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Research Communication

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Pollen Production in Some Allergenically Significant Plants of Asansol Industrial Belt, West Bengal

***Abstract*: Pollen productivity of 30 probable allergenic pollen producing plant taxa growing in Asansol Industrial belt was determined. The number of pollen per anther, anther number per flower along with the detailed particulars like anther length, pollen grain size, mode of pollination, habit of plant were also recorded during determination of pollen productivity. It has been observed that the pollen productivity was directly related to anther length and inversely related to pollen grain size. The habit of the plants is also correlated to the pollen production number of the particular species. Trees are the highest pollen producers followed by the shrubs and the herbs. *Ailanthus excelsa* (1337850 pollen / flower, Tree) is the highest pollen producer followed by *Bauhinia variegata* (844645 pollen / flower, Tree), *Ricinus communis* (599040 pollen/flower, Shrub), *Argemone mexicana* (463400 pollen/ flower) etc. On the other hand *Casuarina equisetifolia* (1061 pollen/ flower) is the lowest pollen producer followed by *Lantana camara* (1835 pollen/flower), *Alstonia scholaris* (4240 pollen/ Flower) and *Ageratum conyzoides* (4825 pollen/Flower) etc. Variation has been also noticed in anemophilous and entomophilous plants in terms of pollen grain production.**

Keywords: Pollen production, allergenically significant plants, Asansol industrial belt, West Bengal

Pollen production and their dispersal mechanism are highly significant in aerobiological study. In flowering plants, pollen productivity is referred to as the number of pollen grains produced per anther of the flower. The total pollen production of a particular plant depends on the number of anthers per flower and the number of flowers per plant.

Anemophilous plants are generally known to produce copious amount of pollen as pollinating agent in air that carries and disperse the pollen grains and thus effective pollination is a matter of chance. These large number of pollen grains released are not all involved in fertilization rather they may float in air or water and finally get deposited on the earth's surface . Some of these pollen grains cause various allergic diseases and thus considered as biopollutants. Allergenic pollen in the atmosphere is instrumental for the onset of allergic symptoms if found in great abundance in the air. The dispersal in air is controlled by factors like morphology of the flower, flowering season, and nature of pollination like anemophily, entomophily and amphiphily. It has been proved that plants with high pollen production are more capable of inducing pollen allergy. Total enumeration of pollen productivity thus contributes immensely in aerobiological works related to pollinosis.

In the present study total 30 plant taxa, that grow profusely in the Industrial belt of Asansol, West Bengal play a significant role in allergy problems were selected to enumerate pollen productivity. The selected plants belong to trees, shrubs and herbs.

Material and Methods: Plants occurring in their natural habitat with probable significance of allergenicity (Table: 1) in and around Asansol, an industrial city in West Bengal, were selected for the study.

The study was carried out following the method of Nair and Rastogi[1] and Mandal and Chanda[2]. Unopened and matured flowers with un-dehisced anthers were collected in the morning between 7.30- 9.00 a.m. The anther separated from the flower was crushed and dispersed uniformly in 50 drops of 50% Glycerine. One drop of the mixture was put on a slide and covered with a cover glass. The number of pollen grains in this area was counted with an average of five drops for each plant species. This average was multiplied by 50 to get the number produced per anther.

The pollen count was made for ten anthers randomly collected from the different flowers of the selected plants. The morphology of the pollen grain was studied and the size was measured using standardized ocular micrometer by Erdtman[3].

