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# Chemical control of *Prosopis farcta* (Banks and Sol.) Macbride in the Jordan Valley

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**Abstract**

Syrian mesquite, *Prosopis farcta* (Banks and Sol.) Macbride, is a nuisance, rhizomatous perennial weed dominating an important part of productive agricultural land in the Jordan Valley. It tolerates traditional methods of weed control such as soil solarization and mechanical methods. Two field experiments were carried out to evaluate the effect of different herbicides against this weed on cultivated land in the Jordan Valley during the 1998/1999 growing season. Several herbicides were evaluated including glyphosate, mecoprop, 2,4-D amine and ester, trichlopyr, paraquat, oxyfluorfen, bromoxynil and MCPA as individual treatments, mixtures or sequences. All treatments except the bromoxynil/MCPA mixture reduced *P. farcta* growth. Trichlopyr, 2,4-D ester and glyphosate followed by paraquat were the best in affecting weed recovery. Results indicated that control of *P. farcta* during a fallow period may be effectively achieved by two or more applications of some of the tested translocated herbicides such as trichlopyr, 2,4-D and glyphosate.


*Keywords:* Glyphosate; Mecoprop; Trichlopyr; 2,4-D; Paraquat; Oxyflourfen; Bromoxynil and MCPA mixture (buctril®)

## 1. Introduction

The genus *Prosopis* contains 44 species of shrubs and trees belong to the Mimosaceae family (Burkart, 1976) from which 11 species have been reported as weeds in different countries (Holm et al., 1991). Certain species were mentioned to cause direct losses in the United States of some $ 200–500 million annually and the total economic loss was estimated to be $ 0.5–1.5 billion (DeLoach, 1985).

Syrian mesquite [*Prosopis farcta* (Banks and Sol.) Macbride] is a woody perennial dwarf shrub of 0.4–1 m in height, with a well-developed root system and rhizomes. Stems erect, branching from the base and carry small yellow flowers appear from May to August (Post and Dinsmore, 1932). On each raceme there are 1–2 pods which are dark brown when ripe. *P. farcta*, an invasive weed, distributed from India to Iran and spread more to the Middle East, and occurs in Cyprus, Turkey, Ukraine and along the north African coast as far as Algeria (Pasiecznik et al., 2004). It has been reported among the most prevalent weeds in *Sesamum indicum* L. in Turkey (Bukun et al., 2005) and in range land in the USA (Pasiecznik et al., 2001). The weed affects a large area in the Jordan Valley. Its seeds and seedlings appear to tolerate a wide range of temperature and moisture conditions. It is dominant under irrigation conditions in the central Jordan Valley, where it forms dense impenetrable thickets in cultivated fields. Like other *Prosopis* spp., it possesses characteristics that makes it very competitive. It is found growing along irrigation channels and water courses, waste places, roadsides, orchards and vegetable fields (Qasem, 2003). It is spreading widely towards the Jordan River and appears to tolerate saline conditions (Qasem, 1999). *P. farcta* regenerates from seeds and basal buds on rhizomes located at or just below the soil surface, and its roots can extend up to 15–20 m depth into the soil. It resumes growth after a very short dormancy period in the winter and spring and re-vegetating during the summer through the autumn. It can attain more than 2 m in height and grow as tall as grapes and citrus trees in certain places where weed control is absent. It harbors different species of dodder (*Cuscuta* spp.) and

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serves as a primary host for these parasites in different places in the Jordan Valley (Qasem, 2006). In addition, it hosts the white fly (*Bemisia tabaci*) the vector of the tomato yellow leaf curl virus (TYLCV) which is the epidemic disease of tomato cultivation in the area (Sharaf, 1986).

In Jordan, its control is a real challenge to local farmers and depends on understanding all factors affecting its growth and regeneration. Weeds can penetrate through plastic cover on the soil. Its rhizomes and/or seeds appear unaffected by soil solarization treatment commonly practiced in the area reflecting its deep root system and rhizomes or the hard seed coat from which it regenerates. Burning and hoeing are both ineffective measures as these methods remove only the upper parts leaving the below ground structures and hoeing may disseminate rhizome fragments and increase infestation. Grazing in certain places may be partially effective in reducing its vegetative mass but only at early growth stages when spines on weed stem and branches are still soft, as after that the weed may be grazed only by camels. However, a reduction in grazing pressure alone may at best result in a reduction in the rate of invasion and will not prevent weed invasion entirely. In all cases such grazing is not practiced in cultivated area in the Jordan Valley. The weed can resume vegetative growth shortly after being removed and was observed to spread rapidly in the cultivated land after initial infestation.

Based on our own observations, seeds of this species are attacked by certain beetles and the larvae can penetrate the hard seed coat and feed on the endosperm. Sertkaya et al. (2005) reported that the insect *Carydon palaestinicus* Southgate (Coleoptera, Bruchidae; Pachymerinae) was found feeding on seeds of this species.

