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# Performance of medicinal plants under mango based multistoried agroforestry system

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**Abstract**: The investigation was carried out at the BAU Germplasm Centre of Bangladesh Agricultural University, Mymensingh during January 2005 to July 2007 to evaluate the performance of medicinal plants in mango based multistoried agroforestry system. Three medicinal plants viz. aloe vera (*Aloe indica*), asparagus (*Asparagus racemosus*) and misridana (*Kaempferia angustifolia*) were cultivated in the floor of a mango based multilayered garden (MAF). It was consisted of mango at the top layer, guava at the middle layer, and the tested medicinal crops were at the ground layer. Again, as control treatment all the medicinal plants were grown in open conditions. In the open conditions the crops received 100% sunlight; while multistoried agroforestry systems allowed 19 to 23% sun light for the growth of the ground layered medicinal crops. The influence of mango based multistoried agroforestry systems on growth, yield and economics of the three ground layered crops were studied for two consecutive years. The results of the study revealed that there was a significant effect of mango based multistoried agroforestry systems (MAF) on the growth and yield of the crops. Among the three medicinal plants, asparagus and misridana gave maximum yield under MAF, while aloe vera gave maximum in sole cropping. The yield of the cultivated medicinal plants under MAF may be ranked as misridana>asparagus>aloe vera. In the economic point of view it was very interesting that in spite of lower yield of aloe vera and asparagus, the highest gross returns were registered under mango based multistoried agroforestry systems compared to sole cropping. It was due to the substantial additional contribution by mango and guava fruits, while extra benefit is absent under sole cropping. Moreover, among the tested three medicinal crops, the degree of their profitability under mango based multistoried agroforestry systems may be ranked as misridana>aloe vera> asparagus. So, the present study suggest that the growing of all the three medicinal plants in mango based multistoried agroforestry systems ensures regular income from MAF intervention.

**Key words**: Multistoried, agroforestry system, mango, guava, aloe vera, asparagus and misridana.

## Introduction

Exploitation of herbal wealth from forests for pharmaceutical purposes is an old practice. Medicinal plants have remained an essential component of natural vegetation in Bangladesh. According to a survey report by WHO, about 25% of prescribed human medicines are derived from plants and 80% people still depend on traditional systems of medicines. FAO (1984) reported that more than 500 species of medicinal plants have been listed from the ground level vegetation of the forest and villages groves in Bangladesh. Many of them are used by the villagers and the tribal communities for human and animal treatments. But these valuable medicinal plant species have been reported to be disappearing rapidly due to heavy demand from pharmaceutical industry, leading to over exploitation and destruction of habitats. Again, due to over exploitation and unscientific collections, the genetic resources of valuable medicinal plants are getting exhausted very fast. To overcome this situation, it is, therefore, necessary that the cultivation of medicinal plant species in various agroforestry systems be exploited at commercial level to boosts up the production of medicines; achieve the target of providing cheap medicines to the population and to safe the drainage of hard foreign exchange. Now, there is every need to promote the cultivation of medicinal plants under agroforestry systems in agriculture as well as wasteland of the country. Shift from gathering to cultivation of medicinal plants will also ensure purity, authenticity and sustainable supply of raw materials required for herbal drugs. However, there is practically no information available on the probability of growing medicinal plants with multipurpose tree species except for the exploratory studies made on inclusion of some medicinal plants in India, which showed improved profitability (Pareek and Gupta, 1984; Maheshwari *et al*., 1985). However, not much research efforts have gone into this field and it needs a strong research base to identify suitable medicinal plants to be integrated with multipurpose tree species to develop potential, diversified and profitable agroforestry system. In addition, there is a strong need to develop cultural practices to raise these plants as part of agri-silviculture or agri-horticulture systems. Therefore, keeping this view in mind, the experiments has been conducted to evaluate the performance of three commercial and important medicinal plants like aloe vera (*Aloe indica*), asparagus (*Asparagus racemosus*) and misridana (*Kaempferia angustifolia*) as intercrops under mango based multistoried agroforestry system.

## Materials and Methods

The experiment was conducted in the existing multistoried mango garden of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh throughout the growing seasons of 2005-2007. 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 laid out in randomized block design with five replications and two treatments viz. $T_1$= mango + guava + individual three medicinal crops as ground layer crops; $T_2$= sole cropping of the three individual medicinal crops (open conditions).Treatment $T_1$ was a three layered mango garden consisted of mango at the top layer, guava at the middle layer, and the three medicinal plants were at the ground layer and $T_2$ was in open conditions. In the open conditions, $T_2$ received 100% sunlight; while mango+guava based multistoried agroforestry system ($T_1$) allowed 19 to 23% sunlight for the growth of the medicinal plants. The upper layer occupied by mango tree was planted in 1978 and the spacing of plantation was 8m x 8m. As the middle layer plant, guava was seven years old and was in full bearing conditions. The guava trees were planted between the rows of the mango trees maintaining 3m x 3m plant to plant and

row to row distance i.e. the guava population was 897 trees/ha. Standard pruning techniques for mango and guava trees were followed and the pruned materials were not added into the plot. Mango and guava trees were not dressed with fertilizer. But, the ground layer crops were fertilized with the recommended doses of fertilizers for each crop consisting of cowdung, urea, triple super phosphate (TSP) and muriate of potash (MP). Seedling of aloe vera and asparagus was planted on 28 February 2005 and 10 March 2005, respectively. The mother rhizomes of misridana were also planted in the experimental plot on 5 March 2005 and 13 March 2006. These planting materials were collected from Haybotpur village of Natore district. The spacing of the planting was maintained by 60 x 45 cm for both aloe vera and asparagus and 50 x 40 cm for misridana. The experimental plots were kept weeds free by weeding frequently. The plots were irrigated whenever needed by using hose pipe and watering cane. 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 aloe vera, asparagus and misridana were statistically analyzed and the mean differences were evaluated by Least Significant Difference (LSD) test (Freed, 1992).

## Results and Discussion

### Performance of aloe vera

**Growth and yield contributing characters:** The influence of the two different production systems like sole cropping and mango+guava based MAF on the growth and yield contributing characters of aloe vera were significant (Table 1). The tallest plant (54.75cm) was found in mango+guava based MAF and the shortest plant (42.30cm) was recorded in sole cropping. Numbers of leaves per plant of aloe vera were also significantly influenced and the maximum number of leaves (9.90) was obtained in sole cropping while the lowest number of leaves (8.26) was found in mango+guava based MAF. The trend of leaf length under different production systems was almost similar to that of plant height. Width of aloe vera leaves was increased with the decrease of shade level. The highest leaf width (5.03cm) was recorded from the sole cropping and the lowest leaf width (3.08cm) was recorded from the mango+guava based MAF. Similarly, a significant variation in canopy volume of aloe vera plant due to practiced different production systems was observed. It is clear from the Table 1 that the canopy volume of aloe vera was decreased under shade conditions. In case of **i**ndividual fresh weight of aloe vera leaf, it was also decreased under shade conditions. Significantly, the maximum fresh leaf weight (371.1 g) was observed in sole cropping. On the other hand, the minimum fresh leaf weight (242.97g) was produced under mango+guava based MAF. Again, data in Table 1 suggest that leaf dry weight of aloe vera was significantly influenced by and the pattern of leaf dry weight observed was as sole cropping>mango+guava based MAF.

**Table 1.** Growth and yield of aloe vera as Influenced by the mango based multistoried agroforestry system

| Treatments | Plant height (cm) | No. of leaves per /plant | Leaf length (cm) | Leaves width (cm) | Canopy volume $(cm)^3$ | Fresh wt of leaves/ plant (g) | Dry matter of leaves/plant(g) | Yield (t/ha) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1st harvest | 2 nd harvest | Total |
| M+G+Aloe vera ($T_1$) | 54.75 | 8.26 | 41.05 | 3.08 | 8311.44 | 242.97 | 11.06 | 7.00 | 9.98 | 16.94 |
| Open ($T_2$) | 42.30 | 9.90 | 33.23 | 5.03 | 11889.69 | 371.15 | 23.37 | 13.35 | 15.57 | 28.73 |
| Lsd $_{0.01}$ | 11.57 | 1.27 | 8.61 | 1.72 | 2131.05 | 101.76 | 7.36 | 1.98 | 4.02 | 4.52 |
| CV (%) | 8.19 | 4.82 | 7.97 | 9.91 | 7.25 | 11.40 | 14.70 | 6.69 | 10.76 | 6.79 |

**Yield (t/ha):** Leaf yield of aloe vera was significantly influenced by the two different production systems. In general, leaf yield of aloe vera was reduced under shade conditions. The highest yield (28.73 t/ha) was recorded under sole cropping of aloe vera. and the lowest yield (16.94 t/ha) was recorded in mango+guava based MAF. This yield reduction was 41.03 per cent over the sole cropping. The reason of maximum yield reduction in MAF might be that upper and middle layer trees i.e. the canopy of mango and guava, respectively made shade on the entire ground layer plots, consequently shading effect on aloe vera was prevailed. As a result, yield of aloe vera was low.

**Economic analysis:** The values in Table 2 indicate that the total cost of production was the highest (107575 Tk./ha) in sole cropping and the lowest cost of production (104619 Tk./ha) was recorded from mango+guava based MAF. But, the highest value of gross return (754826 Tk. /ha) was obtained from the mango+guava based MAF. On the other hand, the lowest value of gross return (114920 Tk. /ha) was obtained from the sole cropping. The highest gross return was obtained from mango+guava based MAF due to the high price of mango and guava.. In case of benefit-cost ratio the highest (7.21) was recorded from mango+guava based MAF and the lowest benefit-cost ratio of 1.07 was observed in sole cropping.

### Performance of asparagus

**Growth and yield contributing characters:** The perusal of data (Table 3) shows that the plant height of asparagus was significantly influenced by the two different production systems and it ranged from 77.52cm to 129.42cm. Plant height was increased under shade conditions. An insignificant variation was observed in canopy volume of asparagus plant. Reversely, number of tuberous roots per plant of asparagus was significantly influenced by the different production systems. The maximum number of tuberous roots per plant (51.88) was obtained in sole cropping and the lowest (38.82) was found in mango+guava based MAF. Other than, the maximum tuberous roots length (15.13 cm) was observed

in mango+guava based MAF and the minimum (14.63 cm) was observed in sole cropping. In case of root diameter, the highest (1.58 cm) was recorded from the sole cropping and the lowest (1.14 cm) was recorded from the mango+guava based MAF. The inclination of fresh weight of tuberous roots under different production systems was also similar to that of number of tuberous roots per plant. Root dry weight of asparagus was insignificantly influenced by the two different production systems and sole cropping of asparagus gave higher root dry weight per plant than that of mango+guava based MAF.

**Yield (t/ha):** Root yield of asparagus was significantly influenced by different production systems. The highest yield (10.52 t/ha) was recorded in sole cropping of asparagus (Table 3) and the lowest yield (7.12 t/ha) was recorded in mango+guava based MAF. This yield reduction was 32.31 per cent over the sole cropping.

**Table 2.** Economics of aloe vera production under mango based multistoried cropping system (during 2005 & 2006)

| Treatments | Return (Tk./ha) | | | Gross Return (Tk./ha) | Total cost of Production (Tk./ha) | Net Return (Tk./ha) | BCR |
|---|---|---|---|---|---|---|---|
| | Aloe vera | Guava | Mango | | | | |
| M+G+Aloe vera ($T_1$) | 16940 | 60924 | 676962 | 754826 | 104619 | 650207 | 7.21 |
| Open ($T_3$) | 114920 | -------- | ------- | 114920 | 107575 | 7345 | 1.07 |

**Table 3.** Growth and yield of asparagus as influenced by the mango based multistoried agroforestry systems

| Treatments | Plant height (cm) | Canopy volume (cm) | No. of Tuberous root per plant | Length of Tuberous root (cm) | Diameter of Tuberous root | Fresh wt of Tuberous root /plant (g) | Wt of Dry matter of Tuberous root /plant (g) | Fresh tuber yield (t/ha) |
|---|---|---|---|---|---|---|---|---|
| M+G+Asparagus($T_1$) | 129.42 | 89838.78 | 38.82 | 15.13 | 1.14 | 212.94 | 21.76 | 7.12 |
| Open ($T_2$) | 77.52 | 105038.15 | 51.88 | 14.63 | 1.58 | 254.65 | 25.31 | 10.52 |
| Lsd $_{0.01}$ | 23.87 | NS | 8.85 | NS | 0.42 | 88.65 | NS | 3.37 |
| CV (%) | 7.92 | 6.86 | 6.70 | 10.77 | 9.39 | 10.73 | 11.24 | 7.78 |

**Economic analysis:** The total cost of production was the highest (160875 Tk./ha) in sole cropping and the lowest (117980 Tk./ha) was recorded from mango+guava based MAF (Table 4). But, the highest value of gross return (784000Tk. /ha) was obtained from the mango+guava based MAF. On the other hand, the lowest value of gross return (263000 Tk. /ha) was obtained from the sole cropping. The highest gross return was obtained from mango+guava based MAF due to the high price of mango and guava. Moreover, the highest benefit-cost ratio (6.65) was recorded from mango+guava based MAF and the lowest benefit-cost ratio of 1.63 was observed in sole cropping.

**Table 4.** Economics of asparagus production under mango based multistoried cropping system

| Treatments | Return (Tk./ha) | | | Gross Return | Total cost of Production | Net Return | BCR |
|---|---|---|---|---|---|---|---|
| | Asparagus | Guava | Mango | (Tk./ha) | (Tk./ha) | (Tk./ha) | |
| $S_1$+$G_1$+Asparagus ($T_1$) | 44500 | 62538 | 676962 | 784000 | 117980 | 666020 | 6.65 |
| Open ($T_7$) | 263000 | --------- | ---------- | 263000 | 160875 | 102125 | 1.63 |

Note: Asparagus 25 Tk./kg, Guava 6 Tk./kg; Lemon 1 Tk./piece, Mango 22 Tk./kg.

**Performance of misridana**

**Growth and yield contributing characters:** The influence of the two production systems like mango+guava based MAF and sole cropping on growth and yield contributing characters of misridana were significant during both the growing seasons (Table 5 and Table 6). Misridana plant cultivated under mango+guava based MAF grew more vigorously than those grew in open field. The tallest plant was observed in mango+guava based MAF and significantly, the most dwarf plant was found in sole cropping during both the growing seasons. Correspondingly, numbers of leaves per plant of misridana were significantly influenced and the maximum number of leaves (15.60 in 2005 and 16.80 in 2006) was found in mango+guava based MAF. Again, the trait of number of tillers per hill was more in partial shade conditions. The upper limit of the number of tillers per hill (9.80 in 2005 and 10.90 in 2006) was recorded in mango+guava based MAF. Nonetheless, the poorest number of tillers per hill (8.20 in 2005 and 9.20 in 2006) was experienced in the sole cropping. The maximum mother rhizome weight (50.68g in 2005 and 53.78g in 2006) was observed in mango+guava based and significantly, the minimum (30.67g in 2005 and 30.89g in 2006) was produced under sole cropping. Again significantly, the highest number of primary finger (67.20 in 2005 and 77.30 in 2006) was recorded in mango+guava based MAF. On the contrary, the lowest number (38.80 in 2005 and 44.20 in 2006) was

produced in sole cropping. Similarly, the maximum primary finger weight (174.88g in 2005 and 189.25g in 2006)) was recorded under mango+guava based MAF and the minimum (120.67g in 2005 and 126.67g in 2006) was produced under sole cropping. The uppermost number of secondary finger per plant of misridana (14.90 in 2005 and 17.80 in 2006) was reaped in mango+guava based MAF. Furthermore, the secondary finger weight of misridana was also maximum (17.78 g in 2005 and 19.12 g in 2006) in mango+guava based MAF. The fresh rhizome weight was almost parallel to the weight of primary and secondary finger weight.

