

# Maize Yield Improvement in Argentina (1965-2010). Indirect Effect on Yield Components and Nitrogen Use Efficiency.

Ferreira, Juan Matías<sup>(1)</sup>; Arisnabarreta, Sebastian<sup>(1)</sup>; Andrade, Fernando<sup>(2)</sup> and Valentinuz, Oscar<sup>(3)</sup>.

(1) Monsanto Argentina, Pergamino, Argentina, (2) INTA-Balcarce, Argentina, (2) INTA-Paraná, Argentina.

## Introduction

The yield gain on a breeding program could be explained by the progress in the nitrogen use efficiency (NUE) during the improvement process.

## Objectives

The objectives of this work are: a) compare the yield and grain yield components of maize hybrids at their specific selection management (SSHM) evaluated through different level of nitrogen (N) and b) quantify changes in the efficiency of N uptake (NUpE= Kg N uptake Kg N available in the soil<sup>-1</sup>) and nitrogen internal efficiency (NIE=Kg grain Kg N uptake<sup>-1</sup>).

## Materials and Methods

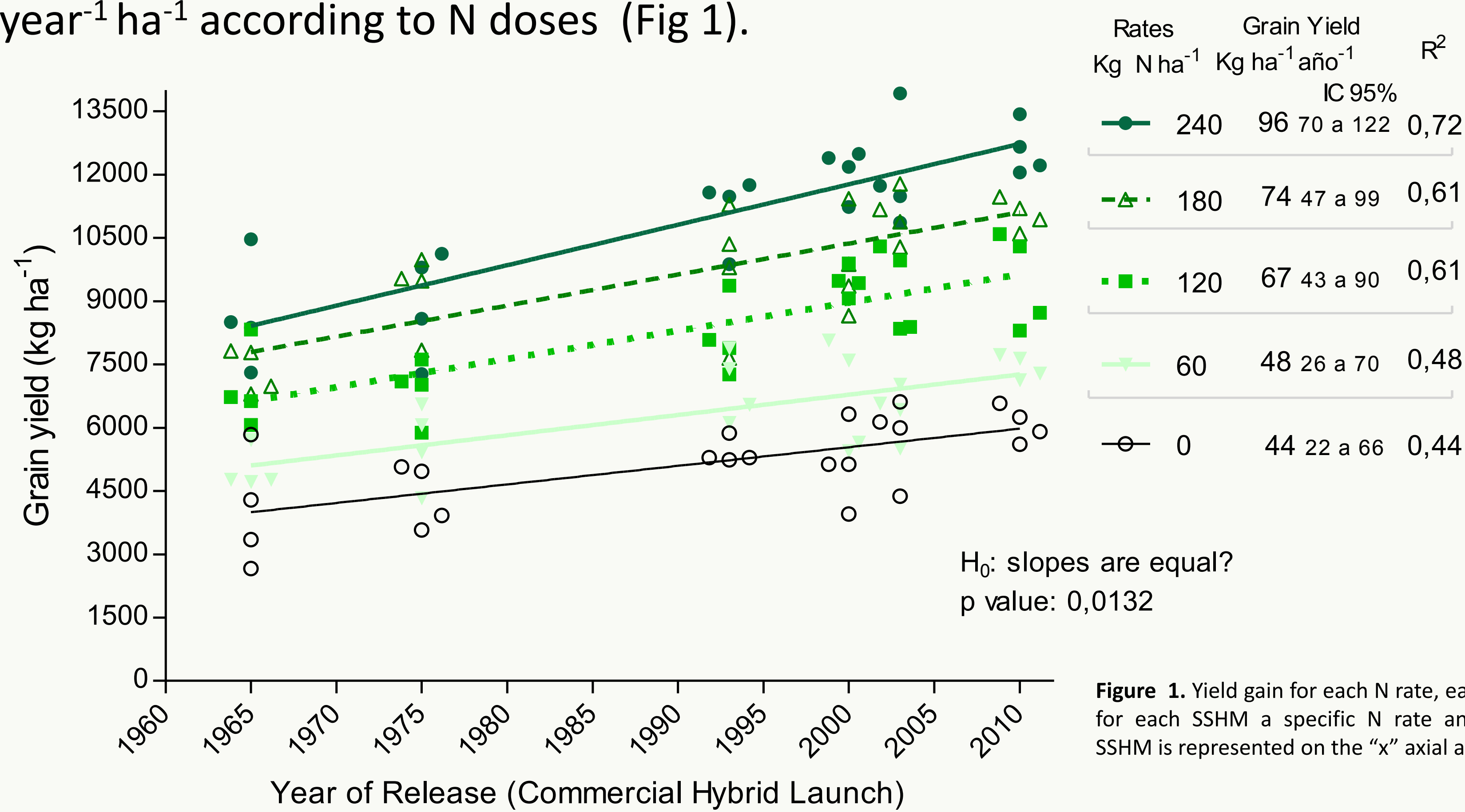
• Experiment carry on in the Monsanto Fontezuela Research Station (Buenos Aires, Argentina) during the crop season 2010/11. 7 genotypes at their optimal plant population (SSHM) were combined with 5 N rates (0, 60, 120, 180 y 240 kg N ha<sup>-1</sup>) randomized in a Split-plot design.

