

ГОДИШНИК НА УНИВЕРСИТЕТА ПО АРХИТЕКТУРА, СТРОИТЕЛСТВО И ГЕОДЕЗИЯ – СОФИЯ

Юбилейна приложна научно-техническа конференция
„65 години Хидротехнически факултет и 15 години немскоезиково обучение”

6–7 ноември 2014
6–7 November 2014

International Jubilee Conference
„65th Anniversary Faculty of Hydraulic Engineering and 15th Anniversary Hydraulic Engineering in German”

ANNUAL OF THE UNIVERSITY OF ARCHITECTURE, CIVIL ENGINEERING AND GEODESY – SOFIA

XLVII ^{TOM}
vol.

2014

сб.
fasc. I-B

DISTRIBUTION OF ARTIFICIAL RAIN'S INTENSITY ON THE IRRIGATED SURFACE, RELATION WATER – YIELD AND EFFECT OF IRRIGATION

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***Keywords:** sprinkler irrigation, artificial rain's intensity and quality, distribution function of intensity, relation water – yield, effect of irrigation, simulated numerical study*

***Research area:** irrigation and drainage engineering*

ABSTRACT

In the work are compared in dimensionless form the obtained in also represented at the Conference reports [1, 2] discrete distribution function of intensity $i(S)$, mm/h of artificial rain on the irrigated surface S for a square and triangular scheme of sprinklers placement and the relation water – yield, as simulated numerically is determined the effect of irrigation with a introduced coefficient CE , and through it are evaluated the schemes of sprinklers placement and the examined irrigation equipment qualities.

1. Summary, object of the study

This study *completes* obtained before an algorithm, a logical bloc-scheme and program for numerical simulated artificial rain quality's determination. With them are determined the uniformity with the Christiansen's coefficient CU and variation's coefficient C_V , the rain's intensity i , mm/h and the function $i(S)$ of its distribution on the irrigated surface S for ring rotated identical sprinklers, located in square or triangular (rhombus) scheme with known function $i(r)$ of rain change's intensity on the length of the radius of action R , and with an *arbitrary* side a of the square or triangle and number c of

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with *the same* for the whole surface fallen water layer h_m , mm of water height and with the *same* intensity $i_m = h_m / t$, mm/h. Because 1 mm of water height corresponds to 10 m³/ha, the intensity may be determined by

$$i_m = \frac{10}{t} \cdot m, \quad \text{where } i_m \text{ is in mm/h; } m \text{ is in m}^3/\text{ha and } t \text{ is in h,} \quad (1)$$

or the relation water-yield $Y_{ad} = f(M)$ under the above assumptions could be consecutively replaced by $Y_{ad} = f(m)$ and by the equivalent to him function $Y_{ad} = f(i)$;

– for $M = M_{\max}$ each $m_i = m_{i,\max}$ also *totally fills* the capacity of the water reservoir of the active soil layer with change of soil's wet from the lower limit of the optimum water security to the maximum field humidity, *without drainage* to groundwater, as *equally* participates in the formation of $Y_{ad,\max}$, when the incoming water is distributed *uniformly* over the irrigated surface S .

– for sprinkler irrigation however the adopted uniform distribution of the given water on the surface S for the determining of M_{\max} and its corresponding yield $Y_{add,\max}$ can't be accomplished, because of the type of the characteristic $i_{spr}(r)$ and the different overlapping of the streams of sprinklers, situated in corners of square (triangular) scheme with a different side size a . For the different measuring points (vessels) is obtained dispersion in intensity's $i_{spr,i}$ values, compared to the average $i_{spr,m}$, given by the distribution function $i_{spr}(S)$. Or by the relation $Y_{ad} = f(i)$ for $i_{spr,i} \geq i_m$ is formed a component, corresponding to yield $Y_{add,\max}$ (when $i_{spr,i} > i_m$ the more water is drained down unused), and for $i_{spr,i} < i_m$ is formed a component, corresponding to yield $Y_{add} < Y_{add,\max}$, reading by the function $Y_{ad} = f(i)$;

– the function $Y_{ad} = f(i)$ is presented in *relative* quantities with $Y_{*ad} = f(i_*)$ and has the limit values $Y_{*ad} = 0$ for $i_* = 0$ (for $m = 0$) and $Y_{*ad,\max} = 1$ for $i_{*m} = 1$ (of m_{\max} , which *fills* the water reservoir of the active soil's layer, in sprinkler irrigation *responds not maximum but middle intensity* i_{*m}), and $Y_{*ad} = f(i_*)$ is *linearized by sections* (g in number) with an equal horizontal length;

