# EFFECT OF SURFACTANTS ON THE PENETRATION OF $^{14}$C-GLYPHOSATE IN *CYPERUS ROTUNDUS* IN PAKISTANI AGROCLIMATIC CONDITIONS

M. JAMIL QURESHI, ANWARUL HAQ, UZMA MAQBOOL
Nuclear Institute for Agriculture and Biology,
Faisalabad, Pakistan

XA9846661

**Abstract**

The penetration of $^{14}$C-glyphosate was studied in *Cyperus rotundus* with three nonionic surfactants. Among the three surfactants Synperonic A20 was more effective than A2 and A7 in enhancing penetration of glyphosate 24 hours after treatment both in dry and wet seasons The addition of diesel oil to Synperonic A20 further increased penetration of glyphosate in both seasons.

## 1. INTRODUCTION

The cotton crop with its multifarious advantages can be rightly called the life line of Pakistan's economy. It accounts for 60 percent of the export earnings and 55 percent of the domestic edible oil production in the country. It also provides raw material to 1035 ginning factories, 262 textile mills and 13,000 oil expelling units, and job opportunities to millions of people.

Cotton production is badly affected by insects and weeds. With the increase in use of insecticides, the losses due to insects have been significantly controlled. However, losses due to perennial weeds like *Cyperus rotundus; Trianthema partulacastrum; Digera alternifolius* and *Ephorbia hirta* are still significant and may range from 15–55%. These weeds are difficult to control mechanically because they either have underground perennating organs or produce seeds which are viable for several years [1]. Herbicides are not always effective at least partly because spray droplets are not well retained and/or the penetration and translocation of the active ingredient is limited. Commercial herbicide formulations together with application specifications have usually been developed for a range of weeds and are thus not optimum for any one in particular. Also they are commonly designed for temperate and not tropical weeds. Thus improved performance on particular targets is possible by manipulating formulation and applications factors and this has been achieved for some grass weeds [2]. The present investigations are therefore, aimed to study the effect of three non-ionic surfactants on the penetration of $^{14}$C-glyphosate in *Cyperus rotundus* L. in Pakistani climatic conditions.

## 2. MATERIALS AND METHODS

The herbicide used was $^{14}$C-glyphosate and the test plant selected was *Cyperus rotundus*. The additives were Synperonic A2, A7 and A20 at 0.1% in the spray solution and each was used with $\pm$1% ammonium sulfate. The optional additives used were 1% diesel and 1% glycerol.

*Cyperus rotundus* tubers were pre-germinated in wet blotting paper and average weight was noted. The time period noted for the pre-germination of the sprout in the blotting paper was at room temperature. The germinated sprouts were transferred to the pots and the times noted for the emergence of the plant from the soil and reaching the 5–6 leaf stage. The temperature during this period was also noted. Four treatments each containing 7.2 kBq per 4 µL of labelled glyphosate along with other constituents were applied on the 2nd leaf of *C. rotundus* when the plant was at the 5–6 leaf stage. Eight 0.5 µL drops were applied on either side of the

midrib in a 2 cm area starting 10 cm from the tip without touching the leaf. Aliquots (4 µL) were added to 2 scintillation vials to check the application rates. After 24 h, the treated area was painted with cellulose acetate in 9:1 acetone/water. After drying, the cellulose acetate film was removed with tweezers and dissolved in 2 ml glacial acetic acid and 5 – 10 ml of the scintillator permaflour was added for counting. The treated leaves and plants were harvested after 4 and 24 h and 5 d.

## 3. RESULTS AND DISCUSSION

The emergence of the plants took two days and the 5-6 leaf stage was reached after 15-21 days during summer and 75 days in winter. In the summer (August) minimum temperatures were 24–29°C and maxima 37–42 °C; corresponding winter (January–March) temperatures were 7–21°C and 13–32°C. Relative humidities in summer were 68–71% in the morning and 42–54% in the evening. Winter values were 62–88% and 43–58% respectively. The only rainfall in both periods consisted of light showers at night.

The amount of radioactivity in the cellulose acetate film, treated zone, remaining zone, 10 cm zone and remaining part of the plant harvested after 4, 24 hours and 5 days after five treatments are recorded in Tables 1 and 2.

TABLE 1. EFFECT OF SURFACTANTS ON THE PENETRATION OF GLYPHOSATE IN *C.ROTUNDUS* AFTER APPLICATION AT THE 5 TO 6 LEAF STAGE IN SUMMER

