Journal of Research in Forestry, Wildlife & Environment Vol. 11(1) March, 2019
http://www.ajol.info/index.php/jrfwe
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E-mail:jfewr@yahoo.com
ISBN: 2141 – 1778
Ekhuemelo and Owoicho 2019

EFFECT OF CRUDE EXTRACT OF *Allium sativum* L. and *Zingiber officinale* Rosc. ON THE POST - HARVEST MANAGEMENT OF *Botryodiplodia theobromae* Pat ON BANANA FRUITS

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ABSTRACT

Banana is a popular food crop that provides income for many rural farmers and urban traders. Post - harvest rot of banana caused by Botryodiplodia theobromae limits banana availability due to reduced quality and deterioration during storage and sale. This study was conducted to determine the effect of garlic (Allium sativum) and ginger (Zingiber officinale) crude extracts at three concentrations of 10 %, 20 % and 30 % w/v on the management of Botryodiplodia theobromae in vivo. The study was a factorial experiment laid out in a Completely Randomized Design with three replicates. Data were recorded on the lesion growth, percentage weight loss, percentage lesion inhibition and the acceptability of treated banana (Musa acuminata Colla) fruits by consumers. The result shows that the percentage weight loss of treated banana fruits was not significantly different (p > 0.05) across the treatments. The A. sativum extract at 30 % concentration had the highest percentage inhibition throughout the period of study. The lesion growth percentage inhibition trends showed that 30 % A. sativum > 30 % Z. officinale >20 % A. sativum >10 % A. sativum > 20 % Z. officinale >10 % Z. officinale > control. Banana fruits treated with 30 % w/v were more acceptable to the panellists and were comparable with the un-inoculated control.

Keywords: *Allium sativum*, Banana, *Botryodiplodia theobromae*, Crude extract, *Z. officinale*

INTRODUCTION

Banana (*Musa acuminata* Colla) is a staple starchy crop consumed in Nigeria and the tropical regions of the world (Honfo *et al*., 2011). Bananas are a major food crop globally and are grown and consumed in more than 100 countries throughout the tropics and sub-tropics (INIBAP, 2001). They are the fourth most important food crop after rice, wheat and maize (INIBAP, 2001). Over 1000 banana cultivars or landraces are recognised (Heslop-Harrison and Schwazacher, 2007).

Nigeria is a major producer of banana in West Africa (Cauthen *et al*., 2013). About 450,000 hectares are utilized for banana production with 2.8 metric tonnes produced in 2013 (Vezina, 2016). Banana can be eaten raw, deep fried, pounded and eaten with soup, eaten in fruit salad or made into jam (Tshinza *et al*., 2001). Dried banana are also ground to make banana flour. Banana powder is used as the first baby food (Cauthen *et al*., 2013; Yakub, 2015). Twenty two percent of the fruit weight of banana is made up of carbohydrate, Vitamin A, C and B6.It is also a rich source of Calcium, Potassium and Phosphorus and dietary fibre (INIBAP, 2001; Honfo *et al*., 2011). Banana is used in the treatment of gastric ulcer and diarrhoea (INIBAP, 2001). It is a source of livelihood for about 80% of banana farmers involved in small scale banana production (Tijani *et al*., 2009). Banana provides 10 to 25% of the carbohydrate of the consumers in sub-Saharan Africa (SSA).The daily consumption of banana and plantain based foods is reported as 372 g for Nigerian mothers and 159 g for Nigerian children (Honfo *et al*., 2011).

Previous studies have been focused on the consumption patterns, preferences and marketing of

banana in Nigeria (Ayinde *et al*., 2010; Honfo *et al*., 2011; Offor *et al*., 2017). Dimelu (2015) identified high incidence of pest and diseases as the major challenge needing management strategy in banana production. Ekhuemelo and Yaaju (2017) reported *B. theobromae* as the fungi causing crown rot of banana in Makurdi.

Banana infected by *B. theobromae* Pat causes a great harm to the fruit resulting in loss in the nutritive value and palatability of the fruit. Infected banana fruits command lower market prices. The report of Diedhiou *et al*. (2014) indicated that the treatment of banana fruits with myclobutanil, azoxystrobin and mancozeb did not satisfactory protect banana fruits against rot. The increase in consumer's demand for fruits with little or no chemical treatment and additives necessitated the search for plant extracts that can be alternatives to chemicals used in post - harvest management of *B. theobromae*. The study was conducted to evaluate the effect of *A. sativum* and *Z. officinale* aqueous extract on the management of banana rot caused by *B. theobromae* on banana fruits and to determine the acceptability of treated banana fruits by consumers.

