THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22-Issue-34-December -2019

Turmeric Cultivation in Guava based Agrihorticulture System-A Practice of Agroforestry

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Abstract

Various alternatives methods have been tried by the farmers to substitute wheat-rice rotation with other crops like fruit plantation, oil seed, vegetable and flower crops etc. It also includes other agricultural subsidiaries like pisciculture poultry, piggery and dairy, etc. Despite these professions, significant achievement has not been accomplished because of faulty marketing system and other monetary issues. The transpiration process of all plants is lowest under shade situations irrespective of the crop kind. Under shady conditions water use efficiency also increases than in open. Various inter cropping systems have been tried in guava plantation, in general they were found superior as compare to sole cropping of guava. Such intercropping systems are also suitable as they add extra income (net and gross) to the grower's revenue.This review paper is compiled to evaluate the benefits of turmeric cultivation under guava plantation. Above all, to motivate the grower for such agrihorticulturesystem.The endurance in such type of practices, structured market and distinct policy of "Agroforestry Policy" will be capable in inspiring the growers to implement agroforestry approaches for maximization of crop production. Today's altering climate scenario, such tree-crop interface may be an implementation as an approach for the viability.

Key words-Intercropping, Guava, Shady and open conditions, Agroforestry

Introduction

Fruits of guava are significant sources of potassium, fiber, carbohydrates, folic acid including many vitamins etc. They may be used as a dynamic and energetic part of our daily diet. But above all, minor documentation concerning guava benefits in prevention of some diseases like cancer and proper functioning of kidneys as they contain ascorbic acid (vitamin C), can't be

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ISSN:0971-1260
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ignored (Jatinder *et al*., 2018). Guava is considered as hardy and high revenue generating fruit crop even under almost neglecting conditions. This fruit is much perfect for nutritional security (Jatinder *et al.,* 2016).Agroforestry is a communal terminology for multipurpose land usage schemes and practices of deliberately combination of woody plants (tree/shrubs) with animals or herbaceous crops on the similar land with some kind of spatial arrangement or in series system. This system offers more opportunity for effective use of various resources in comparison to monocropping system of crops or trees (Venkatrao, 2005).Agroforestry permits returns from land even in extreme droughts or other natural calamities when pure agriculture fails and also allows diversified land use and reduces the risk associated with monoculture. It generates high income and minimizes risk in cropping enterprises (Rahangdale, 2011).

Under agroforestry system, fruits owe special significance on account of short juvenile phase than timber trees and assure regular production for long period (up to 40 years). This is the most common management system. This system is highly profitable for the farmers having small holdings which cannot afford the investment required to make their holdings more productive. Under certain circumstances available solution in the agrihorticulture system which combines fruit trees with agricultural crops. The horticultural trees provide cash returns to the growers. The farmers can continue to harvest arable crops until the trees develop a dense canopy or bear fruits. Experiences have indicated that agrihorticulture, obviously due to assured returns and national security is preferred by the farmers than agrisilviculture. It provides higher economic return under stressed conditions. Guava, the "poor man's fruit" is a popular fruit of the subtropical and tropical climate and is indigenous to the tropical America. It surpasses most other fruit trees in, adaptability and productivity. Being high in nutritive value, it gives good revenues involving little input. This has prompted many farmers to take up guava fruit cultivation on a marketable scale is the most important fruit after mango, banana and citrus which is native to tropical America. Although, the area and production has inclined in last century, but no significant increase has been seen including its productivity. As for as production is concerned, Madhya Pradesh (23.8%) and is the leading state. It is followed by other states viz. Uttar Pradesh (21.2 %), Bihar (9.26 %) and Maharashtra (6.94 %) respectively. However, finest guava is produced in Uttar Pradesh in India. Ranking wise guava stands 5th after banana, mango, citrus and apple. This crop is cultivated almost in area, 2.54 lakh ha while production is 40.5 lakh metric tons with average productivity figures of 15.9 mt/ha (Bal 2018). The leaves are used for toothache

