J. Sher-e-Bangla Agric. Univ., 4(1): 100-105, January 2010 ISSN 1997-6038

PERFORMANCE OF PINEAPPLE IN TERMS OF YIELD AND QUALITY GROWN UNDER MULTISTORIED AGROFORESTRY SYSTEMS

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ABSTRACT

An experiment was conducted at the experimental farm of Bangladesh Agricultural University, Mymensingh during the period from May 2002 to August 2003 with the objective to study the fruit quality and yield of pineapple (var. Giant Kew) grown under different fruit tree based multistoried agroforestry production systems. Pineapple was grown under the shade of four fruit trees and one shrub viz. sissoo, mango, coconut, guava and lemon in different combinations. The treatments were T_1 = sissoo + guava + pineapple, T_2 = sissoo + lemon + pineapple, T_3 = mango + guava + pineapple, T_4 = coconut + guava + pineapple T_5 = coconut + lemon + pineapple and T_6 = control having pineapple only. Due to variation of shade created by trees different treatments showed significant differences in yield contributing features and quality of pineapple fruit. The yield of fruits showed considerable variations such as T_2 treatment showed highest fruit yield (27.08 tha^{-1}) followed by T_3 (26.67 tha^{-1}), T_1 (26.35 tha^{-1}) T_4 (25.52 tha^{-1}) and T_5 (25.21 tha^{-1}) and the lowest was in T_6 (23.44 tha^{-1}). The fruit set (82.33%), individual fruit weight (0.65 kg), fruit length (12.25 cm), pulp of fruit (0.46 kg), pulp-peel ratio (2.35) and yield of fruit (27.08 t/ha) had been found to be the highest in the treatment T_2, where light intensity was 22.99% under partial shade condition. The p^H and titratable acidity of juice were the highest (5.16) in sunny treatment of T_6 while the lowest value was obtained in the most shady treatment of T_3. Total sugar contents of pineapple (27.17%) including reducing sugar (6.69%) and non-reducing sugar (5.48%) was the highest in moderately shady treatment (T_4), where the light intensity was 16.3%. Similarly, total soluble solid content of pineapple was the highest (21.23%) in moderately shady treatment (T_4) and the lowest (18.86%) in the slightly shady treatment of T_1. Therefore, for desirable quality and high yield, pineapple can be grown successfully in suitable agroforestry model.

Keywords: Pineapple, growth, quality and yield, agroforestry model

INTRODUCTION

Pineapple is a popular and nutritious fruit of Bangladesh. Its cultivation is confined to limited areas such as Gazipur, Tangail, Narsingdi, Chittagong Hill Tracts and Sylhet districts etc. Pineapple occupied an area of about 1,457 hectares of land and produced 1,48,350.00 metric tones of pineapple per year (BBS, 2006). The average yield of pineapple is 9.88 tha^{-1} in Bangladesh, which is low as compared to India (15 tha^{-1}) and Hawaii (40 tha^{-1}).

Pineapple is originated in South America and grows very well in Hawaii. It also grows quite well in the tropic, which is relatively moist areas of Australia, Southern and Northern America and Southeast Asia. However, it grows well in moist and shady places. In Bangladesh, it grows in selected areas. Under multistoried tree garden, pineapple would be a compatible fruit crop due to its shade tolerant nature. Farmers can easily grow this popular fruit and can meet up their nutrient requirement. On the other hand, during non- bearing season of pineapple, farmers can harvest various types of fruits from their tree-shrub component. Thus, they can earn reasonable money through out the year. Moreover, an owner can easily meet up their fuelwood, timber and fodder demand from multistoried agroforestry production systems (Jackson, 1987). In fact, multistoried agroforestry systems offer several advantages such as soil conservation, nutrient cycling, microclimate amelioration, labour efficiency

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and continuous production. Farmers of Bangladesh used to practice this production system by planting trees in homestead, in and around the crop field or by managing naturally grown trees. They can produce various types of fruits, fuel wood and timber. Quite easy growing fruit like pineapple can be grown in various fruit gardens and orchards, kitchen gardens, integrated farm forests, poultry farms, homesteads and various other shady places (Haque, 1996). The fruit tree improvement project of Bangladesh Agricultural University, Mymensingh (FTIP-BAU-DH), recently, has trialed pineapple production under different tree shades for quality and yield of pineapple (Rahim and Haider, 2002). The present study was undertaken to investigate the effect of trees viz. sissoo, mango, coconut, guava, lemon on the yield and quality of pineapple and to evaluate the performance of different multistoried cropping systems.

