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Effect of different organic sources on growth, yield and quality of rainfed maize (*Zea mays* L.) + guava (*Psidium guajava* L.) based agri-horti system

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Abstract
All the experimental observations were made on the "Effect of different organic sources on growth; yield and quality of rainfed maize (*Zea mays* L.) + Guava (*Psidium guajava* L.) based agri-horti system" at Agronomy Research Farm of Rajiv Gandhi South Campus, Banaras Hindu University, Barkachha Mirzapur, Uttar Pradesh (India) during *kharif* season of the agriculture year 2015-16. The site of experimental field is situated at 25º 10' North latitude, 82º37' East longitudes, 427 metres above mean sea level in the semi-arid eastern plain zone. The field experiment was conducted under nine years old guava based agri-horti system with split plot design having four levels of row spacing (60 cm and plant to plant 20 cm) and four level of organic source (RDN as FYM, RDN as vermicompost, RDN as FYM + vermicompost and RDN through inorganic sources). The investigation was replicated thrice. Under the various observation the field experiment taken into consideration as the height, girth and canopy of the fruit tree in nine years old guava which were up to (4.07 m and 5.41 m), respectively. T_3 -50% of RDN as FYM+50% VC recorded significantly higher plant height (169.49 cm) over all other treatments. However, lower plant height (154.90 cm) was recorded with control treatment (T_4 - 100% of RDN through inorganic sources) got significantly, more number of leave plant^{-1} (13.05) over the RDN as vermicompost and through inorganic source at 120 DAS but at par with RDN as vermicompost (12.47) and non significantly higher dry matter accumulation plant^{-1} (169.15g) T_3 50% of RDN as FYM+50% VC at harvest stage. The maximum chlorophyll content, leaf area index maize was observed under T_3 50% of RDN as FYM+50% VC and lowest (T_4 - 100% of RDN through inorganic sources).

Keywords: Agri-horti system, growth, guava, maize, organic source, 50% tasseling, 50% silking, quality

Introduction
Maize (*Zea mays* L.) is also used as fasten food in many countries and ranks third most essential cereal crop in India. Uttar Pradesh (U.P.), where every sixth Indian lives, contributes to 20.37 percent of the country's agricultural production (GOI, 2005) [4]. If Indian agriculture has to prosper, the situation in Uttar Pradesh has to improve in all sectors including crop diversification (Kareemulla *et al.*, 2005; Saxena, 2000) [7, 18]. Agroforestry is an ideal scientific approach for eco-restoration of degraded lands and sustainable management. Numerous studies have described the beneficial effects of agroforestry systems in long-term soil productivity and sustainability (Kirby and Potvin, 2007; Nair *et al*., 2009) [8, 14] but the magnitude of the beneficial effects may vary with a number of site specific factors and attributes of associated tree species. Increased nutrient inputs and recycling, reduction in nutrient losses, and improved soil physical properties are all characteristics of agroforestry systems as compared to sole cropping systems under hilly ecosystems (Nair, 1993) [13]. Udawatta *et al*. (2008) [22] have reported improved soil aggregate stability, nutrients availability and microbial activity under agroforestry systems in comparison to other land use systems. Tree species has the potential to increase the crop productivity however, the effects are inconsistent. Several studies have shown increased or decreased crop productivity under certain circumstances. For instance, intercultural, weed control, tillage, mulching etc. applied to the crop also benefits the trees in Agroforestry system (Schroth, 1995) [19]. Maize occupies an important position in the world economy and trade as a food, feed and industrial grain crop. To meet the growing demand, per hectare yield of maize is estimated to rise to 2.36 tons as against 1.7 tons currently, by the end of 2020. Appropriate tillage and mulch practices are used to conserve soil moisture and increase the yield of crops. Crop residues at the soil surface act as shade which serves as a vapor barrier against moisture losses from the soil, causing slow surface runoff. Rathore *et al.* (1998) [16] have reported that more water conserves in the soil profile during the early growth period with straw mulch than without it.

