OPTIMIZATION OF THE TECHNOLOGY OF RAPESEED CULTIVATION IN THE CONDITIONS OF CLIMATE CHANGES

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Abstract. Optimization of agricultural technologies in private farms can not be conceived without sustainable development to be integrated in new technological elements, economically efficient and profitable and sustainable relationship with the environment. The purpose of this paper is to investigate the effect of sowing, fertilization and distance between rows, on the development and production of the rape culture or technology optimization of winter rape growing in the Carei plain. Research carried out leading to the recommendation that seeding in the Carei plain should be done in late August. The seeding era is of particular importance in relation to climatic conditions. Fertilization influence rapeseed production depending on the composition in the complex fertilizer. The best results are obtained when fertilization type b_1- 8:24:24 + microelements, as well as fertilization type b_2 - 7:10:32 + microelements. Fertilization is a centerpiece of technologies with the greatest impact on yield. The recommended distance between rows in the research area is 25 cm or 37.5 cm. Sowing density, provided by the number of grains per m^2 germinable, provided in the field and the distance between rows of the rape, it is important because of its positive correlation with the number of plants/m^2 present in the chain forming plant density and harvest. The distance between rows and the mass of a thousand grains acquis has influence also on weed control in the rapeseed crop.

INTRODUCTION

Increased production of field plants, while achieving stable production and economic efficiency of the agricultural holding can only be achieved through judicious combination of the following factors (Gus et al., 2003): natural resource used (environmental conditions: relief, rock, soil pore space etc. and vegetation factors: light, water, air, heat, nutrients and soil biological activity), ie capacity for utilizing optimum conditions for conservation and improvement of its quality and quantity; biological factors, ie the variety or hybrid that is grown and its location in relation to the 'place bid'; cultivation technology, namely the rotation, crop rotations, tillage system, seeding, fertilization, maintenance work etc.; economic management, through which interventions are evaluated and optimized to adjust resources, biological factors and the choice of technology elements. Management of natural resources by linking environmental factors with biological factors and technological optimization through applied agricultural technique, is a priority in the practice of sustainable agriculture and trade. In the last three decades of world planted surfaces has been a sharp increase in the areas planted with the main species of oilseeds of over 200 million hectares (236 million ha in 2013), mainly due to increased areas with soybean, rapeseed, sunflower and peanuts.

Rape currently occupies a particularly important place in the world economy as a source of vegetable oils. The seeds contain 42-48% oil used both in human nutrition, in the preparation of margarine, as well as in industry. In developed countries of Western Europe (Germany), rapeseed oil mixed with butane is used as fuel for diesel engines as such or as methyl ester, called Diester more economical than diesel, biodegradable and with implications for limiting air pollution and combating the greenhouse effect (Berea, 1998).

Add to this the many phytotechnical advantages (Gus et al., 2003) sown and harvested outside the busy periods; reacts favorably to fertilization; It enables full use of the same set of machines as cereals; It can be used as excellent pre successive crop or winter grain; raises soil fertility and prevent erosion on slopes; It is a good meliferous plant (for one hectare of oilseed rape one could get 80-90 kg honey); Rape honey is a natural remedy for ailments of the liver, pancreas or bone (osteoporosis); cakes and grits are rich in protein (38 to 41.9%), carbohydrates (32-37%) and minerals (8-9%) have good forage value; epigenous part of the plant (straw) can be used to manufacture particleboard; It can be used as green fodder in late fall and early spring (Borcean, 2003). From 100 kg of rapeseed oil one can obtain 30-35 kg and 50-55 kg Schrot. Rape show some disadvantages as wellgiven by: drought during sowing, alternation of freezing and thawing in spring and frost during the bud-flowering.

The rape is a plant of temperate areas with mild winters, cool and wet summers. The amount of degrees of temperature for winter varieties is 2100-2500°C, and spring varieties 1.500-1.800°C(t>0°) (Muntean et al., 2014). Rape is very demanding regarding the soil. It grows well in permeable, deep, loamy texture, rich in humus and calcium soils, with a neutral reaction so that it can easily penetrate the deep part with the roots. Such soils are chernozems, fluvisols, preluvisols. The intensive growth of rapeseed, high intake of nutrients that takes place in a short time, require very fertile soils.