MATERIALS AND METHODS

Source of Materials

A banana bunch was purchased at green stage from the Railway Fruit Market in Makurdi. The hands were detached from the bunch, weighed and tagged. They were further sterilized by dipping in 10% Sodium hypochlorite solution and rinsed in three changes of Sterile Distilled Water (SDW).

Preparation of Plant Extract

Fresh bulbs of *A. sativum* and rhizomes of *Z. officinale* used for the experiment were obtained from the Railway Fruit Market in Makurdi, Benue State. The *A. sativum* bulb and *Z. officinale* rhizomes were washed with distilled water, peeled, macerated and filtered with double layer cheese cloth. The concentrations of the extracts were obtained by weighing 10 g, 20 g, and 30 g extracts and infusing in 100 mL of SDW to give 10 %, 20 %, and 30 % w/v concentration of each of the plant extracts. Each concentration of plant extract was boiled separately at 100 ^{o}C using the magnetic hot plate.

Experimental Design and Treatments

Banana samples were dipped in the prepared plant extracts for five minutes and then perforated using a cork borer (1mm diameter) for inoculating *B theobromae*. The experiment was a 2 x 3 factorial experiment consisting of two plant extracts and three concentrations and two controls were set up in a Completely Randomized Design with three replications. The experiment involved eight treatments which consisted of banana hands separately dipped in 10, 20 and 30 % w/v of *A. sativum* and Z. *officinale* extract for five minutes. Banana fruit samples were perforated using a 1mm cork borer and inoculated with seven days old *B. theobromae.* A negative control consisting of banana fruit samples dipped in SDW and inoculated with *B. theobromae* alone and a positive control which consisted of untreated banana fruit sample neither soaked in any plant extract nor inoculated with *B. theobromae*.

Three banana fruit samples for each treatment were placed in each transparent plastic container with perforated cover. The fruits were kept at room temperature (Average maximum temperature of 31^{o}C and minimum of 22^{o}C; Relative humidity of 74-85 %) for seven days.

Data Collection

Data collection was carried out daily by recording lesion diameter of *B. theobromae* on the banana fruits 7 days after inoculation using a meter rule.

The labelled banana fruits were reweighed at the end of the experiment and the percentage weight loss calculated using the formula:

$$\text{Weight loss (\%)} = \frac{\text{initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

A panel of ten people were used to determine the consumer acceptability of the treated banana fruit samples. The acceptability test was done using a seven point hedonic scale adapted from Ahmed *et al*. (2013) where 1 - disliked very much 2 -disliked much 3 - disliked moderately 4- Neither liked nor disliked 5 - Liked moderately 6 - Liked and 7 - Liked very much.

Data Analysis

Data was subjected to analysis of variance (ANOVA) using SAS version 9.2 statistical software package (SAS 2009). Significant treatment

means were compared with Fishers least significant difference (FLSD) at 5% level of probability.

RESULT

At 4 Days After Inoculation (DAI), the lesion growth of the banana rot pathogen *B. theobromae* recorded on banana fruits treated with 10 % (1.88cm) and 20 % concentration (1.63 cm) of *Z. officinale* was not significantly ($p > 0.05$) different from the lesion growth recorded on fruits treated with 10 % *A. sativum* (1.45 cm). Similarly, the lesion growth of *B. theobromae* on banana fruits treated with 30 % *Z. officinale* concentration (1.32 cm) and 20 % concentration of *A. sativum* (1.10 cm) was not significantly different ($p > 0.05$). The application of 30 % concentration of the *A. sativum* extract had the least lesion growth of 0.82 cm compared with the inoculated control (2.75 cm).

