

## Weed Nitrogen Uptake as Influenced by Nitrogen Rates at Early Corn (*Zea mays* L.) Growth Stages

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### ABSTRACT

The effect of nitrogen (N) levels on N uptake by high weed densities at early growth stages of corn (*Zea mays* L., CV. Double Cross 370) was investigated for two years (2008-2009) at the Agricultural Research Station of Shiraz University. The experiment was arranged in a split-plot arrangement in the randomized complete blocks design with three replications. Two levels of weed control (weedy and weed free) and three levels of preplanting N (0, 50, and 90 kg ha<sup>-1</sup>) were employed as main and subplots, respectively. One month after crop sowing, total weed species were determined and shoot dry weights of both corn and weeds were measured. The highest weed biomass and N uptake by weeds were obtained from the application of 50 kg N ha<sup>-1</sup>. In the first year of the study, average N content of weed seedlings grown at any rates were not significantly different, whereas in the second year, N content of the weeds in the zero N plot was 31 and 39 % less than the weeds grown in 50 and 90 kg N ha<sup>-1</sup> applied plots, respectively. Higher uptake of N by weeds, especially redroot pigweed (*Amaranthus retroflexus*) at the early corn growth stage is an important issue for crop-weed competition.

**Keywords:** Corn, Nitrogen uptake, Redroot pigweed, Weed.

### INTRODUCTION

Corn is an important crop in Iran and weed competition is a major limitation for corn production. An approach to improve corn yield and decrease weed-crop competition is the manipulation of crop fertilization [6], particularly N application. Among macronutrients, N is the most important nutrient for increased crop yield [4] but it is not always recognized that altered soil N levels can affect crop-weed competitive interactions. Many weeds are high-N consumers [10] thus limiting N for crop growth. Weeds not only reduce the amount of N available to crops, but also the growth of many weed species is enhanced by higher soil N levels [2].

Impacts of weeds on lowering crop yield vary with factors such as N fertilizer level, application timing, and methods [8, 10].

However, some researches showed that N level or application methods had little effect on crop-weed competition [1, 2].

Critical period knowledge has been useful for evaluating the effects of weeds on crop yields under different management systems. It is essential for making decisions on the appropriate timing of weed control [8]. Soil N content is the most important factor influencing critical weed period, but unfortunately most N level experiments are conducted in weed free environments and most weed control experiments are conducted in the absence of N limitation [1].

Effect of weed emergence on crop yield has been widely studied. Previous research has suggested that 4 to 5-wk weed-free period were required after corn planting to avoid significant yield losses [8, 20]. Donald and Johnson [7] reports that weeds continue to emerge after crop canopy closure; they do

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not reduce corn yields. Farmers usually apply higher rates of N as preplanting for corn than actually required. Weed-corn competition may be affected by higher N application and thus, N fertilizer must be used exactly to maximize profits and minimize weed competition. The objective of this study was to determine the effects of different N levels on weed N uptake at the early growth stages (before 7-leaf stages) of the corn.

## MATERIALS AND METHODS

A field experiment was conducted for two cropping seasons (2008–2009) at the Experimental Station, College of Agriculture, Shiraz University, Shiraz, Iran (52°46'E, 29°50'N, altitude 1810 m asl), 12 km north of Shiraz, on a fine mixed, mesic typic calcixerpets soil with silty loam texture (Table 1). The preceding crop in both seasons was wheat (*Triticum aestivum* L.) (Shiraz cultivar). Means of rainfall and temperatures during the experimental period were 0 mm and 23.7 °C in 2008 and 0 mm and 22.8 °C in 2009, with forty years of rainfall and temperatures of 0.23 mm and 23.03 °C, respectively. The experiment was conducted as a split-plot arrangement in the randomized complete blocks design with three replications. Two levels of weed control (weedy and weed free) and three levels of preplanting N rates (0, 50, and 90 kg ha<sup>-1</sup>) as urea were employed as main and

subplots, respectively. Corn (CV DC 370) was planted in June 22 in wheat stubbles and harvested in the middle of October in both years. The seeds were sown in 6 × 3 m plots. Inter row and plant spaces were 75 and 20 cm, respectively, expecting 67000 plants ha<sup>-1</sup> (12 kg seed ha<sup>-1</sup>). The sums of heat unit of corn were calculated using a base temperature of 10° C [17]. Irrigation method was furrow with 8-day intervals.

All weeds samples were oven dried at 80° C for 48 h, weighed, and analyzed for total N [3]. Weed and crop sampling dates were 30 days after corn planting. Corn samples were harvested from two rows in the middle of plots. Soil samples were taken from 0-30 cm depth from the middle of the subplots, air dried for one day, ground and analyzed for mineral N [12] and organic matter [16].

