Germination Rate of Mung bean (*Vigna radiata*) Seeds on Different types of Soil Textures

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ABSTRACT

Mung bean *is called in Filipino* "monggo" which is a plant species belonging to the legume family. The objective of this study was to determine the germination rate of mung bean on the different types of soil textures. The study has four treatments, namely loam, silt, peat, and clay. A 50 ml of water was added to the seeds from the first to last day of observation. 5 seeds of Mung bean were planted on each type and observed their germination rate in a span of 15 days. A ruler was used to measure the height of Mung bean's germination rate daily. This study revealed that a mung bean seed grows best on clay soil (exposed to sunlight) and on the silty soil (without sunlight).

Keywords : Germination; Mung bean; Soil Texture; Loam; Silt; Peat; Clay

1 INTRODUCTION

SINCE ancient times, agriculture has always been a source of income for most of the Filipino people. It is one of the main sources of Filipinos' livelihood and is the foundation of the Philippine economy. Philippine has a land area of 30 million hectares, which is 47% of it is used for agricultural purposes. Despite the size of the land area and the fact that about half of the land is used for agriculture, there are various soil textures that influence the plants' development and germination rates.

Mung bean (*Vigna radiata*) is a member of the legume family (Fabaceae). This family is a wide spread family occupied the third largest family of flowering plants, with approximately 650 genera and nearly 20,000 species (Doyle, 1994), and is consumed by most households in Asia, especially in China and Southeast Asia, due to its characteristics of relatively drought-tolerant, low-input crop, and short growth cycle. It has many local names including "Mung bean, mash, golden gram or green gram". Mung bean is usually grown on marginal lands under rain fed condition. It is well adapted to arid and semi-arid conditions and is suitable for planting on a range of altitudes, temperatures, and soil types. However, it grows best in subtropical regions with average annual rainfall in the range 600-900 mm and at altitude not exceeding 2000 mm on well-drained loam or sandy loam soils (Mogotsi, 2006). Mung bean is well-suited to many cropping systems due to its ability to improve soil fertility and sustain productivity of subsequent crops in subsistence agriculture (Senaratne et al., 1995; Dey et al., 2016). Mung bean's protein is easily digestible, as compared to protein in other legumes. Consuming Mung bean has been documented to ameliorate hyperglycemia, hyperlipemia, and hypertension. It also prevents cancer and melanogenesis. Mung beans possess hepatoprotective and immunomodulatory activities.

This study will serve as a guide to further understand the four selected soil textures as treatments – loamy soil, silty soil, peaty soil, and clay soil, – and how they affect the plant growth and development. Most farmers do not see these factors (soil textures) to affect their garden. In this study, thus, shows the direct effect of various soil textures on plant germination rates.

2 RELATED LITERATURE

Mung beans (*Vigna radiata*) are traditionally grown in various parts of Asia and have been accepted as a part of the local diet for many people (Zhou et al., 2017). The beans contain a balanced source of protein, dietary fiber, and significant amounts of bioactive phytochemicals. Considering the beans are rich in protein, amino acids, and antioxidants there are many health benefits associated with the beans as they have detoxifying, anti-inflammatory and diuretic properties. Typically, Mung beans have a slightly sweet taste to them and are sold as sprouts or in dried form. As they are not popular in Western culture, they can still be found in most grocery stores. Generally Mung beans benefit in warmer climates where the optimal temperature is 27-30° C and they are known for germinating and sprouting at quick rates in these conditions (Zhou et al., 2017).