MATERIALS AND METHODS

The study was conducted in the field of Fruit Tree Improvement Project, Bangladesh Agricultural University (FTIP-BAU-DH), Mymensingh, during the period from May 2002 to August 2003. Geographically, Mymensingh is located between 22.03^{0}N Latitude, 90.26^{0}E Longitude. The experimental site was located in the tropical monsoon climate. The soil was sandy loam with a p^H of 6.8 containing about 0.83% organic matter. The treatments were T_1 = Sissoo + Guava +Pineapple, T_2 = Sissoo + Lemon + Pineapple, T_3 = Mango + Guava + Pineapple, T_4 = Coconut + Guava +Pineapple, T_5 = Coconut + Lemon + Pineapple, T_6 = Control plot (open). Light intensity at noon time was measured using Linear PAR Ceptometer Accu PAR (Model: 800-755-2751) as reported by Shapla (2001). At about the level of pineapple (0.5-0.6 m above ground level), the light intensity was to be 21.91, 22.99, 13.45, 16.30, 17.91 and 86.30 in T_1, T_2, T_3, T_4, T_5, and T_6 treatments, respectively. The highest shady treatment was T_3 followed by T_5 and T_3 . The least shady treatments were T_1 and T_2 while T_6 was the most sunny treatment. The age of the sissoo, mango, coconut, guava and lemon was 9, 20, 20, 4 and 4 years, respectively. Pineapple (var. Giant Kew, collected from Madhupur, Tangail) was planted on May 28, 2002 under these combinations as the lower layer along with a control pineapple plot. The treatments were arranged in Randomized Complete Block Design (RCBD) with four replications. In total, 24 plots were set up and each plot size was 6 x 8 m. The distance between two plots was 4 m and the spacing of pineapple was 40 x 60 cm. Fertilizer doses such as 5 ton, 140 kg, 30 kg and 100 kg as cow dung, N, P, K per hectare, respectively were applied at the time of final land preparation. Neither fertilizer nor irrigation was applied during cropping season. Only weeding and de-suckering were done before weeding. Fruits were harvested during June to July 2003 at ripening stage, determined on the basis of orange-yellow color of the lowermost eyelets and flattering in the center of eyes, when bracts become loose and turned brown in color. Twenty (20) pineapples were selected randomly, of which 5 from each replication from each plot and recorded qualitative features such as percent fruit set, fruit size and shape, fruit weight, pulp/peel ratio, fruit length, fruit diameter, yield etc. in the field and quantitative features, such as ascorbic acid, TSS (Total Soluble Solids), TA (Titratable Acidity), TS (Total Sugar), reducing and non-reducing sugar, p^H etc. in the laboratory. Different apparatus, equipments and chemicals, such as Abbe Refractometer, Oven, p^H meter and chemicals like; 0.1N NaOH, Fehling's solution, lead acetate solution, HPO_3, phenolphthalein indicator etc. were used in the laboratory. The collected data were statistically analyzed by MSTAT Computer Program. The means were compared by Duncans Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Fruit set

The percent of fruit set was calculated on the basis of plants fruited at the time of harvesting season. The plants grown in various shade levels were differed significantly in respect of fruit set. The highest fruit set (82.33%) was found in T_2 treatment closely followed by T_3 (82.24%) and T_6 (82.24%), while T_1 showed the lowest (81.42%) fruit set (Table 1).

Length of individual pineapple fruit without crown

Different treatment combinations had significant effect on length of pineapple fruit without crown. The highest fruit length (12.25 cm) was observed in T_2 (Table 1). The second highest fruit length (11.85 cm) was recorded in T_3 followed by T_1 (11.30 cm) and T_4 (11.13 cm), while T_6 produced the shortest fruit (10.53 cm).

Fruit diameter

Pineapple grown under different shade levels had significant influence on fruit diameter. The maximum (9.63 cm) diameter was recorded in the T_5 followed by T_3 (9.40 cm). The lowest (8.95 cm) fruit diameter was recorded under full sunlight (T_6). Fruit diameter produced in T_1 (9.15 cm) and T_4 (9.18 cm) were statistically similar. The lower fruit diameter under full sunlight might be due to lower mobilization of reserved assimilates to reproductive organ (Hossain, 1999).

Weight of individual pineapple fruit

Pineapple planted under different multistoried agroforestry production systems was influenced by different shade levels in respect of fruit weight without crown (Table 1). The individual fruit weight in different tree combinations was higher in T_5 (0.67 kg), which was statistically similar with T_2 & T_3 (0.65 kg). Weight of individual fruit was the lowest when grown in T_6 (0.56 kg). In different treatments, the weight of pineapple fruit had been found to be 22-28% less than that of the fruit with crown. In the present investigation pineapple had always been considered as the pineapple fruit without crown.

