

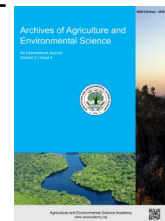


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ORIGINAL RESEARCH ARTICLE



Effect of different concentration of ethephon on banana (cv. Malbhog) ripening and post-harvest life at laboratory condition

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ABSTRACT

A research study entitled effect of different concentration of ethephon on banana (cv. Malbhog) ripening and post-harvest life at laboratory condition was conducted to find out the best concentration of ethephon on banana ripening and quality parameters after harvest under ordinary room conditions. The experiment was laid out in completely randomized design which comprised of five treatments; control, ethephon @ 250 ppm, Ethephon @ 500 ppm, ethephon @ 750 ppm and ethephon @ 1000 ppm replicated four times. Different post-harvest parameters were recorded on alternate days for 10 days. From the experiment, the use of ethephon @ 1000 ppm and Ethephon @ 750 ppm was found more effective regarding banana ripening and other parameters. On the final day of storage, the highest (2.937) pulp to peel ratio was recovered with ethephon @ 1000 ppm. The maximum TSS/TA ratio (31.51) was recorded in bananas treated with ethephon @ 750 ppm. The highest vitamin C content (6.285 mg/100g) was observed with ethephon@1000 ppm. The respondent gave a higher score for fruits kept as control than ethephon treated banana. Overall acceptability regarding sweetness, flavor was superior in control banana than the ethephon treated banana. The minimum spoilage loss was recorded with ethephon @ 1000 ppm (25.0%) and ethephon @500 ppm (25.0 %). From the experiment the concentration of ethephon 1000 ppm and 750 ppm was found to be effective for banana ripening.

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INTRODUCTION

Banana (*Musa* spp.) is one of the cheapest, most plentiful and nourishing all fruits (Khader *et al.*, 1995). It belongs to the family Musaceae. In Nepal banana is regarded as a high-value commodity and thus it can play a significant role in the upliftment of the economy of poor farmers. Among the major fruit crops grown in Nepal, the banana ranks 4th position after citrus, mango and apple. In the Nepalese geophysical situation, it can be grown from Terai to 1500 m altitude of mid-hills, where frost does not occur usually (Gautam and Dhakal, 1993). For nutritional security, banana plays a significant role in the human diet supplying vitamins, minerals and dietary fiber. A variety known as Jhapali

Malbhog is commercially grown in Jhapa, Morang, Sunsari, Chitwan and Nawalparasi districts. This variety probably belongs to the Cavendish type and resembles the William Hybrid phenotypically and is widely adapted in Chitwan and Nawalparasi. Malbhog is one of the most common local cultivars which is superior in its quality, storability and taste and has got higher demand (Basnyat *et al.*, 1996). Banana being a climacteric fruit can ripe in the plant itself as well as after harvesting by the application of various chemicals and plant materials. Ethylene is commonly practiced in commercial banana ripening in developed countries (Gautam and Dhakal, 1993). Nepalese farmers are using their indigenous knowledge in the ripening of bananas since time immemorial. In many places, the bunch of bananas

after wrapping with a jute bag are hung over fire to meet the optimum desired temperature (Gautam and Dhakal, 1993). The most commonly used chemical for banana ripening is Ethephon and calcium carbide. The dose of chemicals to be applied depends on the variety, harvesting time, temperature and relative humidity. The banana traders are facing many problems related to chemical use to ripen banana. They are unaware of safe and use appropriate dose of Ethephon. In the growing debate on the use of the Ethephon for ripening, it is important for the use of appropriate doses and its consecutive effect on the ripening of banana. With these points in view, the experiment was undertaken to know the appropriate concentration of Ethephon on banana ripening, to study the physico-chemical changes of banana during storage and ripening under different postharvest treatments and to study the disease incidence and severity on banana during storage by using plant extracts.

