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IMPACT OF MULTISTOREYED AGRO-FORESTRY SYSTEMS ON GROWTH AND YIELD OF TURMERIC AND GINGER AT MYMENSINGH, BANGLADESH

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A B S T R A C T

An experiment was conducted to evaluate the growth and development of turmeric and ginger under five different light levels at Department of Horticulture, Bangladesh Agricultural University, Mymensingh during March to December, 2009. Treatments consists of, open field condition or production under full sunlight (T1) which consider as 100% of light level, Sissoo + Guava based agro-forestry system (T2) which allowed 65-75% of PAR, Sissoo + Lemon based agro-forestry (T3) which allowed 35-45% of PAR, Coconut + Guava based agro-forestry system (T4) which allowed 70-80% of PAR and Coconut + Lemon based agro-forestry system (T5) which permitted 25-30% of PAR at the Germplasm Centre (GPC), were evaluated in randomized complete block design .Results indicated that growth parameters, yield attributes and yield of turmeric and ginger were increased gradually with the decrease of light levels. Significantly the maximum growth parameters were recorded under T5 whereas yield attributes and yield was highest under T4 followed by T3. The tallest plant and the highest length of leaves were found under treatment. All spices gave maximum yield under partial shade (T4). Growth parameters of ginger were significantly the highest under T5 and it were at par with T3 and T4 respectively. Yield attributes and yield of ginger were significantly the highest under T4 followed by T3 and T2.

Keywords: Agro- forestry, Ginger, Multistoried, Turmeric.

INTRODUCTION

At least 25% area of a country should be covered with forest to maintain the environmental equilibrium and rate of socio-economic development. In Bangladesh the total forest area covers about 17% of the land area (BBS, 2010) but the actual estimated tree cover around 6% which is decreasing at an alarming rate (BER,2012). Due to continuous transformation of forest land into agricultural land, aquaculture, homestead, industries and some forest lands were subjected to shifting cultivation. So, the effective area of forest in Bangladesh is neither in a position to fulfill the requirements of the people's for fuel, fodder and timber nor to stabilize the climatic condition. On the other hand demand of food crops increasing rapidly due to increasing population. The country has only a land area of 14.39 m ha and decreasing per capita land availability at an alarming rate, puts heavy pressure on land for human habitation and crop production (BBS, 2010).

However, the fertility of our land is decreasing rapidly due to intensive cropping and cropping with poor management. Under this situation, it is necessary to find out the suitable alternate options for raising crops. Since, there is no scope for expanding forest and crop area. In that situation combined production of field crops with perennial trees, may be a viable option to improve productivity of land, and the being called multilayer agro-forestry system. It is generally assumed that the total production is several times higher than that of an annual crop system or forestry alone, because growth resources viz. light, nutrient, water are used

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efficiently in this system. In fact, it is highly productive and sustainable systems provide continuous production round the year. However, this system is one kind of insurance of the farmers against the risks of total crop failure in case of mono cropping. Shade loving spices e.g. turmeric and ginger grown well under agro-forestry system. Turmeric (*Curcuma longa*) is one of the most important and ancient spices of Indian sub-continent. It is a unique colorful and versatile natural plant product combining the properties of flavoring and colorant (Shankaracharya and Natarajan, 1971). In Bangladesh total production of turmeric is 1,17,081 MT in area of 56,203 hectare (BBS,2010).

Ginger (*Zingiber officinale*) belonging to the family of Zingibaraceae is one of the most important spice crops in Bangladesh. In the country total production of ginger is 74,841 metric tons in an area of 22,403hectare in the year of 2009-2010(BBS,2010). Under multistoried agro-forestry system turmeric and ginger is compatible crop due to their shade loving nature and easily grown habit in all homestead. In this way, production will increase per unit area/unit time. It ensures better use of natural resources as well as maintains natural equilibrium. It also ensures biodiversity. Although some sporadic studies for some spices were done, but no systematic information is available on growth under agro-forestry system. With this view, the present investigation was undertaken to evaluate the growth and yield of turmeric and ginger under agro-forestry system.

MATERIALS AND METHODS

The study was conducted on the existing multilayer garden at the Germplasm Centre (GPC) of fruit Tree Improvement Project (FTIP), Bangladesh Agricultural University, Mymensingh during March to December 2009. The Experimental field is located at 24°25´N Latitude and 90°50´E Longitude at an elevation of 18 m above the sea level and climate is characterized by heavy rainfall during the months from April to September and scanty rainfall during the rest period of the year. Total rainfall was 76.90 cm during the crop season. The soil of the experimental area was silty loam in texture. It was a medium high land, fertile, well drained and slightly acidic in nature with pH 5.7 and the amount of organic carbon, total N, available P, and K were 0.835%, 0.068, 18ppm and 0.28 me/100g of soil , respectively. Spices e.g ginger and turmeric were laid out on the Randomized Complete Block Design (RCBD) with single factor experiment. Five treatments were used in this study viz. T_1 = Spices grown under open condition, T_2 = Sissoo + Guava spices based agro-forestry system (partial shade condition), T_3 = Sissoo + Lemon + spices based agro-forestry system (severe shade condition), T_4 = Coconut + Guava + spices based agro-forestry system (partial shade condition) and T_5 = Coconut + Lemon + spices based agro-forestry system (severe shade condition) were replicated thrice in 5X2 X3 m plot size.

In treatment T_1 sunlight was allowed to fall over the spices without any barrier which was consider as 100% light level. The seed rhizomes / finger of the turmeric var. Dimla were planted maintaining 50X25 cm spacing between and within the rows at a depth of 7.5 cm. The seed rhizomes of ginger were planted maintaining a row to row distance of 60 cm and plant to plant distance of 20 cm. The depth of planting was 9-10 cm.. Recommended doses of fertilizers were applied to the experimental plots of turmeric and ginger were 66 kg, 22 kg, 54 kg, 12 kg, 0.6 kg and 90 kg, 34 kg, 76 kg, 12 kg, 0.6 kg as N, P, K, S and Zn per hectare respectively. Half of the nitrogen and full dose of other fertilizers should be applied at the time of land preparation. The remaining N should be applied at 6 weeks of growth followed by irrigation. Crop was raised by following general agronomic practices.

Turmeric was harvested on December 2009 after 270 days of planting when leaves turned yellow and started drying up. Ginger was harvested on November when leaves turned yellow and started to dry. Ten plants were randomly selected recording data on the following parameters: height of the main plat, number of leaves per hill, number of tillers per hill, weight of primary fingers, weight of secondary fingers, fresh weight of rhizomes per hill, yield of rhizomes per hectare.

In turmeric data on the following characters were collected from 10 selected plants/plot for plant height, number of leaves per clump, number of mother rhizome, weight of mother rhizome, number and weight of primary fingers, number and weight of secondary fingers, weight of secondary fingers, leaf length and breadth, yield of fresh rhizome per clump and yield of fresh rhizome per hectare.

The data on various characters of spices were statistically analyzed to draw a valid conclusion.

RESULTS AND DISCUSSION

Turmeric

Plant height: Turmeric plant cultivated under shade grew more vigorously than those grew in open field Table 1. With the increase of shade levels plant height increased significantly. The shortest plant (98.23cm) was found in the open field condition which was at par to T_2 (99.68cm). The tallest plant (112.6cm) was recorded under the heaviest shade condition of T_5 .Significantly the tallest plant under heavy shade in okra was reported by Ali (1999).

Number of leaves per clump: Number of leaves per clumps was significantly influenced by reduce light levels Table 1. The highest number of leaves per clumps was recorded under severe shade condition of T_5 (21.72). The lowest number of leaves per clumps was recorded under full sunlight (15.80).Similar result was reported by Miah (2001).

Leaf length: Leaf length of turmeric was increased gradually with the increase of shade levels Table 1. The longest leaf (92.62cm) was found under heavy shade condition of treatment T_5, which was statistically at par to leaf length (90.12cm) of treatment T_4 and leaf length (91.57cm) of treatment T_3. The shortest leaf was recorded under full sunlight (68.08cm).

