Scientific Papers. Series A. Agronomy, Vol. LVI, 2013
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

.

RESEARCH REGARDING THE UNIFORMITY OF SPRINKLER IRRIGATION IN FORESTRY NURSERY

Nicuşor BOJA[1], Florin BOJA[1], Alin TEUŞDEA[2], Petru Aurel DĂRĂU[1]

[1]"Vasile Goldiş" Western University of Arad – Faculty of Natural Sciences, Engineering and Informatics, Cocorilor Street nr. 57, Arad, Romania
[2]University of Oradea – Faculty of Environmental Protection, Gen. Magheru 26, Oradea, Romania

Corresponding author email: bojanicu@yahoo.com

Abstract

The research was carried out in the Iarac forestry nursery in the O.S. Iuliu Moldovan during 2010-2012, on an alluvial soil (the vertical-gleyed subtype). The placement of the sample markets was carried out according to the "divided parcels method" in two repetitions, and the surface of a parcel was 450 m^2.
The present paper displays the results obtained after the sprinkler irrigation, when we determined the quantity of water spread by the 6 sprinklers on a 15 m-radius, placed on the direction of the cardinal points.
The purpose of the research was to observe the correlation between the qualitative work indexes of the sprinkling devices, by spreading a uniform quantity of water on the entire surface and the maintenance of an ecological balance of cultivation of the saplings in the forestry nursery.
In a close connection with the purpose stated, the paper also focuses on the study of the work indexes of the sprinklers used in forestry nurseries, among which the most important is the uniformity of sprinkling.
The uniformity of sprinkling, the intensity of watering, the fineness of the rain, and the energy of the drops are also called qualitative indexes or the sprinkling's characteristics - key elements for the assessment of the sprinkling irrigation devices. Sprinklers are active organs of the watering devices. They can transform the water pumped out into drops which can be spread on the surface that needs irrigation.
The main means used for the improvement of sprinkling uniformity are the following: the usage of sprinklers with a small radius of sprinkling, having correct pluviometric curves; the correct placement of sprinklers on the terrain, according to the schemes of work recommended; avoiding to water when the speed of the wind surpasses the speed limit established for the sprinklers used.

Key words: *sprinkler, sprinkler irrigation, uniformity of sprinkling, qualitative indexes of the sprinkling.*

INTRODUCTION

The condition of a uniform distribution of the water on the terrain is determined with the aid of an index of sprinkling uniformity. The condition of a minimum loss of water through surface leaking and the condition that the watering does not worsen the properties of fertility of the soils, through the deterioration of the soil (the formation of the crust) or through erosion are determined with the aid of an index of uniformity.
The condition of a minimum loss of water through evaporation during watering is determined through the index of the fineness of the rain. The same index serves together with the index of intensity for the appreciation of watering from the point of view of the formation of the crust and of the mechanical effects of the water on the tissues of the irrigated plants (Nedelcu, 2004).
In order to diminish the negative effect of the wind and to improve the uniformity of the sprinkling, it would be good to reduce the distance between sprinklers on the wing of sprinkling according to the speed of the wind (Grumezea and Kleps, 2005).
The height of the sprinkler at 0.50 m when the wind blows is more favourable than at 1.50 and the stability to wind of the jet increases together with the size of the nozzle. Uniformity of watering depends on the speed of the wind and its direction, and also on some technical characteristics of the sprinklers, height of placement, etc. (Cazacu et al., 1989).
While modifying the schemes, we must take into consideration the speed of the wind at the height of the sprinkler. The wings are placed as

possible perpendicularly on the dominant wind and the sprinklers at the height of 40-60 cm above the soil in order to avoid the turbulence of the wind which is formed immediately on the soil (Vlad et all., 1982).

On the basis of the different indexes found in the specialty literature, we acknowledge the limit speed of the wind at 5 m/s, bigger speeds being prohibitive for the sprinkling. At a wind speed of 1.5-5 m/s, one needs special schemes of placement of the sprinklers. At wind speeds less than 1.5 m/s, the influence of the wind is considered to be insignificant for the uniformity of the sparkling (Mihai, 1970); (Siseşti, 1971).

