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Influence of Gypsum Application in Disease Management of Onion (*Allium cepa* L.)

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Abstract:- In Asian cuisines, the onion (*Allium cepa* L.) is an essential **ingredient. However, one of the most significant challenges for onion cultivation is pest and disease control. The major constraints are fungal bulb rot by *Fusarium* spp., *Pythium* spp. *Sclerotium* spp. and *Rhizoctonia solani*, anthracnose disease or twister diseases by *Colletotrichum* spp., purple blotch disease by *Alternaria poori*, and bacterial bulb rot. There's also the issue of tip burning and secondary microbial infections to consider. The onion is water and fertilizer-sensitive crop. As a result, farmers follow a variety of fertilizer and water management schedules based on their climatic conditions. The use of gypsum as a fertilizer in terms of disease management and tip-burning issues was highlighted in this study. Mineral nutrition plays an important role in the control of several plant diseases. According to the findings of the study, gypsum plays a dominant role in enhancing growth and total bulb yield from the 50 kg/ha gypsum application as the basal fertilizer is followed by the 50 kg/ha application two weeks after planting is superior to all other treatments with the lowest disease conditions and no tip-burning problem. Although 50 kg/ha gypsum application has some tip-burning conditions, it also has no significant difference with the best treatment in terms of total yield and diseases conditions.**

I. INTRODUCTON

Onion (*Allium cepa* L.) is a major cash crop that is cultivated all over the world. Many countries use onions as a condiment. Plant diseases are a major constraint in agricultural development. Fungal diseases such as bulb rot, twister disease or anthracnose, purple blotch, and bacterial diseases such as bulb rot are common in onion cultivation in Sri Lankan climatic conditions. When it comes to controlling the major onion diseases that have been identified in Sri Lanka, integrated disease management is critical, and it involves a combination of genetic, agronomic, chemical, and biological resources. Mainly, genetic, and agronomic agents are important as a rule for preventing disease; they manifest themselves in resistant varieties, crop rotation, and crop residue disposal [1],[2].

Soil nutrients are one of the most important aspects of agronomic practices. Plants and microorganisms require nutrients for growth and development, and mineral nutrition plays an important role in the control of several plant diseases [3]. Mineral nutrients have an impact on plant health. A healthy plant will have increased vigor and resistance to diseases, resulting in lower disease incidence. Plants that are stressed by nutrient deficiencies are more susceptible to disease, whereas adequate crop nutrition makes plants more tolerant or resistant to disease. Each important nutrient seems to have a measurable impact on disease severity [4]. However, since a specific nutrient can reduce the severity of the disease, there is no generally accepted practice. The nutrient should be supplied to increase onion yields and to obtain optimum yield with the lowest possible cost and proper fertilizer use efficiency while maintaining the least amount of pest and disease damage that causes severe yield loss. According to reference [5], nutrients may influence disease resistance or tolerance. In addition, nutrient deficiencies and toxicities influence plant diseases [6], [7]. Minerals can influence primary resistance mechanisms through the formation of mechanical barriers, such as cell wall thickness, or the synthesis of natural defense barriers, including antioxidants, phytoalexins, and flavonoids [8]. According to some findings, it is essential to control diseases with proper nutrient management to improve yield [4] [6]. However, some plant nutrients have demonstrated their ability to control certain diseases. These effects, however, differ from one disease to the other in a different environment. That nutrient may reduce the occurrence of one disease while increasing the occurrence of another [8].