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ISSN:0971-1260
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treatment. Guava wood is discreetlydurable and strong and used in making of handles, in turnery and various woodworking. In addition, the wood is excellent as fuel wood and a valuable resource for charcoal. However, general performance of various varietieslikeLucknow-49, Allahabad Safedaare hopeful for cultivation in malwaplateau conditions (Mahour*et al*., 2012). Turmeric is supposed to be originated in South Asia particularly India and it belongs to Zingiberaceae (family). (Parthasarthy*et al*., 2006). It thrives well under shade and can be grown on different soil types from sea level to 1500m elevation. Due to underground portion of plant, known as rhizome, turmeric has high nutritional value and extract of the same can be used as natural colouring agent for various foods, cosmetic and dyes. One of the most important ingredients found in turmeric is Curcuminoids. This active principle of turmeric has many medicinal features and has been used in curing many circulatory problems, dermatological disorders and liver diseases.

Globally, India is prime producer as well as consumer of turmeric. (Parthasarthy*et al*., 2006). The worldwide production of turmeric is about 11 lakh tones per annum. India dominates by contributing 78 % followed by China and Myanmar, Nigeria and Bangladesh together contributing 6%. ButIndian turmeric is supposed to be the best inthe global market as it contains high curcumin content (3.14% byweight). Turmeric exports of India reached $236 million (around Rs 1,632 crore) in 2018 (Trade Promotion Council of India).The cultivated area under turmeric in India is 238,000 Ha and the production are1133,000MT (N.H.B, 2017-18).Earthing is an important cultural practice in cultivation of turmericfor good harvest, which is beneficial for proper growth, developmentand yield of this crop. Earthing up provides adequate soil volume for roots, encourages exchange of gases and leads to better anchorage to the plant and helps to avoid lodging of the plant and helps to control weeds. The root development starts after 30 days and so this operation is conducted in various phases of crop growth i.e., 30, 45, and 60days after sowing etc.It was reportedthat crops like turmeric and ginger etc. can be taken successfully, butthe suitable packages of practices to grow these crops under shadedconditions are not developed hence, the present investigation wasconducted to study the effect of planting method and time of earthing onthe growth and yield of turmeric under guava based agrihorticulturepractice. Emphasis should be focused on more efficient ecologically, economically and sustainable agricultural production system, designing more competent sustainable agroforestry systems to overcome various constraints like ecological, physiological and economical. It should be aimed

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ISSN:0971-1260
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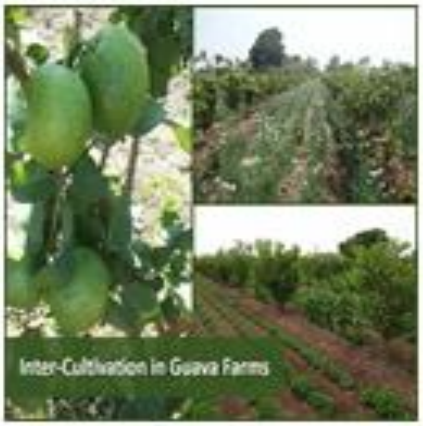
at to achieve the highest probable output per unit of natural resources including labour (Venkatrao, 2005). Intercropping is best techniques for land utilization for optimal production (Bhattanagar*et al*., 2007).

Guava + mustard

Guava + wheat



I. Impact of planting system on the growth and yield of turmeric under shade of orchard plantation

Baghel*et al*., (2004a) described that cv. Suroma (turmeric) cultivated under the shady conditions of mango exhibited the highest plants (52.85 cm) having more leaves number and tillers/clump. They also stated that cv. Suroma resulted in production of the higher fresh marketable yield and it has taken more time (255 days) to mature. Kumar (2002) submitted that cultivation of herbal plants in orchard of papaya exhibited no adverse influence on flowering and yield of papaya.Baghel*et al*., (2004b) found that cultivation of turmeric as an intercrop in the vacant

