Carib.J.Sci.Tech

EVALUATION OF GROWTH AND ECONOMIC PARAMETERS OF CURCUMA LONGA AND AMORPHOPHALLUS PAEONIIFOLIUS INTERCROPS IN MEDIUM AGED PISIDIUM GUAJAVA ORCHARD

Authors & Affiliation:

K.K. CHANDRA

Associate Professor,
Department of Forestry, Wildlife and Environmental Sciences,
Guru Ghasidas Vishwavidyalaya, Bilaspur, C.G.- 495009

Correspondence To: **K.K. CHANDRA**

Keywords: Pisidium guajava Intercrops, BCR, Fruit yield, rhizome yield

ISSN 0799-3757

http://caribjscitech.com/

Abstract

In the present study, growth and economic parameters of two intercrops Amorphophallus paeonifolius (Variety-Gajendra-1) Dennst Nilolson and Curcuma longa L. (Variety- Narendra haldi-1) were investigated in 11 year old guava (Variety-Allahabadi Safeda) orchard. The survival percent, plant height, number of leaves, collar diameter, leaf length and rhizome length were enhanced significantly through intercropping under P. guajava. Under intercropping, C. longa yielded 150.48 qha^{-1} and A. paeoniifolius gave 304.53qha^{-1} which was 11.57 percent and 17.54 percent higher respectively than pure crop. There was 30.25 percent improvement in the emergence of new shoots, 27.45 percent in fruit numbers due to intercropping. Gross profit was found Rs. 3.76 lakh ha^{-1} for C. longa and Rs. 5.48 lakh for A. paeoniifolius in intercropping than pure crops which rendered gross profit of Rs.3.32 lakh ha^{-1} and Rs. 4.51 lakh ha^{-1} respectively. The Benefit Cost Ratio (BCR) was recorded 4.74 for Fruit tree + C. longa and 2.70 for fruit tree + A. paeoniifolius respectively while the same parameters computed 2.78 and 1.52 for C. longa and A. paeoniifolius with monocropping. The cultivation of A. paeoniifolius proved more remunerative and better intercrop than C. longa.

Introduction

Guava (Pisidium guajava L.) is one of the most popular fruit in India and grown in more than 75 countries in a wide range of soil types. It is relished for its flavor, delicious taste and high nutritive value and gives more than one crop during the year. Since last decades, an establishment of the fruit orchard is promoted at farmer's field through golden revolution programme. Besides lot of efforts the coverage of guava orchard is not increased as per target of government because of many reasons such as poor economic productivity and prolonged juvenile as well as productive phase of fruit crop, low land holding, adverse effect of tree on agricultural crops etc. The use of inter space between fruit orchard may be important to create an interest among growers by providing additional income and by reducing the waiting period.

Intercropping aims at improving productivity by effective utilization of air space which is not utilized in single tier system. The multitier system aims at sustainable management of natural resources like soil, water, space and environment. In perennial orchard, top 50cm soil depth is almost devoid of feeder roots and 75% feeder roots of perennials are remain between 50 and 150cm depth and 80% active roots of grown up trees are confined to 2-3m radius in grown up trees. The canopy of perennial crops utilizes only 20 to 30 percent of land area up to 10 years. Thus only 20-30percent of the land resource is utilized by P. guajava trees and only 50-100cm soil depth is utilized by inter crops in uplands which offer ample scope for exploitation of soil depth and inter-space potential through multi-storied cropping. The spatially differential root distribution of different component of crops in the system helps in higher nutrient and water use efficiency as a result of higher yield and fruit quality and increased income per unit area (Das et al., 2009).

Elephant foot yam (Amorphophallus paeoniifolius Dennst. Nicolson) and Turmeric (Curcuma longa L.) constitute important rhizomatous cash crops tolerate and persist under partial shade (Hossain et al., 2009). In some part of Utter Pradesh these crops are cultivated as pure crop in an open field. There have been numerous attempts to improve their productivity through the introduction of high yielding cultivars, balanced nutrient supply and improved agronomic practices but not tried under P. guajava orchard. Such studies assume a special significance owing to the selection of crop on the basis of their nature and tolerance to different factors and rising interest among farmers for sustainable agroforestry systems (Jaswal, et al., 1993). Agroforestry system can conserve resources, improve environment and rehabilitate degraded lands (Sukla et al., 2012) and capable of producing concurrent higher yield. It is equally important to evaluate the growth and development responses of a main crop in relation to intercropping besides the effect to the local climatic and edaphic factors for understanding proper cultivation practice (Ishimine et al., 2004). In the present study, growth and economic performance of two rhizomatous crops under P. guajava orchards and their effect on yield and income of farmers of orchard is compared.

