SEEDLING RAISING METHOD FOR PRODUCTION OF TRANSPLANTED MAIZE

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Accepted for publication: March 15, 2009

ABSTRACT

Biswas, M., Islam, N., Islam, S. and Ahmed, M. 2009. *Seedling raising method for production of transplanted maize.* int. j. sustain. crop prod. 4(2):6-13.

The experiment was conducted at the Regional Agricultural Research Station, Jamalpur during the *Rabi* season 2002-2003 to find out suitable seedling raising method for early plant establishment of maize thereby producing higher grain yield. There were two varieties viz. BARI maize-6 and Pacific-11 as main plot treatment and seven seedling raising methods viz. direct planting of seed (Dp), dry bed nursery (M_1), compost nursery (M_2), mud cake nursery (M_3), poly bag nursery (M_4), cup nursery (M_5) and dapog nursery (M_6) as a sub plot treatment in the split plot design. Fifteen-day old seedlings were grown in different seedling raising methods in the experiment. The results revealed that the variety Pacific-11 produced 17.49% higher grain yield than the composite BARI maize-6 mainly attributed by the higher number of cobs m^{-2}, number of grains per cob and 1000-grain weight. Seedling raising methods showed significant variation in respect of cob diameter, number of cobs per m^2, 1000-grain weight, grain yield, stover yield and harvest index. Statistically identical and the highest grain yields were obtained from both the methods M_4 and M_5. Grain yields of M_2, M_3 and M_6 were also statistically identical to M_4 and M_5. Grain yields of M_1 and Dp were statistically identical but significantly different and lower from M_4 and M_5. Both the varieties matured 6-7 days earlier when they were grown through planting of seedling than direct planting of seed. None of the characters differed significantly due to interaction effect of variety and seedling raising methods.

Key Words: Maize seedling, transplanted maize, grain yield

INTRODUCTION

Maize is the top most ranking cereal in terms of higher grain yield and holds third position in respect of total production following wheat and rice in the world. It is a multi-purpose crop plant that can be utilized as food, feed and fuel, and for manufacturing starch, flakes, alcohol, salad oil, soap, varnish, paint, painting and similar products (Ahmed, 1994). In Bangladesh, maize is primarily used as feed for livestock and poultry, and a considerable proportion of grains and green cobs are used for human consumption. *Rabi* season is reported to be the best time for maize cultivation with the optimum time of planting ranging from mid November to end November (BARI, 1997). But maize is generally grown after harvest of transplant *Aman* rice and consequently, planting gets delayed. In the *char* lands, the potential maize growing areas of Bangladesh, the lands attain '*joe*' condition in late after recession of flood water and thus, maize planting goes beyond the optimum time. Grain yield reduces due to late planting as the crop experiences high temperature with the advancement of growth which reduces the duration for grain filling and dry matter accumulation resulting in small grain size (Thompson, 1986). Mohamed and Shams (1991) reported that grain yield of hybrid maize was affected less by late sowing than the synthetic and open pollinated varieties. Porwal and Jain (1999) stated that grain yield of maize reduced due to early and delayed plantings to mid November by 3.9 to 66.4%. Hence, planting time and choice of variety should be important considerations for maize cultivation. However, in addition to reduced grain yield the late sown crops may experience natural hazards at the later stage of growth due to Norwester. Again the sowing of following crops like jute, *Aus* rice, mungbean, black-gram etc. may be affected by the late maize harvest. So, the development of an appropriate early plant establishment technique through agronomic management is essential for maize cultivation under these situations. Basu *et al.* (2003) opined that transplanting of 21-day old seedlings gave identical grain yields with direct sown crop and matured 8-10 days earlier. Maize crop could also be established much earlier through transplanting technique which may produce higher yield (Dale and Drennan, 1997b). Badran (2001) stated that under late planting conditions, transplanting of maize may be a possible alternative to direct sowing. Therefore, transplanting of seedling may be an important area of study for maize cultivation considering the field duration and early plant establishment under Bangladesh conditions. This study was conducted to find out a suitable seedling raising method for production of maize through transplanting.

