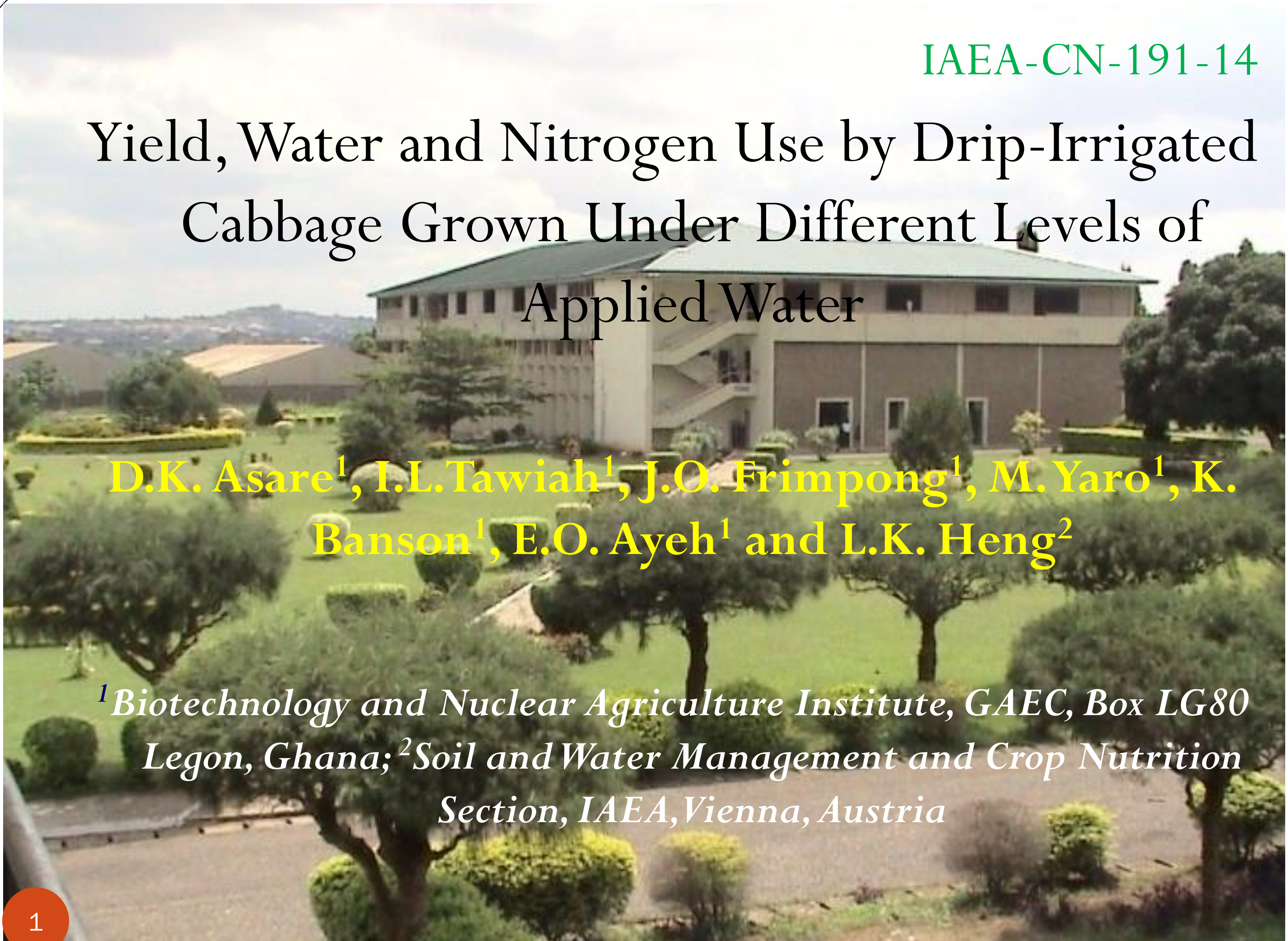

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Yield, Water and Nitrogen Use by Drip-Irrigated Cabbage Grown Under Different Levels of Applied Water

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ORDER OF PRESENTATION

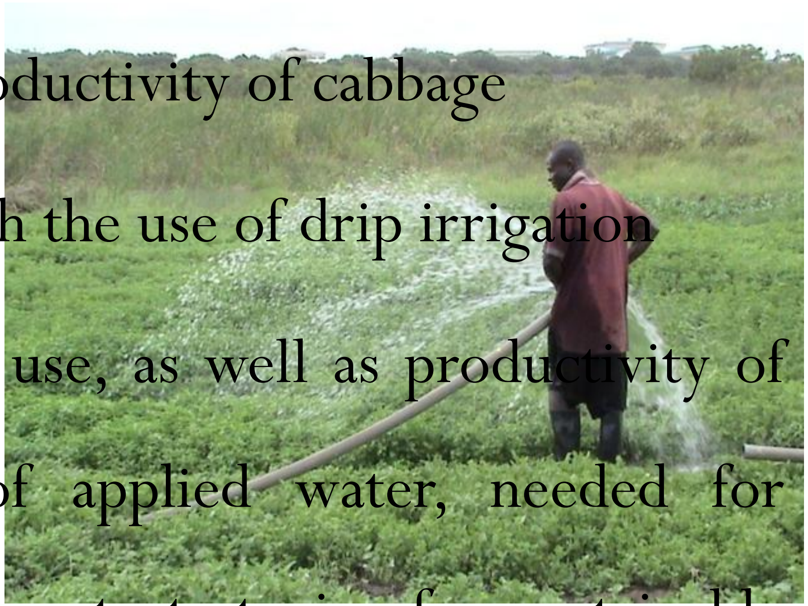
- INTRODUCTION
- OBJECTIVES
- MATERIALS AND METHODS
- RESULTS
- DISCUSSION
- CONCLUSION
- REFERENCES
- ACKNOWLEDGEMENT

INTRODUCTION (1/2)

- Cabbage is one of the high value crops in Ghana
- Cabbage mostly grown in the peri-urban/urban areas in response to high demand
- Its cultivation is a source of livelihood as farmers obtain good returns
- Cabbage production levels generally low during the dry season due to inadequate water

INTRODUCTION (2/2)

- Efficient application of scarce water could enhance water and nutrient use, as well as the productivity of cabbage
- This could be achieved through the use of drip irrigation
- Information on water and N use, as well as productivity of cabbage at varying levels of applied water, needed for developing effective management strategies for sustainable cabbage production during the dry season



OBJECTIVES

For two drip-irrigated cabbage cultivars at different levels of applied water, determine:

(i) Total fresh yield (TFY) and total dry matter (TDM),

(ii) Water use efficiency, based on TFY and TDM,

(iii) Nitrogen fertiliser use efficiency (NFUE).

MATERIALS AND METHODS (1/7)

- Cabbage cultivars, KK-Cross and Oxylus, grown using the family size drip irrigation system
- Seedlings transplanted on 14th Nov., 2010 and harvesting done on 29th Jan., 2011
- Five levels of applied water used (100, 85, 70, 55, and 40 % of the optimal required level, equivalent to 260.9, 222.5, 184.1, 145.7 and 107.3 mm, respectively)
- The optimal required water was determined as:

$$ET_C = ET_O \times K_C \quad [1]$$

where K_c is the crop coefficient and ET_O is the reference evapotranspiration computed using a previous day's daily weather variables as inputs using the Penman-Monteith model (Allen *et al.*, 1998).

MATERIALS AND METHODS (2/7)

- Experimental design: split-plot
  - main plot: cabbage cultivars
  - subplot: levels of applied water
  - replication: three (3)
- Fertiliser applied: 120 kg N ha^{-1}, 50 kg P ha^{-1} and 130 kg K ha^{-1}
- Full irrigation (100% of required water) when fertiliser was applied
- Weeds and insects controlled whenever necessary

MATERIALS AND METHODS (3/7)

- Micro plot (1.08 m^2) established in each subplot for:

  - N^{15} application

  - Moisture monitoring in a 120 cm soil profile

- Neutron probe (CPN® 503 DR model) used to monitor moisture in the 120 cm soil profile.

MATERIALS AND METHOD (4/7)

- Soil moisture data were used to estimate the actual evapotranspiration (ET_a) based on the water balance approach:

$$ET_a = P + I \pm \Delta S \pm \mathrm{RO} \pm \mathrm{D} \qquad [2]$$

where P is precipitation (mm), I is irrigation (mm), ΔS is change in moisture stored in the soil profile (mm), D is deep drainage or capillary rise below the 100 cm soil profile (mm) and R is run- off/on (mm).

MATERIALS AND METHODS (5/7)

Water use efficiency was estimated as:

$$WUE_{TFY} = \frac{TFY}{CAET} \quad [3a]$$

and

$$WUE_{TDM} = \frac{TDM}{CAET} \quad [3b]$$

where WUE_{TFY} and WUE_{TDM} is water use efficiency based on total fresh yield and total dry matter, respectively; CAET is the seasonal actual evapotranspiration

MATERIALS AND METHODS (6/7)

Nitrogen fertiliser use efficiency (NFUE in percentage) was estimated as:

$$\text{NFUE}= \frac{\{N_{Yield}\ (kg\ ha{-}1) \times \%NdfF\}}{Napplied\ (kgha{-}1)} \quad [4]$$

where

$$\%NdfF = \frac{\{\%N15\ a.e.\ in\ plant\ sample\}\times 100}{\%N15\ a.e.\ in\ fertiliser} \quad [5]$$

and $\%NdfF$ is the fraction of nitrogen derived from the fertiliser.

MATERIALS AND METHODS (7/7)

- TFY, TDM, WUE and NFUE data analysed based on the split-plot design using GENSTATS statistical package
- Least significant difference (LSD) used to separate means when significant differences were observed at $P \leq 0.05$
- Linear correlation analyses used to assess the existence of a linear relationship between WUE_{TDM} and NFUE for the cabbage crops drip-irrigated at different levels of applied water

RESULTS (1/11)

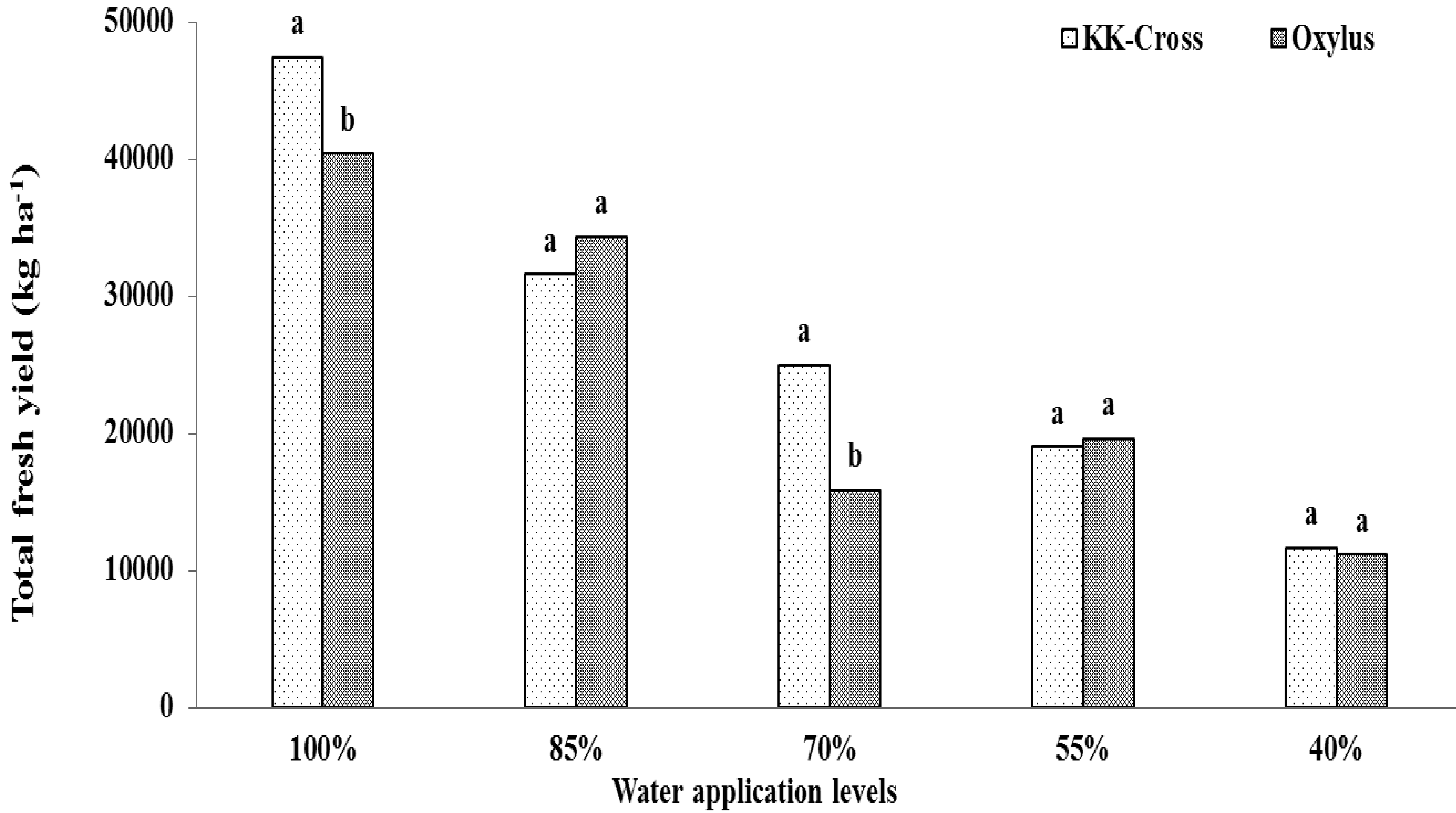


Figure 1. Total fresh yield of cabbage cultivars K-K Cross and Oxylus at different levels of applied water. Bars with the same letters were not significantly different at $P \leq 0.05$.

RESULTS (2/11)

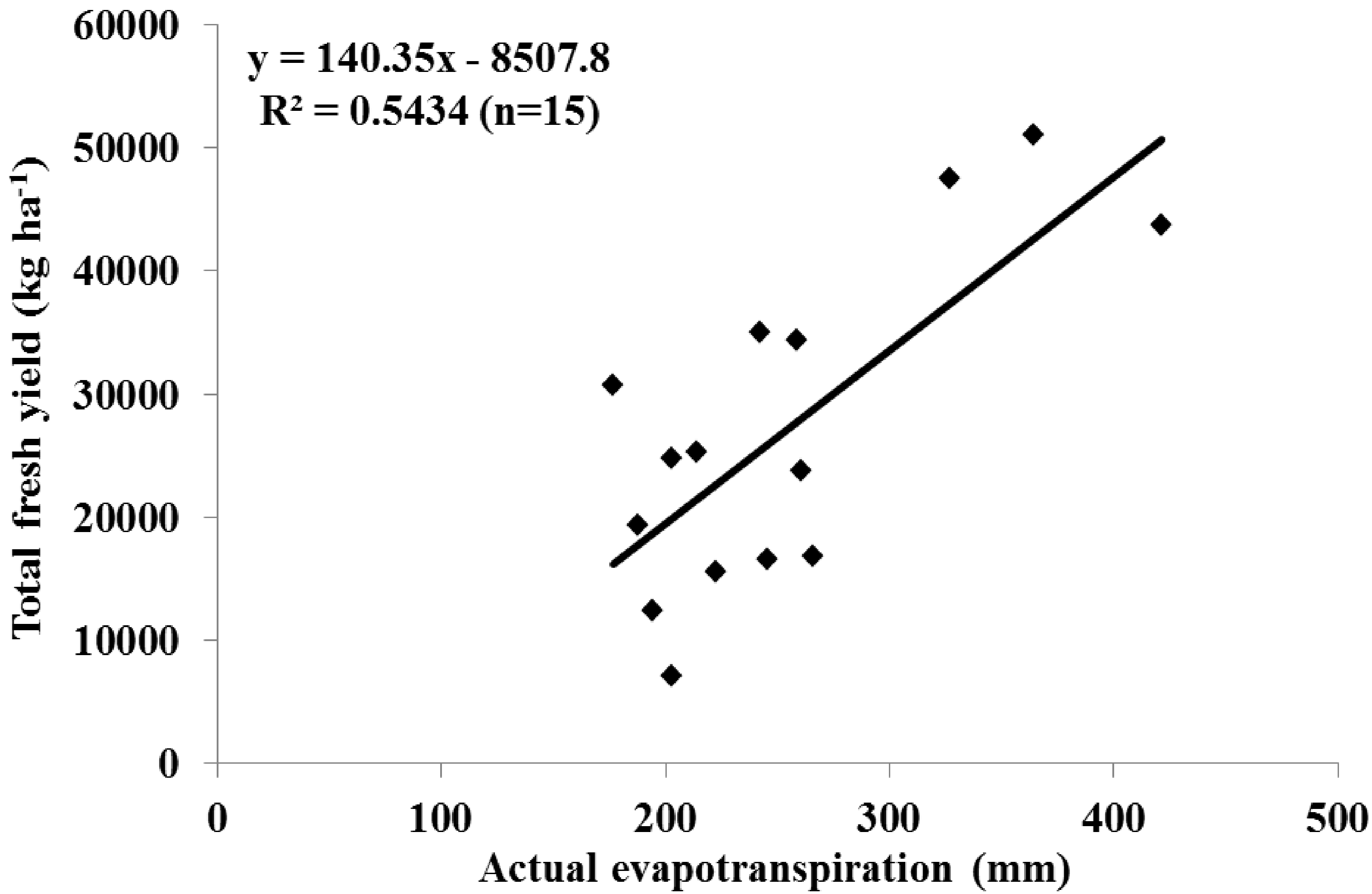


Figure 2. Relationship between total fresh yield and actual crop evapotranspiration for K-K Cross cultivar

RESULTS (3/11)

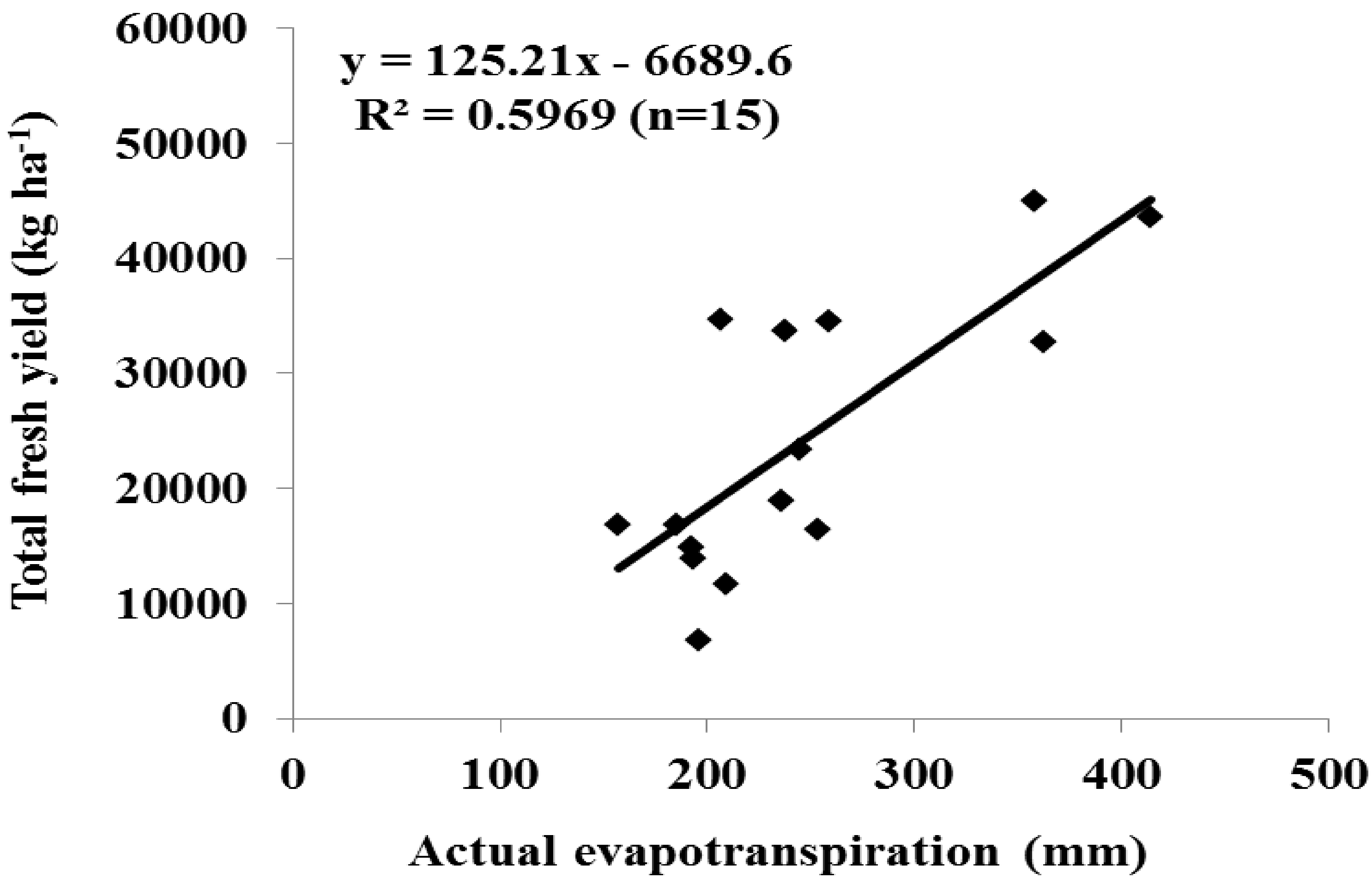


Figure 3. Relationship between total fresh yield and actual crop evapotranspiration for Oxylus cultivar

