J. Agrofor. Environ. 4 (1): 143-146, 2010 ISSN 1995-6983

Production potential of ginger under different spacing of *Dalbergia sissoo*

M. S. Bari and M.A. Rahim
Department of Agroforestry, Hajee Mohammad Danesh Science and Technology University, Dinajpur and Department of Horticulture, BAU, Mymensingh, Bangladesh

Abstract: The study was conducted to evaluate the growth and productivity of ginger under sissoo based Multistrata Agroforestry System (MAF) during the period of April 2005 to December 2006. The experiment was laid out in randomized complete block design with three replications. There were seven treatments in this experiment viz. T_1= sissoo (spacing 4m x 4m) + guava (spacing 2m x 2m) + ginger; T_2= sissoo (spacing 4m x 4m) + lemon (spacing 2m x 2m) + ginger; T_3= sissoo (spacing 5m x 5m) + guava (spacing 2.5m x 2.5m) + ginger; T_4= sissoo (spacing 5m x 5m) + lemon (spacing 2.5m x 2.5m) + ginger; T_5= sissoo (spacing 6m x 6m) + guava (3m x 3m)+ ginger; T_6= sissoo (spacing 6m x 6m) + lemon (spacing 3m x 3m) + ginger and T_7= Control (sole cropping of ginger). The treatments T_1 to T_6 were three layered woodlot consisted of sissoo at the top layer, guava and lemon at the middle layer and ginger at the ground layer. Results revealed that multistrata agroforestry systems with different tree spacing significantly influenced the rizome yield of ginger. The rhizome yield was reduced at closer spacing of *Dalbergia sissoo* as compared to that of wider spacing. The highest yield (25.76 t/ha in 2005 and 25.47 t/ha in 2006) was recorded under wider spacing of sissoo+guava based MAF during both the years. The lowest yield (12.64 t/ha in 2005 and 11.15 t/ha in 2006) was recorded in narrower spacing of sisoo+lemon based MAF in both season, which was followed by the narrower spacing of sissoo+guava based MAF and sole cropping of ginger. The yield under wider spacing of sissoo+guava based MAF was increased by 39.24 per cent in 2005 and 52.15 per cent in 2006 over sole cropping of ginger. Among the treatments, it was found that the highest benefit-cost ratio of 3.73 was recorded from the wider spacing of sissoo+guava based MAF and the lowest benefit-cost ratio of 1.43 was observed in sole cropping of ginger.
Key words: Multistrata, sissoo, lemon, guava, ginger, agroforestry system, woodlot.

Introduction

The existing land use systems of Bangladesh with separate allocation to agriculture and forest are insufficient to meet the demands for food, fuel, fodder, timber and other minor products in the 21st century. One should follow effective and compatible cultivation approaches where fruits, vegetables, spices, medicinal plants and timber can be grown combined in the limited land. In this link, the multistrata agroforestry system may be the best substitute cultivation approach. By practicing this cultivation arrangement, one can efficiently amplify the production of fruits, vegetables, spices, medicinal plants and timber vertically. Consequently, multistrata agroforestry is considered a panacea for overcoming most of the problems related to the alleviation of poverty, socio-economic instability and lessening ill effects of the global warming. The increasing demand and high prices of wood (fuel, timber, pulp) unlike the agriculture crops is a foremost reason for farmers to plant more trees in association with cereals, pulses, vegetables and spices. The potential benefits of growing trees in blend with annual and perennial crops are to uphold and sustain soil productivity and fertility (Nair, 1984; Singh *et al*., 1989; Chauhan *et al.*, 1997). But there is practically no information available on the production potentiality of growing spices like ginger in a multistrata sissoo woodlot. Therefore, keeping this view in mind the study has been conducted to evaluate the performance of ginger under sissoo based multistrata agroforestry systems.

