SOME EFFECTS OF IPC AND CIPC ON GROUNDNUTS

By S. T. W. KIRINDE

(Agronomist, Dry Zone Research Station, Maha Illuppallama, Ceylon)

SUMMARY

GROUNDNUTS grown in pots were treated with IPC and CIPC at each of the following stages :—(*a*) pre-emergence, (*b*) emergence, (*c*) 4-leaf stage or 7-8 days from emergence, (*d*) 5-leaf stage or 14-15 days from emergence and (*e*) flowering or 24-25 days from emergence.

The chemicals were applied in the form of a dust at the rate of 1.0 lb/ac. active material ; common responses evoked were death of seedlings, stunting, chlorosis and curling of leaflets. Resistance to the effect of the chemicals increased with the age at application, but whereas CIPC depressed the final yield in terms of nut number and weight by application at all five stages, IPC depressed yield compared with untreated controls only by application at or earlier than the 4-leaf stage.

INTRODUCTION

The control of weed grasses is one of the most difficult problems encountered in highland cropping in the dry zone of Ceylon ; their control in crops such as cotton, groundnuts, maize, sorghum and highland paddy has so far been mechanical, either by means of tractor-drawn rotary weeders and intercultivators, or more usually, by gangs of labourers wielding hoes.

Chemical weed control in highland crops has up to now been confined to the pre-emergence application of 2, 4-D, PCP and DNBP ; post-emergence treatments have not been of much success due to the predominance of grasses among the weed flora. Earlier experiments have shown that a pre-emergence treatment of either Pentachlorophenol (PCP) or 2, 4-dinitro-6-sec-butyl phenol (DNBP) to get rid of the dicotyledonous species, followed by two or three post-emergence hand weedings to control the grasses, is a useful routine, but it was not greatly superior to three or four hand weedings alone.

Among the chemicals used for the control of grasses in standing crops, varying degrees of success have been achieved with the phenyl carbamates, especially CIPC, particularly in cotton, soyabean, lucerne and sugar beets. The experiment described below was undertaken as a preliminary study in the chemical control of weeds in a legume crop rapidly gaining in importance in the dry zone of Ceylon.

MATERIAL AND METHODS

The groundnut variety " Uganda Erect " was grown in 12" clay pots at the rate 16 seeds per pot ; all pots were thinned at the four-leaf stage to eight plants and at flowering to four plants per pot.

Pure isopropyl-N-Phenyl carbamate (IPC), and isopropyl-N-(3-chlorophenyl) carbamate (CIPC), were applied to the groundnuts at each of the following stages :—(*a*) pre-emergence, (*b*) emergence, (*c*) the 4-leaf stage or 7-8 days from emergence, (*d*) the 5-leaf stage or 14-15 days from emergence and (*e*) flowering or 24-25 days from emergence.

The chemicals were applied at approximately 1 lb/ac. active material. For application, each chemical was made into a 4 per cent. mixture with oven-dried clay ; 1.0 gm. of this heavy mixture was then mixed with a further 5.0 gram. clay and dusted over the entire surface of the soil at each time of application.

There were two blocks of 12 pots each, made up of 2 × 5 chemical treatments plus 2 untreated controls per block ; due to the small number of replicates the experiment was repeated twice, but results of only the second experiment are given.

RESULTS

1. Effect of pre-emergence application

The chemicals were dusted on to the bare soil soon after planting. Germination in all pots commenced on the fifth day after planting ; in the controls germination continued for about two days and attained a maximum of about 70 per cent. In pots treated with IPC, germination in a large number of seeds did not progress beyond the radical stage ; these cases of arrested germination were soon subject to heavy secondary fungal infection and died with the cotyledons still within the soil. With CIPC the maximum percentage germination approximated that of the controls, and nearly all these seedlings had their cotyledons and plumules raised above the soil.

Completely emerged seedlings in both IPC and CIPC treated pots were extremely chlorotic and five to seven days after emergence were less than 15 mm. in height ; they had only two leaves, borne on short, thickened petioles 15-20 mm. long ; the leaflets in these were correspondingly tiny, thin, pale greenish yellow in colour and not fully expanded. Untreated controls of the same age were 25-30 mm. tall, and had two fully expanded leaves with a partially expanded third leaf, and an emerging fourth. Petioles in the controls were 50-55 mm. long and bore leaflets with a long axis of about 1 inch.