At 5 DAI, the untreated inoculated control recorded the highest lesion growth of 3.62 cm. Lesion growth of B. *theobromae* on banana fruits was significantly reduced by the application of 10 % *Z. officinale* resulting in a lower lesion growth of 2.88 cm. The lesion growth recorded by the application of 20 % *Z. officinale* concentration (2.01 cm) and 10 % *A. sativum* (1.93 cm) was not significantly different ($p > 0.05$). *A. sativum* extract applied at a concentration of 20 % and Z. officinale extract applied at 30 % concentration recorded lesion growth of 1.55 cm and 1.52 cm respectively and this was not significantly different. The application of 30 % *A. sativum* extract significantly ($p < 0.05$) reduced the growth of *B. theobromae* with the least lesion growth of 1.12 cm.

The application of 30 % concentration *A. sativum* and 30 % concentration of *Z. officinale* extract 6 DAI, recorded significantly ($p < 0.05$) lower lesion growth of 1.82 cm and 2.02 cm compared with when 20 % concentration of *A. sativum* and 20 % concentration of *Z. officinale* with lesion growth of 2.14 cm and 2.45 cm respectively was applied to banana fruit. The application of an even lower concentration of 10 % A. *sativum* and 10 % *Z. officinale* extract recorded significantly ($p < 0.05$) lower lesion growth of 2.59 cm and 3.28 cm compared with the untreated control (4.93 cm).

Lesion growth of *B. theobromae* recorded at 7 DAI by the application of 10 %, 20 % concentration of *Z. officinale* (3.85 cm, 3.39 cm respectively) and 10 % A. *sativum* concentration (3.15 cm) was significantly ($p < 0.05$) lower compared with the untreated control (5.72 cm). The application of 20% *Z. officinale* recorded reduced lesion growth of 2.04 cm while the application of 30 % A. *sativum* and 30 % *Z. officinale* recorded significantly ($p < 0.05$) lower lesion growth of 2.02 cm and 2.04 cm respectively.

Table 1: The effect of different concentrations of *A. sativum* and *Zingber officinale* extract on lesion growth of *Botryodiplodia theobromae* inoculated on Banana fruit

Plant Extract	Lesion growth			
	4 DAI	5 DAI	6 DAI	7 DAI
Allium sativum (%)				
10	1.45	1.93	2.59	3.15
20	1.10	1.55	2.14	2.37
30	0.82	1.12	1.82	2.02
Zingber officinale (%)				
10	1.88	2.88	3.28	3.85
20	1.63	2.01	2.45	3.39
30	1.32	1.52	2.02	2.04
Control	2.75	3.62	4.93	5.72
FLSD(0.05)	0.26	0.20	0.38	0.24

Means are values of three replicates
FLSD (0.05) = Fisher's Least Significant Difference at 5% level of probability

The lesion growth inhibition of *B. theobromae* by the three concentrations of *A. sativum* and *Z. officinale* extract on banana fruit in comparison with the untreated control showed significant differences between the extracts (Fig. 1). The application of *A. sativum* at 30 % w/v significantly ($p < 0.05$) inhibited lesion growth of *B. theobromae* by 70.2 % compared with the control. Generally, higher concentrations resulted in decreased lesion growth 4 DAI to 7 DAI. *Zingber officinale* extracts at 30 % w/v significantly ($p < 0.05$) inhibited lesion growth of *B. theobromae* by 52.0 % compared with 20 % w/v *Z. officinale* extract (40.7 %), 10 % w/v *Z. officinale* extract (32.0 %) and the control.

