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The Growth and Yield of Five Seedling Tuber (Clones) as Affected by Planting Depth and Seedling Tuber Sizes.

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ABSTRACT

Seedling tubers have been on the list of improved ways to cultivate the potato crop thereby increasing the scope of the reach of tuber cr to complement the population increase in the world. This present study could be a roadmap for a better cultivation of diseased free potato. A field study was carried out at Ritdung Integrated Farm, located in Jos South Local Government Area of Plateau state. The study was done during the period of March – June 2020 to evaluate the effects of five seedling tuber (Clones) as affected by 3 Planting Depth and 2 Seedling tuber sizes. The 30 treatment studied were factorial combination of 5 Seedling tubers (Clones), 3 Planting depth and 2 Seedling tuber size. The potted experiment which was replicated three (3) times was laid out in the format of a Randomized Complete Block Design (RCBD). The Clones show significant differences in both the growth and yield parameters under study, namely Shoot emergence, Plant height, Number of leaves, Number of above ground shoots, Number of tubers and mean weight of tubers. There were significant differences within the means due to variations in Planting Depth for all parameters examined in the study. Similarly, Seedling tuber sizes significantly influenced all parameters studied in this experiment. Clone 4 had the highest number of tubers and mean weight of tubers at harvest, these differences was also revealed in all growth parameters examined. The 5cm Planting depth also performed best thereby producing plants with a high shoot emergence, plant height, number of leaves, number of above ground shoots, number of tubers and mean weight of tubers. In the same vein, the Large Seedling tuber sizes recorded the highest shoot emergence, plant height, number of leaves, number of above ground shoots, number of tubers and mean weight of tubers. This experiment has shown that Seedling tubers (Clones) can best be successfully grown using the 5cm Planting depth and using the large seedling tuber size.

Key Words: True Potato Seeds (TPS), Seedling tuber clones, and genetic populations.

INTRODUCTION

The importance and usefulness of True Potato Seeds (TPS) in conventional breeding methods of potato is to the fact that TPS provides a basis to generate new genetic populations of potato (Foster *et al.*, 2009). TPS, also known as the True Botanical Seeds of potato are seeds derived or produced in the berries of a potato plant. These berries arise as a further development of the flower, basically as a result of the fertilization and sexual seed formation process (Struik and Wiersema, 1999). The genotypes that grow as seedlings from true seeds produce tubers called "Seedling tubers" that can be replanted as vegetative tuber seed, and hence clones can be established, maintained and propagated by asexual (vegetative) reproduction (Mihovilovich *et al*., 2017). The reliability of using seedling tubers derived from TPS for the cultivation and production of potato crop is in the fact that it ensures a high health status of the resultant crop. However, this advantage can be easily lost when too many (not more than three) field multiplications are done from the resultant tuber; the use of seedling tuber has become an alternative planting material (Bhattarai and Gautam, 2016). Tuber seed size is a major factor for consideration when selecting good seedling tubers for the production of the potato crop. In most regions of the world, seedling tubers, 1g and above, can be convenient for potato production (Adhikari and Rai, 2004).

However, further studies done by Adhikari and Girish (2004) shows that a high level of viability and yield of tubers is obtained when tubers of about 5g of weight are used. On the other hand, the depth of planting has been the first and most important factor for proper root development. This has proven over the years and seasons of planting that when planting is done at shallow or too deep level, it results in uneven germination and growth performances, yield reduction and great losses (Tamirat Wato, 2009).

Seedling Tubers and True Potato Seeds (TPS)

Breeding programs all over the world are geared towards the production of cultivars that have a short maturity period for reduced production costs giving maximum yield, for an effective production of potato, seed potato has been an important ingredient (Lacha *et al.,* 2012). Breeders in the present world of advance farming and technology tend to choose methods that ensure the rapid production/ multiplication of tubers for primarily commercial purposes, in this case, TPS is mostly preferred and used (Muthoni *et al*., 2014). In the cultivation of potato using TPS technologies two broad methods exists. They are the

