

RESULTS ON SOYBEAN TIME OF SOWING AND DISTANCE BETWEEN ROWS IN ROMANIA IN THE EXPERIMENTAL YEARS 2015 AND 2016

Dragoş Costin DIMA

Donau Soja Association, Wiesingerstrasse 6/9, 1010 Vienna, Austria

Corresponding author email: ddima@msat.ro

Abstract

From 2013 to 2015 soybean planted area in Europe - including Ukraine and the European part of Russia - increased 160% respectively, from 2,653 thousand ha to 4,206 thousand ha. The most favorable area for soybean, Danube region recorded 170% increase of the soybean area from 2013 to 2015, from 441 thousand ha to 758 thousand ha. The new CAP measures - entering into force in 2015 - allows EU member states to grant subsidies under Voluntary Coupled Support (VCS) for protein crops, soybean being included. VCS amounts are on top of the Single Area Payment System (SAPS). Therefore, the soybean crop is more and more reconsidered by the farmers all over Europe in general, mostly in the Danube region due to the agronomic and commercial benefits. In some countries from the Danube region, such as Romania and Bulgaria, soybean cultivation was disrupted for many years. Under present growing interest in cropping soybean, the development of farmers' technological skills and the transfer of know-how became more and more important for obtaining high and good quality yields. The experimental plots have been created with the purpose to provide farmers with field observations and solutions for various factors of soybean technology such as soybean genotypes, time of sowing, distance between rows, seeding density, weed control, bacterization, fertilization and micro-elements.

The research was focused on two technological factors: time of sowing and distance between rows. The information and data were collected cover two consecutive years, 2015 and 2016.

Key words: soybean, technology, time of sowing, distance between rows.

INTRODUCTION

From 2013 to 2015 soybean planted area in Europe - including Ukraine and the European part of Russia - increased 160% respectively, from 2,653 thousand ha to 4,206 thousand ha (Figure 1).

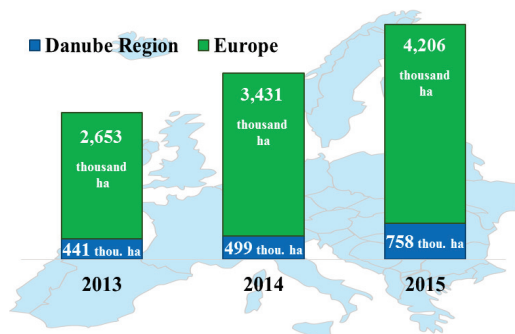


Figure 1. Soybean planted area in Europe and Danube region (2013-2015)

The most favorable area for soybean, Danube region recorded 170% increase of the soybean area from 2013 to 2015, from 441 thousand ha

to 750 thousand ha. All Danube region countries increased the planted area with soybean (Kruppa, 2016). Out of these countries an increase over the average of 170% was registered in Germany (360%, from 5 thousand ha to 18 thousand ha), Romania (246%, from 67 thousand ha to 165 thousand ha), Croatia (189%, from 47 thousand ha to 89 thousand ha), Hungary (174%, from 42 thousand ha to 73 thousand ha) and Czech Republic (171%, from 7 thousand ha to 12 thousand ha). A significant increase was recorded in Bulgaria where the soybean area increased from below one thousand ha to 30 thousand ha. The new CAP measures - entering into force in 2015 - allows EU member states to grant subsidies under Voluntary Coupled Support (VCS) for protein crops, soybean being included. VCS amounts are on top of the Single Area Payment System (SAPS). The countries introducing VCS are Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Poland, Romania, Spain and Slovenia (Kruppa, 2017). Therefore, the soybean crop is more and more reconsidered by the farmers' all over Europe in

general, mostly in the Danube region due to the agronomic and commercial benefits.

In some countries from the Danube region, such as Romania and Bulgaria, soybean cultivation was disrupted for many years. Under present growing interest in cropping soybean, the development of farmers' technological skills and the transfer of know-how became more and more important for obtaining high and good quality yields (Dima, 2016).

