TECHNOLOGY TRANSFER OF CHRYSANTHEMUM CULTIVATION IN DISASTER AREA OF MOUNT MERAPI TO IMPROVE PEOPLE REVENUE

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Abstract. Chrysanthemum flowers are a main income source of surrounding communities of Hargobinangun. Hargobinangun became the main cut flower's supplier to the province of Yogyakarta before the Merapi's eruption. However, due to the shortage of cut flower production, currently those have to be imported from other areas such as Cipanas, Pasuruan and Malang. One of the production's obstacles is the environmental damage. Soil in planting area was covered by thick sand and volcanic ash from Mount Merapi eruption. Research and transfer of technology has been carried out by R & D team of Universitas Pembangunan Nasional "Veteran" Yogyakarta (UPNVY). The technologies of amelioran's addition to the soil in the disaster areas was using simple techniques, inexpensive and available materials from surrounding farmers site, such as manure, bamboo leaf litter and garden's compost. The materials were initially fermented by using PGPR that were produced by R & D UPNVY. In addition, application of horticultural mineral oil (HMO) was performed to avoid white rust infection. The results showed the increase of soil fertility and plant growth significantly which is expressed by the increase of plant height, stem diameter, and leaf area after application of ameliorant. The quality of cut flowers was also increase, in the form of the increase of flower diameter, and numbers of ribbon flower.

Keywords: Chrysanthemum, environmental damage, ameliorant, HMO

1. Introduction

Merapi eruption in 2010 brought tremendous impact on environment, socioeconomic, and agriculture. One of the affected areas was Pakem district. It was exposed by ash and sand directly Village on the slopes of Merapi, which has the potential to be developed as center of ornamental plants is Hargobinangun, subdistrict Pakem. Since 2005 the region has been appointed to be the center of chrysanthemum flower cultivation of Yogyakarta Province, considering the altitude of the area (500-800 m above sea level) are eligible for the growth of chrysanthemum. Curently, chrysanthemum cultivation has been carried out by more than 100 local farmers which are grouped in 13 farmer groups to manage an area of 10,000 m^2 with a production capacity of 15,000 cut flowers per week (BAPPEDA DIY, 2003).

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After the eruption of Merapi on November 5, 2010, Chrysanthemum cultivation in the Hargobinangun village becomes stagnant. Most farmers did not know what to do because the chrysanthemum planting area conditions were destroyed. That's because the area is an area that is very close to the Mount Merapi. The planting area locations are just 4-10 km from the peak of Merapi. Post the eruption, planting area was covered by volcanic ash and sand, and could not be used for cultivating anymore.

Chrysanthemums, in the form of cut flowers, produced by farmers in Wonokerso were much degraded, so that consumers were switching on chrysanthemum imported from other regions, such as West Java and East Java. In the field survey showed poor production quality was due to the plant roots were not well developed, brown coloured with short size. Volcanic material with a thickness of 5-15 cm that covers Wonokerso became compressed (compact), hard, water-resistant. Addition of ameliorant was needed to restore the crumb structure. Wijayani, *et al*. (2011) reported that the volcanic material that was given ameliorant vermin compost and cow manure was good for dahlias plant growth in the Kinahrejo region. Basically dahlias and chrysanthemums almost the same, so as to improve the planting area of chrysanthemum can be used the same ameliorant.

Chrysanthemum white rust (CWR) can be a serious disease of chrysanthemum crops. According to Kristina *et al.* (1994), white rust disease (Puccinia horiana P. Henn.) may decrease freshness of chrysanthemum flowers (vase -life) into only 5 days, significantly shorter than the healthy ones. It freshness can last up to 12 days at room temperatures (27-29°C). Chrysanthemum yield loss caused by white rust disease is reaches 30% in Indonesia (Suhardi 2009), 80% in Turkey (Gore 2007), and 100% in New England (Ellis 2007). Some insects reported as vector of some virus diseases, i.e. *Aphis craccivora*, *Acyrthosiphon pisum*, and *Myzus persicae* (Rahardjo *et al.*,2005) *Macrosiphoniella sanborni*, *Rophalosiphum sp*. (Aphididae) (Balithi, 2007) also attack leaves of chrysanthemum. Various pest and disease control measures has been done, such as the use of tolerant varieties, culture technique (i.e. cutting infected leaves and setting watering), the use of natural enemies, and the application of synthetic pesticides. However, the intensity of pest and disease still high. Recently, mineral oils were found to be highly effective against citrus pest (Rae *et al.* 1996; Cen *et al.* 2002). Horticultural mineral oil (HMO) is highly refined mineral oils originated from crude petroleum oils. It is paraffinic compound (≥60% of carbon atoms occur in chains). It has unsulfonated residue (UR) values ≥92 % (therefore it contains ≤8% aromatic molecules). It molecule weights vary and is reflected in the number of carbon atoms. The lightest oils are nC21 oils, and the heaviest oils are generally *n*C25 oils. These values reflect the median equivalent n-paraffin carbon numbers and distillation temperatures (Agnello 2002; Beattie 2005). Several factors favor the use of horticultural mineral oil, including low cost, low mammalian toxicity, and few deleterious environmental effects (Fernandez *et al*., 2006).

