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Sesame (*Sesamum indicum* L.) improvement by induced mutation: effect of Mutagenesis on drought tolerance and productivity

Seyni Boureima

Supervisor: Patrick Van Damme

Department of Plant Production, Ghent University

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This study focused on the induction of genetic variability in sesame (*Sesamum indicum* L.) through radiation mutation with the purpose of contributing in broadening the genetic base of sesame and improving sesame yield in Senegal. Scientific targets were to: (i) carry out some preliminary tests on the radiation-sensitivity of sesame seeds, (ii) create and identify genotypes that had traits that were not existent or rarely present in the existing germoplasm (iii) select for drought tolerance at early stage of development and (iv) select for genotypes with good yield during moisture stress.

Therefore, sesame seeds that originated from Senegal were exposed to gamma radiations of different levels to induce mutations. Germinating mutant seedlings were screened for drought resistance using Polyethylene glycol (PEG) 6000. Vegetative genotypes were subsequently on-grown in a glasshouse under limited irrigation to determine water deficit tolerance. Finally, genotypes were tested in the field for their yield potential with or without moisture stress. During the moisture stress period at germination stage, germination, emergence percentages and root length were investigated. Physiological and morphological parameters were evaluated during moisture stress period at vegetative stage in glasshouse. Furthermore, the effect of moisture stress on agronomic parameters was investigated in field.

The key findings of this work were that sesame seeds can resist to gamma radiation. However, there were variations in the degree of resistance to radiation between varieties. Radiations levels ranging from 300 to 400 Gy were efficient in generating a wide range of genetic variability with viable mutations in sesame. Several characters rarely encountered in the base collection as indehiscent, the broken petals, the male sterility and the red color of seed coat were induced. In addition, several characters including size of the capsules, number of capsules per node, number of carpels per capsule and the flowering date have been improved.

The use of PEG-6000 solution to induce osmotic stress at germinating stage of sesame plants has been a very promising method. Seeds were exposed to five levels of moisture stress (0 MPa, -0.5 MPa, -1 MPa, -1.5 MPa and -2 MPa) that significantly affect the treated seeds, compared to the control. Moisture stress corresponding to -1 MPa is the limit beyond which sesame seeds do not germinate. In the mild moisture stress treatment (-0.5 MPa), radicle elongation was enhanced for the majority of the genotypes tested when compared to the control plants. However, a severe moisture stress impedes root growth and emergence which was the most character sensitive to moisture stress in our experimental conditions. Some induced-genotypes were found to be more resistant to moisture stress than their parental source at germinating stage.

During the drought tolerance screening at vegetative stage in glasshouse, the technique of chlorophyll fluorescence has been used to evaluate the response to moisture stress of induced-genotypes of sesame by suspending the water supply to plants. The effect of water deficit on stomatal conductance, leaf temperature and biomass production was also monitored.

Kinetic curves of chlorophyll fluorescence were analyzed by Biolyzer software to reflect changes induced by water stress in quantitative parameters. Results showed that the maximum quantum yield of primary photochemistry (φPo = FV/FM) was not very sensitive to moderate water stress. As against, the performance index (PI) was more sensitive to water stress than FV/FM. The drought factor index, calculated from PI, is proposed in this work to screen for improved drought tolerance in sesame. Although the responses varied according to genotype, water stress caused stomatal closure leading to a decline of stomatal conductance and a rise of leaf temperature. Also, water stress caused a decrease in aboveground biomass, root biomass and plant height.

Water deficit reduced yield of induced genotypes by 28.70%, ranging from 1% to 50% depending on genotypes. However, in some genotypes, a moderate water deficit induced an increase in yield from 4 to 50%. Among indices used to screen genotypes for drought tolerance at reproductive stage, the Stress Tolerance Index (STI) appeared to be the most discriminatory trait. STI was highly correlated with performance in both water stress and optimal moisture conditions. Several induced mutants out-yielded the parental sources in both water regimes. Under water stress conditions, plant height, number of capsules per plant and number of seeds per capsule had direct and positive impact on grain yield of sesame. The height of insertion of the first capsule has a direct but negative effect on grain yield of sesame.

The use of induced mutation technique has allowed the induction of a great genetic variability in the sesame base collection of Senegalese Institute of Agricultural Research and obtaining mutants that out-yielded the parental sources in drought conditions. From these results it appears that, although sesame seeds were known to be resistant to gamma radiation, it is not necessary to apply higher doses since medium doses (300-400 Gy) was enough to induce viable and useful mutations in sesame. Furthermore, the photochemical performance index (PI), the stress tolerance index (STI), the size of the plant, the height of insertion of the first capsule on the main stem, number of capsules and the number of seeds per capsule are relevant parameters for sesame breeding in dry areas.

Reproductive Phase

Maturity

Flowers and buds

Dehiscent and indehiscent lines

High branched line

The rooting system