Gypsum is generally recognized as an important nutrient for enhancing onion bulb production and quality [9], [10]. One of the major sulfur supplements is gypsum. It is a sulfate mineral with the chemical formula $CaSO_4.2H_2O$ and is an important source of calcium and sulfur for the plant [11]. According to reference [12]; gypsum is essential not only as a source of sulfur and calcium but could also enhance changes in soil structure that support water management and plant growth. By reducing soil dispersion and promoting flocculation, gypsum can improve soil physical properties. It facilitates the reduction of soil crust forming, which helps in seed emergence and plant establishment. It increases the rate of surface penetration and movement of water through the soil. Gypsum promotes deep rooting, which improves water and nutrient uptake in corn, wheat, and soybeans. The application of $CaCl_2$ decreases bulb pungency for several reasons, including chloride competing with nitrate or sulfate for plant uptake [13]. Calcium sulfate, which is much less soluble than other sulfate-containing compounds, forms until calcium is added. There is a positive significant relationship between calcium and sulfur, and the presence of Ca+ ion promotes S uptake and photosynthesis, resulting in increased yield by advancing the growth and biochemical portion [14]. Gypsum improved the pungency character. Furthermore, the addition of gypsum to the soil improved soil quality and increased leaf P and S concentrations [15]. The use of gypsum or other calcium-containing amendments can reduce phosphorus and nitrogen losses due to runoff. A soil application of gypsum increases the soil's ionic strength and calcium concentration, resulting in a stronger phosphate (PO_4) adsorption process. A decrease in organic phosphorus' solubility was also noted [16], [17]. Calcium promotes photosynthesis, increases plant size, and improves fruit quality in a variety of vegetables such as onion and tomato because it increases nitrogen, phosphorous, and potassium absorption in roots [18], [19], [20]. Sulfur is essential in the catalytic or electrochemical activities of biomolecules in cells [21]. When soil pH, N, P, and K are optimal, the yield response to gypsum and ammonium sulfate revealed that S may be the limiting component in onion cultivation [15]. Field experiments significantly reduced phosphorus runoff [22], [23].

Sulfur is an essential unit in the production of amino acids, oligopeptides, chlorophyll, certain enzymes, vitamins, proteins, and a wide range of secondary products in *Allium* [24], [25]. Sulfur has long been recognized as being important in nutrient value, flavor, and control of pests and diseases [26]. Sulfur is a necessary plant nutrient that contributes to the distinctive flavor of onions. Increasing plant growing temperatures [27] improves sulfur absorption by onion plants and increases the strength of bulb flavor. Some of the sulfur compounds responsible for pungency can inhibit the growth of fungi and bacteria and reduce onion storage loss [28], [29], [30], [31], [32]; but high sulfur content in the soil does not affect pungency [30]. Severe sulfur deficiency during onion bulb growth harms onion yield quality [26]. Furthermore, a lack of sulfur causes a decrease in quality parameters such as pungency [18]. The sulfur in gypsum is already in the sulfate form, which crops can easily utilize [12].

Onion is commonly thought to be a sulfur-loving crop because sulfur uptake by a high-yielding onion can reach as high as 100 kg ha^1 [33]. High N levels, on the other hand, can reduce sulfur absorption by onion plants and reduce bulb pungency. In most cases, field studies have revealed that applied sulfur has a positive effect on onion harvest. As documented in various countries, the ideal range of applied sulfur ranges from 30 to 60 kg ha^1. The type of fertilizer used is one of the primary reasons for the extremely broad sulfur ranges [11], [34], [35].

Calcium imbalance is also a cause of a variety of plant diseases. Pathogens normally secrete enzymes to melt the middle lamella, which is strongly inhibited by calcium [6]. The third most important nutrient required by onions is calcium. Calcium is an important component of cells, as it helps to maintain the structure of cell walls and stabilizes cell membranes. It also affects the salt balance within plant cells. Pathogens have a difficult time infiltrating and establishing themselves in plant cells due to the thick cell walls. Because calcium promotes pollen germination, it will help onions to produce true seeds. It also influences growth and regulates some enzyme systems. The presence of calcium reduces onion bulb storage quality. Furthermore, a lack of calcium promotes the leakage of metabolic products, which promotes pathogen infections [36]. Plants secrete several compounds. When certain nutrients are depleted, the released compounds contain higher levels of sugars and amino acids, promoting fungus growth. Plant antifungal compound production is also influenced by mineral nutrition [8]. And also, enzymes are released by the pathogenic bacteria, which dissolve the plant tissue. Calcium is well-known for its ability to inhibit enzymes of this type. Bacterial spread within plant tissues is dependent on the strength of the internal cells, which is greatly influenced by mineral nutrition. And also pathogenic bacteria spread throughout the plant by forming slime within the vessels and blocking them, causing stems and leaves to wilt and die. Certain plant nutrients inhibit the ability of bacteria to produce this slime by promoting the synthesis of natural defense compounds. Sucking insects and fungi spread viruses to plants. Even though silicon is not a nutrient for plants, it has been found to reduce the risk of virus infection due to inhibiting the feeding ability of some sucking pests such as aphids.

