Effect of Different Types of Mulch on Maize under Guava (*Psidium guajava*) based Agri-Horti System

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Abstract

The experiment was conducted to the study the effect of different types of mulch on maize under guava based agri-horti system at Agricultural Research Farm of Rajiv Gandhi South Campus, Barkachha, Mirzapur. The experiment was conducted in complete randomized block design with nine treatments which were replicated thrice. These treatments were different types of mulch (at rate of 6 tons/hectare) that is, control (T_1), dust mulch (T_2), green weed mulch (T_3), kans grass (*Saccharum spontaneum*) mulch (T_4), legume mulch (T_5), paddy straw mulch (T_6), ridge sowing (T_7), subabul (*Leucaena leucocephala*) mulch (T_8) and wheat straw mulch (T_9). Mulch is directly related to growth, plant biomass and yield of maize. Results showed that application of different types of mulch gave varying yield. Lowest yield (36.75 q/ha) was obtained with the application of 0 tones/ha and highest yield (53.34 q/ha) was obtained with the application of paddy straw mulch. It is concluded that the application of legume mulch gave highest Benefit/Cost ratio of maize and more remunerative in *Vindhyan* region.

KEYWORDS: agri-horti system, growth, guava, maize, mulch, yield.

INTRODUCTION

Agroforestry system can be more productive provided that trees and crops are at least partly complementary in use of growth resources (above and belowground). Tree and shrub are known to use their extensive root system to absorb nutrients from lower soil horizons. It is a general apprehension of the farmers that trees in association with crops in agroforestry system compete strongly with crops for nutrients and moisture (Dhyani *et al.*, 1990). In agroforestry, trees and agricultural crops are combined together and they compete with each other for growth resources such as light, water and nutrients. The resource sharing in component crops may result in complementary or competitive effect depending upon nature of species involved in the system. *Psidium guajava* L. is one of the fast growing fruit tree species, which is being promoted for cultivation by the wood fruit based industries in the farmers field in Uttar Pradesh state. Hence many of the small and marginal farm in Vindhyan region, are growing this particular tree species on the field bunds. Among various AFS, agrihorticulture AFS have been found most suitable in terms of sustainability, overall production, and tree-crop compatibility (Bhatt *et al.*, 2001).

Agri-horti system is an improved cropping system in which maximum utilization of natural resources markedly increases the return per unit area per unit time. Farmers realize the problem of no economic returns in the initial stage of fruit tree orchards till the tree starts bearing fruits. There is ample scope to utilize the introduction of the fruit tree during the initial 5 to 6 years by growing arable crops (Gill and Bisaria, 1995). Worldwide concern about environmental degradation has led to the need to evaluate more trees species for their suitability in agroforestry systems. The beneficial effects of organic matter from forest trees on the physical and chemical properties of the soil, and on crop performance, are well documented (Tian *et al.*, 1993; Sanchez *et al.*, 1996).

Maize is an important crop being utilized as food, feed, especially corn, starch etc. for both domestic consumption as well as export. Maize is the third most important crop in the world and is grown throughout the country under diverse environment. The area, production and productivity of maize in India is 8.6 mha, 20.5 mt and 2.4 t /ha, respectively in the year, 2010-11.

With dry regions covering approximately 45% of the Earth's Land surface, dryland farming system may constitute the world's largest biome and are indispensible for food production (Schimel, 2010). Water deficit is frequently the primary limiting factor for crop production under arid and semi-arid conditions (Hussain *et al.*, 2004). Limited water resources are the major constraints on crop production (Rockstrom *et al.*, 2007), especially when combined with low spring temperatures (Liu *et al.*, 2009). Despite the potential for irrigation, most of the available water for crop growth in semi-arid regions originates from limited precipitation (Wang *et al.*, 2009). Declining precipitation in the future is likely to reduce the yields of a number of important crops and increase the threat to the food supply in semi-arid regions (Lobell *et al.*, 2008). As the global population increases the drought conditions worsen, continuing to improve rain-fed dryland agriculture with optimized water management is a key priority to guarantee food security and sustainability.

Mulch provides a better soil environment, moderates soil temperature, increases soil porosity and water infiltration rate during intensive rain and controls runoff and erosion as well as suppresses weed growth (Bhatt and Kheral, 2006; Anikwe *et al.*, 2007; Sarkar and Singh, 2007; Glab and Kulig, 2008).

It is essential to understand how mulching practices influence soil conditions, crop growth, and resource utilization for optimizing water management and improving maize yield. However, knowledge about the effects of different mulching practices on maize is lacking. The present study was therefore taken to investigate the effect of different types of mulching on growth and yield performance of maize under guava based agri-horti system in rainfed conditions of *Vindhyan* region. Such study will be useful in order to create awareness among the farming community about the use of mulching to get maximum production.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Agronomy Farm of Rajiv Gandhi South Campus, Barkachha (BHU), Mirzapur which is situated in *Vindhyan* region of district Mirzapur (25° 10' latitude, 82° 37' longitude and altitude of 147 m) occupying over an area of more than 1000 ha where variety of crops like agricultural, horticultural, medicinal and aromatic plants are grown. *Vindhyan* soil comes under rainfed and invariably poor fertility status. This region comes under agro-climatic zone III A (semi-arid eastern plain zone). The climate of Barkachha is typically semi-arid, characterized by extremes of temperature both in summer and winter with low rainfall and moderate humidity. Maximum temperature in summer is as high as 39.8°C and minimum temperature in winter falls below 9ºC. The annual rainfall of locality was 225 mm in 2012, of which nearly 90% is contributed by South West monsoon between July and September. The total rainfall during the crop duration was 98.2 mm; maximum and minimum temperature fluctuated between 32.9 and 21.3°C, and relative humidity between 86.5 and 45%.

Soil analysis

The soil of the experimental field was sandy loam in texture with low drainage. It was acidic in reaction, poor in nitrogen as well as phosphorus and potash.

Experimental design and treatment

The experiment was conducted in Randomized Block Design with 9 (nine) treatments which were replicated thrice. These treatments were different types of mulching, that is, control (T_1), dust mulch (T_2), green weed mulch (T_3), kans (*Saccharum spontaneum*) mulch (T_4), legume mulch (T_5), paddy straw mulch (T_6), ridge sowing (T_7), Subabul (*Leucaena leucocephala*) mulch (T_8) and wheat straw mulch (T_9). The fertilizer application was done with fixed doses of nitrogen at 150 kg/ha and phosphorus at 65 kg/ha and potassium at 65 kg/ha. All the nutrients were applied as basal and the sources of N, P and K were urea, DAP and MOP, respectively. The guava variety "Lucknow-49" was planted at 7 m × 7 m distance. Maize variety "Hybrid K-25a" was sown as an intercrop. The seeds were sown manually in the furrow opened by *kudal* at a row distance of 60 cm. A plant spacing of 20 cm within the row was maintained by thinning done about 15 days after sowing. The different types of mulch at of 6 tons/ha were applied after 15 days of sowing. The biometric observations on growth attributes were recorded at an interval of 20 days, that is, 20th, 40th and 60th days after sowing and at harvest. Growth attributes that is, plant height, number of leaf per plant, dry matter accumulation per plant and yield attributes i.e, cobs length, number of grains per cob, test weight, grain yield and harvest index were measured.

RESULTS AND DISCUSSION

Plant height (cm)

Different types of mulch affected the plant height significantly (Table 1). At 20DAS, the plant height did not differ significantly. However, paddy mulch recorded highest plant height at 40, 60 and at harvest, 124.29cm, 231.81cm and 235.49cm, respectively. Paddy mulch and legume mulch remained at par with 40 DAS over rest of the treatments. Minimum plant height was noticed in control. These results are in line with Mohler *et al*. (1992) reported that crop height increased with higher crop density and mulching practices. It was due to better moisture supply and decrease in the evaporation losses of moisture from soil and maintained the moisture in the soil. Khurshid *et al*. (2006) pointed out that maize crop grew taller and taller under greater mulch levels, because of availability of more soil moisture contents for plant growth and development**.**

Number of leaves plant^{-1}

Number of leaves plant^{-1} was significantly influenced by different treatments at 40DAS, 60 DAS and at harvest. At 20 DAS, there was no significantly difference, but paddy mulch and legume mulch remained at par at 40 DAS, 60 DAS and at harvest with rest of the treatments. Paddy mulch was done recorded significantly higher (11.6) number of leaves plant^{-1} over all the other treatments (Table 1). Better soil moisture conductive for good germination brought good establishment and supported growth parameters between two rows of guava fruit tree. Xue *et al*. (2013) have found that the straw mulch significantly improved the plant growth in terms of leaf area, number of leaves plant^{-1} and stem diameter.