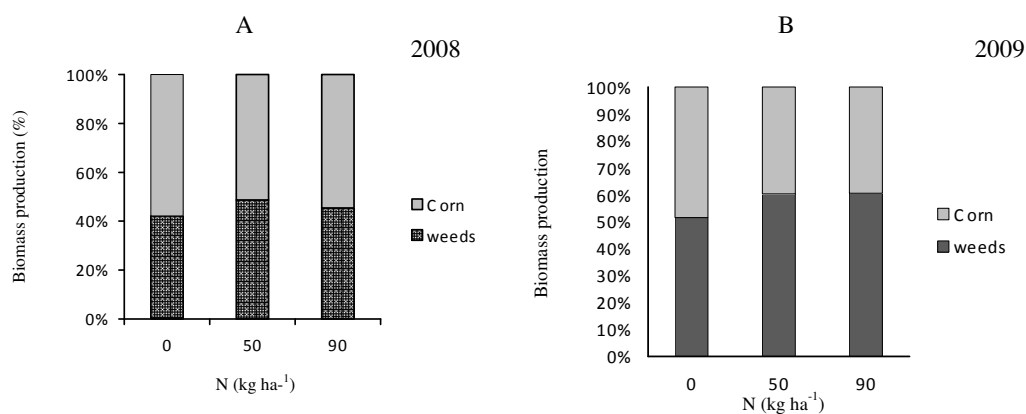
Weeds consisted of redroot pigweed (*Amaranthus retroflexus*), field bindweed (*Convolvulus arvensis*), camel thorn (*Alhagi camelorum*), common lambsquarters (*Chenopodium album*), wild safflower (*Carthamus sp*), Russian thistle (*Salsola iberica*) and lettuce (*Lactuca sp*). Weed free plots were maintained free of weeds throughout the season by hand hoeing. Weeds were harvested from two 0.25 m<sup>2</sup> quadrates staggered on each side of the second corn row within each split plot experimental unit. Weeds were clipped at the soil surface, sorted by species, counted and dried at 80° C. Data were analyzed using SAS software program [18]. Means were compared at the 5% level of significance using Duncan's multiple range test.

**Table1.** Chemical and physical characteristics of the experimental soil.

Characteristic	Value
Texture	Silty loam
Silt (%)	57
Clay (%)	21
Sand (%)	22
pH	7.85
N (%)	0.08
P (mg kg <sup>-1</sup> )	21.8
K (mg kg <sup>-1</sup> )	600
EC (dS m <sup>-1</sup> )	0.52
OC (0-15 cm) (%)	0.86
OC (15-30 cm) (%)	0.74

## RESULTS AND DISCUSSIONS

Although corn is a vigorous and tall growing plant, it is susceptible to weed competitions [8]. In the first year, the effect of weed cover was reflected by the corn biomass production (Figure. 1A). Proportionally, weed biomass production under zero N application was 8 and 5 percent lower than 50 and 90 kg N ha<sup>-1</sup> application, respectively. In the 2<sup>nd</sup> year,



**Figure1.** Corn and weed biomass at different N rates, 30 days after cultivation 2008(A), 2009(B).

weed populations were highly diversified in all three N applications (Figure 1B). Redroot pigweed was the most abundant weed in both seasons (Table 2). Weed biomass productions under 50 and 90 kg N ha<sup>-1</sup> treatments were significantly higher than the 0 kg N ha<sup>-1</sup> treatment (10%), but there was no significant difference between the 50 and 90 kg N ha<sup>-1</sup> treatments (Figure 1B).

The majority of *Amaranthus* species are opportunistic weeds [15]. In the 1<sup>st</sup> year, dry

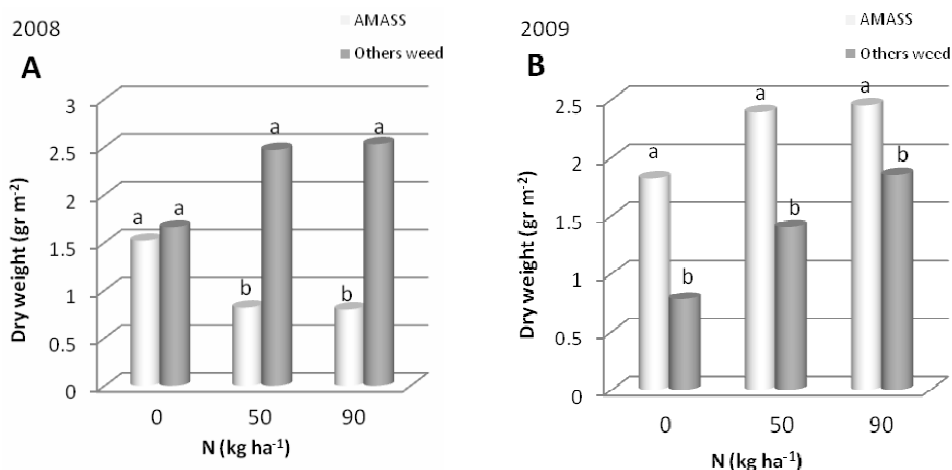
weight of redroot pigweed was lower than sum of the other weeds (except for the control N treatment) (Figure 2A). But in the 2<sup>nd</sup> year, dry weight of redroot pigweed was significantly higher than sum of the other weeds (Figure 2B). Contributions of redroot pigweed dry weight to total weeds dry weight were 43, 58.5, and 75.5% in the 0, 50 and 90 kg N ha<sup>-1</sup> treatments, respectively which are similar to the findings of Massinga and Currie [15]. Redroot pigweed

