

2012 International Conference on Modern Hydraulic Engineering

Multivariable Linear Regression Equation for Rice Water Requirement based on Meteorological Influence

ZHU Shi-jiang^{a,c}, SUN Ai-hua^b, ZHANG Zhong-xue^{a,c}, WANG Bin^{a,c}, a*

^a*School of Water Conservancy and Civil Engineering, Northeast Agricultural University, Harbin 150030, China;*

^b*College of Hydraulic & Environment Engineering, China Three Gorges University Yichang 433002;*

^c*Key Laboratory of Agricultural Water Resources Use, Ministry of Agriculture, P.R. China*

Abstract

The paper firstly analyzed meteorological influences on rice water requirement referring to temperature, wind speed, air saturation deficit and sunshine hours. Then, it analyzed the other meteorological factors' influences. Through introduction of natural water surface evaporation factor, a multivariable linear equation with five variables was established for rice water requirement. A five variable linear equation model, FAO56 Penman-Monteith formula and a four variable linear equation which don't have natural water surface evaporation factor were used to calculate rice water requirement in cold areas. It shows that multivariable linear equation with five variables has a more accuracy, compared with Penman-Monteith formula and four variable linear equation. As a regional empirical formula, the five variable linear equation can be applied in cold area.

© 2012 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of Society for Resources, Environment and Engineering

Keywords: crop water requirement; water-saving irrigation; Penman-Monteith formula; meteorological factors; multivariable linear regression equation; irrigation planning; rice water-saving irrigation; mathematical model. Introduction

1. Introduction

Rice water consumption includes water requirement and leakage. Rice water requirement consists of transpiration and evaporation, which has an important influence on yield. Rice water requirement is the theoretical basis of rice water-saving irrigation and optimizing the allocation of farm water resource. For rice irrigation zone planning, design, management and forecasting, water requirement is an essential basic

* Corresponding author :ZHANG Zhong-xue. Tel.:+86-451-55191285;
E-mail address: zhangzhongxue@163.com

data. Thus, research on rice water requirement mathematical model and accurate calculating rice water requirement have not only theoretical significance but also practice value.

Through mechanism analysis of meteorological influence on rice water requirement, the natural water surface evaporation factor was introduced and the multivariable linear equation with five factor was established, based on four variable linear equation. Five variable linear equation model, FAO56 Penman-Monteith formula and four variable linear equation were used to calculate rice water requirement in cold area. It shows that five variable linear equation has a more accuracy, compared with Penman-Monteith formula and four variable linear equation.

2. Analysis of meteorological influence on rice water requirement

Rice water requirement is comprehensive affected by aspects of SPAC [1]. Among them, meteorological factors are major factors which affect rice water requirement. Relative research showed that temperature, air saturation deficit, sunshine hours and wind speed has the greatest impact.

Solar radiation is the source of all energy on Earth and unique source of crop evapotranspiration. It plays a key role in crop water requirement.

Due to absorption of solar radiation, Earth surface accumulates heat and temperature increases, which, at the same time, Earth surface radiate heat to atmosphere as long-wave radiation. According to radiation law, the radiation density of object is proportional to its fourth power. So, greater solar radiation, more heat absorption and accumulation of surface, greater long-wave radiation density from Earth surface to atmosphere. So, when solar radiation becomes greater, long-wave radiation becomes greater, energy absorption by atmosphere becomes more and temperature increases. Thus, temperature closely relates to atmospheric radiation and also closely relates to crop evapotranspiration.

Rice evapotranspiration consists of plant transpiration and evaporation among plants. The vapor pressure of evaporation surface which referring to leaf surface and water surface among plants is saturated or close to saturated. The vapor pressure of any surface which has some height from evaporation surface is actual vapor pressure, always less than saturation vapor pressure. Under gradient of saturation vapor pressure and actual vapor pressure, also called saturation deficit, water molecules spreads from evaporation surface into air. Thus, rice water requirement is affected by air saturation deficit. Some researchers showed that rice water requirement is proportional to air saturation deficit [2] [3] [4].

Rice is yoshimitsu crop and has high light compensation point and saturation point. Within a certain range, photosynthesis increases with the strengthening sunshine, following by metabolic process is enhanced which referring to root water uptake, body water delivery and leaf stomata opening. It results to enhancing transpiration. Studies have shown that sunshine hours has a linear relationship to rice water requirement [1] [3].

Water vapor from field need help of water vapor gradient and wind swirling action to spread into atmosphere. Only when water vapor gradient exists, the evaporation can continued to proceed. Thus, wind speed has some certain influence on water vapor flow over rice field. In the case of no wind, air humidity over rice field is higher and the water vapor gradient is smaller. In the case of wind, lower air humidity and greater water vapor gradient. It shows wind speed makes the water vapor gradient increase. Besides, wind can make temperature gradient between leaf and air increase, resulting to rice water requirement increasing.

Among all of meteorological factors, the other ones except those above, such as rainfall, relative humidity and so on, affect rice water requirement too. Those influences are less, but their processes are compacted. Because rice water requirement is also a kind of evaporation, its nature is the same to natural water surface evaporation which is a basic data in meteorological monitoring [5]. Because of the linear relationship between rice water requirement and natural water surface evaporation, the function of natural

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات