Influence of physical properties of some types of soil on the percentage of springing and average weight of bulbs at onion crop directly sowed in Braila County

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Abstract

The research had been performed in the scope of establishing the suitability of different types of soil (typical chernozem, saline chernozem, calcareous alluvial soil and saline alluvial soil) for onions' crop set up through direct sowing into the field, in the period 2003-2005.

Following to the researches set up, it was found that the types of soil: typical chernozem and saline chernozem, due to the loamy texture (medium), apparent density (1,15- 1,16 g/cm³), glomerular structure well developed and to favorable porosity, it ensures a medium springing percentage of over 80% and an average weight of onion's bulbs that vary between the limits of 50.05-52.40 g.

At types of calcareous and saline alluvial soil, due to the loamy-clayish texture (soft), apparent density (1.25-1.34 g/cm³), grainy structure poorly developed and unfavorable porosity, the average springing percentage was of about 60 % and the weight of the bulbs varied between the limits of 39.48-45.19 g.

Keywords: onion, texture, clay, apparent density, structure.

Introduction

Onion is a precious vegetable species cultivated on large areas in the world and in our country. The value of this vegetable species comes both from alimentary importance and from the economical one.

Onion occupies 4th place in the world among vegetable species, the main producer of onion being China and European Union. In our country, from economical importance point of view, onion occupies 3rd place after cabbage and tomatoes. In Braila County, county that is found in an area which is very favorable to onions crop, out of total vegetables production, onions represent about 17%. Setting up onions crops is made through direct sowing in a ratio of 4/5, worldwide. In Romania, up to 1993-1995, over 90 % of the onion production was obtained from chive. Massive decrease in the domestic production of chive made producers find other culture technologies.

Using the culture technology of onion through direct sowing expanded in the last years due to certain advantages, such as: reducing expenses through elimination of the ones necessary for the purchase of chive and the ones related to its planting and decreasing the time of obtaining the bulbs from 2 years to one year. The appearance of West-European hybrids created for the culture through direct sowing in the field and with short vegetation periods makes the technology of cultivating the onion through direct sowing be used increasingly more often.

In order to obtain high, stable and qualitative productions with the culture of onion, it is recommended to use homologated hybrids in the last years by companies that are big producers of seeds especially in Europe, due to the fact that in the case of onion, the development of the bulb is definitely influenced by the duration of the day and by the temperature during vegetation.[6]

The actual sort was enriched with some hybrids that are pliable to the culture through direct sowing and it is characterized through large productions and through earliness: Daytona, Romito, Milena, Tamara, Cortland. [3]

Physical properties of the soils (texture, structure, apparent density, etc.) determines creating some conditions favorable or unfavorable to onion bulbs springing or growing.

Due to the root system poorly developed, the onion must be cultivated in rich soils, with a good structure, with sufficient moisture, having no grass. The best soils are the ones from rivers' meadows, with neutral or slightly alkaline reaction. [2]

Of great importance in the success of the onion crop set up through direct sowing is machines' schema that would help the producers at integral mechanization of agricultural works. [4]

The decreased level of hydraulic conductivity of infiltration rate determines a poor water stability of structural aggregates, with effect on air-water regime of the soil and implicitly on the production of onion. [8]

The soil can be a limitative factor of cyclamate onion crop, firstly due to the texture, because forming the crust after sowing can compromise partially or totally this crop.

Best recommended soils for onion culture are the ones with smooth or medium texture, fertile; structured, these requirements are based on the fact that onion has a root system poorly developed and superficial.

Alluvial soils are often recommended, but not always they are corresponding, due to the fact that in some meadows, alluvial deposits contain much clay that is equally allotted on soil's profile. [5]

Setting up the onion crop through direct sowing, using the best performing cultivars leads to increasing the profitability of the crop, along with obtaining large productions, the degree of mechanization and the price of sale. Turning to profit of the crop with this technology starts from a production of minimum 20 t/ha, even with manual harvesting.[7].

Materials and methods

The experience developed on four types of soil: typical chernozen, saline chernozen, calcareous and saline alluvial soil, using two cultivars: Diamant and Daytona F1, applying the same crop technology.