**Table2.** Mean weed biomass (%) and species composition at three N rates at the 6- leaf stage of corn in 2008 and 2009.

Year	N rate kg ha <sup>-1</sup>	Weed Biomass g m <sup>-2</sup>	Species-specific contribution to weed biomass (%)						
			AMAS	CONV	ALHA	CHEN	CART	SALS	LACT
2008	0	39.90 b	42	9	6	4	4	25	10
	50	52.02 a	23	14	0	21	10	20	2
	90	48.07 a	22	15	8	23	3	29	0
2009	0	128.0 b	75	6	0	0	8	0	11
	50	183.0 a	64	11	0	0	5	5	15
	90	195.0 a	61	8	2	13	10	6	0

-AMAS= (*Amaranthus retroflexus*), CONV = (*Convolvulus arvensis*), ALHA= (*Alhagi camelorum*), CHEN= (*Chenopodium album*), CART= (*Carthamus sp*), SALS= (*Salsola iberica*), LACT=(*Lactuca sp*).

- Means of each column with similar letters are not significantly different (Duncan's Multiple Range Test 5%).



**Figure 2.** Comparison of dry weight of redroot pigweed (AMASS) and other weeds in different N treatments, 2008 (A) and 2009 (B). Means, with similar letters are not significantly different (Duncan's Multiple Range Test 5%).

is a C4 weed and its presence can severely reduce the yield of corn, especially under hot and arid climates [13].

Weed biomass was higher in the 2<sup>nd</sup> than in the 1<sup>st</sup> year, regardless of N level (Table 2). This was most likely due to the abundance of redroot pigweed (*Amaranthus retroflexus*) in the 2<sup>nd</sup> year. This weed species produced large number of seeds in the 1<sup>st</sup> year which were accumulated in the soil and germinated in the 2<sup>nd</sup> year. Redroot pigweed grew earlier than other weeds,

securing a competitive advantage in the 2<sup>nd</sup> year. Because of their aggressive growth, *Amaranthus* species are able to compete with crops for water, nutrients and light, causing severe yield, quality and harvest efficiency reductions [19]. N application significantly influenced weed biomass during both years (Table 2).

In the 2<sup>nd</sup> year, the application of 90 kg N ha<sup>-1</sup> produced higher weed biomass and higher N uptake by weeds than 50 kg N ha<sup>-1</sup> with no significant difference between them

**Table 3.** Mean nitrogen consumption (%) by weeds, and species composition at three N rates at the 6- leaf stage of corn in 2008 and 2009.

Year	N rate kg ha <sup>-1</sup>	N accumulation by weeds (%)	Species-specific contribution to weed biomass (%)						
			AMAS	CONV	ALHA	CHEN	CART	SALS	LACT
2008	0	3.18 a	48	12	5	5	3	18	9
	50	3.30 a	25	17	0	28	11	17	2
	90	3.33 a	24	21	7	10	3	35	0
2009	0	2.6 b	70	4	0	0	12	0	14
	50	3.8 a	63	13	0	0	8	4	12
	90	4.3 a	57	6	4	16	11	6	0

-AMAS= (*Amaranthus retroflexus*), CONV= (*Convolvulus arvensis*), ALHA= (*Alhagi camelorum*), CHEN= (*Chenopodium album*), CART= (*Carthamus sp*), SALS=(*Salsola iberica*), LACT=(*Lactuca sp*).

- Means of each column with similar letters are not significantly different (Duncan's Multiple Range Test 5%).

(Tables 2 and 3).

Average soil N uptakes by weeds in the 1<sup>st</sup> year were not significantly different at any N levels, whereas in the 2<sup>nd</sup> year, the control plot had 31 and 39 % lower N uptake than the 50 and 90 kg N ha<sup>-1</sup> treatments, respectively (Table 3). These observations clearly showed the unfavorable effects of weeds on N uptake by corn plants which were reflected in biomass production (Figures 1A and 1B).

