L fungicide solution was sprayed on four sides of the pits from top to bottom to avoid post-planting infection. The fungicide solution includes carbondazine (30g in 15L water), chloropyriphus (16mv in 8L water), josh AltEq (13g in 20L water) and Tagmycain (2.4g in 10 L water) were applied in each pit. About 50kg of well decomposed farm yard manure was added into pits to supply nutrients to the transplants. About 340-500L of water was poured in the pit. Then, up-rooted tree was brought over pit and gradually lowered into pit and the tree was rested in the center of pit by the TTM. Then, spades of TTM was slowly released inch by inch without disturbing the root ball and plant while filling the pit with top soil around the transplant. After filling the pit with soil above one feet from the ground, soil around the transplant was leveled and compressed well by both manual and JCB machine to avert water stagnation in root zone of the transplant. Saucer was made around transplant to hold sufficient water. Sufficient watering was done using water tanker. The trees were up-rooted and re-planted from 9.00am to 12.00pm and 3.00 to 6.00pm during the month of November and December, 2017 (Fig 1 a-e). Average 5-6 plants per day were up-rooted and re-planted using TTM. Regular watering was done to all transplants for 42 days. At end of 6-months from date of transplanting, observation on survival, health status and establishment of transplants were recorded (Fig. 2 a-f). Transplants which have full green foliage and new sprouted leaves were considered as established transplants and those transplants which had fully dried leaves or dead or pest/ disease infection were counted as non-survival transplants. The data on weather conditions of transplanting date were collected from web source (www.timeanddate.com/ weather). The effect of weather data of planting time was analyzed with survived and dead transplants at end of 6-period from date of planting.

RESULTS AND DISCUSSION

A total of 177 trees of 19 species belong to 14 families with girth at breast height (gbh) ranged from 20 to 72.8 cm were transplanted in barren land in IZRC during month of November and December, 2017. Majority of transplants belong to three families *viz*., Meliaceae, Arecaceae and Fabaceae. *Soymida febrifuga, Phoenix sylvestris, Dalbergia sissoo, Chloroxylon swietenia and Diospyros melanoxylon* were predominant species which represents with 78% of the total transplants. Members of Arecaceae, Flacourtiaceae, Rutaceae and Tiliaceae were shown 100% survival establishment where as in both Meliaceae and Rubiaceae had more than 50 % survival (Table 1).

TABLE 1 Details of transplants of families planted in IZRC, Nagpur

Sl No.	Family	No. of Species	No of Individuals planted	Girth Range	Mean GBH	No of survival plants	Survival %
1	Arecaceae	1	43	52-92	72.8	43	100
2	Caesalpiniaceae	1	2	34-49	41.5	0	0
3	Combretaceae	3	5	44-64	50.4	2	40
4	Ebenaceae	1	7	40-49	47.2	2	29
5	Fabaceae	3	30	24-70	41.5	4	13
6	Flacourtiaceae	1	2	29-46	37.5	2	100
7	Lythraceae	1	2		63.0	1	50
8	Meliaceae	2	61	21-69	41.3	48	79
9	Phyllanthaceae	1	5	37-83	58.0	2	40
10	Rubiaceae	1	6	31-64	53.3	5	83
11	Rutaceae	1	8	29-66	45.4	8	100
12	Simaroubaceae	1	1		20.0	0	0
13	Tiliaceae	1	1		34.0	1	100
14	Verbenaceae	1	4	33-72	60.4	1	25
	Total	19	177			119	

The data revealed that transplant shock tolerance, survival and establishment were depending upon type of species, size of transplants and local weather. Although, *Phoenix sylvestris, Lagerstroemia parviflora, Grewia tilifolia, Gmelina arborea, Flacourtia ramontchi, Chloroxylon swietenia and Anogeissus latifolia* were shown 100% survival, the tree species *viz., Soymida febrifuga, Phoenix sylvestris and Chloroxylon swietenia* were best performing species in terms of number of individuals. The gbh range of above-said best performing species was 21-69, 52-92 and 21-69cm, respectively (Table 2). None of plants of *Ailantus excelsa, Azadirachta Indica, Buchanania lanzan Hardwika binnata Tamarindus indica and Terminalia belerica* were survived. Maximum number of causality was found in *Dalbergia sissoo* and *Soymida febrifuga* with 34% and 18% of total dead plant. The mean gbh range of dead plants ranged from 20 to 64 cm (Table 3).