The technology for cultivation of rape is differentiated first, depending on the specific climate and topography of agricultural areas and within them, depending on the particular soil and purpose, the system of agricultural machinery and the impact of technological elements on the environment. Rapeseed crop success depends heavily on the technology applied and strictly requires meeting the following four criteria (Gus et al. 2003): achieving a stable culture, with appropriate development densities in autumn; introduction of varieties resistant to thermal fluctuations, diseases and pests; keeping the crop free of weeds and healthy; targeting the technology for increasing the oil content in seeds. The correct implementation of recommended technology is the main direction for rapeseed crop production intensification through: correct tillage of the soil and full introduction of mechanized technology adapted for the rape crop; using irrigation and other land improvement works in order to regulate water regime and salinity of soils; controlled use of fertilizers and other chemicals as essential means to increase yields; controlling diseases, pests and weeds through integrated measures.

The purpose of this paper is to investigate the effect of sowing, fertilization and distance between rows, on the development and production of the rape culture or technology optimization of winter rape growing in the Carei plain.

MATERIALS AND METHODS

Besides the mentioned advantages, rape has its limitations of which the most notable is the uncertainty of culture (some authors have called it a "risk culture"). This shortcoming, current to the knowledge on the biology of the plant is largely eliminated due to climatic conditions (drought during sowing, alternating between freezing and thawing in the spring hoarfrost during flowering) or even the attack of some pests. The frost resistance of winter rape is conditioned by variety, degree of development of plants in winter, and the oscillations of meteorological factors in autumn, winter and spring. Winter rape is a very important crop and if we master the correct technology, we can arrive at optimizing production available for the climatic conditions.

Starting from the mentioned problems regading the rape culture and consistent with the thesis title, research objectives are: the achievement of an experimental research in a trifactorial experience, including planting dates, row spacing and fertilization; establishing the optimal time of sowing, as a measure of adaptation to climate change in recent years and increasing the security of production; optimal dosing of fertilizers to optimize production and maintain soil fertility traits; research influence of sowing distance between rows on the yields achieved and establishing optimal seeding density; developing a rape culture technology optimized to achieve, given the area of western Romania, respectuvely Carei plain.

To achieve the objectives we created an experimental field in Petresti town, Satu Mare, belonging to Carei Plain - subunit of Western Plain of Romania. Western Plain (also called Banato-Crisana Plain) is located west of the Occidental Carpathians and the Western Hills being the second biggest area after the Romanian Plain. Petresti commune has a relief consisting of plain area. Located in the south-west of the county, is part of the Carei Plain geographical subunit, which in turn is within the great unity of Somes Plain; the geographic subunits altitude is between 120-163 m. Currently, Carei Plain has altitudes between 120-160 m, it presents some morphological subunits, tiered stepwise and partially covered with wind materials. Compared to the Ecedea-Ier's plains' meadows (112-115m), the altitude relative to which are located the main storied surfaces is especially at 10-20 and 30m. It also notes the existence of a high field, drained, at the relative altitude of 35-45m, "witness" of an ancient Pleistocene plains (Sandulache, 2015).

The investigations were carried out in the period 2010-2014 and had as a working hypothesis the technical possibilities to optimize rapeseed cultivation technology, from a trifactorial experience: AxBxC-R: 4x3x3-3 with the following experimental factors:

Factor A – Seeding period with 4 graduations: a_1 – 25.08.2010, 2012, 2013 (control); a_2 – 10.09.2010, 2012, 2013; a_3 – 13.09.2010, 2012, 2013; a_4 – 15.09.2010, 2012, 2013.

Factor B – Fertilization with 3 graduations: b_1 – 8:24:24 + microelements (control); b_2 – 7:10:32 + microelements; b_3 – 16:26:7 + microelements.

Factor C – Line spacing with 3 graduations: c_1 – 25 cm (control); c_2 – 37,5 cm; c_3 – 50 cm.