Materials and Methods

The experiment was conducted in the existing multistrata sissoo woodlot of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh throughout the growing seasons of 2005-2006. Geographically it is located about 22.03^0 North latitudes and 90.26^0 East longitudes. The experimental area is under sub-tropical climate characterized by heavy rainfall during the months from April to September and scanty rainfall during the rest period of the year. The soil of the experimental area is silty loam in texture. It is a medium high land and fertile well drained. The experiment was conducted a single factor Randomized Complete Block Design (RCBD) with three replication for each treatment. There were seven treatments in this experiment viz. T_1= sissoo (spacing 4m x 4m) + guava (spacing 2m x 2m) + ginger; T_2= sissoo (spacing 4m x 4m) + lemon (spacing 2m x 2m) + ginger; T_3= sissoo (spacing 5m x 5m) + guava (spacing 2.5m x 2.5m) + ginger; T_4= sissoo (spacing 5m x 5m) + lemon (spacing 2.5m x 2.5m) + ginger; T_5= = sissoo (spacing 6m x 6m) + guava (3m x 3m)+ ginger; T_6= sissoo (spacing 6m x 6m) + lemon (spacing 3m x 3m) + ginger and T_7= sole cropping of ginger. Among the treatments, T_1 to T_6 were three layered woodlot consisted of sissoo at the top layer, guava and lemon at the middle layer and ginger at the ground layer. T_7 was in open condition. In the open condition T_7 received 100% sunlight; while sissoo + guava based Agroforestry system (T_1, T_3 and T_5) and sissoo + lemon based Agroforestry system (T_2, T_4 and T_6) allowed, respectively 33 to 54% and 45 to 69% sunlight for the growth of ginger. The upper layer sissoo tree was planted eight years ago i.e. July 1997. As the middle layer plant, guava and lemon both were five years old and were in full bearing condition. Standard pruning techniques for sissoo, guava and lemon tree were followed and the pruned materials were not added into the plot. Sissoo, guava and lemon tree were not dressed with fertilizer. But as the ground layer crop ginger was fertilized with recommended doses of fertilizers and the doses for ginger was 5 ton-304kg-267kg-111kg as cowdung, Urea, TSP and MP per hectare, respectively (BARC, 1999). The uniform size of seed rhizomes of ginger cultivar local were planted maintaining a row to row distance of 50 cm and plant to plant distance was 25 cm. The depth of planting was 9 cm. The planting date was 5th April 2005 and 12th April 2006. The experimental plots were kept weeds free by weeding frequently. The plots were irrigated whenever needed by using hose pipe

and watering cane. Ginger was harvested on 21st December 2005 and 27th December 2006. Economics of various treatments was calculated taking into account the current costs of inputs and produce. The data on various growth and yield performance characters of the ginger was statistically analyzed to examine the significant variation of the results due to different shading condition as well as different tree-crop associations. The mean differences were evaluated by Least Significant Difference (LSD) test (Freed, 1992).

Results and Discussion

Growth and yield contributing characters of ginger as influenced by the multistrata sissoo woodlot: The height of ginger amplified gradually with the lowering of light intensity (Table 1 and Table 2). The tallest plant (78.30 cm in 2005 and 79.57 cm in 2006) of ginger was observed in narrower spacing of sissoo+guava based MAF (T_1), which was followed by the treatment T_2. On the contrary, significantly the most dwarf plant was found in sole cropping of ginger (T_7). Nevertheless, the moderate plant height was observed in the treatment T_3, which was statistically similar to the treatments T_4 and T_5 in both the growing year. The corresponding figure of the wider spacing of sissoo+lemon based MAF (T_6) was 48.70 cm in 2005 and 45.11 cm in 2006. Leonardi (1996) cited that shading (60% light reduction) enhanced plant height in peppers. Probably, the presence of shade compelled the plant to become taller in receiving natural light. It is vital to pin point that the enhancement in plant height was coupled with long internodes only, not for the number of internodes.

Table 1. Growth and yield of ginger as Influenced by the sissoo based multistoried agroforestry systems during April, 2005 to December, 2005

Treatments	Plant height at 120 DAP (cm)	Plant height at 180 DAP (cm)	No. of leaves / hill	No.of tillers/hill	No. of primary finger/hill	No. of secondary finger/hill	Weight of primary finger/hill (g)	Weight of secondary finger/hill (g)	Fresh rhizome wt./ hill (g)	Yield (t/ha)
S_1+G_1+Ginger (T_1)	78.30	88.90	154.30	11.10	3.43	16.50	86.15	122.48	210.16	14.28
S_1+L_1+ Ginger (T_2)	67.83	70.24	138.40	10.37	3.10	15.80	78.71	119.24	197.53	12.64
S_2+G_2+ Ginger (T_3)	62.48	67.24	146.67	13.50	4.30	18.30	122.95	177.35	301.48	21.71
S_2+L_2+ Ginger (T_4)	59.12	65.57	124.83	11.80	3.90	15.07	116.89	156.80	274.85	19.41
S_3+G_3+ Ginger (T_5)	57.73	62.91	122.80	13.97	5.67	26.73	143.63	202.57	348.23	25.76
S_3+L_3+ Ginger (T_6)	48.70	59.60	115.67	13.03	4.40	19.90	133.79	178.73	314.07	22.59
Open (T_7)	47.96	53.24	106.37	11.23	3.73	17.83	109.82	141.15	252.17	18.50
Lsd $_{0.05}$	10.40	-	-	-	-	-	-	-	-	-
Lsd $_{0.01}$	-	12.80	23.27	2.46	1.25	3.10	10.40	18.97	62.64	3.47
CV (%)	9.69	7.68	7.19	8.11	14.26	6.68	3.69	4.85	9.26	7.22

