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Effects of Planting Depth on Seed Germination and Emergence of *Crotalaria Brevidens* on Maseno Soils Maseno (Kenya)

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Abstract: *Crotalaria brevidens is a medicinal delicious African vegetable with leaves that have a very bitter-sweet taste due to the presence phytochemicals compounds. Sufficient knowledge for farmers on the effect of planting depth on seed germination and emergence was very scarce before this study in comparison to other vegetables; therefore this study was initiated to show the effect of planting depth on germination and emergence of seeds. Experiments were mounted in Maseno University botany laboratory and green house located at the university botanic garden. Its geographical coordinates are 0 1'0'' S, 34 36'0'N at an altitude is 1503 meters above sea level. C. brevidens seeds were bought from the market, viability of the seeds tested at a temperature between 25°C - 29°C. Seeds were sterilized then grown in the green house, 10 seeds were planted in pots measuring 12 inches in diameter and 12 inches in height that contained soil sterilized to prevent the entry of pathogens. The seeds were planted in the pots at varying depths of 0.0cn, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0cm. Seedling emergence, number of leaves, shoot height, root length, fresh weight, dry weight and chlorophyll content were attributes that were measured. Seeds sown in pots with deep depths germinated last, while the ones planted with low depths germinated quicker. The number of leaves, root height, shoots height increased with the number of days. This is because as the number of days increased, the seeds grew, and the said parts increased in number and length. The results obtained are useful to C. brevidens farmers, who are always rural, uneducated and small scale. These results also dictates the most appropriate depth for planting to be between 4cm and 8cm that ensure proper anchorage to the soil, and increased yield as determined by the number of leaves harvested.*

Keyword: *Crotolaria, emergence, germination, growth, seed, vegetable,*

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I. Introduction

Crotalaria brevidens is an erect herb with many branches, usually 0.5 to 1.2 m high, 600 or more species of the genus *Crotalaria* are described worldwide mostly from the tropics where at least 500 species are known from Africa alone [1]. Many species of genus *Crotalaria* are grown as ornaments while many are used as delicious vegetables particularly in Africa where about 70% of its people rely on the vegetable as source of food. Communities in western Kenya value this leafy vegetable and value its taste, nutritional qualities and medicinal properties. There is an increase in demand for this vegetable [1] in view of a rapid population growth in Kenya in recent years.

C. brevidens extracts have shown anti microbial potentials in the laboratory trials [2] thereby proving its potentials as a potential antimicrobial agent. The role of the African medicinal and indigenous vegetables together with the factors affecting their growth are not fully understood, therefore in order to assist farmers with adequate knowledge to grow these very important plants, there is a need for various studies to be conducted [3] to answer many existing questions. Several biotic and abiotic stresses are known to limit productivity of many crop plants, though not much research has been done on the seed depth on germination, resistance to; drought, salinity, pests and diseases [4].

C. brevidens flowers are bisexual, zygomorphic, 5-merous; calyx 3–8 mm long, becoming truncate at base, deflexed against the pedicel, hairy to glabrous, lobes shorter to slightly longer than tube; corolla yellow, with ovate or elliptical standard veined reddish brown, wings about as long as keel with a long beak, up to 2.5 cm long; stamens 10, all joined in a sheath open at base; ovary superior, 1-celled, style curved, stigma small. Fruit a narrowly cylindrical pod 3.5–5 cm × 0.5–1 cm, often slightly curved at the ends, pubescent, black when dry, many-seeded. It produces seeds that are oblique-cordiform, up to 3 mm long, smooth, pale yellow, turning orange to dark red [3].

The effect of planting depth on germination and seedling emergence on various crop plants has been a subject of interest for many workers. Different plant species have been known to have the ability to grow in a wide range of planting depth [5]. While working with the American ginseng (*Panax quinquefolius* L.) [6] the optimum seeding depth resulting in a maximum emergence of dry matter measurement depended on the seedling depth. *C. brevidens* seed germinates in 3–4 days after planting [7]. Initially the *C. brevidens* plant grows slowly and is ready for harvesting 8 weeks after sowing, where continuous harvesting of leaves for food may continue for 4 months [6].

Deep seed sowing has a number of effects on growth of seedlings, for instance, there may be an increase in the time between seed germination and seedling emergence. An increase in hypocotyl or epicotyl length, as noted in deep seedling reduce the probability of the seedlings being capable of overcoming soil strength and render the seedlings more susceptible to attack by pathogens [7].

