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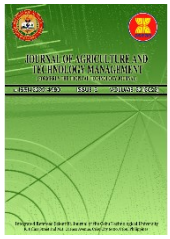

Original article

Production trial of lettuce (*Lactuca sativa L.)* using formulated organic foliar fertilizer in lahar-laden areas

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ABSTRACT

The substitution of conventional fertilizer with foliar organic fertilizer for lettuce in addition to reducing the risk of contamination of the soil and the water table, can increase the efficiency of fertilization and so the yield, minimizing the costs of mineral fertilizers. This research was conducted to evaluate the growth and yield performance of Tyrol and Fanfare varieties of lettuce using the different rates of application of formulated organic foliar fertilizer under lahar- laden soil. Fermented banana stems were used in this study. The two-factor experiment was laid down using a 2x4 factorial experiment in Randomized Complete Block Design (RCBD), replicated three times. It was conducted at President Ramon Magsaysay State University Organic Vegetable Project Site, which was affected by lahar during the eruption of Mt Pinatubo. The study's findings indicated that the application of fermented plant juice slightly improved Lettuce's growth and yield performance. The Fanfare variety of lettuce had significantly better growth performance than Tyrol variety. However, there were no significant differences in the yield performance of lettuce as affected by variety and the different rates of application of fermented plant juice. This study would benefit the vegetable growers in the lahar-laden areas in Central Luzon.

KEYWORDS: *Lettuce, Fermented Plant Juice, Molasses, Microorganisms, Organic Foliar Fertilizer*

1 INTRODUCTION

Lettuce (*Lactuca sativa*) an annual plant of the Compositae family is one of the most important vegetables in the human diet. The plant is full of vitamins and minerals with lots of fiber. Lettuce is 26th among 39 vegetables and fruits of nutrition value and is fourth in consumption. It is the most popular salad crop in the world, which mainly grows in temperate regions and sometimes in tropics and subtropical regions. The best temperature for the cultivation of Lettuce is 18-25 degrees. Lettuce is commonly known as lechugas in the Philippines. It is mainly produced in the highlands of the Cordillera Administrative Region (CAR) where the temperature is cooler. There is a high demand for Lettuce especially when it is grown organically. The number of medium to small farming operations in the mid-to high-elevated areas of the country which are producing mixed varieties of Lettuce have increased in the last five years. Harvesting volumes of the leafy veggie have grown because of the increased demand from farmers' markets, supermarkets, hotels, restaurants, fast-food chains, and high-end food service companies (Rodriguez, 2018).

Commercial and conventional farmings have relied on inorganic fertilizers to grow vegetables (Lampkin 1990). This is because they are easy to use, quickly absorbed, and utilized by crops. However, these fertilizers are believed to contribute substantially to environmental problems, to humans, animals, and food intoxication. The chemical fertilizers used in conventional farming contain just a few minerals that dissolve quickly in damp soil and give the plants large doses of minerals. Organic fertilizers can therefore be used to reduce the amount of toxic compounds (such as nitrates) produced by chemical fertilizers in vegetables like Lettuce (Masasirambi et al., 2010).

Production of vegetables, especially lettuce in lahar-laden areas, is challenging due to its characteristics. In many areas, lettuce is grown under protective structures. In this study, lettuce was planted in lahar- laden areas. Lahar deposits due to the eruption of the Mt. Pinatubo in 1991 have sandy loam textures that are generally less fertile than the original soil (Aganon, et al 2013).

Based on its mineral composition, the banana stem has the potential to be utilized, among others as the raw material of bokashi/ compost. According to Krisnawati (2015), bokashi made from 2-month-old banana stem containing C organic (29,7%), C/N ratio (17,8%), pH H2 O (5,64), total NPK (7,74%) is qualified as organic fertilizer. Faozil et al. (2018) found that bokashi made from banana stem has a chemical composition that can be used as a soil conditioner and a source of nutrients to increase the growth and yield of soybean crops in the coastal sand area. The growth of leaf area, dry weight of roots and canopy, and the yield of seeds of several soybean varieties varied depending on the bokashi dose