**Table 5.** Growth and yield of misridana as influenced by the mango based multistoried agroforestry systems during March 2005 to December 2005

| Treatments | Plant height at 120 DAP (cm) | Plant height at 180 DAP (cm) | No. of leaves per plant | No of tiller/ hill | Wt of mother rhizome /hill (g) | No. of primary fingers /plant | Wt of primary fingers /plant (g) | No. of secondary fingers /plant | Wt of secondary fingers /plant (g) | Total fresh wt. of rhizom/ plant (g) | Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 53.48 | 68.86 | 15.60 | 9.80 | 50.68 | 67.20 | 174.88 | 14.90 | 17.78 | 247.21 | 11.68 |
| Open ($T_2$) | 30.24 | 36.87 | 11.90 | 8.20 | 30.67 | 38.80 | 120.67 | 9.60 | 11.32 | 163.78 | 7.45 |
| Lsd $_{0.01}$ | 11.61 | 9.62 | 3.89 | 2.62 | 10.58 | 18.37 | 32.33 | 3.74 | 4.22 | 58.04 | 2.34 |
| CV (%) | 9.53 | 6.25 | 9.71 | 10.0 | 8.93 | 11.91 | 7.51 | 10.49 | 9.97 | 9.70 | 8.42 |

$T_1$ = C+G+ Misridana

Table 6. Growth and yield of misridana as influenced by the mango based multistoried agroforestry systems during March 2006 to January 2007

| Treatments | Plant height at 120 DAP (cm) | Plant height at 180 DAP (cm) | No. of leaves per plant | No of tiller/ hill | Wt of mother rhizome /hill (g) | No. of primary fingers /plant | Wt of primary fingers /plant (g) | No. of secondary fingers /plant | Wt of secondary fingers /plant (g) | Total fresh wt of rhiz./ plant (g) | Yield (t/ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | 50.73 | 50.78 | 16.80 | 10.9 | 53.78 | 77.30 | 189.25 | 17.80 | 19.12 | 263.86 | 12.46 |
| Open ($T_2$) | 31.84 | 37.73 | 12.70 | 9. | 30.89 | 44.20 | 126.67 | 10.90 | 11.93 | 171.69 | 7.86 |
| Lsd $_{0.01}$ | 14.96 | 9.92 | 4.05 | NS | 11.01 | 14.46 | 52.78 | 4.42 | 4.76 | 46.94 | 2.38 |
| CV (%) | 12.45 | 7.70 | 9.43 | 9.61 | 8.93 | 8.17 | 11.48 | 10.58 | 10.52 | 7.40 | 8.05 |

$T_1$ = C+G+ Misridana

**Table 7.** Economics of misridana production under mango based multistoried cropping system (average of two years)

| Treatments | Return (Tk./ha) | | | Gross Return (Tk./ha) | Total cost of Production (Tk./ha) | Net Return (Tk./ha) | BCR |
|---|---|---|---|---|---|---|---|
| | Misridana | Guava | Mango | | | | |
| C+G+Misridana ($T_1$) | 120700 | 33422 | 338481 | 492603 | 57419 | 435184 | 8.58 |
| Open ($T_2$) | 306200 | ------- | -------- | 177330 | 76117 | 101213 | 2.33 |

Note: Misridana 40 Tk./kg, Guava 6 Tk./kg; Lemon 1 Tk./piece, Mango 22 Tk./kg

**Yield (t/ha):** The practice of the two different production systems were found to significantly influence on corm yield of misridana during both years of experimentation (Table 5 and Table 6). The corm yield was more at multistoried agroforestry systems as compared to that of sole cropping. As a result, mango+guava based MAF gave better yield as compared to sole cropping.

**Economic analysis:** The total cost of production was the highest (76117 Tk./ha) in sole cropping and the lowest (57419Tk./ha) was recorded from mango+guava based MAF. But, the highest value of gross return (492603 Tk. /ha) was obtained from the mango+guava based MAF (Table 7). The highest gross return was obtained from mango+guava based MAF due to the high price of mango and guava. In case of benefit-cost ratio, the highest (8.58) was recorded from mango+guava based MAF and the lowest benefit-cost ratio of 2.33 was observed in sole cropping.

The study suggests that the combination of medicinal crop with commercial fruit tree species on the same land ensures diversified products and greater profit to the farmers. Three high value medicinal crops viz. aloe vera, asparagus and misridana can be grown successfully as intercrops in the floor of mango orchard.

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