The 'Cocoa Pod Nozzle'

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Many cocoa farmers are smallholders, who usually minimise inputs for pest and disease management, and may do nothing when cocoa prices are low. However, pod diseases such as *Phytophthora megakarya* (black pod in W.Africa) and *Crinipellis* (formerly *Moniliophthora*) *roreri* (frosty pod rot in Latin America) have the capacity to reduce yields by up to 80% and many farmers spray copper compounds and other fungicides in an attempt to control them.

These fungicides are often mixed with large volumes of carrier water – which is both inefficient in terms of dose transfer, and makes spraying tedious and labour intensive. In commercial operations, the cost of labour can be reduced substantially by reducing volume application rate, and thus increasing work rate (effectively by reducing the number of tank loads per hectare).

One of the spraying components that can be adjusted most easily, to improve efficacy, is the nozzle. These are available in a number of different sorts (and are often made up from a number of standard parts). Cone nozzles are usually considered most appropriate for applying insecticides and fungicides to complex surfaces. Smallholders commonly buy spraying equipment fitted with variable atomisers that produce indeterminate sprays (*i.e.* a range of droplet size spectra). Because they are infinitely variable, the spray pattern cannot be duplicated and farmers often have difficulty deciding which setting to use.

Discussion about variable hollow cone nozzles at a farmers' field school at Ndangueng, Cameroon. One of the problems with variable nozzles is that operators (or for that matter researchers) rarely know what setting is most appropriate for efficient dose transfer (of chemical or biological agents) to the pest target.

Adjustments to configuration and pressure can substantially affect droplet size spectra, and thus, the capacity of sprays to impact and stick to a target. Larger droplets are highly likely to fall back onto the ground ("run-off") and be wasted, contaminating both the operator and the environment. Simply replacing variable nozzles with standard cone nozzles is an imperfect solution since they are designed and recommended for row crops, and typically produce a wide angle (>70°) of spray. The spray pattern and droplet spectrum will also vary at different pressures.

In 2000-03 the USDA Agricultural Research Service sponsored a research programme that included a survey of cone nozzle configurations with a view to optimising dose transfer efficiency to pods, flowers and branches using narrow-angled spray cones. Field tests indicated that large (x2 – x3) improvements in efficiency can reliably be achieved by selecting specific, optimised cone nozzle configurations. Inclusion of pressure regulating valves (as illustrated) should further improve reliability. Although these nozzle configurations are not normally used, they are made up from standard sprayer parts. Further technical data are available on www.dropdata.net.

A cocoa pod nozzle in use during field trials in Costa Rica. Optimisation of nozzles to produce a very narrow angle (25-35°) and low flow rates substantially improved deposits on pods (per volume emitted) and should reduce pesticide costs.

For less than €10, this "**cocoa pod nozzle**" could be fitted to sprayers, and would obviate the need for such local decision making, allowing farmers to concentrate on other aspects of better crop management. Provided that cocoa pods, or similar ***narrow structures are the true biological target***, it should be possible to recoup this investment rapidly through reduced amounts of pesticide costs or improved yields from existing area dosages.

Sprayer testing to date with active fungicides has been limited to studies on frosty pod rot. However, our spray studies (measuring recovery with a fluorescent tracer dye) enable us to recommend that the cocoa pod nozzle be tested for the control of other diseases and insect pests. This might include other targets where a narrow spray is required such as the branches where moths of the cocoa pod borer (*Conopomorpha [Acrocercops] cramerella*) alight. The "nozzle" actually is a "family of configurations", making possible fine adjustments to cone angle, flow rate and spray quality, thus the technique should also have applications in other pest control situations and crops.

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