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Research Application Summary

Comparison of selection indices for drought tolerance in common beans for the dry environments of Tanzania

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Abstract

This study assessed yield performance of common bean genotypes under different levels of drought stress (waster stress periods). Subsequently, drought susceptibility index (DSI), sensitivity index (SI) and drought intensity index (DII) were derived from the grain yield data under the three water stress treatments. DSI was found to be the most reliable index to identify drought tolerant genotypes, while DII and SI were better suited to identifying intensity of drought at a location and grouping of drought tolerant genotypes, respectively.

Key words: Drought selection index, grain yield, *Phaseolus vulgaris*, waster stress duration

Résumé

Cette étude a évalué la performance du rendement des génotypes communs de haricot sous différents niveaux de stress à la sécheresse (périodes de stress hydrique). Par la suite, l'indice de susceptibilité à la sécheresse (DSI), l'indice de sensibilité (SI) et l'indice d'intensité de sécheresse (DII) ont été calculés à partir des données de rendement des grains dans les trois traitements de stress hydrique. DSI a été trouvé comme l'indice le plus fiable pour identifier des génotypes résistants à la sécheresse, pendant que DII et SI étaient convenables pour identifier l'intensité de la sécheresse en un lieu et le regroupement des génotypes résistants à la sécheresse, respectivement.

Mots clés: Indice de sélection pour la sécheresse, le rendement de grain, *Phaseolus vulgaris*, la durée du stress hydrique

Background

Beans (*Phaseolus vulgaris* L.) are an important crop in Tanzania grown by a wide range of farming communities. Its production, however, is very low due to various factors of which drought are becoming very important due to its frequency in the recent past. In Tanzania continuous drought years have been occurring in some areas mainly in the Central, Eastern and Northern zones, leading to total crops failure or reduced

yields. In addition, quality of the grains produced under drought conditions has always been poor.The average bean yields in Tanzania are around 500 kg/ha although the potential yield under rainfed condition is 1500-3000 kg/ha using improved varieties and proper crop husbandry (Hillocks *et al.*, 2006). This low yield is mainly due to unreliability of rainfall (Mduruma *et al.*, 1998). Evaluation of plant types capable of tolerating or escaping moisture stress is therefore a major consideration in crop improvement programmes.

To mitigate the effects of drought several strategies can be employed including irrigation and use of drought tolerant varieties. Irrigation is not a viable option for most small scale farmers due to the cost factor. On the otherhand, drought tolerance is a complex trait that cannot be selected directly as it is influenced by many traits. Therefore, the study aimed at developing a simple selection strategy for drought tolerance that will be used to identify drought tolerant bean lines.

Literature Summary

Drought is a worldwide constraint to dry bean production. It is one of the most important problems affecting bean production because about 60% of the crop is grown in regions with water shortage. Intermittent and terminal droughts are the two distinct kinds of drought associated with limited rainfall. The intermittent drought is due to climatic patterns of sporadic rainfall that causes intervals of drought and can occur at any time during the growing season (Schneider *et al.*, 1997). In contrast terminal drought occurs when plants suffer lack of water during later stages of growth or experienced when the crops are planted at the beginning of dry season.

Munoz-Perea *et al*.(2006) pointed out that intermittent or terminal drought affects >60% of dry bean production worldwide. A moderate drought stress can reduce yield by 41% (Foster *et al.*, 1995). However, severe drought stress can reduced yields by up to 92 % and in some cases, total crop failure (Castellanos *et al.*, 1996).

Study Description

This research was conducted in 2009 at Sokoine University of Agriculture (SUA) Horticulture Unit, Morogoro, Tanzania (latitude 6º5‘ South and 37º37‘East at an elevation of 525 m above sea level in the leeward side of Uluguru mountain). The climate of the area is between sub-humid and semi- arid with predominantly alfisols and entisols. The temperature of this area ranges from 24ºC-34ºC with relative humidity of 70-90%.

Fourteen genotypes, MN 14059-4-4P, RWR 109, MR 14000-2-1P, MR 14144, MMS 243, MN 14059-4-4P, MR14000-2-10P, MR 14140 -45-4P, MR 14215-9-8P, MR13944-14-9P, MR 14153-3-2P, MR 14198-13-1P, CNF5547 (Control), MR 13095-6-1P and DOR 390 were planted in a split-plot design with water stress period as main plot and bean genotypes as subplot factors at Sokoine University of Agriculture Horticulture unit in Tanzania. Grain yield, seeds/pod; pods/plant, 100-seed weight, root length, root weight, days to physiological maturity, days to 50% flowering and dry matter content were determined. Drought susceptibility index (DSI), sensitivity index (SI) and drought intensity index (DII) were derived from the grain yield data under the three water stress treatments.

Research Application

The water stress imposed at different periods of plant growth and development significantly influenced the phenotypic expression of the bean line in morphological traits and grain yield and its components. Days to 50% flowering dropped from 43 in the no water stress treatment to 41 days when water stress was imposed from flowering to mid-pod filling. The early maturing lines however showed less sensitivity to water stress with regards to days to 50% flowering. Root weight and dry matter weight were reduced under water stress while root elongation was enhanced from 27 cm to 29 cm when stress was early. Water stress imposed during any period of growth and development negatively affected grain yield. In this study yields dropped from 1188 kg/ha (stress I) to 720 kg/ha (stress II) and 432 kg/ha (stress III).Yields of early maturing genotypes were relatively less affected by water stress at any of the periods due to the earlier flowering, thereby escaped the full effects of the stress. Medium maturing lines gave the lowest yield reduction from stress I to stress II and this was associated with relatively high retention of root weight, dry matter accumulation and enhanced root elongation under water stress. DSI was found to be the most reliable index to identify drought tolerant genotypes, while DII and SI were better suited to identifying intensity of drought at a location and grouping of drought tolerant genotypes, respectively.

Recommendation

In this regard the current study recommends DSI to be used as a tool for assessing genotype tolerance to drought in further breeding programmes. Based on DSI MR 14154-4-6P, MR 14153-4-2P, MR 14000-2-10P and MR 14144-11-5 were the most tolerant genotype.

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