Research reference to establishing the degree of suitability of some types of soil for the green pepper crop in the field

Received for publication, April 10, 2008
Accepted, April 20, 2008

AURICA SOARE[1] , GH. CAMPEANU[2], N. ATANASIU[2], GH. VOICU[1]
[1]*"Dunarea de Jos"* University, *Galati - Faculty of Engineering Braila, Calea Calarasilor, nr. 29, Braila, e-mail: aurica.soare@gmail.com*
[2]*University of Agronomical Sciences and Veterinary Medicine Bucharest, Bd. Marasti 59, Bucharest*

Abstract

Following to the researches performed based on the productions obtained on the four types of soil analyzed, it results that the physical properties of typical chernozem and saline chernozem types of soil determine a suitability for the culture of green pepper greater than the calcareous and saline alluvial soil.

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

Introduction

Pepper occupies 5th place between vegetable species, large areas with pepper being cultivated in Asia, Africa and North America.

In Europe, about 8 % from world area is cultivated, large producing countries being: Spain, Italy, Hungary, and Romania.

In our country, pepper production represents 5% of the total vegetable production, Braila County being in an area which is very favorable to pepper cultivating.

In Braila County, the area cultivated with pepper represents 20% of the total area cultivated with vegetables and 25% from the total of the vegetables production at county level.

Setting up green pepper crops is performed with predominantly through seedling, but there are also units in which the green pepper crop is set up through direct sowing when it is not pursued crop's earliness.

Setting up the crop through seedling presents certain advantages such as: uniformity and earliness of the crop, but it also has disadvantages: high expenses with labor force necessary for production and planting of the seedling, a superficial development of root system that implies applying a higher number of irrigations.

The soils that are suitable are the ones rich in humus, permeable, warm, with medium texture, a good capacity of retaining water and ionic exchange, with a pH=5.5-6.6. Also, the field must be protected against dominant, cold winds. [4]

Clay soils are not suitable for pepper, because they are compact, cold, little permeable, with a poor air circulation. [7]

Through ensuring an optimum and constant regime of humidity in the period of development of the pepper plants, it was noticed that the number of fruits per plant has increased as compared with the plants developed in conditions of water stress. [6]

Against the humidity from soil, the pepper presents high requirements whereas against atmospheric humidity, the claims are moderate. The lack or shortage of water in the soil, associated with atmospheric dryness, blocks flowers' fertilization, diminishing the production of fruit. [2]

The soil chosen for pepper crop must have the following characteristics: medium texture, structured, permeable for water, deep, with a very good fertility. [5]

The pepper requires medium to light soils (sandy-loamy, loamy-sandy and loamy), deep, with a good structure and with reaction from neutral to light acid (pH=6-7), rich in humus (3-5 %). The pepper does not tolerate the soils that have a content higher than 0, 2 % mineral salts and alkaline soils. [3]

Materials and Methods

The research was performed on four types of soils: typical chernozem, saline chernozem, calcareous and saline alluvial soil, using two inland sorts for Galben Superior and Export green pepper, applying the same technological elements, in the period 2003-2005.

For each type of soil, the experimental variants had been mounted in superposed blocks without randomization, the experimental area being of 448 m², total area of the experience for those two types of soil being of 1792 m².

The biological materials used in performing the experiment were the sorts: **Export and Galben Superior**.

Materials

Galben Superior is a semi-earliness sort, with the period of vegetation of 110 -120 days, the plant has the height of 55-60 cm, vigorous, the fruit has sharp cone form, with the length of 8-10 cm, diameter: 6.5-7 cm, number of lobes: 3-4, pulp's thickness: 7.5-8 mm, of yellow color at consumption maturity and of red color at physiological maturity, the weight of the fruits being of 110 -120 g. Production potential is of 30-35 t/ha.

Export is a semi-earliness sort, with the period of vegetation of 110 -115 days, the plant has the height of 50-60 cm, compact vigorous, the fruit has blunted cone form, with the length of 9-11 cm, diameter of 7 cm, number of lobes: 3-4, pulp thickness 7-8 mm, of whitish green color at consumption maturity and of red color at

physiological maturity, the weight of the fruits being comprised between 75-110 g. Production potential is of 35-40 t/ha.

Methods

Soil texture was determined based on the proportion of granulometric fractions (sand, dust, clay) that intervene in its set up that was made through treating soil sample as per Kacinski method and separation of granulometric fractions by 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 the total volume of soil sample.

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

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

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

Results and discussion

The horizons notation signification is the next one:

The horizon A, 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 in the granulometric set up of typical chernozem soil on the depth of 0-50 cm predominates soft sand (42.08-44.44%) that determines a loamy texture (medium), with positive properties on soil's suitability for the green pepper crop.

The value of apparent density 1.16-1.18 g/cm³ shows an aerated soil that allows a good development of root system in depth, the resistance opposed by soil against performing works of ploughing and preparing germinal bed is small, fact that implies 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.

Table 1. Physical properties of chernozem soil formed 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 well-developed glomerular structure ensures a total porosity of 55.2-56.3 % out of which the porosity of aeration is of 23.6-23.8 %, 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 300-450 m³/ha, being applied 10 irrigations with an irrigation norm of 3 950 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

From the results presented in **table 2** it follows that the texture of saline chernozem soil on the depth of 0-50 cm is loamy (medium), the particles of soft sand predominating in the granulometric set up in proportion of 40.0-43.68 %, the structure of soil is glomerular and it ensures values of total porosities of 53.1-55.4 % out of which between 23.7-28.5 % is the aeration porosity, values that ensure a favorable air-water regime.
The value of apparent density of 1.17-0-1.20 g/cm³ shows an aerated soil that allows an optimum development in depth of the root system.

Just like typical chernozem soil, the soil is structured, that ensures a total porosity of 55.4-51.6 % out of which the porosity of aeration is between 28.5-21.6 % that ensures a proper exchange of gases at the level of root system of pepper plants.

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

Table 3. Physical properties of calcareous alluvial soil set up on rivers 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 ***horizon Ao (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 follows that in granulometric set up of calcareous alluvial soil on the depth of 0-50 cm it predominates clay mineral fraction of 42.88-44.01%, determining soil's framing in soft textural class, clayish loam sub-class, with negative properties on soil suitability for green pepper crop.

The value of apparent density of 1.25-1.37 g/cm³ shows a soil with a moderate compacting even from surface, the consumption of energy in order to perform works of ploughing and preparing germinal bed should be high, also for obtaining some quality works it is necessary to perform it many more times, and the time interval when the soil can be worked is short. Soil's compacting has as effect also the fact that the soil will hardly heat.

On the depth of 30-50cm the value of apparent density has values of 1.42 g/cm³,which shows a compact soil in depth.

Small granular, poorly developed structure ensures values of total porosity of 45.6-47.5 %, out of which between 5.7-10.3 % represents aeration porosity. These values of aeration porosity are smaller, that is why the air regime from soil is insufficient to the respiration of plants' roots. This issue presupposes applying a higher number of soil's aeration works during the period of vegetation (5 works of mechanical hoeing).

Over the depth of 40 cm, the soil is not well structured and that is why no water reserves can be formed in depth; consequently, occurrences of puddles appear when abundantly precipitations fall or high norms of irrigations are used. On this type of soil, the rainfalls in small quantities are not turned to advantage; 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 norms of irrigation were of 300-400 m³ and nine irrigations were applied with an irrigation norm of 3200-m³ water/ha.

Table 4. Physical properties of saline alluvial soil set up on rivers 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

From **table 4** it results that granulometric fraction that predominates in the composition of saline alluvial soil on the depth of 0-50 cm is clay 42.12-43.42 % that determines framing the soil in soft textural class, clayish loam sub-class, with negative properties on soil suitability for green pepper crop.

The high value of apparent density on the depth of 0-50 cm between 1.34 -1.40 g/cm³ shows a process of compacting even from the surface of soil, with negative effects on the depths of roots' entering and on the rhythm of soil's heating.

Small granular, lightly developed structure in arable layer and lack of structuring in depth of the soil determines values of total porosity between 46.5- 49.8 %, out of which between 11.4-14.2 % represents aeration porosity, than ensures an insufficient air regime.

Also, the soil cannot form water reserves in depth, due to the poor structuring, the water is lost through evaporation-transpiration at soil surface and at short time after humidification, the superficial layer of soil will dry, the plants suffering due to the lack of water.

Table 5. Influence of soil type on total production at the green pepper set up through seedling in Braila County, in the period 2003-2005

Variant no.	Type of soil	Cultivar's	Average production		Differences t/ha	Signification
			t/ha	%		
1 (mt 1)	Typical chernozem	Galben superior	33.43	100.00	0.00	-
2 (mt 2)		Export	33.33	100.00	0.00	ns
3	Saline chernozem	Galben superior	30.95	92.58	-2.48	o
4		Export	30.74	92.23	-2.59	o
5	Calcareous alluvial soil	Galben superior	24.12	72.15	-9.31	ooo
6		Export	25.40	76.20	-7.93	ooo
7	Saline alluvial soil	Galben superior	20.98	62.75	-12.45	ooo
8		Export	22.19	66.57	-11.14	ooo

DL 5 % = 2.43 t/ha
DL 1 % = 3.50 t/ha
DL 0,1 % = 5.15 t/ha

From the results presented in table 5, it results that the type of soil powerfully influences the level of production.

Accordingly, for Galben Superior sort, the highest level of production was recorded on typical chernozem soil 33.43 t/ha. Cultivating this sort on other types of soil had as consequence decreasing the level of production, being recorded negative differences against mt 1 (V1) with statistic cover.

On the type of saline chernozem soil, the production decreases against control sample with – 2.48 t/ha, significant negative difference.

Negative differences of -9.31 t/ha and of -12.45 t/ha against control sample, registered at cultivating the same sort on calcareous alluvial soil (V5) and saline alluvial soil (V7) are very significant.

At Export cultivar, against control sample (V2), at variant 4 (culture on saline chernozem), statistic interpretation evidences a negative difference of -2.59 t/ha that is significant. At the same cultivar, negative differences of production of -7.93 t/ha (V6) and -11.14 t/ha (V8) are very significant.

Conclusions

- Galben Superior sort is recommended to be cultivated on typical chernozem and saline chernozem, due to the fact that its usage on the other three types of soil on which it was worked within the experience has as consequence decreasing the production against control sample with moderate or very high differences that are significant in case of variant 3 and very significant in case of variants 5 and 7;
- The influence of the type of soil on the production at Export soil is shorter in case of variant V4 at which it was registered a negative significant difference against control sample -2.59 t/ha; the similar cultures on soils – calcareous and saline alluvial soil resulted in high negative differences (-7.93 t/ha at V6 and -11.14 t/ha at V8) against control sample that are highly significant. Accordingly, for the green pepper crop set up through seedling with Export sort, it is recommended only the typical chernozem soil.

References

1. BASARABA A., PUIU ST., 2000 –*Soil Science – practical projects* –Piatra Craiului Printing House, Bucuresti;pg 107
2. BERAR, V., 2006 – *Vegetable growing* - Ed. Mirton, Timisoara; pg 84
3. INDREA, D., 2004–*Solano-fruit vegetbales -The cultivator guide of vegetables*–Ed. Ceres, Bucuresti;pg 162
4. INDREA, D., 2007 – *Solanacee vegetables – Vegetables culture* – Ed. Ceres, Bucuresti;pg 464
5. MUNTEANU, N., 2003 –*Solanacee vegetable culture* – Vegetable growing, vol III, Ed. Ion Ionescu de la Brad, Iasi;pg.192
6. PELLITERO M., PARDO A., SIMÓN A., SUSO MA. L., CERROLAZA A., 1993- *Effect of irrigation regimes on yield and fruit composition of processing pepper (Capsicum annuum L.)*- International Symposium on Irrigation of Horticultural Crops, ISHS Acta Horticulturae pg.335
7. VOINEA, M., ANDRONICESCU D., 1977 - *Criterions for vegetable growing division into zones* – Ed. Ceres, Bucurestipg.35