# Effects of harvesting methods on seed yield and quality of *Scorpiurus muricatus* L.

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## Abstract

*Scorpiurus muricatus* L. is an annual legume, widely distributed in Mediterranean pastures, that is appreciated by farmers for its productivity, forage quality, and palatability. It is characterised by long flowering and ripening periods and by pod shedding. These characteristics cause high seed losses, which could reduce its seed harvest efficiency in terms of seed yield and quality. In this study, we investigated the effects on seed yield and quality of different harvesting methods (windrowing at different times with subsequent combining was compared with direct combining). Our results show that direct combining when the pods were fully ripened reduced pod losses compared with swathing methods, producing the highest yield of seed actually harvested. However, in this study, the unique climatic conditions during the pod development stage (extremely high temperatures) accelerated the ripening process, presumably limiting pod shedding.

Keywords: prickly scorpion's tail, seed production, *Scorpiurus muricatus*

## Introduction

Prickly scorpion's tail (*Scorpiurus muricatus*) is a self-seeding annual legume widely distributed in the natural pastures of the Mediterranean area and appreciated by farmers for its productivity (Le Houérou, 2001), forage quality (Licitra *et al*., 1997), and palatability.

Although *S. muricatus* represents a very interesting species for Mediterranean areas, the use of this annual legume as a forage crop in agricultural cropping systems is not well documented. In particular, information on seed production is almost completely lacking. *Scorpiurus muricatus* is characterised by long periods of flowering and ripening (Di Giorgio *et al*., 2007a) and it is possible to observe flowers and green and mature pods on the plant and shed pods on the soil surface at the same time during the reproductive stage. These characteristics cause high seed losses, and could reduce seed harvest efficiency in terms of seed yield and quality.

## Materials and methods

A field study was conducted at the Pietranera farm about 30 km north of Agrigento, Italy (37°30'N; 13°31′E; 178 m a.s.l.) on a deep, well-structured soil, classified as a vertic haploxerert. The seeds of a Sicilian ecotype of *S. muricatus* were sown in early January 2007 at a rate of 500 viable seeds per m$^2$, a soil depth of 3 cm, and a row spacing of 18 cm. The field was kept free of weeds by hand weeding. The plants were swathed when the first pods were mature (T1) or when 50% of the pods were mature (T2), and the swaths of both treatments were then combined when dry. A standing crop treatment (T3)

was also directly combined when all the pods were mature. The swaths were laid with a plot swather and left to dry in the field. A plot combine was used for both direct and windrow combining. The experimental design was a randomised complete block with three replications. The dimensions of each plot were 20 × 1.44 m and each contained eight rows. At each swathing time and during the direct harvest, an above-ground biomass sample was collected from an area of 1.44 × 0.50 m in each plot. The pods were separated suddenly from the plants and divided into two fractions on the basis of pod colour: green and green-brown (immature pods) or brown and yellow-brown (mature pods).
A sample from each fraction was weighed before and after drying at 60°C for 48 h. In a subsample of 100 pods from each fraction, the number of seeds per pod and the seed weights were determined. At harvest, the total pod production was calculated by summing the following fractions: (1) pods harvested by combine; (2) separation losses (pods lost because of threshing inefficiency) – all the pods were collected together with the straw on a plastic sheet placed behind the straw walkers, and (3) shed pods (naturally or as a result of mechanical operations); this fraction was determined after combining by manual pod recovery in five sample areas of 1.44 × 0.50 m each. A sample of 200 pods from each fraction was hand-threshed to determine the seed weights. The seeds were stored for the germination test. The remaining pods were threshed with a laboratory hulling machine to assess seed production. The germination test was carried out in November 2007 using 400 seeds (100 seeds × 4 replicates; 20°C in the dark). The germinated seeds were counted daily for 21 days and the mean germination time (MGT) was computed.

## Results and discussion

At the stage of the first mature pods (T1), the plants were still green and the moisture of the standing biomass (stems, leaves, flowers, and pods) was about 650 g kg$^{-1}$. At the subsequent swathing date (T2), the moisture content had decreased to 350 g kg$^{-1}$, and when all the pods were mature, it was about 90 g kg$^{-1}$. Drying was more rapid than that observed by Di Giorgio *et al*. (2007b) because in this experiment the temperatures after the first pods had matured were particularly high (on average, a maximum daily temperature of 38.0°C; Figure 1).