II. METHODOLOGY

The experiment was carried out at the Regional Agricultural Research and Development Centre, Aralaganwila, Sri Lanka. The experiment was conducted in a field that belongs to Non-Calsic Brown (NCB) soil in Sri Lanka's DL_{2b} agro-ecological zone. A field experiment was conducted to investigate the effect of gypsum on cluster onions (*Allium cepa* L.). Treatments comprised of four levels of gypsum (T1- 50 kg/ha, T2- 75 kg/ha, T3- 100 kg/ha, T4- 50 kg/ha as the basal fertilizer and 50 kg/ha two weeks after planting, T5- no gypsum as a control). In a Randomized Complete Block Design (RCBD), all treatments were replicated three times. Individual plots were $3m^2$ in size, with plant spacing of 10cm * 10cm. Cow dung was applied to the field at the current recommended rate of 10 t/ha. The variety 'Vethalan,' which is the most widely used in the country, was used for the study. Crop management practices were implemented by the recommendations given by the department of agriculture. At weekly intervals, plant height and disease data were collected in the field. The plot yield was used to calculate the total bulb yield per hectare.

III. RESULTS AND DISCUSSION

Plant growth and total bulb yield

As growth data in Fig 01, plant height was collected. T4 has the highest plant height in both the Yala and Maha seasons (Yala season 39.6 cm and Maha season 41.6 cm). Plant height increased with gypsum application due to its role in chlorophyll synthesis, and sulfur application

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increases nutrient uptake, which influences stored materials synthesis and translocation [14]. Tip-burn is one of the main problems in onion cultivation. Onion leaf tip-burn is a symptom of a variety of biotic and abiotic stresses. Leaf tip burn may be considered a general stress symptom in onion due to the long list of biotic and abiotic stresses that can cause it. Leaf tip-burn in onion nursery transplants or seedlings may be the first sign of several diseases, including botrytis leaf blight (*Botrytis squamosa*), purple blotch (*Alternaria porri*), stemphylium leaf blight (*Stemphylium vesicarium*), basal rot (*Fusarium oxysporum*), and/or downy mildew (*Peronospora destructor*) [37], [38]. This can also be due to nitrogen deficiency sulfur deficiency [39], and boron deficiency [40] as well as exposure to ozone [41], and salinity [42]. These findings will show that nutrients influence onion tip-burning. In T4 the effect of tip burn was not reported. It shows with the length of the leaves. The hard cell walls could be formed because of the continuous supply of Ca from the split application of gypsum.

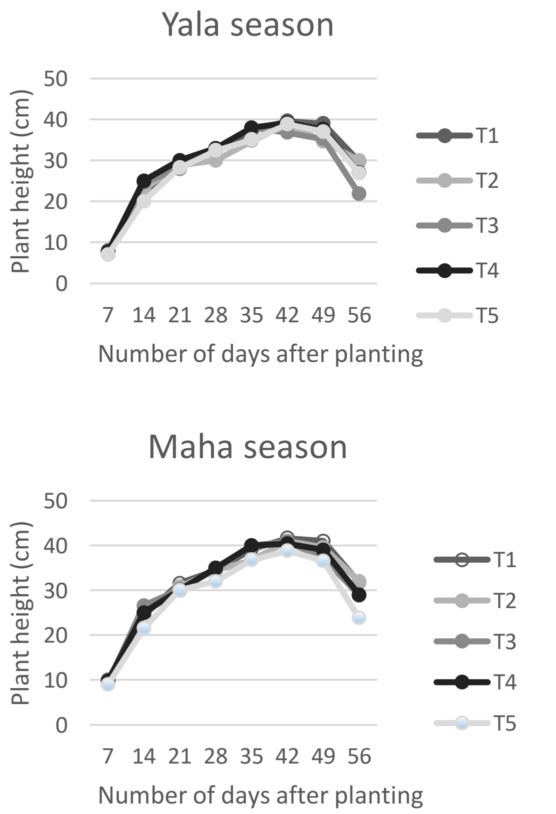

Fig 01: Plant height of Yala and Maha seasons

As data illustrated in Fig 02, T1 (Yala season 22 t/ha, Maha season 20.39 t/ha) and T4 (Yala season 21.1 t/ha, Maha season 19.89 t/ha) yields were significantly higher in both seasons.

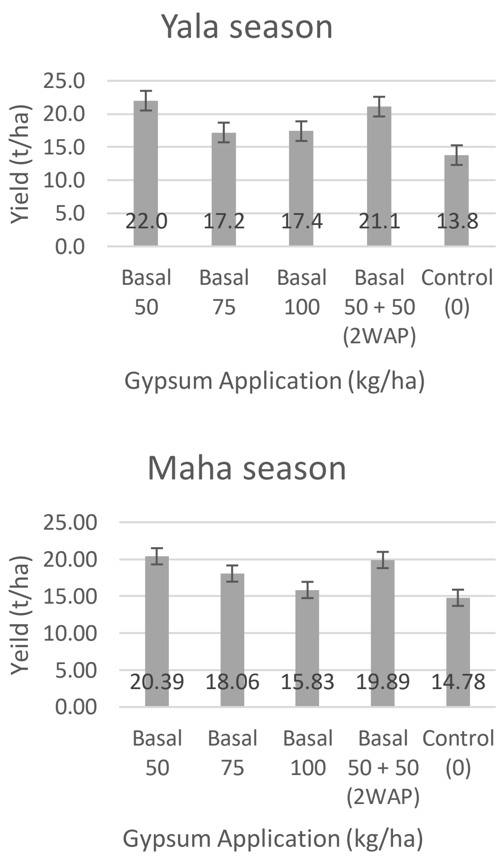

Fig 02: Total yield of Yala and Maha seasons

Plant diseases

Infection mechanisms differ between pathogens [8]. Fungi enter the surface cells (epidermis) by passing between or through the cells. Stronger cell walls can prevent infection by acting as a physical barrier to the fungus. Certain nutrients, such as calcium, play an important role in the plant's ability to create stronger cell walls and tissues. And also; sulfur acts as a strong fungicide in vegetable cultivation. In cluster onion cultivation, anthracnose disease commonly occurs as twister disease or disco disease in the early crop stages and as anthracnose leaf spots in the mature crop.

The percentages of anthracnose disease severity are shown in Fig 03 throughout the cultivation period. In this study, T4 had the lowest disease severity index for anthracnose disease in both seasons (0% Yala and 3.67% maha), while controls had 3% and 9.67% in the Yala and Maha seasons, respectively. It may be due to the creation of comparatively hard cell walls with the split gypsum application.