In this research (with any level of N) weed free plots had higher corn biomass than the weedy plots. Corn was better grown in the weed free plots with N application (average of two levels N application) and N uptake was more efficient than the weedy plots with N application (Table 4).

Many weeds are high-N consumers [10] limiting N for crop growth. Weeds not only reduce the amount of N available to crops, but also the growth of many weed species is enhanced by higher soil N levels [2]. The most critical time in corn-weed competition is 30 days after the sowing of corn [14].

The negative effect of corn-weed competition revealed the corn biomass. Corn biomass reduced, as a consequence of competitions with weeds at early growth stages (with any level of N and in both years). These results are similar to the findings of James et al [11] and Cavero et al [5] who found reductions of corn

biomass (>30%) with weed competition and in contrary with Evans [8] and Evans et al [8] who confirmed that corn resistance to weed increased when high N was applied at the early growth stage.

## CONCLUSIONS

The supply of N available to a crop and weeds can significantly influence crop-weed interference relationships. A high reduction in corn biomass (10%) was observed with 50 kg N ha<sup>-1</sup>. Among the tested weeds, redroot pigweed was dominant and had the highest biomass. Therefore, efficient weed control in the areas where redroot pigweed exists in large numbers is a necessity.

Practical implications of this study are that reductions in N rate may warrant more intensive weed management. This study showed that a 44.5% reduction in N applied before crop establishment (90 to 50 kg N ha<sup>-1</sup>) may not result in lower corn biomass, but it is more likely that soil N uptakes by weeds decrease and weed-crop competition change in benefit to the crop. Weed interference will have more immediate and pronounced effects on yield potential and N uptake by weeds. However, application of higher N levels beyond the crop requirement can increase the risk of N loss due to weed uptake and environmental contamination.

**Table 4.** Mean corn biomass at three N rates at the 6- leaf stage of corn in 2008 and 2009.

Year	Nitrogen Rate (kg ha <sup>-1</sup> )	Corn biomass (g m <sup>-2</sup> )	
		Weedy	Weed free
2008	0	425b	426b
	50	475a	527a
	90	483a	532a
2009	0	430b	440b
	50	495a	539a
	90	509a	530a
Corn biomass (gr m <sup>-2</sup> ) (average of two years)		Weedy	469 b
		Weed free	499 a

Means of each column with similar letters are not significantly different ((Duncan's Multiple Range Test 5%).



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## جذب نیتروژن خاک توسط علف‌های هرز در مقادیر مختلف نیتروژن در مراحل اولیه رشد ذرت (*Zea mays* L.)

ا. ه. جلالی و م. ج. بحرانی و ع. ر. کاظمینی

### چکیده

تأثیر مقادیر نیتروژن بر جذب نیتروژن از طریق تراکم‌های بالای علف‌های هرز در مراحل اولیه رشد ذرت (رقم دبل کراس ۳۷۰) در یک پژوهش ۲ ساله (۱۳۸۸-۱۳۸۷) در ایستگاه تحقیقات کشاورزی دانشگاه شیراز مطالعه گردید. پژوهش به صورت کرت‌های خرد شده در قالب طرح بلوک‌های کامل تصادفی با ۳ تکرار صورت پذیرفت. دو سطح علف هرز (حضور علف هرز و بدون علف هرز) به‌عنوان کرت اصلی و ۳ سطح نیتروژن (۰، ۵۰ و ۹۰ کیلوگرم در هکتار) به‌صورت قبل از کشت به‌عنوان کرت فرعی در نظر گرفته شدند. یک ماه پس از کشت، وزن خشک بخش‌های هوایی علف‌های هرز موجود و ذرت اندازه‌گیری گردید. بیشترین زیست توده علف هرز و جذب نیتروژن از طریق علف‌های هرز با به‌کارگیری ۵۰ کیلوگرم نیتروژن در هکتار به‌دست آمد. در سال اول پژوهش میزان نیتروژن نهال‌بذرهای علف‌های هرز در هیچ‌یک از سطوح نیتروژن به‌کار رفته تفاوت معنی‌داری نداشتند در حالی که در سال دوم مقدار نیتروژن علف‌های هرز در کرت‌هایی که نیتروژنی دریافت نکرده بودند به ترتیب ۳۱ و ۳۹٪ پایین‌تر از علف‌های هرزی بود که در کرت‌هایی با مقدار ۵۰ و ۹۰ کیلوگرم نیتروژن در هکتار رشد یافته بودند. مقادیر بالای جذب نیتروژن از طریق علف‌های هرز به‌ویژه از طریق تاج خروس ریشه قرمز در مراحل اولیه رشد ذرت یک فاکتور مهم برای رقابت علف هرز- گیاه زراعی محسوب می‌گردد.