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Oilseed rape and seasonal symptoms: epidemiological and environmental studies

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Abstract

Background **– There is widespread concern that the cultivation of oilseed rape leads to seasonal epidemics of respiratory symptoms in populations living in the neighbourhood, and it has been suggested that the plant is a potent allergen. A study was therefore undertaken to determine the prevalence of seasonal symptoms in rural populations close to and far from areas of oilseed rape cultivation, and to measure the levels of allergen and other potentially harmful substances released by the crop.**

Methods **– Random samples of 1000 adults from the general practice populations of two villages surrounded by oilseed rape fields, and 1000 adults from one village far from such cultivation, were taken. The subjects completed a previously validated questionnaire on respiratory and other symptoms, including questions on symptom seasonality, occupation, and smoking habits. Pollen and fungal spore counts were made around fields of oilseed rape and in the villages. The chemicals released by oilseed rape were measured in the field.**

Results **– Overall, 86·8% of the subjects completed the questionnaires and the populations of the two samples were generally comparable. Spring and summer exacerbations of symptoms occurred equally in the two areas in approximately 25% of the population. There were small but significant excesses of cough, wheeze, and headaches in spring in the oilseed rape area (2·3% *v* 1·1%, 6·8% *v* 4·6%, and 4·8% *v* 2·8%, respectively), and cough, wheeze, and itchy skin were more prevalent in smokers. Counts of oilseed rape pollen were generally low except adjacent to fields, and counts of fungal spores were mostly higher in the rape than the non-rape areas. Oilseed rape was shown to give off terpenes and these were detected close to fields.**

Conclusions **– While it is likely that a proportion of the spring symptoms occurring in people living in close proximity to oilseed rape is caused by the plant, the excess of such symptoms is small. This, together with the low levels of pollen in the area, suggests that allergy to oilseed rape pollen is uncommon. The general prevalence of seasonal symptoms in rural areas is of interest, and a proportion of these cases is likely to be caused by factors other than allergy. Release of chemicals by plants and natural rises in summer ozone levels may be contributors.**

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The area of oilseed rape cultivation increased in the United Kingdom from 6500 hectares in 1968 to 421 100 hectares in 1992. Over 85% is the species *Brassica napus* which is sown in winter and starts to flower, in north east Scotland, during late April for a period of six weeks. *Brassica campestris*, sown in spring, flowers in mid June. The crop is normally harvested in August and September and the oil produced from crushing the seed is used as a source of vegetable oil.

Many doctors have been consulted by patients who attribute seasonal eye and respiratory symptoms to local cultivation of oilseed rape. While true allergy and IgE mediated reactions to extracts of the pollen have occasionally been found,[1–3] most such patients do not have evidence of this. As oilseed rape is largely insect pollinated and gives off a number of chemicals, at least partly acting as insect attractants,[4,5] it is possible that these, rather than pollen, are the cause of the symptoms. We have carried out a study of seasonal symptoms and airborne allergens and chemicals in relation to oilseed rape cultivation in north east Scotland.

Methods

CROSS SECTIONAL SURVEY

The study population comprised 2000 individuals identified from the lists of general practitioners in the study areas. Five hundred individuals were selected from each of two practices situated in areas densely planted with oilseed rape and 1000 from a general practice in a similar rural agricultural area but where very little oilseed rape is grown. Equal numbers of men and women between the ages of 14 and 50 were randomly selected from each area. After approval had been sought from the general practitioners and the local ethical committee, subjects were invited by letter to attend for an appointment. A questionnaire was administered either by trained clerks or by one of the authors. Non-responders were sent reminders. Those unable to attend were either visited at home or interviewed over the telephone. Each subject was contacted if necessary at least twice by letter and at least three attempts were made to contact them by telephone. Finally, those who could not be con-

tacted in any other way were sent the questionnaire by post and asked to complete and return it. Individuals who had moved away from the area or died were replaced by randomly chosen individuals of the same age and sex. The study was carried out between October 1989 and September 1992.

QUESTIONNAIRE DESIGN

The questionnaire was designed to identify symptoms of a seasonal nature and possible exacerbating factors. The main questions were those used in a study in the wool industry, in which they had been validated against the external standard of dust exposure.[6] The questions were designed to determine the presence or absence over the previous two years of allergic or irritant symptoms; supplementary questions were intended to determine the seasonality of such symptoms, if present. In addition to questions on rhinitis, conjunctivitis, respiratory symptoms, itchy skin, and headaches, control questions on feverishness and shivering were also included since it was thought that such symptoms were unlikely to be associated with exposure to oilseed rape. Information on previously diagnosed allergic disease, occupation, place of residence, and smoking habit was also collected. The draft questionnaire was piloted on both healthy volunteers and patients in a chest ward. In order to reduce bias, care was taken not to mention oilseed rape during the interviews, which were also undertaken outside the oilseed rape season. However, respondents were given the opportunity of suggesting possible causes of their symptoms if present.

Table 1 Characteristics of the study population

	Oilseed rape area		*Non-oilseed rape area*	
	No	*% response*	*No*	*% response*
Total number	869	86·9	867	86·7
Sex				
Men	415	83·0	408	81·6
Women	454	91·0	459	91·8
Age				
14–20	145	81·5	182	87·1
21–30	211	84·4	177	80·0
31–40	301	91·5	274	87·0
41–50	212	87·2	234	91·1
Smoking habits		*% total*		*% total*
Smoker	214	24·8	234	27·1
Ex-smoker	161	18·6	164	19·0
Non-smoker	489	56·6	466	53·9

Table 2 Occupations and places of work of study population

	Oilseed rape area		*Non-oilseed rape area*	
	No	*%*	*No*	*%*
Occupation				
Agriculture	115	13·2	38	4·4
Construction	29	3·3	28	3·2
Manufacture	77	8·9	69	8·0
Energy and water supply	30	3·5	29	3·3
Service	422	48·6	448	51·7
Student	45	5·2	81	9·3
Housewife	121	13·9	146	16·8
Unemployed/unclassified	30	3·5	28	3·2
Location				
Local	486	55·9	482	55·6
Outside	316	36·4	328	37·8
Offshore	29	3·3	25	2·9
Not stated/applicable	38	4·4	32	3·7

Table 3 Overall prevalences of symptoms and of diagnosed allergic disease

	Oilseed rape area		*Non-oilseed rape area*	
	No	*%*	*No*	*%*
Any symptom	683	78·6	703	81·1
Cough	84	9·8	88	10·4
Wheeze/tightness	248	28·8	236	27·3
Rhinitis*	262	30·1	312	36·1
Conjunctivitis	247	28·5	275	31·8
Itchy skin	252	29·1	262	30·4
Chills	97	11·2	99	11·5
Headaches*	435	50·2	388	44·9
Diagnosed hayfever	80	9·3	105	12·2
Diagnosed asthma	53	6·2	36	4·2
Diagnosed hayfever and/or asthma	110	12·7	126	14·5
Allergy	106	12·7	123	14·2

* $p < 0.05$.

ANALYSIS

Information from the questionnaires was stored on a database (Paradox v. 3.5, Borland International). All statistical tests were carried out using SPSS/PC+; in most cases χ^2 tests were used to compare prevalences of symptoms in each area and to test for associations between seasonal symptoms and village.

ENVIRONMENTAL STUDIES

A daily programme of air sampling was carried out using Burkard continuous pollen samplers during April, May, and June 1989 and 1990. In 1989 sampling was carried out adjacent to and 300 m north east of a 7·3 hectare field of oilseed rape. In 1990 sampling was carried out in the centres of one of the villages in the oilseed rape area which was surrounded by the crop, and in one of the villages where none was grown locally. In 1989 full counts of all pollen grains were made throughout the season, and fungal spores were also counted on days when the oilseed rape counts equalled or exceeded 100 grains/m^3. In 1990 full counts were made throughout the 64 day sampling period at both sites. In 1992 air was sampled 2 m above a field of oilseed rape (variety envol) from April to July. Air was pumped through glass tubes packed with 2 g of 30–60 mesh active charcoal at 10 l/min. Samples were desorbed into dichloromethane and analysed by GC-FID.

Results

CROSS SECTIONAL STUDY

Overall, 1736 (86·8%) of the 2000 subjects completed questionnaires, 869 in the oilseed rape area and 867 in the non-oilseed rape area. There was no significant difference in the numbers completing the questionnaire by interview, telephone, or post between the two areas. The characteristics of the samples are shown in tables 1 and 2; there were differences in occupational make-up, with fewer agricultural workers and more students in the non-oilseed rape area, but otherwise the populations were very similar.