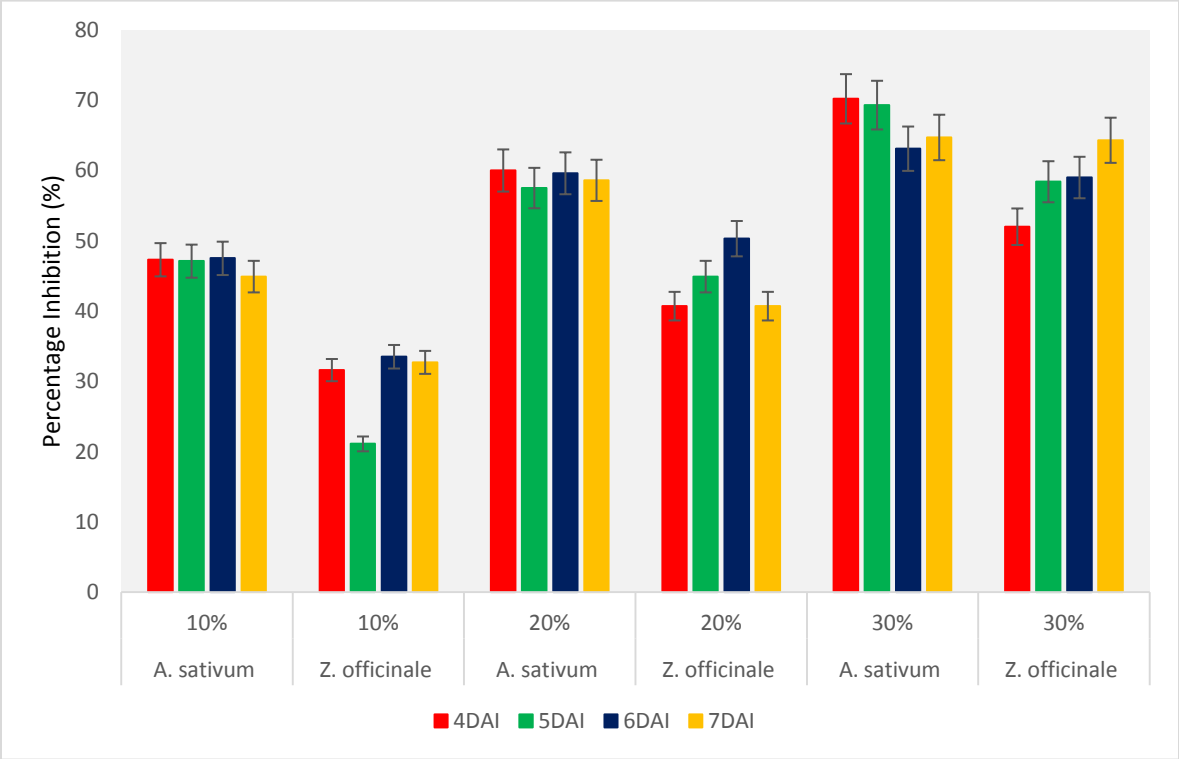

Fig. 1: The effect of three concentrations of *A. sativum* and *Z. officinale* on the percentage lesion growth inhibition of *Botryodiplodia theobromae* I = Standard error of the means (P= 0.05)

The extract of *A. sativum* at 30 % concentration resulted in the highest inhibition of the lesion growth of *B. theobromae* by 70.2 % at 4 DAI while the least inhibition was by *Z. officinale* at 10 % concentration by 21.1 % at 5 DAI. The percentage inhibition by *A. sativum* was significantly ($p<0.05$) higher than the inhibition of lesion growth of *B. theobromae* by *Z. officinale* extract at the three concentrations tested and the control.

The inhibitory activity of the different concentrations of *A. sativum* and *Z. officinale* increased with increasing concentration with a toxicity trend of 30 % *A. sativum* > 20 % *A. sativum* > 30 % *Z. officinale* >10 % *A. sativum* > 20 % *Z. officinale* >10 % *Z. officinale* throughout the duration of the study.

At 5 DAI 30 % concentration of *A. sativum* had the highest lesion growth inhibition of 69.3 % followed by 30 % *Z. officinale* concentration with percentage inhibition of 58.4 %. The lesion growth percentage inhibition trends showed that 30 % *A. sativum* > 30 % *Z. officinale* > 20 % *A. sativum* >10 % *A. sativum* > 20 % *Z. officinale* >10 % *Z. officinale* > control.

The percentage lesion growth inhibition at 6 DAI indicated that 30 % *A. sativum* > 20 % *A. sativum* > 30 % *Z. officinale* > 20 % *Z. officinale* >10 % *A. sativum* >10 *Z. officinale* > control.

At 7 DAI, *A. sativum* at 30 % concentration had the highest percentage inhibition. The percentage inhibition trend showed that 30 % *A. sativum* > 30 % *Z. officinale* >20 % *A. sativum* > 10 % *A. sativum* > 20 % *Z. officinale* >10 % *Z. officinale* > control.

