VARIABILITY OF QUINOA GENOTYPES IN RESPONSE TO ORGANIC FERTILIZATION

By

MARIAM SABRY AL-METWALLY AL-METWALLY
B. Sc. Agric. Sci. (Agronomy), Fac. Agric., Cairo Univ., Egypt, 2006
M. Sc. Agric. Sci. (Agronomy), Fac. Agric., Cairo Univ., Egypt, 2014

THESIS

Submitted in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

In

Agricultural Sciences
(Agronomy)

Department of Agronomy
Faculty of Agriculture
Cairo University

EGYPT

2022

Format Reviewer

Vice Dean of Graduate Studies
Prof. Dr. / Ayman Yehia Amin

Name of Candidate: Mariam Sabry Al-Metwally **Degree:** Ph.D.
Title of Thesis: Variability of Quinoa Genotypes in Response to Organic Fertilization
Supervisors: Dr. Ahmed Medhat Mohamed Al-Naggar
Dr. Mohamed Mohamed Mohamed Atta
Dr. Maisa Lotfy Abd El-Moneim
Department: Agronomy
Date: 4 / 8/ 2022

ABSTRACT

Quinoa is a nutrient-rich pseudo-cereal novel crop with high tolerance to a wide range of abiotic stressed environments. The objectives of this investigation were to assess the effects of fertilizer type, low nitrogen, genotype and their interactions on quinoa traits, the superiority of organic to mineral fertilizer, and the superiority of low-N tolerant (T) to sensitive (S) genotypes, to estimate heritability (H^2_b) and genetic advance (GA) for 28 traits under LN, MN and HN organic and mineral fertilizers, to determine the extent of genetic diversity among 37 quinoa genotypes and to identify stable and high yielding genotypes under 12 different environments. A two-year field experiment was conducted, using a split split-plot design with three replications. Main plots were devoted to two fertilizer types (compost and ammonium nitrate), sub-plots to three N rates (30, 60 and 90 kg N/ha), and sub sub-plots to 37 quinoa genotypes. Mean seed yield across seasons was 2009 kg/fed when using the compost, while it was 791 kg/fed when using ammonium nitrate. Superiority of organic to mineral fertilizer in SYPF was accompanied by superiority in seed yield/plant (SYPP), inflorescence weight, 1000-SW, inflorescence diameter (ID), biological yield/plant (BYPP) and harvest index (HI). Quinoa plants under the organic fertilizer were more N efficient than under the mineral fertilizer. The seed contents of protein, oil and ash were higher under organic fertilizer than under chemical fertilizer. The best genotype for each trait was identified under each environment. Low N tolerant (T) and susceptible (S) genotypes were identified. SYPF of T was significantly superior to S genotypes by 308.8, 123.8, and 152.6 % under organic fertilizer and 100.6, 123.6, and 212.6 % under mineral fertilizer, for LN, MN, and LN, respectively. Branches/plant, seed diameter, SYPP, BYPP, 1000-SW, seed oil content, plant height, ID, inflorescences/plant and chlorophyll concentration index were strongly correlated with seed yield/fed, had high estimates of H^2_b and GA and thus could be considered as secondary traits for high seed yield. The clustering analysis assigned the 37 quinoa genotypes into three groups. The highest genetic dissimilarity was recorded between G23 and each of G8, G34, G4, G9, G24 and G5, but the lowest dissimilarity was between G13 and G26. Based on AMMI stability model, NAD-1-W, and Agritec-Beige could be considered stable and among the five highest seed yielding genotypes. R-103, Sekam-Bitter, Nat-1, ICBA-Q5 and CICA-17 were the highest yielding genotypes, but were considered the most unstable genotypes.

Key words: Quinoa, Organic fertilizer, Compost, Low-N, Mineral fertilizer, Stress tolerance index, NUE, Heritability, Genetic advance, Selection criteria, Cluster analysis, GT-biplot, PCA, AMMI, GGE-biplot, Stability.

CONTENTS

CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES