

## Screening of Effective Botanical Extracts for the Control of Aloe vera Rust in Field Condition

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### ABSTRACT

*Aloe vera is severely affected by rust disease at Wondo Genet Agricultural research center field experiment. The rust pathogen (*Uromyces aloes*) is responsible for severe infection as well as a very serious limiting factor to Aloe vera production. This causes in a qualitative and quantitative loss of Aloe vera gel. The present study was undertaken to screen effective botanical extracts for the control of rust on Aloe vera plant. Botanical extracts such as *Datura stramonium*, *Maesa lanceolate*, *Milletia ferruginea*, and Lemon grass were investigated in field conditions based on the recommended rate. The fungicide Progress 250 EC was used as a standard check and untreated plots were used as control check. The experiment was arranged in randomized complete block design with three replications. The botanicals extracts were sprayed at 20% concentration on to diseased plants at 15 day interval for five rounds. Data was recorded on disease severity, disease control, plant height, branch number, fresh leaf weight, and gel weight were recorded. Among the treatments, Lemongrass (DC=70.29%), was the most effective botanicals followed by Progress 250 EC (DC=61.06%) fungicide against Aloe vera rust in field condition. Further study should test lemongrass at different concentrations and provide botanical products for Aloe vera rust management.*

**Key words:** *Aloe vera; Botanical extracts; Rust; Disease control; Gel weight*

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### Introduction

The genus Aloe L. is a member of the Liliaceae family comprising of more than 360 species and subspecies from subtropical as well as temperate parts of the world. Aloe vera is indigenous to Africa and to Mediterranean countries. In Ethiopia, there are 46 species of Aloe in which about 66% of these Aloe species are endemic to the country [1].

Aloe vera is a stemless or very short stemmed, succulent, 60-100 cm tall, perennial, spreading by offsets. The leaves are lanceolate, spirally arranged, rosette, thick and fleshy, green to grey-green with white flecks on the upper and lower stem surfaces, leaf margin serrated with small white teeth. Mature leaf is 7-10 cm across at the base, weighing 1.5-2.0 kg. Roots are fibrous, fleshy. The flowers are produced in summer on a spike up to 90 cm tall, each flower pendulous, with a yellow tubular corolla 2-3 cm long.

Aloe is derived from the Arabic word "Alloeh" which means "shinning bitter substances" [2]. Aloe vera is found as the wild herb along the coast of south India. It is under cultivation in fairly large areas in many parts of India viz; Tamil Nadu, Gujarat, Maharashtra etc. [3]. Aloes are often thought to only grow in hot and dry climates but they actually grow in a variety of climates including desert, grassland, and coastal or even alpine locations [4].

Its products are available in the form of spray, cream, gel, lotion and capsule and liquid. Aloe is very useful for destroying the micro-organisms in the last part of large intestine and has the capability to overcome the problem of constipation. Juice of Aloe vera may also be used in treating inflammatory bowel disease [5,6]. Aloe vera is used typically for osteoarthritis, and sunburns. Pain in the joints and muscles due to arthritis may be treated by using Aloe vera sprays or gels [7,8]. It also decreases blood sugar level in hyperglycemic patients. For this purpose, its juice is taken twice daily [9,10].

Aloe vera has number of uses and mainly they are used as a food preservative and medicine. Commercially, Aloe can be found in pills, sprays, ointments, lotions, liquids, drinks, jellies, and creams.

Mealy bug, termite and fungus causing anthracnose and leaf spots are reported to affect yield and quality of gel adversely but spraying recommended fungicides can control fungal infections; while, light irrigation can manage termite problem. Diseased plants and dried flower stalks must be removed regularly.

Among all the pest problems, Aloe vera is affected by rust disease at Wondo Genet field experiment. The rust pathogen (*Uromyces aloes*) is responsible for severe infection, a very serious limiting factor to Aloe vera production. This results in a qualitative and quantitative loss of the gel of Aloe vera. *Uromyces aloes* has been recorded from different parts of the world viz, Africa (Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Rhodesia, Tanzania and Uganda), Asia (India), Europe and UK. *Uromyces aloes* enjoys a wide species range on the genus [11,12]. Based on previous study results leaf rust has been found the abundant disease of A. vera at Wondo Genet Agricultural Research Center, Ethiopia. The disease is characterized by the appearance of golden yellow big pustules, arranged concentrically on both sides of leaf which upon maturity turns brown to black. These leaves turned yellow and finally die depending on the severity of infection. Sometimes, severe infection may lead to premature death of the plant.

Therefore, the present study was conducted with objectives to develop effective botanical extracts for the control of Aloe vera rust and also to determine effective and environmentally save management measures for the control of Aloe vera rust.

## Materials and Methods

### Description of the Study Area

The experiment was conducted at Wondo Genet Agricultural Research Center experimental field, Ethiopia. The site is located at 7° 19' 2" N latitude and 38° 38' 2" E longitudes with an altitude of 1,780 m above sea level. The site receives a mean annual rainfall of 1,000 mm with minimum and maximum temperatures of 10°C and 30°C, respectively. The soil textural class is clay loam with an average pH of 7.2.

### Experimental Design and Treatment Application

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. A plot size of 3.6 m × 3.6 m with 60 cm × 60 cm spacing between plants was used. Spacing between plots and blocks were 1 m and 2 m, respectively to minimize the spread of the disease by wind. Healthy planting materials were planted at the beginning of the main rainy season.

Integrated cultural practices + botanicals + chemical at recommended rate, integrated cultural practices + botanicals, integrated cultural practices + chemical and control are the treatments for this study. All possible integrated cultural practices will be applied to each treatment except to the control. Only watering and cultivation will be applied to the control (Table 1).

### Preparation of Plant Extracts

Healthy leaves were collected from selected plants and the excess water content was removed by keeping them under shade for few minutes till they become semi dried.

Then semi dried material (50 gm) of each plant was grounded using mortar and pestles and then dipped into 500ml acetone for 48 h for complete extraction of the active ingredients. After that the grounded materials were filtered with the help of a very fine and clean piece of cheesecloth separately for every plant species. The extracts obtained were considered as stock and used to prepare desired test concentration (v/v) using tap water. The stock extracts were preserved in glass bottles in a refrigerator at 4°C for further use. Then the botanicals each at 20% concentration were sprayed on to diseased plants at 15day interval for five rounds.

### Data to Be Collected

Percentage data on disease incidence, severity and disease control were calculated using the following formula:

$$\text{Disease incidence (I)} = \frac{\text{Number of affected plant units}}{\text{Total number (healthy and affected) units assessed}} \times 100$$

$$\text{Disease severity (S)} = \frac{\text{Area of plant tissue affected by disease}}{\text{Total area of plant (tissue)}} \times 100$$

PDC = DC-DT/DC, where PDC is Percent disease control, DC is disease control, DT is disease treated.

Other agronomic data such as fresh leaf weight, dry weight and gel weight were recorded.

### Statistical Analysis

The collected data were analyzed using analysis of variance using SAS software version 9.2. Treatment means were separated using least significant difference (LSD at  $P=0.05$ ).

## Results

### Pathological Observation

**Disease severity and disease control:** The result revealed that some botanical extracts significantly controlled the disease as compared to the untreated control plot. The highest disease control was recorded by Lemongrass (70.29%) followed by chemical Progress 250 EC (DC=61.06%) and *Milletia ferruginea* (DC=46.35%).

Lemongrass was the most effective botanical extracts against Aloe vera rust, followed by Progress 250 EC (chemical) with a reduced disease severity compared to the other treatments and untreated control. There were least effect of botanical extract in rust disease control on the treatment *Datura stramonium* (DC=16.66). The disease severity level was higher on *Datura stramonium* plant extracts compared to the other treatments. This is may be due to the species of *Datura stramonium*, the concentration levels of the botanical extracts used and the time exposure of the botanical extract (Table 2).

