

The effect of nitrogen status of ragweed plants on certain pollen characteristics

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*Ragweed plants (*Ambrosia artemisiifolia*) were grown to maturity in sand cultures supplied with nutrient solutions containing a low, medium, or high concentration of nitrogen. Pollen was collected from each of the treatments, and its size, density, and nitrogen content were determined. Pollen grains produced by the medium and high nitrogen plants had a greater diameter and a lower density than those produced on nitrogen-deficient plants. The rate of fall, as determined by Stokes' law, was similar for all pollen regardless of treatment. The nitrogen content of the pollen from the medium nitrogen ragweed plants was greater than that of the pollen from the low and high nitrogen treatments.*

In the formulation of ragweed control regulations, the question arose whether the growth status of a plant might influence such pollen grain characteristics as size, density, and nitrogen content. It was thought that pollen from ragweed plants in marginal nutritional condition growing along the roadside might differ from that produced on plants in cultivated fields. At one time, it was assumed that pollen size was constant for a particular plant species, but reports now indicate that such factors as flower position,¹ soil moisture,² air temperature,³ time of pollen shedding, and nutrition^{2, 4} affect pollen size. Unfortunately, ragweed was never included as an experimental plant in any of these studies. Regarding pollen density, Durham⁵ in 1943 found that, while most tree and grass pollens have a density of 1.0, the density of ragweed pollen is only 0.5. He pointed out that the theoretical rate of fall for ragweed pollen of 20 μ diameter would be 0.022 foot per second instead of 0.04 foot per second as previously calculated for a density of 1.0. As for the nitrogen content of ragweed pollen, Moore and Moore⁶ in 1930 reported that whole pollen contained 4.26 per cent nitrogen, but nothing was stated regarding the plant source. This present study

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was therefore initiated to determine whether manipulation of the nitrogen supply of growing ragweed plants would change the size, density, or nitrogen content of the pollen.

Ragweed plants (*Ambrosia artemisiifolia*) were grown to maturity in a greenhouse in sand culture supplied with a complete nutrient solution containing a low, medium, or high concentration of nitrogen (14, 56, and 224 ppm). Pollen was collected by hand from each of the three treatments on seven occasions between August 27 and September 19. It was placed in vials in a desiccator over calcium chloride, and measurements were made on the day following collection. The density or specific gravity of the pollen was derived in the manner used by Durham⁵ from the mass per volume relationships. The mean weight of a single grain was obtained by weighing 10 mg. of pollen into 10 ml. of Calberlas's solution and counting the number of grains in a given volume with a Howard mold counting chamber. The mean diameter of the pollen grains from each treatment was determined microscopically. Both means were derived from 50 replicate measurements. The net volume of a single grain was obtained by the formula for volume of a sphere ($4/3\pi r^3$). The data for the seven collection dates were averaged for each nutritional treatment, and statistical significance was determined from Fisher's Table of *t* for $P = 0.05$. Ragweed leaves were analyzed for total nitrogen as evidence that the plants reflected the varied nitrogen treatments. Likewise, the pollen was analyzed for total nitrogen on five of the collection dates. Data on nitrogen content were again analyzed by the Fisher test.

Table I contains data on the nitrogen content of the ragweed leaves and pollen resulting from each nitrogen treatment. Plants grown with 14 ppm N in the substrate showed symptoms of N deficiency. The leaves had a nitrogen content of 1.75 per cent. A supply of 56 ppm N produced normal-looking plants with leaves containing 3.15 per cent N. A further increase to 224 ppm N in the substrate produced even more luxuriant plants with a leaf content of 3.92 per cent N. The pollen from the plants grown with the medium nitrogen supply had a slightly higher nitrogen content than the pollen from the other treatments (3.74 per cent as compared with 3.32 and 3.64); in fact, the N content was significantly greater than that of pollen from the 14 ppm treatment. This variation in nitrogen composition of the pollen might relate to its allergenicity and therefore be of interest to those studying allergenic properties.

Table II presents data relating to the size, weight, and specific gravity of pollen from the three nitrogen treatments. The mean diameter of the grains representative of the medium and high nitrogen plants was statistically greater than that of the nitrogen-deficient plants (20.82 and 21.10 μ as opposed to 20.15

Table I. *N content of leaves and pollen from ragweed plants grown with various concentrations of nitrogen*

N supply (ppm)	N content (%)	
	Leaves	Pollen
14	1.75	3.32 $\pm$.27
56	3.15	3.74 $\pm$.28*
224	3.92	3.64 $\pm$.32

*Significant difference from N 14 ppm.

Table II. *Size, weight, and specific gravity of pollen from ragweed plants grown with various concentrations of nitrogen*

<i>N supply (ppm)</i>	<i>Diameter (μ)</i>	<i>Weight 1 pollen grain (Gm. by 10^{-9})</i>	<i>Specific gravity</i>
14	20.15 $\pm$.35	2.69 $\pm$.18	0.64 $\pm$.067
56	20.82 $\pm$.58*	2.71 $\pm$.26	0.57 $\pm$.063*
224	21.10 $\pm$.45*	2.86 $\pm$.30	0.59 $\pm$.056

*Significant difference from N 14 ppm.

Table III. *Velocity of fall of pollen from ragweed plants grown with various concentrations of nitrogen*

<i>N supply (ppm)</i>	<i>Velocity (cm. per second)</i>
14	0.788 $\pm$.074
56	0.797 $\pm$.144
224	0.788 $\pm$.101

μ). The weight of the pollen grains from all nitrogen treatments was similar. The specific gravity of pollen from the 56 ppm N plants was 0.57, as compared with 0.64 and 0.59 for pollen from the low and high N plants, again statistically less than that of the deficient plants. Durham reported the probable mean specific gravity to be 0.55. A more recent report by Harrington⁷ from the Meteorological Laboratories at the University of Michigan states that the effective density of ragweed pollen varies from 1.05 to 1.28, depending upon the humidity. These measurements were made with a new instrument, the Beckman air comparison pycnometer. Even if this method proves the more valid one, for the purpose of comparing the relative density of treated pollen the older method is still applicable.

The velocity of fall of pollen from the three treatments was calculated by Dahl's expression⁸ of Stokes' law:

$$V = \frac{2 \text{ gr}^2 (d_1 - d_2)}{9K}$$

Durham previously reported that the velocity of fall of common ragweed pollen was 0.671 cm. per second by calculation and 0.884 cm. per second by the experimental method.⁹ In this present experiment, the calculated velocity of fall for all the ragweed pollen obtained from plants representing deficient, optimum, and luxury supplies of nitrogen was similar, ranging from 0.788 to 0.797 cm. per second. The differences in diameter offset the change in specific gravity in the three treatments, which accounts for the similarity in the rate of fall.

Thus, it can be concluded that the nitrogen status of ragweed plants does not influence the rate of fall of pollen grains. Whether pollen comes from nitrogen-deficient plants or from those with adequate nitrogen apparently has little effect on dispersion. Indications are, however, that the nitrogen status of the plant does determine the nitrogen content of the pollen grains, which could in turn alter its allergenic properties.

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