The experiences are organized after the subdivided parcels method. Choosing this method of settlement of the experiences is imposed by the difficulty of experimental factors graduations. Experimental plot area is 3708 m^2 and the number of parcels in a rehearsal is 36. The experimental device from Petresti was placed on a low sloping field with soil type chernozem cambic (SRTS, 2003). Chernozems are one of the most important types of soil area of Romania, both because of large surfaces on which they occupy, but especially for their high fertility and very intensive use in agriculture.

RESULTS AND DISCUSSIONS

Research were conducted during 2010-2014 and have as a working hypothesis the technical possibilities to optimize rapeseed cultivation technology, based on an experience with the next trifactorial experimental factors: the seeding era, fertilization and the distance between rows.

The number of harvestable plants per m^2 is an important indicator to determine the influence of experimental factors on crop development and rape yield to justify results. The largest number of plants/m^2 was recorded at the variant sown in September 10, respectively 55.61 plants/m^2, followed by the variant sown on September 13 with 53.23 plants/m^2. B_2 and B_3 graduation of fertilization (53.24-57.63 plants/ m^2) and seeding distance of 37.5 to 50 cm between rows have provided the best values of this indicator (51.2 to 51.87 plants/ m^2).

Analysis of the results on the influence of the three experimental factors on mass of a thousand grains for winter rape show significant influence of sowing in September 25 and September 10 with the highest values of 5.89 to 5.96 grams. Differences obtained as a result of fertilization factor graduations do not differ statistically, and in the case of distance between rows graduation factor finds the highest value determined of 5.86 grams respectively at 50 cm seeding between rows.

The density and the distance between rows is particularly important for controlling weeds for the wither rape culture. In the experimental field it was found that the degree of weeding, at the moment of harvest, increased by reducing the distance between rows. The increase is 5% at 37.5 cm distance between rows and 20% at 50 cm distance between rows. With the degree of weeding. perennial monocotyledonous and dicotyledonous percentage increase.

From the analysis of annual data obtained it is found that productions are influenced primarily by the climatic conditions of the agricultural year, ranging between: 3511.33 to 3969.67 kg/ha in the agricultural year 2010-2011, between 3678.00 to 3976.67 kg/ha in the crop year 2012-2013 and between 3901.00 to 4232.67 kg/ha in the crop year 2013-2014.

Influence of sowing time

Highest average production for the research period 2010-2014 (table 1), was recorded in the sowing variant done on August 25, respectively 3894.21 kg/ha, yield differences being negative as sowing was done later. Differences in yield (-15.74 ...- 50.09 kg/ha) are not statistically ensured for seeding in September 10 and 13, but differences in yield (-84.11 kg/ha) at sowing in September 15 are significantly negative compared to the control (August 25).

Table 1

The influence of factor A (sowing era), 2010-2014

Variant	Yield, kg/ha	Yield, %	Difference, ± kg/ha	Significance	Duncan Test
a_1 – 25.08	3894.21	100	-	C	B
a_2 – 10.09	3878.47	99.6	-15.74	-	AB
a_3 – 13.09	3844.12	98.7	-50.09	-	AB
a_4 – 15.09	3810.10	97.8	-84.11	0	A
DL (p 5%)=68.39 kg/ha; DL (p 1%)=103.56 kg/ha; DL (p 0.1%)=166.36 kg/ha;					

The interaction between the seeding and fertilization shows advantages of sowing in August 25 with fertilization a1b1-8: 24: 24 (where there were 3960.45 kg/ha) and a1b2 fertilization - 7:10:32 (where there were 3921.18 kg/ha). Sowing in September 10 did not cause significant differences, regardless of variant of fertilization, even if productions are lower. Yield differences significantly negative and significantly distinct negative are registered only in seeding after September 13. The interaction of all three experimental factors highlight the advantages of the variant sown in August 25 ($a_1b_1c_1$ with 4040.22 kg/ha). Delaying seeding and fertilization but keeping the distance between control rows, provide the most meaningful or very distinct significantly negative output gap.

Influence of fertilization. Fertilization is a centerpiece of technologies with the greatest impact on yield (table 2). Fertilization influence rape production depending on the composition of the complex fertilizer. The best yield of 3882.43 kg/ha is achieved when using the fertilization b_1- 8:24:24 + microelements. Lower yields are obtained when using the fertilization b_2 - 7:10:32 + microelements, but without statistical ensurance, respectively b_3 - 16:26:7 + microelements, statistically ensured, differences being distinct significant negative.

