ABSTRACT

Improvement of sprinkler irrigation performance under Egyptian conditions

M. A. M. Ahmed

2010

Understanding the distribution characteristics of an individual irrigation sprinkler or spray nozzle is necessary to improve the uniformity of any sprinkler system. Relevant factors affecting the improvement of the irrigation performance of sprinkler systems are the engineering factors (i.e. operating pressure, riser height of sprinkler / nozzle, sprinkler type, deflector plates, and nozzle diameter) and the climatic factors (i.e. wind speed, air humidity and air temperature). It is important to highlight that this study has been focused on center pivot sprinkler irrigation system as it is the widely used sprinkler irrigation system in new lands of Egypt (Toshka, Sinai and Nobaria). Therefore, in addition to four types of rotating sprinkler heads, five different types of spray nozzles, used on center pivot irrigation system, have been tested and evaluated.

Several outdoor single -sprinkler and overlapped -sprinkler irrigation tests have been conducted for determining: water application rate, uniformity of water distribution, and application efficiency, under different engineering and climatic conditions.

Various sprinkler type – pressure –-riser height combinations were used and weather conditions (i.e. air temperature, relative humidity, and wind speed) were measured during the test.

A statistical approach has been used with these data to estimate water distribution uniformity coefficient CU, and water application efficiency AE, using a multiple regression analysis.

CU and AE as sprinkler irrigation performance parameters were estimated as functions of the sprinkler type, nozzle characteristics, riser height, operating pressure, and wind speed. Other climatic and engineering factors were not of significant effect on the CU or AE in this study. The model can be a useful tool to select the operational conditions suitable for certain environmental conditions leading to improve water distribution uniformity CU and water application efficiency AE.

TABLE OF CONTENTS

4. RESULTS AND DISCUSSIONS.

LIST OF ABBREVIATIONS

A:	Wetted area (m^2)
AE:	Water application efficiency (%)
AITC:	Australlian for Irrigation Tecnology Center
ASAE:	American Society of Agricultural Engineers
CIT :	Center for Irrigation Tecnology
CP:	Center pivot
CPED:	Center pivot evaluation and design
CU:	Christiansen's coefficient of uniformity (%)
CV:	Coefficient of variation (%)
DUlq:	Distribution uniformity low quarter (%)
fd:	Feddan = 4200 m^2
FSPS:	Fixed spray plate sprinkler
Iav:	Average application rate (mm/h)
Ic:	Average application rate by catch cans (mm/h)
Imax:	Maximum application rate (mm/h)
Imin:	Minimum application rate (mm/h)
IPTRID:	International Programme for Technology and Research Irrigation and Drainage
ISAAC:	Irrigation System Analysis and Computation
Ith:	Theoretical application rate (mm/h)
i-Wob (6G):	Wobbler spray nozzle plate with six grooves
LEPA:	Low energy precision application
LESA:	Low elevation spray application
LPIC:	Low pressure in-canopy
MESA:	Mid elevation spray application

P:	Operating pressure (MPa)
PAE_{lq}:	Potential application efficiency low quarter (%)
PivNoz:	Pivot Nozzle program
Psi:	Pound per square inch
Pw:	Pattern width (m)
Qapp:	Applied discharge (m³/h)
Qm:	Measured discharge (m³/h)
Qs:	Sprinkler discharge (m³/h)
r :	The ratio of the peak rate to the average rate
R3000 (6G):	Rotator spray nozzle plate with six grooves
Ra:	Average application rate (mm/h)
RB:	Rain Bird sprinkler head
R.C 160 N:	Name of sprinkler head
Re:	Effective radius (m)
RH:	Relative humidity (%)
R/m:	Distance between catch cans (m)
Rp:	Peak application rate (mm/h)
RSPS:	Rotating spray plate sprinkler
S3000 (6G):	Spinner spray nozzle plate with six grooves
SB:	Straight Bore
SCS:	Soil Conservation Service
T:	Air temperature (C^{o})
VYR:	Vyrsa (name of sprinkler head)
W:	Wind speed (m/s)