MATERIALS AND METHODS

The experiment was conducted at the Regional Agricultural Research Station, Jamalpur during *Rabi* 2002-2003 to find out the suitable seedling raising method for successful establishment of maize plant having better growth and grain yield. Treatments of the experiment were two varieties viz. BARI maize-6 and Pacific-11 and seven seedling raising methods viz. direct planting of seed, dry bed nursery, compost nursery, mud cake nursery, poly bag nursery, cup nursery and dapog nursery. Design of the experiment was split plot assigning variety in the main plot and seedling raising method in the sub plot having three replications. Unit plot size was 5.25 m x 3.5 m and plant spacing was maintained as 75 cm x 25 cm. Fifteen-day old seedlings grown in different methods were transplanted on 1 December 2001 in the main field. To attain the 15-day old seedling, seeds were sown on 16 November in different nurseries.

Seedling raising methods: Seedling raising methods are described below:

i. **Dry bed nursery: D**ry bed nursery was made like the traditional seed bed used for raising rice seedlings. No manures and fertilizers were mixed-up with bed soil. After preparation of bed, maize seeds were sown in line maintaining a spacing of 3.0 cm x 3.0 cm. Bed size was 1 meter width with 25 m length having 0.5 m width foot path between beds to facilitate proper management. Proper watering was done with a rose can after sowing seeds as and when necessary to ensure germination of seeds and growth of seedlings.

ii. **Compost nursery:** To prepare a compost nursery, the layer of weeds and stubble above the soil surface was removed by spading and about 4-5 cm thickened compost layer was spread above the leveled soil. This nursery was made to ensure nutrient supply for the seedlings so that the seedlings become healthy. After placement of seeds a thin layer of pulverized soil was spread on the top of the bed to prevent drying-up of the compost. Size of the bed, placement of seed and other operations followed remained similar to that of dry bed nursery. Similar method was followed by Khehra *et al*. (1990) and Ibrahim and Gopalasamy (1989).

iii. **Mud cake nursery:** This method involved making cakes from mud and hence it is named so. In Viet Num, maize seedlings are usually grown in the mud cake in the marshy land and 12-day old seedlings are transplanted in the main plot (Uy, 1996). The top soil of the nursery bed was made level first and banana leaves were put on the bed. Then clay materials prepared from soil aside of the bed were spread on the banana leaves up to 4-5 cm depth. When the mud almost dried out on the surface, it was cut into square pieces like cake with a sickle to have sizes of 5cm in length and 5cm in width using a scale in order to grow 2 weeks old seedlings. Variable larger sized cakes were thus made for growing more than 2 weeks old seedlings e.g. 6 cm x 6 cm for 3 weeks old seedlings, 7cm x 7 cm for 4 weeks old seedlings, 8 cm x 8 cm for 5 and 6 weeks old seedlings. Sprouted seeds were placed at the centre of each mud cake and gently pressed with fingers so that the individual seed was sunk to a depth of about 1 cm. It was then covered with pulverized soil. Frequent watering was done to maintain proper growth and development of seedling.

iv. **Cup nursery:** Small size plastic cup was used (height-5.5 cm, face dia-5.5 cm and bottom dia-4.0 cm) and it was filled-up with friable soil. No manures and fertilizers were mixed-up with soil. Each cup had a small pore at the bottom to drain out excess water if any during watering to ensure proper germination of seeds and growth of seedlings up to optimum age.

v. **Poly bag nursery:** Poly bags having sizes 10 cm x 8 cm were used to raise seedlings in this method. Each poly bag was filled-up with friable soil. No manures and fertilizers were given. A single seed was placed in each bag at 1-1.5 cm depth. After placing seeds watering was done as and when necessary for proper germination and growth of the seedlings.

vi. **Dapog nursery:** Dapog method is usually followed by Bangladeshi farmers in the emergency to combat the natural hazards like flood, submergence of cultivated land and when there is no room in the field to grow rice seedlings. It is usually done for raising rice seedlings to be transplanted after recession of flood water. The

primed rice seeds are soaked overnight and then the seeds are placed on a banana leaf on *pucca* floor with a thin layer. No nutrients are supplied and the seedlings live on the reserve food in the caryopsis only. Like the dapog method followed in rice, sprouted maize seeds were placed on banana leaf. Watering was done 3-4 times with a rose can daily after placement of sprouted seeds on the banana leaf. Transplanting was successful in cotton with seedlings raised from dapog nursery (Gopalasamy, 1982).