Material and Methods

The present study was carried out in a block design with five replications represented each in village Rema, Badora, Faguiya, Khurhunja and Digghi at Chandauli (lies at $25^0$27'N latitude and $83^0$27'E longitude) Utter Pradesh, India. The mean annual rainfall was 1025mm, with an average of 67 rainy days per year. The mean maximum temperature was 43^0C in the month May and minimum was 8^0C in the month of January.

On the basis of field survey, five field each of size 0.20ha area consisting average of 54 Guava (Pisidium guajava L.) trees aged 11 years, planted at 6m X 6m spacing were selected and farmers were convinced for the demonstrative experiments on intercropping of Turmeric (C. longa) and Elephant foot yam (A. paeoniifolius). The selected plots were divided into 3 equal sections and coded as T0 (Guava alone), T-1 (Turmeric + Guava), T-2 (Elephant Foot Yam+Guava). The control studies were conducted in the open area adjoining the orchards.

First the overcrowded, dead and unproductive branches were removed and cleared the stems up to 40cm height on April, 2010. The fields were started preparing with summer ploughing on 20^{th} -25^{th} May followed by two subsequent ploughing in the last week of June at the onset of Monsoon.

Seed Rate and seed treatment

C. longa (variety Narendra Haldi- 1) and A. paeoniifolius (Variety Gajendra-1) planting materials (seed rhizome) were procured from Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP) and bigger piece of rhizome and corm were cut into pieces in 20-25g and 400g size respectively for C. longa and A. paeoniifolium. These materials were

subjected to treatment with Carbendazim @ 0.2% by coating two layers over the surface of rhizomes. For open field monocropping 25 qha^{-1} and 160 qha^{-1} rhizomes were used for C. longa and A. paeoniifolius respectively while 21.25q and 136q planting materials were used in intercropping of one hectare area.

Planting method and experiment

The experiment was laid out during the last week of June to I^{st} week of July. The planting bed of 5 X10m size was prepared and C. longa was planted at 20X40cm (8-10cm depth) between plant to plant and line to line distance while the distance kept for A. paeoniifolius was 50X50cm (15-20cm depth). Similar spacing was kept for both mono and intercropping system. Soil working near root zone and ring basin was prepared for P. guavaja.

Fertilizer Management

The FYM (Farm Yard Manure) @10 t $ha^{-1}$was added at the time of last ploughing and recommended doses of fertilizers were applied in the trial which was @ 60:50:120kg NPK $ha^{-1}$for C. longa and 120:60:100kg NPK ha^{-1} for A. paeoniifolius. These rates were splitted in to three equal quantities and applied as a basal dose in July (Planting time), in August (vegetative and tillering stage) and in the last week of September (Rhizome growth stage).

Measurement of plant growth parameters

The survival percentage was recorded at 45 days after planting while, the plant height (cm), number of tillers, number of leaves, collar diameter, leaf length and leaf breadth were recorded during the month of November when the crops attained maximum growth and started yellowing. C. longa was harvested on II^{nd} week of February 2011 and A. paeoniifolius was in IInd week of March, 2011 when shoots withered completely. Fresh weight of shoot and rhizome of both the crops from different plots were taken after digging and cleaning the rhizome while dry weight was determined after drying the samples of both the crops at 80^0C for 48 hours. The mean and standard error (SE) of five replications were calculated and tabulated.

The girth of P. guajava stem (cm), number of new shoot per tree and shoot length per branch per year was measured in two occasions viz. first at April 2010 (before experiment) and second in April 2011 (After experiment). The number of fruit per tree, fruit size and fruit weight per tree were measured and determined in the month of January, 2011.

Calculation of Cost of Production, Profit and BCR

The net economic returns in respect of crops were worked out with considering material cost, labour cost etc. at the market rate. BCR was calculated by dividing gross profit and total cost.

Statistical Analysis

Standard error of mean value was calculated from the sample of ten plants chosen from each replications and critical difference was computed at 5% probability using SPSS software.

