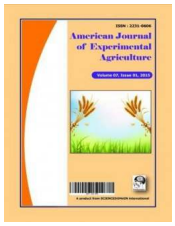

American Journal of Experimental Agriculture
10(3): 1-7, 2016, Article no.AJEA.21560
ISSN: 2231-0606

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Development of Guava + Pineapple Two Tier Cropping System under Rain-Fed Ecosystem of Jharkhand Province of India

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Authors' contributions

Author BRJ designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author MKM the analyses of soil sample of the study and managed the literature searches developed to the up-to-date manuscript. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJEA/2016/21560
Editor(s):
(1) Luis F. Goulao, Tropical Research Institute - IICT, Agri4Safe/BioTrop: Polo Mendes Hand, Agro-Industries and Tropical Agriculture Pavilion (3rd floor) Capped Help, 1349-017 Lisbon Portugal.
Reviewers:
(1) Raúl Leonel Grijalva Contreras, Forestales Agrícolas y Pecuarias, Mexico.
(2) Dequan Sun, South Subtropical Crop Research Institute, China.
(3) Levent Son, University of Mersin, Turkey.
Complete Peer review History: http://sciencedomain.org/review-history/11899

Original Research Article

Received 23rd August 2015
Accepted 29th September 2015
Published 19th October 2015

ABSTRACT

Aims: In the present agricultural scenario in India, the major thrust is to increase crop productivity with judicious fertilizer application so as to ensure sustainability in crop like fruit production system. Eastern plateau region of India provides ample opportunity for fruit cultivation in monoculture or multitier cropping under rain-fed ecosystem and mulching as moisture conservation.
Study Design: In this production system, Guava L-49 was collected from our own farm where as Pineapple Kew was procured from state farm of Jalpaiguri (West Bengal) India. A field trial with two crops with four level of fertilizers and three levels of mulching was laid out in Split-plot Design and ANOVA's were calculated.
Place and Duration of Study: From three years study (2008-2010) two tier cropping system of guava + pineapple has become promising and profitable to the farmer of ICAR-RCER, Ranchi region for its early returns with crop diversification. This was the first kind of growing intercrop pineapple with guava simultaneously from very beginning at Research Centre, Ranchi in India.

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Methodology: 10 fruits of guava and 4 fruits of pine apples are taken as a replication sample. TSS was measured by ATAGO digital refractometer, total and reducing sugar was measured by Lane and Eynon method. Available soil nitrogen, phosphorus and potash were estimated by Alkaline $KMNO_4$, $NaHCO_3$ extraction and NH_4OAC extraction methods, respectably. Organic carbon in the soil was estimated by Walkley and Black method whereas soil EC and pH were analyzed by 1:2 soil water suspension method.
Results: Study revealed that F3 fertilizer treatment i.e., 100% pineapple and 50% recommended fertilizer dose of guava along with local weed mulching accounted for maximum fruit production 3.6 q pine apple +3.2 q guava from one acre in the third year (2010). Plastic mulching induces early flowering and improve fruit quality regarding total sugar to both of the crops. The highest total soluble solids (TSS) 13.8° B in pineapple crop are observed in third year and the maximum TSS of 12.2°B was recorded in winter guava and total sugar per cent was 6.92. Fruit quality of rainy season guava did not differ significantly among treatments.
Conclusion: Development of Guava + Pineapple two tier cropping system provided the maximum production of fruits crops from marginal land. Local weed mulching increases high sugar content of both the fruits but plastic mulch causes early flowering. F3 treatment (100% recommended fertilizer dose of pineapple and 50% recommended fertilizer dose of Guava) resulted in higher production of both the crops with local weed mulching and sufficed nutrients to guava in intercropping system.

Keywords: Guava; pine apple; production; fruit quality and two tier cropping.