The effect of three concentrations of *A. sativum* and *Z. officinale* extract on the Weight loss and Acceptability test of Banana fruits are presented in Table 2. The percentage weight loss of treated banana fruit was not significantly different ($p > 0.05$) across the treatments. The three concentrations of garlic and *Z. officinale* extracts used in the study significantly ($p < 0.05$) affected the acceptability of banana fruits by the panellists. The un-inoculated banana fruits had the highest acceptability score of 5.67 (liked) while banana fruits treated with 30% *A. sativum* and *Z. officinale* had a significantly high ($p < 0.05$) acceptability score of 5.33 (liked moderately) and 4.67 (liked moderately) respectively and this was comparable with the un-inoculated control. Banana fruits treated with 20 % *A. sativum* and *Z. officinale* had same acceptability score of 3.67 (neither liked nor disliked) while banana fruits treated with 10 % *A. sativum* had acceptability score of 2.67 (disliked moderately). Banana fruits treated with 10 % *Z. officinale* had acceptability score of 2.33 (disliked much) and these were not significantly different ($p > 0.05$) from the inoculated control with acceptability score of 1.67 (disliked much).

Table 2: Effect of three concentrations of *A. sativum* and *Z. officinale* extract on the Weight loss and Acceptability of Banana fruits.

Plant Extract	Weight loss (%)	Acceptability Score
Allium sativum (%)		
10	6.78	2.67
20	10.41	3.67
30	6.91	5.33
Zingiber officinale (%)		
10	11.60	2.33
20	8.18	3.67
30	9.98	4.67
Inoculated control	9.47	1.67
Control(Uninoculated)	7.54	5.67
FLSD (0.05)	NS	1.17

DISCUSSION

The reduction of the lesion of *B. theobromae* in this study indicates that *A. sativum* and *Z. officinale* can be used to manage *B. theobromae* causal agent of banana rot *in - vivo*. This result agrees with the report of Ekhuemelo and Yaaju (2017) in which 30 % w/v concentration of the crude extract of *A. sativum* significantly inhibited the *in-vitro* growth of *B. theobromae* isolated from banana fruit by 100 % seven days after inoculation.

This present study show that lesion growth generally increases with lower concentration of the botanical extract while percentage inhibition increases with higher concentration of botanical extracts. The higher level of inhibition exhibited with higher concentrations of A. *sativum* and *Z. officinale* reveals the importance of concentration level in extracts effectiveness. This is in line with the report of Ojo and Olufolaji (2011) which reported that the inhibitory action of different extracts on mycelia growth increases with increasing concentration.

The activity of *Z. officinale* in this study can be attributed to its medicinal and antifungal properties. Bliddal *et al*., (2000) reported that *Z. officinale* contained biologically active aromatic compounds such as 6-gingerol, zingiberene, bisabolene and lipids which gave *Z. officinale* extract its characteristic flavour and made it preferable in drug for osteoarthritis treatment. Similarly Opara and Obani (2009) attributed fungitoxicity of *Z. officinale* to antioxidants such as gingerols and polyphenol which are effective against many diseases that affect cultivated crops. *A. sativum* is reported as a potent antifungal which contains more than two hundred chemical compounds including allicin and ajoene which are water stable and has antifungal effect both in - vitro and in - vivo (Ledezma and Apitz-Castro, 2006).

Weight loss was not significantly different among the treatments in this study. This is in line with the report of Tadesse (2014) in which no significant difference was observed in weight loss of fruits treated with different ethylene sources. However Larotonda *et al.* (2008) reported that weight loss in banana fruits increased with increase in temperature. Ayinde *et al.* (2010) reported that banana consumers preferred the absence of black spots caused by *B. theobromae* on banana peel. The use of *A. sativum* and *Z. officinale* as revealed from the present study will prevent the incidence of crown rot on banana fruits.

CONCLUSION

This study has shown the potential of different concentrations of *A. sativum* and *Z. officinale* crude extracts in reducing post - harvest losses due to infection by *B. theobromae*. The use of *A. sativum* extract at 30 % w/v concentration is recommended for the suppression of the mycelia growth of *B. theobromae* in- vivo.

REFERENCES

Ahmed O., Aliyu, T.H and Badmos A.H (2013). Control of postharvest loss of tomato fruits caused by *Fusarium verticilloides* with aqueous leaf extracts *Azadirachta indica Juss* and *Vernonia amygdalina* Del. *Journal of Biology, Agriculture and Healthcare* 3 (10).