Table 1. Fruit set, fruit size and fruit weight of pineapple under different treatments

Treatments	Fruit set (%)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)
T_1	81.42c	11.30abc	9.15bc	0.63 abc
T_2	82.33a	12.25a	9.33b	0.65 ab
T_3	82.24ab	11.85ab	9.40ab	0.65ab
T_4	81.58bc	11.13abc	9.18bc	0.59 bc
T_5	81.58bc	10.93bc	9.63a	0.67a
T_6	82.24ab	10.53c	8.95c	0.56c
CV (%)	0.51	6.38	1.89	7.41

Means in a column having same letters do not different significantly at 5% level of estimation by DMRT.

Pulp and peel of pineapple fruit

Pulp and peel of fruit differed significantly in different multistoried production systems as compared to open place (Table 2). The highest pulp weight (0.46 kg) was recorded in T_2 which were statistically similar to T_5 (0.45 kg), T_3 (0.44 kg) and T_1 (0.42 kg), while the lowest pulp weight (0.36 kg) was observed in T_6. The peel of pineapple was not significantly affected by different shade levels. It may be said that different multistoried production systems had no significant effect on the peel. The highest (0.22 kg) peel was found in T_5. The second highest in T_6 (0.20 kg) and the reaming constant weight of 0.19 kg in T_1, T_2 and T_4. The peel of pineapple fruit showed no significant effect of shade.

Pulp-peel ratio of pineapple fruit

The pulp to peel ratio of pineapple fruit was significantly influenced by the effect of different shade combinations (Table 2). T_2 produced fruit with higher pulp peel ratio (2.35) followed by T_1 (2.31), while T_6 produced the smallest pulp peel ratio (1.82). The ratio in T_3, T_4 and T_5 were statistically similar. Pineapple produced in sunny place contained thinner peel than that of the fruits grown in shade (Botrel *et al.*, 1993).

Yield of pineapple fruit (tha^{-1})

Significant differences in the yield per hectare were found in different treatment combinations (Table 2). The treatment T_2 gave the highest yield (27.08 t/ha) followed by T_3 (26.67 t/ha), T_1 (26.35 t/ha), T_4

(25.52 t/ha), T_5 (25.21 t/ha) and T_6 (23.44 t/ha). Chadha *et al.* (1974) reported from that densely planted pineapple resulted in high yield respective of quality or size of fruits in India. Like all other corps, the yield of pineapple depends on a number of factors including variety, location of cultivation, application of fertilizers and cultural management (Hossain, 1999, Khaleque and Gold, 1993).

Table 2. Individual fruit pulp, peel, their ratio and final yield of fruit (t/ha) under different treatments

Treatments	Fruit Pulp (kg)	Fruit Peel (kg)	Pulp-Peel ratio	Fruit yield (t/ha)	Light Intensity	Darkness
T_1	0.42ab	0.19a	2.31a	26.35a	21.91%	Slight Dark
T_2	0.46a	0.19a	2.35a	27.08a	22.99%	Slight Dark
T_3	0.44ab	0.22a	1.96b	26.67a	13.45%	Moderate Dark
T_4	0.40bc	0.19a	2.10ab	25.52a	16.30%	Moderate Dark
T_5	0.45ab	0.22a	1.98b	25.21a	17.91%	Moderate Dark
T_6	0.36c	0.20a	1.82b	23.44b	86.30%	Sunny
CV (%)	8.33	12.19	9.61	4.41	-	

Means in a column having same letter (s) do not differed significantly at 5% level of estimation by DMRT.

P^H of pineapple fruit juice

The different shade levels had significant effect on p^H of pineapple fruit pulp (Table 3). The highest p^H (5.16) was observed in T_6 followed by T_5 (5.06) and T_4 (5.05). The lowest p^H (4.65) was recorded from T_3. The treatments T_1, T_2 and T_3 were statistically similar but significantly different from T_4, T_5 and T_6. It may be concluded from the result that low and high p^H value may be regulated by shade. Different levels of p^H in pineapple juice ranging from 3.5 to 5.5 were reported by a number of workers (Botrel *et al.,* 1993; Sen, 1996; Singleton and Gortner, 1965).

Total titratable acidity

The quality of pineapple depends on the percentage of acidi present in fruit juice which is called titratable acidity. The total titratable acidity was influenced by different shade levels. The highest titratable acidity was observed in T_3 (0.59%) followed by T_1 (0.58%). The lowest titratable acidity (0.53%) was found in T_6 (control). Estimated titratable acidity found in T_2, T_4 and T_5 were statistically similar (Table 3). A continuous increase in total titratable acidity was obtained with the increase of shade levels. Dull (1971) reported 0.6-1.62% total titratable acidity in pineapple.