TABLE 2 Details of survived transplants at end of 6-month period

Sl No.	Family	Total transplants	Girth Range	Mean GBH	No of survival	Survival %
1	*Anogeissus latifolia*	1	47	47.0	1	100.0
2	*Chloroxylon swietenia*	8	29-66	45.4	8	100.0
3	*Cleistanthus collinus*	4	39-60	49.5	2	50.0
4	*Dalbergia paniculata*	4	36	36.0	1	25.0
5	*Dalbergia sissoo*	22	39-52	47.7	3	13.6
6	*Diospyros melanoxylon*	5	40-49	64.5	2	40.0
7	*Flacourtia ramontchi*	2	29-46	37.5	2	100.0
8	*Gmelina arborea*	4	33-69		4	100.0
9	*Grewia tilifolia*	1	34	34.0	1	100.0
10	*Lagerstroemia parviflora*	1	63	63.0	1	100.0
11	*Mitragyna parvifolia*	6	31-61	51.2	5	83.3
12	*Phoenix sylvestris*	43	52-92	72.8	43	100.0
13	*Soymida febrifuga*	58	21-69	40.4	48	82.8
14	*Terminalia alata*	2	44	44.0	1	50.0
	Total	161			122	

TABLE 3 Details of dead transplants at end of 6-month period

Sl No.	Family	Total Individuals	Girth Range	Mean GBH	No of Dead plants	Dead %	No of days Survived DAP
1	*Ailantus excelsa*	1		20.0	1 (1.8%)	100.00	5
2	*Azadirachta Indica*	3	32-50	42.7	3 (5.5%)	100.00	47
3	*Buchanania lanzan*	1	56	56.0	1 (1.8%)	100.00	5
4	*Cleistanthus collinus*	5	37-71	54.0	3 (5.5%)	60.00	5
5	*Dalbergia paniculata*	4	34-77	52.3	3 (5.5%)	75.00	47
6	*Dalbergia sissoo*	22	28-57	38.6	19 (34.5%)	86.36	47
7	*Diospyros melanoxylon*	7	36.5-49	45.9	5 (9.1%)	71.43	20
8	*Hardwika binnata*	4	24-52	35.0	4 (7.3%)	100.00	10
9	*Mitragyna parvifolia*	6	64	64.0	1 (1.8%)	16.67	47
10	*Soymida febrifuga*	58	29-68	45.5	10 (18.2%)	17.24	47
11	*Tamarindus indica*	2	34-49	41.5	2(3.6%)	100.00	30
13	*Terminalia alata*	2	64	64.0	1 (1.8%)	50.00	15
14	*Terminalia belerica*	2	46-51	48.5	2 (3.6%)	100.00	10
	Total				55 (100%)		

The prevailing weather conditions and its variations on day of planting were played significant role in survival and establishment of transplants. The results revealed that the temperature variation at 00.00hrs, 06.00hrs, 18.00hrs and mean maximum - minimum temperature difference of the planting day had showed significant effect in survival and establishment of *Cleistanthus collinus, Dalbergia paniculata, Dalbergia sissoo, Diospyros melanoxylon, Mitragyna parvifolia, Terminalia alata and Soymida febrifuga*. When the day mean maximum - minimum temperature difference of the planting day was $>6.5^0$C, none of *Cleistanthus collinus plants were survived. Similarly, Terminalia alata* plants were dead when day mean maximum - minimum temperature difference went beyond 6.3^0C.The *Dalbergia paniculata* transplants were not survived at day mean maximum- minimum temperature difference at $>5.5^0$C. *Mitragyna parvifolia* was not survived *at* mean maximum - minimum temperature difference at above 4.5^0C. All transplants of *Dalbergia sissoo were dead* when maximum - minimum temperature difference at 18.00hrs of planting day falls below 10^0C. None of transplants *Tamarindus indica, Terminalia belerica, Hardwika binnata, Azadirachta Indica, Ailanthus excels, Buchanania lanzan* were survived due to transplanting shock and unfavourable weather conditions. On the hand, the weather conditions of planting day did not have any detrimental effect on survival and establishment of *Phoenix sylvestris, Gmelina arborea, Grewia tilifolia* and *Lagerstroemia parviflora* (Table 4). The findings of the present study were comparable with that of similar studies reported earlier. Time of transplanting potentially affects tree growth and establishment, as it dictates the specific physiological status of plant (*e.g*., dormancy, leaf drop, bud set, shoot expanding) as well as specific weather conditions (*e.g*., temperature and moisture, wind, light intensity and quality) that influence root regeneration capacity (Richardson-Calfee and Harris 2005). Autumn and spring are commonly considered as the best times for transplanting most trees and shrubs due to the favorable soils and air temperature conditions with least chance of desiccation (Richardson-Calfee and Harris 2005; Etemadi *et al*., 2013). Transplanting in dormant season, if the winter soil temperature remains high provides opportunities for a tree to regenerate its root system prior to shoot growth in spring time (Buckstrup and Bassuk 2000). However, transplanting in the dormant season is not recommended in climates with severe winters (Richardson-Calfee and Harris, 2005). Tree species vary in their responses to season of transplanting. While autumn transplanting could improve growth and survival of some species (Buckstrup and Bassuk, 2000; Harris *et al*., 2002), spring transplanting may be preferable to autumn transplanting for other species (Buckstrup and Bassuk, 2000).

