

A Comparison of Weed Control Programmes in Coffee

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A previous article in Harvest (Vol. 1, No. 3) described two weed control trials in coffee at Aiyura. They were in coffee which was heavily infested initially with perennial grasses and this resulted in all treatments being relatively expensive. The trial described here was on a plantation with a more normal weed population, and the costs quoted are more directly comparable with most other highlands coffee areas.

One of the treatments compared in this trial is based on the soil-applied herbicide simazine. A recent large price drop has brought this herbicide into consideration for use in coffee so its performance in this trial is of interest.

As in the previous article, herbicides are generally referred to by the common name of their active ingredient. Where details of trial treatments are given, however, it is usually more convenient to refer to the commercial product used in the trial and the quantity quoted is then the quantity of that product (not of the active ingredient). The naming of a commercial product does not imply any preference over another product containing the same active ingredient. Table 1 gives the trade names of formulations of the herbicide chemicals referred to in this article.

Table 1.—Glossary of trade names and common names

Common Name	Trade Names*
Paraquat	Gramoxone
Diuron	Diurex, Karmex
Amitrole	Weedazol TL Plus
Dalapon	Basfapon, Dowpon, Gramevin
2,4-D	Amoxone-50, Weedkiller D
MSMA	Ansar 529, Daconate
MCPA	Methoxone-30
Simazine	Gesatop-80

*This list is not exhaustive, but includes products most readily available in Papua New Guinea.

The trial which commenced in January, 1970 was on Aionora Plantation near Kainantu, in mature multiple stem coffee spaced at 9 by 9 ft. Initially the coffee was under light Albizia shade but this was removed after the trial had been running for a few months. The area used had not previously been treated with herbicides.

The trial compared four weed control treatments, each on an area of 1 acre. The trial area was heavily infested with weeds, but they were almost entirely annual species. The main species present at the beginning were *Galinoga parviflora*, *Bidens pilosa* (cobbler's peg), *Eleusine indica* (crowsfoot grass), *Amaranthus lividus* and *Crassocephalum crepidioides* (thick-head). There were also about 15 other species present in lesser amounts, including the perennials *Commelina diffusa* (wandering jew), *Cynodon dactylon* (couch grass) and *Paspalum conjugatum* (thurston grass). All these weeds are illustrated in the booklet *Weeds of Coffee in the Central Highlands*, Botany Bulletin No. 4, by E. E. Henty, published by the Division of Botany, Department of Forests.

The four treatments were—

(1) *Based on paraquat.* Paraquat was applied to emerged weeds as required. Initially this was as a blanket spray but as the weed cover decreased it became a spot-spray. Other herbicides were to be used as necessary to control weeds not adequately controlled by paraquat. The only additional herbicide used was amitrole.

(2) *Based on diuron.* The diuron was applied as blanket sprays to predominantly bare ground at intervals of from 4 to 8 months. In between these applications, spot-sprays of species which were not being controlled were made with the most appropriate foliar-acting herbicide. The additional herbicides used in this way were dalapon, amitrole, paraquat and 2,4-D.

(3) *Based on simazine.* The simazine was applied as blanket sprays to predominantly bare ground at intervals which ranged from 4 to 8 months. Weed species not being adequately controlled by these applications were spot-sprayed with the most appropriate foliar-acting herbicide. The additional herbicides used were dalapon, amitrole, paraquat, 2,4-D and MCPA.

(4) *Hand-weeded.* This was done using spades, at intervals comparable with normal plantation practice. Whenever possible weeding was done during periods of dry weather, so that a good kill of weeds would be obtained.

At the beginning of the trial, the herbicide plots were hand-weeded. This was necessary in the case of the diuron and simazine plots to allow the first application of these herbicides to be made to predominantly weed-free ground. For uniformity, and because the weed growth was too high to permit easy and safe spraying, the paraquat plot was also weeded. In each case the cost of the weeding was included in the costs of the control programme. The hand-weeding cost was a necessary part of the soil-applied treatments, but could have been avoided in the paraquat treatment. The replacement of a paraquat application by a hand-weeding probably added about one dollar to the cost of the paraquat-based treatment.

RESULTS

The costs of the four treatments over the 2-year period are given in *Table 2*. The following is a summary of the applications made in each treatment during the trial, and the results obtained:—

(1) *Based on paraquat.* In the first year there were 7 applications of paraquat, made at intervals of 6 to 8 weeks. The first two were with a spray concentration of 1 pint of Gramoxone per 45 gal, the next two with 2/3 pint and the remaining 4 applications were with a concentration of $\frac{1}{2}$ pint per 45 gal of spray. In each case a surfactant was included at a concentration of $\frac{1}{2}$ pint per 45 gal of spray. For the first application, 38 gal of spray were required to cover the 1 acre area, but by the end of the year this had dropped to 25½ gal due to the decreased weed cover. In addition to the paraquat sprays, amitrole at a concentration of 4 pints of Weedazol TL Plus was applied on one occasion to small patches of thurston grass.