Gaps filling: In case of direct planting of seed gaps filling was done where seeds were not germinated immediately after completion of 80% seedling emergence in the plot. Direct seeded plots were infested more by cut worm at early stage of seedling while transplanted crop was infested very minimum by cut worm. The habitat of the cut worm might be more favorable under dry land condition. Hence, more gaps filling was needed in direct planted plot. Very rare case, seedling died after transplanting due to failure of plant establishment and the gap filling was about 4% only other than mud cake, poly bag and tray nurseries. Hundred per cent plant establishment was found in the latter cases.

Seedling uprooting

Dry seed bed and compost nursery: Seedlings were uprooted from the dry bed nursery with the help of a *nirani/khurpi*. Seedlings were carefully uprooted to reduce root injury. Immediately after uprooting from the bed the seedlings were kept into water bowl till transplanting in the main field.

Cup nursery: The cups were positioned downward and lightly shaked to remove easily the seedlings from the tray for transplanting in the main field. Before removing the seedlings from the trays, enough water was given to make the entire soil volume saturated so that it remains attached to the seedling root. Consequently, the root system was disturbed at a minimum and seedling could establish rapidly in the main field.

Poly bag nursery: Each poly bag was watered before removing the seedling from bag like the tray method. Then each poly bag was torn to separate the seedling keeping the soil volume intact. This also could help like tray nursery for easy and rapid plant establishment of maize in the main field.

Weeding: One weeding was done at 15-20 days after planting (DAP). Weeds remained close to the maize plants were removed by *nirani.* Spading was done in the space between the rows just to kill the weeds remained there.

Thinning: Thinning was also done only in case of direct planting at the time of weeding at 15-20 DAP. Excess seedling was uprooted from the hill having more than one and a single plant per hill was maintained.

Earthing-up: Earthing-up was done at 40-50 days after second irrigation. The soil in between the plant rows was made loose by spading and then it was used for earthing-up. -up was done in such a way that the plant brace roots could hold the soil firmly thereby resisting the lodging against high velocity wind if prevailed.

Irrigation: Irrigation frequencies for direct planting of seed were followed as per Razzaque *et al.* (2000). Probably time of irrigation was determined on the growth stage of the crop plant. For transplanted crop, irrigation was given assuming the timing of irrigation followed in the direct planting and age of seedling so that irrigation may be concurrent with the greatest need of the crop. However, irrigation schedule was as follows:

i. For direct planting of seed: Four irrigations were given in total in direct sown crop at 20-25 DAP, 35-40 DAP, 60-65 DAP, and 80-85 DAP.
ii. For transplanted crop: This crop was irrigated 4 times also at transplanting, 20-25 DAP, 35-40 DAP and 60-65 DAP. As the seedlings are raised in the nurseries, its may attain different growth stages earlier. Hence, irrigation scheduling is different than that of direct planting.

Flood irrigation was given at all times and after each irrigation excess water was drained out as soon as possible. Irrigation was applied in the respective plots cautiously so that the neighbor plots did not receive any water through overflow of the boundary.

Fertilizer rate (kg per ha)

i. For composite variety (BARI maize-6): Fertilizers at the rate of 140-97-86-27-6-1.5 kg per ha N-P_2O_5-K_2O-S-Zn & B were applied as suggested by Razzaque *et al.* (2000) through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boron, respectively for both direct and transplanted crop.

ii. For hybrid variety (Pacific-11): Fertilizers at the rate of 248-117-120-40-6-1.5 kg per ha N-P_2O_5-K_2O-S-Zn and B were applied as suggested by Razzaque *et al.* (2000) through urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boron, respectively for both direct and transplant crop.

Fertilizer application method

i. For direct planting of seed: One-third N and all other fertilizers were applied as basal during final land preparation. The rest N was top dressed in 2 equal splits at 1st and at 2nd irrigation i.e. at 20-25 DAP and at 35-40 DAP, respectively (Razzaque *et al*., 2000).

ii. For transplanted crop: One-half N and all other fertilizers were applied as basal during final land preparation. The rest N was top dressed at 1st irrigation i.e. at 20-25 DAP. Transplanted crops may attain different growth stages earlier and with reduced crop duration than direct planting. Hence, to supply N at proper stage as per requirement, it was applied in two split application.

