# Effects of Sheep Grazing on Weed Control in Saffron Fields

R. Ghorbani, M.H. Rashed-Mohassel, H. Makarian and M. Rastgoo
Department of Agronomy
Faculty of Agriculture, Ferdowsi University of Mashhad
P.O. Box 91775-1163
Mashhad
Iran

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**Abstract**

**To study the effects of sheep (*Ovis aries* L.) rates and grazing duration on weed control and saffron biomass, a field experiment was conducted during the year 2006, in a saffron (*Crocus sativus* L.) field located in Boshrooyeh (33° North latitude, 57° East longitude), Razavi Khorasan, Iran. A split plot design based on randomized complete block with three replications was used. The treatments comprised three sheep rates, 200, 400 and 750 sheeps per hectare allocated in main plots and three grazing durations, 2, 3 and 4 days (8 hours per day) allocated in subplots. The factors studied consisted of above-ground dry weight of common grasses (*Hordeum spontaneum*, *Lolium rigidum*), broadleaf weeds (*Cardaria draba* and *Carduus pycnocephalus*) and dry weight above-ground biomass of saffron. Results showed that sheep rates had significant effects on above-ground dry weight of grass and broadleaf weeds. Duration of grazing had a significant effect on saffron above-ground biomass. With increasing sheep rates from 200 to 400 per ha, dry weight of weeds (grass and broadleaf) decreased significantly. In the highest rate of sheep (750 per ha) with increasing the duration of grazing from 2 to 4 days, dry weight of saffron leaves decreased significantly. Our results suggest the idea that grazing with 400 sheep per hectare for duration of 3 days is required for acceptable control of weeds in saffron field without any significant reduction in above-ground saffron biomass.**

## INTRODUCTION

Weed management is an important issue in crop production. There are various weed species in saffron fields that can reduce the crop yield (Rashed, 1992). Sheep grazing for weed management in saffron fields is a relatively new subject in many countries such as Australia and New Zealand (Popay and Field, 1996). Grazing can either promote or reduce weed abundance depending on the local conditions. Grazing animals may be particularly useful in areas where herbicides cannot be applied (e.g., near rivers) or there are large infestations that are expensive to control. Cattle, goats, sheep, and even geese may be used to control weeds. Sheep and goats prefer broadleaf herbs and are used to control leafy spurge (*Euphorbia esula*), Russian knapweed (*Acroptilon repens*), and toadflax (*Linaria* spp.) (Walker, 1994). These animals appear to be able to neutralize the toxic phytochemicals present in these and other forbs (Walker, 1994). Sheep could control many weeds such as spotted knapweed (*Centaurea maculosa*), kudzu (*Pueraria lobata*), and oxeye daisy (*Chrysanthemum leucanthemum*) (Olson and Lacey, 1994). Since sheep do not graze an area uniformly, a method (i.e.: herding, fencing, or the placement of salt licks) is needed to control animal grazining activities in the field (Olson and Lacey, 1994).

Plant availability, hunger, and previous experience can determine a grazer's selection of food plants (Walker, 1994). The containment and movement of grazers within and between infested areas are necessary for the successful implementation of an appropriate grazing plan. Temporary fencing erected to contain animals in a particular area may be suitable for goats and sheep. In some cases, continuous grazing by sheep resulted in significant reductions of leafy spurge stem density and viable seedbank (Olson

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and Lacey, 1994; Olson and Wallander, 1998). Leafy spurge is nutritious forage for sheep and can comprise up to 50% of their diet without having negative effects. An added bonus is that sometimes the use of sheep for weed control does not cost anything to the landowner, because they provide free forage for the sheeps (Olson, 1999).

Availability of animals for grazing and the ability to fence them onto or off weed infestations are essential. Introducing different kinds of animals, like sheep into a cattle system or goats into a sheep system can be useful for controlling any weeds (Popay and Field, 1996). Bell et al. (1996) applied a post-emergence herbicides, a combination of pre-emergence and post-emergence herbicides, and untreated treatment (control plants) where weeds were harvested with the hay. They found that herbicide treatments reduced total above-ground biomass (alfalfa plus weeds) yield compared with the grazed treatments and the untreated control. They concluded that grazing by lambs is a good weed control method in alfalfa during the winter grazing season in the irrigated Sonoran Desert. Grazing of the purple capitula of nodding thistle (*Carduus nutans*) and scotch broom (*Cytisus scoparius*) by sheep in lieu of pasture indicates the potential sheep grazing for weed control in weed-infested pastures (Holst et al., 2004). Amor (1978) pointed out that sheep grazing is the main method of biological control on dryland farms in Australia. However more widespread adoption of grazing animals for control of weeds could lead to a reduction in herbicide use, itself seen by some as a healthy trend, which may lead to pastures with a greater diversity of useful species (Popay and Field, 1996).

In Khorasan during winter and spring period, weeds in saffron fields are a feed source for sheep. In addition, considering the negative effects of agrochemicals, sheep grazing could be a promising strategy for weed management in saffron fields. The objectives of the present study were to investigate the efficacy of number of sheep and the length of grazing on weed infestation and saffron yield.

## MATERIALS AND METHODS

A field experiment was carried out during 2006 in a saffron (*Crocus sativus* L.) field located in Boshrooych (33° North latitude, 57° East longitude), Khorasan, Iran. The saffron field had a sandy loam soil and the annual mean precipitation was 87.5 mm. The fields were fertilized with 250 kg $ha^{-1}$ ammonium phosphate based on the results of soil tests. Saffron field had been sown in late August of 2002. A broadcast application of Galant super TM [haloxyfop-R-methyl] was applied as a post-emergence herbicide at a rate of 162 g.a.i $ha^{-1}$ during the first week of 2004 in order to control winter annual grasses. *Hordeum spontaneum* (L.) HUDS. subsp. Gussoneanum (Mouse barley as a winter annual grass), *Lolium rigidum*, *Cardaria draba*, *Carduus pycnocephalus* were the most important weeds monitored in saffron fields in Iran (Rashed, 1992).

A split plot design based on randomized complete block with three replications was used. The treatments comprised three sheep (*Ovis aries* L.) rates, 200, 400 and 750 sheeps per hectare allocated in main plots and three grazing duration of 2, 3 and 4 days (8 hours per day) were allocated as subplots. A non-grazed plot beside the experiment field was also included as control treatment. Main plots were 30m long and 20 m wide. Subplots sizes were 20 m long by 10 wide. Sheep weights at the beginning of experiment were between 30 to 45 kg/head. Grazing was performed at four leaf-stages of common weeds in early March. In order to apply heavy grazing on weeds, around each plot were fenced and the sheep were pushed inside the fences. The studied factors consisted of above-ground dry weight of common grasses, broadleaf weeds and dry weight of above-ground biomass of saffron. The above-ground biomass of weeds and saffron were harvested by hand and by dropping a quadrat of 50 by 50 cm, at five points in each plot before and after sheep grazing. The harvested biomass was oven dried, and dry matter was weighed. All data applied in statistical analyses were translated as a percent of control. Analyses of variance were performed using the SAS software (SAS, 1989). Least squares means were generated for significant effects, and treatment means were compared using Duncan's new multiple range test at 5% level (Duncan, 1955). The figures were drawn by using Excel.

## RESULTS AND DISCUSSION

Results showed that sheep rates had significant effects on above-ground dry weight of grass and broadleaf weeds. With increasing sheep rates from 200 to 400 per ha, dry weight of weeds (grass and broadleaf) significantly (P=0.05) decreased (Figs. 1 and 2). However, this sheep density did not have any significant reduction in saffron dry weight (Figs. 1 and 3). With increasing sheep rate from 400 to 750 per ha, saffron dry weight significantly decreased (Figs. 1 and 3). Popay and Field (1996) represented that increasing sheep or cattle stocking rates prevent animals from grazing selectively and can help control of some weeds. In our experiment also increasing sheep rates caused non selective grazing which is harmful to the possibility of grazing of saffron leaves. Animals should be brought into an infested area at a time when they are most likely to damage the invasive species without significantly impacting desirable native species. On the other hand, some weeds are palatable only during some part of the growing season. For example, cheatgrass (*Bromus tectorum*) is preferred in spring before seed rates develop, but avoided by cattle once it has begun to set seeds because the seed rates have stiff awns that can puncture the mouth and throat tissue of livestock (Carpenter and Murray, 1999). It seems that grass leaves were palatable food because reduction in grass dry matter was greater than broad-leaf weeds in this experiment (Fig. 1). Walker (1994), represented that differences in vegetation quality may cause an animal to eat one species in one situation and to ignore the same species in another.

Duration of grazing had a significant effect on weeds and saffron's above-ground biomass. By increasing the length of grazing from 2 to 3 days, the percent of weed dry weight reduction was increased significantly (Fig. 2). At the highest rate of sheep (750 per ha) by increasing duration of grazing from 2 to 4 days, dry weight of saffron leaves decreased significantly (P=0.05) (Fig. 3). In rainfed phalaris (*Phalaris aqualical* L.) pasture in Australia annual grass (including wall barley) content in the pasture was reduced by over 60% by increasing duration of the sheep rotational grazing (Morley et al., 1969). In early march saffron leaves were at the final stage of growing period. Thus, at this time saffron leaves were coarse and not palatable. Conversely, grass and broadleaf weeds were at four leaf-stages and so finer than saffron leaves at this time. Thus the sheep preferred eating weeds selectively. Our results nominate this idea that grazing of 400 sheep per ha for duration of three days is required for acceptable control of weeds in saffron field without any significant reduction in the above-ground saffron biomass.

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**Figures**

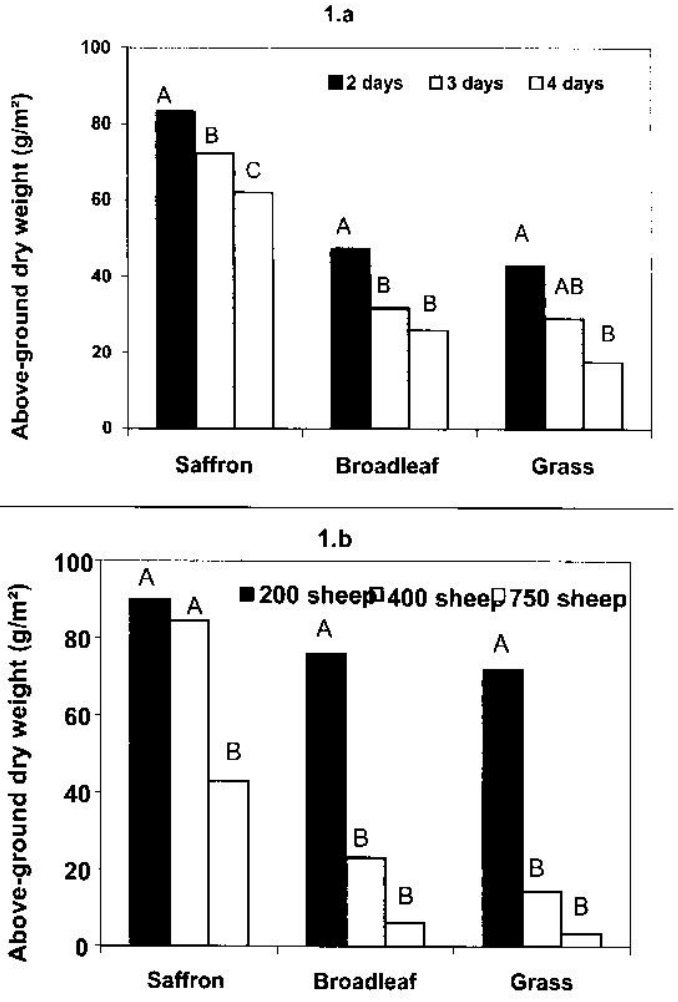


Fig. 1. Effects of grazing duration (1.a) and number of sheep (1.b) on weed and saffron above-ground dry weight. Each point represent the mean of 4 observations and different letters indicating significant differences between means based on Duncan's new multiple range test (P=0.05).