No data are available on the economic impact or control of *P. farcta* in Jordan, and information on these aspects in general are very limited worldwide. Therefore, the present work was conducted to evaluate the effect of certain available herbicides in local markets in controlling this weed in cultivated vegetable fields in the Jordan Valley.

## 2. Materials and methods

### 2.1. Experimental site and procedures

Two field experiments were conducted to study the effectiveness of certain herbicides (Table 1) in controlling Mesquite (*P. farcta*) during the fallow period in vegetable fields. Both experiments were conducted at the University of Jordan Research Station located in the central Jordan Valley at 255 m below the sea level. The soil is sandy-loam of 50% sand, 25% silt and 25% clay with 1.3% organic matter content and a pH approximately 7.6. The selected experimental site was heavily covered by *P. farcta* plants and used to grow vegetables. All herbicides tested were applied as an aqueous spray at a constant pressure onto the foliage parts of *P. farcta* using a knapsack sprayer with a single nozzle at a volume rate of $1000\,l\,ha^{-1}$. However, when glyphosate was followed by paraquat, the latter was applied 10 days after the first to allow enough time for glyphosate translocation to the rhizomes. In both experiments, *P. farcta* was treated at full vegetative stage on 7 December 1998 when plants were 20–30 cm in height; however, in the second experiment and when *P. farcta* plants were treated twice, the same plants were sprayed using the same herbicides at the same doses and spray volume on 4 January 1999.

In both experiments plot size was $3 \times 2.5$ m and four plots were used per treatment.

Table 1
Herbicides tested for *P. farcta* control in the Jordan Valley during 1998/1999

| Common name | Dose ($ai\,l\,ha^{-1}$) |
|---|---|
| Bromoxynil/MCPA mixture | 1 |
| Glyphosate | 3.84 |
| Mecoprop | 2 |
| 2,4-D amine | 1.2 |
| 2,4-D ester | 1.2 |
| Glyphosate followed by paraquat | 3.84 and 0.6 |
| Trichlopyr | 3 |
| Paraquat | 0.6 |
| Oxyfluorfen | 1.2 |

### 2.2. Data collection

Plants in the first experiment were cut and removed from the above soil surface on 26 December 1998, and plants in the second experiment were harvested from the above soil surface on 17 February 1999.

*P. farcta* plants in both experiments were allowed to revegetate for growth recovery evaluation then were harvested by removing their vegetative parts from above soil on 24 May 1999. Shoot fresh weight of *P. farcta* plants in all harvests were determined, then shoots were oven-dried at 70 °C for 72 h and their dry weights recorded.

### 2.3. Statistics

Treatments in both experiments were laid out in a randomized complete block design with four replicates. All data were statistically analyzed by ANOVA and the treatments means were compared using the least significant differences (LSD) at 5% level of probability.

## 3. Results

Single application of all herbicides reduced shoot fresh and dry weights of *P. farcta* compared with untreated control (Table 2). The bromxynil/MCPA mixture and oxyfluorfen resulted in the greatest reduction in weed growth. Shoot dry weight of the weed was significantly reduced by 59% and 69% for both herbicides, respectively. Mecoprop was third in its effect while differences in the effect of other herbicides were not significant.

Table 2
Effect of single application of different herbicides on *P. farcta* plants and their regrowth in the Jordan Valley during the 1998/1999 growing season

| Treatments | *P. farcta* | | *P. farcta* regrowth | |
|---|---|---|---|---|
| | Shoot fresh weight (MT $ha^{-1}$) | Shoot dry weight (MT $ha^{-1}$) | Shoot fresh weight (MT $ha^{-1}$) | Shoot dry weight (MT $ha^{-1}$) |
| Bromoxynil and MCPA mixture | 0.72 | 0.339 | 2.715 | 1.993 |
| Glyphosate | 1.05 | 0.491 | 0.432 | 0.317 |
| Mecoprop | 0.90 | 0.423 | 0.655 | 0.527 |
| 2,4-D amine | 1.27 | 0.593 | 0.323 | 0.144 |
| 2,4-D ester | 1.33 | 0.625 | 0.277 | 0.213 |
| Glyphosate followed by paraquat | 1.13 | 0.532 | 0.239 | 0.184 |
| Trichlopyr | 1.21 | 0.567 | 0.301 | 0.231 |
| Paraquat | 1.27 | 0.593 | 0.757 | 0.647 |
| Oxyfluorfen | 0.60 | 0.260 | 4.511 | 3.481 |
| Untreated (control) | 1.72 | 0.833 | 2.062 | 1.593 |
| LSD ($p = 0.05$) | 0.36 | 0.183 | 1.130 | 0.776 |