Knowing the technical elements of the watering (schemes of watering, intensity of the rain, duration of watering, fineness of the rain, uniformity of the sprinkling) creates the premises necessary for the application of a uniform watering, the correlation of the intensity of the rain with the speed of infiltration of the water in the soil, but also possibility of appreciation of the quality of watering (Mihai, 1970); (Popescu and Popescu, 2000).

An ideal sprinkler must accomplish an intensity whose value grows continuously, with smaller values from the periphery of the jet towards the sprinkler. These types of sprinklers ensure a good uniformity of watering when the work schemes are established judiciously, according to the distribution of the intensity on the radius (Chiru and Mihai, 1972).

The intensity and the uniformity of watering are in a large extent influenced by the work pressure and the nozzle used. Thus, when the sprinkler functions at a too low pressure, it produces too big drops and an un-uniform distribution of the water. When the pressure is too high, the jet of the sprinkler is pulverized in smaller drops which are distributed around the sprinkler (Plesa and Burchiu, 1986).

Thus, the present research had as a purpose the study of the possibility of introducing in the exploitation other types of sprinklers, adaptable to the requirements of the cultures and soils in question.

MATERIALS AND METHODS

The research was carried out in the Iarac forestry nursery in the O.S. Iuliu Moldovan during 2010-2012, on an alluvial soil (the vertical-gleyed subtype). At the time when the measurements were taken, the meteorological conditions were: temperature of 24^{o} C; wind speed of 2 m/s; total nebulosity: 4; and relative humidity 49. The placement of the sample markets was carried out according to the "divided parcels method" in two repetitions, and the surface of a parcel was 450 m^2.

The present paper displays the results obtained after the sprinkler irrigation, when we determined the quantity of water spread by the 6 sprinklers on a 15 m-radius, placed on the direction of the cardinal points.

The determination of the uniformity of sparkling by measuring the quantity of water sprinkled, which is collected in pluviometers, placed after a certain rule on the watered surface.

In the case of the determination of the uniformity of sprinkling of an isolated sprinkler, the pluviometers are placed at equal distances of 1-2 m, on a radius, in conditions of atmospheric calmness or on four radiuses, in a cross, if windy.

In the case of the determination of the uniformity of sprinkling under a wing of rain, it is necessary to use a greater number of pluviometers, placed on two perpendicular directions, under the form of a grid.

Thus, we can produce a regular geometrical platform, having the width equal with the distance between two neighbouring sprinklers, and the length equal with the distance between the two neighbouring wings of rain.

The graphic of the isohyets is made by uniting the points which have the same collected quantity of water in the pluviometers. With the circle watering, the isohyets appear under the form of a concentric curve.

In order to determine the quantity of water distributed from the sprinkler to the surface of the soil, we placed pluviometers at each meter on two diagonals (cardinal points), until the distance of 15 m, thus registering the quantity of water distributed, in mm or l/m^2.

Thus, we established two surfaces for the sampling of the observational data, in a rectangular form, with a 450 m^2 (30 x 15 m) surface, among which one was the witness sample – the un-irrigated soil, and the other surface suffered successive modifications

through the sprinkler irrigation. At each surface, we sampled 60 primary data, placed on the direction of the cardinal points (N, S, E, W) for each of the six sprinklers henceforth abbreviated (A1…A6).

The distribution scheme of the sprinklers and pluviometers for the determination of sprinkling uniformity is given in Figure 1 and Figure 2.

