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Full Length Research Paper

Feasibility studies on the potential of grafting and budding of frafra potato (*Solenostemon rotundifolius*)

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Frafra potato (*Solenostemon rotundifolius*) is a herbaceous root tuber that is grown mainly in the northern part of Ghana. It is used as a hunger crop and brewed for alcoholic beverages. In spite of the socio-economic importance of this crop, little research aimed at improving the crop and its small tuber size has been carried out. In an effort to improve upon the agronomic performance of frafra potato, a randomized complete block design was used to conduct an experiment to determine the possibility of grafting and budding the crop. Approach, Cleft and splice graftings and budding, using dormant and actively growing buds were used to bud the crop. With the exception of the approach grafting, all the grafted plants from cleft and splice grafting produced leaves and shoots. The splice grafting recorded the highest number of leaves and plant survival. The dormant buds used in budding recorded higher number of leaves, longer shoots and plant survival. Only the approach grafted plants established union between the stocks and the scion, while the cleft and splice grafting failed to establish a union. The experiment demonstrated the potential of mixing the genetic materials of different frafra potato materials through grafting. The experiment may be improved through the use of auxin to induce the union of stock and scion.

Key words: Frafra potato, small tuber size, grafting and budding.

INTRODUCTION

Due to the lack of proper storage and inadequate storage facilities, most farmers are not able to store enough food throughout the year. As such, food security has always been a common phenomenon especially during the period between planting and harvesting of succeeding crops (Weibe et al., 2000). As a result, crops that mature and are ready for consumption during these periods are normally cultivated before the main staple crops. One of such crops is the frafra potato, (*Solenostemon rotundifolius*). Frafra potato belongs to the family Labiatae (Tindall, 1983). It is a succulent crop with the stem square in cross-section (Dupriez, 1989). Frafra potato is suited for cultivation on marginal areas in the dry savannah regions with poor soils. It is propagated mainly by tubers. In Ghana, frafra potato is cultivated exclusively in the northern part of the country. Its tuber is used mainly as food. Among the frafra people, the tubers are presented to in-laws as a dowry. The tubers have also been used in the distillation of alcoholic beverage (Apabol, 1997). The leaves have been used in treating dysentery in some rural communities in Nigeria (Tindall, 1983).

Frafra potato is propagated mainly by tubers. However, vine cuttings of two to three nodes can also be used for its propagation (Kay, 1973). Notwithstanding the socio-economic importance of frafra potato, little research has been conducted to improve upon its tuber size which has been the main constrain to its cultivation as a main staple crop. The aim of the study was to determine the potential of grafting and budding frafra potato as a means of improving upon the agronomic performance of the crop.

MATERIALS AND METHODS

The experiment was conducted at the plant house of Nyankpala campus, University for Development Studies Ghana. The study area lies on latitude 9° 25 N and longitude 9° 58 W with altitude 183 m above mean sea level (SARI, 1997). Plastic containers of diameter and height 25 and 35 cm respectively were used as experimental pots for the experiment. The soil for growing the crop

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Figure 1. An insect pest feeding on frafra potato seedlings.

was prepared by mixing top soil, compost and river sand in the ratio 7:3:2. The pots were filled to 2/3 of volume with the prepared soil samples. Surgical blades were used to make various stock and scion cuttings of the experimental materials. Strips of gauze and polythene bag were used to hold the stock and scion together. A tailoring thread was used to tie the scion and the stock firmly together after grafting and budding. Staking sticks 90 cm long were used to keep the plants in an upward position. A randomized complete block design (RCDB) with five treatments and replicated five times were used. Five experimental treatments were carried out as follows: Treatment 1: approach grafting, Treatment 2: cleft grafting, Treatment 3: splice grafting, Treatment 4: budding using dormant buds and treatment 5: budding using actively growing buds.

Planting materials and protection of seedlings

Frafra potato tuber seeds were obtained from the seed bank of University for Development Studies. Healthy tuber seeds were selected and planted in July 2010. Frafra potato seedlings were sprayed with Karate to control insect pests feeding on the leaves (Figure 1). Unhealthy seedlings were uprooted and destroyed to prevent spread of diseases to the healthy seedlings.

Grafting and budding

The grafting and budding operations were carried out 12 weeks after germination of the frafra potato seeds. Cleft and splice grafting were employed with dormant and actively growing buds used for the budding operations.