MATERIALS AND METHODS

Selection of site and experimentation

The banana fingers for the research were brought from Mangalpur 10 km away from Narayangadh, Chitwan, Nepal. The cultivar selected was Malbhog which is one of the most popular and cultivated variety in that locality. The post-harvest analysis was carried out in post-harvest horticulture laboratory, AFU, Rampur, Chitwan, Nepal. Geographically, Rampur is located in the Terai belt at 27° 40' N Latitude and 84° 19' E Longitude at an altitude of 228 masl. This place has a humid sub-tropical climate where summers are hot and winters are cold with total annual rainfall reported as 1582.6 mm. Monsoon rain occurs from July to September. This experiment was conducted from 21st September to 16th of October 2016. The bunch was deheaded and divided into fingers with a help of knife. The fruits will be selected for uniformity of size and freedom from blemishes. Fruits were washed with tap water to remove latex and dust, treated with sodium hypochlorite (500ppm) to reduce fungal infection and air dried. The experiment was laid out in Completely Randomized Design (CRD) with five treatments and each treatment will be replicated four times.

Treatments details

T1 = 0 ppm (control: distilled water)

T2 = 250 ppm

T3 = 500 ppm

T4 = 750 ppm

T5 = 1000 ppm

Layout of experiment

T1R1	T2R1	T1R2	T1R4
T2R2	T3R1	T2R3	T5R2
T3R3	T4R1	T4R4	T4R3
T4R2	T1R3	T5R4	T5R1
T5R3	T2R4	T3R4	T3R2

Preparation of Ethephon of different Concentration

To obtain 250 ppm, 500 ppm, 750ppm and 1000 ppm, the Ethephon, 0.64 ml, 1.28 ml, 1.92ml and 2.56 ml kripone (Ethephon 39 %) respectively per liter of water was used.

Statistical method

Analysis of variance for all parameters was carried out as per the procedures given in GEN STAT (12th Edition). The Duncan's multiple range test (DMRT) for mean separation was done from the reference of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of ethephon on firmness

The data relating to the fruit firmness of post-harvest treated fruits and their mean values are presented in Table 1. Fingers become less firm with the advancement of ripening in all treatments. The firmness of fruits declined during the ripening period in all treatments. The highest value of firmness (0.8375 kg/cm²) was observed on untreated (control) bananas and the lowest firmness (0.5375 kg/cm²) was obtained with Ethephon @ 750 ppm and Ethephon @ 1000 on 10th DAS. This report is in harmony with the reports of Mahajan and Kaur (2010) who reported that the decreased firmness during ripening due to ethylene application. It was reported that post-harvest treatment with ethrel promoted the ripening of mango fruits, and the treated fruits were less firm than the treated ones (Mohamed *et al.*, 2003). Ahmad *et al.* (2001) reported that ethylene-treated bananas were significantly softer than untreated bananas. The loss of firmness is one of the most characteristic changes occurring in fresh fruits during ripening. The decrease in firmness during ripening may be due to the breakdown of insoluble proto-pectin into soluble pectin or by cellular disintegration leading to membrane permeability. Thompson (1996) states that the softening of banana fruit during ripening is associated with three processes: firstly, the conversion of starch to sugars, secondly, the breakdown of pectin substances and the third possibility is the movement of water from the peel of the banana to its pulp during ripening. The later possibility may have affected the turgidity of the skin, which would have been enhanced by transpiration losses. The hard or semi-hard banana fruits are not liked by the consumers. Therefore, to develop desirable quality, the banana fruits need to be ripened artificially for enhancing consumer acceptability.

Table 1. Firmness of banana fruit under different post-harvest treatments during storage at ambient room temperature (30±5°C), Rampur, Chitwan, 2016.