1. INTRODUCTION

Guava (*Psidium guajava* L.) and pineapple [*Annanus comosus* (L.) Merr.] are the two major tropical fruit crops successfully grown in Eastern India. In India guava and pine apple are grown in about 268.2 thousand ha and 109.9 thousand ha, respectively. These two crops contribute total production of 36.67 lakh tones and 17.36 lakh tones, respectively [1]. Guava has a fair source of Vitamin C whereas pineapple is a very good source for protein digesting enzyme bromelain which have great impact on nutrition to the tribal and poor people of this area. The climatic condition of Eastern plateau and hill region provides fruit cultivation as the soil is Alfisol which suitable for pineapple and guava cultivation. The Chota Nagpur regions of eastern plateau and hill agro-climatic zone has been a traditional guava growing region where the crops are mostly grown under rain fed ecosystem. The guava produced in this region is known for its high T.S.S and long keeping quality as weather is sub-humid and subtropical. However lower yield level of guava under this condition is a major constrain for spread of guava cultivation in this region. With burgeoning population, urbanization and continuous depletion of natural resources there is a paradigm shift in production and profitability. In a state like Jharkhand, more than 60% of land is rain-fed upland which is generally utilized under mono cropping of paddy. Under this situation draught hardy and precocious bearing fruit crops like guava and pineapple can play a major role in increase in fruit production per unit area. Suitable intercrops in young guava orchard (L-49) grown under new alluvial soil increases the yield of both the crops [2]. In main crop (1st harvest), application of 18 g N/plant resulted in highest fruit weight and size while best quality fruits were harvested from the plants. Kew cultivar of pineapple grown as intercrop in mango orchard on laterite soil west Bengal needed more nitrogen for growth and development [3]. Elephant foot Yam (90 cm x 90 cm) intercropped with Guava (10 mx 10 m) gave promising yields of both the crops in Odisha (India) conditions [4]. Hassan et al. [5] also mentioned pine apple intercropped with jackfruit gave remarkable return in agro ecosystem of Madhupur district of Bangladesh. In Goa, India, it has been found that pineapple intercropping with cashew nut provides satisfactory income to the small and marginal farmer [6]. Sarkar [7] reported that under Tripura (India) condition inter cropping of Banana with pineapple is promising to the tribal farmer's in block of Sardar subdivision. Intercropping made available for nutritional security and solved deforestation problem in rural areas [7]. Intercropping is more profitable from existing resources when pineapple would be taken as intercrop as it efficiently utilizes surface nutrients [8]. Hence, a study in that direction will provide ample opportunity to the researchers to understand the combination of fruit growing together and their interaction effects. Therefore, an attempt has been made to develop guava + pineapple two tier cropping system under rain-

fed ecosystem of eastern plateau and hill region of India emphasizing primarily on more productivity of fruit crops to improve economic condition of rural farmer of Jharkhand.

2. MATERIALS AND METHODS

The experiment was conducted at ICAR Research Complex for Eastern Region, Research Center Ranchi, India during 2008-09. This area is situated 620 m above mean sea level (msl) and at 23° 25' N latitude and 85° 20' East longitudes experiencing an average annual rainfall is 110-140 cm. Here, guava is cultivated under rain-fed ecosystem. Plot Size was 2 m x 5 m- pine apple bed and guava was planted in 5 m x 5 m- distance. Fertilizer dose for Pineapple was 600:400:600 (N:P:K) kg/ha due to poor soil texture and nutrient status [9] whereas in Guava, fertilizer dose was 260:320:260 g /plant/year [10]. Statistical Design was Split-Plot. Treatments were in Main Plot: F1= 100 % recommended dose of fertilizer in guava (G), F2=100% recommended dose of fertilizer in pineapple (P) F3=100% recommended dose of fertilizer in pineapple(P) and 50% recommended dose of fertilizer in guava (G), F4=50% recommended dose of fertilizer in pineapple (P) and 50% recommended dose of fertilizer in guava (G). Mulching were applied in Sub-plots which were paddy straw mulching (M1), Local weed mulching (M2) and Plastic mulching (M3). Treatment combination details are given in Table 1. No irrigation is provided but life saving irrigation of 1-2 spells may be provided during May –June at an one month intervals to establish young plants at their initial establishment as well as mature plants for flowering and fruiting. The climate is sub-humid and subtropical type. High humidity (78.14%-84.14%) and low evaporation rate is experienced after June and continues up to onset of winter [11]. Soil is acidic and pH range from 5.0-6.5, which is ideal for guava and pineapple cultivation. The experiment was laid out in Factorial Randomized Block Design with four replications and four fertilizers doses are considered in main plot and thee mulching treatments in sub plot. Fruit botanical descriptions were measured by standard methods. Titratable acidity was estimated by titrating the fruit extract with 0.1 N NaOH using phenolphthalein as an indicator and expressed as per cent citric acid equivalent. Reducing and total sugar was estimated by Lane and Eynon method [12]. Soil nitrogen, phosphorus and potash were estimated by Alkaline $KMNO_4$ [13], $NaHCO_3$ Extraction [14] and NH_4OAC extraction methods [15] , respectably. Organic carbon in the soil was estimated by Walkley and Black method [16]. Initial physico-chemical soil properties has been presented in Table 3.

