RUFORUM Working Document Series (ISSN 1607-9345) No. 14 (2) : 659-663.
Available from *http://repository.ruforum.org*

Research Application Summary

Safflower germplasm evaluation for Botswana conditions

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Abstract

Safflower (*Carthamus tinctorius* L.) is a multipurpose oil seed crop that can be used for cooking oil production, as a vegetable crop, cut flower, forage crop (for both forage and seed for animal feed concentrates), industrial crop for dye production and as a medicinal crop. Safflower is a drought, heat, cold and saline tolerant crop. The crop also tolerates a wide range of temperatures from -7 to 40°C, provided there is no frost during the elongation and flowering phases of growth and development. Drought stress is the most important limiting factor to crop production in agricultural systems in arid and semi-arid regions. Drought adversely affects the already fragile food and agricultural situation in the arid and semi-arid regions and seriously impairs the rural economy and socio-cultural structures. Despite the usefulness of safflower and its drought, heat, cold and salt tolerance, it has remained underutilized and a minor crop. This is largely due to lack of information on its management, locally adapted varieties, product development from it, and reluctance of farmers to adopt a new crop. Therefore, it is essential for the scientific community to carry out research on this crop and popularize it as a commercial crop for development of pharmaceuticals, edible oil, paint and varnishes industry, dye extraction (*carthamin*), source of α-tocopherol, livestock feed, vegetable and a cut flower.

Key words: Botswana, climate change, drought, heat tolerant crop, multipurpose oil crop, safflower, salt

Résumé

Le carthame (*Carthamus tinctorius* L.) est une culture de graines oléagineuses à usages multiples qui peut être utilisée pour la production d'huiles de cuisine, des légumes, des fleurs, des cultures fourragères (à la fois pour le fourrage et les semences pour les concentrés d'aliments pour animaux) ou comme une plante médicinale. Le carthame est une culture tolérante à la sécheresse, à la chaleur, au froid et aux conditions salines. La culture tolère aussi une large gamme de températures de -7 à 40 ° C, à condition qu'il n'y ait pas de gel pendant les phases d'allongement, de floraison, de croissance et du développement. Le stress de sécheresse est le facteur limitant le plus important de la production agricole dans les systèmes Semi-arides. La sécheresse affecte négativement la situation alimentaire et agricole déjà fragile dans les régions arides et semi-arides et nuit sérieusement à l'économie rurale et aux structures socioculturelles. Malgré l'utilité du carthame et sa tolérance à la sécheresse, à la chaleur, au froid et au sel, elle est restée sous-utilisée et une

culture mineure. Cela s'explique en grande partie par le manque d'informations sur sa gestion, les variétés localement adaptées, le développement de produits à partir de celui-ci, et la réticence des agriculteurs à adopter une nouvelle culture. Il est donc essentiel que la communauté scientifique mène des recherches sur cette culture et la valorise comme une culture commerciale pour le développement de produits pharmaceutiques, d'huile alimentaire, de l'industrie des peintures et des vernis, de l'extraction des colorants (carthamin), de l'alpha-tocophérol, des légumes et des fleurs.

Mots clés: Botswana, changement climatique, sécheresse, culture tolérante à la chaleur, cultures oléagineuses polyvalentes, carthame, sel

