

## EFFECT OF ADDITIVES ON THE PHYTOTOXICITY OF GLYPHOSATE TO *PANICUM REPENS* (L.) BEAUV.

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The effect of glyphosate applied alone and in combination with additives on *Panicum repens* was studied in two experiments. In Experiment 1, glyphosate was sprayed alone at 2% and at 0.5 and 1.0% concentration in combination with kaolin (3.6 kg ha<sup>-1</sup>) or with a cationic surfactant (at 1 and 2 l ha<sup>-1</sup>) or with sulphate of ammonia (2.5 kg ha<sup>-1</sup>). In Experiment 2 glyphosate was sprayed alone at 2% and at 0.5 and 1.0% concentration in combination with kaolin or surfactant at the rates used in Experiment 1. The results showed that the rate of application of glyphosate could be halved when combined with either kaolin at 3.5 kg ha<sup>-1</sup> or with surfactant (Ethokem) at 1 l ha<sup>-1</sup>.

### INTRODUCTION

The introduction of the herbicide, glyphosate more than two decades ago has considerably enhanced the potential for control of many perennial weeds. The action of this herbicide is rather unique since its desiccating and herbicidal activity is not limited to the area of contact but is actively translocated extensively from leaf and stem tissue to underground roots or rhizomes of target plants. This compound possesses remarkable post-emergence herbicidal properties and controls a broad spectrum of annual and perennial grasses.

*Panicum repens* (L.) Beauv. commonly known as couch grass is a pernicious weed that is widespread in tea plantations of Sri Lanka. Over the years this perennial rhizomatous grass has proved difficult to control as it has remarkable powers of regeneration from small fragments and rhizomes which reach a depth of about 30 cm. Among several herbicides tested glyphosate N-(phosphonomethyl) glycine was found to be effective against *Panicum repens* (Sharma, Haridas and Venkataramani, 1973; Somaratne and Manipura, 1974; Rao and Rahman, 1978).

The desire for more economical use of herbicides has led to a considerable amount of work with the use of additives which can increase herbicidal penetration and thus economise on the amount of herbicide required. The addition of a cheap colloidal kaolin of small size to herbicides is believed to greatly

enhance their foliar penetration. An increasing number of surface active agents have found application in various phases of biological research. These compounds commonly referred to as surfactants were initially used to enhance the penetration and effectiveness of foliar applied herbicides by a reduction in the surface tension of aqueous systems. Ammonium salt additives have been shown to increase the herbicidal activity of glyphosate (Blair, 1975; Sharma, Satyanarayana and Ramachandran, 1980; Sharma and Sundar, 1981). The present study examined the effects on *Panicum repens* of a combination of glyphosate (Roundup) with the additives kaolin, ammonium sulphate and a surfactant.

## MATERIALS AND METHODS

### Experiment 1

*Panicum repens* (couch grass) was raised in cement pots in the glasshouse by planting pieces of rhizomes. Glyphosate was applied alone as well as in combination with fertilizer grade ammonium sulphate or finely powdered kaolin or a cationic surfactant, 'Ethokem' as follows when the grass in the pots were about 15 cm tall:

1. Glyphosate (2.0%) - recommended rate
2. Glyphosate (0.5%) + kaolin (3.6 kg ha<sup>-1</sup>)
3. Glyphosate (1.0%) + kaolin (3.6 kg ha<sup>-1</sup>)
4. Glyphosate (0.5%) + Ethokem (1 l ha<sup>-1</sup>)
5. Glyphosate (1.0%) + Ethokem (1 l ha<sup>-1</sup>)
6. Glyphosate (0.5%) + sulphate of ammonia (2.5 kg ha<sup>-1</sup>)
7. Glyphosate (1.0%) + sulphate of ammonia (2.5 kg ha<sup>-1</sup>)

The design was of the randomized block type with treatments replicated four times. There were 4 pots per treatment. The treatments were applied on 13th March 1985 and an assessment was done on 25th July 1985 when the dry weight and live and dead rhizomes, roots and a count of the number of shoots were made.