Treatments	Firmness (Kg/cm ²) on days indicated				
	2	4	6	8	10
Control	3.395 ^a	3.150 ^a	2.317 ^a	1.688 ^a	0.837 ^a
Ethephon @ 250 ppm	2.662 ^b	2.300 ^b	1.450 ^{bc}	0.925 ^b	0.650 ^b
Ethephon @ 500 ppm	2.538 ^b	2.502 ^b	1.787 ^b	1.075 ^b	0.613 ^b
Ethephon @ 750 ppm	2.750 ^b	2.175 ^b	1.238 ^c	0.925 ^b	0.536 ^b
Ethephon@ 1000 ppm	2.700 ^a	2.487 ^b	1.175 ^c	0.887 ^b	0.538 ^b
LSD _{0.05}	0.603	0.405	0.359	0.265	0.164
SEM±	0.200	0.134	0.118	0.088	0.054
CV (%)	14.2	10.7	14.8	16	17.1
Grand mean	2.809	2.523	1.593	1.100	0.635

Means within the same column followed by the same letter do not differ significantly at 5 % level by DMRT.

Table 2. Pulp to peel ratio of banana fruit under different post-harvest treatments during storage at ambient room temperature (30±5°C), Rampur, Chitwan, 2016.

Treatments	Pulp to peel ratio on days indicated				
	2	4	6	8	10
Control	1.760 ^{ab}	1.875 ^{ab}	2.096 ^{ab}	2.294 ^b	2.085
Ethephon @ 250 ppm	1.603 ^b	1.751 ^b	1.986 ^b	2.205 ^b	2.456
Ethephon @ 500 ppm	1.623 ^b	1.821 ^b	1.991 ^a	2.239 ^b	2.544
Ethephon @ 750 ppm	1.623 ^b	1.870 ^{ab}	2.099 ^{ab}	2.409 ^{ab}	2.516
Ethephon @ 1000 ppm	1.825 ^a	2.039 ^a	2.273 ^a	2.558 ^a	2.937
LSD _{0.05}	0.1730	0.0785	0.1835	0.1912	NS
SEM±	0.0574	0.0555	0.0609	0.0634	0.282
CV (%)	6.8	5.9	5.8	5.4	12.4
Grand mean	1.687	1.871	2.089	2.341	2.51

Means within the same column followed by the same letter do not differ significantly at 5 % level by DMRT.

Effect of ethephon on pulp to peel ratio

The data relating to the pulp-to-peel ratio of postharvest treated fruits and their mean values are presented in Table 2. In Ethephon treated banana fruits, the weight of the fruit pulp increased that accompanied by a decrease in peel weight during ripening. There was a significant difference in the pulp-to-peel ratio right from the 2nd day of the experiment. The highest (2.937) pulp to peel ratio was observed with banana treated with Ethephon @ 1000 ppm and the lowest (2.05) was with control on 10th DAS. This result is in accordance with the reports of Pendharkar *et al.* (2011). The ethylene treated bananas showed greater pulp/peel ratios than untreated bananas (Ahmad *et al.*, 2001). The faster change and higher values of pulp to peel ratio was observed from Ethephon treatment (Mebratie *et al.*, 2015). The pulp: peel ratio of fruits during ripening increased irrespective of treatments as reported by (Pathak *et al.*, 1991). Marriott (1980) reported that a possible increase in weight of pulp and corresponding decrease in weight of fruit peel during ripening. John and Marchal (1995) reported that ratio may be influenced by the magnitude of fresh weight loss during ripening. Shrestha (2010) reported that sugar increase rapidly in the pulp than the

peel and thus due to change in the osmotic pressure, water is withdrawn from the peel and the pulp to peel ratio increased accordingly. The higher pulp to peel ratio for Ethephon treated fruits might be due to the enhanced movement of water from peel to pulp as ripening advances.

Effect of ethephon on ascorbic acid (Vitamin C content) of the banana pulp

The ascorbic acid or vitamin C content of the banana before the imposition of treatment was recorded as 7.82 mg/100gm. The vitamin C content as influenced by different post-harvest treatments is depicted in Table 3. Significant variation in vitamin C content was noticed among the treatments from the 2nd DAS until the 10th day. However, there was not any significant difference in vitamin C content on the 4th and 10th day of storage and the different post-harvest treatments resulted in smaller differences in the level of vitamin C during storage. The highest vitamin C content (6.285 mg/100g) was observed with Ethephon @ 1000 ppm and lowest (5.369 mg/100g) with the control treatment on 10th day of storage. The result obtained in the study was in harmony with Hakim *et al.* (2012) who reported that

Table 3. Vitamin C content of banana fruit under different post-harvest treatments during storage at ordinary room temperature (30±5°C), Rampur, Chitwan, 2016.