Table 2

Interactions for factor B (fertilization), 2013-2014

Variant	Yield, kg/ha	Yield, %	Difference, ± kg/ha	Significance	Duncan Test
b_1-8:24:24 +microelements	3882.43	100	-	C	A
b_2-7:10:32 +microelements	3874.15	99.8	-8.28	-	B
b_3-16:26:7 +microelements	3813.60	98.2	-68.82	00	B
DL (p 5%)=36.92 kg/ha; DL (p 1%)=50.86 kg/ha; DL (p 0.1%)=70.02 kg/ha;					

The interaction between fertilization and the seeding era, do not determine differences statistically ensured, except for the combination b_3a_1. The highest yields are provided by the combinations b_1a_1 (3960.45 kg/ha) and b_2a_1 (3921.18 kg/ha). The influence of the factors a and c on the factor b-fertilization, highlights the advantages of fertilization b1 in all combinations, but especially $b_1a_1c_1$, with a yield of 4040.22 kg/ha. The differences are not statistically ensured at all combinations $b_2a_2c_2$, but are statistically ensured at the combinations $b_3a_3c_3$.

Influence of distance between rows. The distance between rows should be set depending on the material used biological and cultural status of the land. For the Carei plain we typically use the distance of 25 cm between rows (table 3). From average data obtained during the research, it is found that the best Yield is obtained for the control variant (25 cm). Both seeding to 37.5 cm as well as 50 cm determine lower production, but only for the the last graduation the difference is statistically ensured.

Table 3

Interactions between factor C (distance between rows), 2013-2014

Variant	Yield, kg/ha	Yield, %	Difference, ± kg/ha	Significance	Duncan Test
c_1 – 25 cm	3873.37	100	-	C	B
c_2 – 37.5 cm	3857.69	99.6	-15.68	-	AB
c_3 – 50 cm	3839.11	99.1	-34.26	0	A
DL (p 5%)=21.39 kg/ha; DL (p 1%)=28.56 kg/ha; DL (p 0.1%)=37.26 kg/ha;					

The seeding era determine significant changes in relation to the distance between rows for seeding in August 25. Sowing at this time provide most yield at a distance of 25 cm between rows (3936.85 kg/ha) and productions are reduced at distances of 37.5 cm and 50 cm between rows. On the other seeding eras yield differences, with increase in the distance between rows are no longer statistically ensured (except for variant c_3a_3). Fertilization of the type b_1-8:24:24, in combination with the distance between hard lines of 25 cm, provide the highest yield, respectively of 3901.75 kg/ha. Average yields at other combinations are equal to or smaller with no difference statistically ensured, except where the difference of c3b3 combination is very distinct significantly negative.

CONCLUSION

1. Research carried out leading to the recommendation that seeding in the Carei plain should be done in late August. The seeding era is of particular importance in relation to climatic conditions. The drought during sowing or delay can cause uneven emergence sunrise, affecting production since late sprung plants can be destroyed more easily by early frosts in autumn or in winter. In years when drought occurs during sowing due to lack of soil water, emergence occurs only after the first rain. In these circumstances there were situations when seeding August 25 and September 10 have led to a very close emergence. However, for Carei plain area were recorded during the experiment, in most years, rainfall in the period September 5 to 7. This consideration requires seeding until the end of August to benefit from these rainfall, enough to cause germination.

2. Fertilization influence rapeseed production depending on the composition in the complex fertilizer. The best results are obtained when fertilization type b_1- 8:24:24 + microelements, as well as fertilization type b_2 - 7:10:32 + microelements. Fertilization is a centerpiece of technologies with the greatest impact on yield.

3. The recommended distance between rows in the research area is 25 cm or 37.5 cm. Sowing density, provided by the number of grains per m^2 germinable, provided in the field and the distance between rows of the rape, it is important because of its positive correlation with the number of plants/m^2 present in the chain forming plant density and harvest. The distance between rows and the mass of a thousand grains acquis has influence also on weed control in the rapeseed crop.

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