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Article

Response of Three Cucumber Cultivars to the Application of Sulphate of Ammonia as top Dressing with Respect to Fruit Yield and Shelf Life

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Abstract: The experiment was conducted in the experimental field of the Horticulture Department, University for Development Studies (UDS), Nyankpala campus with the aim of determining the response of three cucumber cultivars (Marketer, Nandini, Pointset) to the application of sulphate of ammonia as top dressing with respect to fruit yield, and shelf life. It was a 3 x 3 x 2 factorial arranged in a randomized complete block design with three replications. Data was collected on total fruit yield, shelf life and percentage fruit decay in storage. Their effect on the varieties differed significantly to a varying degree. The factors, however, had no significant impact and caused no difference in the fruit yield and fruit weight. 15:15:15 NPK effect on the cucumbers caused a high decay incidence when applied alone or in combination with $(NH_4)_2SO_4$. Therefore, the application rate may be revised or reduced to experiment if decay incidence would decline in storage. Further studies may extensively be carried out to note if varying the rate of NPK would impact positively on the shelf life of cucumber. $(NH_4)_2SO_4$ effect increased weight loss in cucumbers hence, better storage techniques should be considered by controlling high temperatures. Complete fertilizer; 15:15:15 NPK and $(NH_4)_2SO_4$ had a positive impact on protein and fibre. Hence, their application is recommended for increasing protein and fibre level in cucumbers.

Keywords: Cucumber, Sulphate of Ammonia, Fruit Yield, Shelf Life

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1. Introduction

Cucumber (*Cucumis sativus* L.) is a widely cultivated plant in the gourd family, cucurbitaceae. It is a creeping plant that bears cylindrical fruits that are used as culinary vegetables. There are three main varieties of cucumber: slicing, pickling and burp-less. Within these varieties, several different cultivars have emerged. The cucumber is originally from South Asia, but now cultivated in many continents. Many different varieties are traded on the global market [1]. As a member of the cucurbitaceae family, cucumbers are rich source of triterpene phytonutrients called cucurbitacins. Cucurbitacins A, B, C, D and E are all contained in fresh cucumber. They have been the subject of active and ongoing research to determine the extent and nature of their anti-cancer properties. Scientists have already determined that several different signalling pathways required for cancer cells development but survival can be blocked by the activity of cucurbitacins [2]. Commercial production of cucumbers is usually divided into two types. "Slicing cucumbers" are produced for fresh consumption. "Pickling cucumbers" are produced for eventual processing into pickle. Slicing cucumber fruits are usually larger and have thicker skin, while pickling cucumbers are usually smaller and have thinner skin [2].

According to the Food and Agriculture Organization of the United Nations, China in 2005 produced about 60 % of the global output of cucumbers, followed by Turkey, Russia, Iran and the United States [3]. Cucumber is believed to be indigenous to an area in India between the Himalayas and the Bay of Bengal and was introduced to West Africa by the Europeans in 1940 [4]. Cucumber is grown in all countries of tropical Africa, but nowhere on a large scale. In 2002, Africa produced 507,000 tons on 25,000 ha, accounting for just less than 1.5 % of world production. Egypt is the largest African producer with 360,000 tons. Commercial vegetable production is gaining prominence in Ghana due to the production of crops with export potential, as well as public education from health experts and nutritionist on the need to consume more vegetable to avoid diseases including cancer, hypertension, coronary diseases, diabetes, hepatitis B and anaemia [5, 6]. Ghana is currently in an advantageous position in meeting the demand for crops such as okra, pepper, tomato and cucumber among other forms of vegetables required for the European market [7]. Cucumber requires a warm climate. The optimum temperature for growth is about 30 °C and the optimum night temperature 18-21 °C. In the tropics, elevations up to 1700 m appear to be suitable for cucumber cultivation. A lot of light tends to increase the number of staminate (male) flowers. Cucumbers need a fair amount of water but they cannot stand water logging. High relative humidity encourages downy mildew. The soil should preferably be fertile and well-drained, with a pH of 6.5-7.5 [8].

