Population Improvement by Culling *Taraxacum kok-saghyz*

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ABSTRACT

Taraxacum kok-saghyz (TK) is a promising alternative natural rubber (NR) crop. However, we still need to improve plant size and yield in a grower setting. TK plants in the field are highly variable because of open pollination and the plants being out breeders. This study is being done in conjunction with developing the 'perfect' plant using classical and molecular breeding techniques. We have taken a whole population approach to improve yield of production fields in advance of such plants. 1.2 million transplants, from a single seed lot, were established in three field locations. After 6 months, plants with rosettes smaller than 4 inches in diameter were culled from two fields. The following spring, seed were collected separately from culled and unculled open pollinated fields and in the autumn were planted in outdoor boxes. Plants were harvested one year later. Although the populations were still variable, the progeny of culled parents had larger roots and some increase in rubber concentration, leading to a marked increase in rubber yield per plant.

INTRODUCTION

TK is an important crop because of predicted natural rubber shortfalls. Natural rubber is used in many everyday products, one important one being tires. Having Ohio farmers grow this root crop is ideal because Ohio is the largest US manufacturer of rubber and plastic products.[1]

TK is not fully domesticated and crop traits must be improved. Root size and rubber concentration are key yield traits for commercialization. Focusing on overall root size will improve the crop by making the roots more harvestable by farmers. Two methods, following undercutting the field 12" below the surface, have been used in northern Ohio: (1) Pulling the TK plants out of the ground by hand, which is clearly not commercially-viable; (2) Using a potato digger or ginseng mechanized harvester which works poorly because the small roots fall through the belt and are not grabbed by the machines. TK must have a larger root system to be suited to current commercial root harvesting machinery. Focusing on overall size will improve the crop by making roots mechanically harvestable by farmers. Also focusing on root and concentration will increase overall yield/acre and farm gate value.

METHODS

For this study, 1.2 million transplants, from a single seed lot, were established in three field locations in spring 2013. After 6 months, plants with rosettes smaller than 4 in. in diameter were culled from two fields. The following spring, seed were collected separately from culled and unculled open pollinated fields and in the autumn were planted in outdoor boxes in a random design while ensuring that each seed lot had a north facing and south facing plot. Each plot consisted of 10 rows running the width of the planting box. Furrows were made ¼ inch deep in the rows for seed to be planted in. The planting density was 500,000 plants/acre. Autoclaved grass seed was used as a carrier to ensure even distribution within the rows. Plants were harvested by hand in the autumn of 2015. The number of plants per plot were counted and combined weight taken. Fifteen individual plants were randomly selected from each plot and analyzed for: fresh plant, root, and crown weight, dry root weight, and root rubber concentration (by near infrared spectroscopy).

Figure 1. *Photograph of a section of an unculled TK field. Plants like those overlaid with a red **X** were culled from two fields.*

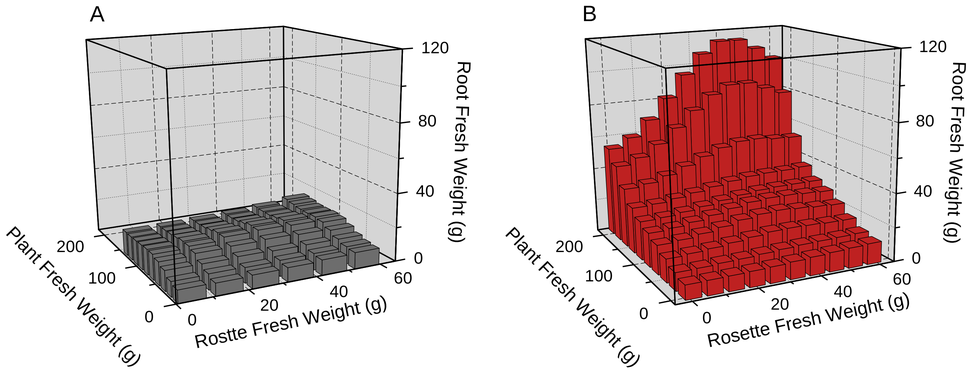

Figure 2. *3D plots of the progeny of open pollinated fields which were (A) unculled and (B) culled of plants with small rosettes, showing the relationship of root, shoot and whole plant fresh weight. The plots are weighted means of 75 plants.*

RESULTS AND DISCUSSION

Clearly the progeny of culled fields are larger, in general, than the unculled progeny (Fig. 2). All large rooted plants in the culled plant progeny are associated with plants with large rosettes. However, many large rosettes have small roots. Leaving small fathers in the unculled field resulted in small rooted progeny overall. Some progeny of culled parents also had higher root rubber concentration than progeny of unculled parents (not shown). Rubber yield/plant (the product of rubber concentration and root size) was considerably enhanced in a subset of the progeny of culled parents (Fig. 3B) compared to progeny of unculled parents (Fig. 3A). After one round of culling the small and low rubber plants segregated out in the progeny (Figs. 2B, 3B). Further rounds of culling should reduce variation and increase plant size and rubber yield, improving harvest efficiency and farm gate value.

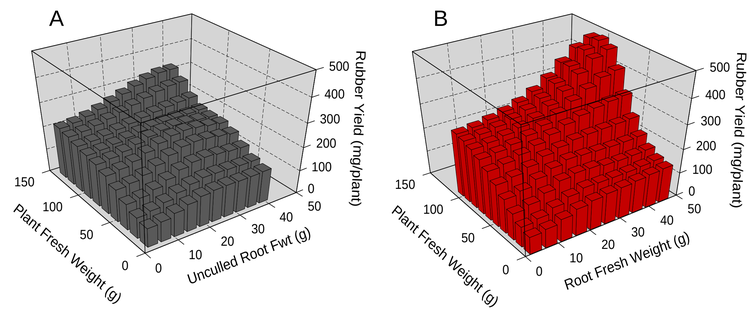

Figure 3. *3D plots of the progeny of open pollinated fields which were (A) unculled and (B) culled of plants with small rosettes, showing the relationship of root and plant size and rubber yield per plant. The plots are weighted means of 75 plants.*

CONCLUSIONS

Large-scale culling successfully increased root size and rubber yield in a TK population. Further rounds of culling should significantly increase improve germplasm on a population scale by eliminating pollination by inferior plants.

ACKNOWLEDGEMENTS AND BIBLIOGRAPHY

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1 https://en.wikipedia.org/wiki/Economy

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