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# Efficacy of Glyphosate with or without Additives/Herbicides for the Control of Purple Nutsedge (*Cyperus rotundus* L.) in Soybean

**Inder Dev, N. T. Yaduraju and K. N. Ahuja**
Division of Agronomy
Indian Agricultural Research Institute, New Delhi-110 012, India

## ABSTRACT

Field trial was carried out during 1994-95 and 1995-96 to find out the residual and cumulative effect of glyphosate with or without additives/herbicides for the control of purple nutsedge (*Cyperus rotundus* L.) in soybean. Efficacy of glyphosate at 1.0 kg/ha was increased substantially when applied in combination with either ammonium sulphate (2%), urea (2%) or 2, 4-D (1.0 kg/ha) as compared to sole application of glyphosate at same dose. The synergism was, however, marginal at 2.0 kg/ha glyphosate. The efficacy of glyphosate was lowered by the additon of oxyfluorfen (0.10 kg/ha). Repeating the application during both the years was relatively more effective in controlling *C. rotundus* than one year application. The treatment which gave good control of *C. rotundus* realised higher productivity of soybean. There was 15-50 and 30-81% increase in seed yield due to one year (direct effect) and two year (cumulative effect) applications, respectively.

## INTRODUCTION

Purple nutsedge (*Cyperus rotundus* L.) is the most troublesome perennial weed in the tropical and sub-tropical regions of the world. Purple nutsedge exhibits prolific vegetative activity with its complex underground system of basal bulb, rhizomes and tubers. *C. rotundus* is known to infest 52 crops in 92 countries (Holms and Herberger, 1969) and reduces crop yield drastically. Control of nutsedge is difficult because of its perennating underground rhizomes and tubers. Glyphosate has been reported as the most promising herbicide for long term control of *C. rotundus* (Thakur *et al.*, 1993; Mir *et al.*, 1994). Glyphosate shows no pre-emergence or residual soil activity thus enabling this to be used as pre-plant treatment in many crops (Rueppel *et al.*, 1977). The efficacy of glyphosate has been enhanced by the addition of surfactants and other adjuvants to spray solutions (Tewari and Shukla, 1991). Adjuvants lower herbicide rates and increase its efficacy thus becomes economical and environmentally safe (Harker, 1995) In the present study, an attempt has been made to study the effect of glyphosate on *C. rotundus* when applied alone and in combination with adjuvants/herbicides.

## MATERIALS AND METHODS

Field experiment was conducted during July-April in 1994-95 and 1995-96 at the research farm of Indian Agricultural Research Institute, New Delhi, on a sandy loam soil. Selected site had a uniform and relatively dense population (350-400 shoots/m$^2$) of *C. rotundus*. The experiment was laid out in a randomised block design with 14 treatments (Table 1) and was replicated three times. In second year, each plot was divided into two and while one received the same treatment as that of first year, the other was given no treatment. This was intended to study the residual and cumulative effects of treatments. The herbicides were applied during July at 6-7 leaf stage of *C. rotundus* using a knapsack sprayer at a volume rate of 500 l/ha. The field was disced and levelled before sowing soybean. Soybean (cv. Pk 327) at 100 kg/ha was sown 10 days after spray on July 28 and 29 during 1994 and 1995, respectively, at row spacing of 50 cm. During both the years, soybean was sown after wheat crop. The recommended doses of

Table 1. Effect of glyphosate applied alone or in combination with additives/herbicides on *Cyperus rotundus* at 60 days after application in soybean