### Experiment 2

*Panicum repens* was established in plots of 3 m<sup>2</sup> size from rhizomes planted at a depth of 10 cm. Glyphosate was sprayed alone and in combination with finely powdered kaolin or a cationic surfactant, 'Ethokem' when the tillers were 15 cm tall as follows:

1. Glyphosate (2 %) - recommended rate
2. Glyphosate (0.5%) + Ethokem (2 l ha<sup>-1</sup>)
3. Glyphosate (1.0%) + Ethokem (1 l ha<sup>-1</sup>)
4. Glyphosate (0.5%) + kaolin (3.6 kg ha<sup>-1</sup>)
5. Glyphosate (1.0%) + kaolin (3.6 kg ha<sup>-1</sup>)

The design was of the randomized block type with treatments replicated 5 times. The treatments were sprayed on 29th April 1985.

The degree of weed control was assessed by visual scoring by two observers at weekly intervals in the scale 0 to 10, with 0 for no control and 10 for 100% control of the couch grass and expressing the percentage control as a mean of the two observations.

An assessment was done on 14th August 1985. A quadrat (30 cm<sup>2</sup>) was placed at 3 randomly-sited points in each plot and all the shoots within the quadrats were removed and then the rhizomes were carefully dug out and washed free of soil. The rhizomes were separated into live and dead rhizomes and their dry weights determined after drying at 100°C for 24 h.

## RESULTS AND DISCUSSION

In Experiment 1, glyphosate at 0.5% concentration in combination with the cationic surfactant (Ethokem) at 2 l ha<sup>-1</sup> as well as glyphosate at 1.0% concentration in combination with either surfactant at 1 l ha<sup>-1</sup> or ammonium sulphate gave as good a kill of couch grass as that obtained with glyphosate at 2.0% concentration (Table 1). The effect of glyphosate at 1.0% concentration in combination with kaolin at 3.6 kg ha<sup>-1</sup> on live rhizomes was as good as that shown by glyphosate at 2.0% concentration.

TABLE 1 — Effect of glyphosate and additives on dry weight (g) of components of couch grass (Experiment 1)

Treatments	Live rhizomes	Dead rhizomes	Total rhizomes	Roots	Shoots
1. Glyphosate (2%)	1.68	8.95	10.63	8.40	11.05
2. Glyphosate (0.5%) + kaolin (3.6 kg ha <sup>-1</sup> )	44.78	5.25	50.03	12.70	15.63
3. Glyphosate (1.0%) + kaolin (3.6 kg ha <sup>-1</sup> )	11.73	10.18	32.70	8.10	10.33
4. Glyphosate (0.5%) + Ethokem (2 l ha <sup>-1</sup> )	12.98	7.35	20.33	11.06	10.15
5. Glyphosate (1.0%) + Ethokem (1 l ha <sup>-1</sup> )	2.95	8.93	11.88	12.28	13.50
6. Glyphosate (0.5%) + sulphate of ammonia (2.5 kg ha <sup>-1</sup> )	41.38	9.80	51.03	12.30	20.95
7. Glyphosate (1.0%) + sulphate of ammonia (2.5 kg ha <sup>-1</sup> )	13.23	6.78	20.00	8.28	13.08
LSD (P=0.05)	18.23	NS	19.45	NS	NS

In Experiment 2 glyphosate at 1.0% concentration in combination with surfactant at 1 l ha<sup>-1</sup> or kaolin reduced the number of live rhizomes (Table 2). This was also borne out by the visual scoring made at weekly intervals (Fig. 1).

TABLE 2—Effect of glyphosate and additives on dry weight (g) of rhizomes of couch grass (Experiment 2)

Treatments	Live rhizomes	Dead rhizomes	Total rhizomes
1. Glyphosate (2%)	1.72	38.04	39.76
2. Glyphosate (0.5%) + Ethokem (2 l ha <sup>-1</sup> )	67.56	14.90	82.46
3. Glyphosate (1.0%) + Ethokem (1 l ha <sup>-1</sup> )	6.62	23.98	30.60
4. Glyphosate (0.5%) + kaolin (3.6 kg ha <sup>-1</sup> )	44.78	22.84	67.62
5. Glyphosate (1.0%) + kaolin (3.6 kg ha <sup>-1</sup> )	3.44	33.62	37.06
LSD (P=0.05)	22.86	8.57	24.85