– are coincided the value of the middle rain's intensity i_m , fallen on the sprinkled surface S , calculated by the ratio $i_m = V / S$, where V is the rain's volume per hour, fallen on S , and the average of values $i_{i,spr}$ in different measuring points, enough in number;

– only vertically is filtered in soil the fallen artificial rain without diffusion out of the way, what *silently is accepted* also when are determined the Christiansen coefficient and other similar coefficients;

– the yield losses due to less given water fields, when is optimized the regime of irrigation (when specially are reduced the number or the size of the single irrigation norms m_i) are studied in the given above conditions and assumptions without optimization modes.

– if the conditions under sprinkling with the individual single norms m_i are different, the study is conducted separately for each norm m_i and is determined their average efficiency coefficient CE , taking into account their relative weight in his formation.

– with $Y_{ad}(i)$ are marked values of additional yield as a function of intensity i in the dependence intensity-yield, and with $Y_{add}(x,y)$ – values of the additional relative yield in the measuring points as a function of coordinates (x,y) , which are reading by $Y_{ad}(i)$.

3. Sequence and algorithm of the solution

The study is conducted in the following sequence:

Input data are the obtained in reports [1,2] discrete distribution's function $i(S)$ of intensity i , mm/h of rain, fallen on the irrigated surface S of the square in a square scheme, respectively of the triangle (rhombus) in a triangular scheme of deploy of sprinklers, and the compared with it water-yield relation $Y_{ad} = f(m_{spr})$ - additional yield of given in the irrigation water. This relation is most frequently presented graphically and in the study is linearized by sections (g in number) with an equal horizontal length – is replaced by sections of straight lines within the scope $0 \div Y_{ad,max}$, divided into g equal parts.

At the simulate determining of the intensity i in reports [1,2] the fictive measuring points (vessels) are disposed on the irrigated surface S according to the standard GOST ISO 7749-2-2004 with number of points n in line and number of points n in column (inclined column in triangular scheme) with total number of points $c = n^2$. In reports [1,2] is given in detail (with algorithm, block-scheme and computer program with a concrete example) the obtaining of the discrete function $i_*(S_*)$ of distribution of intensities i_{*i} over the surface S_* for arbitrary introduced (given, accepted) function $i_*(r)$ of rain change's intensity on the length of sprinkler's radius of action R , number n of fictive measuring points (vessels) in line and in column and side size a of square or of triangle (rhombus). The function $i_*(S_*)$ includes the obtained intensities i_* in all measuring points, presented in the program with values $ii(x,y)$ for $x=1, 2, \dots, n$ and $y=1, 2, \dots, n$, where x and y are the relative coordinates of measuring points, which coordinates are relating to the introduced right oriented coordinate system with x axis, coincided with the base of square (triangle) and start the place of Sprinkler 1, located in its lower left corner.

Due to the symmetry in the scheme of measuring points (vessels) and sprinklers placement, and due to their identical characteristics, the function $i_*(S_*)$ includes a determined number Gr of separate groups of measuring points with the same values of i_* , but with different repeat, frequency F (with different relative part, percentage to the total number of points), as for the square scheme they are

– when n is an even number $Gr_e = Gr_{e,1} + Gr_{e,2} = n/2 + \sum_{i=1}^{n/2-1} (n/2-i)$ with

$$F = 4 * 100 / Gr_{e,1}, \% \text{ for } Gr_{e,1} = n / 2 \text{ and } F = 8 * 100 / Gr_{e,2}, \% \text{ for } Gr_{e,2} = \sum_{i=1}^{n/2-1} (n / 2 - i),$$

$$\text{– when } n \text{ is an odd number } Gr = 2 * (n / 2 - 0,5) + \sum_{i=1}^{n/2-1,5} (n / 2 - 0,5 - i) + 1 \text{ with}$$

$$F = 4 * 100 / Gr, \% \text{ for } 2 * (n / 2 - 0,5) \text{ and } F = 8 * 100 / Gr, \% \text{ for } \sum_{i=1}^{n/2-1,5} (n / 2 - 0,5 - i),$$

and for the central (one) point $F = 1 * 100 / n^2, \%$.