Commercial Launch Year	1965	1975	1985	1993	2000	2003	2010
Hybrids	DKF880	DK4F32	DK3F22	DK664	DK682MG	DK190MG	DK692MGRR2
Density(pl ha <sup>-1</sup> )	40000	45000	55000	60000	75000	80000	85000
Cross type	Double cross		Three-way		Single cross		
SSHM	SSHM'65	SSHM'75	SSHM'85	SSHM'93	SSHM'00	SSHM'03	SSHM'10

• **Assessments:** i) grain yield at 14.5%, kernel number (KN) and kernel weight (KW), ii) plant growth rate (PGR) and kernel set during the grain filling, iii) biomass and harvest index (HI) and iv) nitrogen uptake and remobilizations.

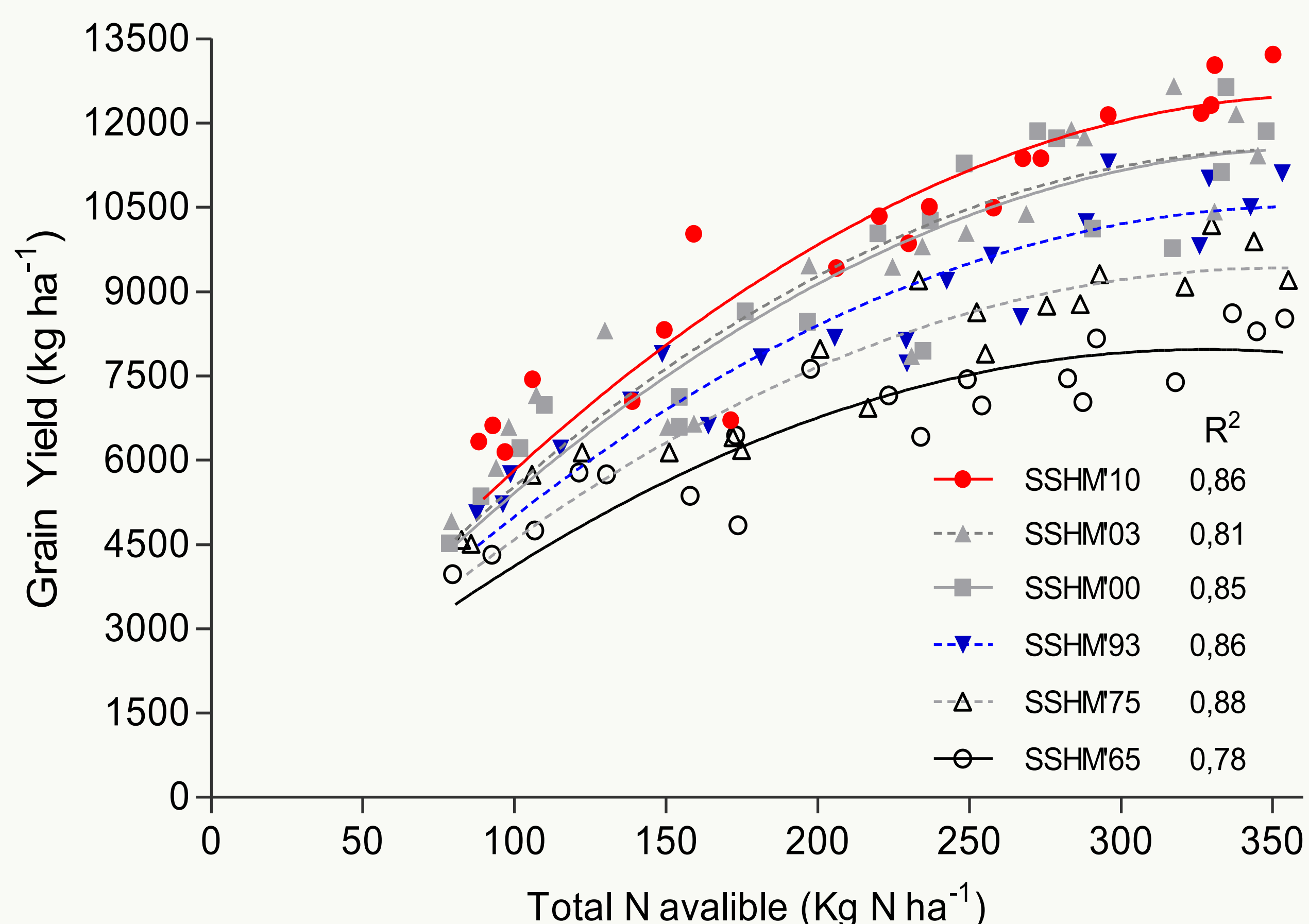
## Results and Discussion

-Grain yield increased linearly during the last 45 years ranging from 44 kg year<sup>-1</sup> ha<sup>-1</sup> to 96 kg year<sup>-1</sup> ha<sup>-1</sup> according to N doses (Fig 1).



H<sub>0</sub>: slopes are equal?  
p value: 0,0132

Figure 1. Yield gain for each N rate, each dot represent for each SSHM a specific N rate and a block. Each SSHM is represented on the "x" axial as Year of release.



-The highest grain yield were obtained at the level of 327 to 367 Kg N available in the soil. The greatest response were found with the newest SSHM (Fig. 2).

Figure 2. N effect on the grain yield for each SSHM, on the "x" axial are represented the N available on the soil (Fertilizer + Soil N mineralization + N at planting), for each data set a quadratic model was fixed (Y= l<sub>0</sub>+ b<sub>1</sub>x + b<sub>2</sub>x<sup>2</sup>, l<sub>0</sub>=0). The modern SSHM has greater NUE than the older ones. Data dispersion is generated by block effect.