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ISSN:0971-1260
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places of mango orchards gave maximum productivity (232.19 q/ha) followed by cultivation of turmeric in the aonla orchard (228.57 q/ha), whereas, minimum productivity (172.86 q/ha) of turmeric was recorded in mix orchard of mango+aonla. Baghel*et al*., (2004c) describedthat ridge planting system gave higher yield than othersper plant per unit area basis than those obtained with furrow and flat method of planting. They further added that furrow and flat method of planting were at par concerning yield. Bisht *et al*., (2004) submitted that turmeric can be cultivated better under the shady conditions of fodder trees in open. Sharma and Rai (2004) also submitted that cv. Ranga gave the maximum yield of rhizomes underneath the shady conditions of mango trees. Pandey *et al*., (2004) revealed that the intercropping of turmeric in between mango and aonla orchards proved feasible as well as productive. The planting of turmeric gave 232.2 and 228.6 q/ha fresh yield of rhizomes under mango and aonla orchards which might be due to the fact that these orchards pass more sunlight, as mango is taller and aonla has thin canopy when compared to citrus and guava orchards.Cohen *et al*., (2005) described that chlorophyll constituent, CO2 uptake and conductanceincreased of grapefruit trees was improved by shading and it resulted in larger grapefruits.Venkatrao (2005) observed that the pod yield of groundnut was higher when teak alley was in east-west direction as compared to teak alleys in north-south direction and it was higher in 4-5 m distance from row of teak as compared to 0-1 m from teak row in various agroforestry systems. The production of groundnut was advanced (1318.62 kg/ha) when cultivated in agroforestry system. Parthasarthy*et al*., (2006) described that India has 149,410 ha area under cultivation of turmeric with annual production of 527,960 tonnes. It was reported that site suitability is a vital factor to regulate the productivity of turmeric.

Leve (2008) reported that growing of turmeric with guava trees produced higher monetary return (Rs. 201950 /ha.) under raised bed method of planting than growing of turmeric alone (Rs. 195550 /ha.) and guava (Rs. 6400 /ha.) under agrihorticulture practice ofagroforestry. Padmapriya and Cheziyan (2009) reported that the quality parameters of turmeric were found to be higher under shade compared to open conditions.Olojede*et al*., (2009) recorded the effect of cultivar, rhizome, and kind of seed bed on production and other traits of turmeric in humid tropical climate and found that planting either on the flat bed or ridge bed using the mother rhizome will ensure optimum yield and rhizome yield. However, optimum yield may be expected when planting on the flat bed, the land must be ploughed and harrowed for the

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ISSN:0971-1260
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formation of good rhizome (underground part).Ahirwar (2009) described that the application of certain fertilizer elements like N and K @ 200 kg/ha each evidenced most suitable quantity of fertilizer for turmeric. Gill *et al*., (2008) assessed the effect of planting dates and approaches of turmeric cultivation in poplar plantation as intercropping and reported that the ridge plating systemyielded more yield which was expressively higher than flat planting. Similarly, Kumar and Gill (2010) evaluated the influence of planting technique, density along with planting material (seed etc.) on development, and yield of crop. They found that improved rhizome yield in case of ridge sowing and flat field systems, but the modifications had shown non-significant results. Closer planting methodlead to production of highest yieldof both kinds i.e. fresh as well as dried and it was declined by lessening in planting density; however, rhizome weight inclined with decrease in planting density.Bhadoria (2010) submitted that the ridge planting method performed well regarding height of the plant and leaves number per plant along with leaf breadth, clumps per turmeric plant. Rahangdale (2011) reported that growing of turmeric with guava produced higher monetaryreturns i.e., 103600/ha under raised bed method of planting thangrowing of turmeric alone i.e., 17300/ha under agrihorticulture practice.Maji and Das (2013) showed that intercropping in guava orchard with chilly increased yield of guava in comparison to other intercrops (brinjal, cabbage, turmeric and other leafy vegetable) as well as better over monocropping. Singh *et al*., (2014) studied the appropriateness of various vegetable crops to be grown as intercrops in guava orchard (18-year-old bearing guava cv. L-49) and proved that maximum plant height, spread and stem diameter was in Suran followed by Turmeric. Swain (2014) obtained the highest cost ratio benefit (2.02) in intercropping systems of mango + guava + cowpea, which was practically equivalent to that of intercropping of guava +mango + turmeric, mango + guava + French bean and mango + guava + tomato.Singh *et al*., (2015) while studying the economic feasibility of intercropping found that highest B/C ratio was accompanying to intercropping system of Guava + Bunda followed by Guava + Arvi, Guava + Turmeric, Guava + Suran whereas in guava cultivation (sole plantation), it was only1:3.96.

