



Short communication

Phenological response of milk thistle (*Silybum marianum* [L.] Gaertn.) to different nutrition systems



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ABSTRACT

Nowadays, growing medicinal plants in sustainable agricultural systems in which sustainable plant nutrition strategies play an important role are more focused. Seeds of milk thistle plants (*Silybum marianum* [L.] Gaertn.) are the main source of silymarin which is known as the biological active component helpful in treating liver and biliary diseases and also preventing liver cancer. Phenological stages, especially the reproduction time and maturity of milk thistle, might be affected by management strategies. In order to investigate the potential effects of different nourishment systems on phenological stages of milk thistle, a field experiment was conducted during 2010–2011, at Research Station, Faculty of Agriculture, Ferdowsi University of Mashhad, Iran. Twelve nutrition systems comprising single and integrated nutrition systems of vermicompost, poultry manure, chemical fertilizer, mycorrhiza (*Glomus mosseae*), and bio-sulfur (*Thiobacillus* sp.) were compared in a completely randomized block design with three replications. According to the results, growth development stages of milk thistle in Mashhad climate were found to have four discrete stages; vegetative, elongating, flowering, and seed maturation stage. Analysis of variance of heat units, expressed in growing degree-days (GDDs), showed that elongating and flowering stages were significantly affected by different nutrition systems ($P < 0.05$). Milk thistle plants treated with mycorrhiza started the elongating stage and flowering stage with less GDDs (845 and 1001 °C, respectively) compared with other treatments. The highest amount of GDDs for starting the elongating stage was recorded for chemical fertilizer treatment and plants under integrated use of mycorrhiza and vermicompost required more GDDs to start flowering stage.

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1. Introduction

Milk thistle (*Silybum marianum* [L.] Gaertn.) is a member of Asteraceae family which has large prickly edged leaves covered with undulating white patches and stems containing a milky juice. Milk thistle is an annual plant that grows naturally in warm climates and different provinces of Iran such as Kurdistan, Kermanshah, Lorestan and Ahvaz (Shamsi, 2009). Seeds of milk thistle plants are the main source of silymarin, which is used in pharmaceutical industries. Silymarin is a flavonoid complex which consists

Table 1
Physicochemical characteristics of the experimental soil collected from depth of 0–30 cm.

Soil texture	Organic carbon (%)	Total N (%)	P (ppm)	K (ppm)	pH	EC (dS m ⁻¹)
Loam	0.5	0.063	13.2	135	7.24	3.21

of different compounds including silybinin, isosilybinin, silydianin, and silychristin, with the common name flavanolignans (Guz and Stermitz, 2000). It is believed that silymarin extracted from the ripe seeds of milk thistle is the biologically active component. The whole plant is used for medicinal purposes, but the highest content of silymarin is accumulated in the seeds. The main reason for the wide cultivation of this plant is due to its importance in treating liver and biliary diseases and also preventing liver cancer (Tamayo and Diamond, 2007). Increased in crop production largely depends on the type of fertilizers used to supplement essential nutrients for plants. The use of chemical fertilizer, organic fertilizer or bio-fertilizer has their own advantages and disadvantages but the advantages need to be incorporated in order to make best use of each type of fertilizer and attain fair nutrient management for crop growth (Chen, 2006). Crop management will definitely be improved by knowledge of crop phenology. Phenology regulation is important for the synchronization on the plant reproductive process resulting in simultaneously seed maturation and harvest. This knowledge is based on observation of the growth and the development stages of the plant. Phenology can also be considered as one of the major component in the adaptation of plants to any given environment (Desclaux and Roumet, 1996). In order to have a constant and stable index for estimating the crop growth and determining the accurate time of phenological stages, GDD or growing degree days seems to be more reliable and has been confirmed by Clarke and Simpson (1978). While the effect of nitrogen fertilizer, seed rate, plant spacing and salinity on grain yield and active substances in milk thistle have been well documented (Ghavami and Ramin, 2008; Omer et al., 1990; Omidbaigi and Nobakht, 2001). No information about phenological response of this medicinal species to a range of nutrition systems is available; therefore this experiment was conducted to understand the single and integrated effects of chemical, biological and organic fertilizers on phenology of milk thistle in Mashhad climate, Iran.

2. Materials and methods

2.1. Experimental site preparation

The field experiment was conducted during 2010–2011, at Research Station, Faculty of Agriculture, Ferdowsi university of Mashhad, Iran (36°16' N, 59°36' E, elevation 985 m). Before conducting the experiment, soil samples were taken from the depth of 0–30 cm to determine the physicochemical characteristics of the experimental site (Table 1). The initial plowing and tillage procedure were performed in Autumn 2010, after 12 month fallow, and second tillage procedure was done in early 2011, after

Table 2
Nutrient contents of vermicompost and poultry manure.

Organic fertilizer	Total N (%)	P (%)	K (%)
Vermicompost	1.3	1.3	1.2
Poultry manure	2.49	2.33	1.67

that plots (3 m × 4 m) were designed for furrow irrigation with 7 rows per plot. Forty days before sowing, the rows in organic treatment plots were thoroughly mixed with organic manures, vermicompost and poultry manure. Plots were separated from each other by two rows spacing. The monthly total amount of natural precipitation for the first 3 months of the growing period were 17.72, 14.35, and 10.52 mm, respectively. No precipitation was recorded in the last 5 weeks of the growing period in Mashhad, Iran.

2.2. Experimental design and treatments

A complete randomized block design with twelve treatments and three replications was used. Treatments were: Control, Vermicompost (V), poultry manure (H), Chemical fertilizer (CH), Mycorrhiza (M), Bio-sulfur (B), M+V, M+CH, M+H, B+V, B+CH, B+H. Detailed information about treatments is presented in Table 3. Vermicompost and poultry manure values were calculated based on their nutrient contents (Table 2) and milk thistle nitrogen requirement in Mashhad region, Iran (Malakooti and Tehrani, 1993). Bio-fertilizers including mycorrhiza and bio-sulfur were added based on factory instruction and recommended dozes at the time of sowing. Integrated treatments contained the same amounts of fertilizers as single treatments. The amounts of chemical fertilizer were determined based on recommended doses in Mashhad soil and weather condition for milk thistle as a medicinal plant (Malakooti and Tehrani, 1993). Urea was distributed three times during the growth period to avoid leaching.

2.3. Phenological stage recordings in field

Five plants were randomly selected in each plot and growth development stages were recorded every few days from emergence. In order to have a better understanding of milk thistle phenological stages, Growing Degree-Days (GDDs) were used and heat units earned at the end of each phenological stage were calculated using the following formula (McMaster and Wilhelm, 1997).

$$GDD = \left[\frac{T_{\min} + T_{\max}}{2} \right] - T_b$$

In which T_{\max} and T_{\min} are daily maximum and minimum air temperature, respectively, and T_b is the base temperature of milk thistle (9 °C) (Omidbaigi, 1995).

2.4. Statistical analysis

Data analysis was done by SAS statistical package. Analysis of variance was computed using the general linear model and mean comparison was based on Duncan's multiple test with significance defined at 5% probability level.

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