Table 3 shows the overall prevalence of all symptoms, seasonal and non-seasonal. There were significant differences only for rhinitis which had a significantly higher prevalence in

Table 4 Prevalence of symptoms in each season

	Oilseed rape area		Non-oilseed rape area	
	No	%	*No*	%
Any symptom				
Spring	221	25·4	212	24·5
Summer	214	24·6	218	25·1
Winter	135	15·5	134	15·5
Cough				
Spring*	20	2·3	9	1·1
Summer	17	2·0	15	1·8
Winter	29	3·4	24	2·8
Wheeze				
Spring*	59	6·8	40	4·6
Summer	54	6·3	46	5·3
Winter	48	5·6	44	5·1
Rhinitis				
Spring	122	14·0	133	15·4
Summer*	101	11·6	129	14·9
Winter	27	3·1	30	3·5
Conjunctivitis				
Spring	111	12·8	112	12·9
Summer	105	12·1	119	13·7
Winter	24	2·8	14	1·4
Itchy skin				
Spring	34	3·9	33	3·8
Summer	51	5·9	35	4·1
Winter	31	3·6	35	4·1
Chills				
Spring	16	1·8	11	1·3
Summer	11	1·3	8	0·9
Winter	21	2·4	16	1·9
Headaches				
Spring*	42	4·8	24	2·8
Summer*	38	4·4	22	2·5
Winter	14	1·6	16	1·9

* $p < 0.05$.

the non-oilseed rape area than in the oilseed rape area, and headaches which were significantly more prevalent in the oilseed rape area. Symptoms were analysed by seasonality, with spring being defined as April, May and June, summer as July, August and September, and winter as October to March; the results are shown in table 4. Very few significant differences were found between the two areas, confined to the spring and summer months, over which period around 25% of the sample in both oilseed rape and non-oilseed rape areas reported exacerbation of their symptoms.

Significant differences were observed during the spring months for cough, wheeze, and headaches, with higher prevalences occurring in the oilseed rape area. A significantly higher prevalence of headache symptoms during the summer months was also observed in the oilseed rape area. Nasal symptoms were significantly higher in the non-oilseed rape area during the summer months. Cough and wheeze were, not surprisingly, more prevalent in smokers (table 5). Itchy skin was less prevalent in non-smokers than in current and ex-smokers.

When subjects reported seasonal symptoms they were invited (without prompting) to name a suspected cause. The main factors suspected were, in the oilseed rape area, oilseed rape, and, in the non-oilseed rape area, other plants and trees.

Table 5 Prevalence of symptoms by smoking category

	Smokers		Non-smokers		Ex-smokers	
	No	%	*No*	%	*No*	%
Cough**	68	15·3	79	8·4	24	7·5
Wheeze/tightness**	188	42·1	208	22·0	86	26·5
Rhinitis	141	31·5	321	33·6	108	33·3
Conjunctivitis	137	29·9	279	29·2	102	31·5
Itchy skin*	145	32·4	250	26·3	117	36·2
Chills	51	11·4	98	10·3	46	14·2
Headaches	207	46·5	451	47·3	159	48·9

* $p < 0.005$; ** $p < 0.0001$.

ENVIRONMENTAL STUDIES

In 1989 oilseed rape pollen counts immediately adjacent to the field varied from 1170 to 9 grains/m^3, reaching 100 or more on only six days. The average weekly count exceeded 10 grains/m^3 on only the first three weeks of the flowering season. At 300 m downwind of the field, counts were extremely low, weekly averages between 1 and 6 grains/m^3 occurring in only five weeks of the 12 week season. Over the same period grass pollen counts were, as expected, low, ranging from 9 to 27 grains/m^3. On the six relatively high rape pollen count days the predominant airborne particles were mould spores, especially hyaline ascospores, *Leptosphaeria*, *Cladosporium*, *Sporobolomyces*, *Tilletiopsis*, and *Ustilago* spp.

In 1990 sampling in the two villages showed very low concentrations of oilseed rape pollen in both, a peak of 99 grains/m^3 occurring on one day in May in the oilseed rape area (fig 1). Highest counts were observed in the oilseed rape area during the second and third weeks of May, and in the non-oilseed rape area during the third week in May. In general, however, oilseed rape pollen was observed on very few occasions and in small amounts in both areas. Other predominant pollens were birch and pine in the oilseed rape area and birch, cedar, and pine in the non-oilseed rape area, with counts for birch and pine being much higher in the non-oilseed rape area. Among the predominant spores recorded, counts of *Cladosporium*, *Sporobolomyces*, and *Tilletiopsis* were generally higher in the oilseed rape than non-oilseed rape areas (fig 2). Counts of *Leptosphaeria* and *Pullularia* were roughly similar at both sites. The number of basidiospores recorded was similar at both sites, apart from the end of April and beginning of May when counts were very much higher in the oilseed rape area. Although *Alternaria* and *Botrytis* are among the major pathogens of oilseed rape, they were recorded only on very few occasions and in very low numbers at both sites.

Sampling over a field of oilseed rape for chemicals during the 1992 season revealed the presence of terpenes, predominantly pinene, sabinene, and limonene. Other terpenes and aromatics were present but not identified. Peak levels recorded were 1·2 μg/m^3 for pinene, 2 μg/m^3 for sabinene, and 2·6 μg/m^3 for limonene.

Discussion

The rapid increase in cultivation of oilseed rape in the United Kingdom, together with the commonly expressed opinion that the plant is responsible for serious outbreaks of allergic symptoms,[7] made it essential to carry out this study. In planning it we were aware of possible bias, since there had been widespread media

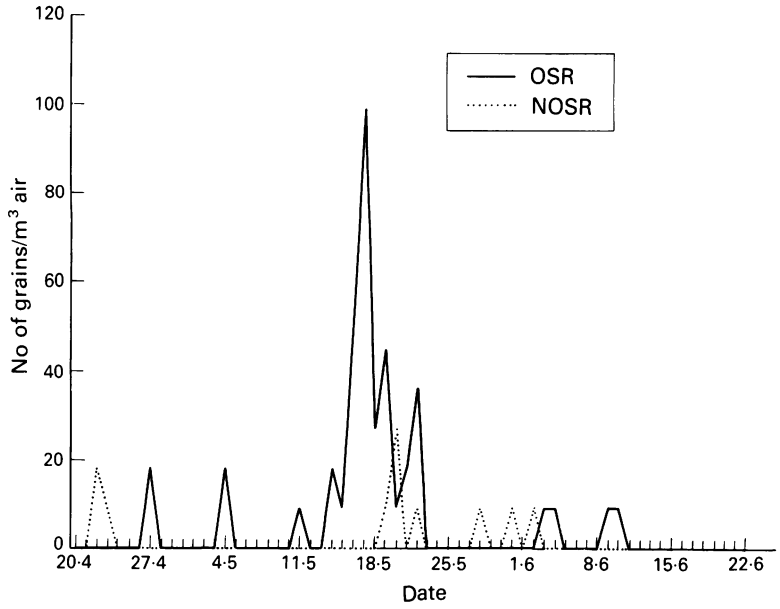

Figure 1 Oilseed rape pollen counts in oilseed rape (OSR) and non-oilseed rape (NOSR) villages, 1990.

interest in the association of the crop with disease. We carried out our survey in the autumn and winter months and were careful to avoid any reference to oilseed rape in the information given to participants; nevertheless, it is likely that some subjects, especially those in the oilseed rape area which was literally surrounded by the plant, would realise our purpose.

It was not our intention to show that oilseed rape can cause allergic sensitisation. This is already established[1-3] and we have seen it in an individual working with the plant in a research setting. Rather, we intended to investigate whether, as had been claimed, it was responsible for epidemic illness. We therefore compared the prevalence of seasonal symptoms in oilseed rape and non-oilseed rape villages and measured pollen and spore levels in those areas. In addition, because our clinical encounters with patients complaining of oilseed rape "allergies" had indicated that they were usually transient irritant-type symptoms, we set out to investigate the chemical emissions of the plant.