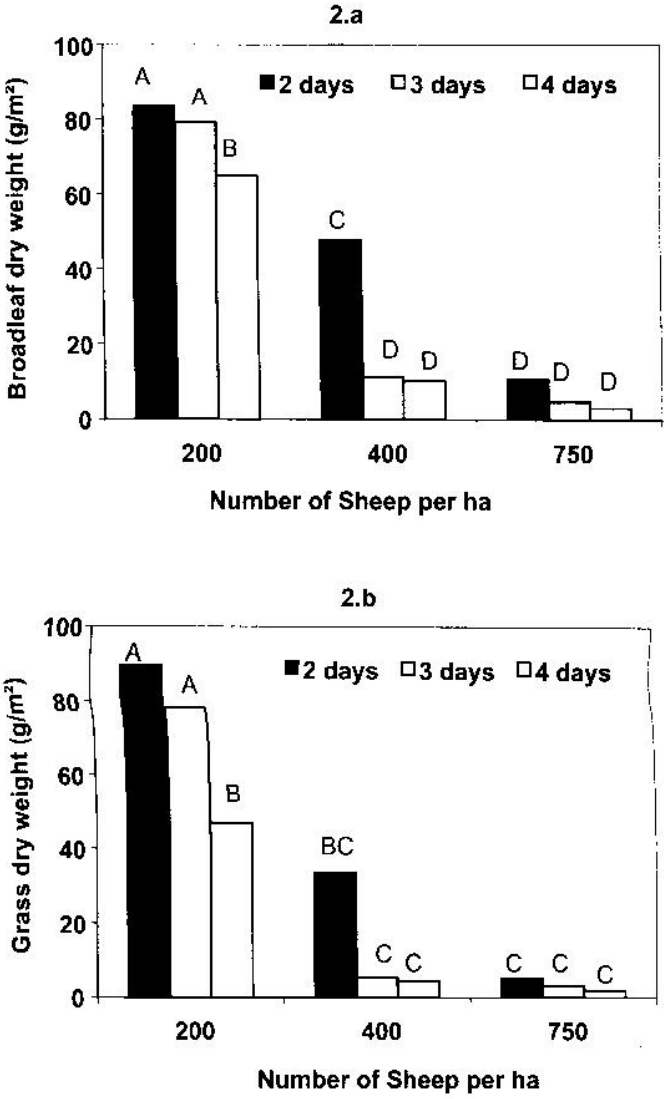


Fig. 2. Effect of number of sheep and grazing duration on dry weight of broad-leaf and grass weeds. Each point represent the mean of 4 observations and different letters indicating significant differences between means based on Duncan's new multiple range test (P=0.05).

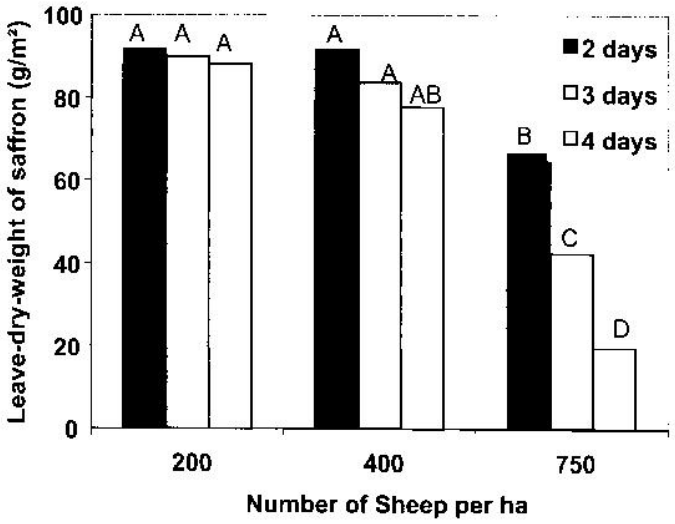


Fig. 3. Effect of number of sheep and grazing duration on above-ground-leaf saffron dry weight. Each point represent the mean of 4 observations and different letters indicating significant differences between means based on Duncan's new multiple range test (P=0.05).

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Photographs on the front cover:

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1. Saffron field. Photograph by courtesy of A. Koocheki.
2. Saffron rows. Photograph by courtesy of A. Koocheki.
3. Saffron flower petals-stigmata. Photograph by courtesy of A. Koocheki.
4. Saffron flower petals-stigmata. Photograph by courtesy of A. Koocheki.
5. Saffron bed.
6. Crocus stigmata.