RESULTS (4/11)

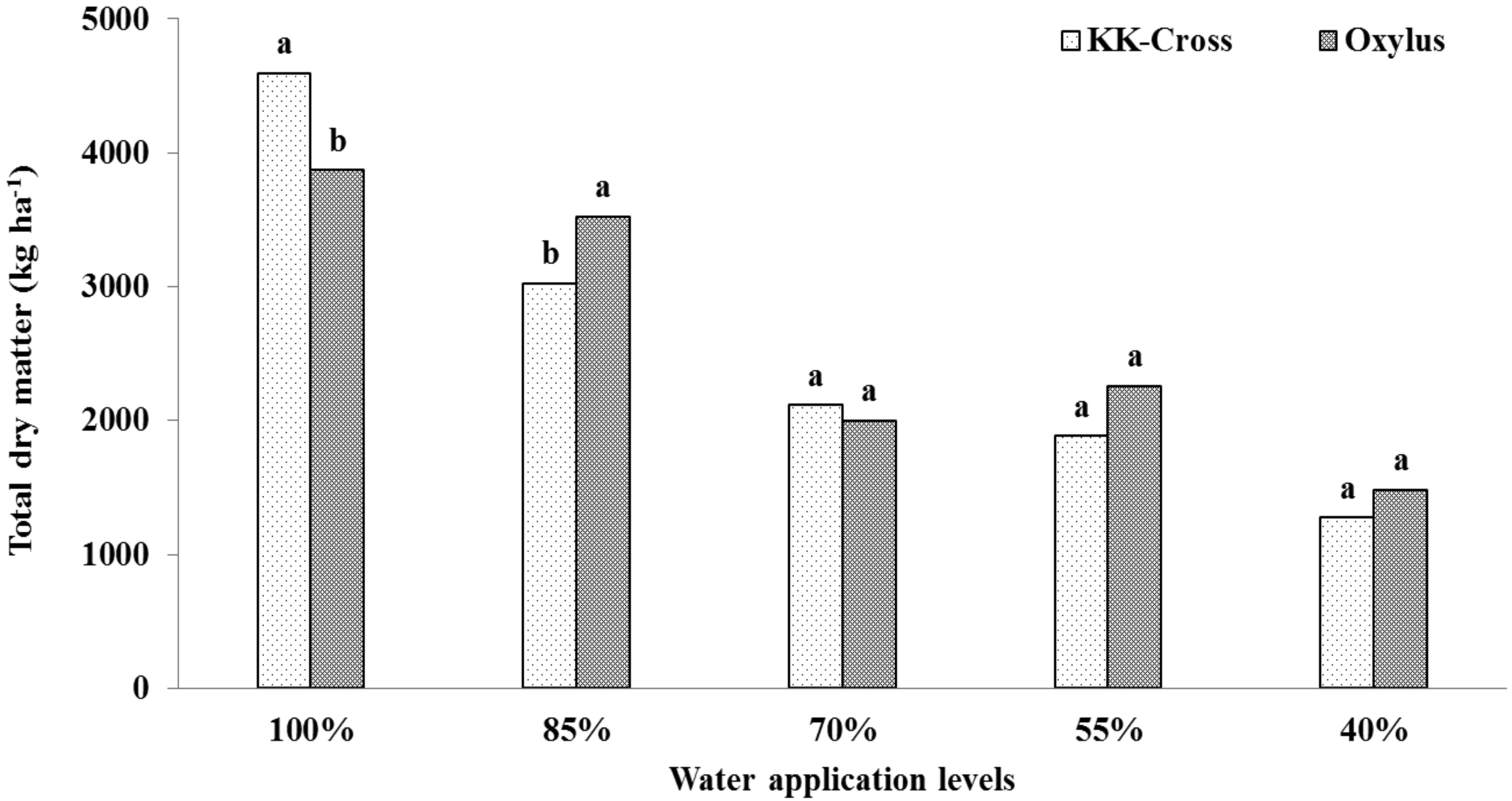


Figure 4. Total dry matter yields of cabbage cultivars K-K Cross and Oxylus at different levels of applied water. Bars with the same letters were not significantly different at P≤ 0.05.

RESULTS (5/11)

