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FIRST STAGES IN THE DIFFUSION OF RAPESEED IN ITALY, RESULTS OF TESTS COMPARING VARIETIES AND NITROGEN FERTILIZATION

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Because of the prevailing and traditional interests for the olive the oil crops could not reach a noticeable production level. Furthermore these crops are in competition with maize and sugar beets, especially in favourable areas. In addition, we did not always have adapted varieties on hand for environmental conditions and the special agronomical technics.

Today the situation seems be changing with the new outlook of the italian economy, in which the importance and the chance of increasing the production of vegetable fat is now recognized.

This new choice seems to verify itself in a short time, particularly considering two crops: the sunflower and the rape-seed.

While the sunflower acreage has been increasing for some years, we are at a standstill with rapeseed because of the actual controversy which came up and continues to slow down the initiatives for production. During the controversy the crop was accused of having damaging effects caused by the content of erucic acid in its oil.

But the basic problem with the diffusion of rapeseed in Italy is, as said above, to find an opportune place for it among our typical crops. It is difficult to evaluate plant characteristics whose performance is not well known under the different italian conditions, with particular regard to the less favourable regions.

This also comes from not having adapted native varieties at our disposal and we often have to use foreign varieties whose special requirements are not yet exactly known.

In this situation, our preliminary research begins by studying the performance, the productivity and the oil characteristics of some italian and foreign rapeseed varieties and the nitrogen fertilizing effects on seed production and oil characteristics.

1. Test on comparing varieties

1.1. Materials and methods

The italian varieties "Olympiade", "Leonessa", "Torrazzo" have been compared with the Swedish ones, "Sinus", "Sv 71/15010" and "Sv 67/8144",

the French ones "Major", "Ramses", "Sarepta" and the German ones, "Sinera", "Erusine", "Synra" and with the "Matador", variety whose seed has been reproduced for many years in Italy.

The sowing date was on the 7th September 1972 and the harvesting at the end of the following spring (15th June). The test was carried out at the experimental field of Pisa University. The climatic conditions during the test are presented in table 1.

The soil's physic-mechanical and chemical characteristics determined according to the classical methods are as follows: clay 20,7 %; silt 41,5 %; sand 37,8 %; pH 7,5; limestone 2,8 %; organic matter 1,28 %; total N 1,12 %; total P_2O_5 1,38 %; total K_2O 2,54 %; P_2O_5 ass. 0,7 mg/100 g; K_2O ass. 5,8 mg/100 g.

We used plots of 60 sq.m., with 4 replications for each treatment, distributed in randomized plots.

The plants were 10 cm apart on rows of 60 cm.
We used the following fertilization levels: N = 200 kg/ha (of which 150 of ammonium sulphate applied in pre-sowing and 50 of ammonium nitrate applied during the vegetation period beginning in spring); P_2O_5 = 150 kg/ha (of triplape applied during soil preparation); K_2O = 150 kg/ha (of potassium sulphate also applied during soil preparation).

During the cultivation we did not have any particular important adversities.

We registered from time to time, the evolution of the principal phase of the biological cycle and the behaviour of the plants, then determining the entity of the product, the oil content, the analytic characteristics and acidic composition of the oil.

From seeds dried at 60° C and powdered by means of a grinder "Ika Werke", were extracted the oils by Soxhlet with petroleum ether (b.p. 40° C). After removal of the solvent by rotavapor, the oils were stored at -10° C.

The main analytical characteristics (acidity, refractive index at 25° C, peroxide value, iodine value and saponification value) were determined following official analytical methods for oils and fats. The oils, diluted with pure isoctan by spectrophotometry, have also been examined in the ultraviolet region for the determination of specific extinction at 232, 262, 268, 274 and 308 nm by a "Beckman DB-GT" instrument.

The acidic composition of oils was determined by gas-liquid chromatography of the methyl esters in a "Perkin-Elmer 900" instrument equipped with an ionization detector.