Among the factors influencing the yield, time of sowing and distance between rows have an important impact. Time of sowing is influencing the production potential of a specific soybean variety (Roman et al., 2011) and should be closely observed under present climate change. The distance between rows has impact on the yield, mainly from the weed control point of view. The seeding can be done either with row crop planter or with small grains drill (Ion, 2010).

MATERIALS AND METHODS

This paper was completed based on the observations and gathering of field experimental data in demonstration platforms organized in three soybean cultivation areas with different climate conditions namely, Turda - Central Romania, Secuieni - East Romania and Caracal - South Romania (Figure 2).

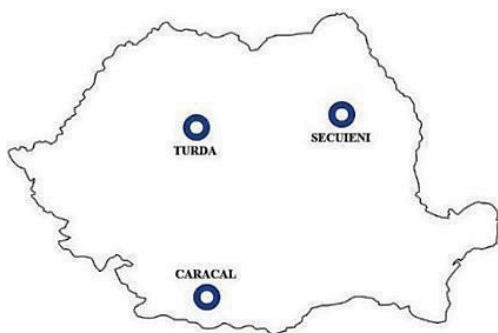


Figure 2. Demo platform locations: Turda, Secuieni and Caracal

Turda experimental fields are located at 46°35' latitude North and 23°47' longitude East and an altitude of 345 - 493 m above sea level. The experimental fields in Secuieni are located at

46°5' latitude North and 26°5' longitude East, altitude of 205.7 m. Caracal experimental fields are located at 44°06' latitude North and 24°21' longitude East, altitude of 98 m.

The rainfall monthly sum for 2015 in Turda, Secuieni and Caracal is presented in Figure 3.

The rainfall data for 2016 in same three locations is presented in Figure 4.

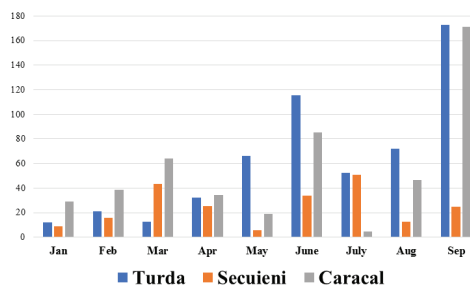


Figure 3. Rainfall in Turda, Secuieni and Caracal in 2015

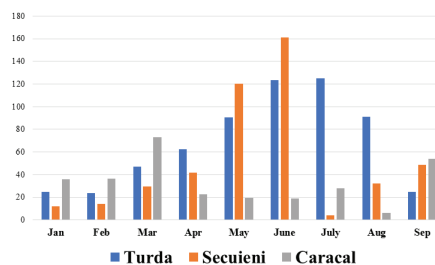


Figure 4. Rainfall in Turda, Secuieni and Caracal in 2016

The air temperature average sum for 2015 in Turda, Secuieni and Caracal is presented in Figure 5.

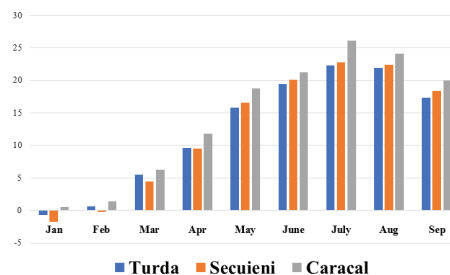


Figure 5. Air temperature in Turda, Secuieni and Caracal in 2015

The air temperature data for 2016 in same three locations is presented in Figure 6.

The information and data collected cover two consecutive years, 2015 and 2016.

The research was focused on two technological factors: time of sowing and distance between rows.

The scope of this paper is to provide farmers and other interested stakeholders with information on soybean technology factors researched in different experiences established in demonstration platforms.

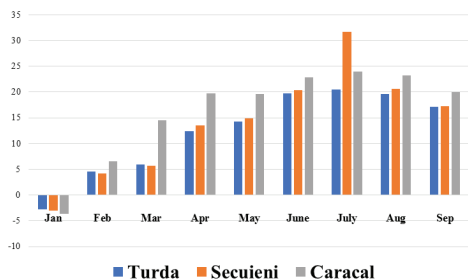


Figure 6. Air temperature in Turda, Secuieni and Caracal in 2016

RESULTS AND DISCUSSIONS

The genetic material used in the research is of Romanian and French origin. The soybean genotypes are presented in Table 1.