II. Influence of time of earthing up on the growth and yield of turmeric under sheltered situations

Newaz*et al*., (2001) described that various trees when grow in connotation with other crops, contend with these crops for requirements like light, space nutrients and moisture etc. which have a contrary influence on the intercrop with the development of trees. Koshta and Khare

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ISSN:0971-1260
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(2003) emphasized that growing of paddy withguava in agroforestry system led to record higher monetary return(Rs.7626/ha) than growing of paddy alone (Rs. 6235/ha) due toreduced investment in weed control.Koshta*et al*., (2004) observed that earthing twice at 60- and 90-days growth stages of turmeric produced maximum yield (7.0 q/ha)which was 36.1% and 19% higher than no earthing (5.14 q/ha), andearthing once at 60 days growth stage (5.88 q/ha), respectively. Twoearthing ups proved to be the best to produce superior yield attributes leaf number /plants, height of the plant,rhizomes number, exceptto number of fingers/plants over no earthing and one earthing.Dhillon *et al*., (2007) verified the influence of poplar plantation (2 years old) on interculturally grown crop of soybean and turmeric found that turmeric cultivated underneath shady condition exhibited reduced yield by 14% while in soybean crop, it was 17.6%.Singh *et al*., (2013) found that various kinds of turmeric planting materials viz. parent rhizome, primary, secondary and tertiary fingers cultivated underneath shade of young guava plants were most suitable as for as vegetative growth, total yield, net revenue and cost benefit ratio than solitary crop were concerned.

III. Impact of various planting systems and time of earthing up operation on development and production of turmeric under open situations

Prajapati *et al*., (2012) accessed maximum plant height, shoots and leaf number, leaf and rhizome size,yield when crops were grown under Kalam in comparison to open condition. Light intensity at its highest under Kalam tree followed by trees of Casuarina and Arjun. They found that cv. Sugundham, when cultivated as an intercrop with Kalam tree, lead to improved growth and production. Islam *et al*., (2002) recommended that there should be optimum planting distance for the obtaining the good yield in turmeric. They obtained the highest average yield at spacing of 45 x 10 but economically 45 x 20 layout was feasible for turmeric yield.Angles and Hosamani (2002) evaluated turmeric cultivation, area and production wise in various zones of South India. Implementation of modern cultural systems and intensive cultivation practices were some of the recommendations forimproving the productivity of turmeric.Yadav *et al*., (2006) reported the genotypic and phenotypic correlation of 12 traits like leaf number, height of plant, number of clumps; length of mother, rhizomes number (primary and secondary) and yield/plant.All consideredtraits showed positive correlation with yield. Shaikhh*et al*., (2006) examined the influence of different plantingmethods (flat bed, furrow bed and raised bed) and earthingup frequency on ginger. Earthing up at 4 monthsafter sowing gave significantly higher

