IMPROVEMENT OF THE USE OF NUTRIENTS IN WINTER RAPE - A STRATEGY OF ECONOMICALLY AND ECOLOGICALLY RESPONSIBLE FERTILIZING

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The use of nitrogen which is necessary for an intensive production of rape is relatively high in spite of using the newest knowledge in the field of plant cultivation and food physiological and fertilization techniques (MAKOWSKI, 1990). For that reason it was tested whether am improvement of the ability to use nutrients could be obtained by breeding measures and the amount of necessary fertilizer thereby reduced. This would be a contribution to a more ecological and economical use of nitrogen fertilizer in winter rape. Essential conditions for the success of such a specialization of breeding are,

- sufficiently high, genetically determined variability among and within the strains;
- a method to record the use of nitrogen irrespective of weather conditions;
- defined direct or indirect characteristics of the selection;
- knowledge about the heritability of the ability to use nitrogen and its components respectively;
- details about the combination ability of selected original material.

First tests for genotype-specific use of nitrogen were carried out with 8 selected 00-rape-DH-lines (doubled haploid lines) under controlled conditions of the pot test at IÖF Malchow/ Poel. The formation of yield with increasing supply of nitrogen fertilizer was analysed (1,0;2,0 and 3,0 g N/6,5 kg soil). All other macro- and micro-nutrients were in an equally high supply situation. One plant was growing per pot and each part had 12 repetitions.

The 00-rape-DH-lines which were tested under these conditions showed a very diverse nitrogen efficiency (Table 1).

Table 1: Yield of rape-DH-lines in relation to increasing amounts of nitrogen (grammes per plant)

Type	DH-line	1 g N/pot	2 g N/pot	3 g N/pot	GD P=0.95
I	553	24,8	32,0	36,6	3,1
	132	29,6	34,8	38,8	3,1
	224	24,8	32,0	45,2	4,1
II	4	22,2	34,4	34,8	4,4
	163	25,2	43,8	41,2	4,0
III	58	19,6	32,6	26,4	5,8
	63	28,8	39,0	27,6	3,1
	67	25,8	44,1	32,6	4,5

Type I - did only show maximum yield with a high amount of nitrogen fertilizer

Type II - reached its maximum yield with reduced amount of nitrogen fertilizer and tolerates a high amount of nitrogen fertilizer

Type III - like type II it reached maximum yield with reduced amount of nitrogen fertilizer, but showed a decrease of yield with a high amount of N-fertilizer

This varied use of nitrogen influenced the yield mainly by the number of pods per plant and the thousand seed weight. The quality was influenced by the oil/protein relation (table 2).

Table 2: Influence of nitrogen fertilizing on the oil- and protein content in relation to the nitrogen efficiency

N-efficiency	N-fertilizing	oil (%)	protein (%)
	1	45,4	27,5
Typ I	2	42,8	29,8
DH-line 224	3	40,6	30,9
	GD P=0.95	1,3	1,2
	1	44,9	27,8
Typ II	2	41,8	30,4
DH-line 163	3	41,1	31,6
	GD P=0.95	1,7	1,6
	1	44,7	27,0
Typ III	2	40,6	31,2
DH-line 67	3	35,9	33,4
	GD P=0.95	3,4	1,0

The fact that these three types of reaction could be observed at an almost equal yield-level indicates a genetically determined modification of the use of nitrogen. This can be recorded by using the pot test technology (Fig. 1).
Thus two essential conditions to cultivate the improvement of the ability to use nitrogen are also realized in winter rape, similar to other sorts of fruits.

According to MOLL et.al (1982) the nutrient efficiency has to be divided into the nutrient absorption efficiency and the nutrient utilization efficiency.
The nutrient absorption efficiency is not only determined by the disposition of the roots (size and morphology of the root system) but also by the rate of absorption (absorbed amount of nutrients per time and length of root.
Under the conditions of the pot test the DH-line of type III has clearly stored more nitrogen into the seed in comparison with the lines of type I and II - as you can see in table 1.