Judging from the number of seedlings soon after emergence, CIPC would appear to be less toxic than IPC, but whereas the few seedlings that arose under IPC recovered from the effects of the chemical and resumed normal growth, all the CIPC treated seedlings died within three weeks of emergence ; in this case too, secondary fungal infection of affected seedlings was very heavy.

Results of pre-emergence application are summarised in Table I.

TABLE I.—Effect of ICP and CIPC applied pre-emergence to Groundnuts

Treatment	Seed No. planted	Number germinated	Number plumules	Number Survivals	Days Emergence to flowering	Number Harvested	Number of Nuts		Weight of Full nuts
							Full	Empty	
IPC	32	13	5	3	40	3	13	14	17·50
CIPC	32	22	18	—	—	—	—	—	—
CONTROL	32	23	23	23	23	8	24	12	44·00

2. Effect of Application at Emergence :

The groundnut seedling at emergence has a pair of cotyledons with a bud in each axil, and a plumule consisting of two folded leaves with a crown of stipules between them. The general colour of the seedlings is maroonish, although the leaflets themselves are pale yellowish green. Within twenty-four hours of emergence the first two leaves begin to unfold and the third leaf commences to appear through the crown of stipules. In another twenty-four hours the first two leaves are fully expanded and dark green in colour, and the emergence of the third leaf is completed although its leaflets still remain folded ; the emergence of the fourth leaf from between the stipules of the second and third leaves also commences at about the same time. Five days after emergence, the plant has four fully expanded leaves and an emerging fifth. After this period of rapid growth, an apparent lull seems to set in, for the expansion of the fifth leaf is completed only when the plant is about two weeks old. By this time, too, the buds

in the axils of the cotyledons have developed into branches with 2-3 leaves, while the opening of the buds in the axils of the first and second leaves has just begun.

Application of CIPC at emergence brings further growth to a virtual halt. The chemical is rapidly translocated to the plumule, where it stunts the growth of the first and second leaves whose leaflets get a diffused chlorosis and are curled downwards and inwards. The developing third and fourth leaves are even more severely affected ; although they emerge from among the stipules, they do not grow to more than 20 mm. in length, and their leaflets become completely chlorotic and rolled inwards ; there is no elongation of the internodes and the plants remain less than 15 mm. in height (Fig. 1). These seedlings die off sooner or later without recovering from the effects of the chemical.

IPC applied at emergence (Fig. 2), does not have such a drastic effect on the growth of the seedlings. The first, second and third leaves get an initial chlorosis, but they soon recover and continue to grow normally ; the fifth, sixth and seventh leaves however are rather more severaly affected, the most striking feature being the abortion of their leaflets ; this condition diminishes progressively with maturity, so that the seventh leaf shows the least amount of abortion, while the morphological features of the eighth leaf are more or less normal. The growth of the plant thereafter proceeds normally, but flowering is delayed and yield is reduced.

The general results of IPC and CIPC applied at emergence are summarised in Table II.

TABLE II.—Effect of IPC and CIPC applied to Groundnuts at Emergence

Treatment	Seedling No. at treatment	No. after first treatment	No. after second thinning	Mortality	Days : Emergence to flowering	Number harvested	Number of nuts		Wt. of full nuts
							Full	Empty	
IPC	25	16	8	Nil	Over 40	8	19	18	34·0
CIPC	24	16	8	7	Over 40	1	2	7	3·8
CONTROL	22	16	8	Nil	23	8	24	12	44·0

3. Effect of application at the 4-leaf stage, 5-leaf stage and at flowering :

The first seven days after emergence is a period of rapid leaf production, for at the end of that period, the main stem bears four fully developed leaves, while the fifth leaf is fully opened only by

the end of the second week. But during the second week, buds become prominent in the axils of the first, second and third leaves ; growth of these buds takes place in the course of the third week, and at twenty-one days, the main stem bears six fully opened leaves, with single-leaved branches in the axils of the first and second leaves. Growth thereafter is somewhat mixed, for the first flower buds may be detected at about twenty-three days from emergence, while growth of the seventh and eighth leaves on the main stem and also development of branches in the axils of the third and fourth leaves take place during that time.