Leaf breadth: Leaf breadth increases gradually up to a certain level of shade condition Table 1. The highest leaf breadth (16.34cm) was recorded under partial shade condition of treatment T_2. Significantly the lowest (12.28cm) leaf breadth was observed under open condition i.e. T_1.

Number of tillers: The highest number tillers (4.73) were found under severe shade condition of T_5 followed by T_4 (4.70). The lowest number of tillers observed under open condition i.e. T_1 (3.18).

Number of mother rhizomes: The highest weight of mother rhizome was found under T_4 (255.8g). Significantly lowest weight of mother rhizome recorded under severe shade condition of T_5 (195.3g).

Number and weight of primary fingers: There was significant variation due to the effects of shade on number and weight of primary fingers per clump. The maximum number (12.32) of primary fingers per clump was recorded from treatment T_4. The production of primary finger (g/plant) was found to be significantly influenced by shading. The highest weight (190.8g) was recorded under partial shade condition of T_4. The lowest weight (138.6g) was found under severe shade condition of T_5.

Number and weight of secondary fingers: There were significant influences of shade on number and weight of secondary fingers per clump. The highest number of fingers found at T_4 (25.65). Weight of secondary fingers were found the highest (150.5g) under partial shade condition of T_4, which was followed by T_2 (120.3g) and T_3 (114.5g). The lowest weight (95.74) was found under severe shade condition of T_5.

Yield of fresh rhizome per clump: Significantly highest rhizome yield (582.1g) was found under partial shade condition of T_4 which was followed by treatment T_2 (479.3g) and treatment T_3 (456.8g). Significantly the lowest fresh rhizome yield (425.6g) per clump was recorded under treatment T_5. This may be attributed due to maximum rates of photosynthesis under partial shade condition. Yield of fresh rhizome per clump affected by different light levels. Similar findings were reported by Ali (1998).

Yield (t/ha): The yield of Turmeric was also affected by different light levels Table 2. Partial shade condition had positive effect on Turmeric (Plate 8). Further reduction of light level, yield decreased drastically. The highest yield (40.25 t/ha) was recorded under partial shade condition of T_4. Significantly the lowest yield (28.69 t/ha) was recorded under treatment T_5. Yield of turmeric increased due to presence of favorite condition in partial shade. The results are corroborated with the findings of Oswald (1994).

Ginger

Plant height: Height of the ginger plant increased gradually with the increase of shade (Table 3). Significantly tallest (76.57cm) plant was found under severe shade condition of T_5. The lowest plant height was recorded under full sunlight i.e. T_1 (67.30cm). Similar result was reported by Amin *et al* (2010).

Number of leaves per hill: Significantly highest number of leaves found under heaviest shade condition T5 (23.27). Lowest number of leaves found under open condition i.e. T_1 (19.21).

Leaf length: Leaf length of ginger increased gradually with the increase of shade levels (Table 3). The longest leaf (23.01cm) was found under heavy shade condition of T_5, which was followed by treatment T_2 (20.25cm).

Significantly the shortest leaf (17.51cm) was recorded under full sunlight (T_1). Leaf of ginger under shade condition grew more vigorously than those in the open field.

Leaf breadth: The highest leaf breadth (2.60cm) was recorded under heaviest shade condition T_5 and the lowest leaf breadth (2.20cm) was observed under open condition.

Table 1 Growth characters of turmeric under different light levels

Treatments (%)of PAR	Plant height	No of leaves per clumps	Leaf length	Leaf breadth	No. of tillers
	(cm)		(cm)	(cm)	
T_1 (100)	98.23b	15.80d	68.08c	12.28c	3.18b
T_2 (65-75)	99.68b	16.91c	72.34b	18.21a	3.45b
T_3 (35-45)	109.58a	21.03ab	91.57a	15.89b	4.71a
T_4 (70-80)	105.24ab	20.56b	90.12a	16.03b	4.70a
T_5 (25-30)	112.60a	21.72a	92.62a	16.34b	4.73a
LSD (0.05)	7.854	0.8420	4.210	1.684	1.021

