IMPACT ASSESSMENT OF REJUVENATION TECHNOLOGY AND INTEGRATED PLANT NUTRIENT MANAGEMENT IN OLD GUAVA ORCHARD THROUGH FARMERS PARTICIPATORY APPROACH

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Abstract : An on farm trial was conducted in old guava orchard to assess the rejuvenation and integrated plant nutrient management (IPNM) technologies to restore yield and quality traits from exhausted trees of cv. Allahabad Safeda for the three consecutive years i.e. 2007-10. The eighteen year old trees of selected guava orchard were pruned drastically at a height of 2.00 meter in 2007-2008. It was observed that topping and heading back increased the number of new shoots (below the cut portion) and spread of plant significantly resulting in reduced tree height and improved fruiting potential of trees as compared to farmers practice. As a result of pruning practices increased flowering shoots (39.66%) have given higher yield 63.44 kg tree-1 (average of Ist, IInd, IIIrd years) followed by un pruned well managed trees (44.16 kg tree-1), with having increased yield 107.72 per cent and 44.59 per cent over farmers practice (30.54 kg tree-1) respectively. However, initial yield was recorded lower in rejuvenated plants (29.00 kg tree-1) as compared to T2 (38.66 kg tree-1) and farmers practice (35.50 kg tree-1). The economic analysis revealed that B: C ratios were much higher in rejuvenated plants i.e. T1 (3.76) than T2 (2.38) and farmers practice T3 (1.43).

Keywords : Canopy management, Heading back, *Psidium guajava* L., Yield & quality attributes

INTRODUCTION

Guava (*Psidium guajava* L.) popularly known as apple of the tropics are commercially grown in U.P., M.P., Bihar and neighboring states since long as suited best to the region, but farmers harvesting low yield from the orchard than potential. Declining yield pattern from old guava orchard over the years are the major cause shifting the interest of farmers towards other crops and leaving the orchard unproductive. There are various limiting factors related to production and productivity which are pertinent and gravest for declining trends in bearing potential of old guava orchards (Singh et al. 2005). The study was particularly confined to Chandaul district of Uttar Pradesh, where average yield of traditional guava orchard is very low (7.5 mt ha-1) than the national average i.e. 11.7 mt ha-1 (NHB data base, 2010). Based on several research investigations it could be said that the fruiting potential of the tree is largely governed by its architectures of tree, canopy density and photosynthetic efficiency (Burondkan et. al. 2000; Singh and Singh 2003; Kalloo et. al.2005). Overcrowded old orchard planted in unsystematic manner favors decreased photosynthetic phenomenon, provides conducive environment to harbor pest and diseases was found the root cause of its decline in terms of production and productivity in the Chandauli district. An unproductive orchard is generally characterized by intermingling, overcrowded shoots with insect & disease infestation having branches not to capable to flower and fruit. The technological gap identified before the implementation of the experiment, revealed that farmers were not aware about pruning response and role of improved management practices. Topping and heading back of shoots in month of May and October were performed up to year 2009, regularly to develop a good framework and to develop better canopy. Practices of integrated plant nutrient management and other recommended cultural practices were also undertaken in rejuvenated and un- pruned plants of alternate rows and compared the performance with farmers practice in remaining trees of orchard. The yield obtained from pruned trees had better quality as compared to farmers practice. This experiment provided an eye opening result to farmers, not only to rejuvenated old unproductive orchard but also interaction effect of pruning response and integrated practices. After seeking the problems of un- productivity of an orchard in the region (Chandauli) an intensive extension approach were made to rejuvenate old guava orchard.

MATERIAL AND METHOD

Identification of technological gap and plan of on farm testing (OFT) :

A study conducted by Krishi Vigyan Kendra, Chandauli, U.P., based on survey and group discussion with farmers interactive group (F.I.G.), of guava growers in the guava belt of Chandauli district (i. e. Rema, Digghi, Ganjkhwaja, Faguiya and Tajpur villages) to identify root cause of low yield and technological gap between improved production technology and farmers practice given in Table-1.

Experiment was conducted at three farmers' orchard in two villages namely Faguiya in Sakadeeha block and Digghi in sadar block from 2007 to 2010 as

suggested by scientists P.F.D.C. (C.I.S.H., Lucknow, U.P.). Before implementation of OFT a group discussion with guava growers were made for identifying potential impediments in acceptance and growers involvement in OFT and willingness to adopt the rejuvenation technology. A list of constraints experienced by farmers on socio-economic, cultural and behavioral factors was prepared and sort listed as appended in Table-2. After assessing the cognitive domain and perception of guava growers as well as potential hindrances to acceptance of technology, an intensive extension program like informal meetings and focused group discussion, gosthies and scientist- growers' interface with video shows were conducted in association with P.F.D.C., Lucknow and department of horticulture Chandauli. Concentrated extension efforts led to change in the mind set of growers and at least nine growers came forward to have this trial in their old orchard. Among these, three farmers having 17-18 years old orchard with poor yield record were selected for the experiment. The farming situations studied of the selected orchards are given in Table-3.