The column packing was 20 % by weight of LAC 3 R 728 coated on acid-washed 80 to 100 mesh chromosorb W. The column length was 2 m and column temperature was 175° C. The injector temperature was 230° C,

Table 1: Mean decadic values of temperature and rain during the experiment period

Month and decade		Temperature °C		Rain - mm
		Minimum mean	Maximum mean	
	1	14,2	25,2	46,5
Septemb.	2	10,6	21,8	40,4
1972	3	11,6	22,9	2,4
	1	7,2	20,5	6,0
October	2	7,2	20,1	20,5
	3	6,9	17,9	29,2
	1	6,7	18,4	13,0
Novemb.	2	9,5	17,7	13,2
	3	4,6	14,4	67,2
	1	7,6	14,6	18,1
Decemb.	2	2,0	12,2	-
	3	3,1	11,1	20,4
	1	2,7	12,3	2,0
January	2	2,1	11,2	32,5
1973	3	1,7	11,7	28,0
	1	3,5	13,0	12,7
February	2	1,0	11,0	30,6
	3	-3,8	12,3	-
	1	0,9	13,0	11,5
March	2	-1,3	11,9	-
	3	4,4	14,3	-
	1	2,9	17,0	9,6
April	2	2,3	14,5	45,7
	3	3,9	16,0	1,8
	1	10,0	22,1	5,0
May	2	7,1	21,1	8,4
	3	11,5	24,0	10,2
	1	13,6	25,5	-
June	2	13,9	27,8	2,0
	3	14,8	27,2	49,0

the nitrogen flow rate 20 ml/minute and the injected quantity 0,3 µl. Identification of fatty acids was done by ECL of the peaks. The amount of each fatty acid was determined by standardization. With the above operating conditions it has been not possible to separate linolenic acid and eicosenoic acid which are included in a single peak.

The spectrographic analysis of oils in I.R. - light (from 2 to 15 μ) was performed with a "Perkin-Elmer 137" apparatus working on a film of oil 0,015 mm thick.

1.2. Results and discussion

The rising of the plants was regular and without apparent differences between the various cultivars (15 days after sowing).

From November to February, the plants remained in a winter rest state.

The development of the vegetation accelerated in March with the increase of temperature (daily average 11° C).

Flowering time, which is shown in table 2, was not the same for all cultivars. In this phase we had an advance in the national varieties "Olympiade" and "Leonessa".

The plant height at the same stage of flowering is also shown in table 2. The greatest height was reached by "Torrazzo", "Sinera" and "Synra".

Table 2: Varietal experiments. Mean flowering period and plant heights at the same stage

Cultivar	Mean flowering period	Mean plant height cm
Matador	9 April	148,2
Olimpiade	28 February	129,7
Leonessa	21 February	140,2
Torrazzo	29 March	165,7
Sinus	2 April	128,5
SV71/15010	26 March	141,0
SV67/8144	2 April	149,7
Sinera	28 March	155,7
Erusine	25 March	149,7
Synra	2 April	152,2
Major	23 March	134,7
Ramses	29 March	138,0
Sarepta	2 April	137,2
D.M.S.	0,01	9,33
	0,05	7,05

The ripening was in June, with a reduction in the differences between the varieties as compared to the registered during the flowering. The accurance (frequent in Italy) if high thermic conditions in the second and third decade of June (daily average of 21°C), with the absence of rain, has accelerated and neared the completion of this phase in the different varieties.

About the seed production (table 3), the best results were obtained, in decreasing order, with "Matador", "Leonessa", "Torrazzo" and "Major" (respectively q/ha 28,85 - 28,17 - 27,57 - 26,95).

The oil content was higher in the cultivar "Matador", "Major", "SV 67/8144", "Synra" (respectively in the percentage of 44,69 - 44,04 - 43,64 - 42,35).

As for the above, the total oil yield resulted definitely higher in the cultivar "Matador", "Major", "Leonessa" and "Torrazzo" (respectively q/ha 12,77 - 11,86 - 11,73 - 11,60).

Tabelle 3: Varietal experiments. Average yield of seed and oil

Cultivar	Average seed yield (q/ha)	Oil % dry matter	Oil yield (q/ha)
Matador	28,85	44,69	12,77
Olimpiade	20,82	40,66	8,46
Leonessa	28,17	41,66	11,73
Torrazzo	27,57	42,11	11,60
Sinus	25,50	43,15	11,00
SV 71/15010	22,82	42,27	9,64
SV 67/8144	23,87	43,64	10,41
Sinera	24,75	42,02	10,39
Erusine	25,45	40,09	10,20
Synra	26,65	42,35	11,28
Major	26,95	44,04	11,86
Ramses	24,75	43,04	10,65
Sarepta	22,50	41,41	9,31
DMS 0,01	1,47		
0,05	1,11		

In tables 4 and 5, the analytic characteristics and fatty acid composition of the oils are shown, which represent definite different colours (from yellow to greenish).