Results and Discussion

Crop Performances

The survival of C. longa and A. paeoniifolius was greater in intercrops than monocrop due to positive response to shade. The survival of plant was increased by 5.74% and 13.18% respectively than monocrops. Similarly, the plant height observed 137cm and 153cm for C. longa and A. paeoniifolius as intercrops while crops under open field showed 79cm and 68cm height respectively (**Table-1**). Such an increase in plant height due to shade was also observed earlier in rice (Kobata et al., 2000) and in turmeric (Jaswal et al., 1993). It is assumed that some physiological process function properly at a reduced light intensity. No significant difference was noticed in tiller number in both crops in both conditions. The length and breadth of leaf of C. longa exhibited significant differences and found 35% and 4.16% greater while the same in A. paeoniifolius was measured 32.46% and 19.30%. This indicates that intercropping helps promote the growth of both crops due to the congenial micro-environment and the shade loving nature of the crops (Safanin et al., 1982).

Yield Performances

The size of rhizome of both crops was found higher as compared to crops at open fields. There was an increment of 51.61% and 37.93% in rhizome length and breadth of C. longa and 34.95% and 30.48% respectively for A. paeoniifolius over pure crops. C. longa under P. guajava rendered 20.25% higher dry rhizome while A. paeoniifolius yielded 19.27% higher dry biomass of rhizome incomparison to control (**Table-1**). The improvement in rhizome yield was due to increased shoot growth which might have been because of the higher availability of soil moisture and nutrients in orchard with diffused light condition as compared to open field (Ishimine et al., 2004). The yield recorded for C. longa was 26.55% higher (150.48 $qha^{-1)}$ as intercrop than in the open field (133qha^{-1}). Similarly 19.06% higher yield (304.53qha^{-1}) was recorded for A. paeoniifolius as intercrops against the yield (251.1qha^{-1}) in open field (**Table-1**). A comparison of yield performance in both crops clearly indicates that in partial shade intercropping gains were more in A. paeoniifolius than C. longa. Similarly, positive results were also reported in C. longa and other crops under different tree plantations (Jaswal et al., 1993 and Jose, 2012) due to different shade regime.

Fruit tree Performances

Intercropping also interact positively to P. guajava orchard as it improved the girth (10.71% and 12.04%), and emergence of new flowering shoots (36.92% and 39.25%) for C. longa and A. paeoniifolius respectively (**Table-2**). The fruit size was increased maximum of 20% with A. paeoniifolius followed with C. longa (9.67%) resulted into higher fruit weight. The fruit yield was founded 35.00% greater with intercropping as compared to orchard without intercrops. It is assumed that the adding of fertilizers and irrigation to intercrops might have ameliorated the status of nutrient and moisture in orchard which inturn enhanced fruit size and yield. Jose et al. (2004) also reported that deeper roots of trees act as a safety net by capturing nutrients that leach below the rooting zone of the crops and recycle them back into the system by tree component. Other studies revealed that yield are influenced by edaphic factors (Deen et al., 1998 and Padmapriya and Chezhiyan, 2009). A. paeoniifolius was proved to be a slightly better intercrop as compared to C. longa as for as fruit yield and income was concerned.

Financial Performances

The total cost incurred on the production of C. longa and A. paeoniifolius has been given in Figure**-1**. This indicates that the monocropping of one hectare area of C. longa cost Rs. 119556/- and A. paeoniifolius Rs. 2,95,696/- which was about 5% and 12% higher respectively as compared to intercropping system. This was posible due to 15% less requirement of seed and fertilizers in intercropping as the same percent of space was utilized by standing fruit trees and only 85% orchard area was available for intercropping.

The net income from C. longa and A. paeoniifolius were computed as 18.86% and 17.54% higher respectively when raised as intercrop with P. guajava. The quantum of net income was found Rs. 2.62 lakh for C. longa and Rs. 2.85 lakh for A. paeoniifolius in intercrops against the net income of Rs. 2.31lakh and Rs. 1.56 lakh in monocropping at open field. The BCR also improved from 2.78 to 3.31 for C. longa and 1.52 to 2.08 for A. paeoniifolius with intercropping system in orchard. In case of A. paeoniifolius the BCR computed was lower than C. longa mainly because of the higher seed rate and cost. The net income and BCR value jumped significantly with the inclusion of the fruit yield. The positive returns in both crops may be attributed to higher yields due to the improvement in soil moisture and nutrients with partial light to crops.

Both C. longa and A. paeoniifolius performed better as intercrops. Though the crops are shade loving in nature, high tree density may hamper their growth and yield, the low density orchard may be used for intercropping. The double tier system also improved the microclimate of orchard which inturn resulted positive effect on fruit yield and quality. The fertilizers applied in intercrop were utilized by fruit trees and therefore there was an improvement in tree health and yield. The intercropping of shade loving crops can be practiced for higher the productivity and returns of the medium aged P. guajava orchard.

