Research Article

Selection of Suitable Organic Manure for Higher Growth and Yield of Medicinal Plant Katuwelbatu (*Solanum virginianum* L)

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Abstract

Although, organic manures can improve the soil fertility, different organic manures may perform differently on soil fertility and on plant productivity. Katuwelbatu (Solanum virginianum) is one of the commonly used medicinal plants in the indigenous medicinal system in Sri Lanka for various ailments. In order to ensure the safety in health aspects of humans and to ensure the continuous supply of this plant's parts in Ayurveda medicine, organic manures are used in cultivation of this plant. This research was conducted in Medicinal Plant Garden, Ganewatta, Kurunegala, Sri Lanka for a period of one year to identify the effect of organic manures on the productivity of Katuwelbatu (Solanum virginianum). This research was arranged in a Randomized Complete Block Design (RCBD) with five treatments and each treatment was replicated three times and each plot was having 20 plants and in total 300 plants were used. Treatments were Compost (10t /ha) (T1), Cattle manure (10t /ha) (T2), Poultry manure (10t /ha) (T3), Poultry manure 30% + Cattle manure 70% (10t /ha) (T4) and Untreated Control (T5). Data were collected on plant height (cm), number of leaves/plants, number of branches/plant, number of flowers/plant, number of berries/plant, plant fresh weight (g), berries weight (g), plant dry weight (g) and berries dry weight and analyzed using SAS statistical package (university version). The highest plant height (cm), leaf number, branch number, flower number, berries number, berries and plant dry weights (g), which were significantly greater ($p<0.05$) with poultry manure (10t/ha) treatment when compared to other treatments. Poultry manure (10t/ha) was found to be the most promising organic fertilizer to obtain a higher productivity from Katuwelbatu among different organic manures tested.

Keywords: *Organic manures, plant growth, poultry manure, yield*

1. Introduction

The medicinal plant katuwelbatu (*S. virginianum* L) is an annual herb of the Solanaceae family. The life span is about 4 months. The whole plant parts are used in dried form in Ayurveda medicine. A very prickly small shrub, 20-40 cm high, horizontally branched, bearing numerous straight compressed bright yellow prickles. Leaves deeply pinnately lobed with sinuous outlines to the lobes, with a length of 6-10 cm and width of 5-9 cm. Inflorescences few flowered, corolla violet. Fruits are spherical, yellow, and glabrous (Dassanayake, and Forsbery, 1987).

Katuwelbatu is well grown in the warmer climate and on sandy soils throughout Sri Lanka and India. It is also called yellow-berried nightshade in English, Kantakari in Sanskrit, and Nelagulla in Kannada. It is also grown in Sri Lanka and Malacca through South-East Asia, Malaya, tropical Australia, and Polynesia. It is a major component of *Dashamula* of Ayurveda due to its phenolic content and flavonoids (Morankar and Jain, 2019).

Ayurveda medicine has prime importance in the health care system of the rural population in Sri Lanka for several centuries. With the COVID pandemic, Ayurvedic medicine has reached considerable importance in the urban population too. Especially *paspanguwa* contains katuwelbatu, which is the common medicinal drink for fever used by patients during the COVID pandemic too in Sri Lanka (Zoysa *et al,* 2017). Sri Lanka is rich in medicinal plants and protecting these medicinal plants for continuous supply for the preparation of Ayurveda medicine is of great importance. Katuwelbatu is widely used in Ayurveda medicine in Sri Lanka for a variety of diseases such as fever, asthma, bronchitis, urinary diseases, and heart diseases and to alleviate physical pain. Dried berries of Katuwelbatu are used in the preparation of *paspanguwa* formula as one of the five major ingredients. Katuwelbatu an ingredient used in ayurvedic preparations is still imported into the country (Zoysa *et al*, 2017).

According to Ayurveda, Katuwelbatu has *katu* (pungent) and *tikta* (bitter) tastes, *laghu* (light), *ruksha* (dry) and *tikshna* (penetrating) properties, *ushna virya* (hot potency) and *katu vipaka*. There are 3 main *dosha* (humors) in the body according to Ayurveda, and they are *vata, pitta* and *kapha.* The main effect of katuwelbatu on these dosha is *kapha-vata shamaka* which means katuwelbatu pacifies the increased or aggravated *kapha* and *vata dosha* in the body. Pharmacological actions of Katuwelbatu are *vedana nashaka* (pain-killing), *hrda uttejaka* (cardiac- stimulating), *kushtaghna* (eradicates skin disorders), *kesha vardhaka* (stimulates hair growth), *deepana* (appetizer), *pachana* (stimulates digestion) and *vajikarana* (aphrodisiac) (Jayaweera, 1992).

