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Impact of Operating Pressure and Weather Elements upon Distribution Uniformity and Conveyance Efficiency of Mini-Sprinkled Irrigation Water.

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This research aimed to examine operation of mini-sprinkler irrigation system and determine the best operational conditions . Such conditions attain best water distribution uniformity and higher conveyance efficiency. Hence. best production per utilized irrigation water unit would be attained . Also water would be saved for wider land reclamation projects . Related to the precipitation rate value . the area irrigated through a single mini-sprinkler (Mikroregner) of about 1.75 mm nozzle diameter could be distinguished into four zones surrounding the mini-sprinkler . It was noticed through the irrigated plants had different growth in each zone . Such zones are . 1 (0 - 120 -) . 2 (120 - 230 -) . 3 (230 - 300 -) and 4 [3oo - 350 (400) cm] from the mini-sprinkler . The precipitation rate decreases as the distance from the mini-sprinkler increases. For an experiment was conducted with a 0 .83 bar (12 psi) nozzle operating pressure under 0.2 m/s wind velocity . 14.4 - air - and 35.0 ° C water temperature . 69.3 % relative humidity and 3.8 m bar vapor pressure deficit . on the average . the wetting depths amounted to 3.65 - . 2.56 - . 2.32 - and 0.32 mm / h . on the average . at zones 1 . 2 . 3 and 4 respectively . Other distribution uniformity standards including the favorable irrigated area portion . uniformity coefficient Cu statistical uniformity coefficient SCu and uniformity coefficient UCH were 48.2 - . 50.4 - . 33.6 - and 47.0 % . respectively . and the conveyance efficiency amounted to 93.6 %. The favorable irrigated area portion . Cu and UCH were similar at nozzle operating pressures higher than 0.76 bar (11 psi) . On the other hand. amounted the average wetting depth at zone 1 (0 - 120 cm) to times that at the other zones . the favorable irrigated area portion was less than 15.5 % . Cu . SCu and UCH had negative values at nozzle operating pressure lower than 0.76 bar (11 psi) .The pattern efficiency PE according to National Resource Conservation Service is not suitable distribution uniformity standard under such conditions .

The higher water temperature (34.0 – 36.0°C) than that of air (14.0-23.0°C) and the about 1.75 mm nozzle diameter cause more spray losses than recorded in the diagram illustrated in p. 386 in Achtnich (1980).

Key words: Operating pressure. weather elements. distribution uniformity. conveyance efficiency. mini-sprinkler. distribution uniformity standards.

Schakschouk (1976) researched a sprinkler irrigation system and (1982) a mini-sprinkler irrigation system and developed other results through the underlying reserch. Five standards were utilized to evaluate the mini-sprinkler performance. According to p. 375 in Achtnich (1980), the favorable sprinkler irrigated area portion (through a single sprinkler) and the uniformity coefficient Cu according to Christiansen (1942) are suitable standards to evaluate the distribution uniformity. The favorable sprinkler irrigated area through a single sprinkler area portion is the percentage of this portion which receives from 0.7 to 1.3 times the average of wetting depth for total sprinkled area .

$$Cu = 100 [1.0 - (\Sigma x / Mn)]$$ where:

Cu = uniformity coefficient, x = absolute deviation of each measured value from the average M of all measured values and n = number of measured values, p.377 in Achtnich (1980). The other three standards are SCu , UCH and PE ;

SCu = Statistical Uniformity Coefficient

$$SCu = 100 [1.0 - (\Sigma x^2 / (n -1) M^2 ,^{1/2}]$$ where:

X = absolute deviation of each measured value from the average M of all measured values and n = number of measured values, p. 380 in Achtnich (1980).

Hart (1961) developed UCH,

$$UCH = 100 (1.0 - 0.798 S/M)$$ where:

S = standard deviation = $[\Sigma (x_i - M)^2 / (n -1)]^{1/2}$, x_i = measuring value and M = average of all measuring values , p. 380 in Achtnich (1980).

National Resource Conservation Service developed Pattern Efficiency (PE)

$$PE = 100 (a^{-} /M)$$ where:

a^{-} = average of lower 25 % of all measured values , and M = average of all measured values , p.381 in Achtnich (1980).

According to Christiansen (1942), Mather(1950) , Wiersma (1955) , Frost and Schwalen (1955) , Supersperg (1966) , Clark and Finely (1975) , Achtnich (1980) and Steiner *et al.* (1983) , the following could be concluded . Water is lost through evaporation as water droplets travel through the air falling and from wetted vegetative growth and soil. The water losses are increased with the increase of temperature, wind velocity, operating pressure, number of sprinkler oscillator kicks per cycle and vapor pressure deficit. The evaporative water losses amounted to 10 - 40 % under different operating conditions. Mather (1950), Frost (1963), Kraus (1966), Stewart (1977), Pearce *et al.* (1980) and Larsson (1981) reported that the total sprinkler irrigation water losses were not a total loss. Such water losses lessen evapotranspiration rate from wetted plants adjacent to the sprinkled area .The net water losses = total sprinkler irrigation water losses - reduction of evapotranspiration for plants adjacent to the sprinkled area.

Materials and Methods

The research was done in Siwa Oasis, Egypt. A mini-sprinkler irrigation network irrigates an area of 28.5 Feddans (11.4 ha.) .The mini-sprinklers are 6 m apart. The mini-sprinkler was supplied with a riser Of 30-cm height and spaghetti tube of 120 cm length. The nozzle diameter is about 1.75 mm. The research area was fallow. The irrigation water resources are artesian wells yielding water of <320 μS/ cm salinity, springs of 2500 - 4375 - and drainage of 4060- in winter and 6250 - in summer, Shatanawi (1990). The weather means through 1931 - 1975 were 3.0 m / s wind velocity (37.3 % were effective winds; >3.6 m / s), 21.9 ° C air temperature (29.6 - max. and 13.3 min.), 41 % relative humidity and almost no rainfall (Ministry of Civil Aviation, 1975). The fifth mini-sprinkler on the first irrigation line at plot 5_1 was examined. It stood in the center of a water collection network (Figs. 1-6). In (Figs. 1 - 6), 3 water collectors rows above C, 3 under D, 1 column at left of A and 1 at right of B were not recorded owing to the limited drawing paper space. However, such absent water collectors were far enough from the mini-sprinkler that they did not receive any water droplets. Mini-sprinkler was tested for one hour for each operating pressure. Weather data was measured 16-17 times; every 4 minutes. Figs. (1-6) present precipitation rate distributions and equipotential lines, radial profiles A - B and C -D, radius of wetting and wetting zones surrounding the single mini-sprinkler, average wetting depth - precipitation rate - at each wetting zone, average wind velocity and direction and total wetted area . Such wetting zones are 1(0-120-),2 (120-230-), 3 (230- 300-), 4 [300- 350 (400) cm],

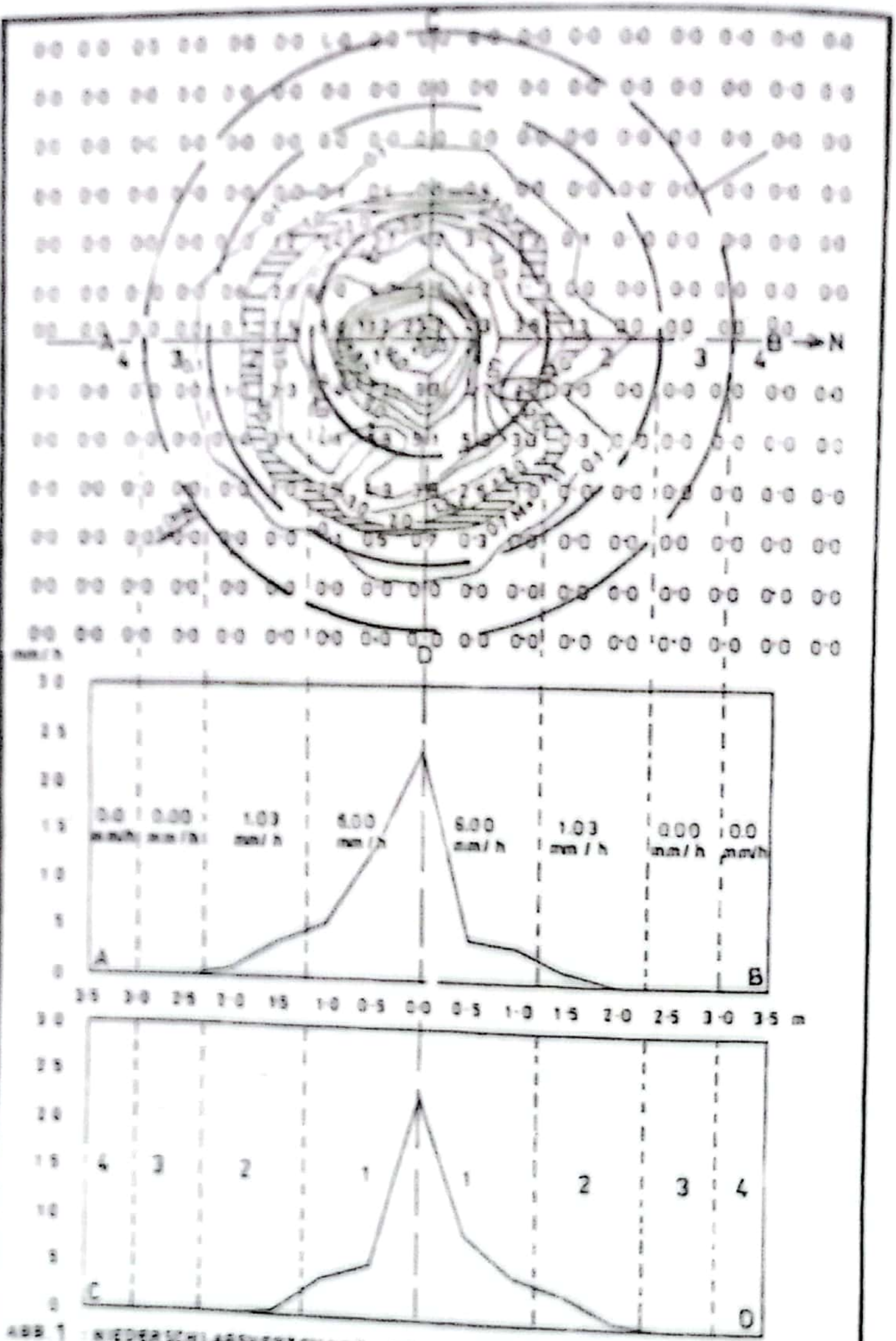

ABB. 1 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M. REGNERS BEI BETRIEBSDRUCK VON 0.34 BAR UND DEN IN DER TAB. 1 GEGEBENEN KLIMABEDINGUNGEN EBENSO DER GÜNSTIG BEREGNETE FLÄCHENANTEIL

FIG. 1 : PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATING RESSURE OF 0.34 BAR AND 0.0 M/S WIND VELOCITY, 32.7 - AIR - AND 33.1 °C WATER TEMPERATURE AND 37.6 % RELATIVE HUMIDITY AS AVERAGES

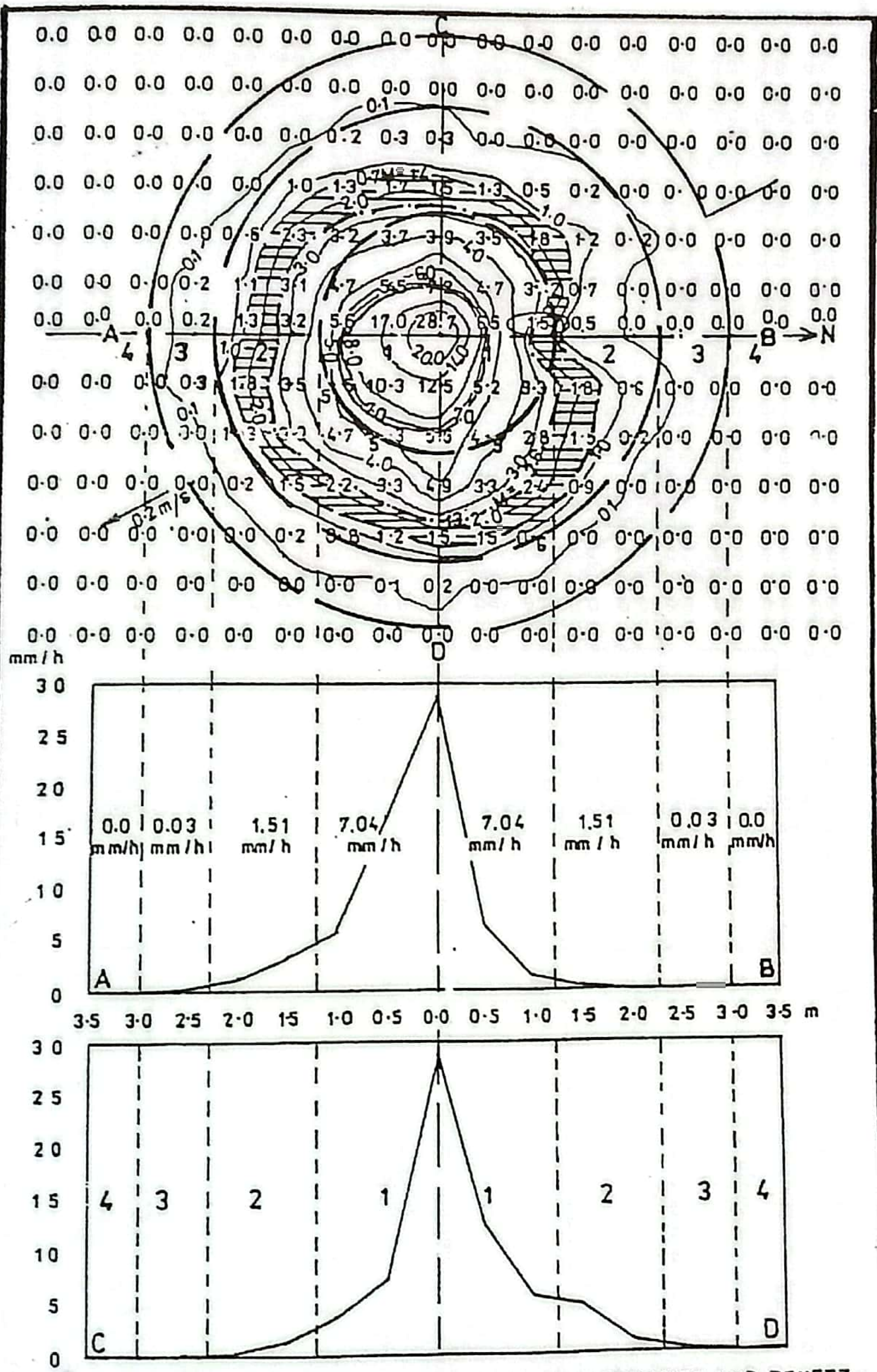

ABB. 2 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI BETRIEBSDRUCK VON 0.55 BAR UND DEN IN DER TAB. 2 GEGEBENEN KLIMABEDINGUNGEN. EBENSO DER GÜNSTIG BEREGNETE FLÄCHENANTEIL.

FIG. 2 ; PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATINO RESSURE OF 0. 55 BAR AND 0.2 M / S WIND VELOCITY, 20. 8 - AIR - AND 35.2 °C WATER TEMPERATURE AND 71. 3 % RELATIVE HUNIDITY AS AVERAGES.

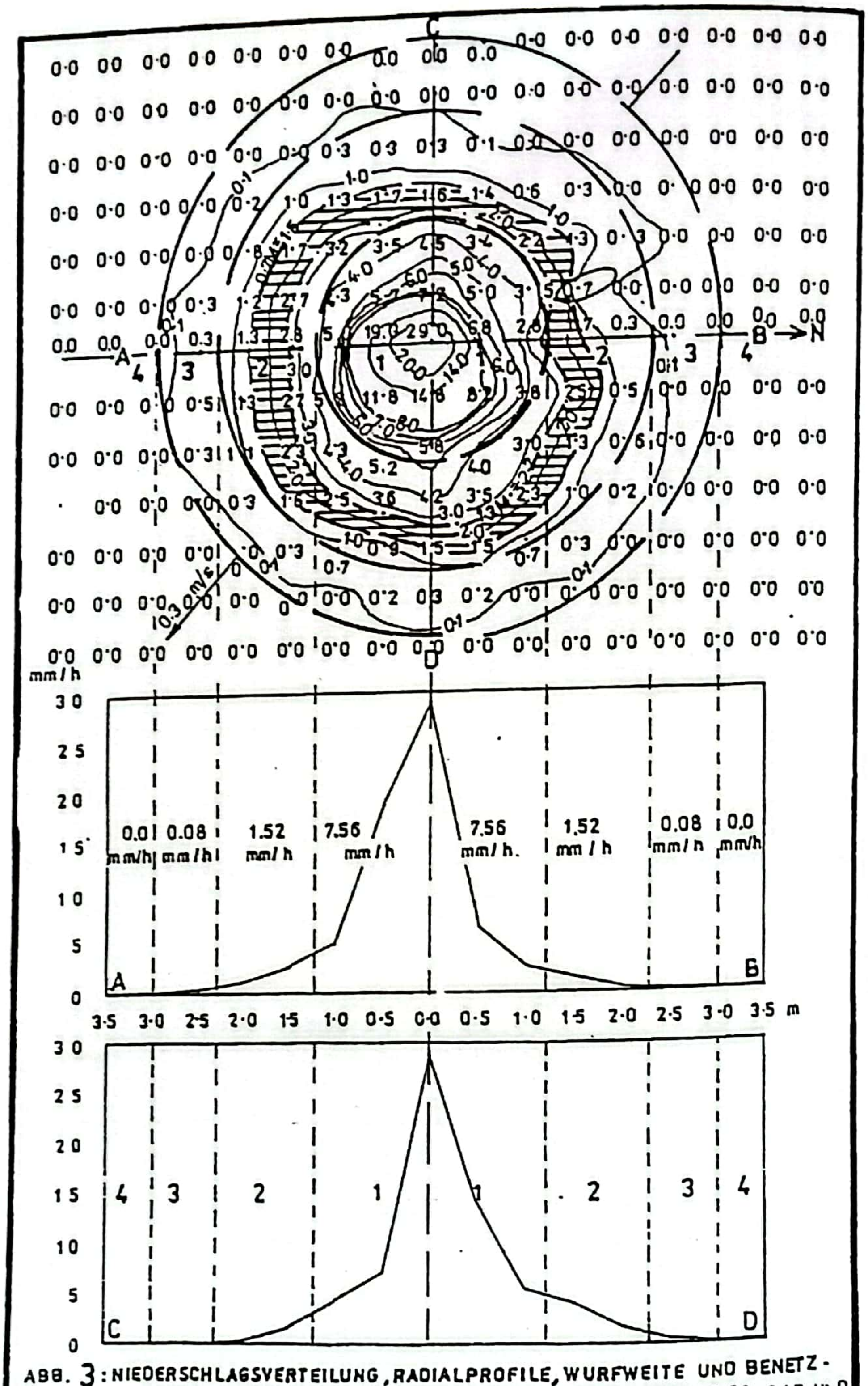

ABB. 3 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI BETRIEBSDRUCK VON 0.69 BAR UND DEN IN DER TAB.3 GEGEBENEN KLIMABEDINGUNGEN. EBENSO DER GÜNSTIG BERFGNETE FLÄCHENANTEIL.

FIG. 3 : PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATING RESSURE OF 0.69 BAR AND 0.3 M/S WIND VELOCITY, 22.8 - AIR - AND 35.7 °C WATER TEMPERATURE AND 61.8 % RELATIVE HUNIDITY AS AVERAGES.

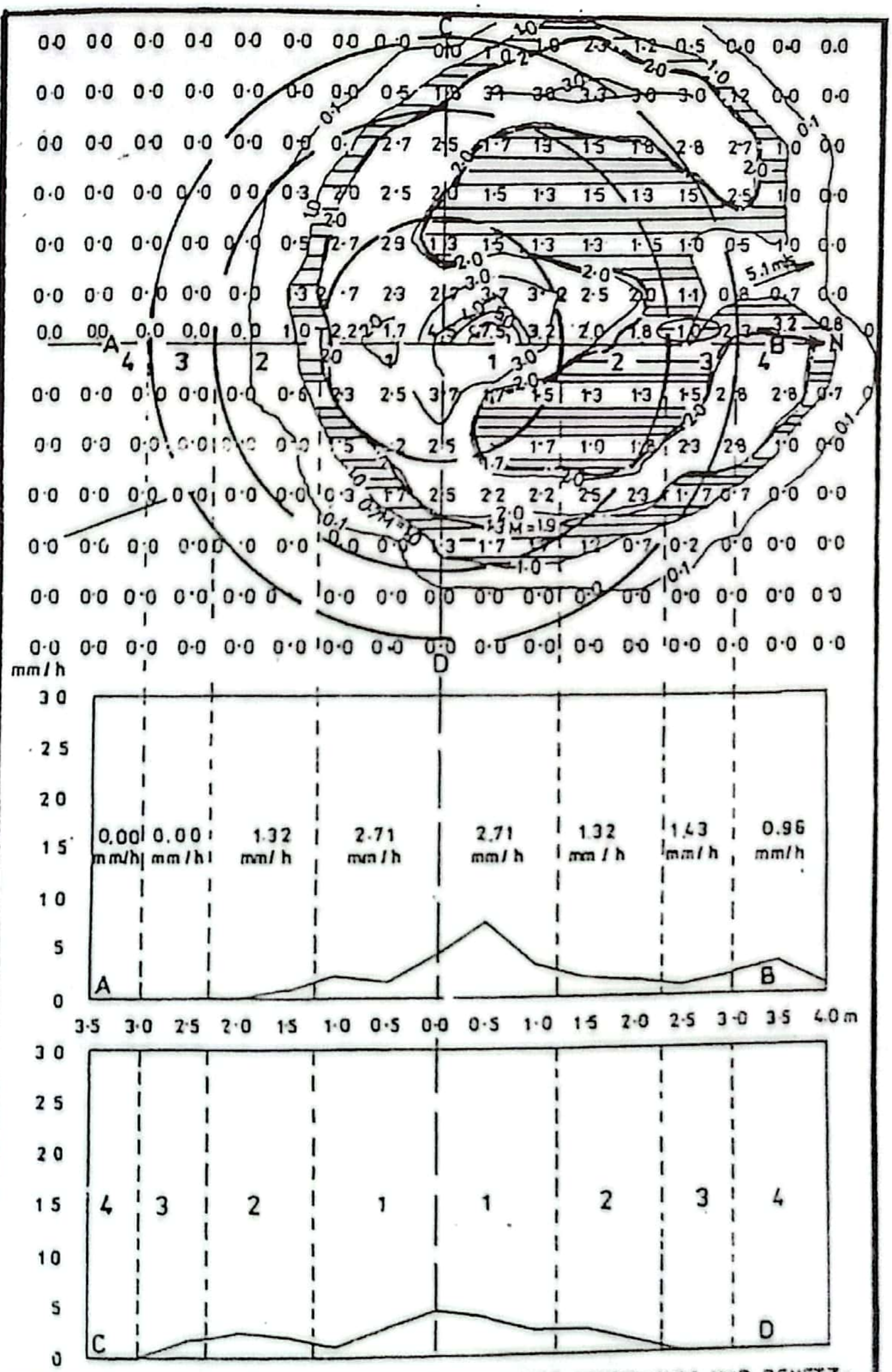

ABB. 4 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI BETRIEBSDRUCK VON 0.76 BAR UND DEN IN DER TAB.4 GEGEBENEN KLIMABEDINGUNGEN. EBENSO DER GÜNSTIG BEREGNETE FLÄCHENANTEIL.

FIG. 4 : PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATING RESSURE OF 0.76 BAR AND 5.1 M / S WIND VELOCITY, 19.7 - AIR - AND 34.7 °C WATER TEMPERATURE AND 63.3 % RELATIVE HUNIDITY AS AVERAGES.

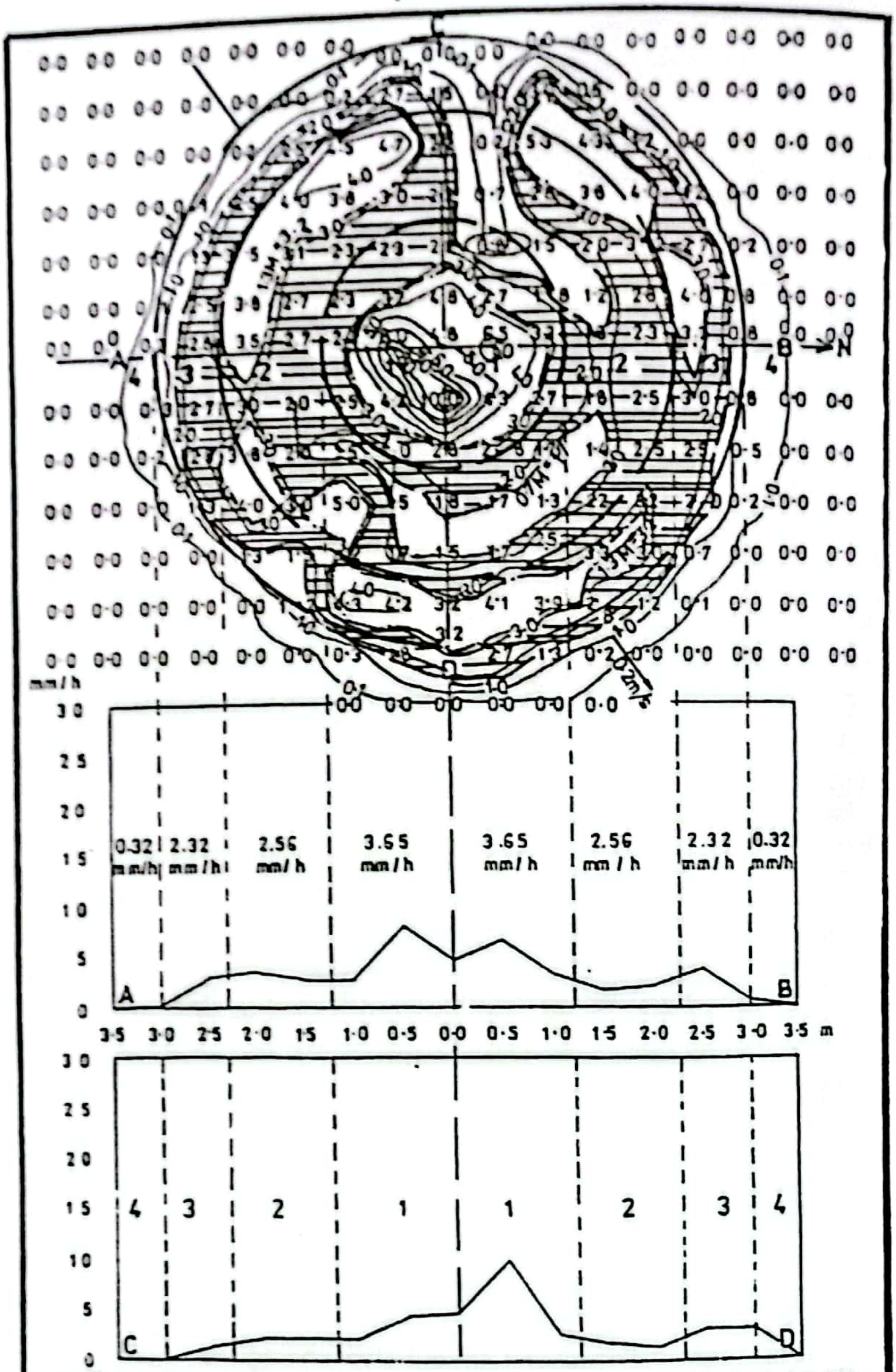

ABB.5 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI BETRIEBSDRUCK VON 0.83 BAR UND DEN IN DER TAB.5 GEGEBENEN KLIMABEDINGUNGEN. EBENSO DER GÜNSTIG BEREGNETE FLÄCHENANTEIL.

FIG. 5 : PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATING RESSURE OF 0.83 BAR AND 0.2 M / S WIND VELOCITY, 14.4 - AIR - AND 35.5 °C WATER TEMPERATURE AND 69.3 % RELATIVE HUNIDITY AS AVERAGES.

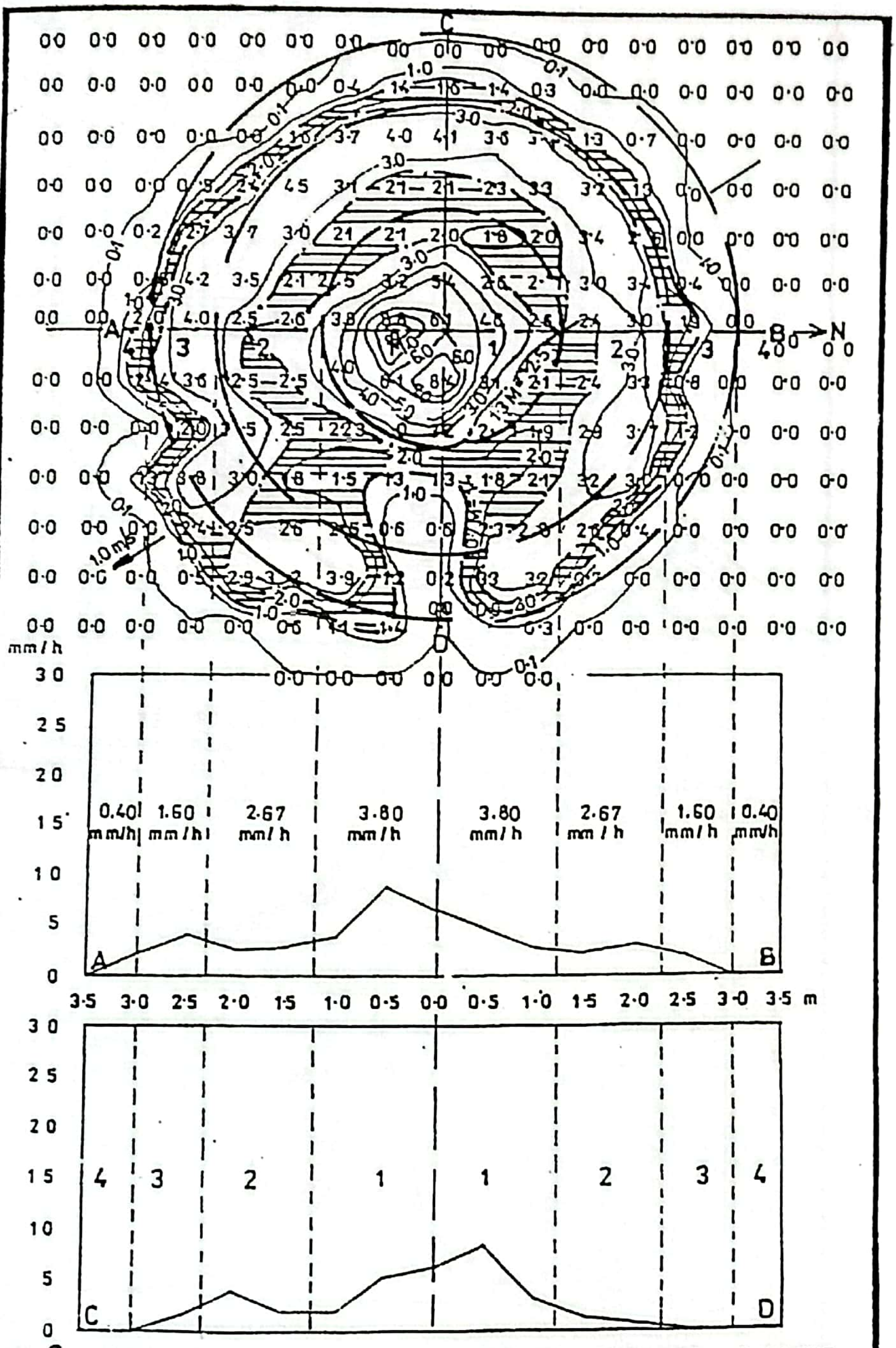

ABB.6 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI BETRIEBSDRUCK VON 1.0 BAR UND DEN IN DER TAB. 6 GEGEBENEN KLIMABEDINGUNGEN. EBENSO DER GÜNSTIG BEREGNTE FLÄCHENANTEIL.

FIG. 6: PRECIPITATION RATE DISTRIBUTION AND EQUIPOTENTIAL LINES, RRADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AND FAVOURABLE MINI-SPRINKLED AREA PORTION OF A SINGLE MINI-SPRINKLER AT OPERATING RESSURE OF 1.0 BAR AND 1.0 M/S WIND VELOCITY. 21.0 - AIR - AND 34.1 °C WATER TEMPERATURE AND 60.1 % RELATIVE HUNIDITY AS AVERAGES.

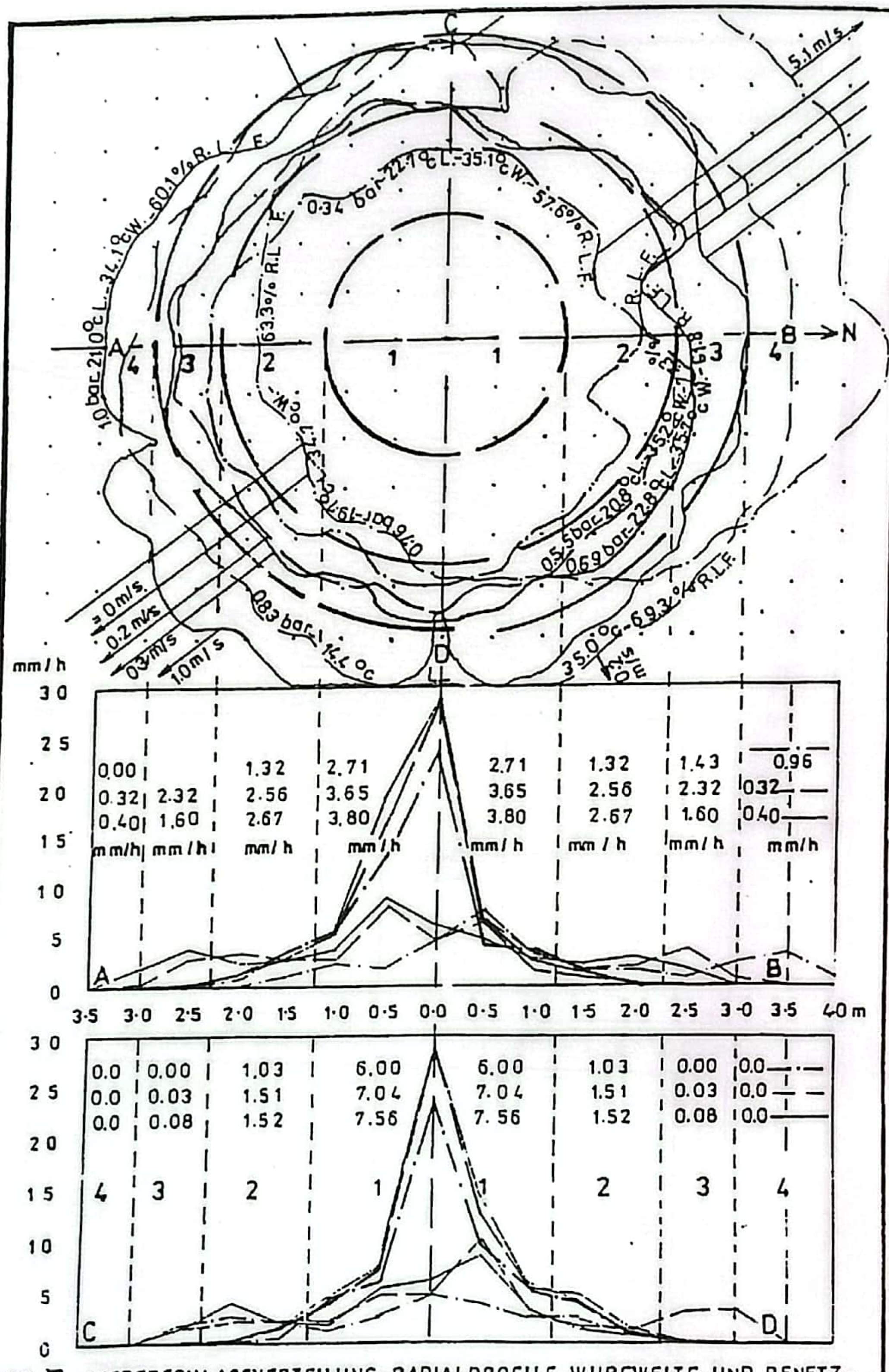

ABB 7 : NIEDERSCHLAGSVERTEILUNG, RADIALPROFILE, WURFWEITE UND BENETZUNGSZONEN DES M.REGNERS BEI DEN AUF DEN KURVEN, DIE DIE BEREGNETE GESAMTFLÄCHE BEGRENZEN, GESCHRIEBENEN UND IN DER TAB.7 GEGEBENEN BETRIEBSDRÜCKEN UND KLIMABEDINGUNGEN.

FIG. 7 PRECIPITATION RATE DISTRIBUTION, RADIAL PROFILES, RADIUS OF WETTING, WETTING ZONES AT WRITTEN OPERATING PRESSURE AND WEATHER ELEMENTS AVERAGES ON CURVE EACH WHICH DETERMINES THE ALL MINI-SPRINKLED AREA.

TABLE 1. Die Leistung des Mikroregners bei gegebenen Betriebsdrücken, durchschnittlichen Klimabedingungen und Wasserleitfähigkeit.

TABLE 1. Mini-sprinkler performance at given operating pressures, weather data averages and water salinity.

Betrieb-sdruck, bar (p.s.i.) Operat-ing pressure	Windge-schwin-digkeit, m/s Wind velocity	Temperatur, °C Temperature		Rel.Luft feuc htigkeit, % Relative Humidity	Sättigung sdefizit, mb+ Vapor pressure deficit	Wasser –leitfähi gkeit, µs/cm Water salinity	Ausflubrate, L/h Discharge rate		Wasserverluste, A-B Water losses		Wirkun-gsgrad= 100 – C, % Conven-yance efficiency	Durchsch-nittliche Wurfweite (m) Average radius of watting	Mittlere Benetzungsintensität auf die Zonen unfassenden den Mikroregner, mm/h Average wetting intensity at zones surrounding mini-sprinkler				Abb. Fig.
		Luft Air	Wasser Water				Gemessen an der Düse von ϕ=1.75 mm,A measured at nozzle of	Gemessen auf der angefeuchteten Bodenoberfläche,Bmeasured at soil surface	L/h	%, C			0 – 120 cm	120-230 cm	230-300 cm	300-350 cm	
0.34(5)	0.0	22.7	35.1	57.6	9.0	556	57.143	43.65	13.493	23.6	76.4	1.97	6.00	1.03	0.00	0.00	1
0.55(8)	0.2	20.8	35.2	71.3	5.6	278	66.055	55.511	10.544	16.0	84.0	2.40	7.04	1.51	0.03	0.00	2
0.69(10)	0.3	22.8	35.7	61.8	8.0	298	69.9	58.65	11.25	16.1	83.9	2.50	7.56	1.52	0.08	0.00	3
0.76(11)	5.1	19.7	34.7	63.3	7.0	284	78.261	48.775	29.486	37.7	62.3	3.09	2.71	1.32	1.43*	0.96*	4
0.83(12)	0.2	14.4	35.0	69.3	3.8	401	83.721	78.368	5.353	6.4	93.6	3.28	3.65	2.56	2.32	0.32	5
1.0(41.5)	1.0	21.0	34.1	60.1	7.5	438	94.737	72.9	21.837	23.1	76.9	3.20	3.80	2.67	1.60	0.40	6

+ Mit Hilfe der durchschnittlichen Klimabedingungen und Nach ACHTNICH (1980). With help of weather data averages and Achtinch (1980).

* bei nördlicher Halb-oberfläche, 230-300-und 300-400 cm bzw. 0.0mm/ h bei südlicher Halb-oberfläche, 230-300- und 300-400cm. At northern-half area, 230-300- and 300-400cm, but 0.0mm/h at southern half –area 230-300- and 300 400cm.

TABLE (2). Beurteilungsmabstäbe der Uniformität bei gegbenen Betriebsdrücken und durchschnittlichen Klimabedingungen.
TABLE (2). Mini-sprinkled water distribution uniformity values according to five standards.

Betriebs-druck, Bar (P.S.I) Operating pressure	Windgeschwindigkeit, m/s Wind velocity	Temperatur, °C Temperature		Rel. Luftfeuchtigkeit, % Relative humidity	Sättigungsdef'izit, mb Vapor pressure deficit	n⁺	M⁺⁺ Mm/h	Mikroberegnete Fläche, m² mini-sprinkled area			Cu, %	Scu, %	UCH, %	PE		
		Luft Air	Wasser Water					Mikroberegnete Gesamtrfläche, A Total mini-sprinkled area	M± 30% M, mm Mikroberegnete Fläche,B Mini-sprinkled area	Günstig Mikroberegnete Flächenanteil, B/A·100, % Favorable mini-sprinkled area portion				25% der n 25% of n	a'	a'/M, %
0.34 (5)	0.0	22.7	35.1	57.6	9.0	113	1.545	13.8	1.8	13.0	-30.5 m=1.5	-102.1 m=1.5	-61.3 m=1.5	28	0.0	0.0
0.55(8)	0.2	20.8	35.2	71.3	5.6	113	1.965	18.9	2.9	15.3	-8.9 m=2.0	-84.3 m=2.0	-47.1 m=2.0	28	0.0	0.0
0.69(10)	0.3	22.8	35.7	61.8	8.0	113	2.076	20.5	3.0	14.6	-8.0 m=2.1	-85.1 m=2.1	-47.7 m=2.1	28	0.0	0.0
0.76(11)	5.1	19.7	34.7	63.3	7.0	136	1.435	27.6	10.4	37.7	33.1 m=1.4	14.8 m=1.4	32.0 m=1.4	34	0.015	1.02
0.83(12)	0.2	14.4	35.0	69.3	3.8	129	2.426	33.0	15.9	48.2	50.4 m=2.4	33.6 m=2.4	47.0 m=2.4	32	0.666	27.44
1.0(14.5)	1.0	21.0	34.1	60.1	7.5	150	1.944	32.1	9.6	29.9	30.3 m=1.9	12.6 m=1.9	30.3 m=1.9	38	0.0	0.0

n^{+} = Znzahl der gemessenen Einze;werte. Number of measured values.
M^{++} = Mittel aus allen Einzelwerten. Average of total measured values
a' Mittel aus 25% der Einzelwerte, die dem niedrigsten Wert am nächsten liegen und diesen mit einschließen. Average of lower 25% of all measured values

The shaded area is the favorable mini-sprinkled area portion which received 0.7 - 1.3 times the average of total wetting depth .The 1.3, 0.7 times the average of the total precipitation rates amounted to (2 .0, 1.1 -), (2.6, 1.4 -), (2.7, 1.5 -), (1.9, 1.0 -), (3.2 - 1.7 -) and (2.5, 1.4 mm /h) for Figs. (1-6) respectively . Each of values (6.00 -, 1.03-, 0.00 - and 0.00 mm / h) at the middle of Fig. (1), (7.04 -, 1.51 -, 0,03 - and 0.00 -) Fig. (2), (7.56 -, 1.52 -, 0.08 and 0.00 -) Fig. (3), (2.71 -, 1.32 -, 1.43 -, 0,96 -) Fig. (4), (3.65 -, 2.56 -, 2.32 - and 0.32 -) Fig. (5) and (3.80 -, 2 67 -, 1,60 - , 0.40 -) Fig. (6) equals the average of wetting depths - the precipitation rates - at each of the aforementioned wetting zones . Fig. (7) summarizes the data of Figs. (1 -6). Tables (1 and 2) present the single mini-sprinkler performance values.

Results and Discussion

It is evident from Figs. (1 - 6) and Tables (1 - 2) that the radius of wetting and the total mini-sprinkled area increased with the increase of operating pressure . There was a slight exception where both values at 1.0 bar operating pressure (3.20 m and 32.1 m^2) were, to some extent, lower than at 0.83 bar (3.28- and 33.0 -) . Such slight exception might be attributed to the higher impact of 1.0 m / s average wind velocity at 1.0 bar than that of 0.2 m / s at 0.83 bar . Fig. (7) and Tables (1 and 2) disclose that the water distribution uniformity amounted to the highest values at 0.83 bar and 0.2 m / s . The averages of wetting depth - precipitation rate - at the wetting zones 1 , 2 , 3 and 4 were 3.65 - , 2.56 - , 2.32 - and 0.32 mm / h, respectively . Also , the favorable mini-sprinkled area portion , Cu , SCu and UCH amounted to 48.2 - , 50.4 - , 33.6 - and 47.0 % , respectively . Operating pressures equaling 0.76 bar or higher increased the mini-sprinkler water distribution uniformity. The favorable irrigated area portion , Cu , SCu and UCH amounted to > 29.8 - , 30.2 - , 12.5 - and 30.2 % , respectively . On the other hand , another picture prevails at operating pressures < 0.76 bar . The average wetting depth - precipitation rate - at the wetting zone 1 (0 -120 cm) amounted to values much higher than those in the other zones . The favorable mini-sprinkled area portion amounted to < 15.4 % . The standards Cu , SCu and UCH amounted to negative values . Mini-sprinkler water distribution uniformity decreased sharply with the decrease of operating pressure . Achtnich (1980) reported that a single sprinkler attained a favorable irrigated area portion of only 25.4 % .

The values of standards; favorable mini-sprinkled area portion, Cu and UCH are similar at operating pressures > 0.76 bar. Hence, it would be advised to apply such standards. The average wetting depth at the aforementioned wetting zones surrounding the mini-sprinkler according to the author is a favorable standard to evaluate mini-sprinkler water distribution uniformity. Under the conditions of the underlying research ,the pattern efficiency (PE) standard is not suitable to evaluate water distribution uniformity, PE at different operating pressures and wind velocities did not give meaningful values. It gave low value of 27.44 % at 0.83 bar and slight value of 1.02 % at 0.76 bar and 0 value at less operating pressures . It also gave value of 0 at 1.0 bar. Table (1) discloses that the water conveyance efficiency decreased to 62.3 % at operating pressure of 0.76 bar and 5.1 m / s average wind velocity , 19.7 -air- and 34.7 °C water temperature, respectively , 63.3 % average relative humidity and 7 mb vapor - pressure deficit . The higher evaporative losses than that recorded in Achtnich (1980), might be attributed to the narrow nozzle diameter 0f about 1.75 mm and to the higher water temperature (34 - 36 ° C) than that of air (14 - 23).

The higher wind velocity disturbed the mini-sprinkler water distribution and increased the evaporative losses. Fig, (4) and Table (2) disclose that 5.1m / s average wind velocity caused nonuniform water distribution. The wind decreased the wetting radius against wind direction to 1.8 m and increased it in wind direction to 4.8 m. Hence, the southern portion of the mini-sprinkled area did not receive adequate water. No water overlapping occurred in this research where the mini-sprinklers were 6 m apart. The evaporative losses in this research amounted to 6 - 38 % at different operating pressures and weather elements averages. In the literature cited, they amounted to 10 - 40 %.

Conclusion

Applying a single mini-sprinkler, the average wetting depth at zones surrounding the mini-sprinkler according to the author ; 1 (0 -120 -) , 2 (120- 230 -) , 3 (230 - 300 -) and 4 [300 - 350 (400) cm] is a favorable standard to evaluate water distribution uniformity.

High wind velocity , high temperature of irrigation water , low relative humidity and high vapor -pressure deficit make the mini-sprinkler a questionable system in the Siwa Oasis. Such factors inhibit applying the system . To apply a mini-sprinkler system successfully the operation conditions must be improved as follows :

1 - Growing of wind breaks in suitable design to reduce wind velocity minimizing the harmful impact upon water distribution uniformity and evaporative losses.

2 - Blending artesian water [warm (34 -36 °C) and fresh (< 320 μ S /cm)] and drainage water (4060 - in winter and 6250 μ S /cm in summer) would reduce fresh water temperature minimizing evaporative losses and alleviating harmful impact of high water temperature upon vegetative growth. The drainage water quality would be improved as irrigation water. Ayers and Westcut (1985) stated in Table (1) that water salinity of < 700 μ S /cm is not harmful . The water salinity of 700 - 3000 μ S /cm has slight to moderate restriction. Barley (*Hordeum vulgare*) yields 100% at irrigation water salinity up to 5300 μ S /cm , Cotton (*Gossypium hirsutum*) 5100 - , Beet , red (*Beta vulgaris*) 4700 - , wheat (*Triticum aestivum*) 4000 - . Date palm (*Phoenix dactylifera*) yields 90 % up to 4500 - and alfalfa (*Medicago sativa*) 2200 μ S /cm . It is a fact that date palms , olives , grape , pomegranate , jujube , barley , wheat , alfalfa , squash , tomato and many other crops thrive at Siwa Oasis applying the aforementioned saline water . Applying drainage water for irrigation would alleviate water logging problems and save the high quality irrigation water for wider land reclamation projects.

3 - Mini-sprinkling only in morning and evening when temperature is low, wind is mostly still and relative humidity is high minimizes evaporative losses and improves distribution uniformity.

4 - The first and third measures alleviate damage from Na^+ and Cl^- adsorption through the wetted vegetative growth. Low temperature, still wind and high relative humidity reduce evaporation through vegetative growth. Hence, the Na^+ and Cl^- concentrations on wetted vegetative growth would not increase at noticeable degree and slight adsorption would occur, according to Ayers and Westcut (1985).

5 - Mini-sprinkler with nozzle diameter > 1.75 mm has larger droplets that are more stable against wind minimizing evaporative losses according to Mather (1950) and Frost and Schwalen (1955)

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تأثير ضغط التشغيل وعوامل الطقس على تجانس توزيع وكفاءة توصيل مياه الرى بواسطة الرشاش الصغير.

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تتميز المساحة الكلية المروية بواسطة الرشاش الصغير ذى قطر الفوهة ١,٧٥ مم تقريبا الى أربع مناطق محيطة بالرشاش الصغير، كما حددتها معدلات نمو النباتات المروية ، وهى ١ (صفر ـ ١٢٠) ، ٢ (١٢٠ ـ ٢٣٠) ، ٣ (٢٣٠ - ٣٠٠) ، ٤ [٣٠٠ ـ ٣٥٠ (٤٤٠) سم] من حيث درجة ابتلالها بالمياه ، ويقل ابتلال التربة بالمياه المرشوشة كلما بعدنا عن الرشاش الصغير .

بلغ تجانس توزيع المياه أعلى قيمة ـ لكن لم يصل للقيمة المثلى ـ عند ضغط التشغيل المقاس عند الفوهة والبالغ ٠,٨٣ بار (12 psi) وتحت متوسطات عوامل طقس أثناء التشغيل متمثلة فى ٠,٢ متر / ثانية سرعة رياح و ١٤,٤ ، ٣٥,٠ °م للهواء والمياه على الترتيب و ٦٩,٣% رطوبة نسبية و ٣,٨ مللي بار نقص تشبع الهواء ببخار الماء ، حيث بلغ متوسط كثافة ابتلال سطح التربة بالمياه المرشوشة على المناطق (١، ٢ ، ٣ ، ٤)؛ (٣,٦٥ ، ٢,٥٦ ، ٢,٣٢، ٠,٣٢ مم/ ساعة) بالترتيب ، وحيث بلغت قيم مقاييس تجانس توزيع المياه ، وهى الجزء من المساحة المروية الذى يروى ريا مناسبا فى (Achtnich, 1980) ، ومعامل التجانس Cu طبقا لـ (Christiansen, 1942) ومعامل التجانس الأحصائى SCu فى ((Actnich, 1980 ومعامل التجانس UCH طبقا لـ (Hart, 1961) ٤٨,٢ ، ٥٠,٤، ٣٣,٦، ٤٧,٠% ، وبلغت كفاءة توصيل المياه من الرشاش الصغير الى سطح التربة ٩٣,٦% .

تتشابه قيم بعض مقاييس تحكيم تجانس توزيع المياه وهى الجزء من المساحة المروية التى تروى ريا مناسبا و Cu و UCH وذلك عند ضغط تشغيل أعلى من ٠,٧٦ بار (11 PSI) و تحت ظروف مناخية معينة . أما عند ضغط تشغيل أقل من ٠,٧٦ بار (11 psi) وتحت ظروف مناخية معينة ، فيبلغ متوسط كثافة ابتلال سطح التربة بالمياه المرشوشة بالمنطقة الأولى (صفر - ١٢٠) المحيطة بالرشاش الصغير قيمة أكبر كثيرا من مثيله على

كل من المناطق الأخرى، وتقل قيمة الجزء من المساحة المروية التى تروى ريا مناسبا عن ١٥,٥% وتكون قيم كل من Cu و SCu و UCH سالبة ، وهنا لا يصلح استخدام المقياس كفاءة توزيع المياه PE طبقا لـ (National Resource Conservation Service in Actnich, 1980).

تسبب درجة حرارة المياه (٣٤ - ٣٦ ° م) (الأعلى منها للهواء (١٤-٢٣°م) و قطر فوهة الرشاش الصغير البالغ ١,٧٥ مم تقريبا فقدا فى المياه (٦-٣٨%) أكبر كثيرا من مثيله الوارد فى (Achtnich, 1980) .

ويهدف هذا البحث الى اختبار تشغيل نظام الرى بالرشاش الصغير المائل وتحديد أحسن الظروف لرفع كفاءة الأداء تحسينا لتوزيع مياه الرى على النباتات تحقيقا لغلة أكبر وكذلك توفير لمياه الرى لاستصلاح وزراعة مساحات أكبر .