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given. The Department of Agriculture-Agricultural Training Institute, through their Fermented Plant Juice Production Guide (2021), recommends the rate of application at eighty (80) ml of FPJ per 16 liters of water and spray on the leaves or apply directly to the soil around the plants from the seedling stage up to the pre-flowering stage. FPJ can be applied weekly or depending on plant vigor. With FPJ there is no overdose; however, the soil must be watered first before applying FPJ to avoid scorching of the roots. According to the College of Tropical Agriculture and Human Resources (2013), Fermented Plant Juice is used as a solution for seed and soil treatments and plant nutrition. Based on the study of Barrera and Farin (2022), the increase in growth and yield parameters in pechay are attributed significantly to the fermented rice bran level of concentrations and the variety of pechay. Studies conducted by researchers were done on the effectiveness of fermented organic fertilizers such as fish bones and onion plants (Jang and Kuk, 2020). In 2015, Jesu (2015) conducted a study on rice bran compared with other organic fertilizers like wood ash and poultry manure. On the other hand, Santosa and Soekendarsi (2018) focused on rice and coconut water waste and found promising results in enhancing the productivity of leafy vegetables like cabbage and pechay.

On the other hand, the recommended dilution is five hundred (500) ml of Fermented Plant Juice for every 16 liters of water or one sprayer tank (Bureau of Agricultural Research (BAR) and Agricultural Systems Cluster (ASC) of University of the Philippines Los Banos (UPLB, 2012).

The study was conducted to determine the effects of foliar organic fertilizer on the growth and yield of Lettuce in lahar- laden areas.

2 MATERIALS AND METHODS

A. Variety

Fanfare Variety (V1)

Loose leaf lettuce is one of the easiest lettuce to grow at home. They are cultivated for the tender, delicate leaves which grow from a central stalk. Loose-leaf Lettuce is very high in Vitamin A, which is converted from beta-carotene (Busch, 2018).

Tyrol Variety (V2)

Romaine lettuce grows in a long head of sturdy leaves with a firm rib down their centers. These thick ribs, especially on the older outer leaves, have an unpleasant milky fluid, so they should not be employed, nor should the leaf- tips, which can be bitter.

Cultural Management Practices

The following cultural management practices were implemented in order to facilitate the collection of data on the growth and yield of lettuce:

Soil Sampling

Soil samples were collected randomly from the experimental area following the standard procedure and submitted for analysis at the Department of Agriculture Regional Field Office III, Regional Soils Laboratory before planting and after harvesting. The essential macro elements were nitrogen, phosphorus, and potassium. The result of the soil analysis was the basis of the rate of application. The soil moisture was determined using the gravimetric method of soil moisture estimation. The soil sample was placed in an oven at 105 degrees Celsius and dried to a constant weight. The difference in weight is considered to be the water present in the soil sample.

Fermented Plant Juice Preparation and Nutrient Analysis

The fermented plant juice was prepared using fresh 2 kg banana stalks and 1 kg molasses. The stalks were cut and chopped into manageable sizes to broaden the surface area. The chopped banana stalks and molasses were mixed thoroughly. The mixture was kept inside the laboratory room under shaded room temperature and was allowed to ferment naturally for 7 days. The fermented plant juice was subjected for its nutrient analysis at the Department of Agriculture.

Land Preparation and Application of Treatments

The area was plowed and harrowed once or until a good tilt was attained. The area was divided into three (3) blocks from which plots were formed for random designation of treatments. The fermented plant juice was applied twice a week as organic foliar fertilizer using a gallon sprinkler.

Seeds of Tyrol and Fanfare varieties of Lettuce were sown and allowed to germinate in a seed tray filled with a mixture of carbonized rice hull and vermicast two weeks prior to planting. The seed trays were set up in a partially shaded area. Water was applied on the seed trays to facilitate pulling of seedlings for transplanting to prevent root damage. Loosening the soil is important for the success of transplanting. Hand-held plastic sprinklers were used to water the plants as needed.

Each plot has four (4) rows with at least fifteen (15) plants within each row. The seedlings were transplanted 20 days after emergence. The distance of planting is 0.25 m between and within each row. Holes measuring 7 cm deep were pre-dug. The seedlings were transplanted late in the afternoon.

Cultivation was done to provide aeration to the roots. Hand weeding was also done depending on the prevalence of weeds. As soon as insects were visible, organic pesticides were used to control proliferation of cutwormand leaf miners. The infected plants during the

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vegetative stage were collected and burned to prevent healthy plants from being contaminated. No replanting was done since the numbers of samples were still enough.

Research Design and treatments

The protocols for the 2x4 factorial experiments in Randomized Complete Block Design (RCBD) were followed, with three replications. Variety (Factor A) and rate of administration of prepared fermented plant juice are the two components in the factorial design (Factor B). The experimental design was based on a randomized whole block pattern. The four FPJ levels were assigned randomly to each degree of diversity in each block (or replication). Each block contained eight plots. The space between plots was kept at 0.5 m, while the distance between plants was 0.25 m x 0.25 m. Figure 1 shows the experimental layout of the study showing the 2x4 factorial experiments in Randomized Complete Block Design with three replications.

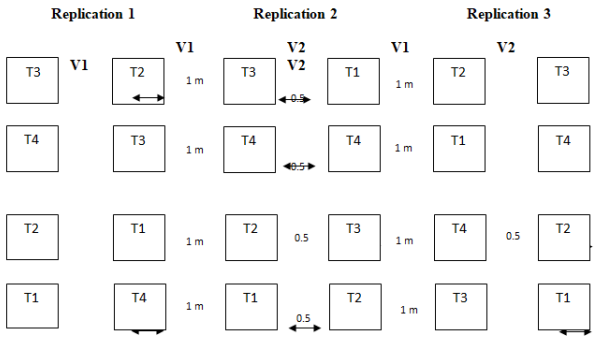

Figure 1. Experimental Lay-Out

The following were the treatments in the field experiment:

Factor A (Variety) V1- Fanfare
V2- Tyrol

Factor B (rate of application of FPJ) F1- control (no fertilizer)
F2- 75 ml per 16 li. of water/plot F3- 80 ml per 16 li. of water/plot F4- 500 ml per 16 li. of water/plot.

Location of the Study

The study was conducted at the Organic Vegetable Project Site, President Ramon Magsaysay State University, Barangay Nagbunga, San Marcelino, Zambales. The area is still covered with thick lahar deposits resulting from the 1991 Mt. Pinatubo eruption.

Harvesting

Lettuce was harvested manually by uprooting with a trowel to avoid plant damage. Plants that could be sold were separated from those that could not. The harvesting

of the lettuce was uprooted or cut early in the morning to keep it crisp and fresh. Lettuce was harvested 30 days after transplanting.

Data Collected

The following were the parameters gathered

1. **Growth Parameters**
   - 1.1 Width of Leaves (cm.). The width of leaves of the twenty (20) sample plants were measured using a ruler.
   - 1.2 Number of leaves. The numbers of primary leaves up to harvesting were counted.
   - 1.3 Diameter of Canopy (cm.). The diameter of the canopy was measured from the tip of the leaves of the other tip of the other leaves.
   - 1.4 Height of the plant (cm). The height of the plants was measured from ground level to the tip of the last leaf in centimeters.
   - 1.5 Average Length of Leaves (cm). The length of the leaves of the twenty (20) sample plants were measured using a ruler.
   - 1.6 Average weight/plant (g). The average weight was determined by taking the total weight of each sample plant after harvest.

2. **Yield Parameters**
   - 2.1 Number of cut leaves. The number of cut leaves per plant was counted.
   - 2.2 Average yield / square meter. The total production in kilograms with regards to the measurement of each plot.
   - 2.3 Average weight/plant (g). The average weight was determined by taking the total weight of each sample plant after harvest.
   - 2.4 Average yield/plot. The total production in kilograms with regards to the measurement of each plot.

Data Analysis

The growth and yield parameters were gathered. Data were analyzed using Analysis of Variance for Factorial in Randomized Complete Block Design. Finally, the comparison among means was done using Least

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Significant Difference.

3 RESULTS AND DISCUSSION

Nutrient Analysis of the Fermented Plant Juice

The fermented plant juice used in this study was analyzed and it contained 0.40% total nitrogen, 0.03% total phosphorus and 0.95 total potassium.