Reducing sugar content in fruit pulp

As a result of different levels of shade, highly significant differences were observed in respect of reducing sugar content in pineapple fruit. There was slow increase in reducing sugar content as shade increased but it decreased in sunny condition (Table 3). The highest reducing sugar content (6.69%) was observed in T_4, while it was 6.36% in T_5. Reducing sugar content in T_6 (6.21%) and T_2 (6.20%) were statistically similar. The lowest reducing sugar content (5.73%) was observed in T_3. So, it may be concluded that moderate shade (T_4 and T_5) is optimum for higher reducing sugar content. Reducing sugar could be as high as 11% (Dull, 1971).

Non- reducing sugar content in pineapple fruit pulp

The highest non-reducing sugar content (5.48%) was observed in T_4 in ripe pineapple fruits (Table 3). Non-reducing sugar content decreased as the shade increased, which was followed by the decrease of reducing sugar. The lowest non-reducing sugar content (3.80%) was observed in T_3 followed by T_5 (3.99%) and T_6 (4.00%). The non-reducing sugar content was statistically similar in T_1 (4.77%) and T_2 (4.53%). Results of the present study on non-reducing sugar content of pineapple are in conformity with the reports of Dull (1971) and Chadha *et al.* (1974).

Total sugar content in pineapple fruit pulp

Total sugar content in pineapple fruit was found to vary significantly in different shade levels. The highest (12.17%) total sugar content was observed in T_4 and the lowest (9.53%) one was in T_3. Total sugar content observed in T_1, T_2, T_5 and T_6 were statistically similar (Table 3). So, it could be stated

that total sugar content had been found to be the highest when pineapple was produced in moderate shade as in T_4, T_1 and T_5. According to Dull (1971) ripe pineapple pulp contained 5.9-12.0% sucrose, 1.0-3.2% fructose and 0.6% glucose.

Table 3. p^H, titratable acidity and reducing and non reducing sugar contains of pineapple under different treatments

Treatments	pH of fruit juice	Titratable acidity (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Vit. C mg/100gm	TSS (%)
T_1	4.74d	0.58a	6.04bc	4.77ab	10.81b	8.27ab	19.0
T_2	4.74b	0.58ab	6.20b	4.54ab	10.74b	7.56b	20.0
T_3	4.65b	0.59a	5.73c	3.80b	9.53c	9.42a	19.5
T_4	5.05a	0.54ab	6.69a	5.48a	12.17a	6.80c	21.5
T_5	5.06a	0.57ab	6.36ab	3.99b	10.35bc	7.40d	21.2
T_6	5.16a	0.53b	6.21b	4.00b	10.21bc	5.70c	20.0
CV (%)	3.87	4.14	4.29	15.50	5.79	4.75	4.87

Means in a column having same letter (s) do not differed significantly at 5% level of estimation by DMRT.

Vitamin C content

Pineapple fruit produced in different multistoried tree combinations had highly significant effect on Vitamin C content of the fruit juice. It was observed that the highest Vitamin C (9.42 mg/100 gm fruit juice) was found in T_3. The Vitamin C content decreased with the increase of light intensity (Table 3). The lowest Vitamin C content (5.70 mg) was observed in T_6 (control). The Vitamin C contents found in T_2 (7.56 mg/100 gm juice) and T_5 (7.40 mg/100 gm juice) were statistically similar. So, it may be concluded that Vitamin C content increased with the increase of shade level.

Total soluble solids content in pineapple fruit pulp (TSS)

In the present study, the TSS content of fruit juice was highly significant in different treatments (Table 3). The treatment of T4 contained the highest TSS (21.23%) followed by T_5 (21.13%). The lowest TSS was observed in T_1 (18.86%). The trend of TSS content in different treatments indicated that TSS content decreased in full sunny and deep shady treatments (T_6 and T_3). High TSS had been found to indicate highly sweetness (Botrel *et al.,* 1993; Dull, 1971). Singletone and Gortner (1965) reported 10.8-17.5% TSS in ripe pineapple juice.

Considering the above mentioned results and discussion, it is, therefore, concluded that the performance of pineapple and its quality under different multistoried agroforestry production systems were different. Among the five different agroforestry gardens with three canopy configurations, the pineapple yield was not significantly different. But as compared to pineapple production in open field, the yield was much higher. Under open condition (86.30% of PAR), the percent of fruit set, individual fruit weight, per cent edible portion, crown length, Vitamin C content declines, whereas sugar content, TSS, individual fruit weight increases with decrease of PAR. It is, therefore, concluded to grow pine apple in partial shade condition.

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