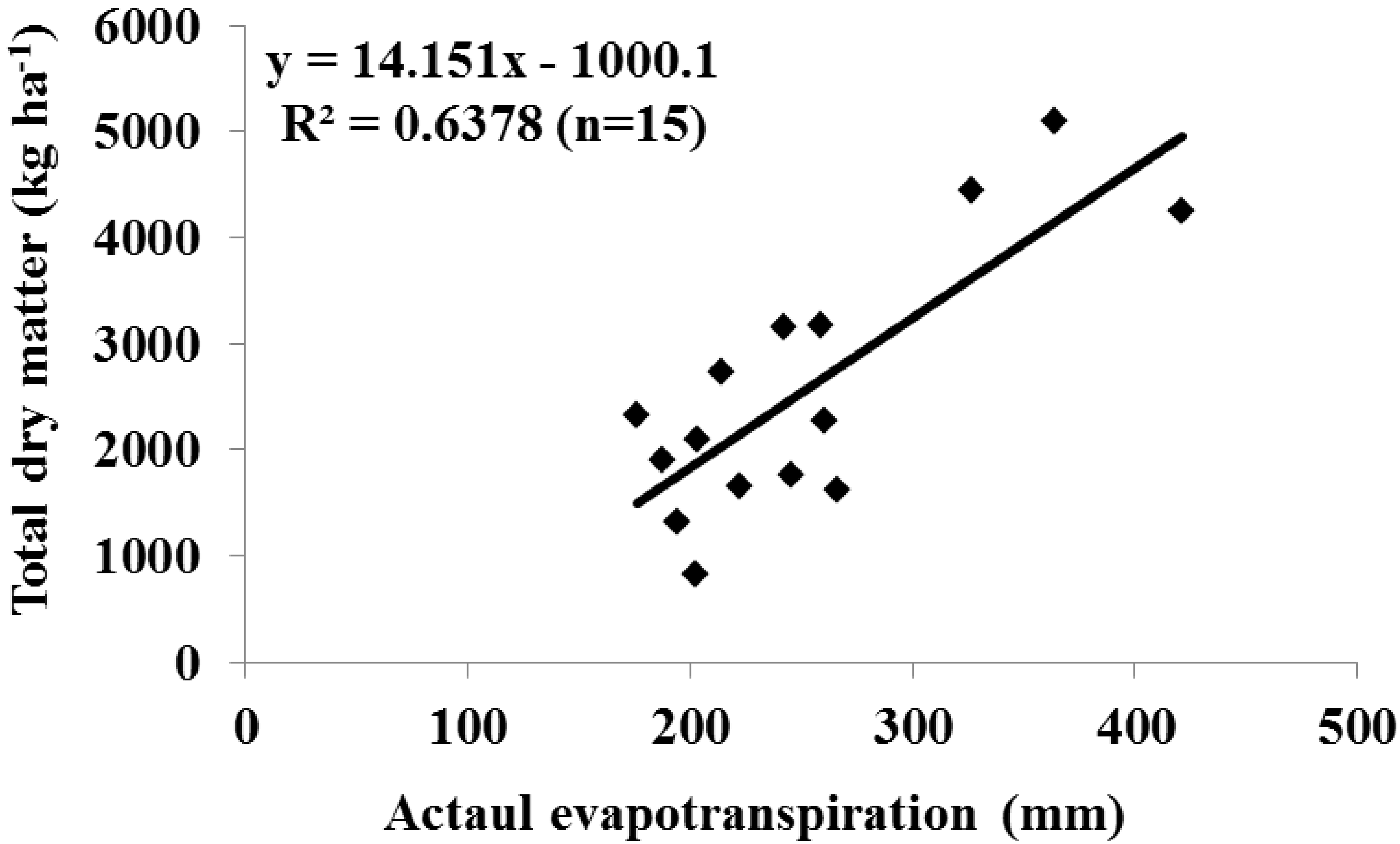


Figure 5. Relationship between total dry matter and actual crop evapotranspiration for K-K Cross cultivar

RESULTS (6/11)

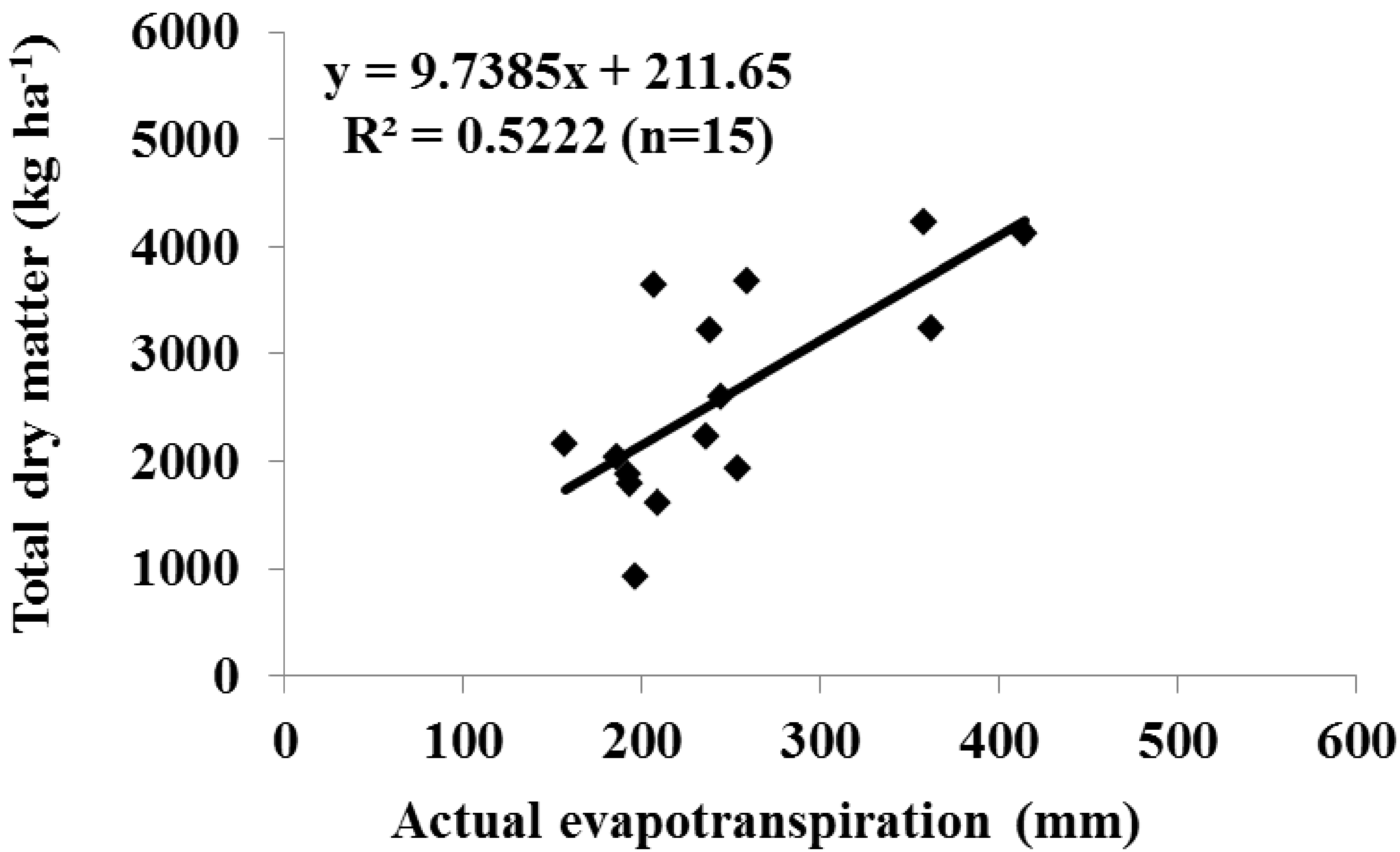


Figure 6. Relationship between total dry matter and actual crop evapotranspiration for Oxylus cultivar

RESULTS (7/11)