Table 2 Yield contributing characters of turmeric under different light levels

Treatments (%) of PAR	No of mother rhizome	Weight of mother rhizome	No of primary fingers	Weight of primary fingers	No of secondary fingers	Weight of secondary finger	Yield of fresh rhizome /clump	Yield
		(g)	(unit)	(g)	(g)	(g)	(g)	t/ha
T_1 (100)	2.34c	207.10b	8.06d	140.58c	15.19b	110.24bc	445.29b	31.58bc
T_2 (65-75)	3.24b	201.23bc	9.89bc	151.92b	16.08b	120.31b	479.32b	36.34ab
T_3 (35-45)	4.01a	200.89bc	9.57c	142.42c	16.11b	114.54b	456.79b	32.54bc
T_4 (70-80)	4.23a	255.82a	12.32a	190.78a	25.65a	150.46a	582.13a	40.25a
T_5 (25-30)	3.26b	195.27c	10.54b	138.56c	14.67b	95.74c	425.56b	28.69c
LSD (0.05)	0.3036	10.95	0.7921	8.420	1.684	14.58	60.13	5.017

Table 3 Growth characters of ginger under different light levels

Treatments (%) of PAR	Height of the main plant	No of leaves per hill	Leaf length	Leaf breadth	No. of tillers per hill
	(cm)		(cm)	(cm)	
T_1 (100)	67.30b	19.21c	17.51d	2.2b	14.27d
T_2 (65-75)	69.23b	20.48c	20.25b	2.4ab	16.21c
T_3 (35-45)	70.45b	21.56b	19.35bc	2.3ab	19.43b
T_4 (70-80)	67.08b	19.40c	18.45cd	2.4ab	16.67c
T_5 (25-30)	76.57a	23.27a	23.01a	2.6a	22.56a
LSD (0.05)	4.210	1.684	1.031	0.3368	1.458

Number of tillers per hill: Shade had significant effect on number of tillers per hill. The highest (22.56) number of tillers per hill were obtained from heaviest shade condition T_5 and the lowest (14.27) from open condition (T_1).

Weight of fingers per plant: Weight of primary and secondary fingers, significantly influenced by shade level. The highest weight was recorded under partial shade condition of T_4 and the lowest weight was found under severe shade condition of T_5.

Rhizome weight per hill: Significantly highest rhizome weight (632.9g) was observed under partial shade condition of T_4 and lowest under T_5. Amin *et al* (2010) found better result in 50 ± 5% shade level.

Yield (t/ha): Yield of ginger rhizome was significantly influenced by different shade levels (Table 4). Highest yield (32.88 t/ha) was obtained from partial shade condition of T_4 and lowest yield (18.75 t/ha) was obtained from severe shade condition of T_5. Rahman (2004) harvested bumper yield of ginger from partial shade conditions.

Table 4 Yield contributing characters of ginger under different light levels

Treatments (%)of PAR	Weight of primary fingers	Weight of secondary fingers	Fresh weight of rhizome per hill	Yield
	(g)	(g)	(g)	(t/ha)
T_1 (100)	110.53bc	127.87cd	282.43c	24.89c
T_2 (65-75)	125.03ab	140.58ab	351.81a	30.32b
T_3 (35-45)	120.56ab	132.78bc	310.51b	25.12c
T_4 (70-80)	127.15a	144.28a	362.92a	32.88a
T_5 (25-30)	98.89c	122.15d	260.84d	18.75d
LSD (0.05)	14.58	8.420	14.58	1.684

CONCLUSION

Growth parameters, yield attributes and yield of turmeric and ginger were increased gradually with the decrease of light levels. Significantly the maximum growth parameters of turmeric were recorded under T_5 whereas yield attributes and yield was highest under T_4 followed by T_3. Growth parameters of ginger were significantly the highest under T_5 and it were at par with T_3 and T_4 respectively. Yield attributes and yield of ginger were significantly the highest under T_4 followed by T_3 and T_2.

However, the findings of the present study were achieved based on one season trial, which may not be sufficient to assess the sustainability of the results. So, similar experiments should be repeated at least in another season so that result should be conclusive.

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