Very shallow seedling can lead to a high incidence of spider roots which develop horizontally just below the soil surface and which are of very low quality. However, provided the radical of the germinating seed penetrates the soil, the seedling will develop normally with a tap root; such seedlings will have contractile roots which ensures that the rhizome and the pen bud are kept below the soil surface to prevent freeze damage.

Factors that affect seed germination in the soil may include; soil type, water needed by a dormant seed, Oxygen in very small quantities for seeds respiration, Temperature for germination between 5-40'C though the optimum for most of the crops is between 25-30'C and light where some seeds need light for germination while for others germination is hindered by light**.**

The seed depth and germination is much varied among the different plant species thus resulting in varied yields. Varied seed depth during planting may lead not only to germination delay but also seedling growth delay, susceptibility to drought, pests and diseases. Therefore there is a need for investigations to be conducted to establish the effect of the seed depth on early seedling growth and germination for all major food plants.

Even though many aspects of *C. brevidens* have been investigated by different workers [3] little or no information was available before this study on the effect of seed depth on its germination and its early growth. Thus this study was initiated to determine the effect of seed depth on germination and seedling emergence of *C. brevidens* in Maseno soils, Maseno, Western Kenya.

II. Materials and Methods

2.1 Description of area of study

This study was carried out at Maseno University Botany Laboratory and the University green house located at the university Botanic Garden. Maseno University lies within the geographical coordinates 0 1'0'' S, 34 36'0'N at an altitude is 1503 meters above sea level.

2.2 Collection of the seeds and viability

Mature stratified seeds positively identified to belong to the species of *C. brevidens* were bought from the market in Maseno because there were no registered cultivars and there could have been genetic diversity [6], after which the seeds were stored safely in sterile conditions to prevent the entry or attack by disease causing organisms. Viability of the seeds was important [5], and was determined before germination experiments when 100 seeds tested at 25°C - 29°C were able to grow in the green house at Maseno University and all emergent growth counted.

2.3 Soil preparations and treatment

The soil was sterilized as required [6] in order to prevent the entry of pathogenic fungi, bacteria and other disease causing organisms present in the soil, and then checked for remains of gravels or coarse stones.

2.4 Planting of seeds and germination

Pots were saturated with water by surface irrigation as earlier described [5] and then 10 seeds mixed with soil were planted in each 20 liter pot measuring 12 cm in diameter by 30 cm in height containing Maseno soil arranged in varying depths of 0.0cm, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0 cm arranged in triplicates. The ten seeds sown in the pot experiment were planted equidistant within the 20 liter pots as earlier described [6].

Experimental pots were continuously irrigated on a daily basis by spraying water until the water was drained from the bottom of the pot [5]. Seedling emergence was determined when the number of seedlings that emerged from the soil for varying sowing depths of 0.0cm, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0cm were counted and germination was measured daily for 28 days (4 weeks), when all plants were harvested to determine the number of leaves, shoot height, root length fresh weight and dry weight. Chlorophyll content was determined as earlier described [9], [10].

III. Results and Discussions

The seed viability tests conducted in the laboratory produced a 100% result when grown on blotting paper, clearly indicating that all the seeds that were sown were viable (plate 1 and 2). The experiments conducted to determine seed emergence showed that there was significant ($p<0.05$) difference in the seedling emergence among the different sowing depths of 0.0cm, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0cm. Any increase in sowing depth led to a corresponding decrease in number of seeds that emerged per day (Table 4.1), while for the number of leaves counted there was no significant ($p<0.05$) difference in number of leaves in sowing depths of 0.0cm, 2.0cm and 4.0cm but there was significant ($p<0.05$) difference between sowing depth of 6.0cm, 8.0cm and 10.0cm (Table 4.1).

Plate 1 & 2; Showing the laboratory germination of the seeds on blotting paper 3 weeks after planting

Shoot height measurements showed a significant ($p<0.05$) difference in the shoot height among the different sowing depths of 0.0cm, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0cm. Any increase in depth led to decrease in number of seeds that emerged per day (Table 4.1). It was also evident that the root length measurements varied and showed a significant ($p<0.05$) difference among the different sowing depths i.e. 0.0cm, 2.0cm, 4.0cm, 6.0cm, 8.0cm and 10.0cm. The number of seeds that emerged per day decreased with increase in sowing depth as shown in Table 4.1.

Table 4.1 Effect of sowing depth on number of leaves, shoot length, and root length of *C. brevidens*.