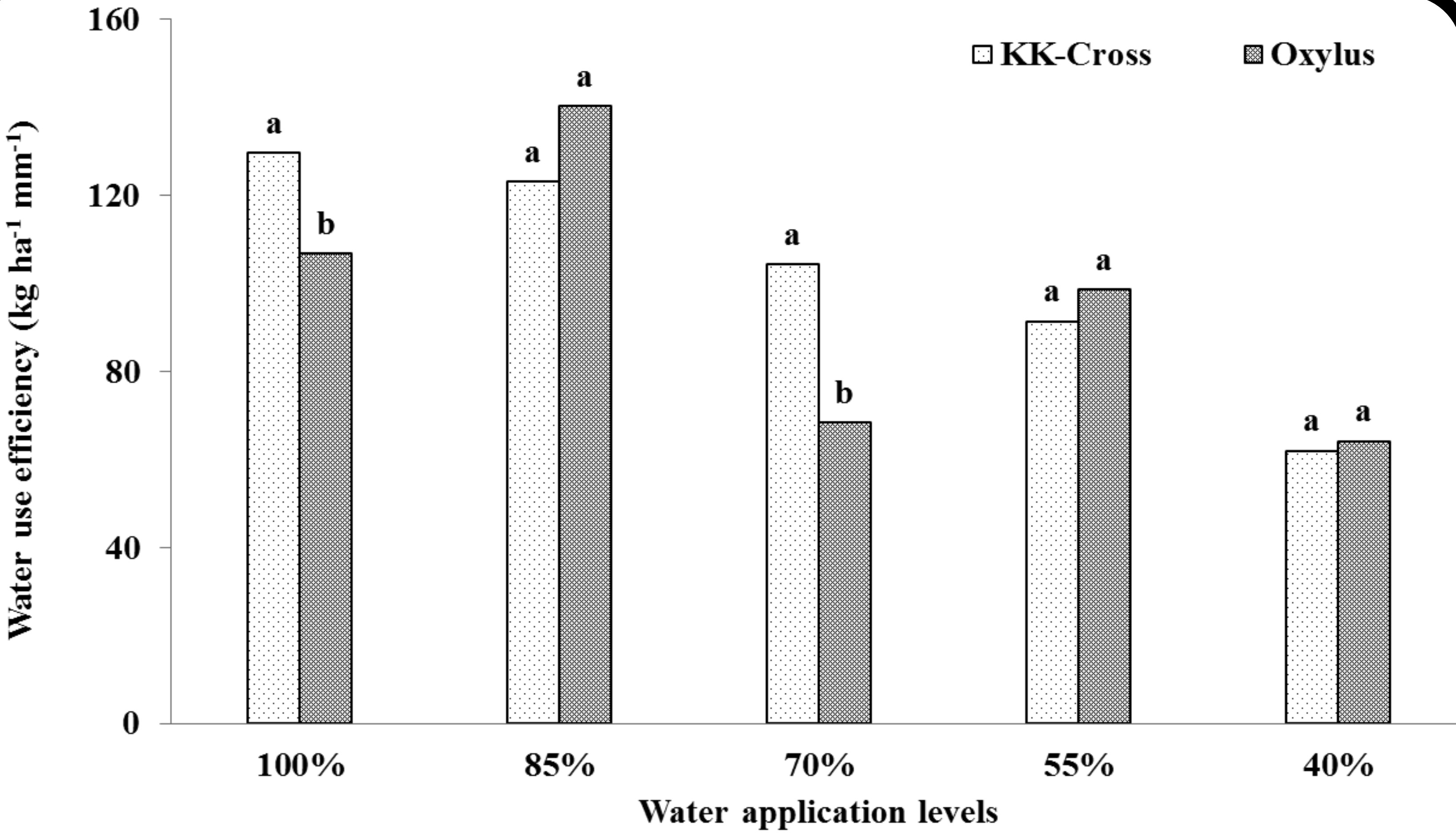


Figure 7. Water use efficiency of cabbage cultivars K-K Cross and Oxylus, based on total fresh yield (TFY), at different levels of applied water. Bars with the same letters were not significantly different at $P \leq 0.05$.

RESULTS (8/11)

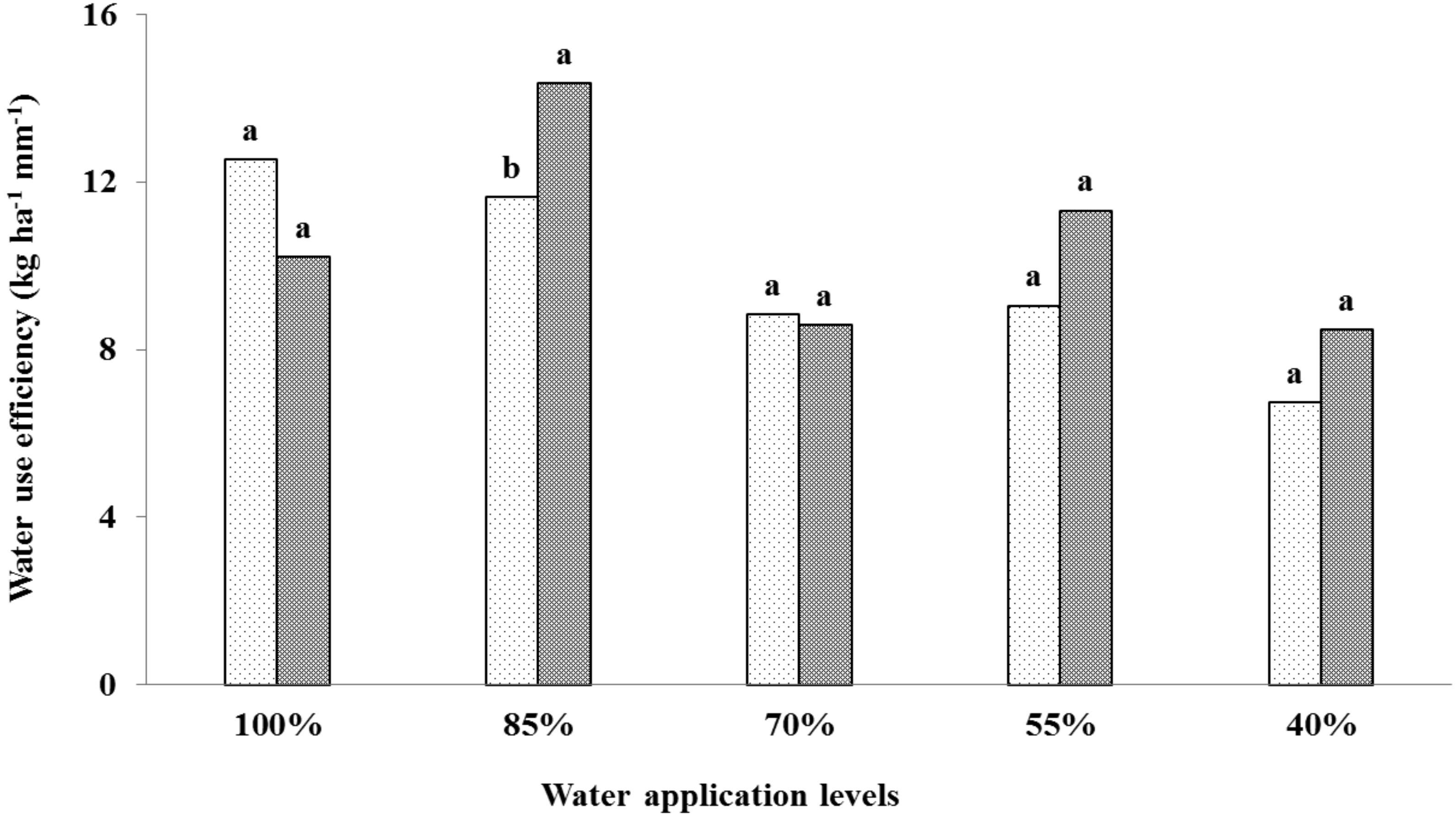


Figure 8. Water use efficiency of cabbage cultivars K-K Cross and Oxylus, based on total dry matter (TDM), at different levels of applied water. Bars with the same letters were not significantly different at P ≤ 0.05.