Experimental plan and module of treatment

Each selected farmers provided 15 plants for heading back having marked decline in yield from his garden in alternate row to conduct the study and other fifteen un-pruned plants of adjoining row. Selected farmers were extended the facility of all the package of rejuvenation technology and remaining plants of orchard were treated as farmers practice in the study.
The experimental module included the heading back of branches at 2.00 meter height from ground level during May 2007. The newly emerged shoots as a result of rejuvenation pruning were allowed to grow up to length of about 40 to 50 cm. These were further pruned to about 50 per cent of its length. These shoots were further pruned to about 50 per cent of its total length in the month of October for emergence of multiple shoots below the pruning portion to modify tree structure and maintained canopy size. Shoot management was continued in 2008 and 2009 in May and October for the purpose. Pasting of copper oxychloride on cut surface and a paste of copper and lime were applied after each pruning.
The trees were irrigated regularly to maintain moisture for proper growth of shoot and fruiting twigs and application of 20 kg vermicompost plant^{-1} was made to each pruned plants. Integrated approaches for the supply of nutrients were adopted after six month of it, having 30 kg vermicompost + half kg neem cake + 1300 g urea + 1875 g single super phosphate and 500 g muriate of potash per plant in two split doses in the month of October and June. The details of treatments followed in the trial are as bellow.

T_1= Rejuvenation pruning followed by consistent pruning of emerging shoots at 50 per cent of length in October and May till 2010 + IPNM package + recommended management practices
T_2= Un-pruned trees + IPNM package + recommended management practices
T_3= Farmers practice (Application of DAP @ 300 g plant^{-1})
Data on vegetative growth were recorded in the month of October every year and for reproductive parameters after May and October shoot pruning. The observations on fruit analysis were noticed in composite sample of 5 fruits from 15 collected fruit of each rejuvenated and non rejuvenated plants. Total soluble solids were measured by Erma hand refractometer. Per cent increase in yield was calculated by using following formula.

$$\text{Increase (\%)} = \left(\frac{\text{Demo yield} - \text{farmers yield}}{\text{Farmers yield}}\right) \times 100$$

$$\text{B: C Ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

RESULT AND DISCUSSION

Cultivation of guava at commercial level in the Chandauli district of U.P., is very popular among the farmers due to its high yield and attractive prices, but data presented in Table-1 revealed that farmers involved in guava production in the district, didn't aware about recommended production technologies i.e. high yielding varieties, crop regulation, high density planting, nutrition management, mulching, intercropping, pruning response, use of bioregulator and plant protection measures. The competitive intercrops i.e. rice, bitter gourd and pigeon pea along with imbalance nutrition management not only reduces the yield and canopy development of orchard but also make the orchard decline due to higher incidence of diseases and pests. The lack of knowledge and skill about management of overcrowded orchard and combined production management approaches were the important causes held responsible to decline. These facts are also in conformity with the findings of Singh et. al.(2003).
The farming situation as given in Table-3 favours the commercial growing of guava in the district. It consist of sandy loam soil with pH 7.5- 8.00, lower N & P with medium K2O and sufficient rainfall which are suitable for guava production, but unmanaged, poorly nourished, overcrowded orchard taken under study were unable to produce higher yield and tend to become uneconomic.
In general, guava bears flower and fruit on newly emerging shoots. Irrespective of time of year, guava tree tend to grow in bush resulting in poor light penetration and utilization (Singh, 2005). In the present trial increase in tree canopy was directed by shoot pruning effectively. The growth of terminal and lateral shoots during the framework development of tree may be stimulated during

growth period (Singh et al. 2005) but these excessive growths must be well managed by pruning and removal of overcrowded shoots.