Treatments	Vitamin C content of the Juice on days indicated				
	2	4	6	8	10
Control	7.555 ^{ab}	7.252 ^a	7.093 ^{bc}	6.760	5.367 ^b
Ethephon @ 250 ppm	7.650 ^{ab}	7.393 ^a	7.240 ^{ab}	6.838	5.548 ^b
Ethephon @ 500 ppm	7.532 ^b	7.247 ^a	7.082 ^c	6.785	5.620 ^b
Ethephon @ 750 ppm	7.603 ^{ab}	7.397 ^a	7.265 ^a	7.015	5.845 ^{ab}
Ethephon @ 1000 ppm	7.763 ^a	7.400 ^a	7.210 ^{abc}	6.953	6.285 ^a
LSD _{0.05}	0.2088	0.2945	0.1425	NS	0.5254
SEM±	0.0693	0.0977	0.0473	0.1167	0.1743
CV (%)	1.8	2.7	1.3	3.4	6.1
Grand Mean	7.621	7.338	7.178	6.870	5.733

Means within the same column followed by the same letter do not differ significantly at 5 % level by DMRT.

Table 4. Acceptability of banana fruit for different organoleptic parameters as influenced by different treatments in ordinary room condition (30±5°C), Rampur, Chitwan, 2016.

Organoleptic Test on 10 th DOS						
Parameters	Ratings	T1	T2	T3	T4	T5
Sweetness	Index value	0.95 ^a	0.65 ^b	0.65 ^b	0.70 ^b	0.90 ^a
	Rank	I	IV	IV	III	II
Flavour	Index value	0.90 ^a	0.65 ^{bc}	0.55 ^{abc}	0.80 ^{ab}	0.55 ^c
	Rank	I	III	IV	II	IV
Astringency	Index value	0.45 ^b	0.50 ^{ab}	0.50 ^{ab}	0.65 ^{ab}	0.70 ^a
	Rank	IV	III	III	II	I
Overall acceptability	Index value	0.95 ^a	0.65 ^{bc}	0.65 ^{bc}	0.70 ^{bc}	0.80 ^b
	Rank	I	IV	IV	III	II

Means within the same column followed by the same letter do not differ significantly at 5 % level by DMRT.

ascorbic acid content of fruits and vegetables decreases due to the prolonged duration of storage. There is continuous decrease of vitamin c content on all day of storage. The vitamin C content was significantly higher in papaya ripened with the aid of ethylene than in the control which is left to ripen on their own (Bal *et al.*, 1992).

Effect of ethephon on organoleptic test

The parameters taken for the organoleptic test on the 10th DAS, such as sweetness, flavor, astringency and overall acceptability were influenced by different treatment combinations of Ethephon using a hedonic scale (Table 4). The significant difference was observed among the treatments for sweetness. The respondent gave higher score for control than Ethephon treated banana. Overall acceptability regarding sweetness, flavor was found to be superior in untreated banana than the Ethephon treated banana on 10th DAS. The index value of overall acceptability (0.80), sweetness (0.95) and flavor (0.80) were depicted highest in control. Therefore, the control fruits were evaluated better in comparison to others by taste panels. This result is in line with the result of (Khatiwada, 2005). In artificially ripened fruits, the internal chemical changes, though slower also occurred side by side as peel colour changes, thus tasted sweeter (Khatiwada, 2005). There was significant increase in the aroma of fruit and juice of passion fruit during ripening due to the increase in certain volatile compounds which act as precursor

for aroma in the fruit cells (Kishore *et al.*, 2006). The early improvement in sensory quality with Ethrel treatments may be due to the role of ethylene in promoting changes which are important to flavour quality and formation of aroma volatiles in climacteric fruit. The softening of texture, production of more sugars and volatile compounds during ripening period is responsible for high acceptability (Mahajan *et al.*, 2008). But this result is in contrary with the reports of (Subbaiah *et al.*, 2013) where panelists gave higher scores for bananas, which were ripened with ethepone than those untreated.