Growth performance of Lettuce

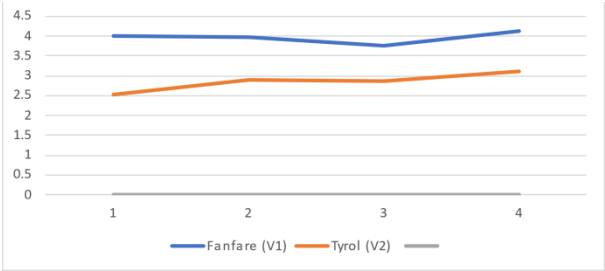

Figure 2. Average Width of Leaves of the Two Varieties of Lettuce as Affected by Different Rates of Application of Fermented Plant Juice

The width of lettuce leaves from plants that did not receive FPJ (3.99 cm) was slightly less than that of plants that did receive FPJ the width of leaves recorded for plots applied with 500 mL FPJ (4.14 cm) for the Fanfare variety. For the Tyrol variety, the width of leaves with no application of FPJ (2.53 cm) was lower than the width of leaves recorded for plots applied with 500 mL FPJ (3.11 cm). The Fanfare variety was significantly higher in terms of width of leaves compared to the Tyrol variety. An increment of 0.36 cm (11.04 %) was observed in the mean width of leaves as the application rate of FPJ increased from 0 to 500 mL FPJ per 16 L of water per plot. The higher N content of organic fertilizer can stimulate higher protein synthesis, resulting in larger leaves in Fanfare variety (3.96 cm). Hossain and Ryu (2017) found a similar result: organic fertilizer application increased leaf size (length and breadth).

Fanfare's average leaf canopy diameter (8.64 cm) was significantly higher than the Tyrol (6.59) variety. On the other hand the leaf canopy diameter of lettuce was comparable to the control when applied with fermented juice. The leaf diameter ranged from 7.13 cm to 7.89 cm. However, the leaf canopy diameter of lettuce slightly increased with the application of 75 ml FPJ and increased further with the application of 500 mL FPJ. The interaction of variety and level of FPJ was not significant. These findings suggest that increasing the FPJ application rate to 500 mL did not result in a corresponding increase in the canopy diameter of Lettuce grown in lahar-laden soil.

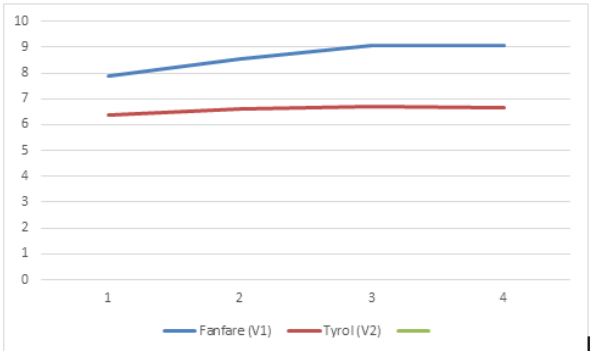

Figure 3. Average Canopy Diameter (cm) of the Two Varieties of Lettuce as Affected by the Application of Fermented Plant Juice

The study does not support the experiment of Sunaryo (2010) that mustard green and lettuce treated by bokashi had better growth than those treated with NPK inorganic fertilizer. Better growth of plants as a result of the application of manure or compost can occur due to the positive effect of manure or compost on physical, biological, and chemical soil fertility. The increasing of water holding capacity, aeration, and essential elements availability were the conditions of soil fertility that were appropriate for plants to have better growth (Darliana, 2007). In the study of Ghanem et al. (2017), the application of Bokashi resulted in the highest head diameter in Lettuce.

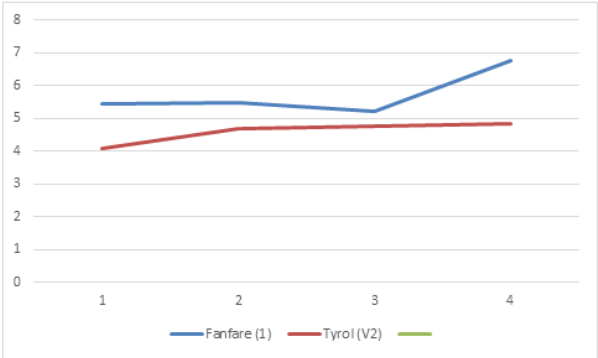

Figure 4. Average Plant Height (cm) of the Two Varieties of Lettuce as Affected by Application of Fermented Plant Juice