The experimental findings summarized in Table-4 revealed that significantly and consistently profuse flowering were observed in rejuvenated guava trees than well nourished un-pruned guava trees (T_2) and farmers practice(T_3). Increased branching complexity results in more fruiting shoots in young trees, promoting precious flowering and fruiting (Campbell and Wasielewski, 2000). Pooled fruit yield data of a year indicated that rejuvenated tree (T_1) had maximum fruiting shoots (39.66 per cent) in comparison to un-pruned well managed tree (T_2) 24.66 per cent and farmers practice (T_3) 15.66 per cent. It is very clear that consistent pruning responded well and stimulated new growth to convert in fruiting shoots. The data related to yield in Table-4 exhibited that rejuvenated trees consistently and significantly produced higher yield (29.00 to 96.00 kg tree^{-1}) as the year passes over the farmers practice (35.50 to 28.80 kg tree^{-1}). However, the yield from T_2 was also found consistently in increasing trend (38.66 to 51.33 kg tree^{-1}) but lower than rejuvenated trees. It is because of increased new growth in T_2 due to management practices, but less conversion of new shoots into bearing shoots in un-pruned trees. Declining in productivity of orchard could largely be due to poor photosynthesis efficiency besides several other compounding factors i.e. age of plants, dense and intermingling branches, neglected and poor management of the orchard (Kalloo et al. 2005). The per cent increase in average yield of three years period reported highest in rejuvenated trees (107.72 per cent) in comparison to un-pruned well managed trees (44.59 per cent) over the farmers practice. The data pertaining to quality parameters revealed that number of fruits plant^{-1} found maximum in farmers practice (330) followed by T_1 (305) and T_2 (300).While the average fruit weight recorded highest (206.66 g) in rejuvenated plants followed by T_2 (146.66 g) and T_3 (93.33 g).Total soluble solids observed maximum 12% in fruits of rejuvenated plants in comparison to T_2 and T_3 (11%). The differences in qualitative characters may be due to location of fruits and light distribution within canopy. It also indicated that even with proper handling and management of shoot within tree canopy is important for maintenance of fruit quality and production system (Campbell and Wasielewski, 2000). Economic aspect of the study listed in Table-5 stated that the margin (net return) was very poor in rejuvenated plants (Rs. 2953ha^{-1}) in 2008 than the T_2 (Rs. 17544 ha^{-1}) and farmers practice T_3 (Rs. 21167 ha^{-1}). However, it was recorded maximum in T_1 (Rs.56982) ha^{-1} and (Rs.97690) ha^{-1} in ensuing years 2009 and 2010 respectively than the T_2 (Rs.23162ha^{-1} and Rs.35192 ha^{-1}) and T_3 (Rs.11352 ha^{-1} and Rs.12088 ha^{-1}). The trend of negative net gain over farmers practice (Rs.-18234ha^{-1}) in rejuvenated plants (T_1) and T_2 (Rs.-3623/ha) were reported due to increased cost of production in 2008. It is because of higher input cost of heavy pruning of plants and better management practices. The B: C ratio was maximum in farmers practice (1.75) in initial year while it was too high in rejuvenated plants (2.70 and 3.76) in comparison to T_2 (1.64 and 2.38) and T_3 (1.42 and 1.43) in the year 2009 and 2010 respectively. It might be suggested to farmers that the yield loss in first year due to rejuvenation technology can be compensated by sale of pruned wood and better yield from intercrops having more light penetration and open space. Raising of intercrop like vegetables (potato, cucurbits, turmeric etc.) fetched income about Rs.45000 to 55000 ha^{-1}.

During the course of study (2007 to 2010) several field days and farmers visits were made by department of Horticulture, Chandauli, Uttar Pradesh. Growers with scientific temperament and entrepreneurial orientation appreciated the potential of technology and ready to adopt by having a refinement in technology by way of alternate row pruning. Farmers also appreciated the better management practice followed in T_2 as well.

CONCLUSION AND RECOMMENDATION

Significance of technology may be concluded by per cent increase in average yield of three years period as reported highest in rejuvenated trees (107.72 per cent) in comparison to un-pruned well managed trees (44.59 per cent) over the farmers practice. The result of On Farm Trial convincingly brought out that the rejuvenated trees consistently and significantly produced higher yield (29.00 to 96.00 kg tree^{-1}) as the year passes over the farmers practice (35.50 to 28.80 kg tree^{-1}). However the yield from T_2 was also found consistently in increasing trend (38.66 to 51.33 kg tree^{-1}) but lower than rejuvenated trees. It may be concluded that the success of this technique largely depends upon the proper management of shoots through precise and timely pruning. Constraint experienced in adoption of trail during the study may be taken under consideration by policy maker to start a campaign to popularize technology.

Table 1: Technological gap between improved management packages and farmers practices

S.N.	Technologies	Farmers Practices	Improved management package
1.	Selection of high yielding variety	Not aware, insist only grafted plants	Improved varieties i.e. Allahabad Safeda, L-49, Lalit etc.

2.	Crop regulation (Bahar treatment)	Not aware	Spray of urea 10-15% for deblossoming for rainy crop. Root exposure and water withholding for enforcing heavy crop.
3.	High density planting	Not aware	Accommodation of 555 plants at 6x3 meter spacing rather than 277 plants at 6x6 meter spacing
4.	Nutrient management	Application of chemical fertilizers at non judicious doses 2 kg DAP/plant	IPNM technology consisted 20 kg FYM +250 g Azotobactor +300 g N + 200 g P2 O5 +350 g K2 O in two split doses
5.	Mulching	Not aware	Mulching with paddy straw/ banana leaf or with black polythene
6.	Pruning and training	Not aware	Mild pruning in April in fruiting plants and rejuvenation of same orchard
7.	Use of bio-regulator	Not aware	Spray of NAA 100 PPM or GA3 150 PPM or Ethephone 300 ppm increasing fruit setting and reduces fruit drop
8.	Selection of intercrop	Growing rice, wheat and bitter gourd ; causes garden decline	Okra, cowpea, dolichus and turmeric can be grown as intercrop in guava orchard synergistically
9.	Pest and disease management	Non judicious use of pesticides	Application of IPM techniques Fruit fly management by use of Methyleugenol pheromone trap and spray of carbaryl and anthracnose management by use of Thiophenol 0.01% and Wilt management by application of Trichoderma and Aspergillus niger

Table 2: Constraints experienced by farmers in adoption of rejuvenation technology

SN	Identified constraints
1.	Lack of awareness and knowledge about rejuvenation technology
2.	Un willingness about deep root pruning in guava tree
3.	Lack of faith in rejuvenation techniques and risk of survival of orchard after deep root pruning
4.	Fear of economic loss by missing two crops
5.	Lack of risk taking willingness
6.	Unavailability of skilled labour and equipments
7.	Fear of forest law and police
8.	Complexity of work

Table 3: Details of farming situation of OFT on rejuvenation of guava

Treatments	Duration of study	Variety	Age of plant	Farming situation	Soil type	pH	Soil status			Seasonal rainfall	Avg. no. of rainy days
							N	P	K		
T_1- Rejuvenated trees	May 2007 to Nov. 2010	Allahabad safeda	18 years	Irrigated	Sandy loam	7.5-8.0	Low	Low	Medium	560 mm	29
T_2- Unpruned well managed trees											
T_3- Farmers practice											

Table 4: Effect of rejuvenation pruning and nutrition management on growth flowering and yield of guava **cv. Allahabad Safeda**

Treatment	Avg. tree height (m)	Emergence of new shoots (no.)	Flowering shoots in (%)	Yield in kg/tree			Avg. yield kg/tree	% increase in yield	Quality parameter		
				Ist year	IInd year	IIIrd year			No. of fruits plants-1	Avg. fruit wt.(g)	TSS (brix0)
T_1- Rejuvenated trees	2.0	7.8	39.66	29.00	65.33	96.00	63.44	107.72	305	206.66	12.00
T_2- Un-pruned well managed trees	7.4	4.0	24.66	38.66	42.50	51.33	44.16	44.59	300	146.66	11.00
T_3-Farmers practice	7.4	3.15	15.66	35.50	27.30	28.80	30.54	-	330	93.33	11.00

Table 5: Economic impact of rejuvenation technology on guava production cv. Allahabad Safeda

SN	Year	Total yield (q ha^{-1}) (@ 277 trees ha-1)			Avg. cost of inputs (Rs. ha^{-1})			Avg. gross of return (Rs. ha^{-1})*					Net return (Rs. ha^{-1})			Net gain OverFarmers practice (Rs. ha^{-1})		B: C ratio		
		T_1	T_2	T_3	T_1	T_2	T_3	T_1			T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_1	T_2	T_3
								Yield	Pruned wood	Total										
1	2008	80.33	107.08	98.33	53832	36000	28000	40165	16620	56785	53544	49167	29953	17544	21167	-18234	-3623	1.05	1.48	1.75
2	2009	180.96	117.72	75.70	33500	35700	26500	90482	-	90482	58862	37852	56982	23162	11352	45630	11810	2.70	1.64	1.42
3	2010	265.92	142.18	79.77	35270	35900	27800	132960	-	132960	71092	39888	97690	33192	12088	85602	23104	3.76	2.38	1.43

* Sale of commodity @ Rs. 500 q^{-1}; T_1- Rejuvenated trees, T_2 – Un-pruned well managed trees and T_3- Farmers practice

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