Background

Safflower (*Carthamus tinctorius* L.) belongs to the family Compositae or Asteraceae, grown for its seed, which is used as edible oil and as birdseed (Dordas and Sioulas, 2008; Istanbulluoglu, 2009; Emongor, 2010). The crop is also grown for dye production for food and fabrics, medicinal purposes, manufacture of high quality paint, as a cut flower, forage crop and vegetable (McPherson *et al.,* 2004; Ekin, 2005; Emongor, 2010; Emongor *et al.,* 2015). Safflower oil has a nutritional value similar to that of olive oil, morever, the high oleic type is suitable for hypo-cholesterol diets, for frying and in the preparation of frozen foods (Ekin, 2005; Emongor, 2010). Safflower is tolerant to saline conditions, drought and a wide range of temperatures from -7 to 40˚C, provided during the elongation and flowering stages of growth and development there is no frost. During the rosette stage, safflower can withstand a temperature of -7˚C (Mündel *et al.,* 1992; Emongor, 2010). Production of the crop is affected by both biotic and abiotic stresses. However, drought stresss is the most important factor limiting crop production in agricultural systems in arid and semi-arid regions (Mollasadeghi *et al.,* 2011). Water stress effects on growth and yield are genotype dependent (Bannayan *et al.,* 2008). The overall goal of this study is to evaluate the adaptability of safflower germplasm in Botswana using agro-morphological traits and biochemical traits in seed with the aim of mitigating the effects of drought and climate change, improve food security, increase income and social welfare of farmers in Botswana, and to reduce reliance on food importation. The specific objectives of this study are to evaluate: 1) safflower germplasm for drought tolerance, developmental pattern and morphological characteristics, seed yield and yield components, oil yield, composition and characteristics; 2) safflower germplasm to identify those that are suitable for summer, winter and/or both seasons; and 3) nutritional quality of safflower seed cake for use in animal feeds.

Research Approach

The study began with importation of germplasm from various countries of the world such as USA, Kenya, Ethiopia, Canada, Australia and India. Seed multiplication was in isolated plots and greenhouses for the purpose of seed bulking. Germplasm were evaluated for oil content, forage production, seed cake quality, vegetable and flower production. Data were also collected on oil extraction, oil composition and

characteristics and nutritional properties of safflower cake. Other traits studied were drought tolerance, developmental pattern and morphological characteristics.

Results and Discussion

The results of the study showed that safflower genotypes differed in agro-morphological traits, percent emergence, growth habit, field performance and maturity date (Table 1). Most of the safflower genotypes under study were spiny with yellow flowers. However, some safflower genotypes had either red or white flowers. Two genotypes were spineless (Table 1). The results of the present study have showed a wide genetic variation in morphological traits of safflower. Similar results have been reported by Pahlavani (2005) who reported a wide genetic variation for both technological and morphological traits of safflower in Iran. Shinwar *et al.* (2014) reported significant morphological diversity in a number of traits in 122 genotypes of safflower in Pakistan. The largest variation was observed for plant height, days to flowering, days to maturity, seed yield/ plant, capitula number/plant, flower colour, leaf shape and spininess. Nutritional quality of safflower as animal feed is reported in Phuduhudu *et al.*(2016).

Table 1. Morphological variables of safflower genotypes

Genotye	Flower colour	Degree of spines	Percent emergence	Field performance	Days to flowering
Kiama Composite	Yellow	Spiny	90.1	Very good	114.7
PI-537632-1038-USA	Yellow	Spiny	95.0	Very good	116.3
PI-30441-BJ-2621-IRAN	Yellow	Spiny	93.3	Very good	116
PI-537598-SINA-USA	Yellow	Spiny	85.3	Excellent	114
PI-407616-BJ-2131-TURKEY	Yellow	Spiny	93.3	Excellent	113.7
PI-537634-1040-USA	Yellow	Spiny	83.3	Excellent	115.7
PI-537668-BJ-1085-USA	Yellow	Spiny	86.7	Very good	113
PI-314650-MILUTIN-114-KAZAKISTAN	Red	Spiny	28.3	Excellent	116
PI-306830-BJ-1632-INDIA	Yellow	Very spiny	55.0	Good susceptible to termites	106.3
PI-537711-1138-USA	White	Spineless	11.7	Poor	90.0
PI-537607-1013-USA	White	Spineless	6.7	Poor	93.3

Conclusion

Morphological characterization of safflower genotypes will help plant breeders, researchers and farmers to identify safflower genotypes and conserving beneficial genes for improvement. Further research on these selected accessions will save a lot of time for breeders in future.

Acknowledgement

The authors are grateful to the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for funding this research. This paper is a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

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