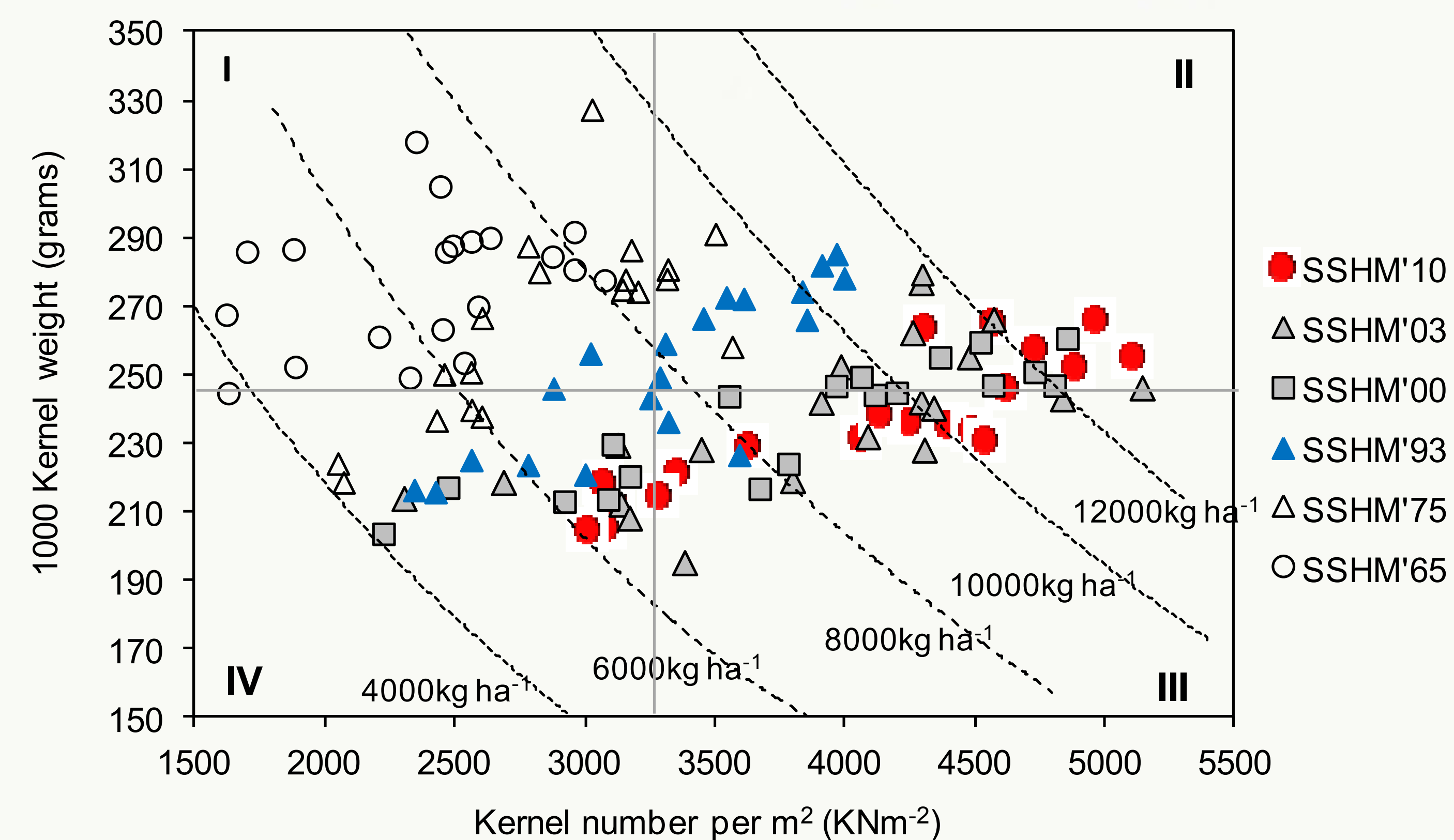


Figure 3. Relationship between kernel weight (grams) and the number of grains for different SSHM. Dashed lines (---) represent same yield points ranging from 4000-12000 kg ha<sup>-1</sup>. The quadrant I, II, III and IV represent the location of the data in terms of average values KNm<sup>2</sup> and KW.

-The grain yield improvement of the new SSHM was due to increments on the KN (Fig. 3) increasing the HI, and with lower KW.

-The greater KNm<sup>-2</sup> on the newest SSHM was associated with more KN fixed per plant at a same PGR (Fig. 4) and more KNm<sup>-2</sup> for unit of PGR giving better stress tolerance.

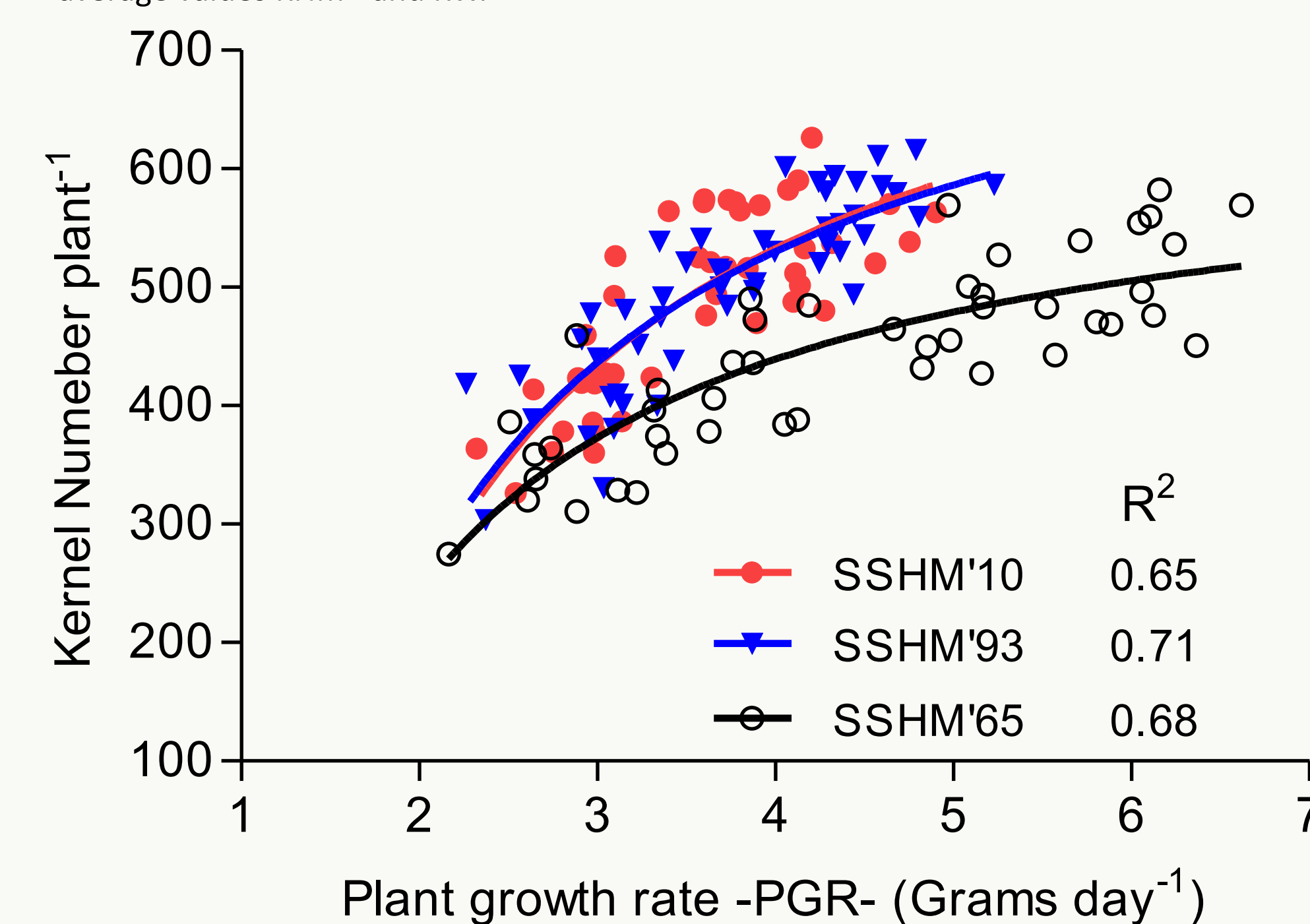


Figure 4. Relationship between kernel number per plant and plant growth rate for the period bracketing silking  $KNP_{SSHM'65} = 505-1546 \exp(-PGR/1.2)$ ;  $KNP_{SSHM'93} = 603-1989 \exp(-PGR/1.2)$ ;  $KNP_{SSHM'10} = 609-2120 \exp(-PGR/1.2)$

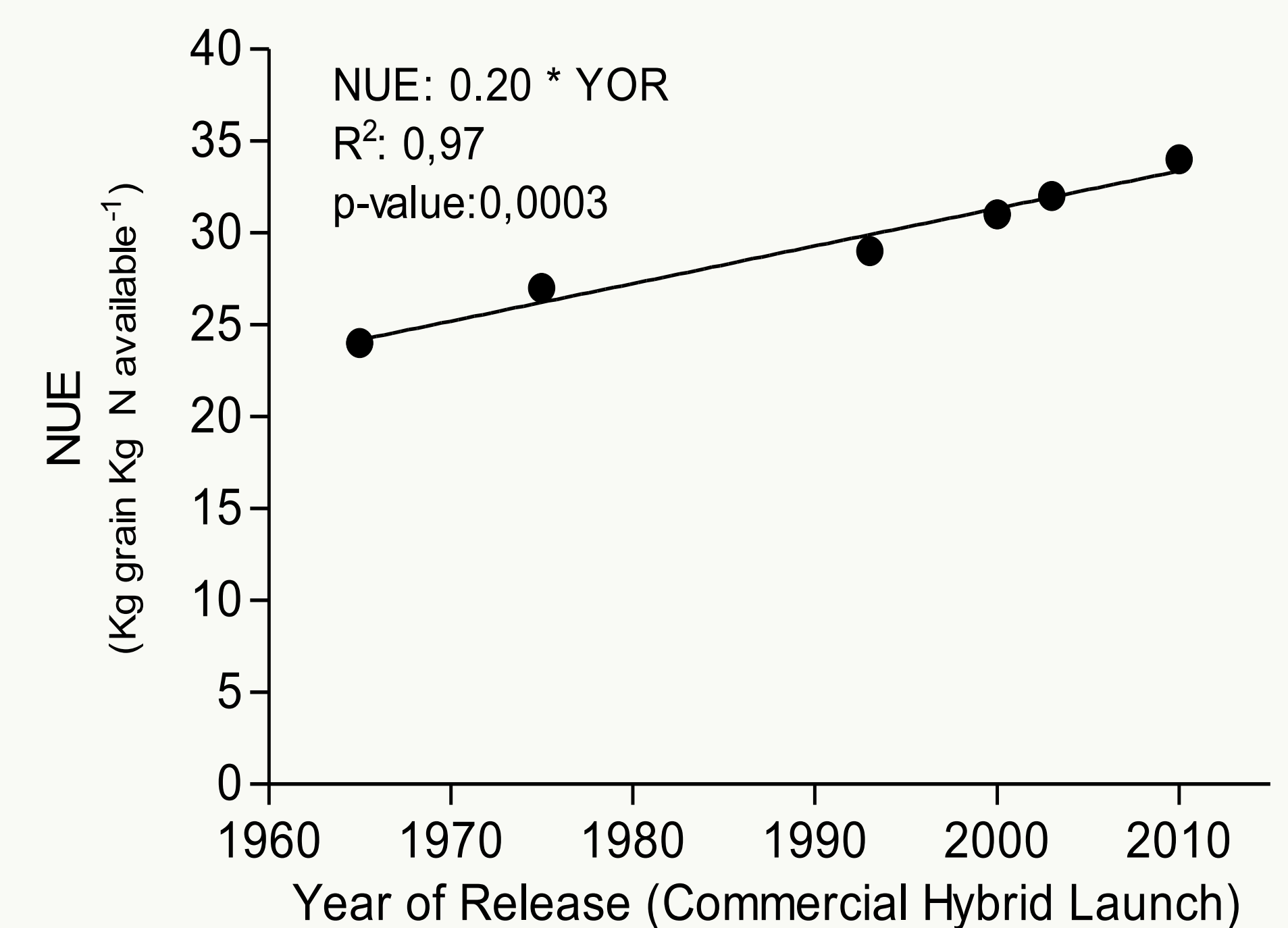


Figure 5. Annual increase on the NUE. Each data point represent the NUE at the highest grain yield.

- The NUE increase during the last 45 years (Fig. 5) from 24 to 34 Kg grain Kg N available<sup>-1</sup> due higher NIE on the new SSHM (Fig. 7) but no difference between SSHM was found for NUpE, except in the SSHM'10 at the highest N level (240 K N ha<sup>-1</sup>) (Fig. 6).

