Potentials use of leachate for turfgrass irrigation on soil coverage landfill Suwung Bali

Rahayu
Soil Department, Agriculture Faculty, Sebelas Maret University
Corresponding author: rahayu_uns@yahoo.co.id

Abstract. Climate change affect water quality and impact water resources and water supply thus using leachate for grass irrigation is hard choice. Suwung landfill is the largest landfill in Bali and was planted with turfgrass and arranged as a park. This study aims to determine the potential use of leachate water for irrigation of turfgrass and determine the type of grass that is survive and suitable for landfills cover and irrigated with leachate water. The study was survey of field and observation by purposive sampling to observe the growth of grass and followed by analysis of the characteristics of leachate water and well water and soil. Results showed that using non potable water landfill leachate for irrigation of turfgrass during one year showed local seashore paspalum grew well, local Bermuda and Zoysia matrella showed relatively less growth inhibition than the Bermuda hybrid and Axonopus compressus. Grass growth on top hills is more survival than in slope and foot hill areas.

1. Introduction
Climate change affect water quality with changing hydrology resulting in reduced oxygen solubility and impact water resources and water supply [1]. Schmidtko et al. [2] estimate a decline in the ocean’s oxygen about 2% between 1960 and 2010, while decline ocean’s oxygen globally is less than 1% over the past 50 years [3]. Due to climate change the water availability and quality are the main pressures on societies and environment [4]. In the other site, irrigation of agricultural crops consume about 69% of freshwater, thus need efficiency in irrigation [5]. Using leachate for plantation irrigation in landfill is a water conservation and way to decrease the harmful effect on environment [6]. Leachate contains high amount organic and inorganic pollutants thus cause considerable pollution problems. However, using fresh water for landfill plantation irrigation is higher cost.

Suwung landfill is the largest landfill with an area of about 20 football fields, accommodates garbage from Denpasar, Badung, Gianyar, and Tabanan areas. The total area is 32 hectares with 22.45 hectares covered with soil for a garden. The hill is 15 meters high with terraces and slope. Suwung landfill has environmental problems due to open, near the airport, and tourist area. Emphasize sustainable resource use by recycling mineral nutrients contained in landfill leachate as irrigation water for agriculture [7]. Landfill vegetation, normally arranged to prevent landfill cover erosion. Selection of suitable plant species and optimum concentration of leachate are important factors in prevention of vegetation damage, when use leachate irrigation [8]. Turfgrass is the most widely used plant for phytoremediation activity [9]. Grass is also widely used for landfill area stability and biological reclamation [10]. Grass has its own mechanism for detoxification and deactivation of anthropogenic pollutants which it absorbs [11] and neutralization through physiological pathways, thus it most resilient to live in areas contaminated with landfill leachate [12]. Application of leachate to the plants caused an increase in the accumulation
of N in the upper parts of plants [13]. The high bioaccumulation of metals highlights the suitability of the species for its employment in phytoremediation and leachate composition [14].

The negative effects of landfill leachate for irrigation on soil crop systems are the high salt content, especially sodium chloride (NaCl) [15]. The total dissolved salt in irrigation water that is acceptable for turfgrass in general is 200 to 500 mg/L or ECw = 0.31 to 0.78 mmhos/cm. TDS concentrations higher than 2,000 mg/L (EC = 3.1 mmhos/cm) can inhibit grass growth and can even cause grass mortality. If using irrigation water with a TDS concentration higher than 500 mg/L, attention should be paid to the duration and frequency of irrigation, drainage, and selection of turfgrass species [16]. Plant damage occurred in irrigation water with a concentration of Na + 600 to 1200 mg/l, Cl- concentrations of 1700 to 2600 mg/l, and EC 8 to 12 mS/cm [17]. Another negative effect of irrigation water is high COD and BOD [18]. The use of landfill leachate irrigation for irrigation requires important management, namely by minimizing the amount of use to avoid salt accumulation and remove ammonium, because ammonium expels K+, Ca2+, Mg2+ from the soil absorption complex. It is very important to check the salt concentration in the soil so that it does not exceed a certain threshold value for plants [17]. The relative concentrations of Na, Ca, and Mg are calculated in SAR (Sodium Adsorption Ratio) and are important indicators of irrigation water quality, because of their potential detrimental effects on soil structure and permeability. In general, a SAR value below 3.0 is safe for turfgrass irrigation, although it depends on the level of sensitivity of turgrass species to salinity. The purpose of this study was to determine the type of rum that survived in the Suwung Bali landfill using leachate as irrigation.