Thus the main problem being urgency (virtue) doing in this research is a complete study of various aspects of the chrysanthemum plant cultivation techniques that can improve growing conditions.

2. Research Methodology

The experiment was conducted in the village Wonokerso, Pakem, Sleman Yogyakarta with the complete randomized block design consists of two factors: material of ameliorant and HMO concentration. The first factor consisted of four levels: vermin compost, fern compost, cow manure and litter of bamboo plants. The second factor consisted of three levels: 0.125%, 0.250%, 0.500% v/v of horticultural mineral oil (HMO: *n*C21 Sunspray Ultra Fine®, Amtrade Pty). As control chrysanthemums was grown in media without ameliorant and without HMO application. From these two factors each repeated three times and each block contains 50 plants with five sample plants, so that the overall number is 1800 crop plants plus 150 control plants.

Research was conducted in UV plastic roofed green house, facing east to form a semicircle dome roof. Land management was done as deep as 30 cm and it was mixed with ameliorant material according to treatment, then beds were made 10-20 cm height. Chrysanthemum seedlings taken from horticultural research institute at Cipanas, West Java were planted in beds that have been given the nets. Plants were treated for three months which includes watering, and fertilizing. Watering the plants was conducted twice a day. Fertilization was done at the beginning of the study using 75 grams N, 75 grams P, and 25 grams K fertilizer per plant and leaf fertilizer once a week.

Assessment was conducted fortnightly before oil spray application on five randomly chosen central plants within each plot on plant height, diameter of flower, number of ribbon flower, leaf area, stem diameter, aphid population, and the spread of white rust disease. Visual observations determined the number of aphid per leaf on five chosen leaves on upper part of tree. The spread of white rust was assessed at same samples as aphid assessment by recording fortnightly the number of leaves infected based on the rating scale of severity (Table 1.)

Table 1. Disease severity rating scale used to access the spread of white rust

Severity rating	Description
0	Leaf without any symptom
1	< 25% part of leaf showing symptom
2	25% up to < 50% part of leaf showing symptom
3	50% up to < 75% part of leaf showing symptom
4	≥ 75% part of leaf showing symptom

Data were subjected to one-way ANOVA (analysis of variance). Duncan's multiple range test (DMRT) was used to determine the differences among treatments when the ANOVA was significant (Gomez and Gomez, 1983). Significance different was arise at $P< 0.05$. Analysis was performed using SPSS® version: 10.0.5 (SPSS, 1999).

3. Result and Discussion

Ameliorant material did not affect on diameter of flower (Figure 1A.), the number of ribbon flowers (Figure 1B.), plant height (Figure 2 A.), and the diameter of stem (Figure 2B.) and there was not any interaction between ameliorant and HMO, but significantly higher than the control. Vermin compost was the best ameliorant material for increasing leaf area (Figure 3). Diameter of flowers, ribbon flower number, plant height, stem diameter and leaf area on treatment of ameliorant were ranging: 5.76 to 6.18 cm, 30.33 to 36.67, 87.55 to 90.44 cm, 6, 33 to 7.00 mm and 550.60 to 808.90 mm^2 respectively. While in control, the flower diameter, number of ribbon flower, plant height and stem diameter were only: 4.17 mm, 23.00, 84.67 cm, and 5.15 mm.