Cucumber plant requires 16 essential elements for growth and development. Carbon, hydrogen and oxygen are derived from the atmosphere and soil water. The remaining 13 essential elements including nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine are supplied either from minerals and soil organic matter through the application of organic or inorganic fertilizer. Each type of plant is unique and has an optimum nutrient range as well as a minimum requirement level. Below this minimum level, plants start to show nutrient deficiency symptoms. Excessive nutrient uptake can also cause poor growth because of toxicity. Therefore, the proper amount of application and the placement of nutrients are important in cucumber production [9].

The population growth rate for people living in the cities of West Africa would rise from 40 % as was in 1990 to 60 % in 2020 [10]. This rise in population calls for increase in food production.

Exotic vegetables such as lettuce, cabbage and cucumber have increasingly become common in many Ghanaian diets [11]. There is also an increase in demand from the export market. The low yield of cucumber in the country is attributed to poor soil fertility and cultivation of low yielding cultivars by local farmers. The situation is worsened by high postharvest losses. The improvement of cucumber production practices is an important way that one can use to improve the yield potential of this vegetable. One way this can be done is by the application of sulphate of ammonia as top dressing to cucumber fields. Also, the fruit yield of cucumber in the country can be improved by cultivating high yielding varieties. There is the need to determine whether the application of sulphate of ammonia can improve the quality and shelf-life of cucumber fruits with three different varieties.

The main objective of the study was to determine the effect of NPK types (15:15:15 and 23:10:5) and sulphate of ammonia on three different cucumber cultivars. The specific objectives were to determine the effect of NPK types (15:15:15 and 23:10:5) and sulphate of ammonia (as top dressing) on:

- Cucumber fruit yield,
- Nutritional quality of cucumber fruits,
- Shelf - life of cucumber fruits in storage.

2. Materials and Methods

2.1. Experimental Site

The experiment was conducted at the Horticulture Department field of the University for Development Studies (UDS) Nyankpala Campus. The field lies in the Guinea Savannah Agro-ecological zone, located at longitude 0° 95′ N, latitude 09° 25′ S and altitude 183 m [11]. The experiment was carried out in the dry season between November, 2015 and February, 2016. The area has a unimodal rainfall of 1,034 mm distributed fairly from April to late November with a uniform mean monthly temperature of 22°C during the rainy season and maximum of 34°C during the dry season. Relative humidity is at its maximum during the rainy season with a monthly value of 80 % which declines to 53 % during the dry season as minimum monthly value [12].

2.2. Soil and Vegetation

The soil at the study area is of the Nyankpala series. It is also known as plinthic Archrosol. The soil is an Alfisol based on the USDA system of classification. It is brown, moderately drained and sandy-loam, free from concretion, very shallow with a hardpan underneath the top few centimetres. The soil is a type of Savannah Ochrosol developed from Voltarian Sandstones [13]. A composite soil sample was collected at depth 0-30cm before ploughing (planting) to determine the soil pH, soil nutrient status and soil particle size (soil texture).

2.3. Cropping History of Site

The site had previously been cropped and the vegetation has been greatly modified by human activities such as continuous cropping. Some of the cultivated vegetables include cucumber (*Cucumis sativus*), tomato (*Lycopersicon esculentum*), sweet pepper (*Capsicum annum*), okra (*Abelmoschus esculentus*) and amaranthus (*Amaranthus spp*).

2.4. Lay-Out and Land Preparation

The land was prepared by the conventional method of ploughing and harrowing. A total land area of 667.28 m^2 (33.2 m x 20.4 m) was used for the experiment. The area was lined and pegged to divide it into blocks (3) and plots (54). There were eighteen plots in a block which measured 2.8 m x 2.4 m. The blocks were 1.5 m spaced out whiles the plots were 1m apart to allow walking paths and also to avoid fertilizer drift. Each plot consisted of twenty (20) plants at 80 cm x 70 cm spacing.

2.5. Brief Description of Cucumber Cultivars Used in the Experiment

Nandini F1 is a monoecious hybride with a rather vigorous plant habit and good side shoot formation. Fruit colour is medium to dark green. Fruit shape is cylindrical and very uniform during harvesting season. Perform well in rather warm circumstances. It has fruit length 18-22 cm, fruit weight 150-180 g and matures in 40-45 days after sowing. (www.technisem.com).Pointset are straight dark green, non-bitter and delightfully crisp cucumbers. They are 7-8 inch long with a 2-2.5 inch diameter. Pointset is one of the best open pollinated, standard slicing cucumbers. It is resistant to many common diseases that plague cucumber plants, including powdery and downy mildew, anthracnose angular leaf spot and scab. It takes about 58-60 days to mature [14].

