THE EFFECT OF AGRONOMIC AND CLIMATIC FACTORS ON PROTEIN CONTENT IN SPRING OILSEED RAPE (*Brassica napus L.*) SEED

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SUMMARY

The effects that growing season duration, mean daily temperatures, precipitation, accumulated growing degree days, nitrogen rates, nitrogen application times, plant nitrogen concentration at different growth stages, plant population densities, and mature seed weight had on protein content in the spring oilseed rape 'Star' was studied in the field. The experiment was conducted on Endocalcari – Epihypogleyic Cambisols. It was determined that an increase in growing season duration and precipitation had a negative effect on mature seed protein content. An increase in accumulated growing degree-days and mean daily temperature positively affected seed protein content. Increasing the nitrogen fertilizer rate gave a strong and positive effect on protein content in mature seed. Delaying the nitrogen application until the 4 – 5 leaf stage, increased protein content as compared to nitrogen applied at sowing. An the increase in plant nitrogen concentration at the 4 – 5 leaf stage, at the start and end of flowering, and at the seed development stage coincided with an increase in protein content in mature seed. Seed protein content tended to increase with an increase in seed weight. Changes in plant population density had a rather negligible and inconsistent effect on spring oilseed rape seed protein content.
Keywords: spring oilseed rape, protein, nitrogen, plant population density, growing degree-days, mean daily temperature, precipitation rate, duration of vegetative growth period.

Introduction

Oilseed rape seed meal remaining after oil extraction is a valuable animal feed, high in protein, which can be used in the place of imported soybeans or other animal feed products especially in countries with a moderate climate. Seed protein content generally shows an adverse relationship to oil content and both are under genetic and environmental control /2,6,9/. Therefore factors increasing seed protein content are also decreasing oil content. The application of nitrogenous fertilizer generally increases plant nitrogen content and thereafter resulting in higher seed protein content /2,5,8/. The positive linear correlation with nitrogen rate and seed protein content, irrespective of timing, was shown /3/. In some experiments seed protein content was affected by nitrogen application time /4,5/. Seed protein content was higher and oil content lower when oilseed rape was grown under warm and dry conditions /9/. The increase in precipitation rate resulted in lower seed protein content /1/. High temperature tended to increase seed protein content /7/. This paper describes experiments results to investigate the effect of environmental and agronomic factors on seed protein content of spring oilseed rape.

Materials and Methods

Spring oilseed rape cv. Star was grown on Endocalcari - Epihypogleyic Cambisols soil. The experiment included three seeding rates of 4, 7, and 10 kg ha^{-1}. Ammonium nitrate was broadcasted at drilling, at 4 to 5 leaf stage, and at the start of flowering. Each application date included five single doze applied nitrogen rates: 0, 60, 120, 180 and 240 kg ha^{-1}. Single granular superphosphate (90 kg ha^{-1}) and potassium chloride (120 kg ha^{-1}) were broadcasted at drilling. Plots were arranged in a split – split – plot completely randomized design with three replications.

The shoots of ten plants per plot were harvested at 4- to 5 leaf stage, at the start and end of flowering, and at seed development stage. Total nitrogen concentration in plant dried at 65^0C and mature seed was determined using Kjeldahl technique. Seed protein content was determined multiplying total nitrogen content by 6,25.

Results and Discussion

Increase in the level of fertilizer nitrogen applied on average increased protein content in spring oilseed rape seed from 21,94% in the treatment without nitrogen application to 25,13% when 240 kg ha^{-1} nitrogen was applied. The increase of protein content in mature seed of spring oilseed rape was approximately 1,74% for every 100 kg ha^{-1} of nitrogen.

Seed protein content also was affected by nitrogen application time. The highest protein content 25,69% was determined when 240 kg ha^{-1} of nitrogen was applied at 4 to 5 leaf stage. Nitrogen application at the start of flowering decreased protein content as compare to nitrogen fertilization at 4 to 5 leaf stage and slightly tended to decrease compare with nitrogen application at sowing. These relationships were expressed with quadratic equations: $y_{(N\ at\ sowing)} = 21,837 + 0,01937x - 0,0000296x^2$; $R = 0,97^*$; $y_{(N\ at\ 4\ to\ 5\ leaf\ stage)} = 22,033 + 0,0165x - 0,000006x^2$; $R = 0,89^*$; $y_{(N\ at\ flowering)} = 22,102 + 0,0175x - 0,0000298x^2$; $R = 0,97^*$.

In the experiment protein content in mature seed was affected by nitrogen concentration in plant dry biomass during the vegetative growth period. The relationship between plant nitrogen concentration at 4 to 5 leaf stage and seed protein content was expressed with regression equation: $y = - 20,0279 + 13,0559x - 0,9306x^2$; $R = 0,99$. The correlation between plant nitrogen concentration at the start of flowering and seed protein content was explained with regression equation: $y = 15,5177 + 2,7487x - 0,16581x^2$; $R = 0,97^*$.

At that time plant nitrogen concentration, depending on nitrogen fertilizer rate, ranged from 1,57 to 1,95%. Statistically proved effect of plant nitrogen concentration on seed protein content was found: $y = - 9,7739 + 30,9673x - 6,7665x^2$; $R = 0,97^*$. The relationship between plant nitrogen concentration at the seed development stage and seed protein content was expressed with equation: $y = 18,6051 + 3,0703x + 2,1914x^2$; $R = 0,97^*$.

In the experiment the increase in mature seed weight by 0,1 gr seed protein content was increasing by 0,76% ($y = - 6,4947 + 7,6274x$; $R = 0,73$).

The effect of stand population density on spring oilseed rape protein content was rather weak and insignificant.

It was found that seed protein content negatively correlated with the duration of the vegetative growth period and precipitation rate. Positive correlation was found between protein content and mean daily temperature of the growth season as well accumulated by plants growing degree days. Correlation analysis revealed that the increase in the duration of vegetative growth period by each 10 calendar days was decreasing seed protein content by

1,44%. During the years of the experiment seed protein content was decreasing by 1,16% for each additional 100 mm of precipitation. According to the data obtained the duration of spring oilseed rape vegetative growth season and precipitation rate influenced seed protein content respectively by 69,4 and 40,3%.

However, seed protein content positively correlated to the mean daily temperature of the growth season and accumulated by plants growing degree days. In the experiment was determined that the rise in mean daily temperature of the vegetative growth period by 1 ^{0}C increased seed protein content by 0,41%. Meanwhile, the increase of accumulated by plants growing degree days by each 100 ^{0}C seed protein content increased by 1,56%.

Conclusions

According to the data analyse protein content of spring oilseed rape mature seed was effected by nitrogen rate and timing, above ground plant nitrogen concentration, seed weight and meteorological conditions such as duration of the vegetative growth period, temperature and precipitation rate. Stand population density did not affected seed protein content of spring oilseed rape.

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