Table 1. Details of treatments

1	100 % recommended dose of fertilizer in guava + paddy straw mulching	F1M1
2	100 % recommended dose of fertilizer in guava +local weed mulching	F1M2
3	100 % recommended dose of fertilizer in guava +plastic mulching	F1M3
4	100 % recommended dose of fertilizer in pineapple+ paddy straw mulching	F2M1
5	100 % recommended dose of fertilizer in pineapple +local weed mulching	F2M2
6	100 % recommended dose of fertilizer in pineapple + plastic mulching	F2M3
7	100% recommended dose of fertilizer in pineapple and 50 % recommended dose of fertilizer in guava + paddy straw mulching	F3M1
8	100% recommended dose of fertilizer in pineapple and 50 % recommended dose of fertilizer in guava + local weed mulching	F3M2
9	100% recommended dose of fertilizer in pineapple and 50 % recommended dose of fertilizer in guava + plastic mulching	F3M3
10	50 % recommended dose of fertilizer in pineapple and 50% recommended dose of fertilizer in guava + paddy straw mulching	F4M1
11	50 % recommended dose of fertilizer in pineapple and 50% recommended dose of fertilizer in guava + local weed mulching	F4M2
12	50 % recommended dose of fertilizer in pineapple and 50% recommended dose of fertilizer in guava + plastic mulching	F4M3

3. RESULTS AND DISCUSSION

The results revealed that soil pH and soil EC were not influenced either by fertilizer or mulching and its interactions. With regard to organic carbon, different mulching treatments and their interaction with fertilizer were significant. Fertilizer treatment F3, i.e. 100% recommended fertilizer dose of pineapple and 50% recommended dose of guava along with local weed mulching resulted in maximum retention of organic carbon in the soil (0.92%). Soil nitrogen content was found highest under the treatment of F3 i.e. 100% recommended dose of fertilizer was given to pineapple [100% (P)] and 50% fertilizer dose was given to guava [50% (G)] under local weed mulching. Nitrogenous fertilizer significantly increases soil nitrogen status (Table 2). Soil order of Ranchi in the region of Central and Eastern plateau is Alfisol (silty loam) having sand 73.28%, silt 13.28% and clay 13.44%, soil pH 4.8 and EC also very less [17]. Therefore, we applied 100% fertilizer dose in pineapple crop to compensate leaching losses of the nutrients. The outcome of Nitrogenous fertilizer and local weed mulching interaction was significant. This might be due to moisture availability for long period increases efficiency of soil nitrogenous fertilizer at root zone of pineapple crop. As the phosphate content of the soil was low, there was no significant results were obtained in case of phosphate retention and its interaction with mulching. The status of exchangeable K was highest under the treatment of F3 directly significant but interaction effect of mulching and fertilizer with mulching have no role in availability of exchangeable potassium. Here under the F3 treatment, there were early inductions of flowering in both the crops (guava and pineapple) due to increase in soil temperature and water stress. This finding was supported by Shaik and Fouda [18] when mulching influenced early flowering in Cucumber by increasing soil temperature. F3 fertilizer treatment (100% recommended dose of fertilizer in pineapple and 50% recommended fertilizer dose for guava) along with local weed mulching accounted for maximum fruit production (22.4 kg pineapple +19.92 kg guava /25 square m plot) in the third year of assessment (Fig. 1). This may be due to efficient utilization of nitrogenous and phosphatic fertilizers in comparison to potassic fertilizer. Hiyang et al. [19] also reported that the applications of Nitrogen, Phosphorus (P_2O_5) and potassium (K_2O) (400:100:500 kg/ha respectively) fertilizers when applied separately, improved the

Table 2. Soil nutrient status during 3rd year growth period at pineapple field

Treatments	pH	EC ml. mohs/cm^2	Organic carbon (%)	N (Kg/ha)	P (kg/ha)	K (kg/ha)
F1	5.17	0.03	0.56	215.64	10.71	217.0
F2	5.00	0.49	0.67	454.63	22.55	470.0
F3	5.04	2.64	0.53	424.15	16.73	558.0
F4	4.77	0.31	0.57	336.94	13.38	442.4
M1	5.05	1.11	0.58	326.94	16.01	416.90
M2	4.91	0.68	0.58	365.65	16.68	409.9
M3	4.98	0.81	0.59	380.38	14.84	439.54
F1M1	5.22	0.03	0.55	212.96	13.70	221.3
F1M2	5.04	0.03	0.57	216.96	8.64	218.7
F1M3	5.09	0.04	0.56	217.00	9.79	210.9
F2M1	5.13	0.50	0.64	311.20	21.88	484.9
F2M2	4.97	0.52	0.69	510.30	30.46	431.4
F2M3	4.91	0.46	0.67	442.40	15.30	495.4
F3M1	5.11	0.63	0.54	466.13	16.91	523.6
F3 M2	4.88	1.20	0.92	393.80	13.46	537.23
F3M3	5.12	2.39	0.55	412.53	19.82	614.83
F4 M1	4.73	0.280	0.59	317.46	11.54	437.80
F4M2	4.77	0.30	0.54	341.56	14.15	452.4
F4M3	4.82	0.35	0.58	349.60	14.46	436.9
Significant						
F	NS	NS	NS	73.31*	NS	61.32*
M	NS	NS	NS	NS	NS	NS
FXM	NS	NS	0.02*	5.86*	NS	NS