True potato Seeds (TPS) also known as the True Botanical seeds of potato are seeds derived or produced through the sexual fertilization of potato. TPS offers an alternative planting material used in the world of commercial production of potato. These botanical seeds resemble seeds of other Solanaceous plants and crops like tomatoes, chilies etc. TPS are gotten from fresh berries of a potato plant with each berry containing an average of 100 – 200 seeds. These botanical seeds which are produced in the berries of potato plants are what is referred to as the True Potato Seed (TPS) (Struik and Wiersema, 1999). Such berries arise as a result of sexual fertilization and seed formation an important procedure in major breeding programs of the world. TPS gains its high importance and usefulness in conventional breeding methods of potato as it provides the basis to generate new genetic populations. The TPS of wild Potato species are often used in the production and release of new varieties (Salaman, 1970; Vander Vossen *et al*., 2003, 2005; Park *et al*., 2005a, 2005b, 2009; Foster *et al*., 2009). The conventional potato tuber has plenty of researches and information on the varieties, seed sizes and planting depth that are available to farmers and researchers alike. Seedling tubers (clones) that are harvested from TPS do not have such luxurious dearth of information. An attempt is being made in this study to add to the little information that may be available. This study was done to investigate the best agronomic practice for a good seedling tuber growth and yield and to further reveal Which is the best clone, seed size and planting depth for the seedling tubers that can be used for the seedling tubers that were harvested from TPS.

Effect of Seed Sizes

Tuber **s**eed sizes have been a key contributing factor in the production of potato crop the world over. In most regions of the world, seedling tubers above 1g size can be used for convenient potato production (Adhikari and Rai, 2004). Studies conducted by Masarirambi *et al*. (2012) shows that plant population and seed tuber size greatly influences growth and yield component of potato (Solanum tuberosum). Yet, Wiersema (1986) recorded that the yield increases significantly with seedling tuber sizes of 5g. In other parts of the world reports have also shown that both growth and yield of individual stems largely depends on the seedling tuber sizes (Allen and Scoot 1980; Wiersema, 1986). Majority of local farmers in the world are faced with the constraint of attached with the propagation of crops using seed tubers as seed tubers are the costliest input in the potato cultivation. This has led majority of farmers to split seed tubers into pieces. The major reason of cutting such large size tubers is to reduce the cost of seeds and to maintain uniform sprouting. Most traditional methods of potato production, seedling tubers sizes and plant population per hill have been found to influence the yield and economic returns (Hossain, 2004). Potato production may be increased by improving cultural practices which are optimization of manure and fertilizer planting date and time, spacing and the use of optimal size seed tubers, all of these factors are greatly influenced the yield of potato (Divis and Barta, 2001). Smaller seed tubers are usually neglected as planting material in some countries of the world, although the genetic constitution of such seedling tubers is or are more or less smaller to that of a standard one (Upadhya *et al*., 2003). Seedling tubers may be planted together on a hill which is known as chump planting and could behave equally to single bigger seed tubers. Seedling tuber size and clump planting may be considered very important factors for the production of potato (Rojoni *et al*., 2014).

Effects of Planting Depth

Sustainable farming methods comprise basically of soil building and conserving practices which includes adding organic matter and minimum tillage approaches (S. Chehaibi *et al*., 2013). Several inputs have been put under control to obtain maximum yield in potato crop production. Factors such as choice of variety, physiological stage of plant, germination and pre treatment plant, planting date and circumstances, soil temperature, the quantities and their positioning, irrigation system, yields remain below expectation (Fraser, 2000). The depth of planting for majority of tuber crops is of paramount importance as a deep planting help reduce the risk of series of contamination of tubers by Mildews but again this act increases the risk of Erwinia development in poorly drained soil (De Reycke *et al.,* 2005). Furthermore, the contamination of seed tubers from foliage can be greatly reduced by planting tubers deep and by creating a mound sharp enough that can allow rainwater drain (Lounbron, 2006).

MATERIALS AND METHOD

Experimental Site

The experiment was conducted at Ritdung Intergrated farm located in Rantya Jos South Local Government Area of Plateau state.

Experimental Design and Treatment

Nine (9) small and nine (9) large seedling tubers from five (5) different clones were used for this experiment. One (1) tuber each from these seedling tuber categories were factorially combined with three (3) planting depth for each of the clones i.e. thirty (30). This factorial combination was replicated three (3) times. As shown below;

$C_1S_1D_1$ $C_2S_1D_1$ $C_3S_1D_1$ $C_4S_1D_1$ $C_5S_1D_1$

$C_1S_1D_2$ $C_2S_1D_2$ $C_3S_1D_2$ $C_4S_1D_2$ $C_5S_1D_2$

$C_1S_1D_3$ $C_2S_1D_3$ $C_3S_1D_3$ $C_4S_1D_3$ $C_5S_1D_3$

$C_1S_2D_1$ $C_2S_2D_1$ $C_3S_2D_1$ $C_4S_2D_1$ $C_5S_2D_1$

$C_1S_2D_2$ $C_2S_2D_2$ $C_3S_2D_2$ $C_4S_2D_2$ $C_5S_2D_2$

$C_1S_2D_3$ $C_2S_2D_3$ $C_3S_2D_3$ $C_4S_2D_3$ $C_5S_2D_3$

These Treatment combinations were replicated three (3) times and laid out in the format of a Completely Randomized Block Design (CRBD) see appendix 1