The application of fermented plant juice on lettuce had no significant effect on the average plant height. However, slightly taller plants were obtained when FPJ was applied. The Fanfare variety had significantly taller plants than the Tyrol variety with 5.72cm and 4.59cm respectively. Organic fertilizers are rich sources of

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phosphorus and nitrogen, both of which are vital building blocks for plant proteins and thus contributed to plant growth (Poliquit et al., 2019). Results of the experiment of Sunaryo (2010) indicated that mustard green and lettuce treated by bokashi had better growth than that treated by NPK inorganic fertilizer.

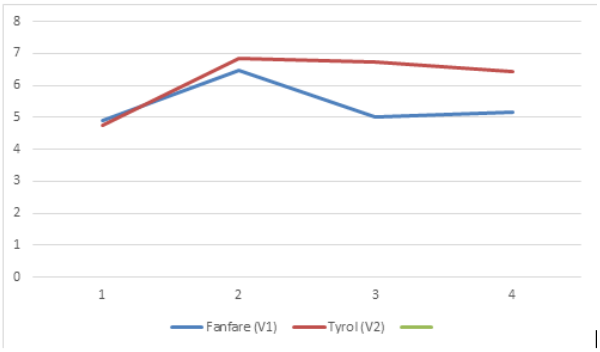

Figure 5. Average number of leaves per plant of the two varieties of Lettuce as affected by different rates of fermented plant juice

There was a significant difference in the number of leaves produced by Tyrol and Fanfare. The average number of leaves reported for Tyrol was significantly higher with 6.63 leaves than the average number of leaves reported for the Fanfare variety with 4.96 leaves.

Applying FPJ to lettuce had no significant effect on the number of leaves. However, plants with 80 ml FPJ had more leaves with an average of 5.87. Increasing the amount to 500 ml FPJ slightly reduced the average number to 5.80 leaves.

The study by Ghanem et. al. (2017) contradicts this which showed that applying Bokashi resulted in the highest number of leaves per head or plant. Applying 75ml of FPJ resulted in more leaves in Tyrol variety, while applying 500 ml FPJ resulted in more leaves in Fanfare. However, in the study of Arshad et al. (2018) the number of leaves increased with increasing concentration of goat manure extract.

The significant difference indicates that the average number of leaves reported for Tyrol was higher than that reported for the Fanfare variety. The effect of the application of fermented plant juice and the impact of the interaction between variety and the c application rate of fermented plant juice did not cause significant difference in the average number of leaves. These findings were contrary to the study of Arshad et. al. (2018) that organic waste extracts significantly influenced the number of leaves of lettuce.

There was a statistically significant difference found in the length of leaves as affected by variety (F=26.65>F(5%)=18.5) and the combined effect of combination and FPJ application rate (F=0.07< F(5%)=3.49). Tyrol had significantly longer leaves with 6.03 cm. A significantly higher number of leaves were found in Tyrol plants applied with 80 ml and 500 ml FPJ.

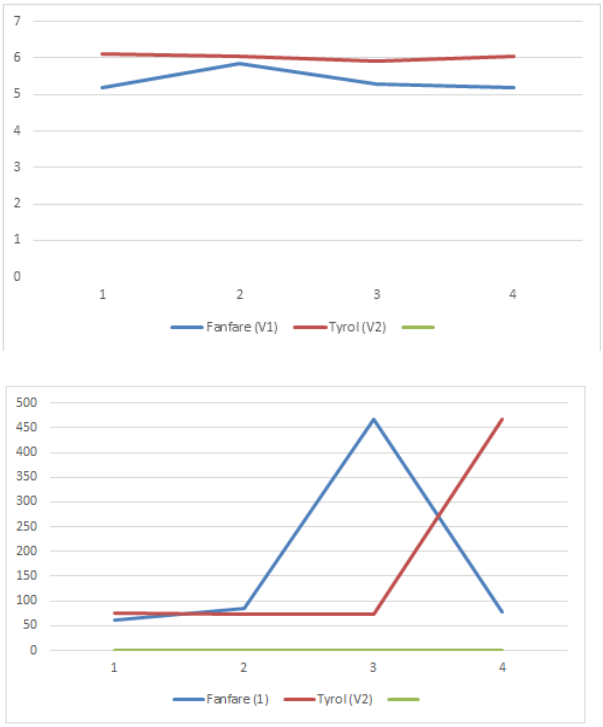

Figure 6. Average Yield (g) per Square Meter of the Two Lettuce Varieties Applied with the Different Rates of Application of Fermented Plant Juice