### Biometric Observation

**Plant height, Branch number, Fresh leaf and Gel weight:** Significant differences ( $P<0.05$ ) were observed between the treated and control groups for most of the measured biometric parameters such as plant height, branch number, fresh leaf weight and gel weight (Table 3). However, Plant height, flower leaf weight and gel weight were not affected by the botanical and fungicide treatments.

**Table 1:** Botanical plants screened in the field experiment.

No.	Treatments	Common name	Family	Plant parts used
1	<i>Datura stramonium</i>	Atsefaris	Solanaceae	leaves
2	<i>Maesa lanceolate</i>	Kelewa	Primulaceae	leaves
3	<i>Milletia ferruginea</i>	Birbira	Fabaceae	leaves
4	Lemon grass	Lomi sar	Poaceae	leaves
5	Progress 250 EC	-	-	-
6	Untreated control	-	-	-

**Table 2:** Efficacy of botanical extract for the control of rust on Aloe vera plant.

No.	Treatments	Disease Severity	Disease Control
1	<i>Datura stramonium</i>	4.666 <sup>ab</sup>	16.66 <sup>d</sup>
2	<i>Mesa lanceolate</i>	3.333 <sup>ab</sup>	31.41 <sup>c</sup>
3	<i>Milletia ferruginea</i>	3.000 <sup>bc</sup>	46.35 <sup>b</sup>
4	Lemon grass	1.666 <sup>c</sup>	70.29 <sup>a</sup>
5	Progress 250 EC	1.666 <sup>c</sup>	61.06 <sup>a</sup>
6	Untreated control	5.666 <sup>a</sup>	0.00 <sup>c</sup>
	<b>LSD (0.05)</b>	1.908	12.04
	<b>CV %</b>	31.46	17.58

Means with the same letter within the same column are not statistically different ( $P<0.05$ )

**Table 3:** Efficacy of different botanical extracts on average number of biometric parameters.

Treatments	Average number of biometric parameters			
	PH	BN	FLW	GW
<i>Datura stramonium</i>	35.600 <sup>a</sup>	8.4000 <sup>b</sup>	435.73 <sup>a</sup>	67.13 <sup>a</sup>
<i>Mesa lanceolate</i>	<b>36.333<sup>a</sup></b>	8.8667 <sup>ab</sup>	462.00 <sup>a</sup>	71.07 <sup>a</sup>
<i>Milletia ferruginea</i>	34.800 <sup>a</sup>	9.0667 <sup>ab</sup>	386.87 <sup>a</sup>	62.07 <sup>a</sup>
Lemon grass	32.600 <sup>a</sup>	9.6667 <sup>ab</sup>	395.47 <sup>a</sup>	<b>77.33<sup>a</sup></b>
Progress 250 EC	33.200 <sup>a</sup>	9.7333 <sup>ab</sup>	<b>502.60<sup>a</sup></b>	57.67 <sup>a</sup>
Untreated control	34.667 <sup>a</sup>	<b>10.0000<sup>a</sup></b>	336.80 <sup>a</sup>	64.53 <sup>a</sup>
<b>CV%</b>	9.28	7.93	22.12	31.47
<b>LSD (0.05)</b>	5.83	1.34	168.98	38.15

PH: Plant height; BN: Branch number; FLW: Fresh leaf weight; GW: Gel weight

Effect of botanical extracts on average number of plant height of Aloe vera was not significantly different. However, the plant height was lower on Lemongrass treated plot than the other treatments. The effect of botanicals on average branch number was significantly different between treatment means. Higher average branch number was recorded on the untreated control.

The average weight of fresh leaf was not significantly different between treatment means. Fresh leaf weight was higher on the chemical treated plot than the other treatments. Significantly higher average fresh leaf weight was recorded on Progress 250 EC chemical treatments than the other treatments. The average Gel weight was not significantly different however higher gel weight was observed on Lemongrass treated plot than the other treated and untreated control.