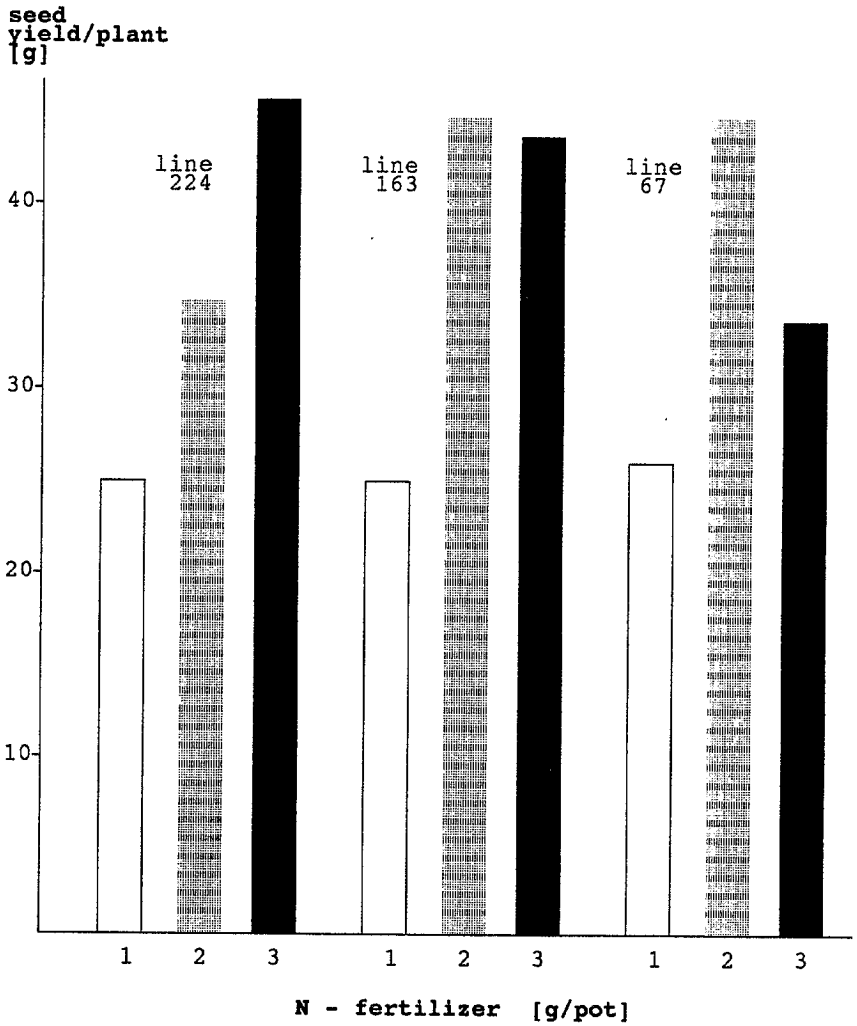

Fig.1: Genetical differences in the nitrogen efficiency of winter rape

Whether this is due to an increased absorption of nitrogen beyond the level of toxicity has to be analysed in further experiments. In spite of this fact it does not appear to be promising to influence the breeding of the nutrient absorption efficiency due to the root system of winter rape which is deep and relatively easy to regulate by means of plant cultivation measures.
It seems to be more promising to improve the breeding of the nitrogen utilization efficiency.
If the influence of the following factors is taken into consideration a variability that could be made use of seems to be possible

- distribution of nitrogen inside the plant
- protease activity with the reduction of enzyme protein during the leaf senescence
- period of time of the leaf senescence
- translocation of nitrogen (total amount of nitrogen and amount of nitrogen per time) in relation to the stage of development
- nitrogen content of the leaf in relation to the absorption of carbonic acid
- content of oil in relation to the content of protein in the seed
- Translocated nitrogen in relation to newly absorbed nitrogen in pod and seed.

After analysing the relevance of these factors to breeding a selection index, which is taking the most important factors into account, should be determined and used for the selection. A lasting improvement of the complex of characteristics of the nitrogen utilization efficiency, which is determined by many genes, is, however, only to be expected after increased accumulation of the corresponding genes. For that purpose the recurrent selection under low input conditions and a specific cross among the different types of reaction by using the haploid technology seem to be useful.

In oder to achieve a sufficiently high limit of the selection and a related high response the N-utilization efficiency of DH-lines should be analysed under controllable conditions of growth (pot test technology). Simultaneously diallel crossings for the selection of nutrient-efficient F1-combinations have to be carried out. This is also done with respect to the synthetic strains, which can be produced by positive types of reaction.

Out of the produced F1-seeds F1 donor plants from suitable types of reaction can be cultivated to produce new DH-lines, directly after analysing the N-utilization efficiency.
Only after at least two of such selection cycles field tests are necessary for the final assessment of the nitrogen

utilization efficiency. These field tests make an evaluation of the newly produced low input original material possible. Apart from the possibility of improving the nitrogen efficiency by breeding it becomes clear by means of the different types of reaction that in future winter rape should be fertilized specificly and according to the nitrogen requirements of the growing stock - for ecological and economical reasons. A decrease of yield and a deterioration of the quality due to a lack or surplus of nitrogen could thereby be avoided and a nitrate lixivation prevented. In order to achieve that it is, however, necessary that the rape farmer will not only be provided with a special certificate regarding the strain but also with corresponding details about the ability to use nitrogen.

SUMMARY

In a pot test three types of nitrogen reactions in DH-lines were found out. Increasing nitrogen amounts brought about an increase of the yield in type I; the yield of type II remained unchanged whereas the effect on type III was a decrease of the yield. This indicates that the variability with regard to the ability of using nitrogen has a genetic cause. The variable use of nutrient became apparent by analyzing the oil/protein relation, the thousand seed weight and the number of pods per plant. All this influenced the yield and the quality of rape. Possible reasous for the above mentioned could be modifications of the C/N assimilation, the senescence of leaves and the nitrogen translocation from the leaves into the pods. It seems to be possible that an improved nutrient efficiency by means of breeding could contribute to an ecologically responsible and economically justified nitrogen fertilizing.

REFERENCES

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