However, the medicinal qualities of katuwelbatu also differ according to the part of the plant. While the plant as a whole has *pachana* (stimulates digestion) and *balakaaraka* (strength promoting) actions, the bark, flowers and fruits have an

anulomana action and the flowers alone have j*waraghna* (cures fever) actions. Compounds containing katuwelbatu are used in respiratory disorders, chronic cough, vomiting, urinary disorders and urinary calculi (Morankar and Jain, 2019). *Dashamoola arishta, Dashamoola kwatha* and *Khantakari kwatha* are some of the medicines containing Katuwelbatu (Compendium of Medicinal Plants, 2001; Jayaweera,1992). Considering the important role of medicinal plants in different industries, it is vital to increase production of biomass without the use of harmful inorganic fertilizers (Badalingappanavar *et al,* 2018). The use of organic manures and microbial symbiosis with species of medicinal plants under organic agriculture helps to improve yield and quality. Organic farming helps to increase farm productivity by enhancing soil fertility and profit by reducing the cultivation cost (Badalingappanavar *et al.*,2018).

Mainly fertilizers can be divided into two types: organic fertilizers and inorganic fertilizers (Chemical fertilizers). Heavy use of artificial fertilizers has been caused to pollute soil and water resources thereby the quality of crop products finally affecting the environment and human health. With the policy decision of the former government, the importation of inorganic fertilizer was banned in 2021 and in line with that, the demand for organic fertilizers increased (Amlinger *et al* 2013).

Organic fertilizers are produced using various types of organic materials that are more environmentally friendly. The organic fertilizers mainly supply nutrients such as nitrogen, phosphorus and potassium with several other micronutrients. But different organic fertilizers may have different effects on plants based on the type of organic material used. The application of organic fertilizer made from agricultural waste regenerate natural resources (Ibrahim and Fadni, 2012).

Organic fertilizers provide several benefits such as improvement of soil structure, enhancement of activities of useful soil organisms, increase in cation exchange capacity (CEC), increase in water holding capacity, decrease of toxicity at low pH and act as a reservoir of plant nutrients. It also reduces the production cost and ensures an environmentally friendly method of cultivation with higher profit (Badalingappanavar, 2018).

Poultry manure is an excellent organic fertilizer and consists of bird faeces, urine, and litter from bedding materials that resulted from intensive poultry production. Poultry manure contains high N, P, K, and other essential nutrients (Farhad *et al.*, 2009). It is proven to supply phosphorous more readily to plants than other organic manures. Cattle manure provides nutrients for plant growth and leads to an increase in soil pH, organic carbon, nitrogen, phosphorus, calcium, potassium, and sodium (Binoy *et al.*,2004). Cattle manure has 70% of moisture, 20% of organic matter and 3% of mineral matter (containing micro and macronutrients). Compost fertilizer is made with the objective of recycling plant and animal remains for crop production. Compost can solve the problem of decreasing fertility of soil because it has

decomposed organic material resulting from the accelerated biological degradation of organic materials under aerobic conditions (Paulin and Peter, 2013). Compost improves the water holding capacity of the soil and helps the soil to maintain good tilth and thereby better aeration for germinating seeds and plant root development (Edwards and Hailu, 2011).

Hence, it is timely and important to study the productivity of katuwelbatu under different organic manure applications assuring a continuous supply of this medicinal plant for Ayurveda medicine. The present study was designed to investigate the impact of different organic manures on the productivity of the katuwelbatu plant and to find the best organic manure among the treatments.

2. Material and Methods

2.1. Location

The investigation was carried out at the Medicinal Plant Garden, Ganewatta, Kurunegala, in the North-Western Province. It is located in Intermediate Zone at 7.87 °N latitude and 80.77 °E longitude. An altitude of 1.0 m above mean sea level. The intermediate climate with 1800 mm of rainfall and warm days and cool nights gives an ideal environment for the most indigenous herbal plants. The experiment site had sandy loam soil suitable for katuwelbatu. This garden has spread over 22 acres and there is a collection of medicinal plants that are used for Ayurveda medicinal treatments.