| Sr. No. | Formulation additive | Distribution of C-14 (% of applied) Cellulose acetate | Treated zone | Remaining zone | 10 cm zone | Remaining plant | Total uptake |
|---|---|---|---|---|---|---|---|
| | | (After 4 hours) | | | | | |
| 1. | Synperonic A-2 | 83.6 | 1.5 | 2.9 | 1.4 | 3.3 | 9.1 |
| 2. | Synperonic A-7 | 88.2 | 1.3 | 2.5 | 2.0 | 2.7 | 8.5 |
| 3. | Synperonic A-20 | 54.2 | 9.4 | 10.1 | 2.5 | 13.2 | 35.2 |
| 4. | Synperonic A20 + Diesel oil | 40.6 | 15.9 | 11.1 | 7.0 | 12.7 | 46.7 |
| 5. | 'Roundup alone | 90.3 | 3.5 | 1.4 | 1.6 | 1.1 | 7.6 |
| | | (After 24 hours) | | | | | |
| 1. | Synperonic A-2 | 56.3 | 4.6 | 8.7 | 5.3 | 20.2 | 38.8 |
| 2. | Synperonic A-7 | 48.4 | 3.3 | 4.4 | 5.8 | 26.6 | 40.1 |
| 3. | Synperonic A-20 | 27.6 | 5.0 | 14.0 | 5.7 | 42.2 | 66.9 |
| 4. | Synperonic A20 + Diesel oil | 12.4 | 8.8 | 14.8 | 6.3 | 49.6 | 79.5 |
| 5. | 'Roundup' alone | 61.2 | 9.1 | 6.2 | 5.8 | 13.4 | 34.5 |
| | | (After 5 days) | | | | | |
| 1. | Synperonic A-2 | 49.5 | 3.3 | 14.2 | 5.4 | 21.6 | 43.3 |
| 3. | Synperonic A-20 | 16.6 | 4.8 | 13.8 | 8.3 | 47.4 | 74.3 |
| 4. | Synperonic A20 + Diesel oil | 8.5 | 7.3 | 11.8 | 8.7 | 54.6 | 82.4 |
| 5. | 'Roundup alone' | 54.2 | 5.0 | 8.6 | 7.8 | 19.3 | 40.7 |

There was a significant decrease in the amount of $^{14}C$-radioactivity in the cellulose acetate and treated zone samples after 24 hours and five days. The amount of radiocarbon significantly increased in the remaining part of the plant after 24 hours and 5 days. However, $^{14}C$-glyphosate was distributed through the treated zone, the remaining zone, the 10 cm zone and remaining part of the plant when harvested after five days (Table 1). Formulation No. 4 (Synperonic A20 plus diesel oil) produced significantly greater penetration of glyphosate than the other treatments. Synperonic A2 and A7 and 'Roundup' produced similar glyphosate penetration patterns whereas Synperonic A20 alone gave penetration intermediate between these and formulation No. 4.

TABLE 2. EFFECT OF SURFACTANTS ON THE PENETRATION OF GLYPHOSATE IN *C.ROTUNDUS* AFTER APPLICATION AT THE 5 TO 6 LEAF STAGE IN WINTER

| Sr. No. | Formulation additive | Distribution of C-14 (% of applied) Cellulose acetate | Treated zone | Remaining zone | 10 cm zone | Remaining plant | Total uptake |
|---|---|---|---|---|---|---|---|
| | | (After 4 hours) | | | | | |
| 1. | Synperonic A-2 | 85.3 | 2.3 | 3.5 | 1.2 | 3.2 | 10.2 |
| 2. | Synperonic A-7 | 80.6 | 1.9 | 2.8 | 1.7 | 2.7 | 9.1 |
| 3. | Synperonic A-20 | 59.3 | 4.9 | 2.2 | 2.6 | 20.6 | 30.3 |
| 4. | Synperonic A20 + Diesel oil | 45.9 | 20.5 | 7.0 | 4.0 | 11.2 | 42.6 |
| 5.. | 'Roundup' alone | 88.4 | 4.3 | 2.6 | 1.4 | 1.3 | 9.6 |
| (After 24 hours) | | | | | | | |
| 1. | Synperonic A-2 | 59.5 | 4.7 | 7.2 | 3.1 | 18.7 | 33.7 |
| 2. | Synperonic A-7 | 62.7 | 7.2 | 5.4 | 4.8 | 13.4 | 30.8 |
| 3. | Synperonic A-20 | 21.5 | 12.9 | 8.1 | 9.4 | 37.9 | 68.3 |
| 4. | Synperonic A20 + Diesel | 63.6 | 7.5 | 8.6 | 6.4 | 7.2 | 29.7 |
| | | (After 5 days) | | | | | |
| 1. | Synperonic A-2 | 51.3 | 6.2 | 4.2 | 3.4 | 24.1 | 37.9 |
| 2. | Synperonic A-7 | 54.2 | 4.2 | 4.7 | 3.2 | 28.3 | 40.4 |
| 3. | Synperonic A-20 | 7.4 | 5.6 | 12.9 | 8.7 | 46.5 | 83.2 |
| 5. | 'Roundup' alone | 62.4 | 4.5 | 9.8 | 7.4 | 10.6 | 32.3 |

Results presented in Table 2 showed the effect of three non-ionic surfactants on the penetration of $^{14}C$-glyphosate in *C. rotundus* during the winter season. They are similar to those obtained in the summer It is, therefore, concluded that formulation No. 4 with Synperonic A20 plus diesel oil is the most effective combination for enhancing the penetration of glyphosate.


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