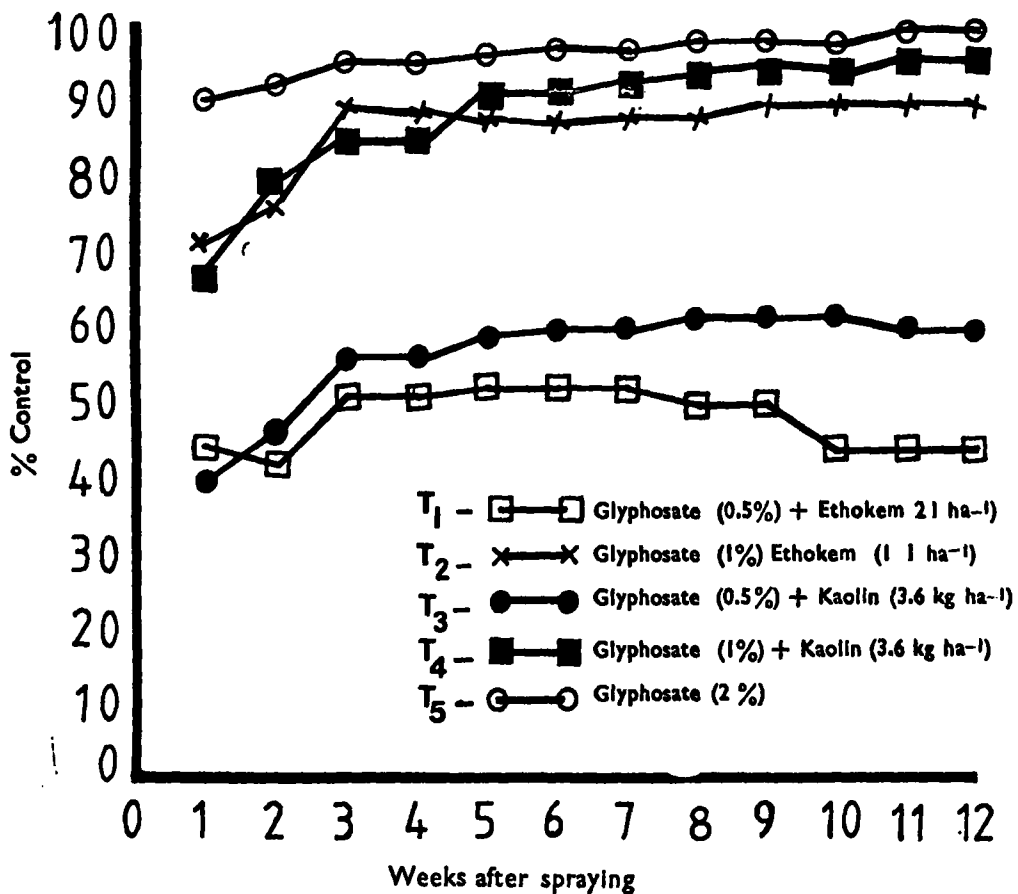


Fig. 1—Visual estimate of weed control.

Surfactants are included in most herbicide formulations including commercially formulated glyphosate, Roundup. One of the purposes of using additives with herbicides is to change the physico-chemical properties of the spray solution. This may enhance the phytotoxicity of the herbicide by, for example, increasing the spreading and retention of the spray solution on the foliage and/or the penetration of the herbicide into the plant. In this study the increased phytotoxicity shown by glyphosate (1%) with added cationic surfactant 'Ethokem' could be attributed to the ability of the surfactant to spread and retain the glyphosate spray solution on the target weed foliage.

When herbicides are sprayed onto leaf surfaces, their effectiveness is limited by their ability to pass from the leaf surface to the cells. It is known that the main route of entry of both water and lipoidal material is through the cuticle; thus an additive which increases cuticular permeability, could improve the penetration of herbicides. The use of colloidal kaolin at 3.6 kg ha<sup>-1</sup> enhanced the herbicidal effect of low doses of glyphosate (Tables 1 and 2). It is probable that this was due to the cuticle damaging properties of kaolin which would have resulted in increased herbicidal penetration of leaf surfaces. Eveling and Eisa (1976) have shown that kaolin particles damaged the cuticle in certain plant species. Sharma and Sundar (1981) noted a high degree of synergism between glyphosate and kaolin; however kaolin proved to be a superior additive to ammonium sulphate.

Sharma, Satyanarayana and Ramachandran (1980) found that the addition of ammonium sulphate at 1.25 kg ha<sup>-1</sup> positively activated lower doses of glyphosate. In this study ammonium sulphate was used only in the glass house and not in the field.

## CONCLUSION

The results of this study indicated that the presently recommended rate of glyphosate could be halved by the addition of either the cationic surfactant 'Ethokem' at 1% ha<sup>-1</sup> or colloidal kaolin at 3.6 kg ha<sup>-1</sup>.

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