2.2. Experimental design and treatments

The experiment was arranged in a Randomized Complete Block Design (RCBD) with three replicates. Five treatments as mentioned below were imposed in the experiment using three organic manures namely Compost alone, Cattle manure alone, Poultry manure alone, a combination of poultry manure (30%) and cattle manure (70%) and; another 'Control' treatment without any fertilizer was included. Each fully air-dried organic manure was incorporated at 10 t/ha according to the Department of Agriculture, Sri Lanka (DoA, 2007) recommendation for Solanaceae crops.

T1 : Compost @ 10 tons/ha

T2 : Cattle manure @ 10tons/ha

T3 : Poultry manure @ 10 tons /ha

T4 : Poultry manure 30% (3 tons/ha) + Cattle manure 70% (7 tons/ha)

T5 : Untreated Control (no organic manure/no chemical fertilizers)

2.3. Preparation of nursery

The seeds were soaked in clean water for 12 hours. Then the seeds were taken out of the water and placed in a wet cloth and wrapped. After 3 days, germinated seeds were established in the nursery bed. The length of the nursery bed was at least 3 meters and width of 1 meter. Organic manure was added with fine sand to prepare the bed. In order to fumigate and sterilize the seed bed, paddy husk and straw layers were put on the surface of the bed and fire was set to burn the seedbed from the opposite side of the wind direction. A nursery bed was established by sowing the seeds after mixing with sand in separate lines and the seeds were covered with fine sand. Finally, the nursery bed was covered using a gauge 1 transparent polythene sheet. In order to avoid wilting and to enhance normal plant growth, clean water was supplied using a watering can every morning.

2.4. Land preparation for plant establishment

The site was mechanically prepared using a tractor. The experimental site was cleared by removing unwanted plant debris, and then ploughed and harrowed for loosening and turning of the soil. Then the land was divided into different plots. Fifteen plots were then marked, each with the size of 2.4 x 4.5 m (10.8 m^2). Each organic manure type according to the treatments were incorporated with topsoil on randomly selected plots at least 3-5 days before planting. Table 1 shows the actual weight of organic manure and fertilizers applied to each plot.

Table 1: Organic Fertilizer requirement per each plot

	Requirement for 1 hectare	Requirement for 1m^2	Requirement for 1 plot	Requirement for 3 plots	Total organic fertilizer requirement for 3 plots (basal dressing + top dressing)
Compost	10 ton	1 kg	10.8 kg	32.4 kg	64.8 kg
Cattle manure	10 ton	1 kg	10.8 kg	32.4 kg	64.8 kg
Poultry manure	10 ton	1kg	10.8 kg	32.4 kg	64.8 kg
Poultry manure 30%+ cattle manure 70%	10 ton	1kg	10.8 kg	32.4 kg	Poultry 30% - 19.44 kg Cattle 70% - 45.36 kg

Four weeks old katuwelbatu seedlings obtained from a nursery were transplanted on plots at a spacing of 90 cm x 60 cm. Size of the planting holes was 30 cm^3 (DOA, 2012). Watering was done daily for two weeks except on rainy days and once a week after 2^{nd} week. After seedlings were transplanted, watering was done manually. Plants were watered daily for two weeks except in rainy days. After that watering was done once a week, weeding was done manually.

2.5. Data recording

The growth and yield parameters were taken weekly. Plant height was measured from the base of the stem to the tip of the highest leaf by using a meter ruler in cm. The number of flowers and the number of berries were measured at two weeks intervals after the initiation of the reproductive growth. At the end of the experiment, fresh weight (g) and dry weight (g) of the plant and berries were measured using a top loading balance.

2.6. Data analysis

The data were analyzed through analysis of variance (ANOVA), using the General Linear Model procedure of Statistical Analysis System (SAS), University version. And the means were compared by Duncan's Test at 5% error probability.

3. Results

3.1. Growth parameters

Mean plant height

The highest (5.8 cm) and the lowest mean plant height (3.8 cm) were measured in poultry manure (T3) treatment and control (T5) treatment, respectively and there was a significant difference between the control treatment and all other organic manure treatments as a result of no organic manure or inorganic fertilizer incorporation into control. However, there was no significant difference ($p<0.05$) between organic manure treatments for the mean height of katuwelbatu (Figure 1).

Mean number of leaves

No significant difference ($p<0.05$) was observed under different organic manure treatments (Figure 2). However, poultry manure (T3) treatment recorded the highest mean value for the number of leaves. Whilst, the control treatment recorded significantly the lowest mean ($p<0.05$) leaf number.