Marketer is a high yielding with long and smooth fruits that are burpless and excel for slicing and good for pickling when picked small. It is an open pollinated cultivar, dark green, uniform for shape and fruit trim. Fruit length is about 23 cm, diameter 4-5 cm and weight 450-500 g. Marketer fruits are ready for harvest from 45-50 days after planting [15].

2.6. Experimental Design and Treatments

The experiment was 3*3*2 factorial arranged in a Randomized Complete Block Design (RCBD) with three (3) replications.

The factors considered were:

a) Three cucumber varieties (Nandini, Pointset and Marketer)
b) Two NPK types and a control (15:15:15, 23:10:5 and 0:0:0)
c) Two levels of sulphate of ammonia

The treatment combinations were:

1. Marketer + NPK 15:15:15 + Sulphate of ammonia
2. Marketer + NPK 23:10:5 + sulphate of ammonia
3. Marketer + zero NPK + sulphate of ammonia
4. Marketer + NPK 15:15:15 + zero sulphate of ammonia
5. Marketer + NPK 23:10: 5 + zero sulphate of ammonia
6. Marketer + control
7. Nandini + NPK 15:15:15 + Sulphate of ammonia
8. Nandini + NPK 23:10:5 + sulphate of ammonia
9. Nandini + zero NPK + sulphate of ammonia
10. Nandini + NPK 15:15:15 + zero sulphate of ammonia
11. Nandini + NPK 23:10: 5 + zero sulphate of ammonia
12. Nandini + control
13. Pointset+ NPK 15:15:15 + Sulphate of ammonia
14. Pointset + NPK 23:10:5 + sulphate of ammonia
15. Pointset + zero NPK + sulphate of ammonia
16. Pointset + NPK 15:15:15 + zero sulphate of ammonia
17. Pointset + NPK 15:15:15 + zero sulphate of ammonia
18. Pointset + control

2.7. Seed Sowing

Direct sowing of seeds was done at two seeds per hill to a depth of about 2 cm. Dry grass was used to mulch the field and watering was done immediately.

2.8. Cultural Practices

Hoeing, hand picking of weeds and regular watering were done. Thinning began when plants had attained 3-4 true leaves and by the end of two weeks after seeds germinated, each stand was left with one plant. 'Dimeking', with active ingredient dimethoate 400 g/L EC, an inorganic insecticide was used to control insect pests. The rate of the 'dimeking' was 12 ml/16L knapsack at seedling emergence, during flowering and at fruiting. There was no disease control measure since no incidence of disease was observed.

2.9. Fertilizer Application

NPK (15:15:15 and 23:10:5) was applied seven days after seedling emergence at nine (9)g per plant. The method of application was side dressing. Four point five grams (4.5g) of sulphate of ammonia per plant was applied at twenty-one (21) days after seedling emergence. The method of application was side dressing.

2.10. Harvesting

Harvesting was done regularly at three days' interval. The first harvesting was done Forty-five (45) days after sowing.

2.11. sampling and Data Collection

Five plants were considered for data collection in each plot on yield parameters and shelf-life of the fruits.

2.12. Parameters Considered

2.12.1. Fruit Yield

Fruits were harvested from 48 DAP to 60 DAP for six times at intervals of three days. Yield was obtained by summing the total fruit weight for the six harvest and expressed in ton/ha.

2.12.2. Mean Fruit Weight

This was determined by dividing the weight of harvested fruits by the number of harvested fruits per treatment. It was measured in kilogram (kg).

2.13. Shelf-Life

Five fruits were selected from each treatment, washed with salt solution (brine) and placed on a well cleaned table for observation under an average room temperature of 30°C. Record taking commenced on day of rotting, shrivelling and disease incidence until the day all the fruits got rotten. The number of days' rot was observed and the occurrence observed. The shelf-life was calculated as average number of days' rot were observed.

2.13.1. Cucumber Fruit Water Loss per Day

The amount of water lost by a fruit per day was determined by taking the initial weight of five (5) fruits. These fruits were weighed 7 days later and the total water loss by the fruits was found by calculating the difference of the two weights, after which the total water loss per fruit was calculated through the average. Fruit water loss per day was then determined by dividing the total water lost per fruit by the number of days the fruits were kept and it was measured in grams (g) using an electronic balance.