Leaf tissue anatomy in monocotyledon is composed of a set of cells that have almost the same shape. It is composed of upper and lower epidermis tissue, and mesophyll tissue which is composed of palisade tissue and spongy tissue. The epidermis covers the upper and lower surfaces of leaves up to epidermal stem (Salisbury and Ross, 1992). Mesophyll layer is the most important leaf part for photosynthesis. Most of palisade layer is composted by chloroplasts, and affects the products of photosynthesis. Damage by high temperatures that occurs in mesophyll, specifically in palisade, will give the highest impact on the photosynthesis activities. The common histological changes in leaf damage by high temperature are plasmolysis, granulation or disorganization of cells constituent, destruction or disintegration of cells and tissue pigmentation (Wijayani, 1999).

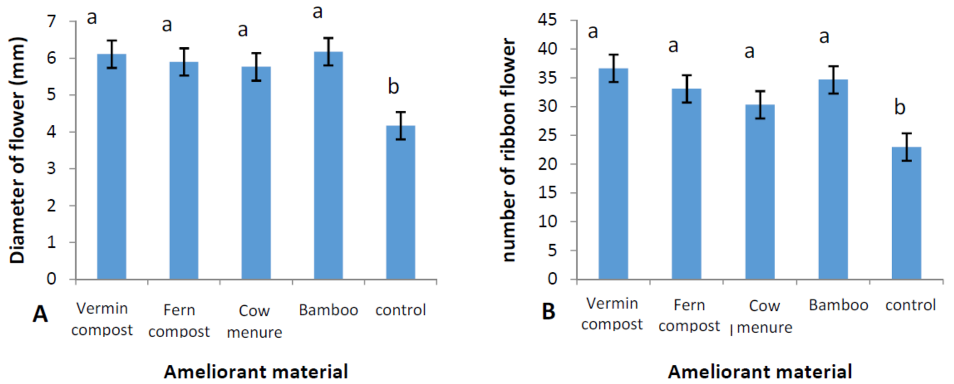

Figure 1. Affect of various ameliorant materials on diameter of flower (A) and number of ribbon flower (B) of chrysanthemum. Bars with the same letter are not significantly different (DMRT, α5%)

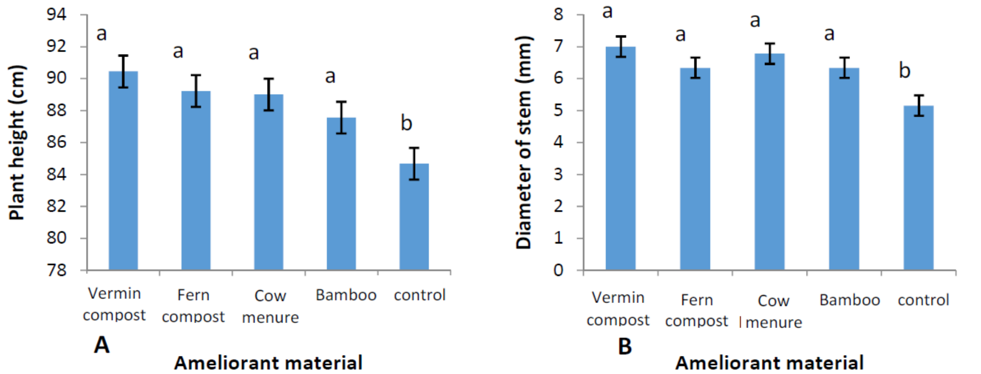

Figure 2. Affect of various ameliorant materials on plant height (A) and diameter of stem (B) of chrysanthemum. Bars with the same letter are not significantly different (DMRT, α5%)

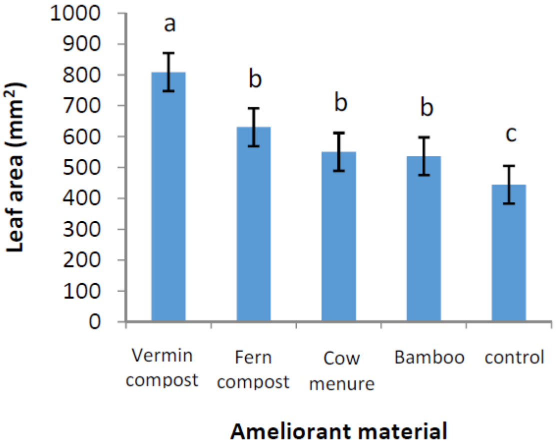

Figure 3. Affect of various ameliorant materials on leaf area of chrysanthemum. Bars with the same letter are not significantly different (DMRT, α5%)