Soil is one of the most important natural resources and a major factor in global food production (Den Biggelaar et al., 2003). There has been an innate interest in soil and land quality since the advent of agriculture (Carter et al, 2004). The soil characteristics below the grounds are recognized as possible key factors in affecting plant species coexistence and community organization (Bonanomi and Mazzoleni, 2005). The characteristics of soil play a big role in the plant's ability to extract water and nutrients. If plants are to grow to their potential, the soil must provide a satisfactory environment for plant growth. Plants obtain oxygen and carbon from the air by photosynthesis. Soil provides the place for plants' roots to anchor and grow. It holds the water in which the soil plant nutrients are changed into ions, which is the form that the plant can use. It holds the air space that prevents the plant from becoming water logged; it holds the chemicals that determine soils pH, salinity and dispersivity (CSIRO, 1979). A soil favorable for plant growth consists of approximately one-half solid mineral particles and one-half pores, voids, and cracks between the particles. Pores, voids, and cracks are of irregular size and shape and are filled with air and water. A mixture of large and small pores is desirable (Gardner & Ross, 1979). Nutrient availability varies and mostly depends on soil types. Nutrient contents of the soil are an important soil chemical property (Brye et al., 2004).

Seed germination is an important and vulnerable stage in the life cycle of terrestrial angiosperms and determines seedling establishment and plant growth. Germination is regarded as phenomenon which commence with the uptake of water by a quiescent dry seed and terminates with elongation of the embryonic axis (Bewley, 1997). There are various environmental factors that affect seed germination. Environmental factors regulating germination include temperature, water, and oxygen for non-dormant seeds along with light and the chemical environment for dormant seeds (Bewley and Black, 1994). Temperature, light, pH, salinity, and water potential are the factors required for seed germination at an optimal proportion. Seed germination is usually the most critical stage in seedling establishment, determining successful crop production (Almansourie et al., 2001; Bhattacharjee, 2008). Salinity stress creates potential problems during the seed germination and survival of seedlings. The crop performance largely determines by germination of seeds which is more susceptible to soil salinity than established plants (Kumar et al. 2008). The chain of various steps that proceeds to protrusion of the radicle is termed as germination.

Bouwmeester and Karssen (1993) stated that the buried seeds of many weeds and ruderals pass through annual cycles of changes in dormancy. As a result, germination and emergence of these species are thereby restricted to certain periods of the year. Such dormancy patterns prevent germination in seasons unfavorable for growth and development of the species (Courtney, 1968; Karssen, 1982; Baskin & Baskin, 1985). Temperature seems to have a dual role in the control of the seasonal emergence patterns. During burial, temperature seems to be the main driving force behind the changes in dormancy (Bouwmeester & Karssen, 1992; Bouwmeester & Karssen, 1993). When germination of exhumed seeds is tested, the main characteristic of the dormancy pattern appears to be the changes in the range of temperatures over which germination can proceed (Karssen, 1982). Baskin & Baskin (1981 a, b, 1983) have shown, that during dormancy relief, the range of suitable germination temperatures widens and that during dormancy induction it narrows again. It was shown for seeds of *Polygonum persicaria* that the interpretation of the dormancy pattern depends on the temperature at which germination is tested after exhumation of the seeds (Bouwmeester & Karssen, 1992). Several authors have also suggested a role for soil moisture content in the control of changes in dormancy (Karssen, 1980/1a; Lonchamp et al., 1984; Baskin & Baskin, 1987).

In a preliminary study, Karssen (1980/1b) showed that the germination response of buried seeds of *S. officinale* is subject to seasonal changes. Other studies have shown that germination of seeds of *S. officinale* is highly stimulated by nitrate. Often germination depended on the combined action of light and nitrate (Karssen, 1980/1b; Karssen & De Vries, 1983; Hilhorst, Smitt & Karssen, 1986; Hilhorst & Karssen, 1988). Desiccation of pre-incubated seeds followed by re-imbibition also increases germination of *S. officinale* (Karssen, 1980/1b). In this paper, the dormancy pattern of buried *S. officinale* seeds is reported in more detail. The factors that control the changes in dormancy were investigated by testing germination over a range of temperatures, in light or darkness, in water or nitrate and following desiccation treatments. Changes in dormancy were also studied under controlled conditions. The influence of several of the environmental factors on the seasonal emergence pattern is described with a preliminary descriptive model. For this model, it was assumed that dormancy is a function of a cold (C) and heat sum (H). Totterdell & Roberts (1979) hypothesized that changes in dormancy in *Rumex obtusifolius* and *R. crispus* seeds were the result of two sub-processes, namely the relief and induction of dormancy. Relief of dormancy was independent of the actual temperature, as long as it was below a critical temperature and the second sub-process, dormancy induction, occurred at all temperatures and increased with increase of temperature. Because the rate of the induction process was lowest at low temperatures, net relief of dormancy was optimal at a temperature just above zero. This theory was elaborated by Bouwmeester & Karssen (1992, 1993) and extended to repeated annual cycles of dormancy for *Polygonum persicaria* and *Spergula arvensis*. According to the theory of Totterdell & Roberts, the two sub-processes may occur simultaneously. However, in the present paper, dormancy relief and dormancy induction refer to the net result of both sub-processes, unless we explicitly mention that it refers to one of them.