Dry matter accumulation (g)

There is direct relationship between the average dry matter production plant^{-1} which is governed by moisture and nutrient availability in soil. At 20 days total dry matter accumulation per plant did not differ significantly (Table 1). However, the highest total dry matter accumulation was recorded with the application of paddy mulch in all growth stages and the lowest dry matter was noticed in control. At harvest stage only legume mulch was at par with paddy mulch. As same finding was got ample support by Mishra (1996) and Samaila (2011) in wheat and tomato crop.

Table 1. Growth response of maize to different types of mulch under guava based agri-horti system.

Treatments	Plant Height(cm)			At Harvest	Number of leaves/Plant			At Harvest	Dry Matter Accumulation (g)/ Plant			At harvest
	20 DAS	40 DAS	60 DAS		20 DAS	40 DAS	60 DAS		20 DAS	40 DAS	60 DAS	
Control (T_1)	39.00	115.45	216.87	220.96	5.12	7.73	11.03	6.69	1.58	6.79	19.34	38.02
Dust Mulch (T_2)	39.75	117.33	218.94	222.99	5.37	9.25	12.00	7.66	1.43	7.80	20.22	40.90
Green Weed Mulch (T_3)	40.33	117.42	219.43	224.39	5.49	9.58	12.77	8.43	1.56	8.37	21.59	41.70
Kans Mulch (T_4)	41.15	119.49	220.98	226.13	5.55	9.92	13.11	8.77	1.48	8.83	24.54	43.12
Legume Mulch (T_5)	41.39	123.50	226.56	231.84	5.81	11.18	14.80	10.46	1.68	10.74	26.01	46.29
Paddy Straw mulch (T_6)	41.41	124.29	231.81	235.49	5.79	12.19	15.49	11.60	1.50	11.16	28.13	49.61
Ridge sowing (T_7)	40.45	118.31	220.08	224.81	5.51	9.50	12.69	8.35	1.46	8.60	23.47	42.80
Subabool Mulch (T_8)	41.52	121.48	224.48	229.41	5.88	10.32	13.82	9.48	1.81	10.05	24.17	44.45
Wheat straw Mulch (T_9)	41.27	120.60	222.49	227.37	5.62	10.24	13.92	9.58	1.55	9.19	22.33	43.45
SE±	0.70	0.65	0.64	0.60	0.3	0.52	0.54	0.45	0.14	0.82	1.52	1.42

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C.D. (P=0.05)	NS	1.97	1.94	1.82	NS	1.56	1.62	1.36	NS	2.46	4.58	4.28

DAS = Day after Sowing
NS = Not Significant

Cob length (cm)
Cob length showed higher in paddy mulch after that legume mulch which is at par with each other. The maximum cob length is (19.46 cm) due to paddy straw mulch and lowest (14.68 cm) in control (Table 2). Wicks *et al.* (1994) and Lal (1995) have reported that early maize growth was retarded by higher mulch levels as a result of reduced soil temperature but maize grew taller and faster under greater mulch levels subsequently due to increased soil moisture and adequate temperature which stimulated root development and growth.

Number of grains cob^{-1}
Paddy straw mulch showed maximum number of grain cob-^{1} (419.81) followed by legume mulch (418.57) and other treatments are statistically differing from paddy straw mulch. These results are also in consonance with Bhatt *et al.* (2004), Khurshid *et al.* (2006) that mulching with crop residue at the rate of 4 and 6 t/ha not only affected both physical and chemical properties of the soil but also maintained good grain yield.

Test weight
The 100 grain weight of grain under paddy straw mulch was maximum (21.63 g) followed by legume mulch (Table 2). The minimum 100 grain weight (15.15 g) was recorded under control. The results showed that with favorable soil tilt, suitable moisture conservation, affected thousand grain weights with use of deep tillage and mulching practices (Ramzan *et al.*, 2012).

