Optimizing N management enhances interspecific complementation in maize-pea intercropping

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Introduction

Cereal-legume intercropping has been shown to be effective in increasing crop productivity and improving water and nutrient use efficiencies. However, little has been reported how the two intercrops may share or compete for resources during their co-growth period under resource-limiting environments. Here, we quantified the competitiveness of the two intercrops in response to soil available N during their co-growth period, and determined the complementary effect of the two intercrops in arid environments.

Fig. 1 Maize-pea strip intercropping system at Wuwei Experimental Station, northwest China

Materials & Methods

A long-season maize (*Zea mays* L.) was alternated in strips with a short-season pea (*Pisum sativum* L.) under four N management systems in 2012 and 2013. Sole maize and maize in the maize-pea intercropping were tested under four N management systems: zero-N as the control (N0), and the other three N rates top-dressed at the different growth stages of maize as N1, N2 and N3. The first topdressing was at jointing, with an amount of 10%, 20% and 30% of the total N (i.e., 45, 90, and 135 kg N ha^{-1}), respectively; the second topdressing was at pretasseling, with 50% of the total N (i.e., 225 kg N ha^{-1}); and the third topdressing was at post-flowering with the remaining N. Monoculture pea was fertilized with the same amount of N fertilizer as those applied to maize in the first topdressing application.

Results & Discussion

- Compared with the zero-N control treatment, N application increased the competitiveness of the intercropped maize to pea by 18 to 33% during the co-growth period (data not shown).

Table 1 Relative growth rates (10^{-3} kg kg^{-1} d^{-1}) of intercropped maize (M/P) and maize monoculture (M) after pea harvest under different N managements

System	2012				2013			
	Jul. 14-Aug. 10	Aug.11-Sep. 4	Sep. 5-Sep. 26	Mean	Jul. 12 - Aug. 17	Aug. 18-Sep. 5	Sep. 6-Sep. 29	Mean
M/PN0	14.3	15.7	11.4	13.8	13.2	15.1	9.6	12.6
M/PN1	15.8	18.0	13.1	15.6	13.7	19.1	12.3	15.0
M/PN2	16.2	19.7	13.1	16.4	13.4	20.2	11.6	15.1
M/PN3	14.5	18.8	13.7	15.7	14.0	17.6	10.5	14.0
MN0	15.3	14.3	6.4	11.0	10.5	12.9	9.7	11.1
MN1	15.6	15.1	7.3	12.7	15.0	15.1	7.9	12.7
MN2	17.5	15.5	8.7	14.6	16.6	16.0	8.5	13.7
MN3	16.0	16.3	7.2	13.2	12.6	15.9	8.0	12.2

- After pea harvest, the intercropped maize obtained a complementary effect from the pea strips, as reflected by the increased maize growth rate by 20, 21, 11, and 17%, respectively, under N0, N1, N2, and N3 managements, compared with monoculture maize (**Table 1**).
- The total yield of the intercropping system is a quadratic relationship with the interspecies competitiveness, with the competitiveness value of –0.059 to –0.076 being most conducive to the improved yield (**Fig. 2**).

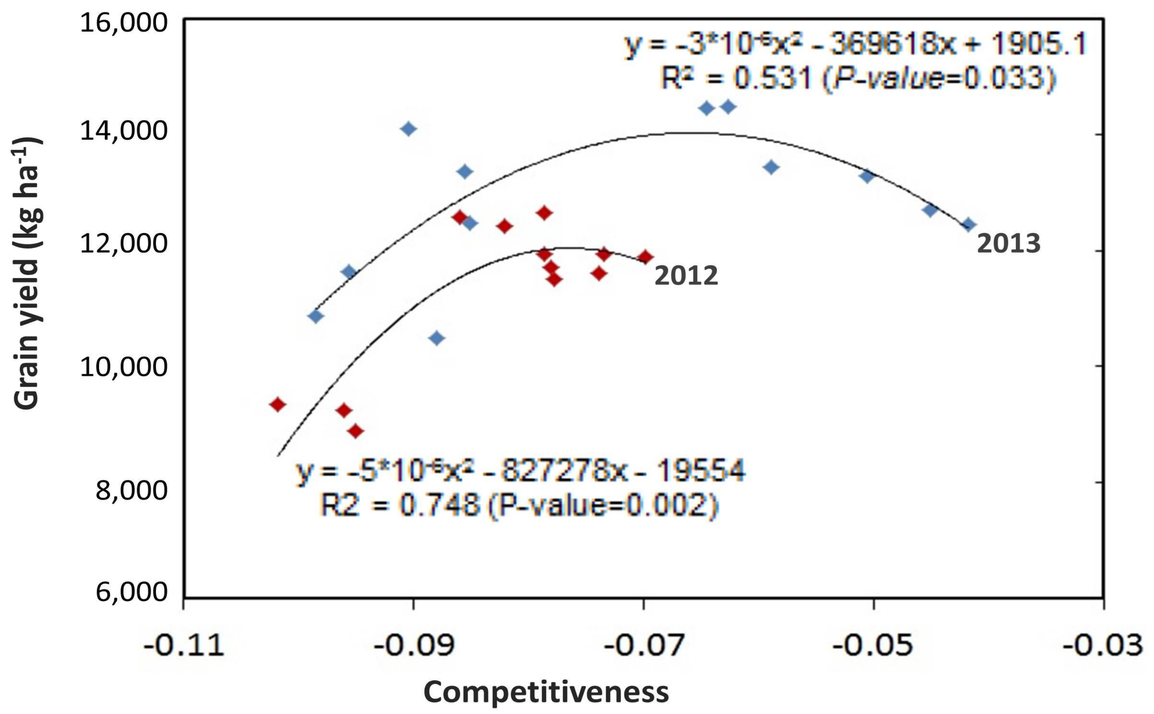

Fig. 2 Regression between competitiveness (maize against the intercropped pea during their co-growth period) and the grain yield of the maize-pea intercropping

Conclusions

A strategy of applying 20% of the total N at maize jointing, 50% at pretasseling, and the remaining N topdressed post-flowering provided greatest benefits for optimizing the competitiveness of the two intercrops while enhancing the complementary effect in cereal-legume intercropping systems.

Acknowledgements

We are grateful to the National Natural Science Foundation of China, the Special Fund for Agro-Scientific Research in the Public Interest, and the National Key Technology R and D Program for financial support.