For a triangular (rhombus) scheme the number Gr_i of groups and their corresponding frequencies F_i are analogically determined and their dependencies are used and included in prepared computer program.

The values of Gr and F permit to estimate the density Gr / c (the number of groups, each with the same values of the intensity in the measuring points, compared to their total number) of grouped discrete values of $i_*(S_*)$, located in the interval of variation of i_* from zero to i_{*max} and the repetition in each group, and so can be evaluate the degree of precision of discretization (the influence of value of n on the sprinkling's effect determination with introduced coefficient CE of efficiency of sprinkling (of irrigation)).

The given (obtained, accepted) function $Y_{ad} = f(M)$ of additional yield, result of the artificially given water, transformed in $Y_{*ad} = f(i_*)$ and obtained discrete function $i_*(S_*)$ of distribution of the intensity i_* on the sprinkled surface are compared, as for each intensity $i_{*i}(x, y)$ (or each group Gr_i of intensities $i_{*i}(x, y)$ with frequency F_{*i}) from $Y_{*ad} = f(i_*)$ is reading $Y_{*add,i}(x, y)$ - its responded part of additional relative yield. The total effect on the yield of all $Y_{*add,i}(x, y)$, or of all groups Gr_k with equal intensities $i_{*k}(x, y)$ (their weight is given with the product of $F_{*k} \cdot Y_{*add,k}$) may be presented with a coefficient of efficiency CE :

$$CE = \frac{1}{c} \cdot \sum_{i=1}^c Y_{*add,i}(x, y) = \sum_{k=1}^{Gr} Y_{*add,k} \cdot F_{*k} \quad (1)$$

It is evident that the coefficient of efficiency CE coincides with the additional yield, presented in relative quantity or in percentage toward the maximum possible yield, responded to uniform irrigation with the same intensity $i_i(x, y) = i_m = const$ for the whole irrigated surface.

The function $Y_{*ad} = f(i_*)$, it is repeated, is linearized by sections (g in number) with an equal horizontal length (with full scale 0÷1 of change of Y_{*ad} , divided in g equal parts!).

Figure 2 presents the dependence's output between the obtained in reports [1, 2] intensities' $i_{*i}(x, y)$ of function $i(S)$ of their distribution on the sprinkling surface S and their corresponding values of parts of relative yields $Y_{*add,i}$ from the linearized function

$Y_{*ad} = f(i_*)$. The values of Y_{ad} (Y_{*ad} in a dimensionless form) on the borders of the parts when increase the value of Y_{ad} , are $Y_{ad}(1), Y_{ad}(2), \dots, Y_{ad}(j), Y_{ad}(j+1), \dots, Y_{ad}(g)$ and $Y_{ad}(g+1)$, as the last two values enclose the g -th section (using relative quantities they are $Y_{*ad}(1), Y_{*ad}(2), \dots$ etc.). The j -th section of $Y_{ad} = f(i)$ (respectively of $Y_{*ad} = f(i_*)$ in relative values) is examined, bounded by $Y_{ad}(j)$ and $Y_{ad}(j+1)$ with intensity $i_*(x, y)$ inside in it, and corresponding additional relative yield $Y_{*add}[i_*(x, y)]$ of the linearized part and

– when $Y_{ad}(j+1) = Y_{ad}(j)$, inside the j -th part $Y_{add}[i(x, y)]$ (respectively $Y_{*add}[i_*(x, y)]$) has the same constant value:

$$Y_{add}[i(x, y)] = Y_{ad}(j) = Y_{ad}(j+1) \text{ when } Y_{ad}(j+1) = Y_{ad}(j), \quad (2)$$

– when $Y_{ad}(j+1) > Y_{ad}(j)$ $Y_{add}[i(x, y)]$ is determined by the scheme of Fig.2;

– no cases with $Y_{ad}(j+1) < Y_{ad}(j)$, because $Y_{ad}(i)$ is increased function.

