THE EFFECT OF WEATHER ON YIELD OF SPRING TURNIP RAPE (BRASSICA CAMPESTRIS)

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Introduction

Finland is the northernmost country where agriculture is practiced on a large scale. The total area of arable land is about 2,5 million hectares, of which 75000 hectares are sown for oilseed rape consisting of 96 % spring turnip rape (B. campestris). The crop is commonly grown between the latitudes 60° and 62°N and occasionally up to 63°N. Spring rape (B. rapa) production is possible only on the south and southwest coasts of the country.

The rates of most biological processes are affected by climate and especially by temperature (Beinhauer, 1980). In particular, the rate of crop development is closely related to the sum of effective temperatures over the growing season (Davidson and Campbell, 1983). This study attempts to quantify the yield responses of spring turnip rape to climatic variations. The rate of development of rape is described by dividing the growing period into phenological stages on the basis of the effective sum of temperature. The present work is a part of a larger study, on how climatic variations influence the yields and production economy of field crops in Finland.

Materials and methods

Yield responses to weather conditions were studied in southern Finland from 1977 to 1983. The statistical yield records of 816 fields were collected from farms located in five regional agricultural districts, and the daily records of various climatic factors were obtained from the respective observation stations. The records comprised the daily mean, minimum and maximum temperatures as well as daily precipitation for the period 1977-1983. Since no radiation data were available, the variable S = MX - M was used as a substitute index for radiation, where MX = average maximum temperature and M = average minimum temperature of the particular phase. When daily variations in temperature are high, cloudiness is then assumed to be low. The growing time of rape was divided into 12 successive phases based on the effective temperature sum above $5^{o}C$. Phase one, that before sowing, fullfilled at 40 degree days (dd). Phase two consisted of sowing time and ended at 100 degree days. The 10 phases followed were gradated in steps of 100 degree days. The values of the effective temperature sum were selected to fit the transition from one phase to another at a specific phenological growth stage of the crop. This method was used previously by Rantanen (1987) for spring wheat.

Multiple selective regression analysis was applied to explain deviations in yield by meteorological variables.

Results

The analyses resulted in a model explaining 91 % of the variation in yields ($F = 31.123^{xxx}$) as follows:

$$\text{Yield}: -1687.84 + 45.07\ C_1 -123.51\ R_3 +17.26\ M_4 +69.30\ M_5 + 151.02\ R_9 + 57.16\ S_9 - 16.17\ C_{10} + 53.10\ S_{11}.$$

where C_i: average daily temperature in phase i

R_i: total precipitation in phase i

M_i: average minimum daily temperature in phase i

S_i: difference between the average maximum temperature and the average minimum temperature in phase i

High temperatures before sowing and during the vegetative stage as well as high solar radiation during post anthesis increased seed yield. Heavy rains during emergence proved harmful causing formation of a crust in clay soils, the most common soil types employed for rape cultivation in Finland.

Table 1. Requirements of spring turnip rape at different phases of growth.

Phase	Important climatic variable	Influence on yield	
1 (0-40dd)	C	+	High average daily temperatures (C) before sowing are beneficial.
3 (100-200dd)	R	-	Heavy rains (R) during emergence proved harmful.
4 (200-300dd)	M	+	Minimum temperatures (M) should not be too
5 (300-400dd)	M	+	low before anthesis.
9 (700-800dd)	R	+	On completion of anthesis rainy weather
9 (700-800dd)	S	+	and cool nights are beneficial.
10 (800-900dd)	C	-	Ripening and harvest time in Finland.
11 (900-1000dd)	S	+	Clear, bright weather with little precipitation is best for harvesting.

Table 2. Mean dates and effective temperature sum (dd) for the main developmental stages in spring turnip rape observed from official variety tests 1977-1983 in southern Finland.

	Mean date	Effective temperature sum
Sown	17.5	77
Flowering, started	28.6	423
ended	25.7	711
Pods ripened	1.9	1076

Table 3. Effective temperature sum, precipitation and yields from farms in southern Finland. Mean 1=1959-83, 2=1977-83.

	Mean 1	Mean 2	1977	1978	1979	1980	1981	1982	1983
Effective temperature sum dd	1306	1278	1129	1178	1313	1382	1294	1215	1432
Precipitation April-Oct. mm	314	352	492	342	345	299	389	350	245
Yield kg/ha		1504	1377	1473	1441	1622	1249	1610	1753

Discussion

The yield data of this study were collected between the years 1977-1983, when interest in oilseed rape as a crop was increasing rapidly in Finland. Oilseed rape proved a good crop for breaking grain monoculture. In addition, the yields were economically satisfactory. It seems that *Brassica*-crops are able to benefit from intensive amounts of radiation during the early summer if the minimum temperatures are not too low. At the end of the flowering stage and also at the beginning of pod development, a deficiency of water had a harmful effect on yield. Cool weather in those stages strengthened growth and had a positive response to yield. Negative correlations between temperature and the length of growing time were observed by Monteith (1981) in wheat. Typical of Finnish weather conditions are strong negative correlations between temperature and precipitation. If a cool northerly air current comes at the end of summer, it is followed by bright weather with little precipitation and then there are the best conditions for harvesting.

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