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ISSN:0971-1260
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fresh rhizome yield in comparison to earthing up at 3 and 5 months after sowing.Kandiannan and Chandragiri (2008) studied the influence of financial inputs on nutrient uptake, growth, production and money matters of turmeric.Sowing the turmeric crop during 15 May was much better than to planting of 15th June and 15th July. Dey and Datta (2009) carried out a field study to select the suitable chilly genotypes under open and Mahogani based agroforestry system. The maximum intensityof light was accessed under open field conditions than the agroforestry system. It wasobserved that vegetative characters such as plant height and stem girthwere promoted in agroforestry, while branches per plant andreproductive characters like fruit length, fruit diameter and yield werehigher in open field CA-5 recorded higher yield (10.23 t/ha).Chatthaet *al*., (2010) achieved maximum number of tillers with no earthing up operation while in earthing up, done after 120 days after planting resulted in production of less tillers.Manhaset *al*., (2011a) carried out the influence of dissimilar planting material, sowing period and harvesting time on the development, yield including value of the turmeric crop. It was concluded that use of rhizomes as sowing material lead to higher growth of various traits viz. height of plants and of leafnumber in comparison to finger planting material.Manhaset *al*., (2011b) evaluated the impact of various cultural methods on yield and monetary study of turmeric crop. They found that oil andcurcumin content in turmeric was not meaningfullyinfluenced by theplanting materials, FYM application or mulch.

IV. Impact ofplanting systems and time of earthing on thedevelopment and production of turmeric under shady conditions

Singh and Singh (2001) investigated the effect of three treespecies (4.5 years old) namely eucalyptus,deshi babul and poplar on theperformance of turmeric. The mean germination count ofturmeric was maximum in control i.e. in open condition.Sharma and Rai (2004) experimented by using uniform sized mother rhizomes of 5 turmeric cultivars namely, Rashme, Ranga, Suroma, Rooma and Sonali, in third week of June at spacing of 60 x 20 cm under shade of 35 to 40-year-old mango trees and all suggested measures for turmeric cultivation were executed and the crop was harvested during April. Ranga cultivar produced the highest rhizomeyield of 143.2 q/ha, whereas Sonali gave the lowest yield of 122.5 q/ha.Ranga, followed by Rashme, is recommended for shaded cultivation inmango orchards of Madhya Pradesh.Dey *et al*., (2006) investigated the growth and productivity of turmeric as a shade-tolerant, with subabul, resulted in the average produce of turmeric which was not affected due to cultivation of subabul plantation.

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ISSN:0971-1260
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This agroforestry system wasfound effective and economic form of land management and isexpected to provide a considerable income 8-10 years after planting.Sarangi *et al*., (2007) described that turmeric grown under the shade of several trees had the highest curcumin content and oleoresin contents. Dhillon *et al*., (2009) explored the performance of turmeric under poplar, showed maximum LAI. Photosynthetic rate and, transpiration process including stomata activity in the crop were advanced under open conditions than in sheltered. Hossain *et al*., (2009) studied the impact of relative light intensity on growth and development processes including production and curcumin constituent present in turmeric and specified that turmeric is a partial shade-tolerant crop and may be cultivated at 59-73% RLI for better production and curcumin constituent.

V. Correlation regression analysis

Jain and Sharma (2011a) evaluated various growth, development and yield accrediting traits of paddy underneath guava tree based agrihorticulture systems. The regression analysis described that grains weight per panicle was the most significant trait towards yield. Jain and Sharma (2011b) studied the correlation coefficient between various growth characters of turmeric on yield, described that yield of turmeric had important highest positive correlation width of finger/plant (0.7954) rhizome yield/plant (0.9390) number of fingers/rhizome (0.9322) and length of fingers/plant (0.7954). The regression analysis demonstrated that with the inclination of 1 cm in height of the plant, increase in fresh yield of turmeric was recorded as 2.056 kg/ha. Similarly, the increase of 3.77, 1.09, 23.76, 14.81 and 85.92 kg. /ha can be predicted with increase of 1 cm in stem girth, 1 gm in yield per plant, 1 finger/rhizome, 1 cm length and width of finger/plant respectively.

Conclusion

Nevertheless, no systematic research trials have been conducted concerning the economic feasibility of competent intercropping system under established guava plantation.Growing of turmeric with guava i.e., agroforestry system not only gives higher net returnsunder raised bed sowing system than cultivation of turmeric alone and guava. Based on reviewed literature, it may be concluded that increased yield of turmeric could be forecast more under shaded condition as compared to open condition. Hence, more productivity of turmeric may be achieved if grown under shaded condition of agroforestry compared with open condition.

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ISSN:0971-1260
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