Grain Yield
The data showed that the application of paddy straw mulch and legume mulch in maize crop under guava based agri-horti system were gave higher grain yield (53.34 q ha^{-1} and 52.88 q ha^{-1}), respectively over the rest treatments. Significantly lower grain yield (36.57 q ha^{-1}) was recorded in control to other treatments (Table 2). Similar result was concluded by Liu *et al.*, (2000) and Mishra (1996).

Table 2. Yield response of maize to different types of mulch under guava based agri-horti system

Treatment	Cob length (cm)	Number of grains cob^{-1}	Test weight (g)	Grain yield (q ha^{-1})
Control (T_1)	14.68	380.43	15.94	36.57
Dust Mulch (T_2)	15.32	388.32	16.03	37.77
Green Weed Mulch (T_3)	16.77	390.02	17.89	39.72
Kans Mulch (T_4)	17.14	396.33	16.46	47.12
Legume Mulch (T_5)	18.51	418.57	20.30	52.88
Paddy Straw mulch (T_6)	19.46	419.81	21.63	53.34
Ridge sowing (T_7)	17.00	391.44	17.01	39.47

Subabool Mulch (T_8)	18.27	410.01	18.48	50.19
Wheat straw Mulch (T_9)	17.88	409.91	18.39	48.26
SE±	0.32	2.64	0.51	0.29
C.D. (P=0.05)	0.97	7.94	1.53	0.88

Growth parameters of guava

Statistically non significant differences observed in the mentioned growth parameters of guava might be due to shorter growth phase of maize which could not realized the noticeable changes in the limited observation period (Table 3).

Table 3. Growth parameters of guava at various crop growth stages in guava based agri-horti system

Treatments	Tree Height (m)		Collor Diameter (cm)		Canopy Spread (m)	
	At crop sowing	At crop harvesting	At crop sowing	At crop harvesting	At crop sowing	At crop harvesting
Control (T_1)	2.25	2.48	5.85	6.0	2.85	3.10
Dust Mulch (T_2)	2.32	2.51	5.92	6.10	2.72	3.15
Green Weed Mulch (T_3)	1.97	2.40	5.12	5.95	1.90	2.75
Kans Mulch (T_4)	2.12	2.45	5.43	6.05	2.80	3.45
Legume Mulch (T_5)	2.32	2.60	5.35	6.15	3.05	3.85
Paddy Straw mulch (T_6)	2.05	2.50	5.25	5.95	2.90	3.60
Ridge sowing (T_7)	2.10	2.42	5.40	5.90	2.65	3.85
Subabool Mulch (T_8)	2.40	2.75	5.73	6.25	3.50	3.95
Wheat straw Mulch (T_9)	2.10	2.41	5.30	5.89	3.12	3.55
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

Economics

It is evident from the data that maximum and minimum gross return recorded Rs. 88836 and Rs. 60891 ha^{-1} from paddy straw mulch and control treatment. Data indicates that the total cost of cultivation also followed the same trend. The highest net return (Rs. 67265) was recorded from the paddy straw mulch at 6 t/ha, while minimum net return obtained with control 0 t/ha (Rs. 50308). Similar results obtained by Palsaniya *et al*. (2012) and Kumar *et al*. (2013) in guava and anola based agri-horti system. The maximum benefit: cost ratio (5.23) was recorded with subabul (*Leucaena leucocephala*) mulch at 6 ton per hectare and minimum (3.11) was obtained with paddy straw mulch at 6 ton per hectare (Table 4).

Table 4. Economics of maize as influenced by different types of mulch under Guava based agri-horti system.

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit/Cost
Control (T_1)	10583	60891	50308	4.75
Dust Mulch (T_2)	12583	63119	50536	4.01

Green Weed Mulch (T_3)	11576	66336	54760	4.73
Kans Mulch (T_4)	15675	78609	62934	4.01
Legume Mulch (T_5)	21245	87901	66656	3.13
Paddy Straw mulch (T_6)	21583	88848	67265	3.11
Ridge sowing (T_7)	12540	66243	53660	4.27
Subabool Mulch (T_8)	13545	83836	70294	5.23
Wheat straw Mulch (T_9)	18547	80532	61985	3.34

CONCLUSIONS

Significant response observed in growth and yield for different types of mulch application at 6 ton per hectare and benefit/cost ratio was also found maximum, so it is recommended that farmers should use at 6 ton per hectare mulch of subabul (*Leucaena leucocephala*) in maize under guava based agri-horti system.

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