The oil acidity of all the cultivar results are very low (with max. 1,4 %) and the peroxide value too, which varies between 3 and 7, showing a noticeable stability with the oxidation.

The refractive index of the various oils practically shows the same results (average value 1,4699 $\pm$ 0,0003), while the iodine value undergoes limited variations, passing from 102,4 to 111,8 in evident relation to the different degree of total unsaturation of the oils.

The saponification value, instead, shows more accentuated variations which are closely related to the different erucic acid content.

The absorption values in the U.V. are very similar for all the oils; in particular the oils show a very low basic absorption and the practical absence of conjugated dienes and trienes (Δ K nearly 0).
Observing the values of the acidic composition percentage, we note that besides the fundamental characteristic acids of the rapeseed oil, there are in many cultivars (sometimes in noticeable quantities) other acids, as lauric, miristic, eptadecanoic, eptadecenoic, eicosadienoic, docosadienoic, lignoceric and tetracosenoic.

From the quantitative point of view, only the acids with 18 carbon atoms and erucic acid have to be taken into consideration. A close correlation is

Table 4: Varietal experiments. Analytical characteristics of oils (mean values of four replications)

Cultivar	Acidity %	$n^{25°C}$ D	Peroxide value	Iodine number	Saponification value	K_{232}	K_{262}	K_{268}	K_{270}	K_{274}	K_{308}	K
Matador	0,9	1,4688	3,9	102,7	173,8	1,889	0,353	0,358	0,338	0,360	0,247	+0,002
Olimpiade	0,6	1,4706	3,7	105,4	173,3	1,759	0,300	0,293	0,296	0,298	0,236	-0,006
Leonessa	0,9	1,4705	3,7	105,4	173,2	1,584	0,179	0,178	0,181	0,182	0,127	-0,002
Torrazzo	0,9	1,4696	3,1	109,9	172,9	1,595	0,223	0,227	0,232	0,235	0,175	-0,002
Sinus	1,0	1,4700	3,9	111,4	185,3	1,756	0,240	0,244	0,247	0,251	0,182	-0,001
Sv 71/15010	1,4	1,4704	5,4	110,9	185,2	1,766	0,168	0,175	0,175	0,177	0,093	+0,003
Sv 67/8144	0,9	1,4698	5,0	109,1	179,3	1,726	0,277	0,275	0,277	0,279	0,217	-0,003
Sinera	1,2	1,4700	3,8	111,7	188,0	1,808	0,326	0,327	0,329	0,330	0,243	-0,001
Erusine	1,2	1,4700	5,9	111,8	186,3	1,826	0,204	0,210	0,213	0,216	0,144	±0
Synra	0,9	1,4698	3,6	103,2	172,6	1,678	0,206	0,207	0,208	0,214	0,125	-0,003
Mayor	0,7	1,4700	7,2	105,1	173,9	1,757	0,208	0,193	0,193	0,191	0,138	-0,006
Ramses	1,1	1,4702	4,2	102,4	173,8	2,187	0,356	0,354	0,356	0,356	0,267	-0,002
Sarepta	0,5	1,4693	3,2	102,5	172,9	1,771	0,258	0,254	0,254	0,254	0,207	-0,002

Table 5: Varietal experiments. Percentual acidic composition of the oils (mean value of four replications)