Subsequent uptake of conserved soil moisture, moderated plant water status, soil temperature and soil mechanical resistance, leading to better root growth and higher grain yields. Applications of crop residue organic source increase soil organic carbon contents (Saroa and Lal, 2003) [17]. Guava (*Psidium guajava* L.) of the family Myrtaceae is one of the most gregarious fruit trees and is popular among local farmers of eastern Uttar Pradesh. It is now widely grown all over the most common of the newly introduced sub tropical fruit in Israel. Guava is quite hardy prolific bearer and highly remunerative even without much care and successfully grown all over the country. Uttar Pradesh is the most important guava producer state and growing best guava in the country as well as in the world. Guava is a rich source of ascorbic acid (75-200 mg/100g) and Pectin (0.5-1.8%) Keeping this in view, the present investigation was planned to determine the Effect of different organic sources on growth, yield and quality of rainfed maize (*Zea mays* L.) + Guava (*Psidium guajava* L.) based agri-horti system.

Materials and Methods

The study was conducted in nine year old guava based agri-horti system which was planted in August 2007 at a spacing of 7.0 x 7.0 metre at Agronomy Farm of Rajiv Gandhi South Campus, Banaras Hindu University Barkachha Mirzapur Uttar Pradesh (India) during *kharif* season of 2015-16, which is situated in *Vindhyan* region of district Mirzapur, 25º10' latitude, 82º37' longitude and altitude of 427 metres above mean sea level. This region comes under agro-climatic zone III A (semi-arid eastern plain zone) and the region is mostly rainfed. Maximum temperature in summer is as high as 38.65˚C and minimum temperature in winter falls below 8.12˚C. The annual rainfall of locality was 53 mm in year 2015. Experiment was laid out in split plot design having three replications. Soil analysis was done before the sowing of the crop and after the harvesting of the crop. The net plot size was 3.6 m x 2 m for 60 cm row spacing, plant to plant 20 cm, respectively. The experiment was comprised of four organic source methods *viz.* T_1 100% of RDN as FYM, T_2 100% of RDN as VC, T_3 50% of RDN as FYM+50% VC, T_4 100% of RDN through inorganic sources and biofertilizer S_1 Control, S_2 *Azotobacter*, S_3 PSB, S_4 PSB + *Azotobacter*, Maize hybrid MRM 3777 was used as an experimental material. Standard procedures were adopted for recording growth, yield and quality parameters. Organic materials (RDN as FYM, RDN as vermicompost, RDN as FYM + vermicompost and RDN through inorganic source was applied in the field after the sowing of the maize. The significance of the treatment effect was judged with the help of 'F' test (Variance ratio). The difference of the treatments mean was tested using critical difference (C. D.) at 5% level of probability (Gomez and Gomez, 1984). Standard procedures were adopted for recording the data of agronomic and yield related parameters. The height, canopy spread and collar girth of the guava tree was measured with the help of measuring tape. First of all the spread of crown in east-west and north-south direction was marked with a wooden stick at last shoot tip of each direction. Crown diameter obtained with using following calculation:

$$\text{Canopy Spread} = (D_1+D_2)/2$$

Where, D_1 = Crown length in east-west direction
D_2 = Crown length in north-south direction

Results and Discussion

Growth parameters of guava tree: The height, girth and canopy of the tree in nine years old guava were up to 3.77-4.04 m, 0.33-0.334 m and 4.99-5.41 m, respectively (Table 1). Statistically standard deviation 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 1: Growth Parameters of guava tree

	Tree height (m)		**Canopy diameter (m)**		**Girth (m)**	
	At time of sowing	**At harvest**	**At time of sowing**	**At harvest**	**At time of sowing**	**At harvest**
Mean	3.77	4.04	4.99	5.41	0.33	0.334
Range	3.34-4.9	3.6-5.2	4.25-5.35	4.6-5.9	0.29-0.35	0.29-0.36
SD	0.64	0.66	0.51	0.52	0.03	0.03