### Discussion

Bio control is the safest and economical method of controlling plant pathogens by using extracts of different plant parts. The present study screened effective botanical extracts at 20% concentration to control Aloe vera rust. Among the botanical extracts lemon grass significantly reduced the rust disease on Aloe vera. Literature reports the essential oil of lemon grass (*Cymbopogon citratus* (DC.) inhibited the growth of the fungus *Colletotrichum gloeosporioides*. Similarly, Baratta et al. reported 91% inhibition of the growth of *A. niger* in liquid culture media when treated with 1000 ppm lemongrass oil. Relating the antimicrobial potential of lemongrass oil to its major components, the monoterpene aldehydes, neral and geranial. Using the essential oil of citronella, observed inhibition of spore germination of the fungus *Phakopsora pachyrhizi*, the causal agent of Asian soybean rust.

The botanical extract *Datura stramonium* showed low control of the rust disease compared to the other treatments. However, Hussain et al. reported that the leaf extract of *Datura stramonium* reduced the development of rust pustules on the leaves of wheat.

The effect of aqueous and organic extract varied with the test species used, concentrations of aqueous and organic extracts and the incubation period. The variation in antifungal activity of extracts in different solvents may be attributed to the different chemical nature of the solvents. It is likely that different types of chemicals were dissolved in different solvents that resulted in variable activity of the extracts of same plant in different solvents. For instance, a study on antifungal activity of aqueous and n-hexane shoot extracts of Aloe vera and reported that inhibitory effect was variable with applied concentrations and caused a significant inhibition in biomass production of the three test fungi, namely *A. alternata*, *Alternaria citri* and *A. tenuissima*. Therefore, different concentrations of aqueous and organic extracts should be employed to obtain variable results.

Neem plant extracts were studied on various crops to control different diseases. The antimicrobial action of the oils from the neem (*Azadirachta indica* A. Juss. (Meliaceae)) and citronella (*Cymbopogon nardus* (L.) Rendle (Poaceae)) on soybean rust, caused by *Phakopsora pachyrhizi*, was observed. Previous studies reported good antifungal activity of *Malia azedarach* against *Alternaria*, *Aspergillus* and *Penicillium* spp. Similarly, others have accounted that extract of *M. azedarach* was effective against *Fusarium chlamydosporum*, *Aspergillus niger* and *Hyloflora ramosa*. Therefore, Neem plant should be included for further study as one treatment against Aloe vera rust disease.

There are studies that describe the direct activity of essential oils from plants on phytopathogens, or indirectly by activating the defense mechanisms of the plants against pathogens. Antifungal activity of essential oils is related to their hydrophobicity, which allows for interaction between the essential oil and lipids of the wall, cell membrane and mitochondria, this interaction altering permeability and causing disturbances in these structures.

### Conclusion

The results of the study revealed that botanicals have the potential to regulate the infestation of leaf rust of disease of Aloe vera by suppressing the growth of mycelia of fungi in field conditions.

The present study illustrated that the tested botanicals were effective for managing leaf rust. Among the tested botanical treatments, Lemongrass significantly reduced the rust disease on Aloe vera. The chemical treatment Progress 250 EC showed effective control of the rust disease next to the Lemongrass. However, the botanical extract of *Datura stramonium* showed low control of the rust disease compared to the other treatments.

Therefore, lemongrass and Progress 250 EC are effective for the management of Aloe vera leaf rust disease and have the potential to be a vital component of integrated pest management for rust diseases of Aloe vera plant. Botanical plant extracts are equivalent in effect but safer alternative option to chemical fungicides. Due to exorbitant cost of

chemicals and the environmental hazards they cause, it is high time to modify the rust management options like botanicals which are safer and cost-effective. Thus, further study should test the promising effective botanicals at different concentrations and provide botanical products for Aloe vera rust management.

#### Declarations

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#### Conflict of Interests

The authors have not declared any conflict of interest.

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