ГОДИШНИК НА УНИВЕРСИТЕТА ПО АРХИТЕКТУРА, СТРОИТЕЛСТВО И ГЕОДЕЗИЯ – СОФИЯ

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ARTIFICIAL RAIN QUALITY'S SIMULATED STUDY OF RING ROTATING SPRINKLERS SITUATED IN TRIANGULAR SCHEME

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Keywords: *sprinkler irrigation, artificial rain's quality, triangular (rhombus) scheme, simulated numerical study*

Research area: *irrigation and drainage* engineering

ABSTRACT

This work is similar to that of a square located sprinklers scheme [1] and also completes the report [4], evaluates: the experimental uniformity's determination by Christiansen of the artificial rain with classic field and laboratory trials in circular rotating sprinklers and center pivot systems, the conditions under which the results obtained by measurements of rain intensity *i*, mm/h in a finite number of points arranged in a particular way area, approach best to real continuous process over the entire irrigated surface and the approach for the accepted standard schemes of the measuring vessels disposition by comparison with an exact simulated uniformity's determination. In this work complementary is obtained and included a simulated artificial rain quality's determination - intensity and uniformity, for a triangular (rhombus) scheme of sprinklers placement with any triangle's size *a*, which determination may in many cases completely replace the field trials execution.

1. Summary, object of the study

In this research are obtained an algorithm, a logical bloc-scheme and program for numerical simulated artificial rain quality's determination – uniformity with the Christiansen's coefficient CU and variation's coefficient C_V, the rein's intensity *i*, its average value i_m and the function of its distribution $i(S)$ for ring rotated identical sprinklers, located in triangular (rhombus) scheme with known function $i(r)$ of rain change's intensity along the length of the radius of action R and an *arbitrary* side size a of the triangle.

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2. Formulation of the study

The formulation of this study is like to that in the reports [1÷4].

It is accepted that:

- are examined working at the same time during one hour four identical sprinklers, placed at the corners of a rhombus, composed of two identical triangles, each with side a;

- is *known* (given) the function $i(r)$ of rain change's intensity on the length of the radius of action R, obtained with experiments, accepted or recommended (examined), the *same* for all sprinklers and is *linearized by sections* (*m* in number) with *an equal horizontal length*;

- the rain's parameters (of the function $i(r)$) are constant on the length of the radius R in the range of the complete sprinklers' turning in 360^0 during all the sprinkling, therefore the body of the rainfall over the surface's S water volume V, m^3/h is symmetrical toward the axis of rotation and is not changing in the time, i.e. is excluded the wind's influence, as well as the shoves with the turn – Fig.1;

- the rain's intensity i and uniformity and the i distribution's function are determined for the rhombus' surface with volume of the fallen on him artificial rain, the same as the volume, given independently by one of the four sprinklers where $R \le 0,866.a$;

- when are used relative quantities, then $R_* = 1$, $i_{\max,*} = 1$, $r_* \le 1$ and $i(r)_* \le 1$.

- the determined with simulated exact values of the coefficients of uniformity CU, of variation Cv and the function $i(S)$ of the intensity's distribution i, mm/h of the fallen artificial rain are for fictitious measuring trial points (vessels) with accepted placement, corresponding to the transformed in rhombus *standard* square scheme from Fig.2 for the realization of complete field trials [8] with *n* measuring points in line and *n* measuring points in rhombus inclined column, with total number n^2 of the measuring points – fig.3, taking into account the influence of *n* on the precision.

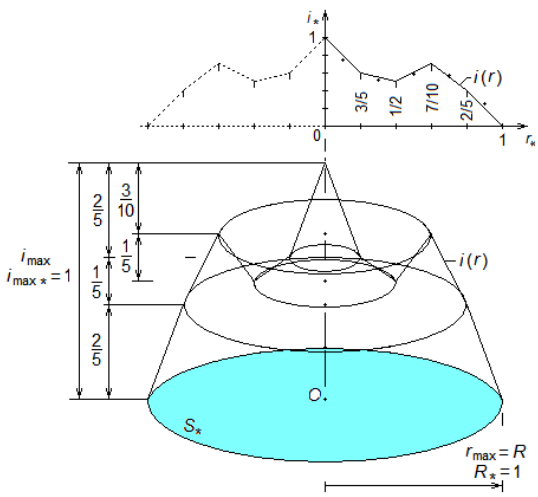

Fig. 1. Body of the water volume V_* artificial rain, fallen from the sprinkler on the irrigated by him surface S_*

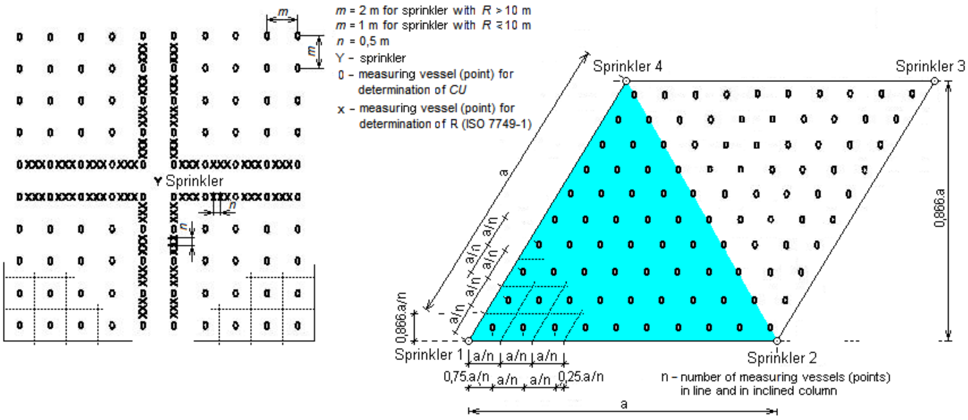

Fig. 2. Standard placement of the measuring vessels for square scheme as GOST ISO 7749-2-2004 [8] and adopted its corresponding placement for triangular scheme

3. Succession and algorithm of the solution

The study is conducted in the following sequence:

Input data is the obtained experimentally, given (recommended) or accepted *function* $i(r)$, mm/h of rain change's intensity *i* along the length of sprinkler's radius of action R, m. It is represented analytically, tabular or most frequently graphically and in the study *is linearized by sections with equal horizontal lengths* along the radius R, devised in m *equal* parts.

A right-handed coordinate system is introduced with axes x coinciding with the base of irrigated rhombus surface and beginning at the place of Sprinkler 1 in its lower left corner – Fig.3. The rhombus side size is a, m, while using relative quantities $a_* = a / R$ is a dimensionless number, indicating the ratio between it and the sprinkler's radius of action (when $R_* = 1$, then $a_* = a$). Accepted number of measuring points (vessels) is n numbers in line and n numbers in rhombus inclined column with total number of points n^2. The horizontal distance between the vessels is a / n, and the vertical distance along the y axis is $0,866.(a / n)$, as the vessels are identified by the "coordinates" (x, y) when $x = 1$, 2, .., $n-1$, n and $y = 1$, 2, .., $n-1$, n. For the first line these "coordinates" are $(1,1)$, $(2,1)$, .., $(n-1,1)$, $(n,1)$, for the second line are $(1,2)$, $(2,2)$, ..., $(n-1,2)$, $(n,2)$ etc. With these "coordinates" are determined theirs relative radii $r_*(1,1)$, $r_*(2,1)$, .., $r_*(n,1)$, ... to the place of the corresponding Sprinkler. Of the rectangular triangle with catheti x and y and hypotenuse the radius vector to this place (for Sprinkler 1 this is the origin of the coordinate system) to each measuring point (vessel) is determined the hypotenuse's size, which coincides with the radius $r_*(x, y)$ to it.

In Fig.3*a-d* are given the measuring points' coordinates and the calculation in cycles of $r_*(x, y)$ (in prepared program they are $R(x, y)$) separately for Sprinkler 1, Sprinkler 2, Sprinkler 3 and Sprinkler 4, taking into account their location to the introduced coordinate system.

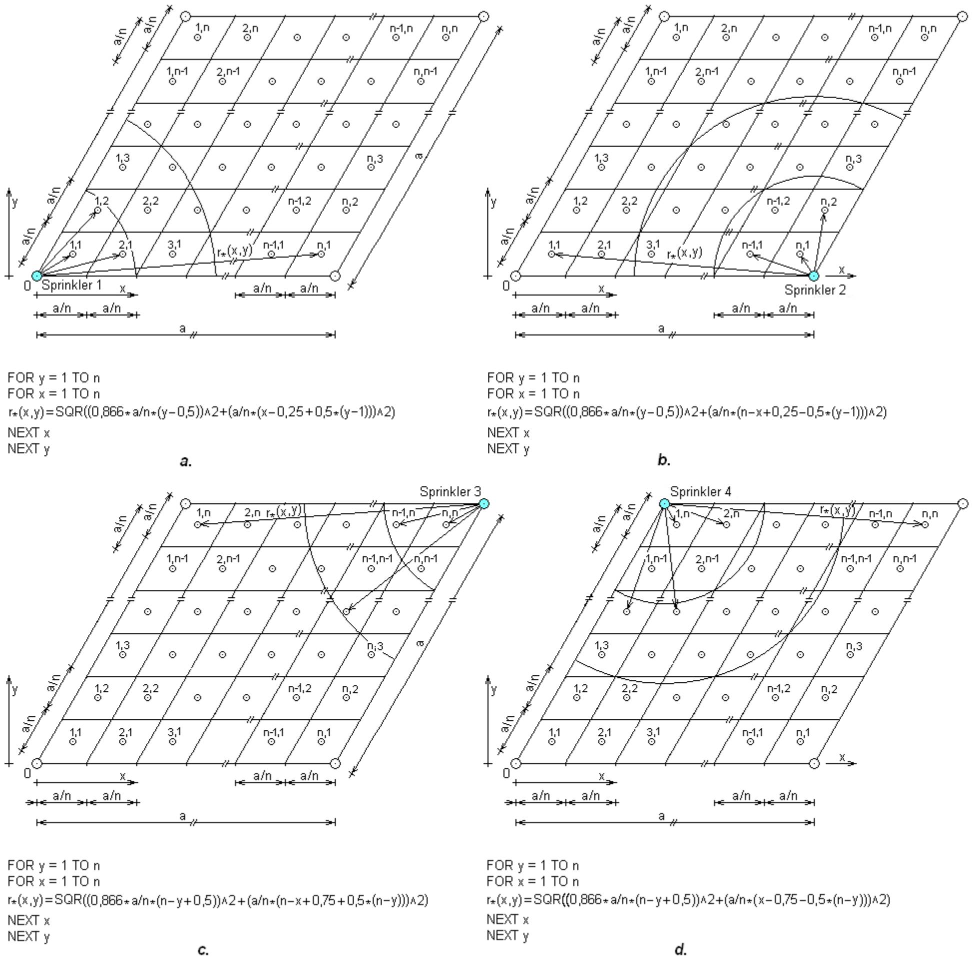

Fig. 3a-d. Determination of the radii $r_*(x, y)$ (in the program they are $R(x, y)$) to the measuring points (vessels) by theirs relative coordinates to the places of self-acting Sprinklers 1, 2, 3 and 4

On fig.3*e,f* is shown in detail the obtaining and presenting the expressions for the radii $r_*(x, y)$ to sprinklers 2 and 4, which coincide with the hypotenuse of a given dark rectangular triangles. Theirs vertical catheti depend only on *y* and given in relative units are:

0,866**a/n**(*y* – 0,5) for Sprinkler 2 (and Sprinkler 1) and (1)
0,866**a/n**(*n* – *y* + 0,5) for Sprinkler 4 (and Sprinkler 3),

and their horizontal catheti due to the inclined columns depend on *x* and *y* and are:

*a/n**(*n* – *x* + 0,25 – 0,5*(*y* – 1)) for Sprinkler 2 and
*a/n**(*x* – 0,75 – 0,5*(*n* – *y*)) for Sprinkler 4, as well (1*a*)
*a/n**(*n* – *x* – 0,25 + 0,5*(*y* – 1)) for Sprinkler 1 and

$a/n*(x + 0,75 + 0,5*(n – y))$ for Sprinkler 3.

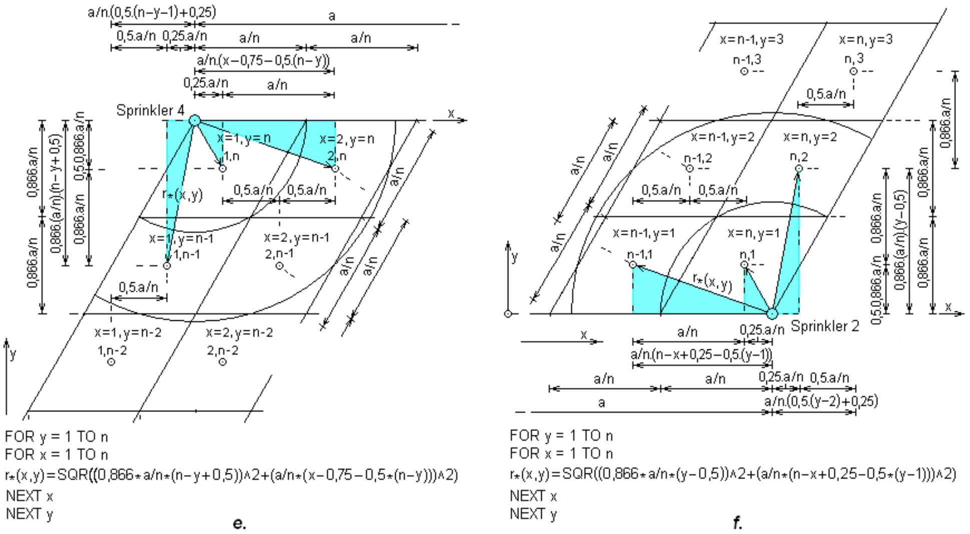

Fig. 3e,f. Detailed determination of the radii $r_*(x,y)$ to the Sprinklers 2 and 4

The intensities $i_*(x,y)$, corresponding of the measuring points' coordinates, *are reading* by the given function $i_*(r_*)$ of rain change's intensity along the length of the radius of sprinkler's action R_*, which, it is stressed strongly again, is *linearized by sections* (*m* in number) with *an equal horizontal length* (or R_* is divided in m *equal* parts!).

Figures 4*a*,*b* illustrate the relation's deduce between the before obtained coordinates $r_*(x,y)$ of the measuring points (vessels) and their corresponding values of intensities $ii[r_*(x,y)]$ of the linearized in parts (*m* in number) function $i(r_*)$.

The values of i (i_* in dimensionless form) at the section's borders where the radius r increase, are $i(1)$, $i(2)$, ..., $i(j)$, $i(j+1)$, ..., $i(m)$ and $i(m+1)$, as the lasts two surround the *m*-th section (using relative quantities they are $i_*(1)$, $i_*(2)$, … etc.). The *j*-th section of $i(r_*)$ (respectively of $i_*(r_*)$) is examined, bounded by $i(j)$ and $i(j+1)$ with $r_*(x,y)$ inside in it, and corresponding intensity $ii[r_*(x,y)]$ of the linearized part

- when $i(j+1) = i(j)$, inside the section $ii[r_*(x,y)]$ have the same constant value:

$$ii[r_*(x,y)] = i(j) = i(j+1)\text{, when } i(j+1) = i(j)\text{;} \qquad (2)$$

- when $i(j+1) > i(j)$, $ii[r_*(x,y)]$ is determined by the scheme of Fig.4*a*;
- when $i(j+1) < i(j)$, $ii[r_*(x,y)]$ is determined by the scheme of Fig.4*b*.

The *j*-th section of $i_*(r_*)$ in Fig.4*a,b* is examined. The catheti's proportion of the two dark similar triangles included into each other (leaded also at the side), gives:

$$ii[r_*(x,y)] = m.[i(j+1) - i(j)].[(r_* - (j-1)/m)] + i(j)\text{, when } i(j+1) > i(j)\text{.} \qquad (3)$$

$$ii[r_*(x,y)] = m.[i(j) - i(j+1)].[(j/m - r_*(x,y)] + i(j+1)\text{, when } i(j+1) < i(j). \quad (4)$$

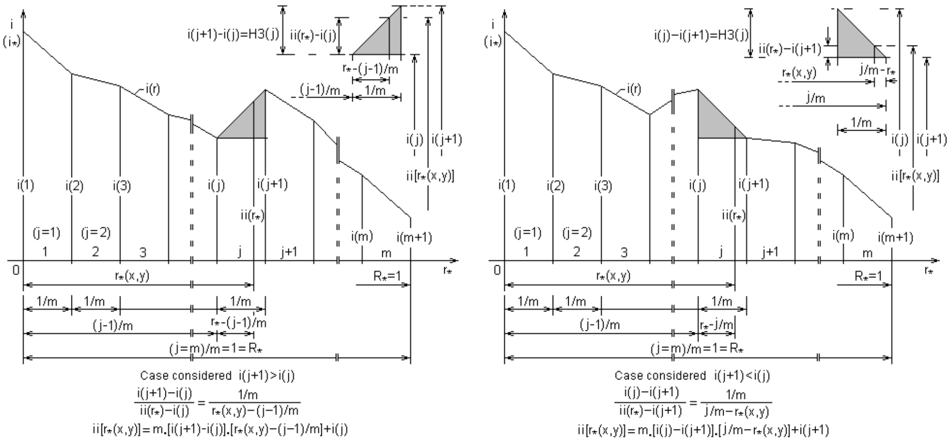

Fig. 4a,b. Determination of intensity $ii[r_*(x,y)]$ in the cases: *a* - of section with $i_*(r_*)$ increased function and *b* – of section with $i_*(r_*)$ decreased function when r_* increases

The zone of action of each Sprinkler is only from zero to $r_* \le R_*$ and

$$ii[r_*(x,y)] = 0 \text{ for } r_*(x,y) > R_*. \quad (5)$$

The fallen artificial rain's *total intensity* $ii(x,y)$ in each measuring point (vessel) is sum of the obtained with eq.(2÷5) aid four values of the different for each of situated in the irrigated rhombus corners four Sprinklers intensities, marked with $i_1(x,y)$, $i_2(x,y)$, $i_3(x,y)$ and $i_4(x,y)$, as

$$ii_k(x,y) = \sum_{k=1}^{4} i_k(x,y). \quad (6)$$

The last part of algorithm includes the calculation of $i_{m,*}$, CU and Cv according to the known dependences, written with the accepted in the program symbols, as the number of measuring points (vessels) is $c = n \wedge 2$:

$$i_{m,*} = \frac{1}{c}.\sum_{i=1}^{c} ii_{i,*}, \qquad CU = 100.\left[1 - \frac{\sum_{i=1}^{c} \left| i_{m,*} - i_{i,*} \right|}{c.i_{m,*}}\right], \qquad C_V = \sqrt{\frac{\sum_{i=1}^{c} (i_{m,*} - i_{i,*})^2}{(c-1).(i_{m,*})^2}}. \quad (7)$$

4. Logical bloc-scheme of the program

The presented in fig. 5 logical bloc-scheme of the prepared program accorded with the developed algorithm visually gives the computing operations' succession. It permits in the base of this algorithm to improve the research and develop also another programs with analogical direction, possibly used another programming language.

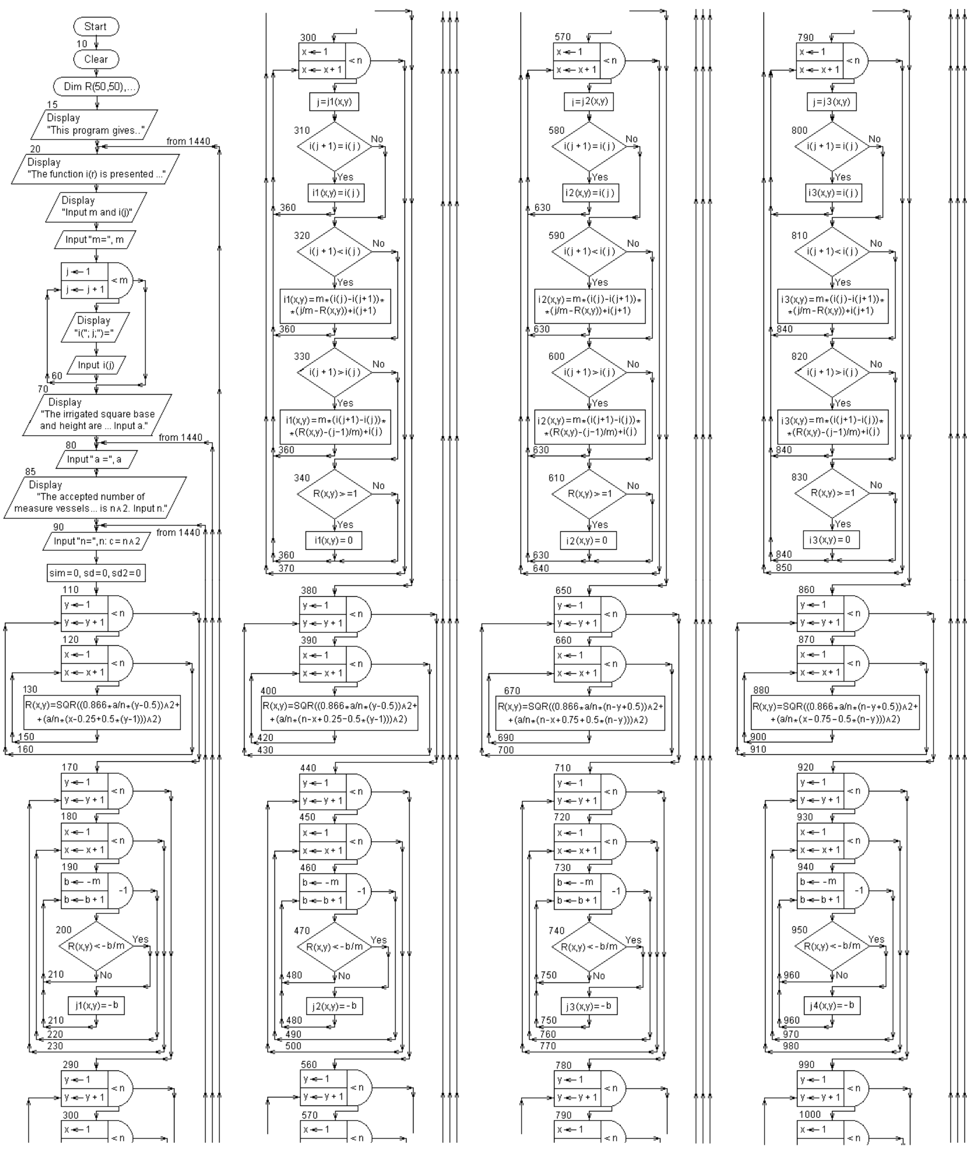

Fig. 5. Logical bloc-scheme of the computing program (initial part)

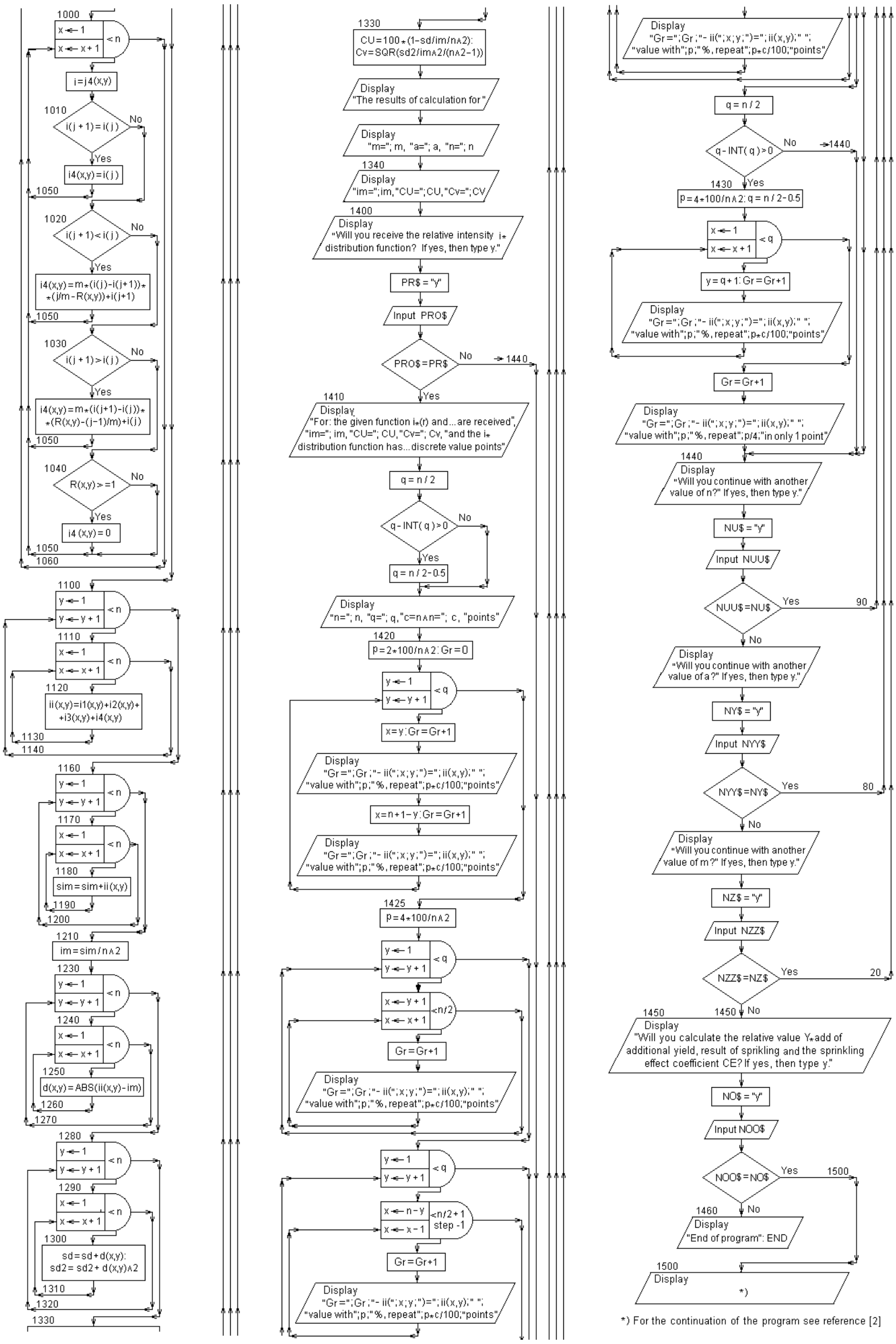

Fig. 5. Logical bloc-scheme of the computing program (end)

5. Program

The program SPR8.BAS is written in BASIC language.

```
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), d(50, 50), Yadd(50, 50), p(50), q(50)
15 PRINT "This program gives the values of Christiansen coefficient CU and the”
   PRINT "coefficient Cv for the artificial rain's uniformity of deployed in"
   PRINT "triangular scheme ring rotating sprinklers and senter pivot systems"
   PRINT "with given function i(r) of the rain changes intensity i, mm/h on the”
   PRINT "length of the radius of action R. (i and R are in relative quantities”
   PRINT "R*=1, imax,*=1)."
20 PRINT " ", "The function i(r) is presented with a linear in parts approximation,
   PRINT "the radius of action R is divided in m equal parts and the i(r) values”
   PRINT "in their borders are i(j), j=1,2,....,m+1, in r increase direction.”
   PRINT "Input m and i(j)."
   INPUT "m=", m
   FOR j = 1 TO m+1
   PRINT "i("; j; ")="
   INPUT i(j)
   NEXT j
70 PRINT "The irrigated rhombus base, formed by two triangles, is a.R, and“
   PRINT “height is 0,866.a.R, but R is presented in relative quantity R*=1,"
   PRINT " or a.R*=a. Input a."
80 INPUT "a=", a
   PRINT "The accepted number of measure vessels, situated in symmetric”
   PRINT "rhombus scheme in n ranges, n vessels in range, n inclined columns,”
   PRINT “n vessels in column, is n^2. Input n."
90 INPUT "n=", n: c = n ^ 2: sim = 0: sd = 0: sd2 = 0
110 FOR y = 1 TO n
120 FOR x = 1 TO n
130 R(x, y) = SQR((.866 * a / n * (y - .5)) ^ 2 + (a / n * (x - .25 + .5 * (y – 1 ))) ^ 2)
150 NEXT x
160 NEXT y
170 FOR y = 1 TO n
180 FOR x = 1 TO n
190 FOR b = -m TO -1
200 IF R(x, y) < -b / m THEN j1(x, y) = -b
210 NEXT b
220 NEXT x
230 NEXT y
290 FOR y = 1 TO n
300 FOR x = 1 TO n
    j = j1(x, y)
310 IF i(j + 1) = i(j) THEN i1(x, y) = i(j)
320 IF i(j + 1) < i(j) THEN i1(x, y) = (i(j) - i(j + 1)) * m * (j / m - R(x, y)) + i(j + 1)
330 IF i(j + 1) > i(j) THEN i1(x, y) = (i(j + 1) - i(j)) * m * (R(x, y) - (j - 1) / m) + i(j)
340 IF R(x, y) > 1 THEN i1(x, y) = 0
360 NEXT x
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```
370 NEXT y
380 FOR y = 1 TO n
390 FOR x = 1 TO n
400 R(x, y) = SQR((.866 * a / n * (y - .5)) ^ 2 + (a / n * (n - x + .25 - .5 * (y – 1))) ^ 2)
420 NEXT x
430 NEXT y
440 FOR y = 1 TO n
450 FOR x = 1 TO n
460 FOR b = -m TO -1
470 IF R(x, y) < -b / m THEN j2(x, y) = -b
480 NEXT b
490 NEXT x
500 NEXT y
560 FOR y = 1 TO n
570 FOR x = 1 TO n
   j = j2(x, y)
580 IF i(j + 1) = i(j) THEN i2(x, y) = i(j)
590 IF i(j + 1) < i(j) THEN i2(x, y) = (i(j) - i(j + 1)) * m * (j / m - R(x, y)) + i(j + 1)
600 IF i(j + 1) > i(j) THEN i2(x, y) = (i(j + 1) - i(j)) * m * (R(x, y) - (j - 1) / m) + i(j)
610 IF R(x, y) > 1 THEN i2(x, y) = 0
630 NEXT x
640 NEXT y
650 FOR y = 1 TO n
660 FOR x = 1 TO n
670 R(x, y) = SQR((.866 * a / n * (n - y + .5)) ^ 2 + (a / n * (n - x + .75 + .5 * (n – y))) ^ 2)
690 NEXT x
700 NEXT y
710 FOR y = 1 TO n
720 FOR x = 1 TO n
730 FOR b = -m TO -1
740 IF R(x, y) < -b / m THEN j3(x, y) = -b
750 NEXT b
760 NEXT x
770 NEXT y
780 FOR y = 1 TO n
790 FOR x = 1 TO n
   j = j3(x, y)
800 IF i(j + 1) = i(j) THEN i3(x, y) = i(j)
810 IF i(j + 1) < i(j) THEN i3(x, y) = (i(j) - i(j + 1)) * m * (j / m - R(x, y)) + i(j + 1)
820 IF i(j + 1) > i(j) THEN i3(x, y) = (i(j + 1) - i(j)) * m * (R(x, y) - (j - 1) / m) + i(j)
830 IF R(x, y) > 1 THEN i3(x, y) = 0
840 NEXT x
850 NEXT y
860 FOR y = 1 TO n
870 FOR x = 1 TO n
880 R(x, y) = SQR((.866 * a / n * (n - y + .5)) ^ 2 + (a / n * (x - .75 - .5 * (n – y))) ^ 2)
900 NEXT x
910 NEXT y
920 FOR y = 1 TO n
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```
930 FOR x = 1 TO n
940 FOR b = -m TO -1
950 IF R(x, y) < -b / m THEN j4(x, y) = -b
960 NEXT b
970 NEXT x
980 NEXT y
990 FOR y = 1 TO n
1000 FOR x = 1 TO n
     j = j4(x, y)
1010 IF i(j + 1) = i(j) THEN i4(x, y) = i(j)
1020 IF i(j + 1) < i(j) THEN i4(x, y) = (i(j) - i(j + 1)) * m * (j / m - R(x, y)) + i(j + 1)
1030 IF i(j + 1) > i(j) THEN i4(x, y) = (i(j + 1) - i(j)) * m * (R(x, y) - (j - 1) / m) + i(j)
1040 IF R(x, y) > 1 THEN i4(x, y) = 0
1050 NEXT x
1060 NEXT y
1100 FOR y = 1 TO n
1110 FOR x = 1 TO n
1120 ii(x, y) = i1(x, y) + i2(x, y) + i3(x, y) + i4(x, y)
1130 NEXT x
1140 NEXT y
1160 FOR y = 1 TO n
1170 FOR x = 1 TO n
1180 sim = sim + ii(x, y)
1190 NEXT x
1200 NEXT y
1210 im = sim / n ^ 2
1230 FOR y = 1 TO n
1240 FOR x = 1 TO n
1250 d(x, y) = ABS(ii(x, y) - im)
1260 NEXT x
1270 NEXT y
1280 FOR y = 1 TO n
1290 FOR x = 1 TO n
1300 sd = sd + d(x, y): sd2 = sd2 + d(x, y) ^ 2
1310 NEXT x
1320 NEXT y
1330 CU = 100 * (1 - sd / im / n ^ 2): Cv = SQR(sd2 / im ^ 2 / (n ^ 2 - 1))
     PRINT "The results of calculation for"
     PRINT "m="; m, "a="; a, "n="; n, “are:”
1340 PRINT "im="; im, "CU="; CU, "Cv="; Cv
1400 PRINT " ", "Will you receive the relative intensity i* discretized"
     PRINT "distribution’s function? If yes, then type y.": PR$ = "y"
     INPUT PRO$: IF PRO$ = PR$ THEN 1410
     GOTO 1440
1410 PRINT " ", “For: the given function i*(r) and accepted”, “a=”; a, “and n=”; n
     PRINT “are received”, "im="; im, "CU="; CU, "Cv="; Cv, "and"
     PRINT "the i* distribution function has the next discrete value points:"
     PRINT "  "
     q = n / 2
```

```
     IF q – INT(q) > 0 THEN q = n / 2 – .5
     PRINT "n="; n, "q="; q, "c=n^n="; c; "points"
1420 p = 2 * 100 / n ^ 2: Gr = 0
     FOR y = 1 TO q
     x = y: Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p; "%, repeat";
     p * c/100; "points"
     x = n + 1 – y: Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p; "%, repeat",
     p * c/100; "points"
     NEXT y
1425 p = 4 * 100 / n ^ 2
     FOR y = 1 TO q
     FOR x = y + 1 TO n / 2: Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p; "%, repeat",
     p * c/100; "points"
     NEXT x
     NEXT y
     FOR y = 1 TO q
     FOR x = n – y TO n /2 + 1 STEP –1: Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p; "%, repeat",
     p * c/100; "points"
     NEXT x
     NEXT y
     q = n / 2
     IF q – INT(q) > 0 THEN 1430
     GOTO 1440
1430 p = 4 * 100 / n ^ 2: q = q – .5
     FOR x = 1 TO q
     y = q + 1: Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p; "%, repeat",
     p * c/100; "points"
     NEXT x
     : Gr = Gr + 1
     PRINT "Gr"; Gr; "- ii("; x; y; ")="; ii(x, y); ""; "value with"; p / 4; "%, in only
     1 point"
1440 PRINT " ", "Will you continue with another value of n? If yes, then type y."
     NU$ = "y": INPUT NUU$: IF NUU$ = NU$ THEN 90
     PRINT "Will you continue with another value of a? If yes, then type y."
     NY$ = "y": INPUT NYY$: IF NYY$ = NY$ THEN 80
     PRINT "Will you continue with another value 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 value Y∗add of additional yield,"
     PRINT "result of sprinkling and the sprinkling effect coefficient CE,"
     PRINT "using a given/accepted relation water-yield? If yes, then type y."
     NO$ = "y": INPUT NOO$: IF NOO$ = NO$ THEN 1500
1460 PRINT "End of program": END
1500 PRINT "  "
     → for the extension of the program see reference [2].
```

Example. With the program SPR8.BAS to determine the values of the average relative intensity $i_{m,*}$, of the coefficient of uniformity CU and of the coefficient of variation C_V in both irrigation with four equal sprinklers, disposed in triangular (rhombus) scheme with the following data: $m = 5$, $i_{1,*} = 1$, $i_{2,*} = 0,6$, $i_{3,*} = 0,5$, $i_{4,*} = 0,7$, $i_{5,*} = 0,4$ and $i_{6,*} = 0$ for $n = 5$, $n = 10$, $n = 20$, $n = 30$ and $a_* = 1,50$, $a_* = 1,732$, $a_* = 1,90$, (for $a_* > 1,732$ remains no irrigable surface in the triangles centers). For the i* distribution function see [7].

The results are given in the next table:

Table

a_*	$n = 5$			$n = 10$		
	$i_{m,*}$	CU	C_V	$i_{m,*}$	CU	C_V
1,50	0,6972512	83,63786	0,2029909	0,7050793	82,21496	0,1986905
1,732	0,5304901	83,24239	0,2323626	0,5269524	81,69001	0,2533278
1,90	0,4404628	60,31682	0,4480532	0,4403637	60,03068	0,4731986

a_*	$n = 20$			$n = 30$		
	$i_{m,*}$	CU	C_V	$i_{m,*}$	CU	C_V
1,50	0,7050157	82,50329	0,1976812	0,7051520	82,51501	0,1977540
1,732	0,5289872	82,24236	0,2480826	0,5288691	82,11728	0,2486743
1,90	0,4395337	60,00246	0,4709129	0,4394928	59,97013	0,4712927

The data analysis from the table been shown that a full quality's valuation of the sprinkling with ring rotated Sprinklers on the yields and for optimum effect should be considered complete:

- the artificial rain's uniformity with the Christiansen's coefficient CU (or with another analogical of him coefficient of uniformity [6]),
- the average (middle) rain's intensity $i_{m,*}$ and
- the discrete function $i_*(S_*)$ of intensity i_* distribution on the sprinkled surface S_*.

At the same high value of CU, but at a lower value of $i_{m,*}$ the net (final) effect of irrigation is lower.

6. Conclusion

For Sprinklers disposed in triangular (rhombus) scheme in the study is given a numerical simulated artificial rain quality's determination of uniformity with the Christiansen's coefficient *CU* and variation's coefficient C_V, of the rein's intensity *i*, and the function of its distribution for ring rotating sprinklers for known (given) function *i*(*r*) of rain change's intensity *i* along the length of the radius of action *R* and for an arbitrary side size *a* of the triangle. In many cases this determination may completely replace the classic labor-intensive field and laboratory trials execution with a limited number of measuring points. It can also be searched in advance a suitable function *i*(*r*) for the desired values of the *CU*, C_V, im and effect of irrigation.

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СИМУЛАЦИОННО ИЗСЛЕДВАНЕ НА КАЧЕСТВОТО НА ИЗКУСТВЕНИЯ ДЪЖД ПРИ РАЗПОЛОЖЕНИ В ТРИЪГЪЛНА СХЕМА КРЪГОВО ВЪРТЯЩИ СЕ ДЪЖДОВАЛНИ АПАРАТИ

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Ключови думи*: *дъждуване, качество на изкуствения дъжд, триъгълна* (*ромбова*) *схема, симулационно числено изследване

Научна област*: *хидромелиорации

РЕЗЮМЕ

Работата е подобна на тази за разположени в квадратна схема дъждовални апарати (ДА) [1] и също допълва доклада [4], оценяващ: определянето с полски или лабораторни опити на равномерността на изкуствения дъжд по Християнсен (Christiansen)

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при кръгово въртящи се ДА и машини, условията, при които получените резултати чрез измервания на интензивността на дъжда *i*, mm/h в краен брой разположени по определен начин точки на площта се приближават най-добре до реалния непрекъснат процес върху цялата напоявана площ, както и приближението за приетите стандартни схеми на разполагане на мерните съдове чрез сравнение със симулирано точно определяне на равномерността. В тази работа вече допълнително е получено и се дава симулирано числено определяне на качеството на изкуствения дъжд – интензивност и равномерност за триъгълна (ромбова) схема на разполагане на ДА при *произволна големина* на страната *a* на триъгълника, с което определяне в редица случаи може напълно да бъде заместено провеждането на полски опити.