2.14. Decay (In Storage)

Rot, shrivelled and disease incidence were used to determine decay. Once any of these factor was observed or seen the fruits were considered decayed. Decay was then expressed as a percentage of the total initial fruit number [13].

2.15. Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) using Statistix Student version. Differences between means were determined using the least significant difference (LSD) test at 1% level and the results were presented in tables.

3. Results

3.1. Soil Physio-Chemical Properties from the Study

Analysis of the soil sample taken at depth 0-3cm from the experimental site revealed that the soil contained 73.16% sand, 18.48% silt and 8.36% clay (given a sandy loam texture).(Table 1). The soil could not be moulded into any lumps when wet without fallen apart. The organic carbon and organic matter values were 0.85% and 1.465% respectively which indicated their low content in the soil. The soil nitrogen content which was less than 0.067% from soil analysis was also considered to be low. However, analysis of exchangeable cations such as calcium (Ca^{2+}) and magnesium (Mg^{2+}) indicated that the soil contained values greater than 0.5 cmol/kg. 5.103mg/kg and 56.84mg/kg of available

phosphorus and potassium respectively were recorded. The soil indicated pH value of 5.92.

Table 1. Physio-Chemical Properties of the soil from the study site

pH H_2O (1:2.5)	OC (%)	N (%)	P (mg/kg)	K (mg/k)	Ca (cmol/kg)	Mg (cmol/kg)	CEC (cmol/kg)	ECEC (cmol/kg)	OM (%)
5.92	0.85	0.076	5.103	56.84	2.11	1.44	3.63	5.87	1.465
Sand (%)				Silt (%)			Clay (%)		
73.16				18.48			8.36		

3.2. Effect of Variety, Sulphate of Ammonia ($(NH_4)_4SO_4$) AND NPK on Cucumber Yield

3.2.1. Effect of Cucumber Variety on Yield

Table 2 shows the varietal effect on fruit yield of cucumber. The study revealed there were no significant variations ($p>0.01$) in the fruit yield and weight.

Table 2. The effect of varietal variation on cucumber yield

Variety	FY (ton/ha)	AFW (kg)
Marketer	6.57 a	0.20 a
Nandini	8.19 a	0.23 a
Pointset	11.06 a	0.23 a
Lsd (1%)	6.68	0.05
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight*

3.2.2. Effect of Ammonia Sulphate Fertilizer on Cucumber Yield

The results on cucumber fruit yield and its dimensions as influenced by application of ammonia sulphate ($(NH_4)_2SO_4$ fertilizer are presented in Table 3. The study showed no significant variation ($p>0.01$) in the means for fruit yield and weight.

Table 3. The effect of ammonia sulphate on cucumber yield

SA Top-dresser	FY (ton/ha)	AFW (kg)
No SA	7.53 a	0.21 a
SA	9.68 a	0.23 a
Lsd (1%)	4.76	0.04
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight*

3.3. Effect of Types of NPK Fertilizer on Cucumber Yield

Table 4 shows the results on the effect of types of NPK fertilizer on cucumber yield. Types of NPK fertilizer had no significant difference ($p>0.01$) on the yield and fruit weight.

Table 4. The effect of types of NPK on cucumber yield

NPK Type	FY (ton/ha)	AFW (kg)
No NPK	7.30 a	0.22 a
15:15:15	9.75 a	0.23 a
23:10:05	8.77 a	0.21 a
Lsd (1%)	6.68	0.05
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight*

3.4. Combined Effect of Cucumber Variety and ammonia sulphate on Fruit Yield

No significant difference ($p>0.01$) was detected in the effect of varietal and NPK interactions on the yield and fruit weight (Table 5).

Table 5. The effect of varietal and $(NH_4)_2SO_4$ interaction on cucumber fruit yield

Variety*SA Top-dresser	FY (ton/ha)	AFW (kg)
Marketer*No SA	8.57 a	0.19 a
Marketer*SA	4.56 a	0.20 a
Nandini*No SA	5.85 a	0.22 a
Nandini*SA	10.52 a	0.25 a
Pointset*No SA	13.96 a	0.23 a
Pointset*SA	8.16 a	0.24 a
Lsd (1%)	11.06	0.08
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight; SA = Sulphate of Ammonia*

3.5. Combined Effect of Cucumber Variety and NPK on Fruit Yield

No significant variation ($p>0.01$) was observed in the fruit – yield and weight due to the interaction effect of the cucumber variety and NPK fertilizer types (Table 6).