| Treatments | 1994 | | 1995 | | | |
|---|---|---|---|---|---|---|
| | | | Residual* | | Cumulative** | |
| | Count/ $m^2$ | Dry wt. ($g/m^2$) | Count/ $m^2$ | Dry wt. ($g/m^2$) | Count/ $m^2$ | Dry wt. ($g/m^2$) |
| Glyphosate (1.0 kg/ha) | 8.1 | 4.2 | 13.5 | 6.2 | 7.8 | 3.4 |
| Glyphosate (2.0 kg/ha) | 5.7 | 2.8 | 10.3 | 5.0 | 4.2 | 1.9 |
| Glyphosate (1.0 kg/ha) + ammonium sulphate (2%) | 6.7 | 2.9 | 10.2 | 4.5 | 4.4 | 2.1 |
| Glyphosate (2.0 kg/ha) + ammonium sulphate (2%) | 4.5 | 1.9 | 8.7 | 4.3 | 3.8 | 1.0 |
| Glyphosate (1.0 kg/ha) + sugar (2%) | 8.7 | 4.7 | 12.1 | 5.9 | 7.2 | 3.2 |
| Glyphosate (2.0 kg/ha) + sugar (2%) | 7.5 | 3.2 | 11.1 | 5.3 | 5.1 | 2.1 |
| Glyphosate (1.0 kg/ha) + urea (2%) | 6.7 | 3.1 | 10.3 | 4.5 | 4.5 | 2.1 |
| Glyphosate (2.0 kg/ha) + urea (2%) | 4.9 | 2.3 | 8.6 | 4.7 | 3.5 | 1.2 |
| Glyphosate (1.0 kg/ha) + 2, 4-D (1.0 kg/ha) | 6.8 | 3.1 | 10.0 | 5.3 | 4.5 | 2.5 |
| Glyphosate (2.0 kg/ha) + 2, 4-D (1.0 kg/ha) | 5.5 | 2.9 | 11.5 | 5.4 | 4.6 | 2.4 |
| Glyphosate (1.0 kg/ha) + oxyfluorfen (0.1 kg/ha) | 10.0 | 5.3 | 14.9 | 7.3 | 11.0 | 6.6 |
| Glyphosate (2.0 kg/ha) + oxyfluorfen (0.1 kg/ha) | 8.8 | 4.3 | 14.3 | 7.2 | 10.6 | 6.5 |
| Unweeded control | 13.1 | 6.2 | 17.2 | 7.9 | 17.2 | 7.9 |
| C. D. 5% | 1.28 | 1.05 | 3.1 | 0.8 | 3.1 | 0.8 |

Data subjected to square root transformation.
* Application made in 1994.
** Application made in 1994 and 1995.

30 kg N, 80 kg $P_2O_5$ and 60 kg $K_2O$/ha was applied as basal dressing in soybean.

An area of 0.25 $m^2$ was selected randomly by throwing a quadrat of 50 × 50 cm to record the observation on nutsedge population and its biomass. At harvest, the dry weight per plant and pods per plant were recorded from five randomly selected plants. The data on *C. rotundus* were subjected to square root transformation before analysis of variance.

## RESULTS AND DISCUSSION

### Effect on *C. rotundus*

Glyphosate applied with or without additives/herbicides decreased *C. rotundus* density and biomass substantially during both the years (Table 1). In general, reduction in *C. rotundus* density was 24-66% during the first year. In the second year, reduction was 13-41% due to residual effect of previous year's treatments and 36-78% due to cumulative effect of treatments and corresponding reduction in biomass were 15-19, 8-46 and 16-87%, respectively. Glyphosate applied at 2.0 kg/ha significantly lowered the density and biomass of *C. rotundus* over glyphosate applied at 1.0 kg/ha. Application of glyphosate at 1.0 kg/ha in combination with either ammonium sulphate, urea or 2, 4-D decreased *C. rotundus* population and dry weight substantially over sole application of glyphosate at the same dose. However, no such synergistic effects were observed with glyphosate at 2.0 kg/ha. On the contrary, tank-mix application of glyphosate and oxyfluorfen decreased the phytotoxicity.