Increasing the application rate of FPJ seems to have an inhibitory effect on the growth of plants. This result conforms with Milagrosa and Balaki (2015) study, indicating that more marketable lettuce heads were noted from those applied with Bokashi and effective microorganisms. Furthermore, the study of Domingo (2019) indicates that the application of plant extracts resulted in improved yield.

With an average mean weight of 272.79 grams per sq. meter, the highest increment in terms of weight was obtained from plants applied with 500 ml of fermented plant juice. It was followed by plants applied with 80 ml of fermented plant juice with 270.41 g . Milagrosa and Balaki (2015) study indicate that more marketable lettuce heads were noted from those applied with Bokashi and effective microorganisms.

For the Fanfare variety, the lowest average yield per plot was recorded at 312.90 grams in the untreated plants, while the plants treated with 80 mL FPJ recorded slightly higher average yield per plot at 2,333,33 grams. The reported yield of 394.73 grams of plants treated with 500 mL FPJ was slightly lower than the yield of 421.87 grams from plants treated with 75 ml FPJ for Fanfare variety.

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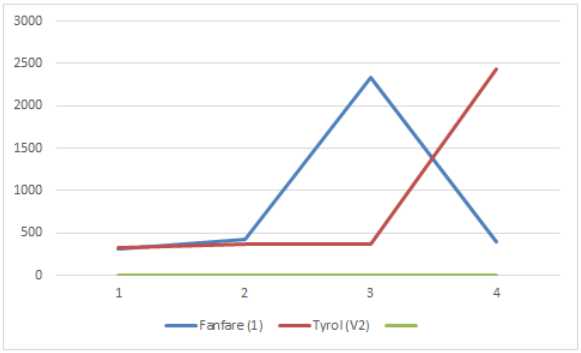

Figure 7. Average Yield per Plot of Two Lettuce Varieties Applied with the Different Rates of Application of Fermented Plant Juice

For the Tyrol variety, the average yield per plot slightly increased from 329.63 grams for the untreated plants to 2,435.00 grams for plants treated with 500 mL FPJ. The average yield per plot for plants treated with 75 mL FPJ was higher in plants of the Fanfare variety with 421.87 grams than the yield of 363.30 grams for plants of the Tyrol variety. The average yield per plot for plants treated with 80 mL FPJ was slightly in plants of the Fanfare with 2,333.33 grams than the yield of 370.73 grams for plants of the Tyrol variety. However, the average yield for plants applied with 500 mL FPJ was higher in plants of the Tyrol with 2435.00 grams than the yield of 394.73 grams for Fanfare varieties. Milagrosa and Balaki (2015) study suggested that Bokashi-treated plants produced more marketable heads, which can be attributed to compactness and thicker leaves.

Figure 8. Picture showing Tyrol and Fanfare varietie of Lettuce in lahar laden soil

4 CONCLUSION

The application of fermented plant juice at different rates slightly improves the growth performance of Lettuce in terms of the width of leaves, canopy diameter, plant height, number of leaves, and leaf length, and yield of Lettuce in terms of the number of cut leaves per kilogram, average weight per plant, average yield per square meter, and average yield per plot. There is a significant difference on the growth performance of Tyrol and Fanfare. On the other hand, comparable yield performance of Tyrol and Fanfare was obtained.

RECOMMENDATIONS

Since the growth and yield performance of lettuce in lahar-laden areas using different FPJ concentrations was comparable, it may be recommended to repeat the study. The concentration of FPJ may be increased from 80 ml per 16 Li of water. Organic liquid fertilizer may be applied to plants planted in poor soils like lahar or sandy soil where leaching or loss of nutrients is fast.

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