2. Method
This research is a field survey of Suwung landfill Denpasar Bali in September 2019. Investigation of the various types of turfgrass that have been planted by observing the presence of different grasses at the sampled area points. Determination of the point is done by purposive random sampling with 20 checking point, and is proportional to the top of the hill of garbage which has been covered with 150 cm thick soil and planted with various turfgrass. Different grasses are then taken and morphological identification is carried out to determine their types and characteristics. Percentage of plant area is done by checking the land cover by estimating proportionally based on the sampling point and grass identification (Table 3). The purposive investigation also covered the lower part of the landfill hill and the leachate inundation area in the leachate drainage ditch. Sampling of irrigation water for identification of characteristics is carried out in leachate reservoirs, the nearest well to the landfill is 50 m away, the irrigation water tank, and water collection from wells, boreholes, leachate ponds from irrigation sources at 50 meters from the foot of the garbage hill. Characteristics analysis and determination of grass types and analysis of irrigation water were carried out in the chemical laboratory and soil fertility of Sebelas Maret University, Surakarta.

Table 1. Soil used to cover the Suwung landfill

| Soil                  | Ca  | Mg  | Na  | SAR  |
|-----------------------|-----|-----|-----|------|
| Sand landfill cover   | 4.2 | 3.57| 6.279| 3.185|
| Soil landfill cover 1 | 31.32| 11.49| 18.86| 4.076|
| Soil landfill cover 2 | 48.62| 10.00| 112.562| 20.79|

3. Results and discussion
Several areas of sharp slope 30° (Table 4), if the grass has not covered the land during the rainy season, trench erosion can occur on the landfill. Turfgrass was planted by plugging using a cutting sod. Dry grass can still be regrown by watering. The grass is planted in a flat area for the top of the hill. More than 50% of the grass area is on the sloping area surrounding the landfill hill.
Table 2. Characteristics of water and leachate for irrigation in Suwung landfill.

| Sample                     | Ca ppm | Mg ppm | Na ppm | SAR | pH  | Ecw uS/cm | TDS ppm |
|----------------------------|--------|--------|--------|-----|-----|-----------|---------|
| well 1 arwash              | 143.2  | 7474   | 41.2   | 1.02| 7.05| 7.31      | 4.678   |
| well Bore UPT              | 482.0  | 5848   | 16.5   | 0.45| 7.2 | 7.27      | 4.652   |
| Water in Tank              | 81.5   | 7056   | 13.7   | 0.35| 8.54| 9.25      | 5.920   |
| leachate 1 (stream)       | 78.9   | 5885   | 5.8    | 0.16| 7.88| 25.5      | 16.320  |
| Leachate pond              | 94.5   | 5225   | 9.2    | 0.27| 7.8 | 34.4      | 22.016  |

The high level of TDS in the landfill leachate is the accumulation of salt carried in the waste and after the waste undergoes decomposition, the salt dissolves and accumulates in the leachate. The division of water quality based on water salinity levels are: Fresh water (EC <1250 mmhos). Saline water (EC: 1250 - 12,000 mhos), and brine> 12,000 mhos). Another criterion is based on TDS (mg/L) where fresh water is 0 - 1,000, slightly brackish water (slightly saline) 1,001 - 3,000, brackish (moderately saline) 3,001 - 10,000, Saline 10,001 - 100,000, and very salty (brine) > 100,000 [19]. In Table 2, it can be seen that leachate ponds and rivers are categorized as heavily brackish, while water from wells, drilled wells and in tanks is moderate brackish water. The use of brackish water for irrigation requires careful selection of cultivars and grass species. The use of 2.5 dS/m irrigation water for two years for Tifgreen bermudagrass, local bermudagrass and Nagisa zoysiagrass showed good growth performance, and up to a salinity of 6.25 to 12.5 dS/m, the three grasses still grew well. However, at 18.8 dS/m, only Tifgreen showed acceptable turf quality, meanwhile local mudagrass and Nagisa Zoysiagrass showed lower quality [20]. Commonly zoysiagrass in general belong to salt tolerant turfgrass with equivalent in salinity tolerance to a highly salt-tolerant seashore paspalum [21].

In this study, grass growth still showed performance, especially in local seashores paspalum, but there were some obstacles in local Zoysia and Bermuda. Seashore paspalum for 50% decrease in growth when irrigated using 25 dS/m saline water [22]. Cynodon dactylon suffered growth damage if irrigated for about 15 weeks with concentrated leachate, and still maintained good growth with an irrigation rate of 10% of leachate [8]. Cynodon dactylon also exhibits good tolerance to salty water, where 60% shoot growth reduction just when the salinity levels of 24 and 33 dS/m [23].