Effect of Ethephon on Spoilage loss (%)

There was not any loss due to spoilage of banana up to the 6th day of storage (Figure 1). However, on the 8th DAS, there was a significant difference regarding spoilage loss. The highest percentage of spoiled fruits occurred with control (25 %) and the lowest (12.5 %) was observed with Ethephon @ 750 ppm. The maximum spoilage loss (40.62 %) was observed with control and minimum spoilage loss with Ethephon @ 1000 ppm (25 %) and Ethephon @ 500 ppm (25 %) on 10th DAS. Similar result was reported by (Pendharkar *et al.*, 2011) in which Ethrel @ 1000 ppm resulted in minimum spoilage percentage and untreated fruits recorded maximum spoilage of fruits during storage. The maximum spoilage loss in control might be mainly due to blackening of peel colour and disease incidence at early days of storage.

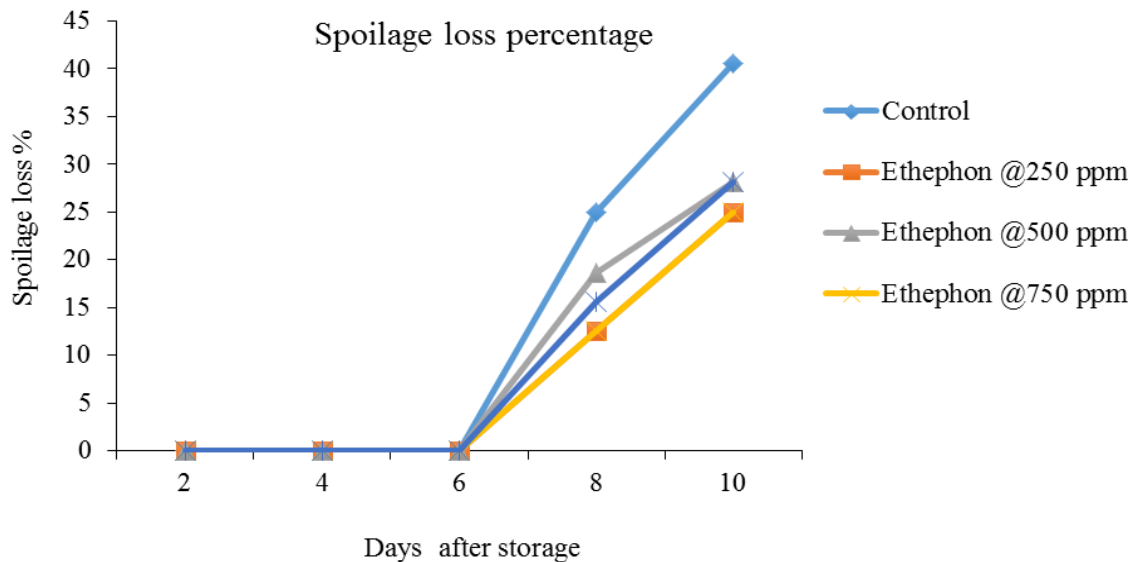


Figure 1. Spoilage loss percentage of banana in different post-harvest treatments during storage at ordinary room condition, Rampur, Chitwan, 2016.

Conclusion

From this experiment, it is concluded that Ethephon can be beneficial for the prolongation of post-harvest fruit quality of banana. Ethephon @ 1000 ppm and 750 ppm had a significant effect on the peel to pulp ratio, TSS: TA ratio, vitamin C content, Overall acceptability and the spoilage loss of Banana. This finding will somehow help selection of appropriate dose of Ethephon on banana ripening. Further studies by the other researchers, stakeholders, policy makers and governmental officials are to be made to examine the effects other concentration of Ethephon on shelf life and quality of banana fruits.

Conflict of interest

The authors of the research affirmed no encounter of attentiveness.

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