ALLO AND AUTO-COMPETITION IN SUGARCANE EXPERIMENTS

By

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KEYWORDS: Competition, Plot Shape.

Abstract

IN BRAZIL, sugarcane experimental plots for genotype evaluation usually have 3 to 5 rows with 8 to 20 m in length. When an experiment has 5 rows, the central ones (R2, R3, R4) will be in auto-competition in both sides (AUTO) and the rows on the edge (R1 and R5) will be in auto-competition on one side and in allo-competition on the other (ALLO50, with parallel neighbour rows N1 or N5 of adjacent plots). To evaluate AUTO and ALLO50, the rows were individually harvested and weighed (kg per metre) in nine experiments with different environmental conditions as part of the IAC Sugarcane Breeding Program. Each experiment was composed of 5 commercial cultivars and 15 new clones replicated in three blocks. The results showed that the average weight of the five best genotypes at ALLO50 were superior by 4 to 6% compared to the averages at AUTO. Some genotypes show better performances when in ALLO50 than in AUTO, indicating that experiments should have the rows planted mainly in AUTO, since this is how they will be grown on a commercial scale. The superior performance at allo-competition has also been observed in other crops and is probably due to more efficient environmental exploration either by the aerial plant part or by the root system. The correlations between the adjacent rows in the AUTO position as well as those in the ALLO50 position with the respective neighbouring rows N1 or N5 were also evaluated. The correlations between production (free from genotype and block effects) were low in the first harvest but, in the fourth harvest and in ALLO50 condition, reached negative values up to –0.4, suggesting competition, i.e., competitive genotypes damage their less competitive neighbours, an undesired situation for the choice of genotypes that will be planted in AUTO.

Introduction

Sugarcane experimental plots in Brazil are usually planted with 3 to 5 rows with the outside row sometimes being in competition with other genotypes (allo-competition) and the inside rows competing with the same genotype (auto-competition).

On a commercial scale, sugarcane crops are planted in monoculture, and therefore the plants only experience auto-competition. In order to ensure that testing is efficient, it is important to establish if there are differential effects between the competition systems.

Other crops, e.g. maize and eucalyptus have demonstrated that allo-competition can increase the production per area, presumably through more efficient exploitation of the architecture of the roots or above ground plant parts (Perecin *et al.*, 1977; Scarpinatti *et al.*, 2009). It has also been shown that the yields of genotypes can change in relation to one another depending on whether they are grown in allo- or auto competition.

The objective of this work was to collect preliminary data regarding differences in sugarcane response to auto- and partial allo-competition systems.

Material and methods

The data were obtained in 2008 from nine previously harvested experiments from the Bonfim Mill, Guariba-SP-Brazil, as part of the IAC Sugarcane Breeding Program. The experiments were planted in a randomised block design with three replications containing 20 genotypes each (5 commercial cultivars and 15 new clones). The nine experiments included in the study are shown in Table 1.

Experiments were planted in five rows (R1, R2, R3, R4, and R5) eight or ten metres long with 1.4 or 1.5 metres between rows. R1 was adjacent to the R5 row of parallel plot (named N1) with a different genotype and R5 had an adjacent row of a different genotype (named N5) resulting in 50% of allo-competition (ALLO50). Rows R2, R3 and R4 were adjacent to the same genotype on both sides; thus, they were in auto-competition (AUTO).

Each row was harvested and weighed (kg per metre) individually, allowing separate evaluations of those in ALLO50 [(R1+R5)/2] and those in AUTO [R2+R3+R4)/3]. Correlations between adjacent rows were also determined, including rows N1 and N5.

Results and discussion

The overall average of the production in kilograms of the cultivars in the 9 experiments showed an increase of 10% for rows in ALLO50 when compared to those in AUTO, The ratio (Ratio = ALLO50/AUTO), presented values ranging from 0.65 to 1.49. There were cultivars that had much higher production when in ALLO50, such as RB867515 (Ratio=1.13), SP83-2847 (Ratio=1.23), CTC15 (Ratio=1.25), IACSP95-5000 (Ratio=1.17). Other cultivars showed Ratio around 1, such as RB72454 (Ratio=0.94), RB855453 (Ratio=1.04), SP91-1049 (Ratio=1.07), CTC4 (Ratio=0.91). The differential Ratios of the genotypes suggest that it is not recommended to establish plots with data being taken from rows in allo-competition since the genotypes will not be planted in this arrangement on a commercial scale. Increased production in allo-competition also has been observed in other crops, (e.g. maize, eucalyptus) and has been attributed to more efficient utilisation of resources by either the roots or aerial part of the plant. The increase in production from allo-competitive plants indicates that mixed planting containing different genotypes might be beneficial.

The correlation of the weights between adjacent rows was also evaluated in AUTO (R2R3, R3R4) and ALLO50 (R1N1 and R5N5). In general, these correlations (free from the genotype and block effects) were low (Table 1), but predominantly negative, suggesting that there is some competition, even in AUTO.

In the fourth harvest and in the ALLO50 condition, the correlations achieved negative values up to –0.48, suggesting that more competitive genotypes may slightly damage their less competitive neighbours or take advantage of the low production of the adjacent row to increase their own. This situation is undesirable for choosing the genotypes that will be planted only in auto-competition. For this reason, it is not advisable to work with plots in which there is a predominance of rows in allo-competition (1 to 3 rows).

Conclusions

1. On average, the genotypes in allo-competition (50%) were 10% superior in relation to the same genotypes in auto-competition.
2. The correlations of the weights between adjacent rows generally is low, but predominantly negative, even in auto-competition, indicating some low competition.
3. Some competitive genotypes may damage or take advantage of their less competitive neighbours, across the years (situation not wanted for the choosing of genotypes that will be planted only in auto-competition).

4. The differential reactions of genotypes suggest that it is not advisable to establish research plots with data being taken from rows in allo-competition since the genotypes will not be planted in this arrangement on a commercial scale.

Table 1—Correlations (free from block and genotypes effects) between rows in allo-competition (50%) or in auto-competition, harvest at 2008, Bonfim Mill, Guariba-SP-Brazil.

Year-season-harvest (experiments)	Correlations R1N1 (ALLO50)	Correlations R5N5 (ALLO50)	Correlations R2R3 (AUTO)	Correlations R3R4 (AUTO)
2008-S1-H1	–0 .14	–0 .25	–0 .19	–0 .18
2007-S1-H1	–0 .13	0 .01	–0 .14	–0 .06
2007-S2-H1	0 .03	0 .11	0 .16	0 .07
2007-S3-H1	0 .21	0 .28	0 .07	–0 .2
2006-S2-H2	–0 .02	–0 .05	–0 .19	0 .09
2005-S2-H3	–0 .1	–0 .03	–0 .05	–0 .02
2007-S1-H4	–0 .48	–0 .39	–0 .24	–0 .12
2007-S2-H4	–0 .08	0	0 .08	0 .06
2007-S3-H4	–0 .2	–0 .41	0 .01	0 .06

S1=autumn; S2=winter; S3=spring; H1=first to H4=fourth harvest

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ALLO ET AUTO-COMPÉTITION DANS LES ESSAIS DE CANNE À SUCRE

Par

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MOTS-CLÉS: Concours, Formulaire Parcela.

Résumé

AU BRÉSIL, les parcelles expérimentales de canne à sucre pour l'évaluation des génotypes sont habituellement de 3 à 5 lignes de 8 à 20 m. Quand un essai a cinq lignes, les rangs centrales (R2, R3, R4) seront en auto-compétition des deux côtés (AUTO). Par contre, les rangs des bords (R1 et R5) seront en auto-compétition d'un côté et en allo-compétition sur l'autre (ALLO50, avec les lignes parallèles voisines N1 ou N5 des parcelles adjacentes). Afin d'évaluer AUTO et ALLO50, les lignes étaient individuellement récoltées et pesées (kg par mètre) dans neuf essais situés dans

des conditions environnementales différentes, qui font partie du programme d'hybridation de l'IAC. Chaque essai était composé de 5 cultivars commerciaux et 15 nouveaux clones, en répétition de trois blocs. Les résultats ont montré que le poids moyen des cinq meilleurs génotypes en ALLO50 était supérieur par 4 à 6% comparé à la moyenne en AUTO. Quelques génotypes ont montré une meilleure performance en situation ALLO50 par rapport à AUTO. Cela démontre que les essais devraient avoir les rangs établis principalement en AUTO, puisque c'est de cette manière qu'ils sont plantés à l'échelle industrielle. La supériorité des performances en allo-compétition a aussi été observée dans d'autres cultures et est probablement due à une exploration plus efficiente de l'environnement soit par la partie aérienne ou par le système radiculaire. Les corrélations entre les rangs adjacents en position AUTO de même que ceux en position ALLO50 avec leurs rangs voisins N1 ou N5 ont aussi été évalués. Ces corrélations entre la production (exempte d'effets du génotype ou de bloc) étaient faibles lors de la première récolte. Toutefois, lors de la quatrième récolte, et en condition ALLO50, des valeurs négatives atteignant –0.4 ont été atteintes, suggérant la compétition. Les génotypes compétitifs endommageaient donc les génotypes voisins moins compétitifs, une situation non-désirée dans le choix des génotypes qui seront cultivés en AUTO.

ALO Y AUTO-COMPETICIÓN EN EXPERIMENTOS DE CAÑA DE AZÚCAR

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PALABRAS CLAVES: Competición, Forma de Parcela.

Resumen

LOS EXPERIMENTOS en Brasil en caña de azúcar para evaluar genotipos, generalmente tienen 3 a 5 filas de 8 a 20 m de largo. Cuando un experimento tiene 5 filas, las filas centrales (R2, R3 y R4) estarán en auto-competencia en ambos lados (AUTO) y las filas de las orillas (R1 and R5) estarán en auto-competencia a un lado y en alo-competencia en el otro lado (ALLO50, con filas paralelas vecinas N1 a N5 de las parcelas adyacentes). Para la evaluación de filas AUTO y ALLO50 fueron cosechadas ínvidamente y pesadas (kg/m) en nueve experimentos de diferentes condiciones ambientales que son parte del Programa de Mejoramiento de IAC. Cada experimento se comparó con cinco cultivares comerciales y 15 nuevos genotipos repetidos en tres bloques. Los resultados mostraron que el promedio del peso de los cinco mejores genotipos en ALLO50 fueron superiores en 4 a 6 % comparando los promedios de los AUTO. Algunos genotipos mostraron mejor comportamiento si su condición es ALLO50 que en AUTO, indicando que los experimentos deberían plantarse principalmente en AUTO ya que de esta forma es como se siembra comercialmente. El comportamiento superior en alo-competencia ha sido observada en otros cultivos que probablemente se deba a una eficiente exploración ambiental, ya sea en la parte aérea de la planta o por el sistema radical. Las correlaciones entre las filas adyacentes en la posición AUTO así como aquellas en ALLO50 con sus respectivas líneas vecinas N1 o N5 también fueron evaluadas. Las correlaciones en producción (libres de los efectos genotípicos y de bloque) fueron bajos en primer corte, pero en cuarto corte y en condición ALLO50 alcanzaron coeficientes negativos de hasta –0.4, sugiriendo competencia, por ejemplo de genotipos competitivos que dañan a los menos competitivos de las filas vecinas, situaciones no deseadas al escoger los genotipos que serían sembrados en AUTO.