IPC or CIPC applied at either of the growth stages described above, gets rapidly translocated to the youngest leaves on the main stem ; thus applied at the 4-leaf stage, the first two leaves are unaffected, while the third leaf may show a trace of chlorosis ; chlorosis is more widespread in the fourth leaf which has only just been fully opened, while the fifth leaf when it emerges is completely chlorotic. The effect of the chemicals is less marked in the sixth leaf while the seventh and eighth leaves develop normally. The most striking difference between IPC and CIPC applied at either of these stages is that while IPC induces only a chlorosis, CIPC also causes the leaves to roll.

Applied at the 5-leaf stage and at flowering, the effect of the chemicals follows a pattern similar to that when applied at the 4-leaf stage ; at the 5-leaf stage, however, the third leaf of the branches in the axils of the cotyledons is also affected ; no branches were affected by application at the 4-leaf stage and at flowering.

The chemicals did not affect the floral morphology but the emergence to flowering interval was prolonged by application at the 4-leaf and 5-leaf stages. The general results of application at these various stages are summarised in Table III, while Figure 3 shows the effect of CIPC applied at the 4-leaf stage.

TABLE III.—Effect of IPC and CIPC applied to Groundnuts at three different stages of Growth

Treatment	Stage of Growth	Number Treated	Mortality	Number Harvested	Days : Emergence to flowering	Number of nuts		Weight of full nuts
						Full	Empty	
IPC	4-leaf	16	Nil	8	30	24	26	36·3
	5-leaf	16	Nil	8	39	26	14	45·0
	flowering	16	Nil	8	23	31	21	43·5
CIPC	4-leaf	16	Nil	8	33	19	21	31·3
	5-leaf	16	Nil	8	Over 40	25	18	34·0
	flowering	16	Nil	8	23	22	11	36·0
CONTROL ..			Nil	8	23	24	12	44·0

DISCUSSION

From the results described above, it is possible to distinguish two distinct effects of IPC and CIPC on groundnuts. The first is their effect on mitosis, cell division and morphogenesis. The phenyl carbamates are generally considered to be potent mitotic poisons, and such symptoms as the curling and abortion of leaflets, stunting of the plant and the site of action being consistently the region round the stem apex are all evidence of this mode of action. Chlorosis in the youngest leaflets appears to be an entirely distinct effect of these chemicals, for in plants treated at the 4-leaf stage or later, there is complete recovery from it, while the symptoms of mitotic poisoning persist. Death of seedlings treated before or at emergence could thus be ascribed to the combined effects of both mitotic poisoning and chlorosis.

Another feature in the effect of IPC and CIPC on groundnuts is the general increase in resistance to the chemicals with age ; but at comparable stages of growth CIPC always exerts a more pronounced effect than IPC, and thus for example, while the yield of groundnuts with IPC applied at the 5-leaf stage or later is similar to that of the untreated controls, the yield of nuts with CIPC applied at the same stages is appreciably less.

The increase in resistance to the chemicals with age appears to be tied up with the amount of chlorophyll in the plant ; thus a seedling treated before, or at emergence, has little or no chlorophyll and is most severely affected ; but seedlings treated at the 4-leaf stage or later are progressively less affected and recover correspondingly faster. It appears as if the greater amount of chlorophyll in the older plants enables them to breakdown the chemicals rapidly into harmless products ; the apparent selective translocation of the chemicals to the apical region of the stem seems to point out an ability of the chlorophyll in the older leaves to repel entry of the chemicals into them, or to an extremely swift breakdown of the material almost as soon as it enters the mesophyll.

In conclusion, the distinction between IPC and CIPC does not lie in a fundamental difference in their mode of action, but rather in the relative degree of toxicity to groundnuts at comparable stages of growth ; where IPC temporarily retards growth, CIPC completely kills off seedlings ; where IPC causes abortion of leaflets, CIPC prevents their development altogether ; and where IPC induces a slight curling, leaflets are tightly rolled in the case of CIPC ; in other words, any effect of IPC is only being expressed in greater degree by CIPC. If the rate of breakdown of both IPC and CIPC within the groundnut

is the same, then the more pronounced effects of CIPC could be a result of the greater volatility of IPC as compared with CIPC, for then, over a given period of time, under the hot dry conditions in the dry zone, groundnut is likely to absorb more CIPC than IPC, with the former thus appearing to be more toxic than the latter.

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