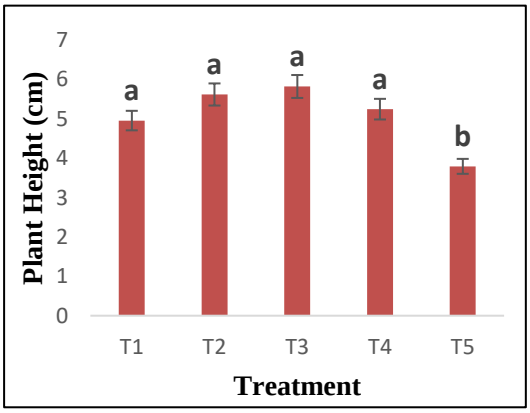

Figure 1: Mean plant height affected by different organic manure treatments

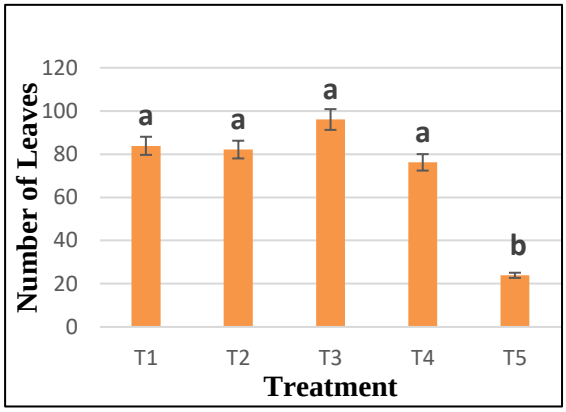

Figure 2: Mean leaf number affected by different organic manure treatments

Mean number of branches

Figure 3 shows that the highest mean branch number was recorded by poultry manure (T3) followed by cattle manure treatment (T2), which are comparable. Compost treatment (T1) and Poultry manure 30% + Cattle manure 70% (T4) treatment were also identical. Control (T5) treatment recorded the lowest mean branch number.

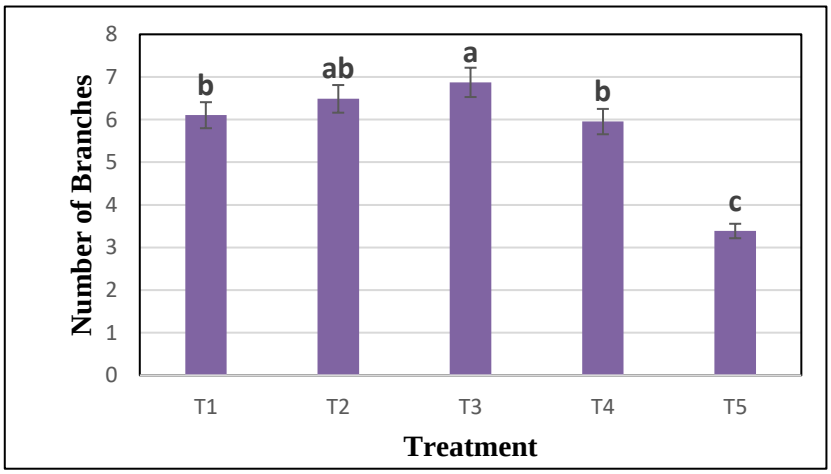

Figure 3: Number of branches as affected by different treatments

3.2. Yield parameters

Mean number of flowers

There was a significant difference between various organic manure treatments in the mean number of flowers (Figure 4). Significantly ($p<0.05$) the highest mean

number of flowers (9) was recorded with poultry manure (T3) treatment. The lowest number was recorded with the Control (T5) treatment. Compost (T1) treatment recorded a higher mean number than the cattle manure (T2) treatment.

Mean number of berries

Significantly ($p<0.05$) the highest mean number of berries (24) was recorded for poultry manure (T3) treatment followed by cattle manure (T2) treatment (18.5) and compost (T1) treatment (16.5). Significantly ($p<0.05$) the lowest mean number of berries (4) was recorded with untreated control (T5). A moderate number of berries (15) was recorded in poultry manure 30% + Cattle manure 70% (T4) treatment. There was a significant difference among the different organic manure treatments (Figure 5).

