WEED MANAGEMENT CONSULTING IN CALIFORNIA

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Summary. Production systems are becoming increasingly complex in irrigated Californian agriculture. Recent regulations will only increase that complexity, favoring larger unit areas and increasing the need for weed management advisers to utilize weed science research in crop management systems. By close association with several 400 to 1500 ha farmers, certain weed management techniques such as proper identification of weeds, predictive techniques, planning of integrated weed management programs, advice on application and timing of operations and monitoring of results were evaluated for several years. Fail-safe programs were established for many vegetable, field and tree crops. Preventative control seemed necessary against many aggressive annual as well as perennial weeds. Identification and roguing of severe competitors seemed logical despite increasing labor costs. Proper timing of plantings and varietal selection greatly affected weed problems. Little interaction with entomology or pathology was apparent unless crops were reduced in competitive ability.

INTRODUCTION

In many parts of California farms are from 500 to 2500 ha. More than 200 crops are grown and these may face 50 or more weed species as competitors in each of many fields. Irrigated crops cost $500 to $21 000 ha^{-1} to grow (averaging $1250 ha^{-1}) (Edwards 1980) and are subject to the many unpredictable weather and pest problems.

In cotton, San Joaquin Valley growers spend about $125 ha^{-1} for weed control, including 3 to 4 cultivations. This compares to an average of about $22 ha^{-1} for nematode control on sandy loams, $2.50 for pathogens, $50 for insects and mites and $37 for defoliation. Thus weed control is over half of the total pest management cost in the San Joaquin Valley and is the main candidate for cost reduction research and better implementation of existing technologies.

Weed control costs in vegetables such as the brassicas, tomatoes, peppers, lettuce, onions, garlic and asparagus average $250 ha^{-1}. Nut crops such as almonds and walnuts require $150 to $175 ha^{-1}, citrus and grapes somewhat less. Where mistakes are made, vegetable weeding costs climb to $500 ha^{-1} and losses in production and quality in tree and vegetable crops can be $550 ha^{-1}.

Though farmers regularly use private entomology consultants at fees of $7 to $60 ha^{-1} on various crops, they rarely employ weed management consultants, relying instead on agricultural chemical salesmen (pest control advisers) to advise them. Most pest control advisers know what herbicides are available and how to use them and provide very good service to farmers. Many others, however, are unable to give the in-depth service and planning aid a diversified farmer needs. In cotton, for example, the profit to the supplier without service on a dinitro-aniline herbicide is often less than 10%. If priced at $7 L^{-1} the profit is only $1.30 ha^{-1} and a salesman cannot spend too much time advising the farmer.

METHODS A PRACTITIONER WOULD USE

A weed management adviser could probably service a number of 800 to 2000 ha farmers and cover 8000 to 10 000 ha in a five day week. Farmers who grow 5 to 10 crops, especially vegetables, would be the most likely candidates for service. Small farmers below 400 ha could not be efficiently serviced because communication becomes a limiting factor.

Such an adviser would first develop a log of weeds which infest his clients' fields (Fischer 1978). This would require visits at least twice a year (especially near harvest) during which he would learn about the growth habits of problem weeds to ensure that certain ones are not maturing before cultivation or hand-weeding. A continued logging of weeds over several years would be necessary to enable better predictive ability, since soils usually contain a seed reservoir of winter and summer germinating species which may last for seven years in tilled soils or 10 to 20 years in non-tilled orchard soils (Roberts 1970).

After such a log is developed better advice can be given as to which fields to rotate crops to, which herbicides to use, when to plant for optimum crop competition, how to best irrigate and cultivate, and what to do in case of inclement weather, equipment breakdown, or limitations of staff, irrigation scheduling or regulations.

As the crop cycle progressed the consultant would make weekly visits to the fields to observe and make written recommendations of weed management practices. Application is a very critical stage of herbicide use and equipment would be calibrated and spot-checked later by him or the farm staff. He would rely on an instructed farm staff to do most day-to-day monitoring of applications but would be on call by radio to handle special problems which arise due to weather, equipment breakdowns, irrigation delays and regulations.

Frequent monitoring would allow the adviser to evaluate the performance of herbicides against weeds in the field. He would develop a profile on the reliability of herbicides and application practices, and this would probably be one of his most valuable contributions.

DISCUSSION

A weed management advisory service could develop in two directions. The best of these would be to offer total weed management services to a farm on a \$7 to \$10 ha^{-1} retainer. This would include keeping weed records, advising on crops and weed control programs, providing recommendations on the timing and application of herbicides and cultivation, spot-checking calibration, monitoring results of programs, doing limited research, keeping up with scientific and regulatory developments and perhaps aiding public agencies in gaining special local need labels. Weekly visits for 75% of the year would be required as well as direct radio communications.