Field Observation and Data Collection

Observations and data collections were carried out first at four Weeks After Planting (4WAP) and continued at two (2) weeks interval until harvest at twelve Weeks After Planting (12WAP). The following observations are taken and recorded; Shoot Emergence count, Plant Height, Number of leaves per plant, Number of above ground shoots/stems, Number of tubers per plant at harvest and Weight of tubers per plant at harvest

RESULTS

Germination/ Emergence Count

The difference in emergence of shoots were significant (P=0.05) throughout all the stages of growth of the experiment. The differences due to planting depth were significant (P=0.05) through all the stages of growth. Seedling tubers planted at 5cm had the fastest and high emergence followed by those planted at 10cm and 15cm. the mean differences showed that seedling tuber planted at 10cm were statistically the same with those planted at 15cm. Differences due to seed sizes were not significant all through the stages of the experiment. There were no significant interactions throughout all the stages of growth in the experiment. Table 1 shows the effect of seed sizes and planting depth on the germination/ emergence of seedling tuber clones at 4, 6, and 8WAP. Table 2 shows the effect of seed size and planting depth on the number of tubers per plant at harvest. The effect of seed size and planting depth on the mean weight of tubers per plant at harvest is shown in Table 3. On a general note, combined effects of planting depth, Clones and Seed Sizes shows similar trends all through the different parameters used in this research work.

Plant Height

Plant height were significantly different (P = 0.050) at all growth stages except at 10 WAP. Seedling tubers from clone4 recorded significantly taller shoots than all the other seedling tuber clones though they were at par statistically with those plants in clone3. Thereafter, the different clones showed statistical parity with one another at the different growth stages. However, the overall plant height ranking performance for the entire experiment is; clone 4, clone 3, clone 1, clone 2 and clone 5 in that order. Plant height differences due to the depth of planting were statistically significant (P=0.050) at all the stages of growth. The seeds planted at 5cm depth had plants with the tallest shoots all through the growth stages. The differences in mean plant height for seeds planted at 10cm and 15cm were not significant through the period of experiment. The differences in the mean plant height due to the seed sizes showed that there were significant differences statistically (P=0.050) at all the early stages of growth (4 – 8WAP) except at the 10 and 12WAP stage of growth. The differences were not significant at the later stages of the experiment. The large seed sizes produced taller shoots than the small seed sizes at all the early stages of growth.

VARIABLES	**weeks after planting**		
CLONES	4	6	8
1	55.56bc	55.56bc	55.56bc
2	55.56bc	61.11bc	61.11bc
3	72.22ab	72.22ab	83.33ab
4	88.89a	88.89a	88.89a
5	44.44c	44.44c	44.44c
LSD	26.446	26.787	26.469
DEPTH (cm)			
5	96.67a	96.67a	96.67a
10	53.33b	53.33b	56.67b
15	40.00b	43.33b	46.67b
LSD	20.485	20.749	20.503

SEEDSIZES (g)			
Small	55.56	57.78	62.22
Large	71.11	71.11	71.11
LSD	-	-	-
INTERACTIONS			
Clone X Depth	NS	NS	NS
Clone X Sizes	NS	NS	NS
Depth X Sizes	NS	NS	NS

Table 1: Effects of Clones, Planting Depth and Seed sizes on Shoot emergence or germination at 4, 6 and 8 Weeks After Planting (WAP)

[1] - Means with the same letter(s) within the same column and treatment are not significantly different at 5% levels of probability using LSD (Least Significant Difference)

NS - Not Significant

cm- Centimeters

Number of Leaves

Differences in the mean number of leaves due to the clones were not significant all through the growth stages of the experiment except at the 6WAP stage of growth. The differences in the mean number of leaves at 6WAP stage showed that clone 4 had the highest number of leaves although they were at par statistically with those plants of clone3. Next in rank were numbers of leaves from clone 2 which were at par with those of clone1 and clone5. Clone 1 and Clone 5 were statistically the same. On a general ordinary note, the performance of the clones as regards no of leaves shows that clone 4 ranked highest followed by clone 3, 2, 5 and 1 in that order. These differences in the mean number of leaves due to planting depth were significantly different (P=0.050) at the early stages of the experiment (4 – 6WAP). The differences at the early stages of the experiment showed that seedling tubers that were planted at the 5cm depth had significantly higher number of leaves than those seedling tubers planted at 10cm and 15cm which were statistically the same. The mean numbers of leaves due to seed sizes were not significant in all the stages of the experiment except in the early stages (4 and 6 WAP).

Table 2: Effects of Clones, Planting depth and Seed sizes on the Number of Tubers per plant at Harvest keys

VARIABLES	
CLONES	Number of Tubers
1	0.5
2	1.44
3	1.28
4	1.61
5	1.61
LSD	
DEPTH (cm)	
5	2.20a[1]
10	0.57b
15	0.90b
LSD	1.087
SEEDSIZES (g)	

Small	1.53b
Large	5.80a
LSD	1.538
INTERACTIONS	
Clone X Depth	NS
Clone X Sizes	NS
Depth X Sizes	NS

[1] - Means with the same letter(s) within the same column and treatment are not significantly different at 5% levels of probability using LSD (Least Significant Difference)

NS - Not Significant

cm- Centimeters

g- Grams

Number of above ground shoots

The differences in the mean number of shoots due to the effect of clones significantly different (P=0.05) through all the stages of the experiment. Seedling tubers of clone4 showed the highest number of above ground shoots although they were at par with those of clone3 and the early stages of growth of clone 1 and 2 (4WAP). Seedling tubers of clone 3 were statistically at par with those of clone 1 and 2 at all stages of growth in the experiment. Seedling tubers of clone5 also produced a high number of above ground shoots which were also at par statistically with those of clone2 at 4, 6, 8, 10 and 12WAP stage of growth and also clone 1 at 6, 10 and 12WAP stages of growth. The overall mean number of above ground shoots ranking performances for the entire experiment is clones 4, 3, 1, 2 and 5 respectively. Differences in the mean number of above ground shoots due to the planting depth were significant (P=0.05) all through the stages of the experiment. Seedling tubers planted at 5cm depth produced the highest number of above ground shoots followed by those planted at the 10cm and 15cm depth which were statistically at par through all the stages of growth in the experiment. The numbers of above ground shoots due to seed sizes were not significant through all the stages of growth except at latter stages of growth (10 and 12WAP). The mean differences showed that the large seed sizes had the higher number of above ground shoots than the small seed sizes. These differences were seen at the latter stage of the experiment. The interactions at all levels were not significant throughout the experiment.

Number of tubers at harvest

Table 5 shows the effect of seed size and planting depth on the number of tubers per plant at harvest. The differences due to clones were not significant at harvest. All the clones were seen to be the same statistically at harvest. The means due to the effect of the planting depth were significant (p=0.50) at harvest. The seedling tubers planted 5cm deep had the highest number of tubers produced. This were followed by those planted at 10cm and 15cm which were statistical the same at of harvest.