Table 2. Growth and yield of ginger as influenced by the sissoo based multistoried agroforestry systems during April, 2006 to December, 2006

Treatments	Plant height at 120 DAP (cm)	Plant height at 180 DAP (cm)	No. of leaves per hill	No. of tillers / hill	No. of primary finger/hill	No. of secondary finger/hill	Weight of primary finger/hill (g)	Weight of secondary finger/hill (g)	Fresh rhizome wt./ hill (g)	Yield (t/ha)
S_1+G_1+Ginger (T_1)	79.57	90.77	137.10	10.50	3.07	14.33	78.99	113.14	173.90	13.07
S_1+L_1+ Ginger (T_2)	73.62	68.94	109.80	9.70	2.93	14.73	71.69	114.32	156.76	11.15
S_2+G_2+ Ginger (T_3)	67.59	62.84	135.03	12.80	3.70	15.53	110.76	105.77	219.86	20.16
S_2+L_2+ Ginger (T_4)	58.68	63.28	121.57	10.93	3.53	13.70	109.70	147.26	210.23	17.96
S_3+G_3+ Ginger (T_5)	56.73	58.77	114.13	12.80	4.87	21.60	133.38	185.97	308.96	25.47
S_3+L_3+ Ginger (T_6)	45.11	52.50	97.70	12.13	3.47	15.43	117.01	167.25	251.78	20.14
Open (T_7)	43.82	51.39	104.17	10.87	3.67	17.20	92.55	127.06	205.43	16.74
Lsd $_{0.01}$	16.47	10.85	35.29	1.63	1.12	3.44	16.27	39.57	60.70	2.02
CV (%)	10.87	6.79	12.09	5.75	12.47	8.57	6.39	11.56	11.16	4.55

** Significant at 0.01 level

This fact becomes lucid from the inconsequential number of leaves per plant. It is to be muscularly weighed that the number of leaves per plant and the number of nodes per plant are hereditarily comparative to each other in case of any ginger variety. However, the pattern of plant height observed was as $T_1>T_2>T_3>T_4>T_5>T_6>T_7$ during both the years. Again, numbers of leaves per hill of ginger were also significantly influenced and the maximum number of leaves (154.3 in 2005 and 137.1 in 2006) was found in narrower spacing of sissoo+guava based MAF (T_1) followed by intermediate spacing of sissoo+guava based MAF (T_3) in both the years. On the other hand, the lowest numbers of leaves (106.4 in 2005 and 97.70 in 2006) were found in sole cropping of ginger (T_1), which was