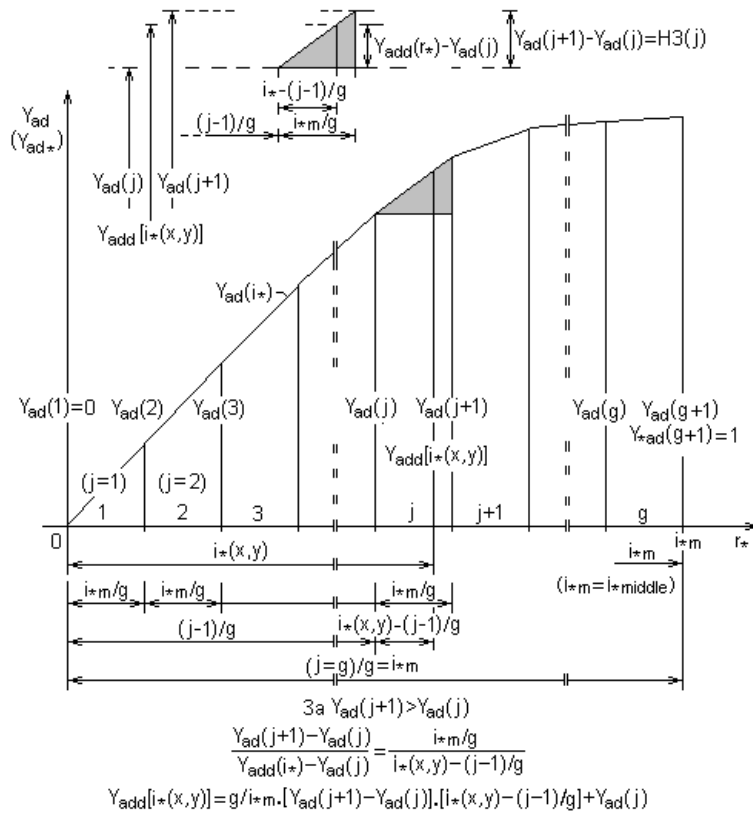


Fig. 2. Determination of the part of additional yield $Y_{add,j}[i(x, y)]$ for the j -th section of $Y_{ad}(i)$

The j -th section of $i_*(x, y)$ in Fig.2 is examined. The catheti's proportion of the two dark similar triangles included into each other (leaded also at the side), gives when $Y_{ad}(j+1) > Y_{ad}(j)$:

$$Y_{add}[i_*(x, y)] = g / i_{*m} \cdot [Y_{ad}(j+1) - Y_{ad}(j)] \cdot [(i_*(x, y) - (j-1) / g) + Y_{ad}(j)]. \quad (3)$$

For $i_* > im_*$, where im_* is the middle relative intensity, the value of the part (component) $Y_{*add,j}[i_*(x, y)]$ of the relative additional yield, result of sprinkling, already correspond to

$$Y_{*add,j}[i_*(x, y)] = Y_{*add,max} = 1 \text{ for } i_* > im_* . \quad (4)$$

When the values of the intensities $i_{*i}(x, y)$ are reduced with a reduction coefficient $k_r \leq 1$ to $i_{*i,red}(x, y) = k_r \cdot i_{*i}(x, y)$, to them correspond and with them according to the presented algorithm are calculated reduced yields $Y_{*add,red,i}[i_{*red,i}(x, y)]$, result of given reduced single norms of irrigation $m_{red,i} = k_r \cdot m_{i,max}$. So It can be determined the relative yield losses of given reduced not enough water.

$$Y_{*add,red,i}(x, y) < Y_{*add,i}(x, y) \text{ for } k_r < 1, \text{ when } i_{*red,i}(x, y) < i_{*i}(x, y). \quad (5)$$

The last part of the algorithm includes a calculation of the coefficients of yield's efficiency CE and of corresponded of $Y_{*add,red}$ coefficient CE_{red} , according to eq. (1).

4. Logical bloc-scheme of the program

The presented in Fig.3 logical bloc-scheme of the prepared *extension* of computer programs SPR7.BAS and SPR8.BAS, given in reports [1,2], is realized in according to the developed algorithm. It visually gives the succession of computing operations for determining the distribution intensity's function $i(S)$ and the yield's efficiency coefficients CE and CE_{red} . It permits also in the base of this algorithm to improve the research and develop another programs with analogical direction, possibly used another programming language.