Sowing depth (cm)	Mean No of leaves	Mean Shoot length(cm)	Mean Root length(cm)
0	7.00a	18.23a	3.133e
2	6.33a	13.92b	4.633e
4	5.50a	10.81c	5.73d
6	3.66c	8.07d	7.73c
8	3.33c	6.55e	9.96b
10	2.66c	4.46e	11.90a
LSD	0.8056	1.7545	0.5624

Means with the same letters are not significantly different at p<0.05.

Dry weight measurement showed a significant ($p<0.05$) difference among the different sowing depths of 0.0cm, 2.0cm, 4.0cm,6.0cm, 8.0cm and 10.0cm. Any increase in sowing depth led to decrease in number of seeds that emerged per day as shown in table 4.2.

Fresh weight measurements showed that there was significant ($p<0.05$) difference in the seedling fresh weight among the different sowing depths of 0cm,2cm,4cm,6cm,8cm and 10cm, any increase in sowing depths led to a decrease in the number of seeds that emerged per day as shown in table 4.2. Chlorophyll content measurements indicated that there was significant

Table 4.2 Effect of planting depth on dry weight, fresh weight, and chlorophyll content of *C. brevidens.*

	DRY WEIGHT(g)	FRESH WEIGHT(g)	CHLOROPHYLL CONTENT(mg/fw)
0	0.4667a	4.4333a	14.1444a
2	0.3667b	1.3000b	13.7222b
4	0.2222c	0.9000b	12.5677c
6	0.2111c	0.4667b	11.7566d
8	0.1999c	0.3667b	10.5672d
10	0.1789c	0.3667b	12.7500d
LSD	0.0721	0.1898	3.9975

($p<0.05$) difference in the chlorophyll content among the different sowing depths of 0.0cm, 2.0cm,4cm,6cm,8cm, and 10cm. any increase in sowing depth led to decrease in number o f seeds that emerged per day as shown in table 4.2.

Plate 3; Showing the first week of planting and emergence of *C. brevidens* from many pots of various depths

The germination and growth of *C. brevidens* in this experiment depended on the depth (Plate 3). Seeds that were planted in high depths germinated last, compared to the ones that were planted in low depths. The number of leaves shoot height, root length also increased with the increase in growth size. The number of seeds that germinated per day decreased with increase in depths. Dry conditions and lack of soil moisture availability, especially during planting time can create water stress resulting in delayed germination, a reduction in plant stands or may prevent seed germination. For comparison, soybeans absorb half of their weight in water before they germinate. Therefore, the level of soil moisture in the soil seedbed at planting dictates this critical process. For successful seed germination, ideally soil moisture should be at or close to field capacity. At field capacity the soil retains the maximum amount of moisture. Field capacity is influenced by soil texture; for example, fine-textured soils, such as clay or loam soils, have larger moisture holding field capacity than coarse-textured soils such as sandy-textured soils.

Very small seeds take time to establish if sown at deep depths and this decreases the mass yields. This study showed significant interactions between sowing depth and *C. brevidens* with the vegetable performing well between 0.0cm and 4.0cm and the lowest means being recorded between 6.0cm to 10.0cm. The negative effect of sowing depth was reported [11] by other workers who found that seedling emergence of cotton seed was decreased with increased depth**.** Soil texture and tillage influence available soil moisture, where dry conditions influence soil moisture availability differently depending on soil texture. Fine-textured soils have less available water than medium or coarse-textured soils [11]. For example, loam soils that contain 20 to 37 percent clay have greater water available to the plant than clay soils that contain greater than 40 percent clay. Factors affecting seed germination include; moisture, air temperature, light and seed depth when planting all these factors must be taken into account when sowing is done.

VI. .Conclusion and Recommendation

The results obtained during these studies have greatly shown that the germination of seeds depends on the planting depth as was also seen by other workers [5]. Germination and emergence reduces with increase of planting depth. The seeds that were planted with deeper depths e.g. 8.0 cm, and 10.0 cm were able to germinate last, as opposed to the ones that were planted with lower depths. The number of leaves, shoot height and root height increased with the number of days when counting was done. This is because, as the number of days increased, then the seedlings grew. Therefore farmers planting *C. brevidens* are advised to have moderate depths for planting. This is to ensure strong anchorage to the soil, and also to ensure faster germination of the seeds.

Recommendation

We recommend that famers try to sow *C. brevidens* seeds at a depth not exceeding 10 cm, possibly between 4cm-8cm followed by a stable watering regime to obtain a good seed emergence and germination in all agricultural undertakings to minimize loss and increase yield. Kenyan famers should be educated on the appropriate agricultural practices on suitable depths and how to grow this delicious vegetable, the farmers should also be advised on how to choose the right soil for growing *C. brevidens* and proper watering techniques to ensure high yield.

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