Data collection

Yield and yield components like number of cobs per plant, number of cobs per m^2, length of cob (cm), cob diameter (cm) was measured by using a Vernier scale in the middle part of each cob (Singh and Singh, 2000), number of grain rows per cob, number of grains per row, number of grains per cob, 1000-grain weight (g), grain yield (ton per ha) at 14% moisture content, Stover yield (ton per ha) (this was calculated by including the well sun dried plant, cob husk and cob stalk). Harvest index was calculated following Khan *et al.* (1999). Twenty cobs selected randomly from each plot were used for recording data as mentioned above. Mean values were calculated in each case. The day at which at least 50% plants of each plot attained the tassel (male flower) and silk (female flower) recorded as days to tasseling and days to silking, respectively. Days at which, at least 80% cobs of each plot attained maturity were recorded as days to maturity. The maturity of cob was determined when base (attachment to the cob stalk) of the grain attained the black layer (Kumar and Singh, 1999).

Data Analysis

Collected data were analyzed statistically following analysis of variance technique as per design of the experiment. Computer package program MSTATC was used for statistical analysis. Mean separation was done at 5% level of probability following Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth parameters

In both the varieties direct planting took maximum duration for tasseling, silking and maturity (Table 1). The variety V_1 (BARI maize-6) took 87-89 days and V_2 (Pacific-11) took 85-89 days for tasseling in the crops grown through planting of seedling. Direct planting (Dp) took 101 days and 100 days for V_1 and V_2, respectively for this parameter. Days to silking ranged from 91-94 days in V_1 while 89-92 days in V_2 with planting of seedling. The crop of Dp took 104 days for both varieties. However, both the varieties matured 7-8 days earlier when grown through planting of seedling than Dp which took about 147-149 days for maturity. The results clearly indicated that the crops of different seedling raising methods availed more grain filling duration compared to direct planting. Yang and Yang (1998) in their study found that crop may be established 15-20 days earlier by transplanting 20-30-day old seedlings. The early harvest may be helpful for saving the crop from Nor'wester as well as for early establishment of the next crop like jute, *Aus* rice, mungbean, sesame, etc. in the system.

Table 1. Interaction of variety and seedling raising method on days to tasseling, days to silking and field duration of maize during *Rabi* 2002-2003

Interaction		Days to 50% tasseling	Days to 50% silking	Field duration (days)
V_1	Dp	101.0	104.3	147.0
	M_1	89.3	93.3	141.3
	M_2	89.3	93.7	141.0
	M_3	88.3	92.3	140.3
	M_4	89.0	93.3	140.3
	M_5	87.3	91.0	140.7
	M_6	88.7	93.7	141.3
V_2	Dp	100.3	104.0	148.7
	M_1	88.7	91.7	142.0
	M_2	88.0	92.0	142.0
	M_3	86.3	89.0	141.7
	M_4	86.7	90.7	140.7
	M_5	85.3	89.3	141.3
	M_6	87.0	89.7	141.3

V_1= BARI maize-6, V_2 = Pacific-11, Dp = Direct planting M_1 = Dry bed nursery, M_2 = Compost nursery, M_3 = Mud cake nursery, M_4 = Poly bag nursery, M_5= Cup nursery, M_6 = Dapog nursery.

Yield and yield contributing characters

The results presented in Table 2 revealed that all the yield contributing characters except number of grains per row and number of grains per cob varied significantly between the varieties. There was a remarkable variation in terms of grain yield, stover yield and harvest index between the varieties. The longer cob was recorded from the variety Pacific-11. Pacific-11 also had the higher values for length of cob, number of cobs per plant, number of cobs per m^2, number of grain rows per cob and 1000-grain weight. Higher grain yield, stover yield and harvest index were obtained from the same variety. There was higher number of cobs m^{-2}, number of grains per cob and 1000-grain weight in Pacific-11 which in turn possibly produced higher grain yield. Pacific-11 produced about 17.49% higher grain yield than the composite variety BARI maize-6. Vasal and McLean (1994) reported that double cross maize hybrid gave 20-26% higher grain yield than open pollinated varieties. In this study, Pacific-11 was the double cross hybrid maize while BARI maize-6 was the open pollinated.