statistically identical to that produced from the treatments T_6, T_5 and T_4. The trait of number of tillers per hill augmented progressively (Table 1 and Table 2) as the light levels were decreased. The upper limit of the number of tillers per hill (13.97 in 2005 and 12.80 in 2006) was recorded in the treatment T_5, which was statistically analogous to the treatment T_3 in both the year. Nonetheless, the poorest number of tillers per hill (10.37 in 2005 and 9.70 in 2006) was experienced in the treatment T_2. In case of number of primary finger of ginger per hill, it was found from the table 1 and Table 2 that significantly the highest number of primary finger (5.67 in 2005 and 4.87 in 2006) was produced in wider spacing of sissoo+guava based MAF (T_5) during both the year. Reversely, the lowest number (3.10 in 2005 and 2.93 in 2006) was produced in narrower spacing of sissoo+glemon based MAF (T_2), which was followed by the narrower spacing of sissoo+guava based MAF (T_1). Careful study of data reveals a noteworthy effect caused by the multistoried agroforestry system on the number of secondary finger per hill of ginger. The uppermost number of secondary finger per hill of ginger (26.73 in 2005 and 21.60 in 2006) was reaped in wider spacing of sissoo+guava based MAF (T_5), which were followed by that in wider spacing of sissoo+lemon based MAF (T_6). The least number of secondary finger per hill (15.07 in 2005 and 13.70 in 2006) of ginger was observed in plants grown under intermediate spacing of sissoo+lemon based MAF (T_4). Similarly, weight of primary finger per hill of ginger varied appreciably due to different treatments investigated. The maximum primary finger weight (143.6g in 2005 and 133.4g in 2006) was observed in wider spacing of sissoo+guava based MAF (T_5) followed by wider spacing of sissoo+lemon based MAF (T_6) during both growing year, but those two treatments were statistically alike. Significantly, the minimum primary finger weight (78.71g in 2005 and 71.69g in 2006) was produced under narrower spacing of sisoo+lemon based MAF (T_2). Again, data in Table 1 and Table 2 also put forwarded that secondary finger weight of ginger was considerably influenced by the agroforestry systems and the trend was similar to the primary finger weight of ginger. The pattern of secondary finger weight observed was as $T_5>T_6>T_3>T_4>T_7>T_1>T_2$ in 2005 and $T_5>T_6>T_4>T_7>T_2>T_1>T_3$ in 2006. The fresh rhizome weight was almost parallel to the weight of primary and secondary finger weight. The premier fresh rhizome weight per hill (384.2g in 2005 and 309.0g in 2006) was gained from the treatment T_5 (wider spacing of sissoo+guava based MAF) gone after by T_6 (wider spacing of sissoo+lemon based MAF) and T_3 (intermediate spacing of sissoo+guava based MAF) in both the years. Significantly, the lower fresh rhizome weight of ginger (197.5g in 2005 and 156.8g in 2006) was observed in the narrower spacing of sissoo+lemon based MAF (T_2) during both the growing seasons.

Yield (t/ha) of ginger as influenced by the multistrata sissoo woodlot: Multistoried agroforestry systems at different tree spacing were found to significantly influence on rhizome yield of ginger during both years of experimentation (Table 1 and Table 2). The rhizome yield was reduced at closer spacing of MAF as compared to that of wider spacing of MAF. The highest yield (25.76 t/ha in 2005 and 25.47 t/ha in 2006) was recorded under wider spacing of sissoo+guava based MAF (T_5) during both the years, which was statistically similar to that of the wider spacing of sissoo+lemon based MAF (T_6). Significantly, the lowest yield (12.64 t/ha in 2005 and 11.15 t/ha in 2006) was recorded in narrower spacing of sisoo+lemon based MAF (T_2) in both season, which was followed by the narrower spacing of sissoo+guava based MAF (T_1) and sole cropping of ginger (T_7). It was attention-grabbing that, the yield under wider spacing of sissoo+guava based MAF was increased 39.24 per cent in 2005 and 52.15 per cent in 2006 over sole cropping of ginger (Fig. 1). From studies conducted in Kerala, India, Jayachandra *et. al*. (1998) also found 11-27% higher ginger yield than the open condition i.e. sole cropping of ginger. They also observed that ginger gave better yield under 50± 5% shade conditions than the full sun light conditions. This may be due to ginger is a sciophytic plant. Rahman (2004) also harvested bumper yield of ginger (32.88 t/ha) from the partial shade conditions while the least yield (18.75 t/ha) was recorded from the severe shaded conditions. In addition, variation in yield resulted from coalitions of shades of different trees with ginger was also noted by Singh *et.al.* (2001) where the yield trend was in the rank eucalyptus tree>open conditions>poplar tee>acacia tree.

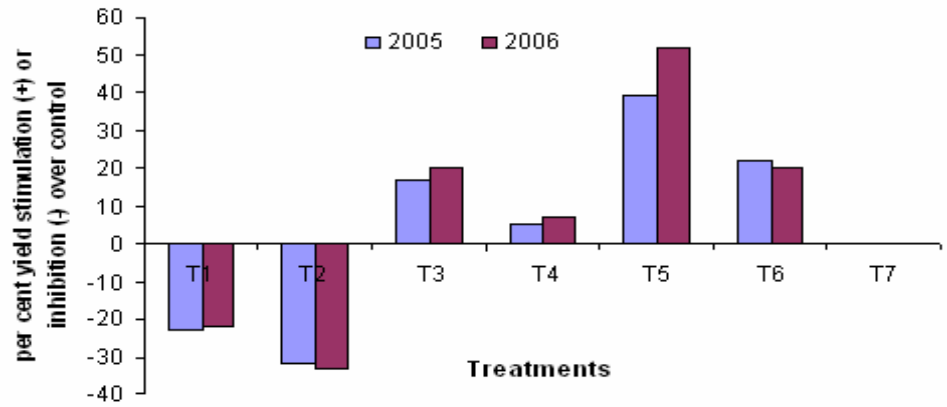

Fig. 1. Effect of sissoo based multistoried agroforestry systems on per cent yield stimulation (+) or inhibition (-) of ginger over control during 2005 and 2006