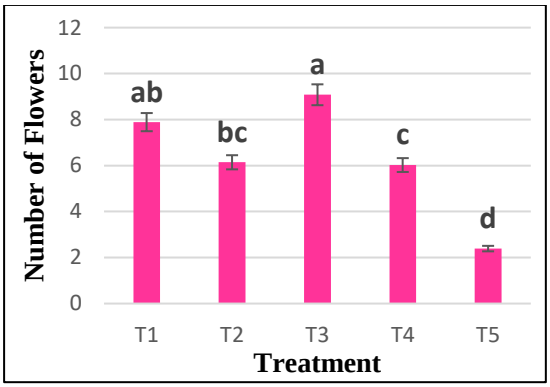

Figure 4: Number of flowers as affected by different treatments

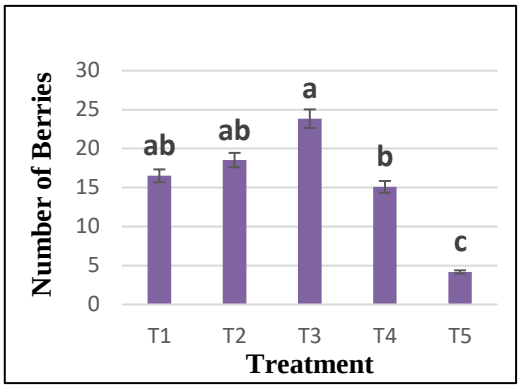

Figure 5: Number of berries as affected by different treatments

Mean fresh weight of berries (g)

Significantly ($p<0.05$) highest mean fresh weight of berries (58.4 g) was recorded with poultry manure (T3) followed by Cattle manure (T2) treatment (52.7 g) and Compost (T1) treatment (36.1 g), and Poultry manure 30% + Cattle manure 70% (T4) treatment (33.1 g). The lowest mean fresh weight of berries (10.7 g) was recorded for control (T5) (Figure 6).

Mean dry weight of the plant

Significantly ($p<0.05$) highest mean dry weight of the plant (34.7 g) was recorded in the poultry manure (T3) treatment followed by cattle manure (T2) treatment (29.2 g), compost (T1) treatment (24 g) and Poultry manure 30% + Cattle manure 70% (T4) treatment (22.9 g). The lowest mean dry weight of the plant (13.7 g) was recorded in control (T5) treatment (Figure 7).

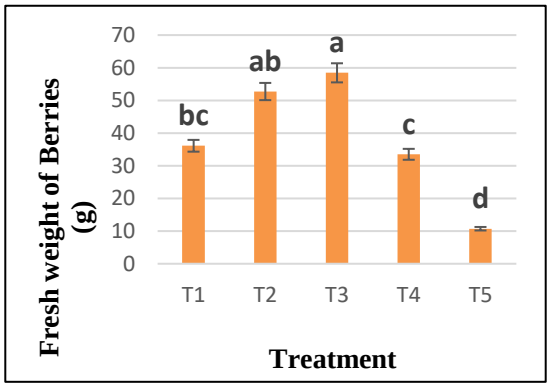

Figure 6: Mean fresh weight of berries as by different treatment

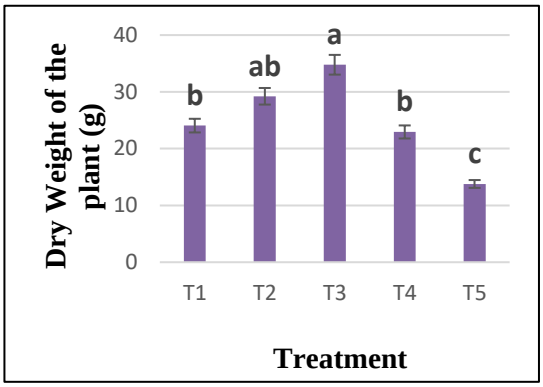

Figure 7: Mean dry weight of plants as affected by different treatments

4. Discussion

Application of organic manure has improved the mean plant height, number of leaves, number of flowers, number of berries, fresh weight of berries, and dry weight of plant of katuwelbatu and these findings are also in agreement with previous studies. Ali *et al*, (2014) showed that the application of organic manure had significantly affected on plant height, leaf number, branch number, leaf area, flower number per plant and fruit yield of Tomato. Ibrahim and Fadni (2012) also noted that growth parameters of tomato in the first season were significantly ($P \leq 0.01$), influenced by different organic manures. Organic fertilizers have a clear impact on the different stages of plant growth. Compost, cattle manure, chicken manure, cattle manure + chicken manure increased plant height, number of branches, fresh and dry weight of roots and shoots in Tomato; in contrast to the untreated control (Ibrahim and Fadni ,2012). According to Boateng *et al.* (2006) Poultry manure contains 1.4-6.8% N, 0.5-1.1% Ammonia, 0.5-3.51% Phosphorus and 1.2-2.7% Potassium. Poultry manure also contains Ammonium-N (NH4-N) which is a significant part of total N in addition to the uric acid. In most soil uric acid metabolizes rapidly to NH4-N and as a result, there will be high NH4-N and uric acid contents in poultry waste. Therefore, larger percentage of N can be converted to nitrate-N (NO3-N) within a few weeks, and it will be readily available for plants (Sims and Wolf, 1994).