Table 2. Effect on yield and yield contributing characters of soybean

| Treatments | Dry matter at harvest (g/plant) | | | Pods per plant | | | Seed yield (q/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1994 | 1995 | | 1994 | 1995 | | 1994 | 1995 | |
| | | Residual* | Cumulative** | | Residual* | Cumulative** | | Residual* | Cumulative** |
| Glyphosate (1.0 kg/ha) | 19.0 | 14.2 | 20.5 | 21.1 | 18.7 | 23.0 | 20.2 | 18.6 | 22.0 |
| Glyphosate (2.0 kg/ha) | 22.0 | 16.4 | 22.9 | 25.8 | 20.8 | 26.3 | 24.5 | 20.0 | 26.3 |
| Glyphosate (1.0 kg/ha) + ammonium sulphate (2%) | 22.8 | 16.0 | 21.3 | 24.2 | 20.2 | 25.6 | 24.0 | 19.9 | 26.0 |
| Glyphosate (2.0 kg/ha) + ammonium sulphate (2%) | 23.5 | 17.4 | 24.5 | 26.1 | 22.6 | 28.4 | 26.1 | 22.3 | 28.8 |
| Glyphosate (1.0 kg/ha) + sugar (2%) | 18.7 | 14.3 | 20.0 | 21.9 | 17.7 | 20.5 | 20.3 | 17.9 | 21.8 |
| Glyphosate (2.0 kg/ha) + sugar (2%) | 17.9 | 14.0 | 22.5 | 23.4 | 18.0 | 23.9 | 22.1 | 18.1 | 24.8 |
| Glyphosate (1.0 kg/ha) + urea (2%) | 22.6 | 14.5 | 21.2 | 24.9 | 19.5 | 26.5 | 23.3 | 19.8 | 24.9 |
| Glyphosate (2.0 kg/ha) + urea (2%) | 23.6 | 17.6 | 23.9 | 25.2 | 22.2 | 28.1 | 26.0 | 22.0 | 28.9 |
| Glyphosate (1.0 kg/ha) + 2, 4-D (1.0 kg/ha) | 18.5 | 14.7 | 21.6 | 24.0 | 18.1 | 26.0 | 23.3 | 18.0 | 24.8 |
| Glyphosate (2.0 kg/ha) + 2, 4-D (1.0 kg/ha) | 22.5 | 15.8 | 21.9 | 25.7 | 20.0 | 24.3 | 25.7 | 19.9 | 25.2 |
| Glyphosate (1.0 kg/ha) + oxyfluorfen (0.1 kg/ha) | 14.7 | 13.9 | 16.0 | 20.7 | 16.3 | 20.8 | 19.9 | 18.3 | 20.9 |
| Glyphosate (2.0 kg/ha) + oxyfluorfen (0.1 kg/ha) | 15.6 | 14.4 | 17.0 | 21.1 | 16.7 | 21.3 | 21.2 | 19.1 | 20.8 |
| Unweeded control | 12.1 | 12.3 | 12.3 | 18.9 | 15.5 | 15.5 | 17.4 | 16.0 | 16.0 |
| Weed free check | 24.4 | 25.8 | 25.8 | 27.5 | 28.9 | 28.9 | 27.3 | 29.7 | 29.7 |
| C. D. 5% | 6.4 | 3.0 | 3.0 | 2.94 | 2.5 | 2.5 | 3.08 | 2.7 | 2.7 |

* Application made in 1994.
** Application made in 1994 and 1995.

Improved performance of glyphosate when mixed with ammonium sulphate against *C. rotundus* has been reported by Thakur *et al.* (1993) and Mir *et al.* (1994).

The increased phytotoxicity of glyphosate with urea is consistent with the findings of Mir *et al.* (1994). The increased phytotoxicity observed in combination with 2, 4-D is in conformity with the findings of Kanwar *et al.* (1992).

**Effects on Soybean**

Applications of additives/herbicides to glyphosate, except tank mixing of glyphosate and oxyfluorfen, improved dry matter production in soybean but differences were not statistically significant over sole application of glyphosate at the same dose (Table 2). Repeated application (application made in both the years) although recorded

slightly higher dry matter production as compared to direct application, the trend in dry matter production was almost similar in both the years. Cumulative effect of all the treatments showed significant increase in dry matter production over their residual effect (Table 2).

Number of pods per plant was the most important variable that affected the seed yield. Glyphosate (1.0 kg/ha) applied in combination with either ammonium sulphate, urea or 2, 4-D recorded significantly more number of pods per plant over sole application of glyphosate at the same dose. The increase was, however, marginal with glyphosate 2.0 kg/ha. Cumulative effect was basically similar to first year application. Except mixture of glyphosate and oxyfluorfen, residual effect of all other treatments resulted in significantly higher number of pods per plant as compared to control (Table 2).

Application of glyphosate resulted in 15-50% increase in seed yield during 1994, while its repeat application in second year showed 30-81% increase, whereas the residual effect restricted the increase to only 14-39% (Table 2). Unweeded control reduced the seed yield to the tune of 36 and 46% in the first and second year, respectively, as compared to weed free check. Application of glyphosate (1.0 kg/ha) with either ammonium sulphate, urea or 2, 4-D resulted in substantial increase in yield over sole application of glyphosate at the same dose, however, no such increment was observed with glyphosate 2.0 kg/ha. Tank-mix application of glyphosate and oxyfluorfen reduced the soybean seed yield.

The yield obtained with cumulative effect of herbicides (Table 2) was almost similar to yields obtained during first year. Cumulative effect of all the treatments except mixture of glyphosate and oxyfluorfen gave significantly higher seed yield over residual effect. The increase in seed yield may be attributed to effective control of *C. rotundus*, while decreased seed yield in residual plots may be attributed to increased infestation of *C. rotundus*.

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