Table 3. Physico-chemical properties of experimental soil

Particulars	Value	Methods
Sand (%)	72.28	Pipette Method
Silt (%)	15.28	
Clay (%)	12.44	
pH (1 : 2.5:: Soil : Water)	4.5	1:2 soil water suspension
EC (mili mos/cm^2)	0.48	1:2 soil water suspension
Organic carbon (g kg^{-1})	0.42	Walkley and Black method
Availble N,(kg/ha)	165.6	Alkaline $KMNO_4$ method
Exchangeble K(kg/ha)	142.73	NH_4OAC Extraction
Available P (kg/ha)	13.75	$NaHCO_3$ Extraction

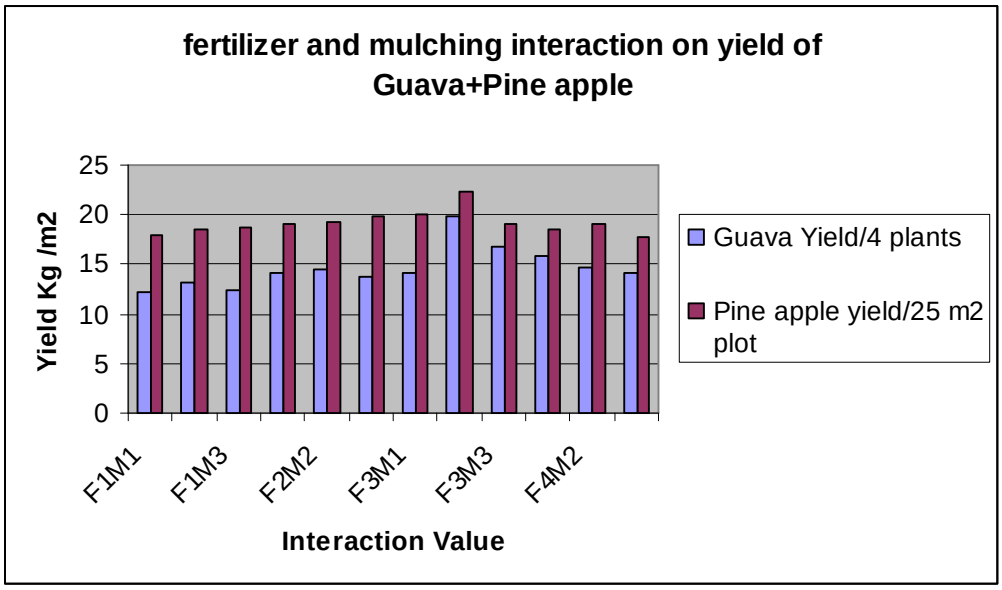

Fig. 1. Treatments interaction on Yield of Guava and Pine apple

yield of Smooth Cayenne pineapple in China. Norman [20] also observed that higher dose of Nitrogen resulted in maximum production of pineapple crop of good quality. Under F3 treatment 100% recommended dose of fertilizer was applied in pineapple due to the deficiency of available N, P and K in hilly and plateau region for higher plant population. Here nitrogenous and potassic fertilizer sufficient to meet the requirement of both the crops grown under plateau condition. This finding corroborates the work of Sarkar [7], where more production was noticed with pineapple and banana cropping system. These results were also supported by Yakushiji et al. [21] and Amarasuriya [8]. In case of interactive effect of fertilizer with mulching, the maximum T.S.S (14.74°B) and total sugars (7.35%) of pineapple were recorded under the treatment of F3 with plastic mulching. These fruit quality values were at par with F3 treatments under local weed mulching in which T.S.S. of 13.8°B (Fig. 2) and total reducing sugars of 7.12% are observed (Fig. 3). Local weeds are easily available and can be used as mulch before flowering of the weed. Fruit quality of rainy season guava did not differ significantly among the treatments of different doses of fertilizers with mulching. However, the quality of winter season guava was highest in F3 treatments with plastic mulching (T.S.S. 12.2°B and total sugars 6.92%). Mulching paved the way for retaining optimum soil moisture in the soil and it also enhances soil temperature resulted in better sugar synthesis in both the crops. This was supported by Yakushiji et al. [21] when they confirmed moisture stress affects many physiological processes including sugar accumulation in citrus trees.