A second approach would be to offer weed control program evaluation to growers with limited evaluation of weeds present. This would give the grower access to a disinterested third party specialist for evaluation of which herbicides are safe and effective, but for a lower fee. The consultant would monitor many more fields but more quickly, relying more on public agricultural advisers than in the previous case. He could also provide a newsletter service and be available by telephone and radio and keep track of prices and availability of chemicals. Litigation risk would be greater with this type of service than with that outlined above.

Weed management advisory services such as these would fit into the full service concept that some advisory firms are offering in California, a service that includes evaluation of nematodes, insects and mites, soil fertility, plant growth analysis, plant growth regulators, and defoliation. Some firms include soil moisture monitoring and computerized weather records as well.

Entomology services operate almost independently of farming operations, relying on scouting (monitoring) of pest populations and then responding to them. Weed management is a much more active, creative service which must involve farm staff, and the chances of litigation are greatly increased. Perhaps each farmer should be a weed manager as well as a crop manager.

Can agriculture afford such weed management advisers? When it is considered that farmers spend close to \$125 ha^{-1} for weed control in cotton, they should be able to make a return on an \$8 ha^{-1} investment, especially since nearly all herbicides used in cotton can cause a carryover problem to subsequent crops. New weeds such as black berry nightshade (*Solanum nigrum*) can cost \$225 ha^{-1} or more to remove by hand and some growers cannot harvest infested fields. Annual morningglory (*Ipomoea* spp.), once established, can add an annual control cost of \$25 to \$37 ha^{-1}. Perennial weeds are a major problem. Field bindweed (*Convolvulus arvensis*) control costs in cotton are \$185 ha^{-1}. To clean up Johnson grass (*Sorghum halepense*) requires an investment of \$125 to \$250 ha^{-1}, a loss of up to 65% if left untended, plus annual costs for seedling control for seven years. Couch (*Cynodon dactylon*) regularly reduces cotton lint value because it is classed as grassy.

Pistachios, almonds and certain grape varieties gross \$6000 to \$20 000 ha^{-1}. Can a grower risk using a herbicide costing \$7.50 ha^{-1} and having only a 2 x safety margin, or should he spend \$125 ha^{-1} for newer, less effective herbicides which have a 4 x safety margin?

Vegetable crops such as onions, tomatoes, peppers and garlic can require handweeding costs of \$500 ha^{-1} and still suffer 10 to 20% losses. The grower must make certain that all labor relations regulations and pesticide safety regulations are followed and may still risk litigation over alleged injuries.

Can a weed management adviser do the things a diversified farmer wants of him?

The germination of weeds is highly unpredictable. Grassy weeds seem to reflect which weeds went to seed the previous year more than broadleafed weeds. Germination of annuals in cotton (which is every third acre in Kern County, California) which is planted into moist soil after an earlier pre-irrigation is only 10 to 25% of what occurs when crops such as tomatoes or onions are sprinkler irrigated. When rains occur after planting cotton, much more germination occurs. Thus it is difficult to predict the amount of weed seeds which will germinate. Likewise, pre-plant residual treatments prevent analysis of weeds in the early part of the season, unless banded. Exact predictive techniques are neither available nor are they cost-feasible.

Predictive services are less important than they seem, since 20 years personal experience with innovative farmers, pest control advisers and consultants has shown that preventative programs are desired, especially for competitive perennials such as Johnson grass, couch and field bindweed. In recent years we have shown that if annuals are kept at low levels, weed costs can be kept down.

This is possible with cheap and cost-effective herbicides which have lessened the need for predicting whether populations of weeds will be light, medium or heavy. Prevention not only cuts weeding cost, it also lessens the hazard of weed buildup when unpredictable situations such as frosts, cold periods, disease or insect problems or delayed harvests occur.

However, knowledge of which aggressive weeds are uncontrollable in crops is still important (Holm *et al.* 1977). Weeds such as sunflower (*Helianthus annuus*), Noogoora burr (*Xanthium pungens*), swamp chinese lantern (*Abutilon theophrasti*), and annual morning glory require vigilance on the part of the weed management adviser so that they can be rogued out before maturity.

Some weed problems are still difficult to solve. For example, nutgrass (*Cyperus rotundus*) is essentially uncontrollable in onions. Winter weeds such as London rocket (*Sisymbrium irio*), shepherds purse (*Capsella bursa-pastoris*), and common groundsel (*Senecio vulgaris*) are not reliably controllable with herbicides, and even an expert needs luck to get good control. The *Solanum* species have increased rapidly in Californian vegetable crops, going to seed in tomatoes, peppers, cantaloupe, beans, onions, garlic, carrots, lettuce, potatoes, cotton, maize, cereals, sorghum, lucerne and peanuts, despite usage of herbicides which are effective in other crops. The *Solanum* species are examples of weeds which are capable of survival in our mechanized monoculture despite optimum usage of all weed management systems. Cold steel and hand weeding may be the only option left in such problem situations, but usually a weed management adviser can blend these with an optimum mix of rotation and herbicides to give a least-cost solution. He can at least evaluate and develop solutions more quickly than a busy farmer can.

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