TABLE 4. Effect of weather conditions of tree transplanting day on survival of transplants

Name of Species	Status	Girth (cm)	Date of planting	Difference between mean maximum – minimum temperature (^{0}C)				
				00.00hrs	06.00hrs.	12.00hrs.	18.00hrs.	Day mean Max- Min
Ailanthus excelsa	D	20	16.12. 17	4.0	14.0	5.0	6.0	7.3
Anogeissus latifolia	S	47	19.12. 17	5.0	14.0	6.0	8.0	8.3
Azadirachta indica	D	46	23.11. 17	2.0	9.0	4.0	4.0	4.8
	D	32	27.11. 17	4.0	15.0	7.0	9.0	8.8
	D	50	01.12. 17	6.0	12.0	5.0	7.0	7.5
Buchanania lanzan	D	56	21.12. 17	4.0	11.0	5.0	5.0	6.3
Chloroxylon swietenia	S	29	22.11. 17	1.0	6.0	8.0	4.0	4.8
	S	66	27.11. 17	4.0	15.0	7.0	9.0	8.8
	S	50	28.11. 17	3.0	15.0	6.0	7.0	7.8
	S	53	28.11. 17	3.0	15.0	6.0	7.0	7.8
	S	41	29.11. 17	4.0	15.0	6.0	6.0	7.8
	S	47	04.12. 17	4.0	14.0	6.0	7.0	7.8
	S	30	05.12. 17	4.0	14.0	4.0	6.0	7.0
	S	47	21.12. 17	4.0	11.0	5.0	5.0	6.3
Cleistanthus collinus	D	83	10.12. 17	6.0	15.0	4.0	9.0	8.5
	D	71	16.12. 17	4.0	14.0	5.0	6.0	7.3
	D	37	19.12. 17	5.0	14.0	6.0	8.0	8.3
	S	39	15.12. 17	2.0	12.0	5.0	7.0	6.5
	S	60	24.11. 17	5.0	10.0	4.0	7.0	6.5
Dalbergia paniculata	D	77	01.12. 17	6.0	12.0	5.0	7.0	7.5
	D	34	02.12. 17	3.0	12.0	4.0	10.0	7.3
	D	46	05.12. 17	4.0	14.0	4.0	6.0	7.0
	S	36	07.12. 17	4.0	9.0	5.0	4.0	5.5
Dalbergia sissoo	D	31	01.12. 17	6.0	12.0	5.0	7.0	7.5
	D	40	01.12. 17	6.0	12.0	5.0	7.0	7.5
	D	44	01.12. 17	6.0	12.0	5.0	7.0	7.5
	D	57	01.12. 17	6.0	12.0	5.0	7.0	7.5
	D	34	23.11. 17	2.0	9.0	4.0	4.0	4.8
	D	38	23.11. 17	2.0	9.0	4.0	4.0	4.8
	D	44	24.11. 17	5.0	10.0	4.0	7.0	6.5
	D	34	25.11. 17	5.0	13.0	5.0	9.0	8.0
	D	40	25.11. 17	5.0	13.0	5.0	9.0	8.0
	D	48	25.11. 17	5.0	13.0	5.0	9.0	8.0
	D	37	27.11. 17	4.0	15.0	7.0	9.0	8.8
	D	38	28.11. 17	3.0	15.0	6.0	7.0	7.8
	D	41	28.11. 17	3.0	15.0	6.0	7.0	7.8
	D	28	29.11. 17	4.0	15.0	6.0	6.0	7.8
	D	31	29.11. 17	4.0	15.0	6.0	6.0	7.8
	D	34	29.11. 17	4.0	15.0	6.0	6.0	7.8
	D	37	29.11. 17	4.0	15.0	6.0	6.0	7.8
	D	38	29.11. 17	4.0	15.0	6.0	6.0	7.8
	D	39	30.11. 17	4.0	14.0	3.0	5.0	6.5
	S	39	02.12. 17	3.0	12.0	4.0	10.0	7.3
	S	52	02.12. 17	3.0	12.0	4.0	10.0	7.3
	S	52	02.12. 17	3.0	12.0	4.0	10.0	7.3
Diospyros melanoxylon	D	49	21.12. 17	4.0	11.0	5.0	5.0	6.3
	D	36.5	04.12. 17	4.0	14.0	6.0	7.0	7.8
	D	54	04.12. 17	4.0	14.0	6.0	7.0	7.8
	D	49	05.12. 17	4.0	14.0	4.0	6.0	7.0
	D	49	05.12. 17	4.0	14.0	4.0	6.0	7.0
	S	49	04.12. 17	4.0	14.0	6.0	7.0	7.8
	S	40	24.11. 17	5.0	10.0	4.0	7.0	6.5
Flacourtia ramontchii	S	29	22.11. 17	1.0	6.0	8.0	4.0	4.8
	S	46	22.12. 17	7.0	14.0	4.0	5.0	7.5
Gmelina arborea	S	69	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	67.5	21.11. 17	2.0	8.0	4.0	5.0	4.8
	S	33	21.11. 17	2.0	8.0	4.0	5.0	4.8
	S	72	22.11. 17	1.0	6.0	8.0	4.0	4.8
Grewia tilifolia	S	34	28.11. 17	3.0	15.0	6.0	7.0	7.8
Hardwika binata	D	70	09.12. 17	4.0	9.0	5.0	5.0	5.8
	D	24	15.12. 17	2.0	12.0	5.0	7.0	6.5
	D	29	15.12. 17	2.0	12.0	5.0	7.0	6.5
	D	52	19.12. 17	5.0	14.0	6.0	8.0	8.3
Lagerstroemia parviflora	S	63	30.11. 17	4.0	14.0	3.0	5.0	6.5

Mitragyna parvifolia	D	64	16.11. 17	3.0	8.0	3.0	4.0	4.5
	S	51	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	53	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	31	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	61	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	60	27.12. 17	5.0	25.0	6.0	7.0	10.8
Phoenix sylvestris	S	75	19.12. 17	5.0	14.0	6.0	8.0	8.3
	S	82	19.12. 17	5.0	14.0	6.0	8.0	8.3
	S	85	19.12. 17	5.0	14.0	6.0	8.0	8.3
	S	62	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	75	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	76	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	76	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	77	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	85	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	87	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	52	21.12. 17	4.0	11.0	5.0	5.0	6.3
	S	59	21.12. 17	4.0	11.0	5.0	5.0	6.3
	S	62	21.12. 17	4.0	11.0	5.0	5.0	6.3
	S	70	21.12. 17	4.0	11.0	5.0	5.0	6.3
	S	57	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	59	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	60	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	62	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	71	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	72	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	77	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	80	22.12. 17	7.0	14.0	4.0	5.0	7.5
	S	64	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	65	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	74	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	76	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	82	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	89	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	92	25.12. 17	5.0	13.0	6.0	5.0	7.3
	S	60	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	69	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	70	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	71	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	79	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	80	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	80	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	82	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	83	26.12. 17	3.0	10.0	6.0	8.0	6.8
	S	70	27.12. 17	5.0	25.0	6.0	7.0	10.8
	S	68	27.12.17	5.0	25.0	6.0	7.0	10.8
	S	70	27.12.17	5.0	25.0	6.0	7.0	10.8
	S	69	28.12.17	6.0	17.0	6.0	8.0	9.3
	S	76	28.12. 17	6.0	17.0	6.0	8.0	9.3
Soymida febrifuga	D	29	14.12. 17	3.0	11.0	6.0	6.0	6.5
	D	32	15.12. 17	2.0	12.0	5.0	7.0	6.5
	D	37	16.11. 17	3.0	8.0	3.0	4.0	4.5
	D	38	16.11. 17	3.0	8.0	3.0	4.0	4.5
	D	60	16.12. 17	4.0	14.0	5.0	6.0	7.3
	D	36	25.12. 17	5.0	13.0	6.0	5.0	7.3
	D	55	27.12. 17	5.0	25.0	6.0	7.0	10.8
	D	58	27.12. 17	5.0	25.0	6.0	7.0	10.8
	D	42	28.12. 17	6.0	17.0	6.0	8.0	9.3
	D	68	28.12. 17	6.0	17.0	6.0	8.0	9.3
	S	47	05.12. 17	4.0	14.0	4.0	6.0	7.0
	S	38	06.12. 17	4.0	11.0	4.0	5.0	6.0
	S	46	06.12. 17	4.0	11.0	4.0	5.0	6.0
	S	69	06.12. 17	4.0	11.0	4.0	5.0	6.0
	S	21	06.12. 17	4.0	11.0	4.0	5.0	6.0
	S	35	07.12. 17	4.0	9.0	5.0	4.0	5.5
	S	42	07.12. 17	4.0	9.0	5.0	4.0	5.5
	S	45	07.12. 17	4.0	9.0	5.0	4.0	5.5
	S	49	07.12. 17	4.0	9.0	5.0	4.0	5.5
	S	53	07.12. 17	4.0	9.0	5.0	4.0	5.5