There were no significant differences in terms of length of cob, number of grain rows per cob, number of grains per row and number of grains per cob while cob diameter, number of cobs per plant as well as cobs per m^2, 1000-grain weight, grain yield, stover yield and harvest index differed significantly among the seedling raising methods (Table 3). The highest cob diameter was found in tray nursery which was at par with that of compost, mud cake and poly bag nurseries. The lowest cob diameter was found in direct planting of seed. The highest number of cobs per plant was also recorded in the cup and poly bag nurseries while the lowest was recorded from dry bed nursery. Dapog nursery produced the highest 1000-grain weight that was similar to dry bed, compost, mud cake and poly bag nurseries. The lowest 1000-grain weight was recorded from direct planting. However, the highest grain yields were obtained from both the cup and poly bag nurseries. The compost, mud cake and dapog nurseries also produced similar grain yields as that of tray and poly bag nurseries. The lowest grain yield was obtained from direct planting which was similar to dry bed, compost, mud cake and dapog nurseries. The results indicated that grain yield was mainly associated with number of cobs m^{-2}, number of grains per cob and 1000-grain weight. Grain yield was compensated by the higher values either of these parameters. Seedlings raised in glass-house planted in the field during or after the optimum time matured earlier and could give higher grain yields than direct planted maize (Dale and Drennan, 1997a). Yang and Yang (1998) in their study found that grain filling stages were 10 days longer in the transplanted crop as it attained silking 10-14 days earlier than direct planting. Increased grain yield of maize was obtained from transplanting of seedling (Feng *et al.,* 1998). Direct planted crop gave the highest stover yield might be attributed by the taller plant stature and it was also similar to tray nursery. Stover yield of tray method was also similar to the rest nurseries. The lowest stover yield was found in the dry bed nursery. Harvest index was

the highest in mud cake nursery which was statistically identical to the rest seedling raising methods and direct planting attained the lowest harvest index. The results indicated that more grain sink could be achieved through transplanting of seedling rather than planting of seed.

None of the characters showed significant differences due to the effects of interaction of variety and seedling raising method. Grain yield ranged from 8.00 ton per ha in the combination V_1 × Dp to 10.24 ton per ha in the combination V_2 × M_4 (Table 4). In general, higher grain yield was observed in the crop grown from transplanting of seedling in different methods than direct planting of seed in both the varieties. Higher grain yield in the crop grown from transplanting of seedling might be resulted mainly due to higher number of grains per cob and larger seed size (data not presented).

Cost and return analysis

The highest total cost of cultivation (59,234.92 Tk per ha) was calculated in the combination V_2 × M_5 due to the high price of plastic cup and requirement of more labourers (Table 4). The lowest (35854.50 Tk per ha) was calculated in the combination V_1 × M_6. In general, cost of cultivation was higher in the variety V_2 mainly due to the high requirement of fertilizers. The maximum gross return 81,520.00 Tk per ha was recorded from the combination V_2 × M_4 and the lowest (64,130.00 Tk per ha) in the combination V_1 × M_1. Higher gross return was found in V_2 due to its higher grain yield mainly. Maximum net return (36,759.43 Tk per ha) was recorded in V_2 × M_6 due to low cost required for raising seedlings. The M_1 and M_2 of V_2 gave the net returns of Tk 36,309.88 and Tk 36,410.08 per ha, respectively also due to the low cost required for raising of seedling. Similar trend was found in the variety V_1 considering the net return. Maximum benefit cost ratio (BCR) (1.90) was found in the method M_6 with the variety V_2. The methods M_1 and M_2 had the BCR value 1.89 each with the same variety V_2. Direct planting gave BCR values of 1.71 and 1.80 in V_1 and V_2, respectively. The minimum BCR in M_4 and M_5 in both the varieties might be due to the requirement of more laborer and higher purchasing cost for poly bag and tray. Transplanting of 5-day old seedlings gave the highest net return as compared to direct planting and 10-day old seedlings (Ibrahim and Gopalasamy, 1989).