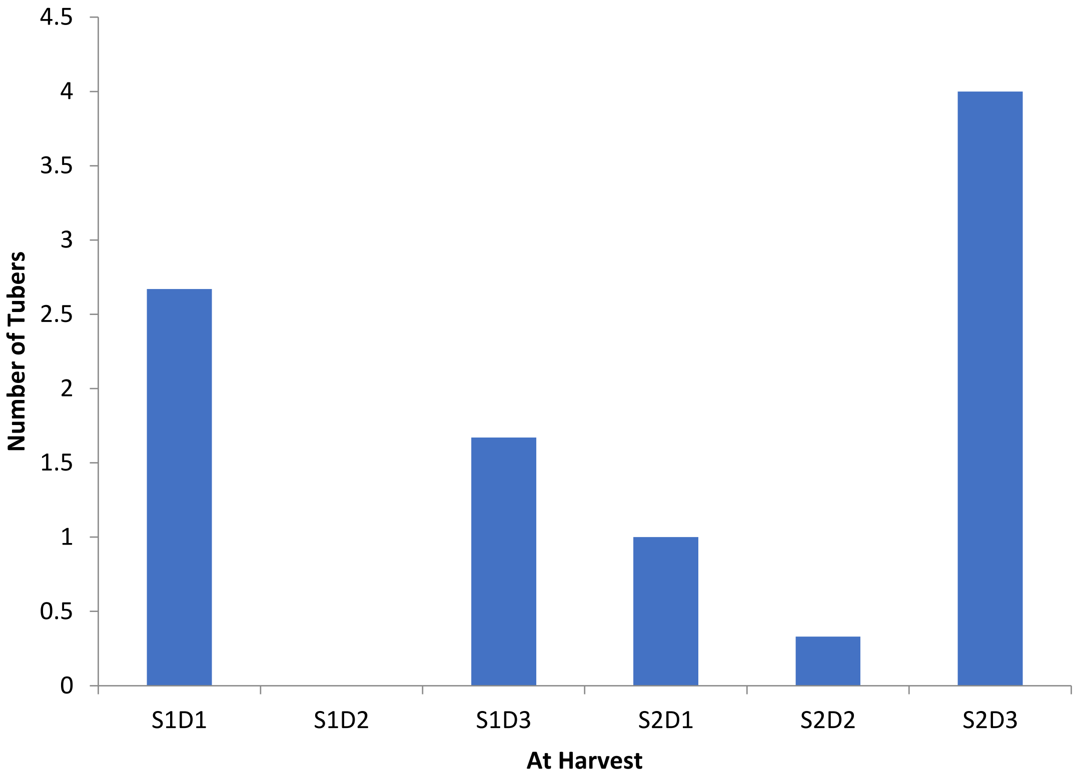

Fig. 1 Number of Tubers at Harvest Clone 4

DISCUSSION AND CONCLUSION

Effect of Clones

The genetic populations of seedling tubers derived from TPS are also referred to as Clones. This is because each TPS found in a berry is a different and unique genotype of its own (Mihovilovich *et al*., 2017). This explains why there were significant differences within the Clones for all parameters examined in the research namely shoot emergence count, plant height, Number of leaves, Number of above ground shoots, Number of tubers at harvest and weight of tubers at harvest. Therefore, the determination of uniformity and homozygosity of the seedling tuber cannot be certain as stated by Mihovilovich *et al*. (2017) who stated that, potato is highly heterozygous, as such, each cross results in a heterogeneous progeny or true seed family. The great variation obtained in this research work is similar to that of Habtamu *et al*. (2016) who reported that such variability across all growth parameters indicates a high level of genetic variability within the Clones. Similarly, Getachew *et al*. (2006) also reported significant differences among 24 potato genotypes in their number of tubers per plant due to genetic variability. Girma (2012), also supported this claims with a report that the differences observed between the Clones in growing periods, leaf setting and maturity might be basically due to differences in genetic makeup.

EFFECT OF SEEDLING TUBER SIZES

Seedling tuber sizes significantly influenced parameters examined in this experiment. The results showed that the large seedling tubers performed best in all parameters under observations this could be due to the availability of a high or more reserved food materials present in the large seedling tubers. Hossain (2004) and Gulluoglu and Aroglu (2009) reported an increase in growth parameters such as the shoot emergence, plant height, number of leaves etc are greatly influenced by the quality and quantity of food reserves in the tubers.

Effect of Interactions

There were no significant interactions between Clones, Planting Depth and various Seedling tuber sizes for all the growth and yield parameters in this very experiment. This implies that there are no visible differences in the combined forces of the data collected Dhaliwal and Sabota (1991), reported that interactions are the tendency of one factor to have a different effect at different levels of another factor.

Effect of Planting Depth

The experiment revealed that planting depth significantly affected all parameters studied in this research work. The 5cm planting depth had the overall best performance all through the parameters examined in this research work. This could be because the seeds were planted at the surface level not too deep and they had just little soil covering the seeds. This gives the seed easy access to water and sunlight (which are important elements in crop production). This performance of the tubers at 5cm planting depth agrees to the findings of Baarveld *et al*. (2002), who reported that surface planting is preferred in areas with heavy soils, where the mother tuber may run out before the seeds can reach the soil surface. The 10cm and 15cm planting depth did not perform as the 5cm planting depth. This could be because of the depth of sowing which is too deep there by limiting the tubers from receiving the effects of some environmental inputs as sunlight etc. Molabud and Maringe (2009), states that when tubers are sown at higher depths the shoot apex of newly germinated seedlings may not be able to push up the soil to come out onto the surface. On the other hand, Lambion *et al*. (2006) further added that deep planting is useful in checking the activities of certain pests on tubers and food materials in the parent mother tuber. This showed that as the tuber size increases growth parameters also increased. This is in agreement with the findings of Shingrup *et al*., (2003), Hossain (2004), Sonawane and Dhoble (2004) and Tohin (2010), who stated that an increase in the size of potato tubers brings about a corresponding increase in the quality and quantity of growth and yield parameters of the potato crop.