In the second year, there were 7 applications of paraquat, all at a concentration of $\frac{1}{2}$ pint of Gramoxone per 45 gal, and one application of amitrole to small amounts of thurston grass. By the end of the second year the volume of spray per application was down to 17 gal per acre.

The treatment maintained effective weed control throughout the 2 years. Five weeks after the final application the percentage of the plot covered by weeds was only about 3 per cent. During the trial there had been some change in the relative proportions of the weed species present. In particular, there was a relative increase in *Polygonum nepalense*, crowsfoot grass and *Cyperus brevifolius*. These species are only just controlled by the spray concentration of $\frac{1}{2}$ pint per 45 gal and need to be sprayed before they reach the flowering stage. There was a relative decrease in *Drymaria cordata* while *Galinsoga parviflora* had disappeared by the end of the second year. However, the disappearance of this weed may have been due to some seasonal effect rather than to the treatment, because it was also absent from the hand-weeded treatment at the end of the second year.

The particularly low cost of the paraquat-based treatment in the second year was due partly to a prolonged dry spell during the latter part of the year. At this time there was a 9-week interval between sprays. Whilst the costs obtained for this period can be considered abnormally low, it can be seen from the costs incurred during the first half of the second year when weather conditions were normal, that the treatment was still relatively inexpensive.

(2) *Based on diuron.* In the first year there were three blanket applications of diuron. The first application at week 1 was at the rate of 4 lb Karmex or Diurex per acre, and the next two, at weeks 16 and 38, were at 2 lb per acre. The spray volume used varied from 36 to 45 gal per acre. In addition there was one spot-spraying with 2,4-D (at 3 pint Weedkiller D per 45 gal) and five spot-sprays with paraquat (at 2/3 to 1 pint Gramoxone per 45 gal) for weeds which were not adequately controlled by the diuron applications. By far the most plentiful of the species treated in this way was thickhead, but also present were cobbler's peg, crowsfoot grass and minor amounts of other species.

In the second year there were blanket applications of diuron at weeks 61 and 97. Both were at the rate of 2 lb Karmex or Diurex per

acre. The second application was postponed for some weeks because of abnormally dry weather. Without rainfall the diuron is not washed into the soil, and so cannot kill the germinating weeds. In addition there will be some decomposition of the herbicide if it remains exposed on the soil surface for an extended period. Instead of applying the diuron at the correct time, that is when a significant number of weed seedlings were starting to appear about 6 months after the previous diuron application, these seedlings were allowed to grow and were spot-sprayed with paraquat when they were about 8 in high.

During the second year there were five spot-sprayings with paraquat, at concentrations of $\frac{1}{2}$ to 1 pint of Gramoxone per 45 gal. The main weed sprayed each time was thickhead. In this period these sprayings required only low volumes of spray per acre— $6\frac{1}{2}$ gal in the case of the final spot-spraying.

The treatment kept the area very clean throughout the 2 years, although a considerable number of spot-sprayings were required to achieve this. If the species which are resistant or less susceptible to the diuron treatment had been allowed to seed and spread, then the control of the area would soon have become inadequate. The ground covered by weeds was never above 10 per cent of the total area, and mostly was not above 2 per cent. Usually it was cleaner than the paraquat plot.

The treatment resulted in changes in the relative quantities of the different weed species. In particular, thickhead greatly increased, while there was also some increase in crowsfoot grass, cobbler's peg and *Polygonum nepalense*. *Galinsoga parviflora*, *Ageratum conyzoides* (goatweed), *Youngia japonica* and wandering jew have either disappeared or have been reduced relative to the other species.

(3) *Based on simazine*. In the first year there were three blanket applications of simazine. These applications were made at weeks 1, 15 and 33 at the rate of 4, 2 and 2 lb Gesatop-80 per acre respectively in a spray volume of 36 to 41 gal per acre. Spot-sprayings were applied as required with 2,4-D (once), MCPA (once) and paraquat (four times), all mainly for *Amaranthus lividus*, although lesser amounts of cobbler's peg, crowsfoot grass, *Galinsoga parviflora* and other species were also treated. In addition small patches of couch grass were treated with 2 applications of dalapon (at 5 lb Gramevin per 45 gal) and small patches

of thurston grass and *Cyperus brevifolius* were treated with 2 applications of amitrole (at 4 pints Weedazol TL Plus per 45 gal).

In the second year blanket applications of simazine at 2 lb Gesatop-80 per acre were sprayed at weeks 61 and 97. As in the diuron treatment, this last application was postponed until a break occurred in a prolonged spell of dry weather. Spot-sprayings were made with paraquat on seven occasions.