	S	25	08.12. 17	5.0	11.0	3.0	7.0	6.5
	S	31	08.12. 17	5.0	11.0	3.0	7.0	6.5
	S	36	08.12. 17	5.0	11.0	3.0	7.0	6.5
	S	43	08.12. 17	5.0	11.0	3.0	7.0	6.5
	S	45	08.12. 17	5.0	11.0	3.0	7.0	6.5
	S	34	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	45	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	49	09.12. 17	4.0	9.0	5.0	5.0	5.8
	S	41	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	42	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	42	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	46	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	55	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	26	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	27	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	27	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	33	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	34	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	39	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	44	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	45	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	49	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	57	13.12. 17	3.0	12.0	3.0	7.0	6.3
	S	26	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	30	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	30	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	31	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	32	14.12.17	3.0	11.0	6.0	6.0	6.5
	S	34	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	39	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	50	14.12. 17	3.0	11.0	6.0	6.0	6.5
	S	31	16.12. 17	4.0	14.0	5.0	6.0	7.3
	S	35	16.12.17	4.0	14.0	5.0	6.0	7.3
	S	61	16.12. 17	4.0	14.0	5.0	6.0	7.3
	S	48	18.12. 17	8.0	13.0	5.0	10.0	9.0
	S	28	19.12. 17	5.0	14.0	6.0	8.0	8.3
	S	45	20.12. 17	5.0	15.0	6.0	5.0	7.8
	S	58	22.12. 17	7.0	14.0	4.0	5.0	7.5
Tamarindus indica	D	49	18.11. 17	4.0	11.0	4.0	6.0	6.3
	D	34	27.12.17	5.0	25.0	6.0	7.0	10.8
Terminalia alata	D	64	10.12. 17	6.0	15.0	4.0	9.0	8.5
	S	44	13.12. 17	3.0	12.0	3.0	7.0	6.3
Terminalia belerica	D	46	15.12. 17	2.0	12.0	5.0	7.0	6.5
	D	51	21.12. 17	4.0	11.0	5.0	5.0	6.3

(Note:- S- Survived, D- Dead)

a. Pit for transplanting

b. Tree Transplanter machine and transplantable tree

c. Tree Transplanter machine with uprooted tree

d. Transplanting of uprooted tree

e. Watering of newly transplanted tree

FIGURE 1. Stages of tree transplanting with tree transplanter machine

a. Gmelina arborea

b. Soymida febrifuga

c. Azadirachta Indica

d. Phoenix sylvestris

e. *Ficus glomurata*

f. *Choloroxylon swieteinia*

FIGURE 2. Survived transplants at end of 6- months period from date of planting

CONCLUSION

The effect of size of transplants, type of species and weather of transplanting time on survival and establishment of transplanted forest tree species were examined in the present study in order to determine the appropriate transplanting conditions of these species as it is important for tree cover retention and extension. From the results of the present study, it is concluded that species and weather conditions of transplanting time have significant influence on tree survival, growth and establishment and transplant shock tolerance vary with species to species depending upon local weather conditions, which decides the specific physiological status of transplants at transplanting site. Among 177 transplants, *Gmelina arborea, Choloroxylon swieteinia, Grewia tilifolia, Gardenia resinifera, Flacourtia ramontchii, Lastromia parviflora, Phoenix sylrestris* and *Anogeissus latifolia* were shown 100 % survival and establishment. None of *Buchanania lanzan, Tamarindus india, Belerica india, Hardwickia binata, Ailanthus excelsa,* and *Albizia odoratissima* species were survived due to transplanting shock and unfavorable weather of the planting day. The size of transplants and weather conditions of planting time did not have influence on survival and establishment of *Phoenix sylvestris, Gmelina arborea, Grewia tilifolia* and *Lagerstroemia parviflora.* Since the success of transplants depend upon several factors, detailed species specific– and site-specific studies are required for tree cover retention and extension and for saving heritage trees in urban trees.

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