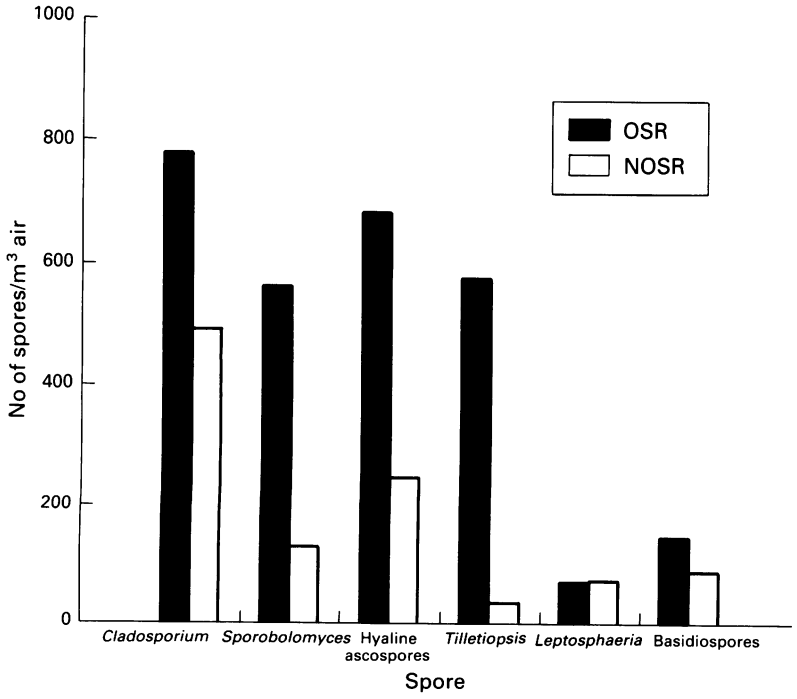

Figure 2 Average daily spore counts from April to June 1990 for the main fungal spores in oilseed rape (OSR) and non-oilseed rape (NOSR) villages.

The epidemiological survey produced a surprising result in that there were few systematic differences in seasonal symptoms between oilseed rape and non-oilseed rape villages. In general it is clear that spring/summer symptoms are frequent in rural areas and are attributed by the sufferers to local vegetation. Since many of these individuals develop symptoms well before the grass pollen season, classical hayfever is the explanation of only a proportion. Indeed, in a small case-control study only eight of 17 people from the oilseed rape area with spring symptoms had positive skin or RAST tests to common and local allergens; in only one case was there a positive RAST to oilseed rape.[8] Nevertheless, the higher prevalence of spring wheeze, cough, and headaches in the oilseed rape area suggests that a proportion of these symptoms may be attributable to something associated with oilseed rape cultivation.

These studies suggest that true allergy to oilseed rape is relatively uncommon, and others in our area have come to the same conclusion.[9] Nevertheless, many people undoubtedly notice symptoms which they attribute to proximity to the plant and it is reasonable to suppose that this is responsible for a proportion of the positive responses in the oilseed rape villages. The lack of striking differences from the non-oilseed rape village may be explained by the possibility that other allergic and irritant substances are also released by local vegetation in that area. Several possible explanations for these ubiquitous summer symptoms suggest themselves, apart from the well recognised grass and tree pollens. Fungal spores occur in high concentrations in rural air in the summer, though we have found no example of fungal allergy in the small study mentioned above.[8] This seems an unlikely explanation of widespread symptoms. More likely is the possibility of chemical irritation or, possibly, allergy.

The metabolic processes of plants produce chemicals and oilseed rape has developed the ability to produce terpenes, simple cyclic organic chemicals, as attractants to pollinating insects.[4,5] These substances are also produced by pine trees and are present in cut grass.[10-12] They are locally irritant to mucous membranes and may cause skin sensitisation, as when turpentine allergy occurs.[13] In at least one case small quantities released from rubber gloves have provoked attacks of asthma.[14] It is plausible that these substances cause nasal and eye symptoms in people close to oilseed rape and, since they are also produced by pine trees, in other areas as well. We have been able to demonstrate the production of terpenes by oilseed rape.

Organic compounds produced by plants, including terpenes, take part in a series of complex chemical changes in the atmosphere which are driven by sunlight. These reactions produce condensation molecules which are responsible for the blue haze seen in summer over vegetated land and mountainscapes.[15] Downwind of oilseed rape fields it is likely that other irritant molecules, including aldehydes and ultimately ozone, will be formed. While these are unlikely to cause symptoms adjacent to fields, they will undoubtedly contribute to the overall irritancy of air in country districts.

In conclusion, we believe that our studies have shown seasonal spring/summer symptoms to be widespread in rural areas, but not significantly more common in relation to oilseed rape cultivation. The plant produces little airborne pollen, and symptoms attributed to it are likely to be irritant, probably caused by volatile organic compounds released by the plant. The causes of these summer symptoms require further investigation; allergy is unlikely to be the only factor.

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