RESULTS (9/11)

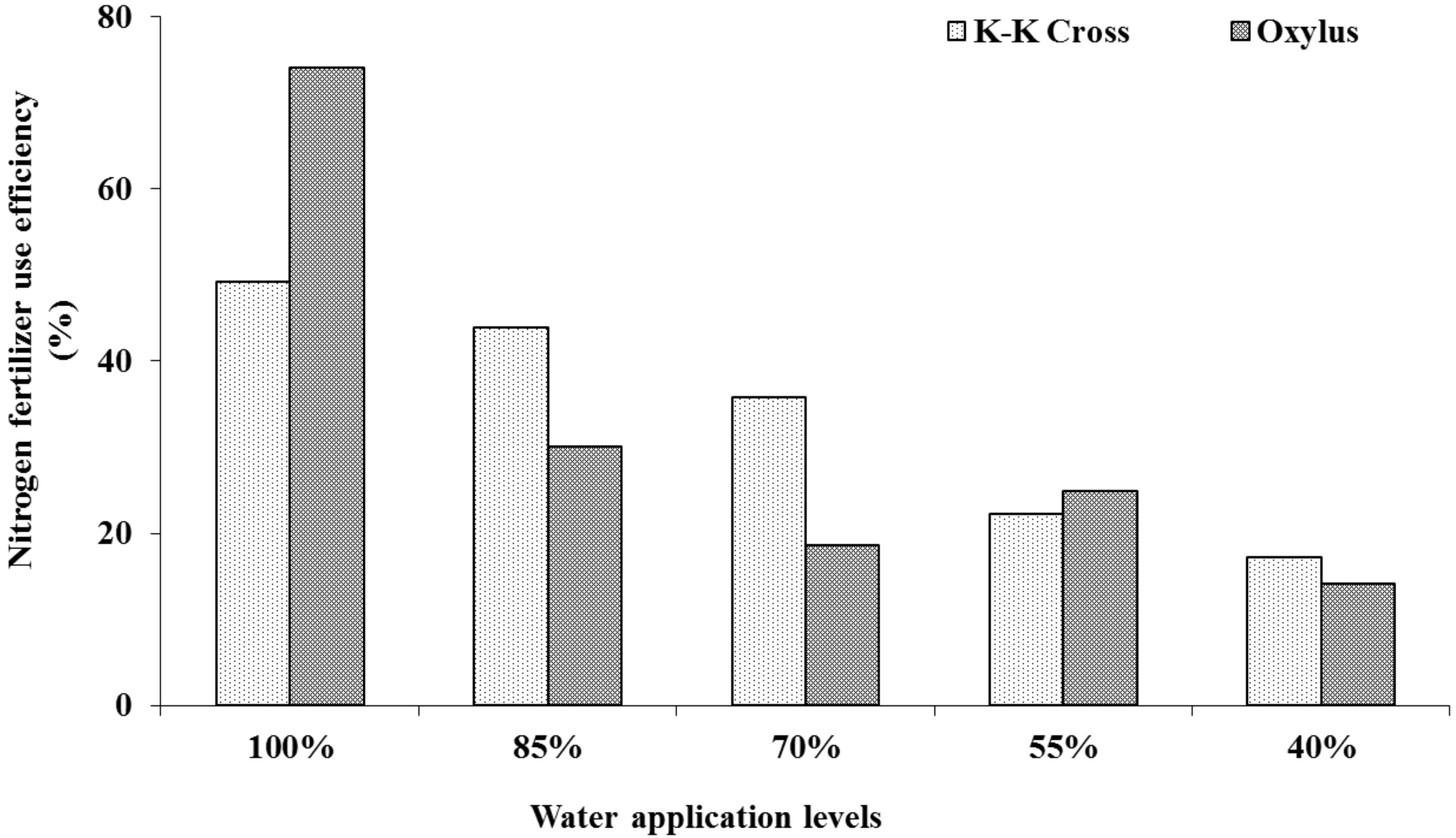


Figure 9. Nitrogen fertiliser use efficiency of cabbage cultivars K-K Cross and Oxylus at different levels of applied water.

RESULTS (10/11)

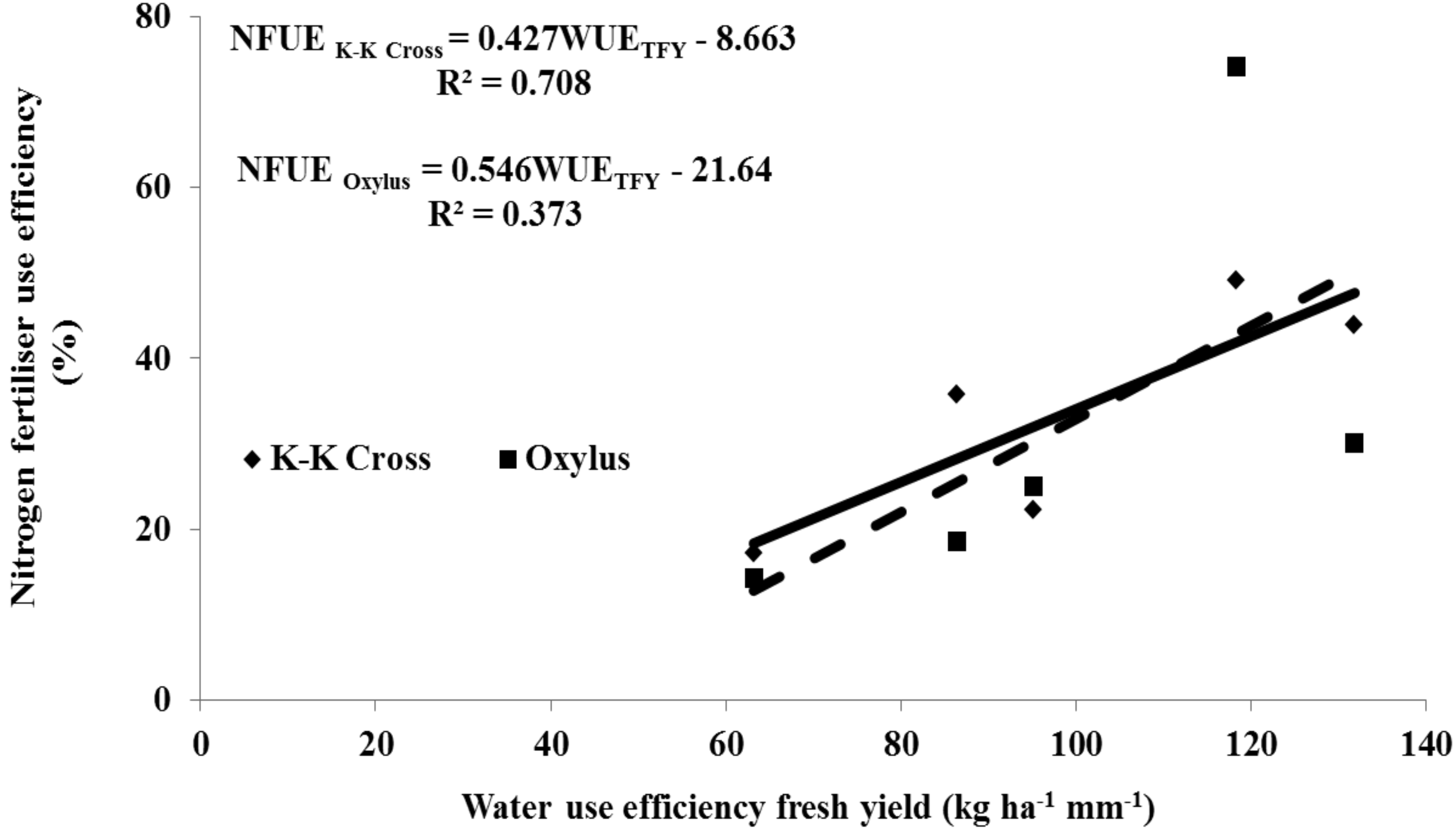


Figure 10. Relationship between nitrogen fertiliser use efficiency and water use efficiency, based on total fresh yield, for K-K Cross and Oxylus.