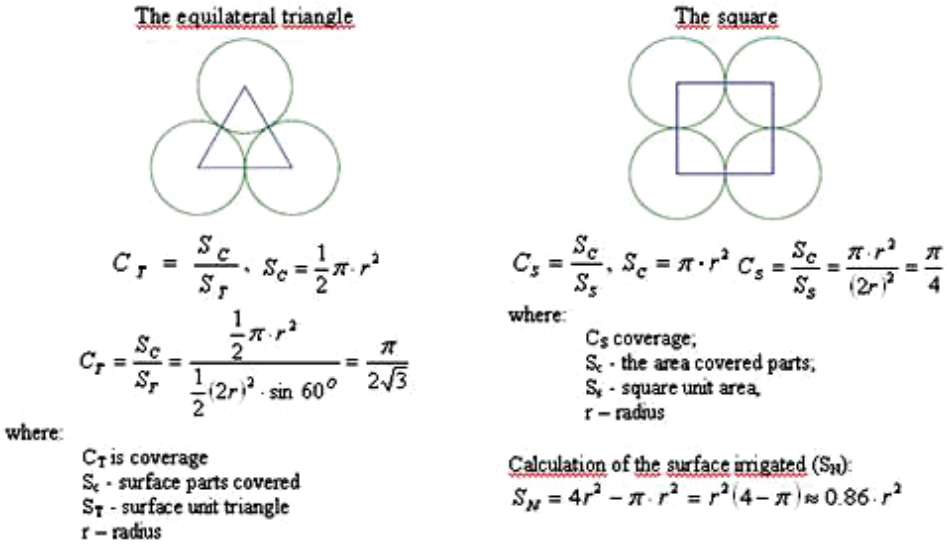

Figure 1. The arrangement reciprocal of coverage area without sprinklers

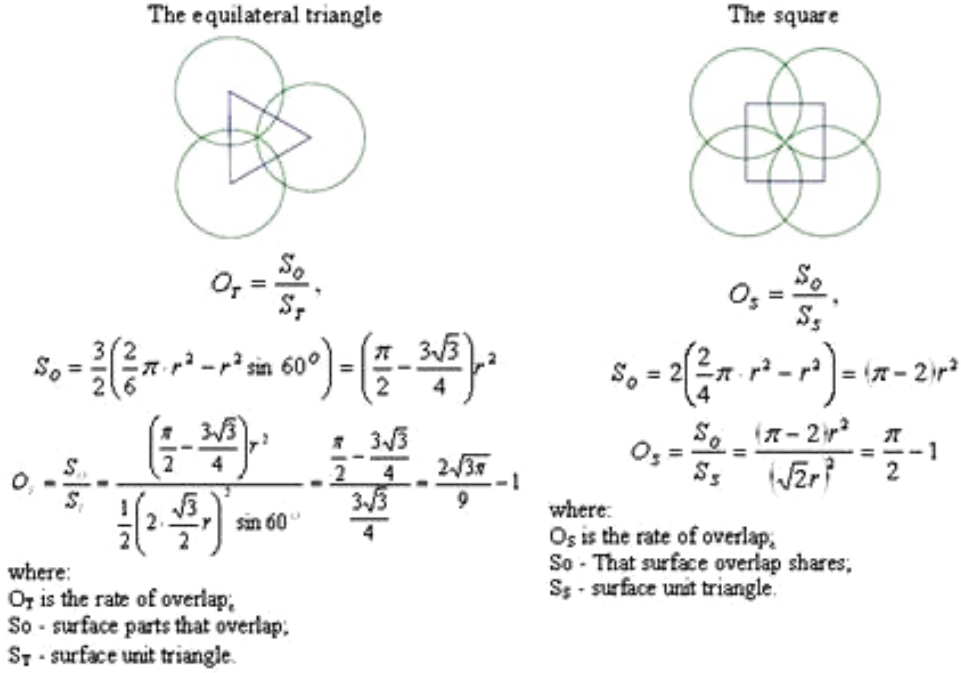

Figure 2. The arrangement sprinklers in areas of reciprocal coverage

RESULTS AND DISCUSSIONS

The quantity of water distributed by the six sprinklers included in the experiment is presented through average values in Table 1, at distances from m to m on a 15 m - radius, placed on the direction of the cardinal points.

Analysing the average values from the table below, we could observe the presence of some optimal values of the water accumulated in pluviometers, after the sprinkling, up to an 8 m distance; on this radius, the quantity of water accumulated presents quite big variances because of the speed of the wind or the functioning of the sprinkler.

Table 1. Average values of the sprinkling uniformity in connection with the cardinal points

Distance from the sprinkler, m	Average values in connection with the cardinal points, mm			
	North	East	South	West
1	7.50	7.00	6.88	7.40
2	5.75	6.43	5.28	5.77
3	5.48	5.48	5.57	5.90
4	5.52	6.22	4.75	4.32
5	5.13	5.62	4.45	3.73
6	5.30	5.38	4.77	3.43
7	6.00	4.63	4.55	3.53
8	5.12	3.63	4.22	3.63
9	4.30	2.40	3.38	2.77
10	4.15	1.58	2.05	2.40
11	2.12	0.88	1.35	2.03
12	1.52	0.40	0.92	1.47
13	0.68	0.28	0.52	0.90
14	0.32	0.15	0.28	0.35
15	0.23	0.12	0.20	0.27

In the specialized literature is referred to minimum amount of water sprayed crop's needs, ranging from 2-6 mm / h depending on soil texture and crop species. (Trifu, 1973)
Analyzing information collected from our research these values are obtained and 10-11 m from the sprinklers.
This is particularly important because it provides information about the optimal distance between sprinklers in order to comply with the initial condition that the entire surface to distribute the same amount of water.
In order to synthetize more efficiently the data and to describe more accurately the intrinsic characteristics of the sample, we proceeded to the statistical processing with the aid of the KyPlot program.
The results obtained are given in Table 2 for the average values of uniformity of the sprinkling in connection with the cardinal points, so that we could emphasize the variance of the quantity of water distributed by the sprinkler and accumulated in pluviometers at the surface of the soil.

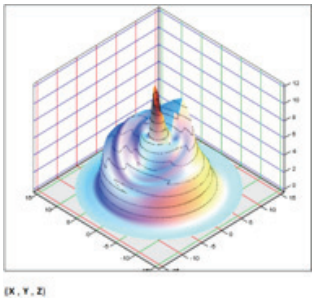

Figure 3. The uniformity variation around the sprinkler spray 2

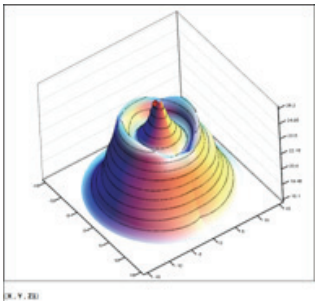

Figure 4. The uniformity variation around the sprinkler spray 3

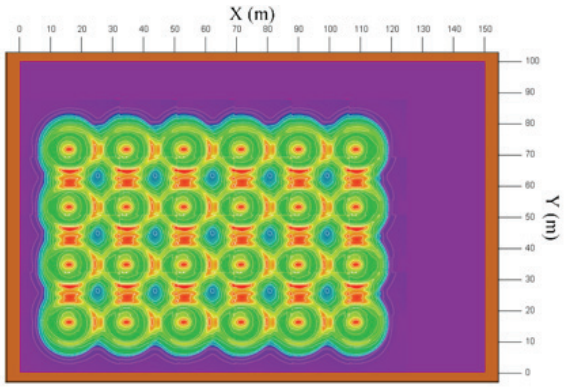

Figure 5. Overlapping sprinklers wings (7m/7m) to a minimum quantity of water 2l/mm^2 the square display

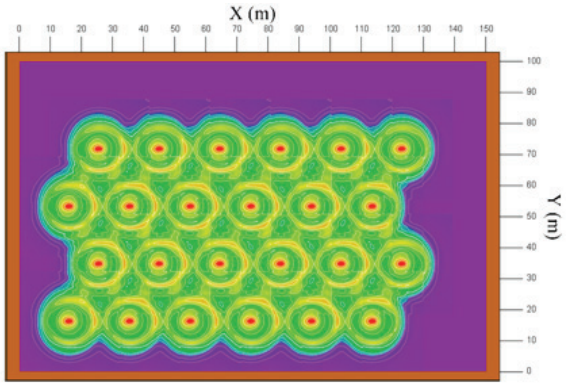

Figure 6. Overlapping sprinklers wings (6.5 m/6.5 m) to a minimum quantity of water 2l/mm^2 the equilateral triangle display

Table 2. Variance of some statistical indexes of the average values of sprinkling uniformity in connection with the cardinal points

Cardinal points Statistical indexes	North	East	South	West
Mean	3.94	3.35	3.28	3.19
S.E.M. (Average standard error)	0.60	0.67	0.57	0.54
Standard deviation	2.34	2.61	2.19	2.08
Coefficient of variation	0.59	0.78	0.67	0.65
Minimum	0.23	0.12	0.20	0.27
Maximum	7.50	7.00	6.88	7.40
The number of feature values (N)	15	15	15	15
Skewness	-0.46	-0.03	-0.15	0.38
Curtosis	-1.14	-1.64	-1.34	-0.59
Mean Deviation	2.12	2.52	2.05	1.74
Median	5.12	3.63	4.22	3.43
Range	7.27	6.88	6.68	7.13
Confidence Level(0,95)	1.29	1.45	1.21	1.15
Lower Confidence Limit	3.34	2.67	2.71	2.66
Upper Confidence Limit	4.55	4.02	3.84	3.73

CONCLUSIONS

When watering through aspersion, the uniformity of distribution of the water for irrigation is rather reduced because of some definite causes. One of the causes for the lack of uniformity of the water on the irrigated terrain through sprinkling is the watering of the sprinklers on circular surfaces. For the integral coverage with rain of the terrain, the circular surfaces must overlap in a smaller or greater extent according to the distribution scheme of the sprinklers. In conditions of correct placement of sprinklers on the terrain, the surface watered twice varies between 15 and 33%.

Another cause which influences the uniformity of sprinkling is the functioning of a sprinkler. It is obvious that the water jet, even at the improved sprinklers cannot be distributed in an absolute uniformity on all its length. That is why the circular surface watered by a sprinkler appears, from the point of view of the uniformity of sprinkling, under some concentric zones, more or less differentiated according to the characteristics and functioning state of the sprinkler used.

At the improved sprinklers, small quantities of water are distributed at the periphery of the circular surfaces. Thus, by overlapping the circular surfaces, we could ameliorate the uniformity of sprinkling.

The uniformity of distribution of the sprinkler is best given with the aid of a pluviometric curve.

Another major source of non-uniformity of the watering through sprinkling is represented by the influence of the wind. The wind deforms the circular form of the surface sprinkled, which becomes a more or less normal ellipsis and a more or less flattened ellipsis, according to the uniformity and intensity of the wind.

Among the main means used for the improvement of sprinkling uniformity are the following:

The usage of sprinklers with a small radius of sprinkling, having correct pluviometric curves;

The correct placement of sprinklers on the terrain, according to the schemes of work recommended;

Avoiding to water when the speed of the wind surpasses the speed limit established for the sprinklers used;

REFERENCES

Cazacu E. et al., 1989. Irrigations. Ceres Publishing House. Bucharest.

Chiru V., Mihai S., 1972. Contributions to the study of the work indexes of the ASM and ASJ 1 Sprinklers. Journal of Forests nr. 8/1972, p. 19-23.

Grumezea N., Klepş C., 2005. Irrigation Installations in Romania. Ceres Publishing House. Bucharest.

Nedelcu M., 2004. Current State regarding the Construction of Installations for Irrigation. Braşov.

Mihai S., 1970. Contributions to the study of the work indexes carried out by the sprinkling installation from the central forestry nursery of Găeşti. Journal of Forests, nr. 7/1970, p. 24-29.

Mihai S., 1970. Contributions to the study of the work indexes of the ASM2 Sprinkler. Journal of Forests, nr. 12/1970, p. 31-35.

Popescu I., Popescu S. 2000. Mechnization of Sylvical Works. Publishing House of the University of Transylvania. Braşov, p. 11-34.

Pleşa I., Burchiu V., 1986. Exploitation of the Systems for Territorial Improvements. Ceres Publishing House. Bucharest, p. 325.

Siseşti V. I., 1971. Irrigated Cultures. Didactical and Pedagogical Publishing House. Bucharest.

Trifu Şt., 1973. Mechanization, irrigation of landscaped land. Ceres Publishing House. Bucharest.

Vlad I. S. et al., 1982. Irrigation of Cultures. Ceres Publishing House. Bucharest.