Table 2. Effects of variety on the yield and yield contributing characters of maize during *Rabi* 2002-03

Variety	Length of cob (cm)	Number of cobs m^{-2}	Number of grain cob^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	HI (%)
V1	14.2b	5.81b	434.95	326.4b	8.16b	8.43b	49.24b
V2	15.9a	6.53a	441.86	344.6a	9.89a	9.35a	51.43a
LS	*	**	NS	*	**	*	**
CV (%)	7.73	4.07	3.24	3.92	5.76	7.83	1.13

V1=BARI maize-6, V2= Pacific-11, LS = Level of significance, Figures in a column having different letter(s) differ significantly at 5% level of probability; * and ** denote significant at 5% and 1% levels of probability, respectively. NS-Not significant at 5% level.

Table 3. Effects of seedling raising method on the yield and yield contributing characters of maize during *Rabi* 2002-03

Seedling raising method	Length of cob (cm)	Number of cobs m^{-2}	Number of grain cob^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Stover yield (t ha^{-1})	HI(%)
Dp	14.97	6.26 b	437.7	322.9c	8.78b	9.66 a	47.57b
Dry bed nursery	14.70	5.87 c	443.7	340.9a	8.81b	8.48 b	50.91a
Compost nursery	14.91	5.96 c	443.5	335.5ab	8.85 ab	8.63 b	50.60a
Mud Cake nursery	15.21	6.24 b	434.8	338.4ab	9.19 ab	8.74 b	51.12a
Poly bag nursery	15.29	6.31b	439.8	336.1ab	9.30a	8.87 b	51.11a
Cup nursery	15.65	6.49 a	437.7	329.8bc	9.30a	9.13 ab	50.39a
Dapog nursery	14.75	6.06 c	431.7	345.0a	8.93 ab	8.68 b	50.65a
Level of sig.	NS	**	NS	**	*	**	*
CV(%)	3.87	2.40	2.19	2.46	4.00	6.02	3.67

Figures in a column having no or similar letter(s) do not differ significantly while those with different letter(s) differ significantly at 5% level of probability; * and ** denote significant at 5% and 1% levels of probability, respectively; NS -Not significant at 5% level.

Table 4. Cost and return analysis of maize production as influenced by variety and seedling raising method during rabi 2002-03

Interaction		Yield (t ha^{-1})		Total cost of cultivation (Tk ha^{-1})	Gross return (Tk ha^{-1})			Net return (Tk ha^{-1})	BCR
V	M	Grain	Stover		Grain	Stover	Total		
V_1	Dp	8.00	9.44	37933.16	60000.00	4720.00	64720.00	26786.84	1.71
	M_1	8.01	8.11	36384.50	60075.00	4055.00	64130.00	27745.50	1.76
	M_2	8.02	7.96	36204.30	60150.00	3980.00	64780.00	28575.70	1.79
	M_3	8.22	8.26	41843.50	61650.00	4130.00	65780.00	23936.50	1.59
	M_4	8.36	8.32	50970.10	62925.00	4160.00	67085.00	16114.90	1.32
	M_5	8.38	8.73	54754.30	92850.00	4365.00	67215.00	12460.70	1.23
	M_6	8.14	8.16	35854.50	91050.00	4080.00	65130.00	29275.50	1.82
V_2	Dp	9.57	9.88	42684.08	71775.00	4940.00	76715.00	34030.92	1.80
	M_1	9.61	9.15	40865.12	72075.00	4575.00	77175.00	36309.88	1.89
	M_2	9.68	8.99	40684.92	72600.00	4495.00	77095.00	36410.08	1.89
	M_3	10.16	9.23	46324.12	76200.00	4615.00	80815.00	34490.88	1.74
	M_4	10.24	9.44	55450.72	76800.00	4720.00	81520.00	26069.28	1.47
	M_5	10.23	9.54	59234.92	76725.00	4770.00	81495.00	22260.08	1.38
	M_6	9.72	9.20	40740.57	72900.00	4600.00	77500.00	36759.43	1.90

Selling price: Maize grain - Tk 7.50 kg^{-1}; Stover- Tk 0.50 kg^{-1}, V_1= BARI maize-6, V_2= Pacific-11, Dp = Direct planting of seed, M_1= Dry bed nursery, M_2 = Compost nursery, M_3= Mud cake nursery, M_4= Poly bag nursery, M_5= Cup nursery, M_6= Dapog nursery, BCR = Benefit-Cost ratio.

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