Decreasing Nitrogen Leaching and Increasing Canola Forage Yield in a Sandy Soil by Application of Natural Zeolite

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ABSTRACT
Selection of an appropriate forage species is an important first step in successful forage production. Among forage species, canola (Brassica napus L.) can be cut for hay or silage to cover certain costs of growing the crop. Because forage production is largely controlled by the environment and management, this experiment was conducted in a semiarid region of Iran during the 2006–2007 and 2008–2009 growing seasons to investigate whether canola forage yield and its nutritive value affected by different rates of N and natural zeolite. The experimental treatments were arranged in randomized complete blocks with three replications and comprised a factorial combination of three N levels (90, 180, and 270 kg N ha⁻¹) and four zeolite rates (0, 3, 6, and 9 t zeolite ha⁻¹). The results showed that the enhanced N application from 90 to 270 kg N ha⁻¹ resulted in a 49% rise in forage yield for the first year and a 39% increase for the second year. The converse effects from N and zeolite yielded a significant interaction on the forage calcium concentration (FCC) (1.13% in dry matter). In contrast, N₂₇₀Z₀ treatment yielded the lowest FCC (0.54% in dry matter). There was a linear response between N application rate and its leaching loss whereas in the zeolite treatments, minimum N leaching was observed after the Z₀ treatment. A combined application of zeolite and chemical N for canola production in a poor sandy soil is recommended to ensure an acceptable forage yield and for soil protection from excess N leaching loss.

The importance of forage crops in livestock feeding and human food production is undeniable. Generally, several crop species such as alfalfa (Medicago sativa L.), corn (Zea mays L.), sorghum [Sorghum bicolor (L.) Moench], and varieties of clover are raised for green-chop forage production in different parts of the world. However, certain climatic limitations such as drought and the special requirements of these crops have generated doubts and questions regarding the relative efficiency of these crops compared to other sources. Traditionally, canola is grown as an oilseed crop with a low level of saturated fat, but with a new approach, it could produce considerable levels of green forage especially at that time when additional forage sources cannot be exploited. It will not compete in yield with alfalfa and corn, but grazed and ensiled winter canola offers high nutritional value and digestibility. In addition, there are many reasons for growing canola as forage, including the considerable levels of fresh and dried forage (Gholamhoseini et al., 2008); optimum use of rainfall in autumn and winter (McRae et al., 2006); high levels of crude protein, nutritional value, and good palatability especially for the ruminants (Amin et al., 2002); and finally high potential for honey production (Zarinabadi et al., 2010).

Thus, for energy and protein, canola could be considered an excellent forage source. Among the agronomic factors that may affect the yield and quality of forage in crop production, the application of N is considered to be the most important. One of the main criteria of forage quality is the crude protein (CP) because CP increases the digestibility of forage (Peyraud and Astigarraga, 1998). Many researchers reported that N fertilization increases CP and dry matter yield in forage crops (Polat et al., 2007; Delaby et al., 1996). Kobayashi et al. (2002) found that N fertilizer significantly increased fiber concentration in the forage of Italian ryegrass (Lolium multiflorum Lam). Also Delagarde et al. (1997) observed that neutral detergent fiber (NDF) concentration was inconsistently affected by the application of N fertilizer in crop forage. Because canola is a strong N consumer, N availability plays an important and critical role in seed and dry matter yield (Rathke et al., 2006). Hence, determining the optimal utilization of N in an agroecosystem is important. Given the low N efficiency for this crop (Dreccer et al., 2000) and the high rainfall in autumn and winter, significant N leaching is expected, and this problem encourages irregular and unreasonable use of N fertilizers by farmers. Excessive N fertilizer application regardless of glucosinolate accumulation (Evans and Islam, 1990) increases nitrate loss from leaching and finally contaminates the ground water. This event is a prevalent and widespread problem for sandy soils. Gholamhoseini et al. (2010) showed that in light texture farm approximately 50% of applied N could be leached. Thus, providing a way to

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Abbreviations: ADF, acid detergent fiber; CEC, cation exchange capacity; CP, crude protein; FCC, forage calcium concentration; FMC, forage magnesium concentration; FNC, forage N concentration; FSC, forage sodium concentration; GTRI, grass tetany ratio index; LAI, leaf area index; NDF, neutral detergent fiber; TDR, time domain reflectometry.