Growth studies

Plant height (cm) The plant height was influenced by organic treatments, T_3 - 50% of RDN as FYM+50% VC was recorded highest plant height at harvesting (169.49 cm) which was significantly different rest of the treatments, and followed by T_2 - 100% of RDN as VC (162.58 cm) and T_1 - 100% of RDN as FYM (155.76 cm). However, minimum plant height was recorded under T_4 - 100% of RDN through inorganic sources (154.90 cm). (Table-2). Under biofertilizer maximum plant height was recorded (165.52 cm) under S_4 - PSB + *Azotobacter* which were significantly higher over all the treatments, and followed by S_3 - PSB (161.28 cm) and S_2 - *Azotobacter* (158.92 cm). However, minimum plant height was recorded under S_1 - Control (157.01 cm). Interaction of different organics treatments and biofertilizer was found significant (Manyuchi *et al* 2013) [11].

Number of green leaves plant^{-1} Number of green leaves was different organic treatments, T_3 - 50% of RDN as FYM+50% VC was recorded highest green leaves 120 Das (13.05) which was significantly different rest of the treatments, and followed by T_2 - 100% of RDN as VC (12.42) and T_1 - 100% of RDN as FYM (12.20). However, minimum number of green leaves was recorded under T_4 - 100% of RDN through inorganic sources (11.69). (Table-2). Various biofertilizers influence the number of green leaves significantly at all the stages of crops growth. Maximum number of green leaves was recorded (12.83) under S_4 - PSB + *Azotobacter* which were significantly higher over all the treatments, and followed by S_3 - PSB (12.35) and S_2 - *Azotobacter* (12.17). However, minimum number of green leaves was recorded under S_1 - Control (12.02). Interaction of different organics treatments and biofertilizer was found non- significant (Kumar *et al.* 2014) [9].

Dry matter accumulation plant^{-1} (DMAP^{-1}). The dry matter accumulation gradually increased up to harvest stage. the significantly higher dry matter accumulation plant^{-1} was observed organic treatment T_3 - 50% of RDN as FYM+50% VC was recorded highest dry matter accumulation plant^{-1} 120 DAS (169.15). (Table-2). and biofertilizer However, minimum dry matter accumulation plant^{-1} was recorded under S_1 - Control (159.46). Mali *et al.* 2015 [10].

Chlorophyll content The data revealed the Chlorophyll content influenced significantly higher at various growth stage due to different treatments T_3 - 50% of RDN as FYM+50% VC was recorded highest Chlorophyll content at harvesting (42.27). (Table 2). However, minimum Chlorophyll content was recorded under S_1 - Control (39.41). Kalaiarasi *et al.* 2015 [6].

Leaf area index The data revealed that Leaf area index influenced significantly at various growth stage due to different treatments T_3 - 50% of RDN as FYM+50% VC was recorded highest Leaf area index at harvesting (2.63). (Table 2). and biofertilizer However, minimum Leaf area index was recorded under S_1 - Control (2.46) (Gholami *et al.* 2009) [3].

Table 2: Effect of different organic source on growth attributes of maize under guava based agri-horty system

	Plant height (cm)		No. Of leaves plant^{-1}		DMAP^{-1}		Chlorophyll content		Leaf area index	
Treatment	**90 DAS**	**At harvest**	**90 DAS**	**At harvest**	**90 DAS**	**120 DAS**	**90 DAS**	**120 DAS**	**90 DAS**	**At harvest**
Organic source										
T_1	144.69	155.76	10.81	12.20	153.70	161.86	41.38	39.71	2.51	2.50
T_2	149.32	162.58	10.99	12.42	157.87	165.46	42.56	39.92	2.70	2.58
T_3	158.17	169.49	12.45	13.05	160.22	169.15	45.15	42.27	2.89	2.63
T_4	139.66	154.9	10.17	11.69	150.98	149.73	40.73	38.85	2.46	2.39
SEm ±	2.02	1.49	0.54	0.56	1.85	0.83	0.86	0.81	0.16	0.10
CD (P=0.05)	6.98	5.16	1.88	1.95	6.42	2.86	2.97	2.8	0.54	0.35
Biofertilizer										
S_1	145.42	157.01	10.77	12.02	153.68	159.46	41.84	39.41	2.48	2.46
S_2	146.46	158.92	11.02	12.17	155.82	160.34	41.98	40.08	2.61	2.52
S_3	148.64	161.28	11.15	12.35	156.09	161.25	42.75	40.30	2.65	2.53
S_4	151.32	165.52	11.48	12.83	157.2	165.15	43.25	40.95	2.82	2.57
SEm ±	1.10	2.33	0.97	1.20	1.23	1.32	1.03	0.58	0.12	0.09
CD (P=0.05)	3.22	6.81	2.84	3.50	3.58	3.85	3.02	1.70	0.35	0.27