Cultivar	12:0	14:0	16:0	16:1	17:0	17:1	18:0	18:1	18:2	18:3 20:1	20:0	20:2	22:0	22:1	22:2	24:0	24:1	$\frac{22:1}{18:1}$
Matador	tr.	0,07	4,54	0,26	tr.	tr.	0,95	12,64	13,30	16,50	0,71	0,80	0,48	47,61	0,86	0,17	1,11	3,5
Olimpiade	tr.	0,06	3,83	0,27	tr.	tr.	0,95	10,24	15,20	18,39	0,64	0,90	0,34	47,19	0,96	tr.	1,03	4,6
Leonessa	tr.	tr.	3,50	0,23	tr.	tr.	0,92	10,61	15,12	18,28	0,52	0,70	0,28	47,39	0,93	0,16	1,36	4,4
Torrazzo	tr.	tr.	3,06	0,19	tr.	tr.	0,88	11,18	14,31	18,14	0,69	0,78	0,47	48,16	0,87	tr.	1,27	4,3
Sinus	tr.	tr.	5,37	0,49	tr.	tr.	1,46	37,45	18,50	20,55	0,45	tr.	tr.	15,73	tr.		tr.	0,3
Sv 71/15010	tr.	0,08	5,13	0,36	tr.	tr.	1,43	42,20	19,72	18,19	0,53	tr.	tr.	12,45	tr.			0,3
Sv 67/8144	tr.	tr.	3,96	0,30	tr.	tr.	1,17	27,14	15,30	20,87	0,52	0,74	0,37	28,58	0,43		0,62	1,0
Sinera	tr.	tr.	4,69	0,14	tr.	tr.	1,66	52,77	21,05	16,09	0,25			3,35				0,1
Erusine	tr.	tr.	5,12	0,37	tr.	tr.	1,61	45,27	21,59	16,52	0,18	0,25		9,09				0,2
Synra	tr.	0,05	3,22	0,32	tr.	tr.	0,90	10,49	14,38	16,89	0,60	0,57	0,48	50,35	0,72		1,03	4,8
Mayor	tr.	0,04	3,52	0,21	tr.	tr.	1,02	13,26	13,53	19,11	0,69	0,74	0,18	45,42	1,30	0,13	0,85	3,4
Ramses	tr.	0,07	3,47	0,17	tr.	tr.	1,08	15,12	11,91	18,63	0,73	0,52	0,20	47,48	0,25		0,37	3,1
Sarepta	tr.	0,05	3,55	0,25	tr.	tr.	0,94	11,27	15,36	15,23	0,65	0,65	0,51	49,71	0,92		0,91	4,4

evident (as shown by their ratio) between erucic acid content and oleic acid content i.e., when the first one decreases the second increases and vice-versa.

This fact has to be regarded in relation with the biosynthesis process of erucic acid in the rapeseed oils (DOWNEY, 1964; RAKOW and McGREGOR, 1973; THIES, 1968).

The contents of oleic, linoleic and linolenic - eicosenoic acids remain within rather limited levels.

Generally erucic acid content is higher in the Italian and French cultivars (from 45 to 49 %), followed by the Swedish and German ones, (except for "Synra" which has a value of 50 %) according to various values referred in bibliography (APPELQVIST, 1970, 1971; CRAIG et al., 1973; RÜNER and OHLSON, 1971; SIETZ, 1972). The lowest erucic acid content is in the cultivar "Sinera" (3 %).

The I.R. spectra made on the oils have not shown any effect tied to the epoxy groups or to free oxydryls or dienic and trienic composition.

2. Test with different nitrogen doses

2.1. Material and methods

It was effectuated at the same time as the preceding one (the sowing was on the 7th September and the harvesting on the 16th June), in a field near the other one. The climate and soil conditions already indicated should be considered.

The cultivars used were "Matador" and "Sinus", the row distances were the same as those of the test already described.

The comparing thesis were: 0 - 80 - 160 - 240 of nitrogen distributed for 2/3 in the sowing (ammonium sulphate). The remainder before the vegetative development in springtime (ammonium nitrate). We used constant doses of P_2O_5 (150 kg/ha) and of K_2O (150 kg/ha) for each thesis which were distributed by ploughing operations.

The crops during their growth did not undergo important adversity.

The harvesting was done by hand trying to avoid accidental seed loss.

2.2. Results and discussions

The two cultivars, tested have reacted to the development of the crops and to the quantitative production of seed, in the same way.

With the evolution of the biological cycle, in plants of different thesis, we have not seen any particular difference.

The flowering was in plots with doses of N = 160 kg and 240 kg/ha respectively with 2 and 4 days delay as to the zero treatment.

In the ripening, instead, we did not note any difference. The entity and characteristics of production is shown in table 6.

