-55- Summary of

SUITABILITY ASSESSMENT OF SOME EGYPTIAN OZONE-BIOINDICATOR PLANT SPECIES UNDER GREEK ENVIRONMENTAL CONDITIONS

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SUMMARY

Ozone is now considered to be the most phytotoxic of all the common air pollutants. It has been estimated to be responsible for up to 90 % of the crop losses that result from air pollution.

Over the years, methods have been developed to use sensitive plant species as bio-indicators for the detection and monitoring of air pollutants. The use of plant bio-monitors is considered an inexpensive, reliable supplement or substitute to very expensive monitoring systems.

The quest for suitable ozone-bioindicator plants adapted to the Egyptian environment which will be available to grow and use within the framework of local, regional or national biomonitoring programs prompted this research.

The research presented was designed to achieve the following objectives:

1- Establishing the relative sensitivity/tolerance status of common bean cultivars taken from the plant material currently cultivated in Egypt in comparison with international varieties and lines.

2- Testing four Jew's mallow ecotypes and four Garden rocket genotypes in order to select one or more tolerant ecotype(s) or genotype(s) to use in a biomonitoring system (sensitive/tolerant) for each species.

3- Checking the relative field sensitivity/tolerance of common bean and two Egyptian ozone bioindicator plants species (Jew's mallow and Garden rocket) previously tested only in environmentally controlled conditions.

4- Studying the comparative suitability of those selected bioindicator plant species for use as ozone biomonitors under European (Greek) open field conditions.

5- Explaining the response of the tested plant species to ozone by measuring physiological parameters, such as stomatal conductance, extractable leaf pigments and leaf Greenness, quantum yield of photosynthesis and studying their interactions.

6- Testing the suitability of these physiological parameters to serve as additional reliable diagnostic tools in predicting ozone effects prior to the appearance of visual foliar injury.

7- Providing a reliable information base about the sensitivity of Egyptian species and cultivars, as a mean in the identification of plant material suitable for cultivation in ozone-polluted areas.

For these aims, environmentally controlled experiments were conducted first to establish the relative sensitivity of four common bean cultivars currently cultivated in Egypt (Nebrasca, Paulista, Bronco and Contender), in comparison with international lines (S156 / R123) and genotype (Pinto) known for its sensitivity to O3.

We searched also for tolerant Jew's mallow ecotype(s) between four ecotypes (Balady, Fallahy, Saidy and Siwi) and tolerant Garden rocket genotype(s) between four genotypes (Nahya, Minufiya, Wady and Wahat) to be used in a biomonitoring system for each species. We recorded O3-induced symptoms on the leaves of all the tested entries. We studied also the different physiological parameters involved in their responses to ozone.

Data collected from the screening tests of common bean yielded three sensitive genotypes: Pinto, S156 and Nebrasca, two intermediate candidates: Paulista and Bronco and two tolerant R123 and Contender. The pair (Nebrasca / Contender) responded to O3 fumigation in a manner that was equal in type and magnitude to the pair (S156 / R123).

Screening experiments of Jew's mallow revealed that none of the ecotypes currently cultivated in Egypt were significantly tolerant,

rather they showed different degrees of sensitivity to O3. Testing Garden rocket did not succeed in identifying a tolerant genotype among the four under study.

The magnitude of total chlorophylls, Ca and Cb reduction correlated positively with the plant sensitivity. Loss in Ca was always greater than loss in Cb in all the plant species tested. In contrast, the decline in carotenoids levels did not reflect the degree of ozone foliar injury or the rank of sensitivity.

A linear relationship was obtained, indicated a very close correlation between the extractable and non-extractable methods (SPAD) used to assess chlorophyll loss in tested species.

Ozone was found to pheophytinize chlorophylls into their equavelant pheophytins resembling the other oxidative air pollutants such as NOx SOx. This mode of action was clearer in, both, Jew's mallow and Garden rocket than common bean.

The leaf stomatal conductance was inhibited significantly in response to ozone exposure in all the species and entries tested. The percent inhibition in stomatal conductance showed a general trend contrasting to the percent foliar injury. Tolerant genotypes and ecotypes were found to decrease their stomatal conductance significantly higher than sensitive ones.

Quantum yield was negatively affected in all the species, genotypes and ecotypes under study in response to ozone exposure. Decline in QY was significant even in tolerant entries which exhibited no visible injury. It was apparent that depression of photosynthesis occurred earlier in response to ozone fumigation.

Bean genotypes which were ranked under controlled conditions (150 ppb) as very sensitive (Pinto) and sensitive (S156 and Nebrasca) did not exhibit symptoms for 40 days after emergence in the open field where ambient O3 concentrations were in the range 45 – 60 ppb. This indicated that those genotypes cannot be considered as suitable for biomonitoring in O3 polluted areas with concentrations close to the background level (40 ppb).

On the other hand, Jew's mallow ecotypes retained their sensitivity in open field experiments. They showed distinctive symptoms after 17 days from emergence in the open field. The PFI reflected the same ecotype ranking obtained in environmentally controlled experiments. Foliar injury was even more severe in the open field. Garden rocket responded similarly retaining their sensitivity and their genotype ranking under field conditions.

In our study, AOT40's values within the critical range for crops (3 - 4 ppm h) caused both Jew's mallow and Garden rocket plants to exhibit symptoms of O3 injury in the open field. This was an added proof that these two species are suitable for use as O3-bioindicator plants. Based upon these results we concluded that:

1. **The pair (Nebrasca / Contender) responded to O3 fumigation in a manner that was equal in type and magnitude to the pair (S156 / R123) which is currently used in European ozone biomonitoring programs.**

2. **Jew's mallow and Garden rocket varieties have proved to be stable as active bioindicators of O3 pollution close to critical background level (40 ppb).**

3. **Quantum yield is not a reliable O3 sensitivity parameter for screening in short term (acute exposures) but is probably good for long term studies (chronic exposures).**

4. **The SPAD greenness measurements could be a good replacement to chlorophyll assessment by extraction in ozone treated plants.**

5. **Stomatal conductance could explain plant responses to ozone in terms of visible sensitivity.**