Based on the study of Finch-Savage, Steckel and K. Phelps (2008), the pattern of seedling emergence within a population is determined by a complex interaction of ambient weather conditions, soil, seed and seedling characteristics. These interactions are little understood in the natural environment. However, some progress is being made in the modeling and prediction of seedling emergence patterns in horticulture. Here the situation is less complex as soil is prepared uniformly, and the whole population of seeds (usually non-dormant) is sown at the same time and to a uniform depth. Despite this, seedling emergence in vegetable crops is still variable and therefore directly influences both their yield and monetary value (Finch-Savage, 1995). For example, in carrots, plant density determines both total yield and mean root size (Bleasdale, 1967) and the uniformity of seedling emergence times can greatly influence the uniformity of plant size at harvest and therefore graded yields (Benjamin, 1982). An understanding of the causes of variation in seedling emergence both within and between sowing occasions is therefore necessary to determine efficient crop production practices. The pre-germination and post-germination phases of the seedling emergence period are each uniquely affected by adverse seed-bed conditions (Finch Savage, 1995). Although the timing of germination in the seed bed can account for much of the variation in the timing of onion seedling emergence (Finch Savage & Phelps, 1993), it is thought to be the post-germination phase where most pre-emergence seedling losses occur (Hegarty & Royle, 1978; Durrant, 1981). However, information on the relative contribution of the pre-germination and post-germination phases to the variation in seedling emergence both within and between sowing occasions is very limited. Under more extreme conditions, seed-bed factors such as increased soil impedance and reduced oxygen supply can have an overriding influence on seedling emergence. However, under good horticultural practice, soil temperature and water potential are arguably the major influences on the timing and pattern of seed germination and seedling emergence in the field. The threshold models of thermal time (Bierhuizen & Wagenvoort, 1974; Garcia-Huidobro, Monteith & Squire, 1982) and hydrothermal time (Gummerson, 1986; Dahal & Bradford, 1994; Bradford, 1995) have been developed to describe the germination responses of a population of seeds to temperature and water potential under constant conditions, but little is known of their descriptive ability under field conditions. Seed advancement studies which limit moisture availability to seeds (i.e. osmotic priming) have shown that metabolic advancement occurs at levels of water stress which prevent radicle emergence from the seed (Khan, 1992; Bradford & Haigh, 1994).

In most species, radicle extension growth is also less sensitive to moisture stress than radicle emergence from the seed (Ross & Hegarty, 1979). Taken together, this suggests that the initiation of radicle growth is a moisture-sensitive, rate-limiting step in the progress of seedling emergence from the soil. The interaction of this step and variable soil moisture levels can largely determine the pattern of onion seedling emergence in the field (Finch-Savage & Phelps, 1993). This suggests that additional conditions might need to be applied to the accumulation of time in threshold models to take account of the influence of this moisture-sensitive step in the prediction of germination and therefore seedling emergence patterns under field conditions Although experiments under controlled conditions that the post-germination growth which leads to seedling emergence is also quantifiable using threshold models (Fyfield & Gregory, 1989; Wheeler & Ellis, 1991) few data are available where this phase of seedling emergence in the field is not confounded with germination.

3 METHODOLOGY

3.1 Research Design

Experimental design was used in the study, where the Mung beans were tested in four (4) different soil types of textures. Experimental design was the most appropriate in this study. Since it has a complete sequence of steps in answering the seed germination rate on the four (4) different soil type textures.

Treatments (T)	Soil texture
T_1	Loamy
T_2	Silty
T_3	Peaty
T_4	Clay

*Treatments (T) used in this study

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3.2 Research Locale

This research experiment was conducted at the municipality of Marantao, Lanao del sur, Philippines. Specifically at baranggay Camalig Bubong, Marantao which is situated approximately 7.9555, 124.2407, in the island of Mindanao in 2022. Elevation at these coordinates is estimated at 740.0 meters or 2,427.8 feet above mean sea level.

3.3 Materials

The 4 soils that were used are loamy, silty, peaty, and clay soil. The equipments that were used in this study are as follows: Seedling bag, gardening gloves, hand trowel, sieve, watering can, and card board.

4 RESULTS AND DISCUSSION

Height in cm (with sunlight)

Among the four soil types textures, it appears that Mung bean seeds grow on clay soil from its fifth day. The series of observation shows that the Mung bean's height were *1cm, 3.5cm, 4cm, 4.5cm, 5cm, 5.5cm, 6cm, 6cm, 7cm, 7cm, and 7.2cm*. However, the Mung bean didn't grow on loam, silt and peaty soil. This result is supported by Stajković-Srbinović, Kuzmanović, Mrvić, and Knežević-Vukčević (2011). Their Study reveals that Mung bean under different soil types showed a 24% increase in bean yield in a clay loam soil compared to a heavy clay soil. They added that low seed yield of Mung bean in heavy clay could be explained by reduced infiltration and slow drainage due to the prevalence of small pores in soil. CSIRO (1979), Further supported that characteristics of soil play a big part in the plant's ability to extract water and nutrients. Soil types satisfy environment for plant growth. In addition plants obtain carbon dioxide from the air to undergo photosynthesis. Soil provides the place for plants' roots to anchor and grow.

Height in cm (without sunlight)

In this set up Mung bean grows on silty soil from its 6th day after planting. Mung bean's heights were *2cm, 7cm, 15cm, 20cm, 25cm, 27cm, 29cm, 31cm, 33cm, and 34cm*. It shows that Mung bean didn't grow on loamy, peaty soil, and clay soil may be due to variations in moisture retension. This result is supported in a study by Ntukamazina et al. (2017), which revealed that differences in Mung bean growth under different soils may be due to variations in moisture retention of soils. Increased height of plants grown in silt loam soils can likely be explained by better tilth compared to the sandy loam soil. Cook,Gupta, Woodhead & Larson (1995);Travlos & Karamanos (2006) have demonstrated that different soil structures can result in differences in particle composition, chemical properties, mechanical impedance and bulk density which affect crop growth and development. Moreover, Bewley and Black (1994) added that there are various environmental factors that affect seed germination. Environmental factors regulating germination include temperature, water, and oxygen for non-dormant seeds along with light and the chemical environment for dormant seeds. This is contradicted by Almansourie et al. (2001) and Bhattacharjee (2008) said that temperature, light, pH, salinity, and water potential are the factors required for seed germination at an optimal proportion. Seed germination is usually the most critical stage in seedling establishment, determining successful crop production.