Ayinde, O.E., Adewumi, M.O. and Folorunsho, W.O. (2010). Consumer preference of banana (M*usa* spp.) in Kwara State, Nigeria. Acta Hort. (ISHS): 879:89-93.

Bliddal, H., Rosetzsky, A., Schlichting, P. (2000). A randomized, placebo-controlled, cross-over study of ginger extracts and ibuprofen in osteoarthritis. Osteoarthritis Cartilage 8:9-12.

Cauthen, J., Jones, D., Gugerty, M. K. and Anderson, L. C. (2013). Banana and Plantain value chain: West Africa.Evans School Policy Analysis and Research Brief Number 239.

Diedhiou, P.M., Zakari, A.H., Mbaye, N., Faye, R. and Samb, P.I. (2014). Control Methods for Post- harvest Diseases of Banana (*Musa sinensis*) Produced in Senegal. *International Journal of Science, Environment* 3(5):1648-1656.

Dimelu, M.U. (2015). Involvement of farm households in banana and plantain production in Aguata agric zone of Anambra State, *Nigeria Journal of Agricultural Extension*, 19(1):105 - 116.

Ekhuemelo, C. and Yaaju, M.D. (2017). Identification and Management of Fungi associated with crown and rot of banana in Makurdi, Benue State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 13 (2): 50-55.

Heslop-Harrison, J.S. and Schwarzacher, T. (2002). Domestication, genomics and the future of banana. *Annals of botany* 100: 1073-1084.

Honfo F.G., Tenkouano, A and Coulibaly, O. (2011). Banana and Plantain- based foods consumption by children and mothers in Cameroon and Southern Nigeria: A comparative study. *African Journal of Food Science* 5(5): 287-291.

INIBAP (2001). Networking Banana and Plantain: INIBAP Annual Report 2000. International Network for the Improvement of Banana and Plantain, Montpellier, France.70pp

Larotonda, F.D.S., Crenena, A.K, Daitela, D., Soares, H.M., Laurindo, J.B., Moreira, R.F.P.M., and Ferreira, S.R.S. (2008). Study of banana (*Musa* aaa Cavendish cv Nanica) Trigger Ripening for Small Scale Process. *Brazilian Archives of Biology and Technology* 51 (5): 1033-1047.

Ledezma, E. and Apitz-Castro, K. (2006). Ajone the main active compound of garlic (*Allium sativum*): a new antifungal agent. *Revista Iberoamericana de Micologia*. 23(2): 75-80.

Offor, E.I., Onu, D.O. and Nnamani G.N. (2017). Economics of Banana marketing in Umuahia South Local Government Area of Abia State, Nigeria. *Nigerian Journal of Agriculture, Food and Environment* 13(3): 65-69.

Ojo, B.A and Olufolaji, D.B. (2011). Evaluation of fungicidal attributes of some botanicals in the control of cashew (*Anacardium occidentalis* L.) anthracnose (*Colletrichum gloeosporioides*) disease. *Nigeria Journal of Plant Protection* 25(1):95-110.

Opara, E.U. and Obani, F.T. (2009). Performance of some plant extracts and pesticides in the control of bacteria spot disease of S*olanum*. *Agricultural Journal* 4 (5): 250-253.

Tadesse, T.N. (2014). Quality Attributes and Ripening period of banana (*Musa spp*) fruit as affected by Plant Ethylene Sources and Packaging Materials. *International Journal of Agricultural Research* 9(6):304-311.

Tijani, I.A., Omonona, B.T., Ashaolu, O.F.and Bamiro, O.M. (2009). Economic Analysis of Plantain Production in Irewole Local Government Area, Osun State, Nigeria. Retrieved from http://www.aensiweb.com/anas/2009/183-187.pdf.

Tshinza, M., Lemchi, J., Onyeka, U., and Tenkouano, A. (2001). Cooking Banana Consumption Patterns in the Plantain growing Area of South Eastern Nigeria. *Tropicultura* 19(3):135- 140.

Vezina, A. (2017). Mobilizing banana science for sustainable livelihood. Published by Musapedia the banana knowledge compendium. Promusa.org/Nigeria Retrieved on 19th April 2017.

Yakub, S. A. (2015). Postharvest profile of banana. Technical report of the Ministry of Agriculture, Nagpur, India. 90pp.