Table 1. The soybean genotypes used in 2015 and 2016

Year	Experience	Genotype	Turda	Secuieni	Caracal
2015	Time of sowing	Variety	Felix	Onix	ES Mentor
		Maturity group	00	00	00
		Breeder	ARDS Turda	ARDS Turda	Euralis
	Distance between rows	Variety	Felix	Onix	Sponsor
		Maturity group	00	00	I
		Breeder	ARDS Turda	ARDS Turda	Euralis
2016	Time of sowing	Variety	Caro TD	Onix	ES Mentor
		Maturity group	00	00	00
		Breeder	ARDS Turda	ARDS Turda	Euralis
	Distance between rows	Variety	Caro TD	Onix	Sponsor
		Maturity group	00	00	I
		Breeder	ARDS Turda	ARDS Turda	Euralis

The experimental plots in Turda in 2015 and 2016 displayed three time of sowing: early, normal and late.

In 2015 (Table 2) the highest yield of 1794 kg/ha was obtained when sowing was executed on April 28th. For the other two sowing dates, the yields were nearly the same, respectively 1443 kg/ha for sowing date April 1st and 1419 kg/ha for sowing on April 15th.

The highest plant height was recorded when sown on April 1st, respectively 114 cm. The lowest plant height of 105 cm was obtained when sowing was done on April 28th. For

sowing on April 15th, the plant height had an intermediate value of 109 cm. The insertion height of the first basal pods registered very close values for all three sowing times (13-15 cm). The highest TGW value of 178 g was registered for sowing on April 15th followed by 175 g on April 1st and 168 g on April 28th.

In 2016 (Table 2), in Turda the highest yield of 3934 kg/ha was obtained when sowing was done on April 18th, followed by 3878 kg/ha for sowing on April 4th and 3483 kg/ha for the sowing date of May 5th.

The plant height ranged between 117 cm for sowing date April 18th, 119 cm in case of sowing on April 4th and 133 cm for sowing on May 5th. The insertion height of the first basal pods presented similar values for all three sowing experiences (13 - 14 cm). In this year, the highest TGW value of 202 g was registered for sowing on April 18th, followed by 188 g on April 4th and 178 g on May 5th.

Table 2. The influence of time of sowing on soybean crop (Turda, 2015-2016)

Year	Sowing Date	Date of Emerging	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	01-Apr	27-Apr	114	14	1443	175
	15-Apr	4-May	109	13	1419	178
	28-Apr	7-May	105	15	1794	168
2016	04-Apr	18-Apr	119	13	3878	188
	18-Apr	4-May	133	14	3934	202
	5-May	14-May	117	14	3483	178

The experimental plots in Secuieni in 2015 displayed three time of sowing: early, normal and late.

In 2016, time of sowing was done normal and late. In 2015 (Table 3), the highest yield of 3244 kg/ha was obtained when sowing was done on April 30th, followed by 3065 kg/ha for sowing on April 20th and 2934 kg/ha for the sowing date of April 9th.

The highest plant height of 103.4 cm was recorded for sowing on April 30th; the next was the plant height of 102.4 cm for sowing date of April 20th. The lowest plant height (92.5 cm) was recorded for sowing on April 9th. The highest insertion of the first basal pods of 10.5 cm was registered for the soybean sown on April 30th, followed by 9 cm on April 20th and 7 cm for the sowing date of April 9th. The highest TGW value of 145 g was registered for sowing on April 30th, followed by 130 g on April 20th and 128 g on April 9th.

In 2016 (Table 3), in Secuieni the highest yield of 1548 kg/ha was obtained when sowing was done on April 27th, the next yield was of 1433 kg/ha for sowing on May 9th.

The plant height ranged from 93.3 cm for sowing date April 27th to 84.3 cm for sowing on May 9th. The highest insertion of the first basal pods of 23.4 cm was registered for the soybean sown on April 27th, followed by 18.1 cm for the sowing date of May 9th. The highest TGW value of 154 g was registered for sowing on April 27th, followed by 151 g on May 9th.