Table 6. The effect of varietal and NPK interactions on cucumber fruit yield

Variety*NPK Type	FY (ton/ha)	AFW (kg)
Marketer*No NPK	8.56 a	0.22 a
Marketer*15:15:15	5.85 a	0.18 a
Marketer*23:10:05	5.30 a	0.19 a
Nandini*No NPK	2.49 a	0.23 a
Nandini*15:15:15	9.93 a	0.24 a
Nandini*23:10:05	12.14 a	0.22 a
Pointset*No NPK	10.85 a	0.20 a
Pointset*15:15:15	13.47 a	0.26 a
Pointset*23:10:05	8.86 a	0.23 a

Lsd (1%)	14.55	0.11
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight*

3.6. Combined Effect of $(NH_4)_2SO_4$ and NPK on cucumber yield

No significant variation ($p>0.01$) was observed in the fruit – yield and weight as regard to the interaction effect of the treatments ($(NH_4)_2SO_4$ and NPK) applied (Table 7).

Table 7. The interaction effect of $(NH_4)_2SO_4$ and NPK on cucumber fruit yield

SA Top-dresser*NPK Type	FY (ton/ha)	AFW (kg)
No SA*No NPK	7.56 a	0.21 a
No SA*15:15:15	8.25 a	0.22 a
No SA*23:10:05	6.76 a	0.19 a
SA*No NPK	7.04 a	0.22 a
SA*15:15:15	11.24 a	0.23 a
SA*23:10:05	10.76	0.23 a
Lsd (1%)	11.06	0.08
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight; SA = Sulphate of Ammonia*

3.7. Combined Effect of Cucumber Variety, $(NH_4)_2SO_4$ and NPK on Yield

No significant variation ($p>0.01$) was seen in the combined effect of the variety, ammonia sulphate and NPK treatments on the cucumbers' fruits in respect to the yield and weight (Table 8).

Table 8. The interaction effect of variety, $(NH_4)_2SO_4$ and NPK on cucumber fruit yield

Variety*SA Top-dresser*NPK Type	FY (ton/ha)	AFW (kg)
Marketer*No SA*No NPK	13.68 a	0.23 a
Marketer*No SA*15:15:15	7.08 a	0.18 a
Marketer*No SA*23:10:05	4.97 a	0.16 a
Marketer*SA*No NPK	3.44 a	0.21 a
Marketer*SA*15:15:15	4.61 a	0.18 a
Marketer*SA*23:10:05	5.63 a	0.22 a
Nandini*No SA*No NPK	1.24 a	0.22 a
Nandini*No SA*15:15:15	11.75 a	0.25 a
Nandini*No SA*23:10:05	4.55 a	0.17 a
Nandini*SA*No NPK	3.74 a	0.24 a
Nandini*SA*15:15:15	8.10 a	0.23 a
Nandini*SA*23:10:05	19.73 a	0.26 a
Pointset*No SA*No NPK	7.78 a	0.19 a
Pointset*No SA*15:15:15	5.92 a	0.24 a
Pointset*No SA*23:10:05	10.78 a	0.24 a
Pointset*SA*No NPK	21.02 a	0.21 a

Pointset*SA*15:15:15	13.93 a	0.22 a
Pointset*SA*23:10:05	6.94 a	0.22 a
Lsd (1%)	23	0.18
CV	74.65	22.25