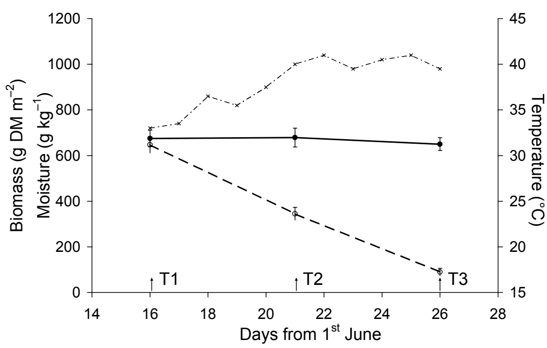


Figure 1. Above-ground biomass (solid line), biomass moisture content (dotted line), and maximum daily air temperature (dash-dotted line). The bars indicate standard errors ($n$ = 4)

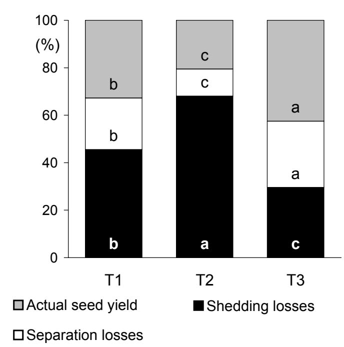


Figure 2. Rate of shedding losses, separation losses, and actual seed yield on total seed production according to the harvest methods studied. Within each seed fraction, a different letter indicates a different value ($P$ < 0.05)

The total above-ground biomass (Figure 1) and total seed production (Table 1) were not significantly affected by the harvest date. The rate of seed production from immature pods decreased rapidly from T1 to T3 (88%, 36%, and 0%, respectively).

When the crop was swathed at the beginning of pod ripening (T1), pod shedding (both natural and that resulting from mechanical operations) led to a 46% loss in seed production. The losses were greater (about 70%) when the swathing was delayed (T2), whereas direct combining reduced the fraction of seed left on the ground to 30% (Figure 2). The separation losses varied significantly, from 11% (T2) to 28% (T3) of the total seed yield. However, the seed losses resulting from threshing inefficiency were about 40% of the total yield picked up by the combine, with no differences among the treatments. The seed yield actually harvested with direct combining (596 kg $ha^{-1}$) was significantly higher than that harvested with either swathing treatment. Early swathing (T1) gave a significantly higher seed yield than did swathing five days later (T2; 459 versus 288 kg $ha^{-1}$, respectively).

Table 1. Seed characteristics from mature and immature pods at different harvest dates

| | Immature pods | | | Mature pods | | | Total or average | | |
|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T1 | T2 | T3 | T1 | T2 | T3 |
| Seed production (g $m^{-2}$) | $115^a$ | $51^b$ | 0c | $15^c$ | $92^b$ | $142^a$ | 130 | 143 | 142 |
| Seed moisture (g $kg^{-1}$) | $550^a$ | $272^b$ | – | $257^a$ | $101^b$ | $82^b$ | $514^a$ | $154^b$ | $82^c$ |
| Seeds/pod (N) | $6.4^a$ | $5.6^b$ | – | 7.0 | 6.8 | 6.8 | 6.5 | 6.3 | 6.8 |
| 1,000 seed weight (g) | 7.5 | 7.4 | – | 8.5 | 8.2 | 8.1 | 7.7 | 7.9 | 8.1 |

Means followed by a different letter are significantly different ($P < 0.05$)

The seed quality (seed weight, germination, hard seed content, and MGT) of the different pod fractions was not significantly affected by the harvest method.

The seeds from pods collected on the soil surface (fraction lost as a result of shedding) showed, on the whole, better seed quality (Table 2) than those from pods picked up by the combine (including both the harvested fraction and the fraction lost during separation). This result can be explained by the fact that most of the pods in the fraction 'lost as a result of shedding' were the first pods formed, which therefore developed under more favourable environmental conditions (higher soil moisture and lower temperatures) than the pods that formed and developed later.

Table 2. Seed quality traits of the different fractions of pod yields (mean values of the three treatments studied)

| | Pods | | |
|---|---|---|---|
| | harvested | lost during separation | lost as a result of shedding$^+$ |
| 1,000 seed weight (g) | $7.68^b$ | $7.71^b$ | $8.02^a$ |
| Germinated seed (%) | $17.3^b$ | $19.7^b$ | $68.1^a$ |
| Hard seed (%) | $81.6^b$ | $79.2^b$ | $29.3^a$ |
| MGT (day) | $4.5^b$ | $4.7^b$ | $3.4^a$ |

$^+$includes pods shed naturally and as a consequence of mechanical operations; MGT – mean germination time

Means followed by a different letter are significantly different ($P < 0.05$)

## Conclusion

In conclusion, the direct combining of Prickly scorpion's tail when the pods are fully ripe reduced pod losses compared with swathing methods and produced the highest seed yield actually harvested. However, the unique climatic conditions during the pod development stage (extremely high temperatures) in this study accelerated the ripening process, presumably limiting pod shedding. Under less stressful conditions, Di Giorgio *et al*. (2007b) observed levels of pod shedding much higher than ours.

## References

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