

Shahid Beheshti University

Analysis of N Use Efficiency of Maize to Optimise N Fertiliser Application under Weed Competition



<u>Saeid Soufizadeh^{1,*}, Majid Aghaalikhani², Mohammad Bannayan³, Eskandar Zand⁴,</u> Ahmad M. Manschadi⁵, Gerrit Hoogenboom⁶

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¹ Department of Agroecology, Environmental Sciences Research Institute, Shahid Beheshti University, G.C., Tehran, Iran. ² Department of Agronomy, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran. ³ Department of Agronomy, Faculty of Agriculture, Ferdowsi University of Mashhad, Mashhad, Iran. ⁴ Iranian Research Institute of Plant Protection, Agricultural Research Education and Extension Organization (AREEO), Tehran, Iran. ⁵ Department of Crop Sciences, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria. ⁶ Department of Agricultural and Biological Engineering, University of Florida, Gainesville, FL, the United States. * Email for correspondence: <u>s_soufizadeh@sbu.ac.ir</u>

Introduction

Cropping of maize is characterized by high N-surplus due to overfertilization.

This not only increases the likelihood of N leaching but also favors weed growth under competition conditions.

Methodology

A two-year field experiment was conducted in 2008 and 2009 at Tarbiat Modares University, Tehran.

The climate is arid and semi-arid with long-term average annual rainfall and temperature of 232.6 mm and 17.6°C, respectively.

- Weeds are strong competitors for N.
- Mechanistic understanding of crop and weed responses to N is essential for the development of strategies that reduce the nutrient availability to weeds and also to optimize N application rate.
- A good criterion to achieve the above goal is crop nitrogen use efficiency (NUE).
- **D** NUE is the product of two components: nitrogen uptake efficiency (NUpE) and nitrogen utilization efficiency (NUtE).
- □ It seems that competition for nutrients plays a more important role in yield loss of maize as a result of weed competition.
- **Experimental factors were:**
 - □ N fertilizer rates: 138, 184 and 230 kg N ha⁻¹
 - Weed species: redroot pigweed (*Amaranthus retroflexus* L.) and

proso-millet (Panicum miliaceum L.) • Weed densities: Low and high (5 and 25 plants m⁻² in redroot pigweed; 7.5 and 37.5 plants m⁻² in proso-millet). At physiological maturity, crop yield and N attributes were measured.





Maize and redroot pigweed



Maize and proso-millet

Research objectives Objective 1: To explore how different weed species affect maize yield. **Objective 2:** To examine the effects of weed competition on maize yield loss through









dissecting NUE into its components.



Results and discussion

Proso-millet was more troublesome in maize compared to redroot pigweed.

Proso-millet was most damaging under lowest N fertilization treatment while redroot pigweed was most damaging under highest N rate.

I High density of proso-millet was more damaging than its low density. However, low density of redroot pigweed was as damaging as its high density.

□ NUE was negatively affected by both weed species.

NUPE was the main contributing factor to the N status of the crop under weed competition.

This may highlight the more important role of belowground compared to above-ground competition in the determination of the overall result of competition between maize and weeds.



Table 1. Grain yield, nitrogen use efficiency (NUE), nitrogen uptake efficiency (NUPE) and nitrogen utilization efficiency (NUtE) of maize at maturity as affected by N fertilizer rate, and weed species and density.