Data collection and analysis

Data was collected every two weeks over a period of eight weeks; after grafting and budding on number of leaves on grafted and budded plants, length of plant shoots after grafting and budding and number of plants surviving eight weeks after grafting and budding. The data was subjected to analysis of variance (ANOVA), using the standard error difference (S.E.D) at significant level ($p < 0.005$) and the means separated using least significant difference (LSD).

RESULTS

Grafting of frafra potato

Number of leaves produced by grafted plants

The number of leaves produced by the grafted plants did not show any significant difference ($p > 0.05$) in Weeks 2 and 8. However, weeks 4 and 6 exhibited significant difference ($p < 0.05$) in the number of leaves produced by the grafted plants (Figure 2).

Length of plant shoot

Growth in the length of shoot produced by the grafted plants showed no significance differences at weeks 2 and 8. However, it showed significant differences ($p < 0.05$) at Weeks 4 and 6 (Figure 3).

Number of plants surviving grafting

There was no significant difference ($p > 0.05$) in the

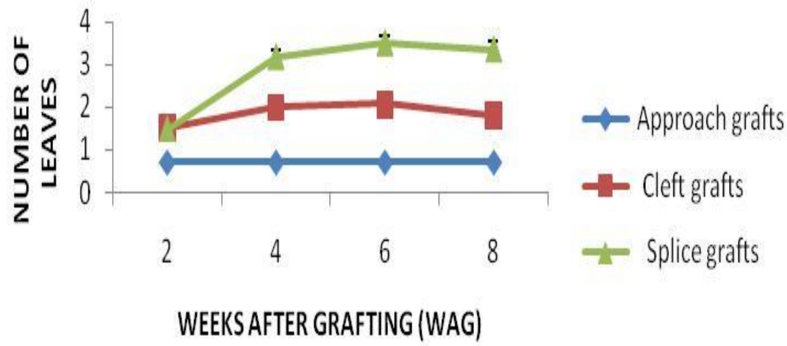

Figure 2. Mean number of leaves produced by grafted Frafra potato plants.

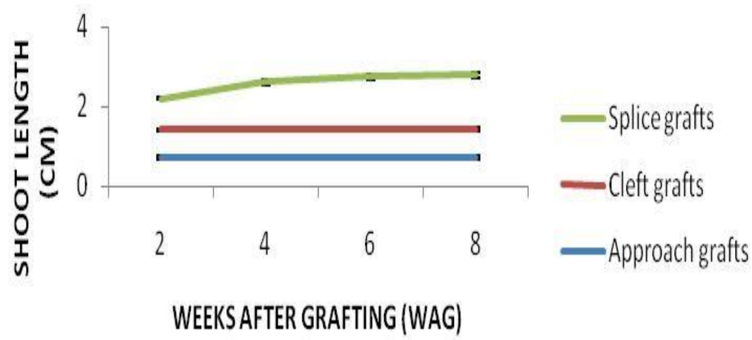

Figure 3. Mean shoot length of grafted Frafra potato plants.

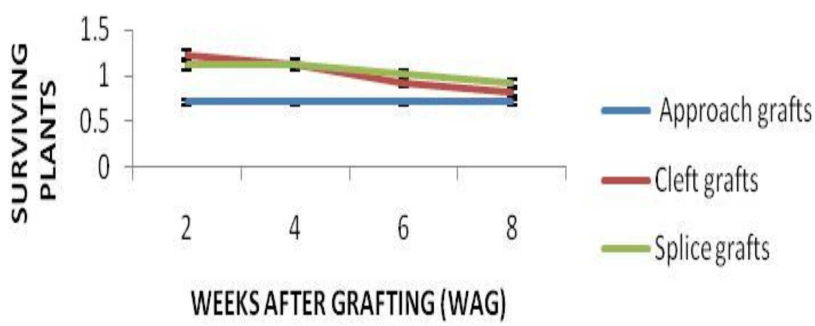

Figure 4. Mean number frafra potato plants surviving grafting.

number of plants that survived grafting at Week 8. However, at Weeks 2, 4 and 6, there were significant differences in the number of plants surviving grafting (Figure 4).

Budding of frafra potato

Number of leaves produced by budded plants

Significant differences ($P < 0.05$) were observed in the number of leaves produced by the dormant and active buds at Weeks 2 and 8. However, differences in the number of leaves produced by the dormant and active buds at weeks 4 and 6 were insignificant (Table 1).

Length of plant shoot

Significant differences ($p < 0.05$) were exhibited in the length of plant shoots generated by the budded plants using the dormant and active buds at weeks 2, 4 and 8.