Table 3
Effect of double applications of different herbicides on *P. farcta* plants, and their regrowth in the Jordan Valley during the 1998/1999 growing season

| Treatments | *P. farcta* | | *P. farcta* regrowth | |
|---|---|---|---|---|
| | Shoot fresh weight (MT $ha^{-1}$) | Shoot dry weight (MT $ha^{-1}$) | Shoot fresh weight (MT $ha^{-1}$) | Shoot dry weight (MT $ha^{-1}$) |
| Bromoxynil/MCPA mixture | 0.73 | 0.317 | 5.23 | 3.520 |
| Glyphosate | 0.71 | 0.320 | 1.23 | 0.976 |
| Mecoprop | 0.93 | 0.403 | 1.46 | 1.125 |
| 2,4-D amine | 0.80 | 0.345 | 0.58 | 0.511 |
| 2,4-D ester | 0.80 | 0.365 | 0.10 | 0.063 |
| Glyphosate followed by paraquat | 0.87 | 0.380 | 0.60 | 0.473 |
| Trichlopyr | 1.07 | 0.461 | 0.05 | 0.050 |
| Paraquat | 0.93 | 0.404 | 0.91 | 0.764 |
| Oxyfluorfen | 0.96 | 0.479 | 1.47 | 1.147 |
| Untreated (control) | 4.18 | 1.528 | 3.53 | 2.784 |
| LSD ($p = 0.05$) | 0.67 | 0.279 | 2.11 | 1.454 |

All herbicides significantly reduced *P. farcta* growth and its ability to recover except for oxyfluorfen and the bromoxynil/MCPA mixture at which the weed produced the highest growth (219% and 125% compared with the untreated control) (Table 2). In contrast, the lowest shoot fresh and dry weights of the recovered *P. farcta* plants were with 2,4-D amine, glyphosate followed by paraquat, 2,4-D ester and trichlopyr herbicides.

Double applications of glyphosate and the bromoxynil/MCPA mixture resulted in the lowest weed growth (Table 3). However, recovered *P. farcta* plants from the latter treatment yielded higher vegetative growth than that of the untreated control, followed by oxyfluorfen and mecoprop. In contrast, translocated herbicides reduced weed growth by 82–98%.

## 4. Discussion

Results obtained showed that all herbicides either of contact or systemic action were effective in killing the vegetation of *P. farcta*. Certain chemicals such as paraquat, the bromoxynil/MCPA mixture and oxyfluorfen desiccated and defoliated the above ground growth of the weed while other translocated herbicides were slow to show their phytotoxic effects on weed shoots. A single spray of all chemicals was enough to reduce shoot fresh and dry weights of the weed compared with the untreated control (Table 2). Reduction in *P. farcta* shoot dry weight ranged between 25% and 69% for 2,4-D ester and oxyfluorfen herbicides, respectively. Oxyfluorfen and the bromoxynil/MCPA mixture appeared most phytotoxic and effective, however, considering shoot growth of the recovered *Prosopis* plants opposite results for both herbicides were obtained (Table 2). *Prosopis* plants treated with these chemicals gave the highest levels of regrowth. Other translocated herbicides severely reduced weed growth and its ability to re-vegetate. Differences in methods of action between contact and translocated herbicides are evident and reflect differences in the effectiveness of these in controlling perennial weeds.

Translocated herbicides were all effective in killing the above and below ground parts of *P. farcta* providing the doses for certain herbicides (e.g., 2,4-D and glyphosate) did not exceed the recommended rates to avoid injury that might prevent their translocation to the below ground parts. These herbicides weakened the weed's ability to re-vegetate and to resume growth (Cobb, 1992).

Glyphosate alone or followed by paraquat, 2,4-D amine and ester forms, and trichlopyr were highly effective in controlling *P. farcta*, reducing its growth and ability to recover after treatments. 2,4-D amine and glyphosate followed by paraquat were the most effective in reducing weed ability to recover their treatments.

Two applications of all herbicides significantly reduced weed fresh and dry weights compared with the control (Table 3). Average reduction in weed shoot dry weight was up to 75% of the weed-infested control. Differences between herbicides however, were not significant. In contrast, clear differences between herbicides were obtained in their effects on re-vegetated *P. farcta* plants. Trichlopyr was the most effective and greatly restricted weed's ability to regrow, followed by 2,4-D ester and glyphosate followed by paraquat. March et al. (1996) reported high efficacy of certain herbicides including trichlopyr on *Prosopis* spp. Glyphosate followed by paraquat was the more effective treatment in preventing weed recovery than glyphosate alone. However, enough time should be allowed for translocated herbicides to reach the below ground parts before killing the vegetative parts using any contact herbicide. The bromoxynil/MCPA mixture, oxyfluorfen and mecoprop resulted in the best regrowth of *P. farcta*. Effective chemical control depends on the size, age, density and habit of the target plants (March et al., 1996). It is worth indicating that the time of herbicide application is critical in controlling the weed and should be compatible with weed stage at which most stored food in roots and rhizomes is directed toward shoots. This occurs at full vegetative growth and before the weed starts flowering. In the present work, although herbicides were applied at different stages during vegetative growth of *P. farcta*, the level of weed control using translocated herbicides or their combination with certain contact herbicides proved highly effective.

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