As at all experiences at which the cultures are set up mechanically, the 4 repetitions were not randomized. For each type of soil, the experimental variants were mounted in multi-staged blocks without randomization, experimental area being of 480 m², total area of the experience for the four types of soil being of 1920 m².

The biological material used at performing the experience was Diamant sort and Daytona F1 hybrid.

Diamant Sort is a typical sort for the culture through direct sowing, semi-belayed, with a period of vegetation of 145-150 days, dry bulbs having sharp cone form, with a slight tendency of flattening, covered with cataphylls of yellow-copper color. The average weight of bulbs is of 140-150 g, with a limit of variation between 90-300 g. The production potential in very good technological conditions is of 40-45 t/ha.

Daytona F1 Hybrid is of Dutch origin, has a period of vegetation of 110-115 days, it presents resistance to Fusarium and tolerance to Botrytis. It has a root system very well developed, the bulbs have ball-shaped – elongated form, the color of cataphylls is beige – brown. The potential of production is very good, under conditions of well applied technology, productions of 50-60 t/ha can be easily obtained. The bulbs have the average weight comprised between 90-100 g and are characterized through an increased uniformity.

The texture of soil was determined based on the proportion of granulometric fractions (sand, dust, clay) that intervene in it's composition that was achieved through treating the soil sample as per Kacinski method and separation of granulometric fractions through screening and dropping.

The method consists in dispersing the granulometric fractions by treating the soil sample with solution of muriatic acid 0,2 n, washing with solution of muriatic acid 0.05 n, treating with aqueous ammonia solution of 1 n and boiling. Separation of particles is made through screening (for coarse sand, with the diameter over 0,02 mm) and dropping (for dust and clay, with the diameter equal to or less than 0, 2mm).

Apparent density (AD) was determined by reporting the sample of dry soil at the strove at 105˚C to total volume of soil sample.

Total porosity (TP) was determined through a calculation as per following formula: $TP = (1-AD) \times 100/D$

Aeration porosity (AP) was determined through a calculation as per following formula: $AP = TP - CC \times AD$

The structure of soil was determined on the field based on morphological characterization of soil's profile. [1]

Results and discussion

For the culture of onion directly sowed, there are under analysis mainly the physical properties of the soil on the depth of 0-20 cm (Ap horizon), but these were determined on the depth of 0-70 cm.(table 1).

Table 1. Physical properties of the typical chernozem soil set up on loamy loess in field conditions

Specification / Horizons	Ap	Am	AC
Depths (cm)	0-20	30-50	60-70
Coarse sand (2,0-0,2mm)%	0.05	0.05	0.04
Soft sand (0,2-0,02mm)%	44.44	42.08	45.75
Dust (0,02-0,002mm)%	25.49	31.29	27.23
Clay (under 0,002mm)% out of which:	30.02	26.58	26.98
Physical clay (under 0.01mm)%	37.93	43.56	39.27
Texture	LL	LL	LL
Apparent density (AD g/cm^3)	1.16	1.18	1.25
Total porosity (TP%)	56.3	55.2	52.8
Aeration Porosity (AP%)	23.8	23.6	19.6

The horizons notation signification is the next one:

The A horizon, is the horizon from the surface of the soil which is characterized through accumulation of humus and total or partial leaching of salts. The horizon can be of more types:

Horizon Ap (A worked) which defines the ploughed layer from the surface of the soil and which because of cultivation, suffers modifications which differentiate it from the rest of the unworked horizon.

Horizon Am (A mollic) is characterized through accumulation of humus of the best quality, which it gives a dark colour and a very good structure, because of which it is aerated.

Horizon AC, is the horizon of transition towards the mother rock.

From **table 1** it results that on all depth in granulometric set up of the typical chernozem soil, soft sand predominates (42.08-45.45%), that determines a loamy texture (medium), with positive attributes on soil's suitability for onion crops directly sowed, due to the fact the soil does not form the crust.

The values of apparent density of 1.16 - 1.18 g/cm³ shows an aerated soil that allows an optimum development in depth of the root system, the sowing is made at a depth of 2.0 cm; the resistance opposed by the soil at performing the works of ploughing and preparing the germinal bed is small, fact that implies a reduced energy consumption.

The value of 1.25 g/cm³ in the horizon AC shows an easily compact soil, mainly because of the low content of organic substance.

Glomerular structure well developed ensures on the depth of 0-70 cm a total porosity of 56.3 – 52.8 % out of which aeration porosity is of 23.8 – 19.6 %, these values ensuring to the plants an air-water regime favorable to an optimum growth and development. Due to the structuring, the soil is humidified on high depth, that leads to forming water reserves in depth and in the periods of drought, no cracks appear in the soil. The norms of irrigation applied are of 300-400 m³/ha, being applied 5 irrigations at Diamant with an irrigation norm of 1350 m³/ha and 4 at Daytona F1 with an irrigation norm of 1750 m³/ha.

Table 2. Physical properties of saline chernozem soil formed on loamy loess in field conditions

Specification / Horizons	Ap	Am	ACsc
Depths (cm)	0-20	30-40	40-50
Coarse sand (2,0-0,2mm)%	1.32	1.07	0.96
Soft sand (0,2-0,02mm)%	43.68	40.0	41.05
Dust (0,02-0,002mm)%	27.18	27.66	29.16
Clay (under 0,002mm)% out of which:	27.82	31.27	28.83
Physical clay (under 0.01mm)%	40.87	43.04	39.85
Texture	LL	LL	LL
Apparent density (AD g/cm^3)	1.17	1.20	1.27

Total porosity (TP%)	55.4	53.1	51.6
Aeration Porosity (AP%)	28.5	23.7	21.6

The horizon notation semnification is for the horizons Ap and Am the same as in the case of the typically chernozem and the semnification of the **ACsc horizon** is the next one: the transition horizon towards the mother rock is associated with a saline horizon (sc) of soluble salts accumulation in the shape of a flowering, in amounts from 0,1 – 1 % in the case of chlorides and 0,15 – 1,5 % in the case of sulphates.

From the results presented in **table 2,** it comes out that the texture of saline chernozem soil is loamy (medium), on all depth (0-50 cm) the particles of soft sand predominating in the granulometric set up in proportion of 43.68 – 40.00 %, the structure of soil is glomerular and it ensures values of total porosities between 55.4 – 51.6 % out of which between 28.5 – 21.6 % is the aeration porosity, values that ensure a favorable air-water regime. The value of apparent density of 1.17 g/cm³ in Ap shows an aerated soil that allows an even springing of the onion plants, over the depth o 30 cm has place a rising of apparent density values in consequnce of lowering the content of organic substance from soil.

At the depth of 40-50 cm it appears a process of poor salinization of chloride nature that has a moderate effect on diminishing the production.

Table 3. Physical properties of calcareous alluvial soil set up on river deposits, in conditions of plain meadow

Specification / Horizons	Ap	Ao	AC
Depths (cm)	0-20	20-30	30-50
Coarse sand (2,0-0,2mm)%	0.19	0.16	0.06
Soft sand (0,2-0,02mm)%	24.56	21.03	14.83
Dust (0,02-0,002mm)%	32.37	34.80	40.54
Clay (under 0,002mm)% out of which:	42.88	44.01	44.57
Physical clay (under 0.01mm)%	65.54	71.64	73.54
Texture	LA	LA	LA
Apparent density (AD g/cm^3)	1.25	1.37	1.42
Total porosity (TP%)	47.5	45.6	44.7
Aeration Porosity (AP%)	10.3	5.7	4.0

The horizon notation semnification is for the horizons Ap and AC the same as in the case of the typically chernozem and the ***Ao horizon (A ocric)*** is characterized through bright colour because of the low content of organic substance and it becomes massive and very hard in the dry period of the year.

From **table 3** it results that in granulometric set up of the calcareous alluvial soil it predominates clay mineral fraction on the depth of 0-50 cm with values between 42.88 – 44.57 %, determining the framing of the soil within soft textural class, clayish loam sub-class, with negative attributes on soil's suitability for onion culture directly sowed, due to the fact that the soil forms a crust.

Determined fine texture: small aeration, humidity excess in the rainy periods and profusion of water at the soil surface, short interval of optimum humidity in the soil, great resistance at ploughing, superficial striking root.

The value of apparent density on the depth 0 – 20 cm of 1.25 g/cm³ shows a soil with a moderate compacting even from surface, fact that determines the sowing to be performed more superficial at the depth of 1.5 cm and the consumption of energy in order to perform works of ploughing and preparing of the germinal bed should be high, also for obtaining some quality works it is necessary to perform it more times, and the time interval when the soil can be worked is short. The compacting of the soil has as effect also the fact that the soil will hardly heat. On the depth of 20 - 50 cm the value of apparent density has values between 1.37 – 1.42 g/cm³, which shows a compact soil in depth.

Small granular, poorly developed structure ensures values of total porosity of 47.5 – 44.7 %, out of which 10.3 – 4.0 % represents aeration porosity. These value of aeration porosity are smaller, that is why the air regime from soil is insufficient to the respiration of the roots of the plants. This issue presupposes applying a higher number of soil's aeration works during the period of vegetation.

Over the depth of 40 cm, the soil is not structured and that is why no water reserves can be formed in depth; consequently, occurrences of puddles appear when abundant precipitations fall or high norms of irrigations are used. The norms of irrigation used were of 250-350 m³/ha and 3 irrigations were applied at Daytona F1 with a norm of 800 m³/ha and 4 irrigations at Diamant with a norm of 1150 m³/ha.

Table 4 Physical properties of saline alluvial soil formed on river deposits, in conditions of plain meadow

Specification / Horizons	Ap	Ao	AC
Depths (cm)	0-20	20-30	30-50
Coarse sand (2,0-0,2mm)%	0.04	0.04	0.03
Soft sand (0,2-0,02mm)%	22.69	22.52	22.23
Dust (0,02-0,002mm)%	33.85	35.32	32.96
Clay (under 0,002mm)% out of which:	43.42	42.12	44.78
Physical clay (under 0.01mm)%	75.96	76.07	79.52
Texture	LA	LA	LA
Apparent density (AD g/cm^3)	1.34	1.40	1.44
Total porosity (TP%)	49.8	46.5	44.8
Aeration Porosity (AP%)	14.2	11.4	9.5

The horizons notation signification is the same as calcareous alluvial.

From **table 4** it results that granulometric fraction that predominates on the depth 0 - 50 cm in saline alluvial soil is clay 43.42 – 44.78 %, that determines framing the soil in soft textural class, clayish loam sub-class, with negative properties on soil's suitability for onion culture directly sowed, due to the fact that the soil forms a crust.

The high value of apparent density of 1.34 g/cm³ on the depth of 0 – 20 cm, shows a compacting process even from the surface of soil, with negative effects on the degree of springing, on the depth of the penetration of the roots and on the rhythm of the heating of the soil.

On the depth of 20 – 50 cm, the apparent density has values between 1.40 – 1.44 g/cm³, which shows a compact soil in depth.

Small granular, poorly developed structure developed in the arable layer and lack of structuring in depth of the soil determines values of total porosity of 49.8 – 44.8 %, out of which 14.2 – 9.5 % represents aeration porosity, that ensures an air regime that is not satisfactory.

Also, the soil cannot form water reserves in depth, the rains in small quantities are not turned to advantage on this type of soil; due to this poor structuring, the water is lost through evaporation – exudation at the surface of soil and at short time after humectation, the superficial soil layer will dry, the plants suffering due to the lack of water.

The percentage of springing for onion crops set up through direct sowing have different values both depending on the type of soil and on cultivar's (**table 5)**.

Table 5. Percentage of springing at onion culture directly sowed

Cultivars	Springing percentage %			
	2003	2004	2005	Average
Typical chernozem				
Diamant	83.4	84.9	86.9	85.1
Daytona F1	84.8	86.1	88.8	86.6
Saline chernozem				
Diamant	82.3	84.2	84.9	83.8
Daytona F1	84.4	85.7	86.5	85.5
Calcareous alluvial soil				
Diamant	55.8	59.4	62.3	59.2
Daytona F1	56.7	61.5	61.9	60.0
Saline alluvial soil				
Diamant	56.5	57.8	60.4	58.2

Daytona F1	57.0	55.8	61.1	57.9

From the results presented in table 5 it comes out that the average percentage of springing has the highest values at Daytona cultivar, on the types of typical chernozem and saline soil, respectively 86.6 % and 85.6 % and the lowest on the type of saline alluvial soil both at Diamant 58.2 % and at Daytona F1 57.9 %.

By comparing the results of the average springing percentage obtained with the content of clay of the four types of soil, it results that the percentage of springing is in inverse ratio correlated with the content of clay of the soils under analyses.

In order to highlight the relation between the content of clay of the soil and the springing percentage, I have calculated Pearson correlation coefficient between the content of the different types of soil in clay and percentage of springing, this coefficient having the value of -0.99 at Daytona F1 and – 1.00 at Diamant, fact that shows that it exists a strong negative linear correlation between the two variables (fig. 1). The negative correlation is stronger in case of Diamant sort than Daytona F1 cultivar.

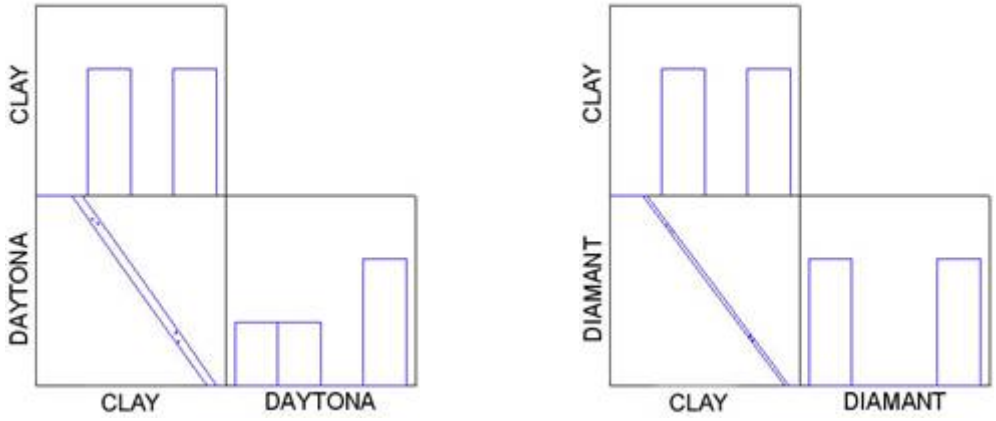

Figure 1. Correlation between the content of clay of the soils and the degree of springing at Daytona F1 and Diamant

Average weight of bulbs is variable as per the type of soil and as per the type of cultivar used (**table 6**).

Table 6 Average weight of bulbs

Cultivar	Average weight of bulbs (g)			
	2003	2004	2005	Average
Typical chernozem				
Diamant	53.2	52.6	51.3	52.4
Daytona F1	51.5	51.2	49.1	50.6
Saline chernozem				
Diamant	51.2	50.5	49.7	50.5
Daytona F1	49.8	51.6	48.7	50.1
Calcareous alluvial soil				
Diamant	45.5	44.7	45.3	45.2
Daytona F1	42.2	41.6	43.2	42.4
Saline alluvial soil				
Diamant	41.1	40.1	41.4	41.1
Daytona F1	38.3	39.2	40.41	39.5

Average weight of onion bulbs has superior values at Diamant sort on the type of soil typical chernozem 52.4 g and it is quite close as value to Daytona F1 on typical chernozem 50.6 g and saline chernozem 50.1 g and Diamant on saline chernozem 50.5 g.

On the type of calcareous and saline alluvial soil, average weight decreases, being at Diamant 45.2 g, respectively 41.1 g and at Daytona F1 42.4 g, respectively 39.5 g.

Conclusions

The results are that for the technology of onion culture through direct sowing, we indicate the following types of soil: typical and saline chernozem due to favorable physical properties, especially due to the content of clay, where the percentage of springing was higher (83.8-86.6 %), while the type of soil: calcareous alluvial soil and saline alluvial soil do not correspond to this technology of onion culture, the percentage of springing being comprised between 57.9-60.0 %.

Between the two cultivars analyzed from point of view of the percentage of springing, Daytona F1 behaved better on the soils: typical and saline chernozem.

In what concerns the variation of the weight of the bulbs, at both cultivars, the values obtained (50.1-52.4 g) recommend them for setting up onion crops sowed on the types of typical and saline chernozem soil.

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