The treatment maintained good weed control although the area was at all times somewhat weedier than the diuron-treated plot, with weeds often covering up to 15 per cent of the area. It also required more frequent spot-spraying than the diuron plot. Against this however, the lower cost of the simazine compared with diuron has resulted in cheaper control.

As with the other treatments, there was a change in the relative proportions of the weed species over the trial period. The most noticeable change was the increase in *Amaranthus lividus* but there was some relative increase in crowsfoot grass and *Cyperus brevifolius*. Cobbler's peg, thickhead, goatweed, wandering jew and *Polygonum nepalense* have decreased while *Galinsoga parviflora* and *Drymaria cordata* were not present at the end of the second year.

(4) *Hand-weeded*. There were six weedings in the first year, at intervals of 9 to 12 weeks. In the second year there were four weedings, at intervals varying from 9 to 18 weeks. The long interval occurred during the dry period referred to previously. During the trial, the main change in the weed population was an increase in the proportion of wandering jew and the disappearance of *Galinsoga parviflora*. An increase in a species such as wandering jew which can spread from cut portions of stem is to be expected under hand-weeding, but the reason for the disappearance of *Galinsoga parviflora* is unknown.

In the situation which existed in this trial, where the weed species were predominantly annuals and the area was well drained, manual weeding can be relatively inexpensive. However, the costs given should be regarded as optimal because the labour was working under close supervision and for only short periods at each weeding. On a plantation scale, under less supervision, the weeding costs could be expected to be higher.

There was a considerable drop in the cost of hand-weeding in the second year. In part this was due to a period of dry weather, but this doesn't account for most of the decrease. It may have been a consequence of the relative smallness of the treatment area. It is possible that as the labour became familiar with the task involved their work output increased in order to finish the task more quickly and return to less arduous work.

DISCUSSION

The costs of all treatments dropped markedly in the second year. With the herbicide treatments this is the expected pattern, although in this trial the decrease was somewhat larger than normal because of a long period of dry weather in the second year and the virtual absence of perennial species capable of taking advantage of the bare ground.

As has usually been the case in other trials, the treatment based on paraquat was the least costly, even though the hand-weeding costs obtained were probably lower than could be expected on plantations. The paraquat-based treatment has been much cheaper over the trial period than the two treatments based on soil-applied herbicides and it seems unlikely that this position would change in future years.

As already indicated, the simazine-based treatment gave somewhat inferior weed control to the diuron-based treatment. It is possible that better results could have been obtained if higher rates of simazine were used, although this may have brought the control costs closer

to those obtained with the more expensive diuron-based treatment.

Neither diuron nor simazine control the full range of species present in coffee. Among annual species, diuron's most obvious weakness is thickhead, while simazine gives no control of *Amaranthus lividus*. Diuron is able to kill larger seedlings than simazine and is somewhat better on perennial weeds, particularly thurston grass. At equivalent rates, it therefore generally gives slightly superior results to simazine.

A possible way of reducing the cost of treatments based on soil-applied herbicides would be to use both diuron and simazine in the spray programme so that the number of species controlled is increased. This could be done by applying diuron and simazine either in alternate applications, or in alternate years, or by applying them mixed together at each application. In a trial where they were applied together at 2 lb plus 2 lb (of commercial product) per acre, the length of control obtained was comparable to that obtained with either herbicide applied alone at 4 lb per acre.

However, under conditions comparable to that existing in the trial described here, it would not be expected that any combination of soil-applied herbicides would, at present prices, give cheaper control than a treatment based on paraquat.

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Table 2.—Costs per acre of weed control treatments

Treatment	COSTS						Total 2nd year	2 year total
	1st 6 months	2nd 6 months	Total 1st year	3rd 6 months	4th 6 months			
Based on paraquat	\$ 11.93	\$ 6.32	\$ 18.25	\$ 4.30	\$ 2.30	\$ 6.60	\$ 24.85	
Based on diuron	\$ 26.00	\$ 11.56	\$ 37.56	\$ 9.62	\$ 7.35	\$ 16.97	\$ 54.53	
Based on simazine	\$ 21.65	\$ 8.33	\$ 29.98	\$ 9.02	\$ 6.80	\$ 15.82	\$ 45.80	
Hand-weeded	\$ 10.17	\$ 7.87	\$ 18.04	\$ 4.81	\$ 3.03	\$ 7.84	\$ 25.88	

Prices used in compiling costs:—

Agral 60 (surfactant)—\$6.20 per gal.
Gesatop-80—\$1.75 per lb
Gramevin—\$0.55 per lb
Gramoxone—\$21.50 per gal
Karmex—\$3.10 per lb
Methoxone—\$3.40 per gal
Teepol—\$1.18 per gal
Weedazol TL Plus—\$7.50 per gal
Weedkiller D—\$5.19 per gal
Labour—10.1c per man hour