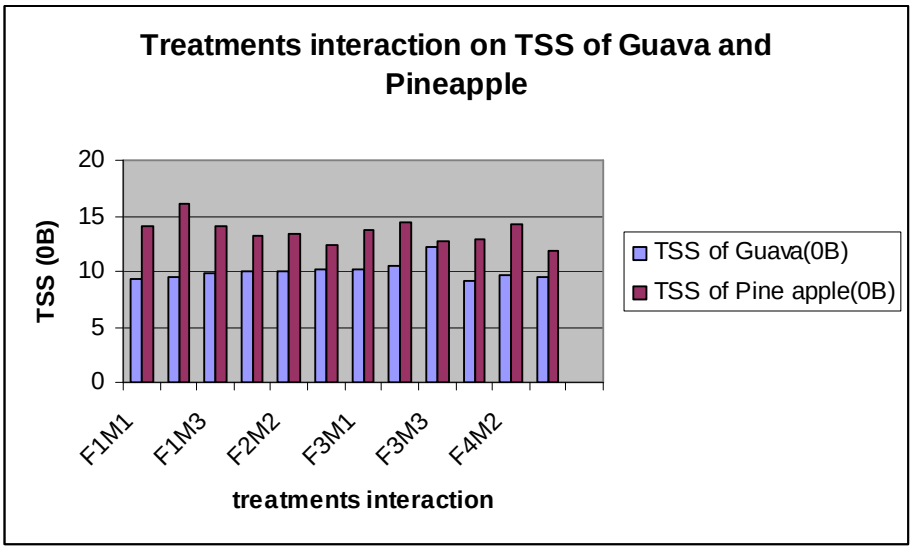

Fig. 2. Treatments interaction on TSS of Guava and Pine apple

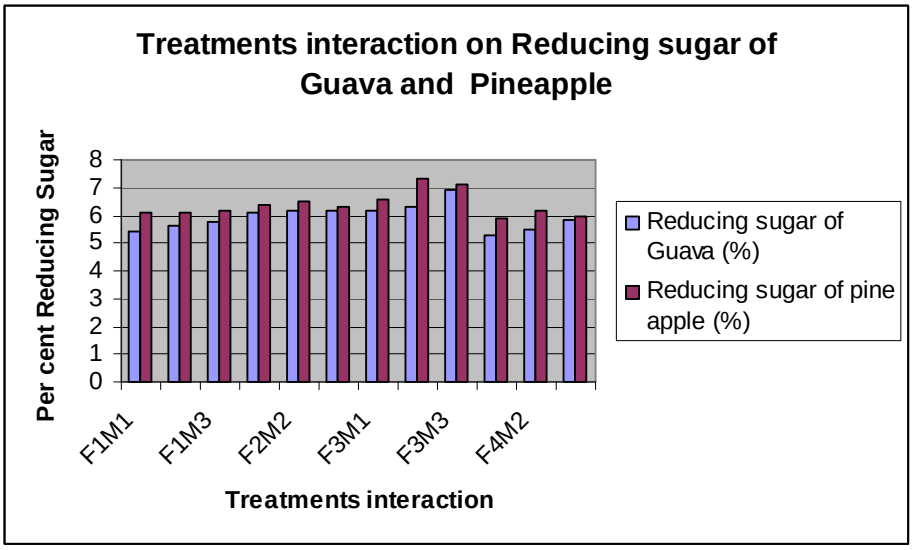

Fig. 3. Treatments interaction of Guava+ Pineapple crop in respect of reducing sugar content

4. CONCLUSION

Development of Guava + Pineapple two tier cropping system provided the maximum production of fruits crops from the marginal land. It also increases paddy equivalent yield and provides opportunity for crop diversification. Fruit quality increases significantly under the treatment of F3 i.e. 100% recommended dose of fertilizer was given to pineapple [100% (P)] and 50% fertilizer dose to guava [50% (G)] under local weed mulching. Fertilizer in combination with local weed mulching resulted in increased NPK status of the soil. Local weed mulching increases high sugar content of both the fruits by osmoregulation in root cells. But plastic mulching causes early flower by increasing temperature of the mulched soil.

ACKNOWLEDGEMENTS

This research work was funded by Indian Council of Agricultural Research (ICAR).The authors are thankful to ICAR-RCER Patna and Research Center Ranchi for providing Lab facilities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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