Table 3: Effects of Clones, Planting Depth and Seed sizes on the Mean Weight of Tubers per plant at Harvest

VARIABLES	
CLONES	Weight of Tubers
1	0.5
2	1.72
3	4.22
4	4.94
5	4.28
LSD	
DEPTH (cm)	
5	5.6
10	1.7
15	1.87
LSD	
SEEDSIZES (g)	
Small	3.53
Large	15.27
LSD	
INTERACTIONS	
Clone X Depth	NS
Clone X Sizes	NS
Depth X Sizes	NS

KEYS

NS - Not Significant

cm- Centimeters

g- Grams

Combined Effects

There were no significant interactions between the various variables at all stages of growth and for all parameters in this research; this result is reflected on the graphs of combined effects of various variables for all the parameters. This shows that, the absence of aberrations on the graphs due to the combined effects indicates that none of the variables (Clones, Planting Depth and Seedling tuber sizes) had a greater effect than the others. This is not in line with the findings of Dhaliwal and Sabota (1991) who reported that significant interactions are the tendency of one factor to have a different effect at different levels of another factor as revealed in figure 2

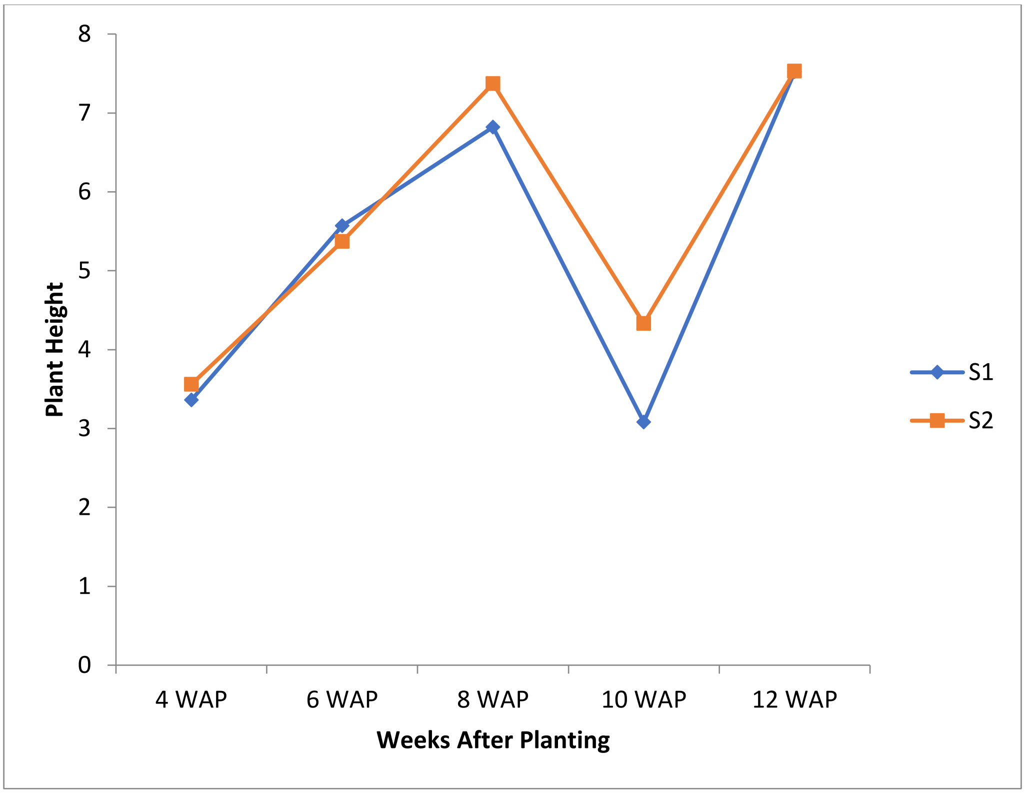

Figure 2. Combined Effects of Clone 4 and Seed Sizes on Plant Height at 4 – 12 WAP

CONCLUSION

It can be concluded that both Seedling tuber Clones, Planting depths and Seedling tuber sizes significantly affect the shoot emergence, plant height, number of leaves and the number of above ground shoots of Clones of Seedling tubers of potato. The Clones performed best at the 5cm planting depth and also with the large seedling tuber (S2).

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