RESULTS (11/11)

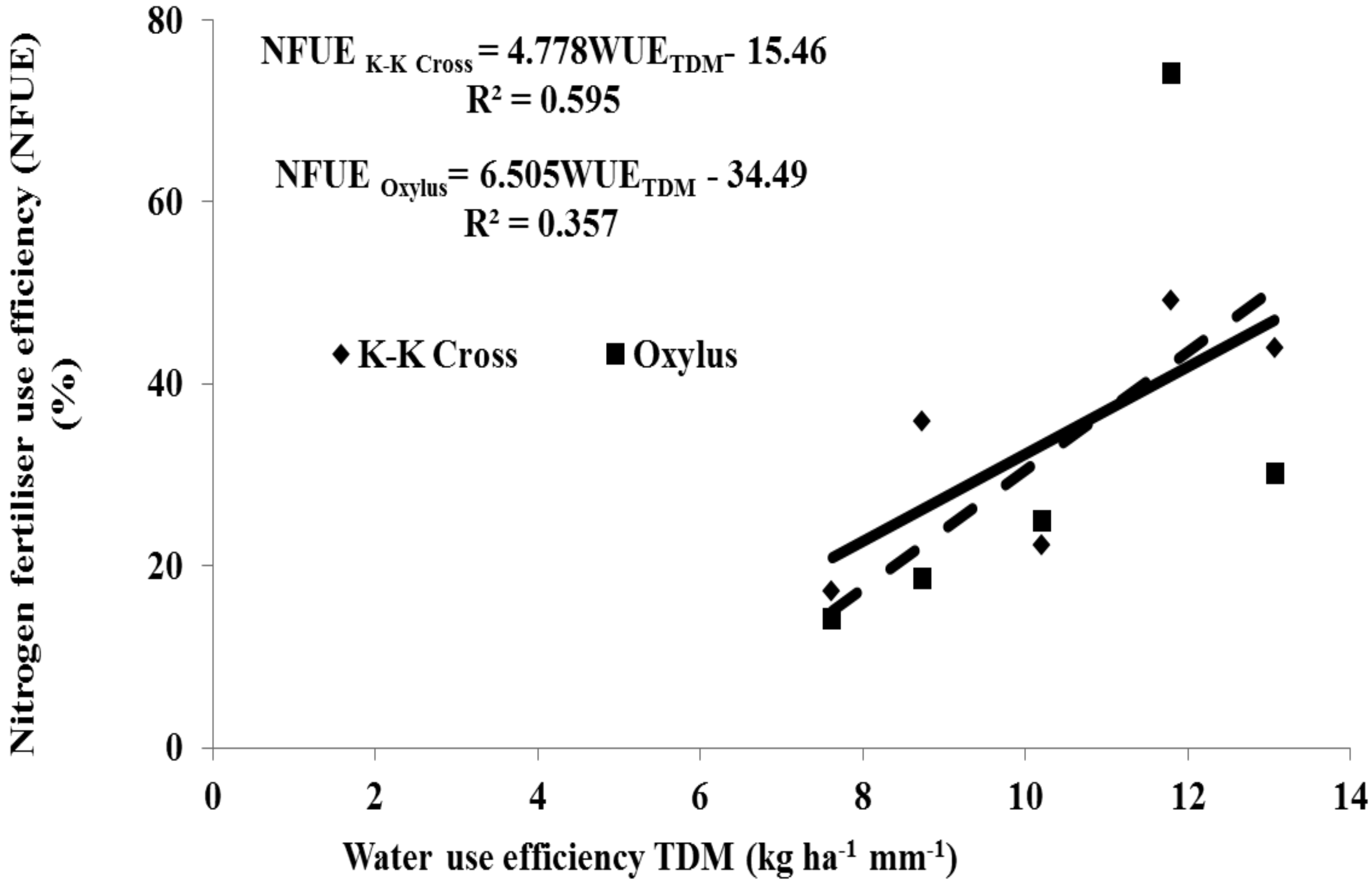


Figure 11. Relationship between nitrogen fertiliser use efficiency and water use efficiency, based on total dry matter yield, for K-K Cross and Oxylus.

DISCUSSION (1/3)

- Fresh yield, ranging between 11 t ha^{-1} and 47 t ha^{-1} across the different levels of applied water, was in agreement with 10-50 t ha^{-1} reported by Lannoy (2001).

- However, this range of values for fresh yield was higher than the 5.5-7.7 t ha^{-1} obtained by Ogbodo *et al. (*2009) under rainfed conditions in Nigeria and also higher than 18-28 t ha^{-1} reported by Obeng-Ofori *et al*. (2007) in Ghana.

- TDM range of 1.2-4.6 t ha^{-1} was higher than 0.3-0.8 t ha^{-1} observed by Ogbodo *et al*. (2009) under rainfed conditions but was within the range of 1.5-10.5 t ha^{-1} for red cabbage grown under mulches (Franczuk *et al*., 2009).

DISCUSSION (2/3)

- The range of WUE_{TFY} values for the cabbage crops, 64.30-140.40 kg ha^{-1} mm^{-1} , is higher than that (39.00-66.00 kg $ha^{-1}mm^{-1}$) reported by Imtiyaz (2000).

- However, the observed WUE_{TFY} values for the cabbage crops are far lower than the 427.00 kg ha^{-1} mm^{-1} reported by Tiware *et al*. (2003) for cabbage grown under drip irrigation with mulch.

- The range of WUE_{TDM} values for the cabbage crops, 6.76-14.37 kg $ha^{-1}mm^{-1}$, is in agreement with 12.00 kg ha^{-1} mm^{-1} reported by Beletse *et al*. (2009) for irrigated cabbage.

DISCUSSION (3/3)

- NFUE decreased from 61.7% at 100% water application level to 18% at the 40% water application level.

- NFUE value of 73.0% for Oxylus was higher than 42.0% reported by Sturm *et al*. (2010) for cabbage and 46.8% reported by Bing *et al*. (2005) for Chinese cabbage.

- NFUE generally increased with increasing WUE, emphasizing the importance of adequate soil water, based on appropriate water management strategies, for ensuring enhanced recovery of applied N by cabbage.

CONCLUSION

- Yield, TDM, WUE and NFUE of drip irrigated cabbage generally increased with increasing levels of applied water.

- Thus, the productivity of cabbage could be enhanced through efficient use of applied N through adoption of good management strategies capable of promoting effective and efficient use of applied water as ensured by drip irrigation technology.

Vegetable farmers observing cabbage being grown under small-scale drip irrigation system

ACKNOWLEDGEMENT

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THANK YOU