9 Methodology for Determining Foliar Penetration of Herbicides with Reference to Oil-Based Adjuvants

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9.1 Introduction

Oils are used extensively in pesticide formulation and in pesticide application as spray adjuvants. They improve the biological efficacy of several foliage-applied herbicides without impairing their selectivity. Beneficial effects were first observed with atrazine in maize (*Zea mays*; Jones and Anderson 1968; Nalewaja 1968) and with phenmedipham in sugar beet (*Beta vulgaris*: Miller and Nalewaja 1973). More recently, oils have met with success as spray adjuvants for graminicides (Buhler...
and Burnside 1984; Nalewaja 1986; Barrentine and McWorther 1988) and for bentazone (Doran and Andersen 1975; Nalewaja et al. 1975). Since they allow the use of reduced herbicide application rates, oils also improve ecological compatibility. This is particularly true for vegetable oils, which are more biodegradable than petroleum oils (Cornish et al. 1993).

Among the parameters of herbicidal action, penetration through the plant cuticle seems to be the most affected by oils (Nalewaja and Adamczewski 1977; Nalewaja and Skrzypczak 1986a,b; Schott et al. 1991). However, oils also influence droplet spreading on the plant surface (McWorther and Barrentine 1988) and the physical state (Dar­chy et al. 1990) and distribution (Hess and Falk 1990) of the active ingredient in the deposit. Some authors also postulate that oils can dissolve epicuticular wax (McWorther and Barrentine 1988). However, the mechanisms and relative importance of these effects are still unclear, and it is obvious that a better understanding of them would help in the design of efficacious adjuvant oils.

There are a number of methodological problems in studying oil-based adjuvants. Some of these arise from the physical properties of oils, some are inherent to studies on cuticular transfer, while others stem from the frequent conflict between two equally worthy aims: (a) to operate under realistic (close to field-use) conditions so as to obtain information of practical value, and (b) to select experimental procedures suitable for mechanistic studies.

### 9.2 Methodological Problems

#### 9.2.1 Emulsifier

Since oils are practically insoluble in water, they need an emulsifier to be used in aqueous sprays. If the objective is to adhere to field conditions, the effects of oils should be studied in the presence of their emulsifying system. This is usually composed of two or more surfactants, each one being far from pure and often composed of a mixture of isomers and oligomers. Some emulsifiers have phytotoxic effects and, as oils, they can increase droplet spreading and pesticide penetration (Holloway et al. 1992), although it is not a general rule (Schott et al.