References

1. Aclain F and Cuisurnbing EC 1976. Fertilizer, mulch and light attenuation on the yield and quality of Ginger. Philippine Agriculturist 60(5/6), 183-191.
2. Deen W, Hunt LA and Swanton CJ 1998. Influence of temperature, photoperiod and irradiance on the phonological development of common ragweed (Ambrosia artemisiifolia). Weed Science 46, 555-560.
3. Hossain MA, Akamine H, Ishimine Y, Teruya R, Aniya Y and Yamawaki K 2009. Effect of relative light intensity on the growth, yield and curcumin content of Turmeric (Curcuma longa L.) in Okinawa, Japan. Plant Production Sciences 12(1), 20-36.
4. Ishimine Y, Hossain MA, Motomura K, Akamine H and Hirayama T 2004. Effects of planting date on emergence, growth and yield of turmeric (Curcuma longa L.) in Okinawa Prefecture, Southern Japan. Japan J. Trop. Agric., 48,10-16.
5. Jaswal SC, Mishra VK and Verma KS 1993. Intercropping Ginger and turmeric with poplar (Populus deltoids G-3 Marsh.). Agroforestry Systems 22, 111-117.
6. Jose S, Gillespie AR, Pallardy SG 2004. Interspecific interactions in temperate agroforestry. Agroforestry system 61, 237-255.
7. Jose S 2012. Agroforestry for conserving and enhancing biodiversity. Agroforestry System 85, 1-8.
8. Kobata T, Sugawara M and Sadanori T 2000. Shading during the early grain filling period does not affect potential grain dry matter increase in rice. Agron. J. 92, 411-417.
9. Padmapriya S and Chezhiyan N 2009. Effect of shade, organic, inorganic and biofertilizers on morphology, yield and quality of turmeric. Indian Journal of Horticulture, 66(3).
10. Safanin S, Chandra S and Etherington DM 1982. A review of recent research on intercropping under Coconuts. Fiji Agi. Journal 44, 51-56.
11. Sukla A, Kumar A, Jha A, Ajit, Rao DVKN 2012. Phosphorus threshold for arbuscular mycorrhizal colonization of crops and tree seedlings. Biol. Fertil Soils 48, 109-116.

Table-1:- Growth and Yield Performance of C. longa and A. paeoniifolius under Pisidium guajava orchard.

SN.	Attributes	Curcuma longa		Amorphophallus paeoniifolius	
		Open	Intercropping	Open	Intercropping
1	Survival (%)	85.30±1.01*	90.50±0.76	81.00±1.33	93.30±1.51
2	Plant Height (cm)	79.00±3.33	137.00±5.22	68.00±2.50	153.00±4.00
3	Number of tiller (plant^{-1})	2.00±0.16	2.00±0.06	3.00±0.10	2.00±0.04
4	Number of Leaves (plant^{-1})	9.00±1.75	14.00±1.55	4.0±0.50	5.0±0.30
5	Collar Diameter (cm)	1.50±0.02	2.40±0.31	3.90±0.08	6.30±1.22
6	Leaf length (cm)	40.00±3.11	61.00±5.00	62.00±1.65	91.80±4.60
7	Leaf Breadth (cm)	11.50±1.22	12.00±1.25	81.50±2.90	101.00±3.33
8	Rhizome Length (cm)	4.50±0.22	9.30±0.56	8.00±0.50	12.30±1.50
9	Rhizome Breadth (cm)	9.00±1.50	14.50±2.50	13.00±1.88	18.70±1.54
10	Rhizome fresh weight (g pl^{-1})	285.00±9.27	466.00±13.55	940.00±12.15	1119.00±32.10
11	Shoot Fresh Weight (g pl^{-1})	139.00±6.33	356.00±9.10	440.00±16.78	678.00±24.50
12	Rhizome Dry Weight (g pl^{-1})	124.80±5.80	156.50±5.50	775.00±5.38	960.00±7.00
13	Shoot Dry Weight (g pl^{-1})	89.30±3.25	135.00±4.81	140.00±6.00	170.50±3.22
14.	Yield (q ha^{-1})	133.00±0.55	150.48±0.72	251.10±2.04	304.53±2.66

*Mean ± Standard Error

Table-2:- Effect of intercropping on growth pattern, fruit quality and yield of P. guajava.

S.N.	Attributes	Orchard (No Intercrops)	Guava + Curcuma longa	Guava +A. paeoniifolius	CD < 0.05P
1	Stem girth (cm)	46.00	51.52	52.30	NS
2	Length of Shoot/branch (cm^{-1} $year^{-1}$)	56.00	70.00	71.33	0.05
3	No of New Shoot ($tree^{-1}$)	4.10	6.50	6.75	0.211
4	Number of Fruit ($tree^{-1}$)	740	1020	980	16.30
5	Fruit Size (cm^2)	56.00	62.00	70.00	3.06
6	Fruit Weight (g $fruit^{-1}$)	57.00	64.00	67.00	2.52
7	Yield (kg $tree^{-1}$)	42.18	65.28	65.66	3.39
8	Yield (q ha^{-1})	105.02	162.54	163.49	2.94

.

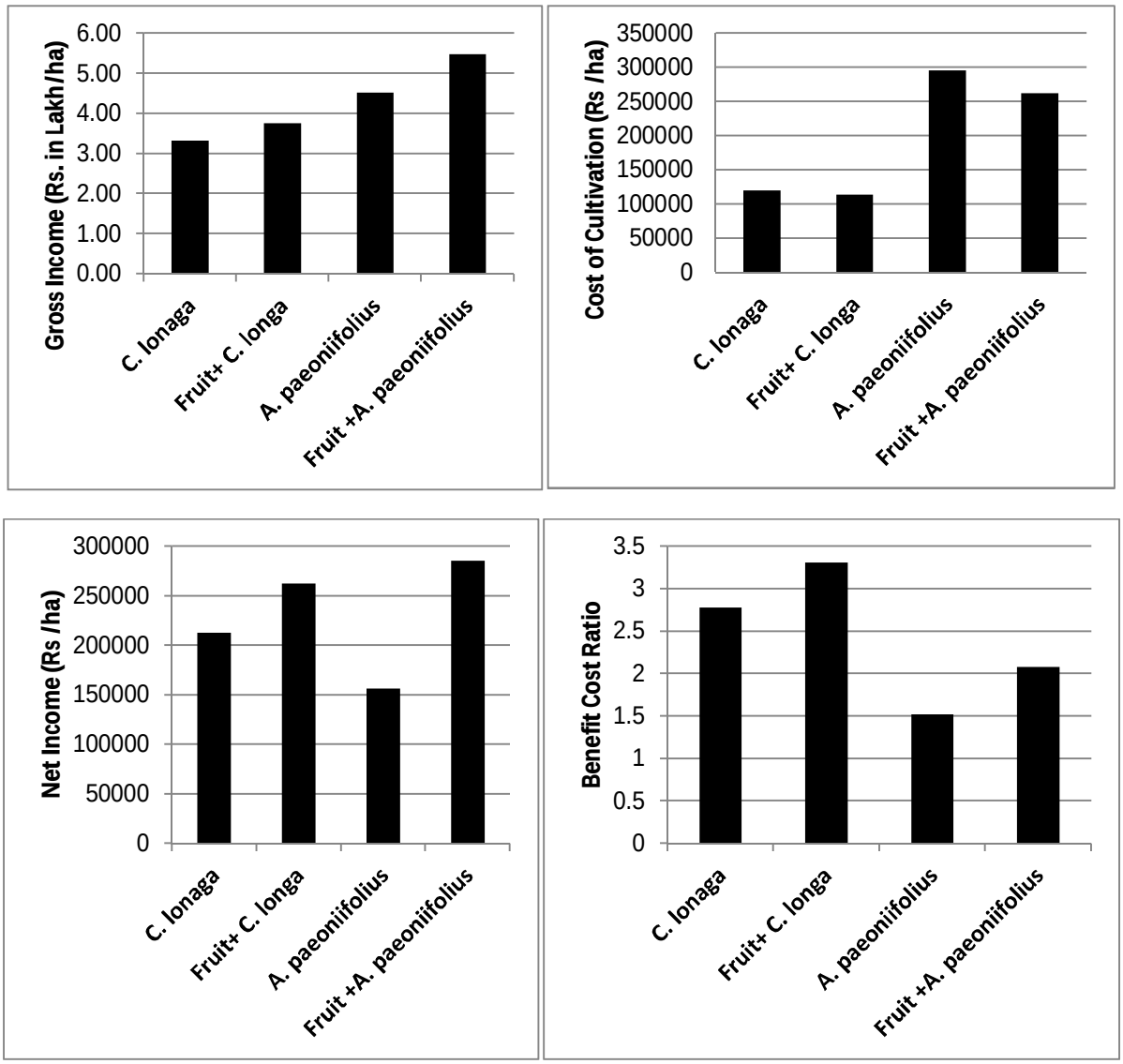

Figure 1:- Economic performances of C. longa and A. paeoniifolius as intercrops under P. guajava orchard