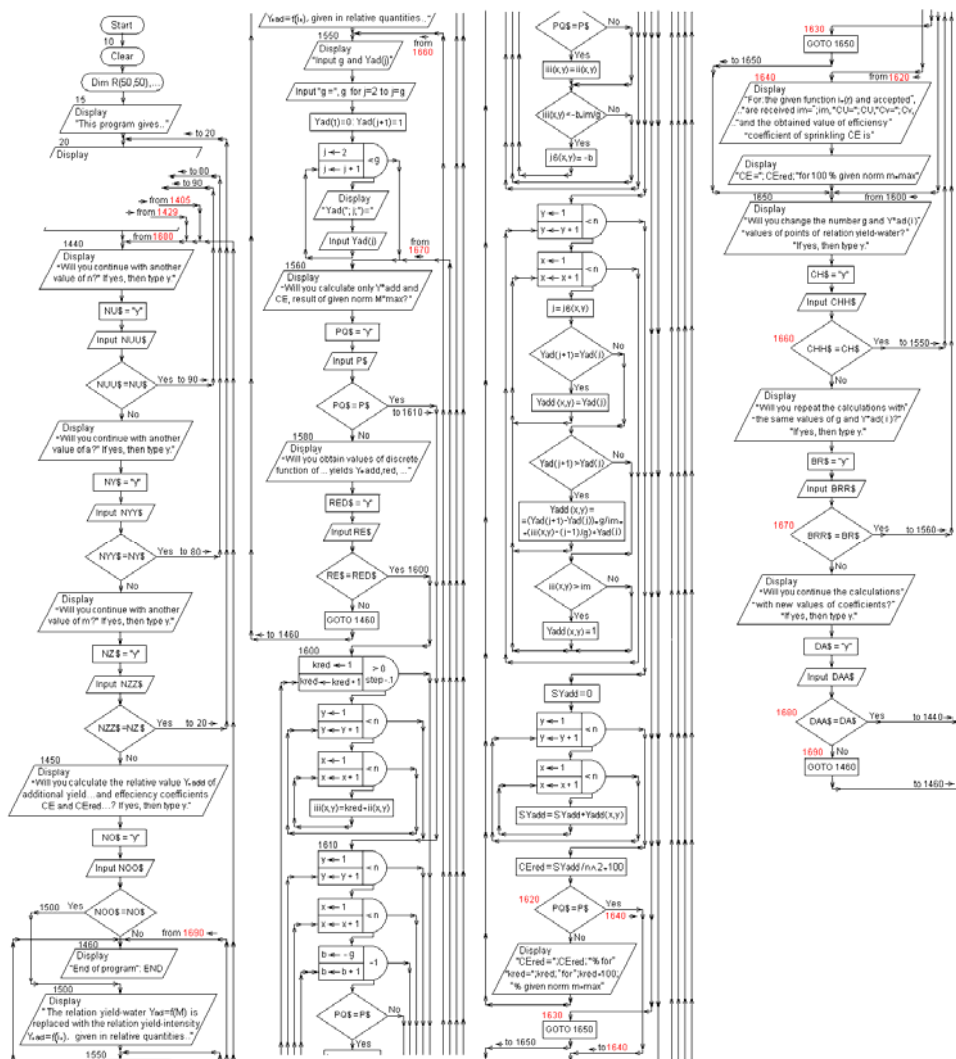


Fig. 3. Logical bloc-scheme of the computer programs' SPR7.BAS and SPR8.BAS extension

5. Extension of programs SPR7.BAS and SPR8.BAS

The programs are written in BASIC language.

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10 CLEAR : DIM R(50, 50), j1(50, 50), i1(50, 50), j2(50, 50), i2(50, 50), j3(50, 50),
i3(50, 50), j4(50, 50), i4(50, 50), ii(50, 50), iii(50, 50), j6(50, 50), d(50, 50),
Yadd(50, 50), Yaddred(50, 50), p(50), q(50), kr(50)
15 PRINT " ", This program gives the values of Christiansen coefficient CU and the"
.....
.....