Table 3. The influence of time of sowing on soybean crop (Secuieni, 2015-2016)

Year	Sowing date	Date of Emerging	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	9-Apr	24-Apr	92.5	9.0	2934	128
	20-Apr	7-May	102.4	7.0	3065	130
	30-Apr	18-May	103.4	10.5	3244	145
2016	27-Apr	5-May	93.3	23.4	1548	154
	9-May	23-May	84.3	18.1	1433	151

The experimental plots in Caracal in 2015 and 2016 displayed three time of sowing: early, normal and late.

In 2015 (Table 4) the highest yield of 3524 kg/ha was obtained when sowing was completed on May 8th, 2015. For the other two sowing dates, the yields were 3374 kg/ha for sowing date April 27th, respectively 3122 kg/ha for sowing on April 16th.

The plant height ranged between 50 cm for sowing date April 27th, 56 cm in case of sowing on April 16th and 65 cm for sowing on May 8th. The insertion height of the first basal pods was between 5 cm to 7 cm. The highest TGW value of 184 g was registered for sowing on April 16th, followed by 176 g on April 27th and 172 g for sowing date of May 8th.

Table 4. The influence of time of sowing on soybean crop (Caracal, 2015-2016)

Year	Sowing Date	Date of Emerging	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	16-Apr	4-May	56	5	3122	184
	27-Apr	8-May	50	6	3374	176
	8-May	12-May	65	7	3524	172
2016	15-Apr	8-May	38	7	3120	210
	26-Apr	15-May	40	6	3300	208
	10-May	22-May	50	8	3220	220

In 2016 (Table 4), in Caracal the highest yield of 3300 kg/ha was obtained when sowing was completed on April 26th, followed by 3220

kg/ha for sowing on May 10th and 3120 kg/ha for the sowing date of April 15th.

The highest plant height of 50 cm was recorded for sowing on May 10th; the next was the plant height of 40 cm for sowing on April 26th, followed by 38 cm for sowing date of April 15th. The insertion height of the first basal pods presented similar values for all three sowing times. The highest TGW value of 220 g was registered for sowing on May 10th, followed by 210 g on April 15th and 208 g for sowing date of April 26th.

The experimental plots in Turda in 2015 and 2016 displayed three distances between rows: 12.5 cm, 25 cm and 50 cm.

In 2015 (Table 5) the highest yield of 1977 kg/ha was obtained for 25 cm between rows, followed by 1710 kg/ha for 50 cm and 1696 for 12.5 cm.

Table 5. The influence of distance between rows on soybean crop (Turda, 2015-2016)

Year	Distance Between Rows (cm)	Sowing date	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	12.5	05-May	106	16	1696	184
	25		106	17	1977	182
	50		108	17	1710	184
2016	12.5	22-Apr	119	16	4277	182
	25		122	15	4607	174
	50		126	15	4721	173

For all three distances between rows the plant height presented very close values: 106 cm for 12.5 and 25 cm, respectively 108 cm for 50 cm between rows. The insertion height of the first basal pods was 16-17 cm. In the same year, TGW recorded very close values for all three experiences, 184 g for 12.5 and 50 cm and 182 g for 25 cm.

In 2016 (Table 5), in Turda, the highest yield of 4721 kg/ha was obtained for 50 cm between rows, followed by 4607 kg/ha for 25 cm and 4277 kg/ha for 12.5 cm.

The highest plant height of 126 cm was recorded for 50 cm distance between rows; the next was 122 cm for 25 cm and 119 cm for 12.5 cm. The insertion height of the first basal pods ranged from 15 to 16 cm. The highest TGW value of 182 g was registered for 12.5 cm between rows; the next was 174 g for 25 cm and the lowest was 173 g for 50 cm.

The experimental plots in Secuieni in 2015 and 2016 displayed three distances between rows: 12.5 cm, 25 cm and 50 cm.

In 2015 (Table 6), the highest yield of 2530 kg/ha was obtained for 50 cm between rows, followed by 1961 kg/ha for 25 cm and 1490 kg/ha for 12.5 cm.