Table 3. Presence of grass species and their conditions in TPA Suwung

| Turfgrass types             | Prosion coverage | condition           |
|-----------------------------|------------------|---------------------|
| Native bermuda              | 40 %             | Slightly injury     |
| Native Seashore paspalum    | 40 %             | Grow well           |
| Bermuda hybrid              | 5 %              | Stress in foot area of hill |
| Paspalum hybrid             | 5 %              | Stress in foot area of hill |
| Zoysia matrella             | 10 %             | Slightly injury     |
| Axonopus compressus Dwarf   | 5%               | Heavy injury        |
From table 3, there are 4 main grass plant species, namely *Cynodon dactylon* (Bermuda) with local and hybrid cultures, *Paspalum vaginatum* species (seashore paspalum) with local and hybrid seashore paspalum cultivars, *Zoysia matrella* species and *Axonopus compressus* Dwarf species (carpet grass). Seashore paspalum grass, *Zoysia matrella* and local Bermuda showed good growth with few obstacles, while Bermuda hybrid, seashore paspalum hybrid and carpet grass showed stress in their growth. Seashore paspalum grass showed the best growth and did not show any stress even though during the growing period it was watered with leachate irrigation water. 

The growth of grass which generally grows with little resistance in local *Zoysia* and Bermuda and the fertility of local seashore paspalum shows that efforts to use irrigation water have not shown any problems with grass growth. Grass has been developed for detoxification and deactivation of pollutants in the soil [11]. Bermudagrass has succeeded in growing well on wetlands contaminated with Pb, Cu, Zn, Cd, Ti, Sb and as metals [24]. However, combination of turfgrass *Cynodon lemfuensis* and *Pennisetum clandestinum* survived and grew on land affected by municipal wastewater for 29 years [25]. In polluted waters bermudagrass in the first- and second-year planting formed healthy, dark green foliage and enough succulent tissue [26]. In this study, the local paspalum seashore showed the best growth and did not show any symptoms of leachate irrigation stress compared to other species and cultivars (Table 3). *Axonopus compressus* dwarf is not suitable for planting in this landfill because it shows stunted growth and experiences stress. *Axonopus compressus* suffered a 50% shoot growth reduction at 18.6 dS/m of salinity, and a root growth reduction at 21.4 dS/m of salinity of sandy soil [27].

**Table 4.** Grass growth conditions in landfill areas

| Part of the hill | Slope | Turfgrass condition |
|-----------------|-------|---------------------|
| top             | 0°    | grow well, the planted trees begin to grow,  
|                 |       | In the nursery area, local Paspalum grass and local Bermuda grass grow well  
|                 |       | The main weeds appear in the flat area of the top of the hill which is the main recreation area |
| Middle          | 30°   | Grass Grows rather well and with some mortality, there are different levels of stress for different grasses |
| Foot of hill    | 30°   | There was a lot of grass mortality, the point of dryness was minimal, and the grass was stressed |
| Around of foot  | 30°   | It grows well for Seashore paspalum and some native bermuda |

The grass growth on the top hill is growing well compared to the middle area and foot hill. Accumulation of irrigation water on the foot hill and some areas that show leachate discharge from the garbage heap is a major cause of stagnation of grass and plant mortality. Each plant has a different level of resistance to irrigation water quality levels. Basically, grass is very resistant to the presence of a large number of harmful compounds in water such as landfill leachate [28], so that even though there is an accumulation of leachate concentration in the lower hill area, the grass can still survive. That is why grass is widely used as biological reclamation and stabilization of landfill space [29]. The accumulation and neutralization of toxins occurs in the physiological pathway of turfgrass [12], so that planting grass is an environmentally friendly method for processing landfill leachate [30].

Figure 2 shows that seashore paspalum hybrid and Bermuda hybrid at the bottom of the sloping area are poisoned by leachate. Poisoning causes the grass to experience death. Grass can still survive on stolon that are not exposed to leachate. Chiemchaisri et al [8] reported in landfill the pH and EC were not the factors causing plant death, but the most cause of grass death might be from additional high organic carbon contents long oxygen deficiency in the soils due to microbial activities. Management
irrigation to reduce accumulation is important. Seashore paspalum requires irrigation of 0.24 to 0.32 inches per day, Bermuda 0.16 to 0.34 and Zoysia 0.19 to 0.30 inches/day [31].

Figure 2. paspalum hybrid (left) and Bermuda hybrid (right) at the bottom of the sloping area

Figure 3. Local paspalum seashore grass growing in landfill leachate drainage ditches (left) and Bermuda grass growth on clay loam soil (right)

Watering the soil with well water shows that the grass is still growing. Weed seeds also germinate and grow. Local seashore Paspalum grass survives in soils that are flooded with leachate in gutters. Manila grass and Bermuda hybrid should be watered with fresher water, because at the location it looks the most stressful compared to other grasses. Seashore paspalum is very salt-tolerant turfgrasses where can use sea water or any type of reclaimed water for irrigation [32]. Seashore paspalum is potential to be the most environmentally compatible turfgrasses [25], since most Seashore paspalum exhibited halophytic responses to salinity and some could tolerate sea water salinity [33].

4. Conclusion
Using non potable water landfill leachate for irrigation of turfgrass during one year showed local seashore paspalum grew well, local Bermuda and Zoysia matrella showed relatively less growth inhibition than the Bermuda hybrid and Axonopus compressus. Grass growth on top hills is more survival than in slope and foot hill areas.

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