Ewulo (2008) showed that poultry manure has significantly increased the yield of Tomato. Usman *et al.* (2015) concluded with an organic manure experiment that the growth and yield of Tomato with poultry manure was positively influenced giving the highest number of leaves and branches per plant and fruit yield of 28.0 t/ha. Comparatively, lesser fruit yield of 11.5t/ha was obtained with the application of goat manure and the lowest was reported in control treatment.

Department of Agriculture (2012) also reported that fresh pod weight of Okra was significantly increased by 34.6% with poultry manure compared to the control treatment. Tiamiyu *et al.*, (2012) showed that Okra grown on poultry manure performed better in plant height than other sources of organic manures and control treatment due to higher soil fertility with poultry manure. These findings are in agreement with the present results that poultry manure is effective in increasing the growth and yield of Katuwelbatu.

The poultry manure contains both macro nutrients (Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulfur (S)) and micronutrients such as Copper (Cu), Iron (Fe), Manganese (Mn), Boron (B). Poultry manure can also increase soil carbon, nitrogen, soil porosity and enhance soil microbial activity (Veeramani *et al.*,2012). It is relatively resistant to microbial degradation. These properties of the poultry manure increase the soil fertility, consequently, increases the growth and yield parameters of vegetable crops and medicinal plants. Studies also proved that the application rates of poultry manure and types of poultry manure (broiler or litter) played major role on soil properties (Gilley, 2000). In addition, poultry manure also provides many other benefits such as improvement of soil properties and prevention of soil erosion, especially with retention of material for a longer period after land application.

Cattle manure is a mixture of cattle dung and agricultural residue which contains 0.5 - 0.7 % N, 0.3 - 0.9 % P2O5 and 0.4 - 1.0 % K, depending upon the type of animals and nature of feed (Belay *et al.*, 2001). Cattle manure releases nutrients slowly and steadily and activates soil microbial biomass. Nutrients in cattle manures are slowly released but stored in soil and available for plants for a longer time period, thereby contribute to the better vegetative growth and root development leading to higher productivity (Ayuso *et al.*, 1996). It also improves the soil nutrients, tilth, aeration, and water holding capacity. Therefore, application of cattle manure improves the growth and yield of Katuwelbatu.

Compost contains significant amounts of plant nutrients such as N, P, K, Ca, Mg, S and a varying amount of secondary nutrients and micronutrients including essential trace elements (Agegnehu *et al.*, 2014). In addition, some composts contain other growth promoting substances such as B vitamins, natural hormones, and organic acids (Harris *et al.*, 2001). As a result, application of compost increases the productivity of Katuwelbatu.

Khandaker (2017) also reported that the different organic fertilizers such as vermicompost, chicken dung, peat moss, fermented fish waste, and cow dung on growth, yield and quality of Capsicum annuum L. var. kulai (Red Chilli). And application of chicken manure showed the highest growth, quality and yield

performance. Control treatment (without organic fertilizer) showed the lowest growth, yield and quality.

Ahmad *et al.*, (2017) also reported that the number of days to germination, leaf number, branch number, leaf area, days to harvest, chlorophyll content of Coriander were significantly increased with organic fertilizers such as FYM, Compost and Poultry. And the plants grown with poultry manure showed the highest number of leaves branch, highest leaf area (14.95 cm2) and minimum days taken to harvest (40.75). The least days taken by the plant to germinate (11) was recorded from plot where compost was applied. Hence, poultry manure is found to be performed best among the organic manures.

5. Conclusion

It can be concluded that the poultry manure (10 t/ha) has significantly affected on all growth parameters and yield of katuwelbatu when compared with other organic fertilizers and their combination tested. Cattle manure was also performed better towards a higher crop growth and yield of katuwelbatu. Poultry manure at 10t/ha can thus be used to get higher productivity of katuwelbatu (*Solanum virginianum*) for sustainable use in Ayurveda and traditional medicine.

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