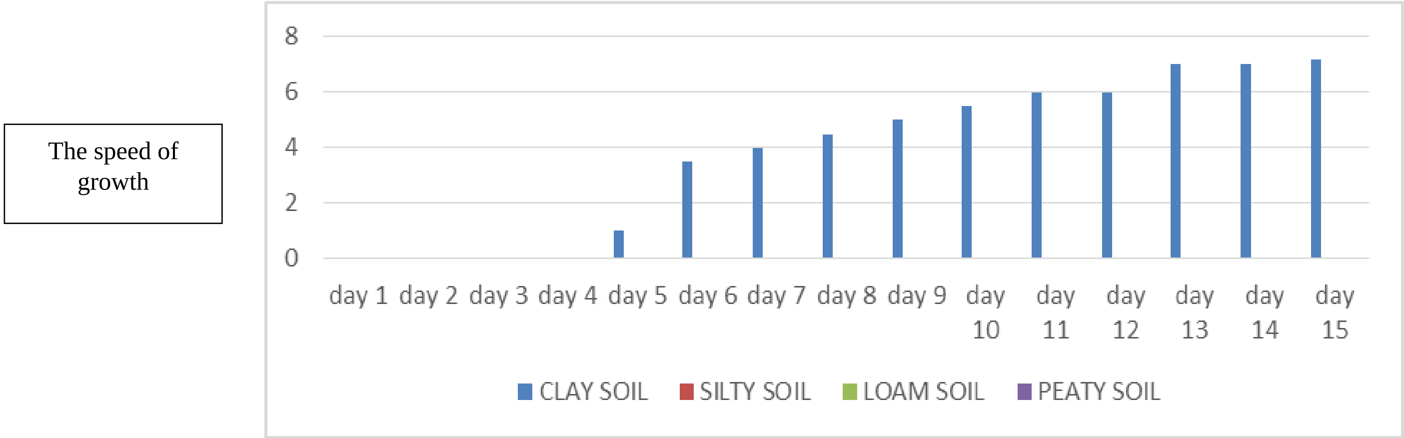

Fig1. *Seed germination of Mung bean (with sunlight)*

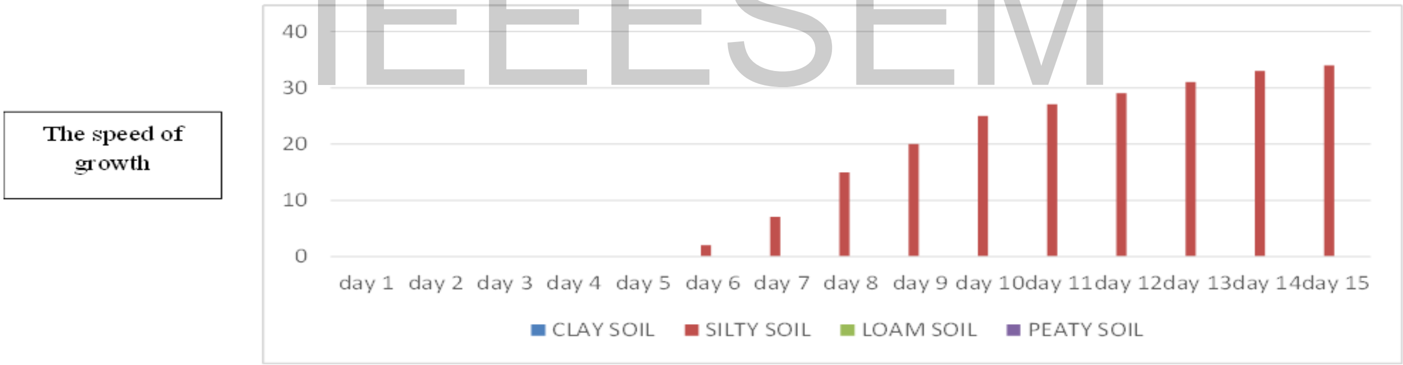

Fig2. *Seed germination of Mung bean (without sunlight)*

4 CONCLUSION

Mung bean germination or growth rate will be affected by different factors like soil textures, sunlight, soil pH, etc. Soil types should not be ignored during cropping. The four soil types textures namely loam, silt, peat and clay soil had found in the germination rate of the Mung bean seeds shows that Mung bean seed grows only on clay soil (with sunlight) and on silty soil (without sunlight). These results are useful to farmers who are cropping Mung bean.

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