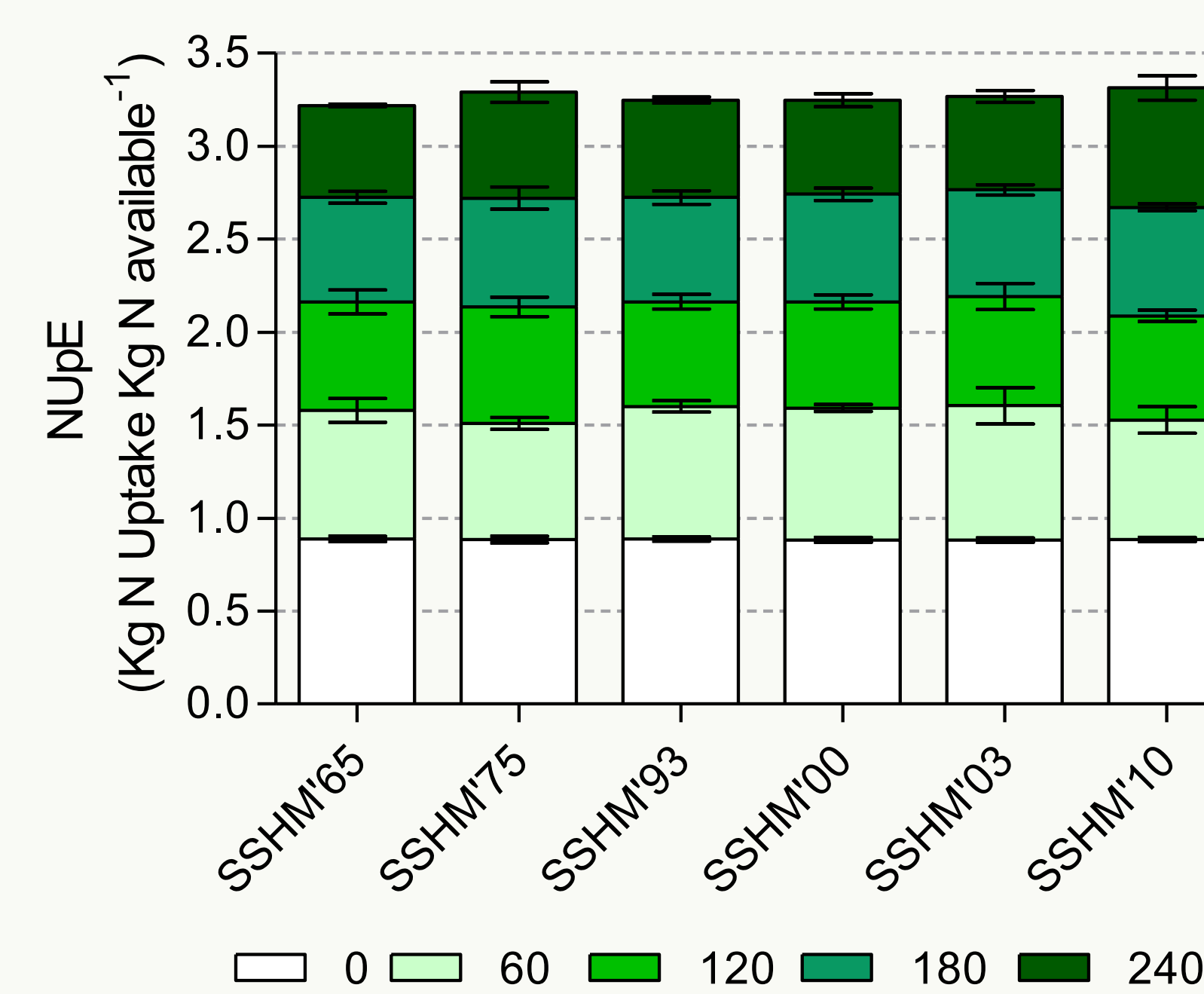


Figure 6. Change on the NUpE for each N rate by SSHM. Only at the highest N rate (240 Kg N ha<sup>-1</sup>) we found difference between SSHM for NUpE. Each bars on the column represent the error standard.