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1440 PRINT " ", "Will you continue with another value of n? If yes, then type y."
      NUS = "y": INPUT NUUS$: IF NUUS$ = NUS$ THEN 90
      PRINT "Will you continue with another value of a? If yes, then type y."
      NY$ = "y": INPUT NYYS$: IF NYYS$ = NY$ THEN 80
      PRINT "Will you continue with another values of m and i(j)? If yes, then type
y."
      NZ$ = "y": INPUT NZZ$: IF NZZ$ = NZ$ THEN 20
1450 PRINT " ", "Will you calculate the relative values Y*add and Y*add,red of"
      PRINT "additional yield, result of sprinkling, and also the sprinkling"
      PRINT "efficiency coefficients CE and CErEd, using a given/accepted"
      PRINT "relation water-yield? If yes, then type y."
      YOS = "y": INPUT YOO$: IF YOO$ = YOS$ THEN 1500
1460 PRINT "End of program": END
1500 PRINT "The relation water-yield  $Y_{ad}=f(M)$  is replaced with the relation"
      PRINT "yield-intensity  $Y_{ad}=f(i^*)$  given in relative quantities,"
      PRINT "presented with a linear in parts approximation with the range of"
      PRINT "variation of  $i^*$ , divided in g equal parts and the  $Y_{ad}$  values in"
      PRINT "their borders are  $Y_{ad}(j)$ ,  $j=1,2,\dots,g+1$ , in  $i^*$  increase direction."
      PRINT "For  $i^*=0$  the additional yield is  $Y_{ad}=0$  and for medial intensity"
      PRINT " $i^*_m$  and above  $i^*_m$  the additional yield is  $Y_{ad,max}=1$ ."
1550 PRINT " ", "Input g and  $Y_{ad}(j)$  for  $j=2$  to  $j=g$ ,"
      PRINT "as for  $j=1$   $Y_{ad}(j)=0$  and for  $j=g+1$   $Y_{ad}(g+1)=1$ ."
      INPUT "g=", g:  $Y_{ad}(1) = 0$ :  $Y_{ad}(g + 1) = 1$ 
      FOR j = 2 TO g
      PRINT " $Y_{ad}(, j; )=$ "
      INPUT  $Y_{ad}(j)$ 
      NEXT j
1560 PRINT " ", "Will you calculate only  $Y_{ad}$  and CE, result of given norm
 $M^*_{max}$ ,"
      PRINT "then type y.": P$ = "y": INPUT PQ$: IF PQ$ = P$ THEN 1610
1580 PRINT "Will you obtain values of discrete function of relative"
      PRINT "reduced additional yields  $Y_{ad,red}$ , dues to sprinkling with"
      PRINT "decreased single norms  $m^*_{red}$  of irrigation, i.e. with reduced"
      PRINT "intensities  $i^*_{red}(x, y)$  for values of reduce coefficient  $k_{red}$  from"
      PRINT "1 to 0 step -0,1? If yes, then type y."
      RED$ = "y": INPUT RES$: IF RES$ = RED$ THEN 1600
      GOTO 1460
1600 FOR  $k_{red} = 1$  TO 0 STEP -.1
      FOR y = 1 TO n
      FOR x = 1 TO n
       $iii(x, y) = k_{red} * ii(x, y)$ 
      NEXT x
      NEXT y
1610 FOR y = 1 TO n
      FOR x = 1 TO n
      FOR b = -g TO -1
      IF PQ$ = P$ THEN  $iii(x, y) = ii(x, y)$ 
      IF  $iii(x, y) < -b * im / g$  THEN  $j6(x, y) = -b$ 
      NEXT b

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NEXT x
NEXT y
FOR y = 1 TO n
FOR x = 1 TO n
j = j6(x, y)
IF Yad(j + 1) = Yad(j) THEN Yadd(x, y) = Yad(j)
IF Yad(j + 1) > Yad(j) THEN Yadd(x, y) = (Yad(j + 1) - Yad(j)) * g / im *
(iii(x, y) - (j - 1) / g) + Yad(j)
IF iii(x, y) > im THEN Yadd(x, y) = 1
NEXT x
NEXT y
SYadd = 0
FOR y = 1 TO n
FOR x = 1 TO n
SYadd = SYadd + Yadd(x, y)
NEXT x
NEXT y
Cered = SYadd / c * 100
1620 IF PQ$ = PS THEN 1640
PRINT "Cered="; Cered; "% for kr="; kr * 100; "% given norm m*."
NEXT kr
1630 GOTO 1650
1640 PRINT " ", "For:"
PRINT "the given function i*(r) and accepted", "a="; a, "and n="; n
PRINT "are received", "im="; im, "CU="; CU, "Cv="; Cv, "and the i*"
PRINT "distribution function has"; Gr; "groups of discrete value points:"
PRINT "and the obtained value of the efficiency coefficient of sprinkling"
PRINT " ", "CE="; Cered; "for 100 % given norm m*max."
1650 PRINT "Will you change the number g and the Y*ad(i) values of points of"
PRINT "relation yield-water? If yes, then type y."
CH$ = "y": INPUT CHH$:
1660 IF CHH$ = CH$ THEN 1550
PRINT "Will you repeat the calculation with the same values of g and Y*ad(i)?"
PRINT "If yes, then type y.": BR$ = "y": INPUT BRR$
1670 IF BRR$ = BR$ THEN 1560
PRINT " ", "Will you continue the calculations with new values of
coefficients?"
PRINT "If yes, then type y.": DAS = "y": INPUT DAA$
1680 IF DAA$ = DAS THEN 1440
1690 GOTO 1460

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Example. With the lengthen program SPR7.BAS and data of examples included in reports [1,2], for a joint action in square scheme of four equal sprinklers ($m = 5$, $i_{1,*} = 1$, $i_{2,*} = 0,6$, $i_{3,*} = 0,5$, $i_{4,*} = 0,7$, $i_{5,*} = 0,4$ and $i_{6,*} = 0$ for $n = 5$, $n = 10$, $n = 20$, $n = 30$ and $a_* = 1,20$, $a_* = 1,41$, $a_* = 1,60$, as for $a_* = 1,60$ remains no irrigable surface in the center of square), to determine also the number (the density) Gr of groups in the function $i_*(S)$ of the intensities i_* distribution on the irrigated surface S_* , the values of the relative

additional yield $Y_{*add}(S)$ and of the coefficients CE and CE_{red} of efficiency of sprinkling (of irrigation). The discrete values of the relation water-yield, presented with the function $Y_{*ad}(i_*)$ - relative additional yield-relative intensity, are given for three variants I, II, and III in Fig.4. To determine also the yield's losses, due to less water brought for values of the reduction coefficient k_r from 1 to 0,1 with step -0,1 for function intensity-yield No II in Fig.4 and $n=10$, $g=10$. The results of calculation are given in tables 1 and 2:

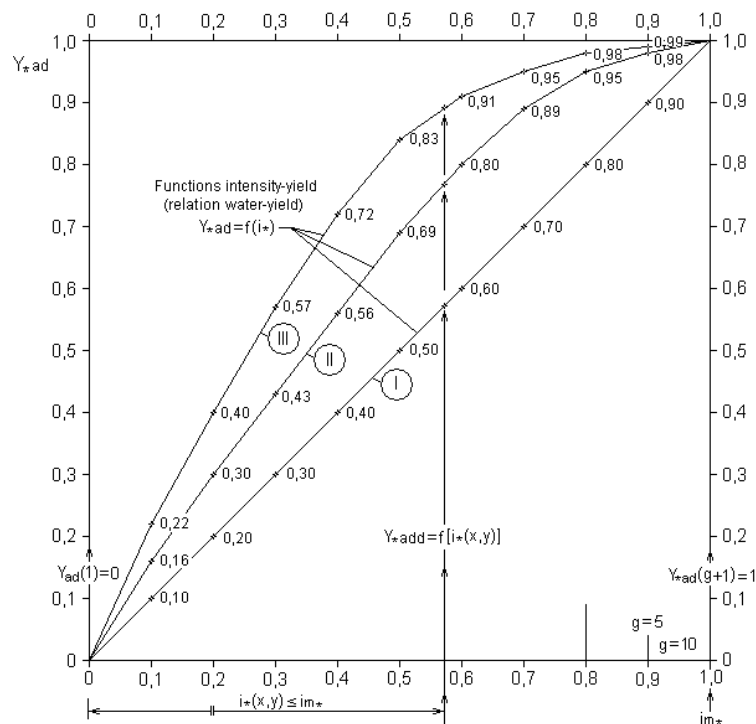


Fig. 4. Functions $Y_{*ad} = f(i_*)$ - intensity-yield in dimensionless form, and reading the values of parts $Y_{*add} = f[i_*(x,y)]$ of relative additional yields, corresponded of points with intensities $i_*(x,y)$

Table 1. $CE_{red} = f(k_r)$

For $a = 1,41$, $n = 10$, $g = 10$ and function intensity-yield No II						
k_r		1,0	0,9	0,8	0,7	0,6
CE_{red} , %		88,39454	81,36265	74,48237	66,94296	56,27809
k_r		0,5	0,4	0,3	0,2	0,1
CE_{red} , %		45,95873	35,91930	27,85247	20,47822	12,51276

Table 2. $CE = f(m, i_* - r_*, a_*, n, g, \text{var } 1 \div 111)$

a_*	$CE = \dots$					
	for $n = 5$ ($c = 25, Gr = 6$)					
	variant I		variant II		variant III	
	$g = 5$	$g = 10$	$g = 5$	$g = 10$	$g = 5$	$g = 10$
1,20	88,00333	87,93909	95,90501	96,89762	98,25243	98,29642
1,41	69,84737	69,04554	89,64075	89,29741	93,65665	93,60511
1,60	82,50650	82,5065	84,28781	83,89845	87,82118	87,23717
a_*	$CE = \dots$					
	for $n = 10$ ($c = 100, Gr = 15$)					
	variant I		variant II		variant III	
	$g = 5$	$g = 10$	$g = 5$	$g = 10$	$g = 5$	$g = 10$
1,20	88,74044	88,60648	95,85927	95,45277	97,91136	97,95716
1,41	73,90326	73,01009	88,38909	88,39454	93,79725	93,84429
1,60	71,62684	68,88931	82,29054	81,63242	87,24317	86,32582
a_*	$CE = \dots$					
	for $n = 20$ ($c = 400, Gr = 55$)					
	variant I		variant II		variant III	
	$g = 5$	$g = 10$	$g = 5$	$g = 10$	$g = 5$	$g = 10$
1,20	87,92656	87,79584	95,06406	95,27653	97,80289	97,8467
1,41	69,64089	67,98857	86,82263	86,90933	93,46555	93,23905
1,60	71,69389	69,27666	83,49958	82,76639	88,14764	87,11687

The data analysis from the table 2 been shown that ceteris paribus the value of CE essentially depends on the value of a_* and on the form of relation water-yield. For this example for CE determination the influence of n and g values is minor, when $n > 10$ and $g > 5$.

It is marked again, that the coefficients CE and CE_{red} take into account the uneven rain intensity's i_* distribution on the sprinkled surface S_* . They are defined for intensities $i_*(x, y)$, limited to the value of im_* (i.e. $i_*(x, y) \leq im_*$ or $i_{*red}(x, y) \leq im_*$), where im_* is the middle intensity, corresponding to the uniform rain's distribution and single norm of irrigation m_{max} , calculated for totally full active soil layer. Or the coefficients CE and CE_{red} give the obtained additional yield in relative quantity or in percentage as part of "maximum" yield, obtained from m_{max} , calculated for uniform rain's distribution.

6. Conclusion

In the study are compared

- the obtained in reports [1, 2] by simulated numerical determination function $i_*(S_*)$ of relative intensity's i_* distribution of the artificial rain, fallen on the sprinkled surface S_* at working of located in square (triangular) scheme sprinklers and
- a given (accepted) relation $Y_{ad}(M)$ – water-yield, transformed in $Y_{*ad}(i_*)$ – intensity of the fallen rain-additional yield of it in dimensionless form.

This allows to introduce the coefficients CE and CE_{red} of efficiency of sprinkling (of irrigation), which under the marked specified conditions are calculated by the presented programs and allow to choose the right scheme and sprinkling's parameters and to estimate the qualities of sprinklers themselves. The programs allow a precise conducting of calculations by changing the relative values of certain parameters. The conduct of full optimization includes also to take into account the costs of irrigation's (sprinkling's) equipment and of irrigation itself, referred to the unit surface, but this is not discussed in the study.

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РАЗПРЕДЕЛЕНИЕ НА ИНТЕНЗИВНОСТТА НА ИЗКУСТВЕНИЯ ДЪЖД ВЪРХУ НАПОЯВАНАТА ПЛОЩ, ВРЪЗКА ВОДА–ДОБИВ И ЕФЕКТ ОТ НАПОЯВАНЕТО

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Ключови думи: дъждоване, интензивност и качество на изкуствения дъжд, функция на разпределение на интензивността, връзка вода–добив, ефект от напояването, симулирано числено изследване

Научна област: хидромелиорации

РЕЗЮМЕ

В работата се съпоставят в безразмерен вид получената в също представени на Конференцията статии [1, 2] дискретна функция на разпределение на интензивността i , mm/h на изкуствения дъжд върху поливаната площ S за квадратна и триъгълна схема на разполагане на дъждовални апарати (ДА) и връзката вода-добив, като симулирано числено се определя ефектът от напояването чрез въведен коефициент CE , с който се оценяват схемите на разполагане на ДА и качествата на изследваната поливна техника.

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