The highest plant height of 98 cm was recorded for 50 cm distance between rows, followed by 97 cm for 25 cm and 77 cm for 12.5 cm. The insertion height of the first basal pods varied from 7.1 cm for 12.5 cm between rows, 6.6 cm for 25 cm to 5.3 cm for 50 cm. TGW registered the following values: 156 g for 50 cm between rows, 134 g for 25 cm and 121 g for 12.5 cm.

Table 6. The influence of distance between rows on soybean crop (Secuieni, 2015-2016)

Year	Distance Between Rows (cm)	Sowing date	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	12.5	24-Apr	77.0	7.1	1490	121
	25		97.0	6.6	1961	134
	50		98.0	5.3	2530	156
2016	12.5	27-Apr	113.6	35.0	1510	138
	25		97.4	26.2	1849	163
	50		94.4	26.8	2206	187

In 2016 (Table 6), in Secuieni, the highest yield of 2206 kg/ha was obtained for 50 cm between rows, followed by 1849 kg/ha for 25 cm and 1510 kg/ha for 12.5 cm.

The highest plant height of 113.6 cm was recorded for 12.5 cm distance between rows, followed by 97.4 cm for 25 cm and 94.4 cm for 50 cm. The highest insertion of the first basal pods of 35 cm was registered for 12.5 cm distance between rows, followed by 26.8 cm for 50 cm and 26.2 cm for 25 cm. The highest TGW value of 187 g was registered for 50 cm between rows; the next was 163 g for 25 cm and the lowest was 138 g for 12.5 cm.

The experimental plots in Caracal in 2015 and 2016 displayed two distances between rows: 25 cm and 50 cm.

In 2015 (Table 7) the highest yield of 2215 kg/ha was obtained for 50 cm between rows, followed by 1503 kg/ha for 25 cm.

The highest plant height of 95 cm was recorded for 50 cm distance between rows, followed by 89 cm for 25 cm. The insertion height of the first basal pods varied from 9 cm for 50 cm between rows to 7 cm for 25 cm. TGW registered the following values: 155 g for 50 cm between rows and 144 g for 25 cm.

In 2016 (Table 7), in Caracal, the highest yield of 4710 kg/ha was obtained for 50 cm between rows, followed by 3300 kg/ha for 25 cm.

The highest plant height of 78 cm was recorded for 50 cm distance between rows, followed by 73 cm for 25 cm.

The insertion height of the first basal pods was 9-10 cm. TGW registered the following values: 153 g for 50 cm between rows and 148 g for 25 cm.

Table 7. The influence of distance between rows on soybean crop (Caracal, 2015-2016)

Year	Distance Between Rows (cm)	Sowing date	Plant Height (cm)	Insertion Height (cm)	Yield (Kg/ha)	TGW (g)
2015	25	8-May	89	7	1503	144
	50		95	9	2215	155
2016	25	8-May	73	9	3300	148
	50		78	10	4710	153

CONCLUSIONS

In 2015, in Turda, sowing on April 1st, the plants emergence occurred on April 27th (26 days since the date of sowing) due to low air temperatures. In case of sowing on April 15th, the emergence occurred on May 4th (19 days). Sowing on April 28th, the emergence was normal and uniform within 9 days (May 7th). The highest yield of 1794 kg/ha was obtained when soybean was sown on April 28th. For this time of sowing, the plant height registered 105 cm, the insertion height of the first basal pods was 15 cm and TGW was 168 g. In 2016, in Turda all three experiences with time of sowing indicated a uniform emergence of the plants (11-16 days). The highest yield of 3934 kg/ha was obtained sowing the soybean on April 18th. For this sowing time, the plant height registered 133 cm, the insertion height of the first basal pods was 14 cm and TGW was 202 g. In 2015, in Secuieni, for the soybean sown on April 9th, the emergence was observed on April 24th, 15 days from the date of sowing. In case of sowing on April 20th, the emergence occurred within 17 days (May 7th). Sowing on April 30th, the emergence occurred on May 18th (18 days). The highest yield of 3244 kg/ha was obtained sowing the soybean on April 30th. For this time of sowing, the plant height registered 103.4 cm, the insertion height of the first basal pods was 10.5 cm and TGW was 145 g. In 2016, in Secuieni, for the sowing date of April 27th, the soybean uniformly emerged within 9 days, on May 5th. For sowing on May

9th, the emergence occurred within 14 days (May 23rd). The highest yield of 1548 kg/ha was obtained when sowing the soybean on April 18th. For this time of sowing, the plant height registered 93.3 cm, the insertion height of the first basal pods was 23.4 cm and TGW was 154 g.