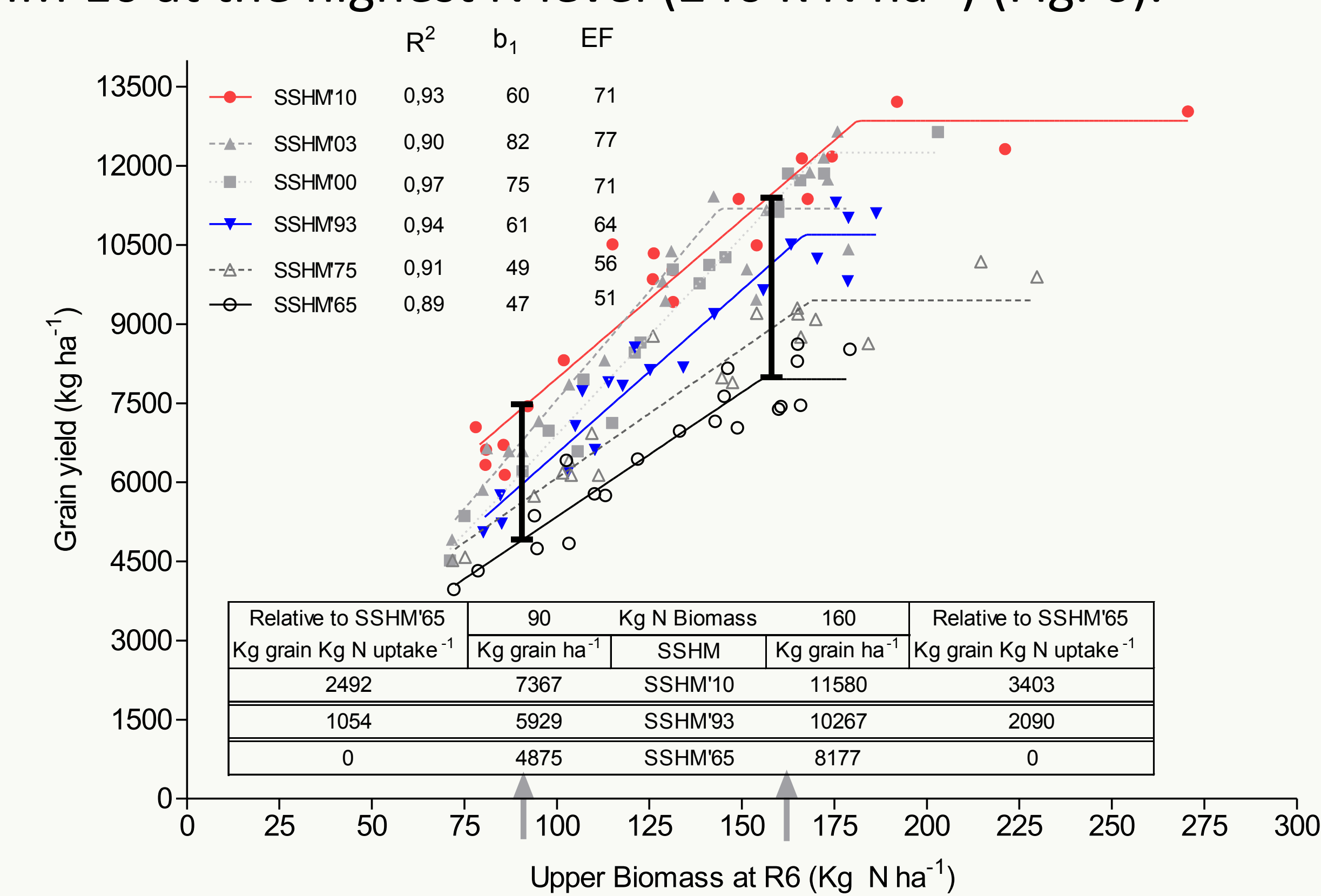


Figure 7. Grain yield according with the N uptake by the aerial biomass at physiological maturity (R6). Lineal plateau model were fixed for each SSHM. The NIE increase during the last 45 years. The table on the chart represent the difference between two SSHM for a specific N level.

## Conclusions

- ✓ Grain yield increase from 1965 to 2010 varied according to N rate.
- ✓ The greater KN on the newest SSHM was due to greater number of kernels fixed per unit PGR and more stress tolerance.
- ✓ NUE increased during the last 45 years because of increments in NIE.