Table 1. Mean number of leaves produced by budded plants.

Treatment	Week 2	Week 4	Week 6	Week 8
Dormant buds	1.600	2.980	3.290	3.580
Active buds	0.710	1.980	1.980	1.360
LSD	0.826	1.342	1.510	1.955
F. probability	0.041	0.107	0.074	0.034

Table 2. Average shoots length of budded frafra potato plants.

Treatment	Week 2	Week 4	Week 6	Week 8
Dormant buds	0.844	1.136	1.306	1.390
Active buds	0.7I0	0.804	0.982	0.828
LSD	0.133	0.308	0.439	0.403
F. probability	0.049	0.040	0.110	0.018

Table 3. Average number of budded frafra potato plants surviving.

Treatment	Week 2	Week 4	Week 6	Week 8
Dormant buds	1.220	1.220	1.220	1.220
Active buds	1.118	1.016	1.016	0.914
LSD	0.283	0.347	0.347	0.347
F. probability	0.374	0.178	0.178	0.070

However, at week 6, shoot length produced by the budded plants using the dormant and active buds showed no significant differences (Table 2).

Number of plants surviving budding

No significant differences ($P > 0.05$) were observed in surviving plant at Weeks 2, 4, 6 and 8. There were no significant differences in survival of plants generated from dormant and active buds (Table 3).

DISCUSSION

With the exception of the approach grafts, the growth pattern of leaves and length of shoots generated by the grafted and budded plants were similar. The number of leaves and shoots generated by the grafted plants initially increased rapidly but later increased at a decreasing rate. The splice grafts recorded the highest number of leaves and shoot lengths as compared with the approach and splice grafting (Figures 2 and 3).

Leaves and shoots length generated were also higher and longer respectively in plants budded with the dormant buds. Leaves and shoots growth of the budded plants decreased with time (Tables 1 and 2). The production of leaves and shoots in the grafted and budded plants was an indication of stock and scion/bud union (Hartmann et al., 1997). The decrease in the number of leaves as well as growth in shoot length by the grafted and the budded plants may be attributed to inadequate water through the limited conducting vessels as transpiration increased with increase in the number and size of leaves coupled with high temperatures. This situation, according to Hartmann et al. (1997) can lead to degeneration of the scion.

Survival of grafted plants was highest in the cleft grafted plants in the first two weeks after grafting followed by the splice grafted plants. However, at Week 8, average survival rate was highest in the splice grafts with the approach grafted plants recording the lowest (Figure 4). Low success rate in the initial approach grafting operation of uniting the stems of the frafra potato plants accounted for the low average number of leaves and shoots generated by the approach grafts.

Degeneration of either the stock or the scion was the cause of deaths in the grafted plants. The inability of the scion to obtain water and nutrients from the stock since the vascular connection between the stock and the scion has not been established may be attributed to the scion degeneration whilst degeneration of the stock may be attributed to the inability of the stock to obtain carbohydrates and other metabolites from the scion due to disruption of the phloem (Hartmann et al., 1997).

Apart from a single approach graft, none of the cleft and

Figure 5. Pictures of budded grafted frafra potatoes at various stages of development (a) frafra potato budded using a dormant bud at Week 2; (b) frafra potato budded using a dormant bud at Week 4; (c) a splice graft at Week 8; (d) a cleft graft at Week 8.

splice grafts as well as the budded plants was able to form a union between the stock and the scion/bud. This may be due to environmental conditions such as temperature and moisture and other factors such as plant species and craftsmanship.

CONCLUSION AND RECOMMENDATIONS

Generally, leaves and shoots were generated in most of the grafted and budded frafra potato plants. Moreover, most of the grafted and budded plants survived throughout the data collection period and although a union between the stock and the scion in almost all the grafted and budded plants was not successful, the results obtained give an indication that, with a controlled experiment, grafting and budding of frafra potato will be possible.

Since graft union was not formed in the cleft and splice grafts, as well as the budded plants, it is recommended that, auxin (IBA, NAA) and cytokine (BA) which was not used in the experiment should be applied during the grafting and budding operation since it has been found to enhance graft union formation in some plants.

It is also recommend, that the experiment should be conducted in a more controlled environment where temperature and moisture can be controlled to favour graft union formation. Other grafting methods can also tried in the grafting operation. Figure 5 depicts some grafted and budded frafra potatoes.

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