**FY = Fruit yield; MFW = average fruit weight; SA = Sulphate of Ammonia*

3.8. Shelf life

No distinct variation ($p<0.01$) was observed in the mean length of shelf life of the specific treatment samples as result of the interaction effect of the variety, NPK and $(NH4)_2SO_4$ except between 15.00 days noted for Marketer when treated with $(NH4)_2SO_4$ without NPK and 10.00 days observed for both Pointset and Nandini when 15:15:15 NPK was applied with $(NH4)_2SO_4$. The result thus indicates that, the application of 15:15:15 NPK and $(NH4)_2SO_4$ had similar impact on the shelf life of Marketer (14 days), Pointset (13 days) and Nandini (12 days). Likewise, when 23:10:05 NPK and $(NH4)_2SO_4$ were applied, the interactive effect on Marketer (14 days), Pointset (14 days) and Nandini (12 days) caused no difference. When 15:15:15 NPK was solely applied on Marketer (12 days), Nandini (10 days) and Pointset (10 days), the effect was same. Also, 23:10:05 NPK had same impact on the shelf life (11 days) of the varieties. No difference was also observed when only $(NH4)_2SO_4$ was applied on the varieties as shelf life was within 13 to 15 days. And the shelf life (13 to 14 days) did not differ among the varieties when no fertilizer was applied.

3.9. Decay

Decay in the cucumber was significantly ($p<0.01$) influenced by combined effect of variety, NPK and $(NH4)_2SO_4$ in regards to the means. Some of the treatment interactions had same effect. When 15:15:15 NPK was applied solely or in combination with $(NH4)_2SO_4$ influenced the highest decay of 70% in Pointset. Likewise, when $(NH4)_2SO_4$ was applied solely or in combination with 23:10:05 NPK influenced the lowest (30%) in Marketer and Nandini. When 23:10:05 NPK was applied alone or in combination with $(NH4)_2SO_4$, same effect (40%) was observed as when both 15:15:15 NPK and $(NH4)_2SO_4$ were applied on Marketer. Their impact was same when no fertilizer or only $(NH4)_2SO_4$ was applied on Nandini. Similarly, Pointset and Marketer had same level of decay (50%) when no fertilizer was applied. The rest of the treatment samples also had no difference as they had 60% of decay.

3.10. Weight loss

There was significant variation ($p<0.01$) observed in weight loss due to the treatment interactions in respect to effect of variety, NPK and $(NH4)_2SO_4$. Weight loss on the daily basis was highest (5.63 g) and lowest (3.72 g) in Marketer when subjected to $(NH4)_2SO_4$ and 23:10:05 NPK application separately. The latter treatment also had similar effect on Pointset as it influenced 3.78 g weight loss.When 23:10:05 NPK and $(NH4)_2SO_4$ were applied on both Marketer and Nandini, the weight loss (4.82 g) was not different but varied from that observed in Pointset (4.32 g). 15:15:15 NPK and $(NH4)_2SO_4$ when applied, influenced 5.27, 5.10 and 4.57 grams' weight loss in Nandini, Pointset and Marketer respectively. When 23:10:05 NPK was applied alone, 4.40, 3.78 and 3.72 grams' loss in weight were noted in Nandini, Pointset and Marketer respectively. The mean 4.40 g differed from both 3.78 and 3.72 grams. The weight loss in Pointset (4.41 g), Nandini (4.32 g) and Marketer (4.23 g) varied in their effect when 15:15:15 NPK was applied alone. Also, the application of $(NH4)_2SO_4$ alone caused variation in the varieties with 5.63, 5.17 and 4.71 grams' weight loss recorded in Marketer, Nandini and Pointset in turn. And when no

fertilizer was applied, the weight loss also varied with 4.64, 4.27 and 4.11 grams recorded in Nandini, Pointset and Marketer respectively in order of decreasing amount.

4. Conclusion

The study showed no significant impact and caused no difference in the fruit yield, fruit weight and size but fruit length – due mainly to varietal difference and sulphate of ammonia application.

The result further showed variation in level of decay among the varieties when both 23:10:05 NPK and $(NH4)_2SO_4$ were applied on Pointset (60%), Marketer (40%) and Nandini (30%). When 15:15:15 NPK and $(NH4)_2SO_4$ were applied, the varieties had 70%, 40% and 60% decay in turn and the variation was significant.

Both Nandini and Pointset suffered same level of decay (60%) but varied from that (40%) noted in Marketer when 23:10:05 NPK was applied. Similarly Marketer and Nandini suffered 60% decay which varied from 70% in Pointset when 15:15:15 NPK was applied. When $(NH4)_2SO_4$ was applied alone, 60%, 40% and 30% decay were observed in Pointset, Nandini and Marketer respectively. With no application of fertilizer, 50% decay of Marketer and Pointset, and 40% of decayed Nandini were recorded. Both means varied from each other.

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