Economic analysis: Profitability of growing ginger as ground layer crop in sissoo based multistrata agroforestry system was calculated on the basis of local market rate prevailed during experimentation. The cost of production of ginger include the cost of production of tree plantation and management of middle and upper layer trees as well as the return of produce and the profit per taka i.e. Benefit Cost Ratio (BCR) have been presented in Table 3. The total cost of production was the highest (113606 Tk./ha) in narrower spacing of sissoo+guava based MAF (T_1) followed by the intermediate spacing of sissoo+guava based MAF (110215 Tk./ha) (T_3). The lowest cost of production (93055 Tk./ha) was recorded from the intermediate spacing of sissoo+g MAF (T_6). Higher cost of production was found in the narrower spacing of sissoo+lemon based MAF due to higher plantation and management cost of sissoo and guava trees. Again, the highest value of gross return (409938 Tk. /ha) was obtained from the intermediate spacing of sissoo+guava based MAF) (T_3). On the other hand, the lowest value of gross return (177330 Tk. /ha) was obtained from the sole cropping of ginger (T_7). The highest gross return was obtained due to higher fruit yield of guava along with the value of sissoo trees. Among the treatments, it was found that the highest benefit-cost ratio of 3.73 was recorded from wider spacing of sissoo+guava based MAF (T_5) followed by T_3, T_1, T_4, T_6 and T_2 treatments. The lowest benefit-cost ratio of 1.43 was observed in T_7 treatment i.e. in sole cropping of ginger. So, ginger can profitably be cultivated in multistrata sissoo woodlot.

Table 3. Economics of ginger production under sissoo based multistrata cropping system (average of two years)

Treatment	Return (Tk./ha)				Gross Return (Tk./ha)	Total cost of Production (Tk./ha)	Net Return (Tk./ha)	BCR
	Garlic	Guava	Lemon	Sissoo				
S_1+G_1+Garlic (T_1)	30900	157081	---------	153904	341885	82412	259473	4.15
S_1+L_1+ Garlic (T_2)	44625	---------	115002	153904	313531	78626	234905	3.99
S_2+G_2+ Garlic (T_3)	40230	118706	--------	140500	299436	72782	226654	4.11
S_2+L_2+ Garlic (T_4)	66150	-------	83201	140500	289851	70353	219498	4.12
S_3+G_3+ Garlic (T_5)	50317	74193	---------	113592	238101.9	61122	176979	3.90
S_3+L_3+ Garlic (T_6)	78635	--------	49499	113592	241726.1	59781	181945	4.04
Open (T_7)	182400	---------	--------	---------	177330	56471	120860	3.14

Note: Garlic 30 Tk./kg, Guava 6 Tk./kg; Lemon 1 Tk./piece, Sissoo (T1 & T2) 179 Tk./tree/year, Sissoo (T3 &T4) 250 Tk./tree/year, Sissoo (T5 & T6) 358 Tk./tree/year

References

BARC. 1999. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council, Dhaka.

Chauhan, H.S., Kamla, S., Patra, D.D. and Singh, K. 1997. Studies on litter production, nutrient recycling and yield potential under (5-6 years old) poplar *(P. deltoides)* and Ecualyptus *(E, hybrid)* interplanted with aromatic crops in Tarai region of Uttar Pradesh. J. Medicinal Aromatic Pl. Sci., 19**:** 1034-1038.

Freed, R.D. 1992. MSTAT-E. Crop and Soil Science Department, Michigan State University, USA.

Jayachandran, B. K. and Nair, G. S. 1998. Performance of mango-ginger (Curcuma amada Roxb.) under different levels of shade. J. Spices and Aromatic Crops, 7(2): 145-146.

Rahman, M. A. 2004. Growth and development of different vegetable and spices grown under multilayer agroforestry system. An M.S. thesis. Department of Agroforestry, Bangladesh Agricultural University, Mymensingh.

Singh, R.P., Ong, C.K. and Saharan, N. 1989. Above and below ground interaction in alley cropping in semi and India. Agrofor: Syst., 9: 259-274.

Singh, H., Singh, S. and Sing, H. G. 2001. Performance of turmeric (Curcuma longa) in association with multipurpose tree species. Central Soi Salinity Research Institute, Karnal, Haryana, India. Applied Biological Research., 3(1-2): 57-60.