Treatments		Grain yield (g m ⁻²)		NUE (g g ⁻¹)		NUpE (g g ⁻¹)		NUtE (g g ⁻¹)	
<i>N rate</i> (kg ha ⁻¹)	2008	2009	2008	2009	2008	2009	2008	2009	
138	463	739	11.12	19.45	0.26	0.39	42.87	49.71	
184	811	710	15.72	14.79	0.26	0.26	60.81	55.13	
230	701	790	11.37	13.62	0.2	0.25	58.4	53.4	
LSD (0.05)	77.05	83.28	1.52	1.68	0.02	0.04	6.27	7.18	
Density									
Low	704	800	13.65	17.07	0.23	0.32	59.16	54.93	
High	612	693	11.82	14.83	0.24	0.29	48.89	50.57	
LSD (0.05)	62.91	68.00	1.24	1.37	0.02	0.03	5.12	5.78	
	ents <i>N rate</i> (kg ha ⁻¹) 138 184 230 LSD (0.05) <i>Density</i> Low High LSD (0.05)	ents Grain yie N rate (kg ha ⁻¹) 2008 138 463 184 811 230 701 LSD (0.05) 77.05 Low 704 High 612 LSD (0.05) 62.91	ents Grain yield (g m ⁻²) 2008 2009 N rate (kg ha ⁻¹) 2008 2009 138 138 463 739 184 1710 230 1701 790 230 771.05 83.28 20 10 10 10 10 10 10 10 10 10 10 10 10 10	entsGrain yie/ (g m-2)NUE (NUE (2008)N rate (kg ha-1)20082009200813846373911.1218481171015.7223070179011.37LSD (0.05)77.0583.281.52Low70480013.65High61269311.82LSD (0.05)62.9168.001.24	entsGrain yie (g m-2)NUE (g f-1)N rate (kg ha-1)200820092008200913846373911.1219.4518481171015.7214.7923070179011.3713.62LSD (0.05)77.0583.281.521.68Low70480013.6517.07High61269311.8214.83LSD (0.05)62.9168.001.241.37	entsGrain yie/ (g m²)NUE (g m²)NUpENUpEN rate (kg ha²)2008200920082009200813846373911.1219.450.2618481171015.7214.790.2623070179011.3713.620.2LSD (0.05)77.0583.281.521.680.02Pensity70480013.6517.070.23High61269311.8214.830.24LSD (0.05)62.9168.001.241.370.02	entsGrain yie/ (g m²)NUE / (g m²)NUE / (g m²)NUPE / (g m²)N rate (kg ha²)20082009200820092008200913846373911.1219.450.260.3918481171015.7214.790.260.2623070179011.3713.620.20.25LSD (0.05)77.0583.281.521.680.020.04Low70480013.6517.070.230.32High61269311.8214.830.240.29LSD (0.05)62.9168.001.241.370.020.03	entsGrain yield m²NUE (g m²)NUE (g 1)NUE (g 1)NUENUEN rate (kg ha²)200820092008200920082009200813846373911.1219.450.260.3942.8718481171015.7214.790.260.2660.8123070179011.3713.620.20.2558.4LSD (0.05)77.0583.281.521.680.020.046.27Low70480013.6517.070.230.3259.16High61269311.8214.830.240.2948.89LSD (0.05)62.9168.001.241.370.020.035.12	



NUE (g g⁻¹)



NUpE (g g⁻¹) Figure 1. The association between maize grain yield (GY) and its NUE, NUPE and NUTE. : Weed-free maize. **L** , **O** , **O** :

Maize competing with low and high densities of proso-millet and redroot pigweed at 138, 184 and 230 kg N ha⁻¹, respectively.

<i>N rate</i> (kg ha⁻¹)								
138	725	768	17.41	20.21	0.27	0.39	65.16	52.47
184	736	832	14.26	17.32	0.24	0.35	57.8	50.22
230	740	633	12.01	10.9	0.21	0.22	55.31	49.66
LSD (0.05)	193.61	158.15	3.78	3.52	0.06	0.06	14.54	14.41
Density								
Low	754	795	14.95	17.21	0.24	0.33	60.8	52.89
High	713	693	14.17	15.08	0.24	0.31	58.04	48.68
LSD (0.05)	158.08	129.13	3.09	2.87	0.05	0.05	11.87	11.77
	N rate (kg ha ⁻¹) 138 184 230 LSD (0.05) <i>Density</i> Low High LSD (0.05)	N rate (kg ha ⁻¹) - 138 725 184 736 230 740 LSD (0.05) 193.61 Density - Low 754 High 713 LSD (0.05) 158.08	N rate (kg ha ⁻¹)	N rate (kg ha ⁻¹) Image: Marce (kg ha ⁻¹) Image: Marce (kg ha ⁻¹) 138 725 768 17.41 184 736 832 14.26 230 740 633 12.01 LSD (0.05) 193.61 158.15 3.78 Density 754 795 14.95 High 713 693 14.17 LSD (0.05) 158.08 129.13 3.09	N rate (kg ha ⁻¹) Image: Construct of the symbol is a symbol	N rate (kg ha ⁻¹) Image: Normate (kg ha ⁻¹) Image:	N rate (kg ha ⁻¹) N rate	N rate (kg ha ⁻¹) Image: N

Conclusion

Generalization of the results showed a critical value of 15 g g⁻¹ for maize NUE under weed competition, below which grain yield declines sharply. It could be concluded that improvement of NUE and its components, especially NUpE, will be a significant step towards rationalizing the use of N fertilizer and selection of genotypes/agronomic strategies that results in better adaptation to low N environments under weed presence.