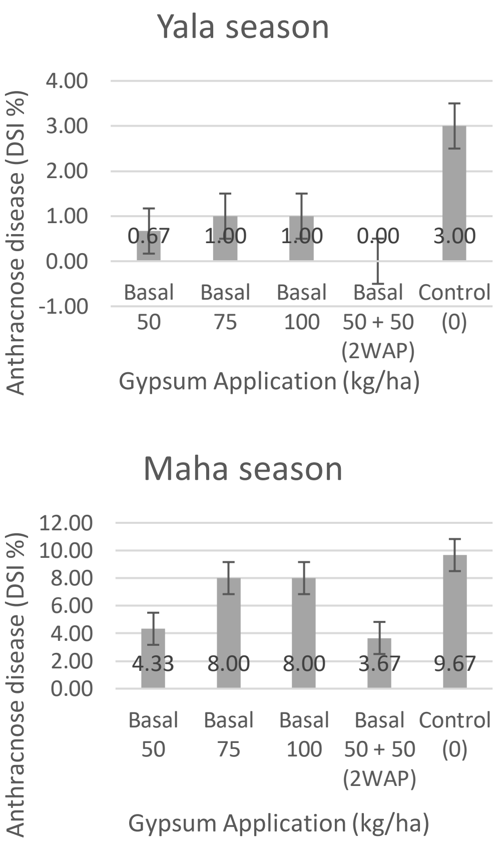

Fig 03: Anthracnose disease severity index percentage of Yala and Maha seasons

In wet weather conditions, bulb rot disease is common. This disease is divided into two types: fungal bulb rot and bacterial bulb rot. In cluster onion cultivation, fungal bulb rot usually appears during the early crop stages and coincides with unfavorable climatic conditions at the mature crop. Furthermore, bacterial bulb rot is caused by unfavorable weather conditions.

Bacterial bulb rot was not present in either season. The cumulative percentages of bulb rot disease incidence in both seasons are shown in Fig 04. With the tested treatments, 50 kg/ha gypsum application at the basal dressing with 50 kg/ha gypsum application two weeks after planting (T4) resulted in the least bulb rot disease (1 % Yala and 2 % Maha), followed by 50 kg/ha gypsum application at the basal dressing (T1) with no significant difference. In both seasons, the control treatment has a bulb rot disease incidence of more than 5%. Pathogens can also cause nutrient deficiency or toxicity by altering membrane permeability or mobilization to infected sites. *Fusarium oxysporum f. vasifectum* can increase P levels in leaves while decreasing N, K, Ca, and Mg levels [4].

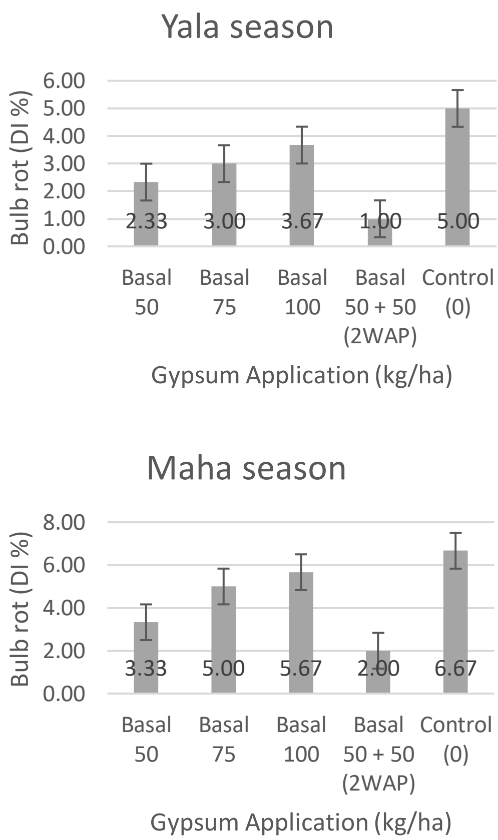

Fig 04: Bulb rot disease incidence percentage of Yala and Maha seasons

According to reference; Ca is required for plant membrane stability and function, and Ca deficiency causes membrane leakage of low-molecular-weight compounds such as sugars and amino acids from the cytoplasm to the apoplast, which promotes pathogen infection [6]. Not only that but the disease can be inhibited in naturally alkaline soil [43]. The application of gypsum into the soil is usually recommended for changing the pH of the soil. As a result, it facilitates disease management.

IV. CONCLUSIONS

The current study concluded that gypsum plays a dominant role in enhancing growth and total bulb yield from the 50 kg/ha gypsum application as the basal fertilizer is followed by the 50 kg/ha application two weeks after planting is superior to all other treatments with the lowest disease conditions and no tip-burning problem. Although 50 kg/ha gypsum application has some tip-burning conditions, it also has no significant difference with the best treatment in terms of total yield and diseases conditions.

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