Marschner (1986) mentioned that pollutants are able to induce physiological damage in the plant long before of the occurrence of physical damage. Other experts said that it is a hidden damage. Hidden damage may be a decrease in the ability of plants to absorb water, slow cell growth or imperfect stomata opening. According to Salisbury and Ross (1992), mechanism of stomata opening dependents on the changes of cover cells turgid. Cover cell containing a high concentration of starch will be closed, especially at night. When the sun is able to generate photosynthesis in chlorophyll, CO_2 level will decline, and it is reduced into CH_2O. This process is followed by the increase of pH and will increase the activity of posporilase enzymes to convert starch into glucose. The glucose formation will increase the osmosis level of cover cell, causing water influx from neighbouring cells. This condition causes stomata turgid and stomata will open.

There was no significant difference between oil concentration treatments (Table 2.). It seemed that oil film could not provide a barrier by masking the feeding and oviposition stimulants, hence preventing the aphid from locating, accepting or using the host plant. It was not consistent with the report on the adult females of two spotted mite (*Tetranychus urticae* Koch [Acari: Tetranychidae]) (Liu & Beattie 2002), Asiatic citrus psylla (*D. citri* Kuwayama) (Rae *et al.* 1997), whiteflies (*Bemesia argentifolii* Bellows and Perring [Hemiptera: Aleyrodidae]) (Stansly *et al.* 2002), greenhouse thrips (*Heliothrips haemorrhoidalis* Bouche [Thysanoptera: Thripidae]) (Liu *et al*. 2002). They do not lay their eggs on plant treated with oils. Density of damage spots caused by citrus red mite (*Panonychus citri* McGregor [Acari: Tetranychidae]) feeding activity was reduced significantly on plant treated with these oils (Cen *et al*. 2002). Greenhouse thrips preferred untreated fruit to HMO-treated fruit as feeding site (Liu *et al*. 2002).

Oil application in concentrations of 0.250% and 0.500% were able to decrease the spread of white rust, with the severity of 69.44% and 65.00% respectively (Table 2.). Oil might be caused deformation of appressoria and affected on uredospores germination to infect chrysanthemum plants. Similar result has been reported by Sallam *et al*, (2001) on wheat rust (*Puccinia recondite* f. sp. *Tritici*.). Oils could also provide a mechanical barrier to prevent the invasion of uredospores germ tube (Tawfik *et al.*, 2001). The success of oil in suppressing plant disease was also achieved on powdery mildew (Fernandez *et al*., 2006).

Significant suppression of aphid would likely require either higher concentration of oil or more frequent application of oil then were used in this study to form appropriate oil layer density on leaves surfaces. The level of suppression related to the number of applications (Fernandez *et al*., 2006). It should be thick enough to prevent the emitting of leaves volatile.

Table 2. Aphid population and disease severity of white rust (Mean ± SE) on chrysanthemum leaf after third application of 0%, 0.125%, 0.250%, and 0.500% v/v oil

Oil concentration (% v/v)	Aphid population	Disease severity (%)
0	24.11 ± 2.86 q	88.89 ± 2.47 a
0.125	23.89 ± 2.20 q	86.67 ± 2.36 a
0.250	21.67 ± 2.66 q	69.44 ± 2.27 b
0.500	18.00 ± 2.25 q	65.00 ± 2.89 b
Probability (*P*)	0.298	< 0.001

Numbers in columns followed by the same letter are not significantly different (DMRT, α5%)

Wonokerso area is used as a center for the cultivation of chrysanthemum. This will be a "pilot project" or as a model for other areas to cultivate chrysanthemum. Observations in the field indicate that the closure of volcanic material with a thickness of 5-15 cm in the ground can cause delays in the entry of air into the soil. This can lead to land degradation as a habitat for flora and fauna that can support the growth of cultivated plants as a source of farmer's revenue.

4. Conclusion

The addition of ameliorant increased soil fertility, plant growth, and cut flower production. Plant growth in the form of plant height, stem diameter, and leaf area was higher than the control. Cut flower production in the form of flower diameter and number of ribbon flower is also better than the control. Oil application on concentration of 0.250% and 0.500% was able to suppress the severity of white rust on chrysanthemum. Higher concentration or frequency was required to achieve significant control on aphid population.

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