Table 6: Nitrogen fertilization experiment. Average yield of seed and oil (Cv. *Sinus* and *Matador*)

Nitrogen supply (kg/ha)	Cv. SINUS			Cv. MATADOR		
	seed (q/ha)	oil % s.s.	oil yield (q/ha)	seed (q/ha)	oil % s.s.	oil yield (q/ha)
0	23,32	46,89	10,93	25,35	43,71	11,08
80	25,12	43,43	10,90	26,55	39,75	10,55
160	27,02	40,10	10,83	29,10	38,19	11,11
240	27,20	39,58	10,73	29,80	35,46	10,56
DMS 0,01	1,06			-		
0,05	0,75			1,24		

With regards to the quantity of seed production, among the various thesis, statistical significant differences are noted, even though the increase were lower than those observed by other AA. in similar tests. On the contrary, the oil content presents, in our case, a decrease while increasing the nitrogen doses, consequently due to the vegetative development increase of the plant (APPELQVIST, 1968). This behaviour is not the same as obtained by some others AA. (C.E.T.I.O.M., 1970) in similar tests of nitrogen fertilization.

The yield of oil per hectare, considering the inverse behaviour of seed production and oil content, has not presented any difference among the various treatments.

The analytical determination based in the oils of different treatments compared with the thesis zero, did not show any significant differences in the acidic percentage composition (table 7).

This fact shows that nitrogen fertilization, on the levels we used it, did not considerably influence the rapeseed oil characteristics, confirmung what is already known in the literature (APPELQVIST, 1966; GARNER et al., 1914; KHAN et al., 1963; SEN and LAHIRI, 1960), regarding the seed oil in general, even if sometimes (APPELQVIST, 1968; SCHMALFUSS, 1940) various AA. have pointed out some influence especially on the degree of total unsaturation and on the relative contents in palmitic and oleic acids.

Table 7: Nitrogen fertilization experiment. Percentual acidic composition of the oils

Dose di azoto (kg/ha)	12:0	14:0	16:0	16:1	17:0	17:1	18:0	18:1	18:2	18:3 20:1	20:0	20:2	22:0	22:1	22:2	24:0	24:1
Matador																	
0	0,07	0,11	4,68	0,30	tr.	tr.	1,00	12,75	13,40	16,60	0,77	0,85	0,61	47,07	0,69	0,10	1,00
80	tr.	0,10	5,36	0,34	tr.	tr.	1,40	14,08	13,38	14,98	0,74	0,98	0,43	46,24	0,91	tr.	1,03
160	0,04	0,09	4,80	0,35	tr.	tr.	1,19	12,96	12,52	15,34	0,84	0,70	0,65	46,96	1,18	0,17	1,38
240	0,09	0,16	4,44	0,36	tr.	tr.	1,34	13,14	13,46	16,42	0,79	0,64	0,61	46,33	1,00	0,10	1,12
Sinus																	
0	tr.	tr.	5,92	0,44	tr.	tr.	1,61	37,20	18,00	20,10	0,73	tr.	tr.	16,00	tr.		tr.
80	tr.	0,13	5,98	0,38	tr.	tr.	1,59	35,16	17,34	20,80	0,76	0,87	tr.	16,99			
160	tr.	0,67	5,40	0,47	tr.	tr.	2,56	35,56	16,47	20,64	0,85	1,21	tr.	16,17			
240	tr.	0,31	5,90	0,42	tr.	tr.	2,01	34,08	17,19	21,89	0,77	1,24	tr.	16,19	tr.		tr.

3. Conclusions

The cultivars "Matador" and "Leonessa" remain, regarding Italian environment, the best from the point of view of seed production.

Among the new tested varieties, the cv. "Sinera", "Erusine", "Sinus" and "Sv 71/150010", characterized by a reduced content of erucic acid have proved interesting. This also in relation to the behaviour of their plants: *strong stem; reduced ramification at the base with shorter branches; contemporary ripening and with silique less dehiscent.* These characteristics determine lower losses by mechanical harvesting.

Regarding the oil content, besides the tight and inverse correlation between erucic and oleic acid, it is noted that most of the tested varieties show a high content of erucic acid. Only some german and swedish ones show a lower content, up to a minimum of 3 % in "Sinera".

In relation to the seed production among the tested nitrogen doses, the best one resulted on the 160 kg/ha level.

The production increase for the other doses of nitrogen have, however, been annulled by the lower oil content obtained.

In our tests, the nitrogen fertilization has not shown noticeable effects on the oil characteristics and acid composition.

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