Organic source: T_1 100% of RDN as FYM; T_2 100% of RDN as VC; T_3 50% of RDN as FYM+50% VC; T_4 100% of RDN Through inorganic sources. Biofertilizer: S_1 Control; S_2 *Azotobacter;* S_3 PSB; S_4 PSB + *Azotobacter.*

Developmental characters

Days to 50% tasseling. It is clear from the data that number of days taken to reach 50 percent tasseling stage significantly influenced due to different treatments T_3 - 50% of RDN as FYM+50% VC was recorded highest 50 per cent Tasseling (78.34). (Table 3.) The different treatments biofertilizers influence significantly at all the stages of crops growth. 50 percent tasseling was recorded However, minimum 50 percent tasseling was recorded under S_1 - Control (2.49). Murtada *et al.*, 2010. Days to 50% silking. An examination of the data reveals that different treatments influence significantly on days taken to 50% silking. T_3 - 50% of RDN as FYM+50% VC was recorded highest 50 per cent silking (83.40) (Table 3). The different treatments biofertilizers influence significantly at However, minimum 50 per cent silking was recorded under S_1 - Control (73.59) The number of days to 50% silking was significantly delayed in s_4 than other treatments. Singh *et al.*, 2003 [20].

Cob height from earth (cm). It is clear from the data that Cob height significantly influenced due to different organic treatments T_3 - 50% of RDN as FYM+50% VC was recorded highest Cob height (80.54 cm). (Table 3). The different treatments biofertilizers influenced significantly at However, minimum Cob height was recorded under S_1 - Control (77.26 cm). Baloch *et al.* 2014 [1].

Quality parameter

Grain protein content (%) With the relevance of organic treatments T_3 - 50% of RDN as FYM+50% VC was recorded grain maximum protein content (12.62%). (Table 3). Different treatments biofertilizers. However, minimum grain protein content recorded under S_1 - Control (11.20%). Naserirad *et al.*, 2011 [15].

Protein yield (kg ha^{-1}) Among the different organics treatments, T_3 - 50% of RDN as FYM+50% VC was recorded highest protein yield (kg ha^{-1}) (545.77 kg ha^{-1}) (Table 3). Various biofertilizers influence the protein yield (kg ha$^{-1)}$ significantly at all the stages of crops growth. However, minimum protein yield (kg ha$^{-1)}$ was recorded under S_1 - Control (438.70 kg ha^{-1}). Taipodia and Yubbey 2013 [21].

Grain oil content (%). Among the different organics treatments, T_3 - 50% of RDN as FYM+50% VC was recorded highest grain oil content % (6.71%). (Table 3). Various biofertilizers influence the grain oil content % significantly at all the stages of crops quality. However, minimum grain oil content % was recorded under S_1 - Control (4.82%). Ghaffari *et al.*, 2011 [2].

Grain yield (q ha-1). Perusals of data indicated significant variation due to different organic treatments on the grain yield ha^{-1}. treatments T_3 - 50% of RDN as FYM+50% VC was recorded highest number of grain yield ha^{-1} (42.66 qha^{-1}) (Table 3). However, minimum grain yield q ha^{-1} was recorded under S_1 - Control (38.53 qha^{-1}). It was found T_3 with S_4 superior grain yield. Baloach *et al* 2014 [1].

Stover yield (q ha^{-1}). Application of effect of organic treatments recorded T_3 - 50% of RDN as FYM+50% VC was recorded highest stover yield (58.75 qha^{-1}) (Table 3). The effect of biofertilizer on the stover yield However, minimum stover yield was recorded under S_1 - Control (50.76 qha^{-1}). Baloach *et al* 2014 [1].

Table 3: Effect of different organic sources on days 50% tasseling and 50% silking and Cob height (cm) and quality parameters in maize guava based agri-horty system.

Treatment	Days to 50% tasseling	Days to 50% silking	Cob height (cm)	Grain protein content (%)	Protein yield (kg ha^{-1})	Grain oil content (%)	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})
Organic source								
T_1	68.32	73.49	77.47	10.86	430.29	4.58	38.81	51.19
T_2	73.45	78.42	78.96	11.54	455.74	5.56	40.18	54.28
T_3	78.34	83.4	80.54	12.62	545.77	6.71	42.66	58.75
T_4	61.76	67.37	75.43	10.29	394.29	3.56	37.42	46.76
SEm ±	1.32	0.86	1.25	0.46	3.52	0.35	1.15	1.21
CD (P=0.05)	4.56	2.97	4.33	1.6	12.2	1.19	3.96	4.19
Biofertilizer								
S_1	68.61	73.59	77.26	11.2	438.7	4.82	38.53	50.76
S_2	69.93	75.08	77.83	11.26	445.13	5.09	39.28	52.03
S_3	71.01	76.12	78.02	11.32	462.37	5.19	40.34	53.36
S_4	72.33	77.89	79.29	11.53	479.89	5.3	40.92	54.84
SEm ±	1.45	1.17	1.36	0.9	27.44	0.66	2.00	2.35
CD (P=0.05)	4.24	3.42	3.98	2.64	80.08	1.92	5.84	6.85

Economic: The data on economics of different organic treatment was calculated taking different input component are presented in (Table 4). Screening of the data clearly shows that the cost of cultivation due to different organic source did not vary significantly. It is evident from the finding that the recorded highest gross return (129192 Rs). Which was significantly superior over T_2 (123787 Rs), T_1 (120736 Rs) and T_4 (117521 Rs). Among biofertilizer how ever minimum was recorded lowest gross return (116274 Rs) amongst biofertilizers. Highest net return was recorded with T_3 (91191 Rs). However minimum was recorded lowest net return S_1 (79653 Rs) biofertilizer treatments. Ghaffari *et al*., 2011 [2].

Benefit: Cost ratio Data related on benefit cost ratio of kharif maize influenced by different organic treatment are summarized in (Table 4). Among the different organic treatments significant highest benefit cost ratio (B: C) ratio was recorded under the highest (T_3) as compared to T_2,T_1 and T_4. (Table 4). Biofertilizer Treatment also proved variation in respect of B: C ratio S_4 recorded highest B: C ratio and remained over all biofertilizer treatments followed by S_3, S_2 and was recorded lowest B: C ratio S_1 biofertilizer treatments. Haque *et al.,* 2012 [5].

Table 4: Effect of different organic sources on the economics on maize guava based agri-horti system.

Treatment	Cost of cultivation	Gross return Rs ha^{-1}				Net return (Rs ha^{-1})	Benefit : cost ratio
		Grain yield	Stover yield	Fruit yield	total		
Organic source							
T_1	37371	77617	5119	38000	120736	83365	2.23
T_2	36997	80358	5428	38000	123787	86790	2.35
T_3	38001	85317	5875	38000	129192	91191	2.40
T_4	37625	74845	4676	38000	117521	79896	2.12
Biofertilizer							
S_1	36621	73198	5076	38000	116274	79653	2.18
S_2	37119	78563	5203	38000	121766	84647	2.28
S_3	37601	80677	5336	38000	124013	86412	2.30
S_4	37429	81847	5484	38000	125330	87901	2.35

Conclusion

Application of organic source and biofertilizer in vermicompost, PSB and *Azotobacter* in maize plot was found suitable to realize the high yield and profit in guava tree + maize agri- horti-system. The maize vermicompost (FYM) as RDN was found highly productive and remunerative as compared to other treatment and control under agro climatic conditions of *Vindhyan* region of India.

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