In 2015, in Caracal, when sowing on April 16th, the emergence occurred within 18 days, on May 4th. In case of time of sowing on April 27th, the plant emergence occurred within 11 days (May 8th). The soybean sown on May 8th emerged rapidly and uniform on May 12th (4 days). The highest yield of 3524 kg/ha was obtained for sowing the soybean on May 8th.

In 2016, in Caracal, for sowing date of April 15th, the plant emergence occurred within 23 days (May 8th). For sowing on April 26th, the emergence was observed on May 15th (19 days). For sowing on May 10th, the emergence occurred within 12 days (May 22nd).

The highest yield of 3300 kg/ha was obtained sowing the soybean on April 26th.

In 2015, in Turda the highest yield of 1977 kg/ha was obtained for 25 cm between rows, closely followed by 1710 kg/ha for 50 cm.

For both 25 and 50 cm distances between rows, identical or very close values had been recorded for plant height (106/108 cm), insertion height of the first basal pods (17 cm) and TGW (182/184 g).

In 2016, in Turda the highest yield of 4721 kg/ha was obtained for 50 cm between rows, closely followed by 4607 kg/ha for 25 cm.

For both 25 and 50 cm distances between rows, identical or very close values had been recorded for plant height (122/126 cm), insertion height of the first basal pods (15 cm) and TGW (174/173 g). Both distances of 25 and 50 cm between rows can be used with good results subject to weed infestation and available equipment and methods for weed control.

In 2015, in Secuieni the highest yield of 2530 kg/ha was obtained for 50 cm between rows. For this distance between rows, the plant height registered 98 cm, the insertion height of the first basal pods was 5.3 cm and TGW was 156 g.

In 2016, in Secuieni the highest yield of 2206 kg/ha was obtained for 50 cm between rows. For this distance between rows, the plant height registered 94.4 cm, the insertion height of the first basal pods was 26.8 cm and TGW was 187 g.

In 2015, in Caracal the highest yield of 2215 kg/ha was obtained for 50 cm between rows. For this distance between rows, the plant height registered 95 cm, the insertion height of the first basal pods was 9 cm and TGW was 155 g.

In 2016, in Caracal the highest yield of 4710 kg/ha was obtained for 50 cm between rows. For this distance between rows, the plant height registered 78 cm, the insertion height of the first basal pods was 10 cm and TGW was 153 g.

ACKNOWLEDGEMENTS

This research was carried out with the support of:

Prof. dr. Gheorghe Valentin Roman, University of Agronomic Sciences and Veterinary Medicine Bucharest, Romania;

Dr. Eugen Mureșanu and Dr. Raluca Rezi, Agricultural Research and Development Station of Turda, Romania;

Dr. Elena Trotuș and Dr. Simona Iscioaia-Pochișcanu, Agricultural Research and Development Station of Secuieni, Romania;

Dr. Eugen Petrescu, Agricultural Research and Development Station of Caracal, Romania.

REFERENCES

- Roman Gh.V., Tabără V., Pîrșan P., Axinte M., Ștefan M., Robu T., 2011. Field Crops - Cereals and Grain Legumes, Vol. I. "Universitară" Publishing House, Bucharest.
- Ion V., 2010. Phytotechnics, Faculty of Horticulture, Bucharest.
- Kruppa B., 2016., Danube Soya - Market Report, Danube Soya Association, Wien.
- Kruppa B., 2017. Donau Soja Statistics, Danube Soya Association, Wien.
- Dima D.C., 2016. Soybean Demonstration Platforms: The Bond Between Breeding, Technology and Farming in Central and Eastern Europe, Agriculture and Agricultural Science Procedia, Elsevier.