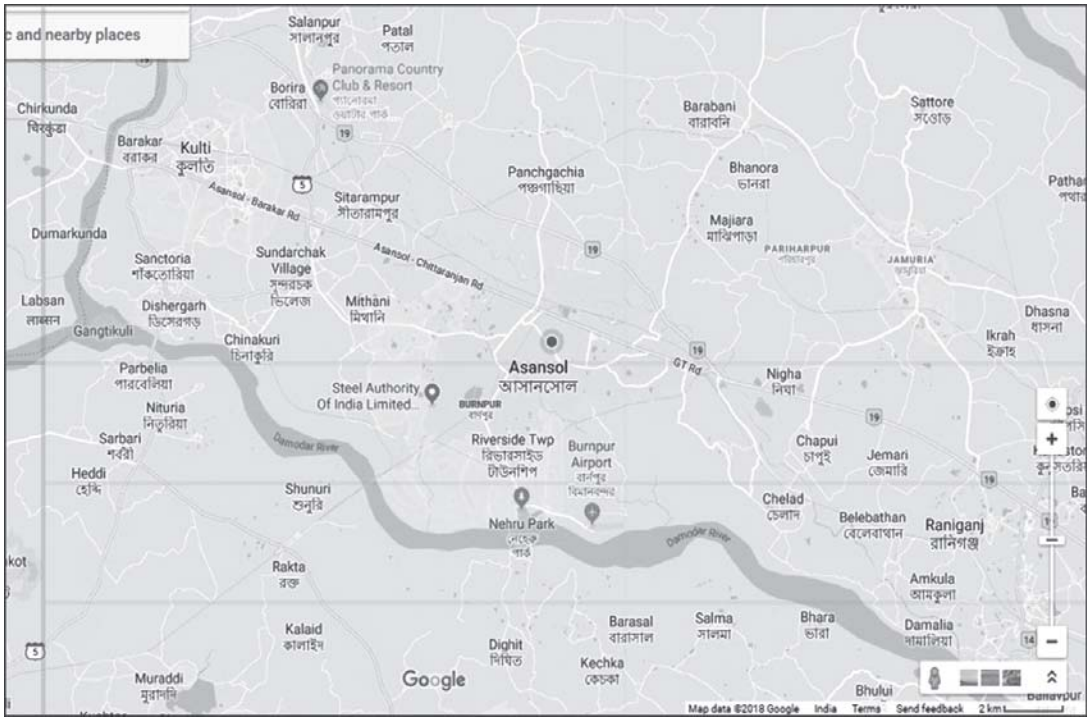

Fig 1: Field Map of Asansol, West Bengal.

Table : 1 Pollination Calendar of Selected Plant Taxa with Allergenic Significance:

	Plant	Family	Mode of pollination	Habit	Flowering period
1	*Ageratum conyzoides*	Asteraceae	E	H	Jun-Sept
2	*Ailanthes excelsa*	Simaroubaceae	A	T	Mar-Jun
3	*Alstonia scholaris*	Apocynaceae	E	T	Nov-Feb
4	*Amaranthus spinosus*	Amaranthaceae	A	H	Apr-Jun
5	*Argemone mexicana*	Papaveraceae	A	H	Mar-Jun
6	*Azadirachta indica*	Meliaceae	E	T	Mar-Apr
7	*Bauhinia variegata*	Caesalpiniaceae	E	T	Dec-Mar
8	*Carica papaya*	Caricaceae	E	T	Feb-Jul
9	*Cassia fistula*	Caesalpiniaceae	E	T	Jun-Aug
10	*Casuarina equisetifolia*	Casuarinaceae	A/E	T	Mar-June
11	*Chenopodium album*	Chenopodiaceae	A	H	Mar-Jun
12	*Croton bonplandianum*	Euphorbiaceae	E	H	RTY
13	*Cocos nucifera*	Arecaceae	A/E	T	RTY
14	*Cucurbita maxima*	Cucurbitaceae	E	H	RTY
15	*Dalbergia sissoo*	Caesalpiniaceae	E	T	Jan-Feb
16	*Datura metel*	Solanaceae	E	S	May-Oct
17	*Delonix regia*	Caesalpiniaceae	E	T	Apr-Jun
18	*Eragrostis uniloides*	Poaceae	A	G	Sep-Jan
19	*Eucalyptus citriodora*	Myrtaceae	A/E	T	Oct-Mar
20	*Ipomoea fistulosa*	Convolvulaceae	E	S	Jun-Sept
21	*Lantana camara*	Verbenaceae	A/E	S	Jun-Sept
22	*Madhuca indica*	Sapotaceae	E	T	Feb-Apr

23	*Mangifera indica*	Anacardiaceae	E	T	Jan-Mar
24	*Morus alba*	Moraceae	A/E	T	Jan-Mar
25	*Parthenium hysterophorus*	Asteraceae	A/E	H	Apr-Dec
26	*Peltophorum pterocarpum*	Caesalpiniaceae	E	T	Apr-Jul
27	*Phoenix sylvestris*	Arecaceae	E	T	Apr-Jun
28	*Ricinus communis*	Euphorbiaceae	A/E	S	Apr-Jun
29	*Solanum xanthocarpum*	Solanaceae	E	H	RTY
30	*Xanthium strumarium*	Asteraceae	A	H	Jul-Oct

Abbr: A- Anemophilly, E-Entomophilly, A/E- Anemophilly/Entomophilly, H- Herb, S-Shrub, T-Tree, G-Grass, RTY- Round the Year

Selected Plants	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Achyranthes aspera												
Ageratum conyzoides												
Ailanthes excelsa												
Alstonia scholaris												
Argemone Mexicana												
Azadirachta indica												
Bauhinia variegata												
Carica papaya												
Cassia fistula												
Casuarina equisetifolia												
Chenopodium album												
Croton bonplandianum												
Cocos nucifera												
Cucurbita maxima												
Dalbergia sissoo												
Datura metel												
Delonix regia												
Eragrostis uniloides												
Eucalyptus citriodora												
Ipomoea fistulosa												
Lantana camara												
Madhuca indica												
Mangifera indica												
Morus alba												
Parthenium hysterophorus												
Peltophorum pterocarpum												
Phoenix sylvestris												
Ricinus communis												
Solanum xanthocarpum												
Xanthium strumarium												

Figure: 1 Flowering Calendar of the Selected Plant Taxa

Table:2 Habit Wise Distribution of Plant Taxa Selected for Investigation

Habit of Plant	No of plants Investigated	Percentage(%)
Herb	9	30
Shrub	4	13.33
Tree	16	53.33
Grass	1	3.33

Table: 3 Percentage of Types of Pollination Mechanism

Pollination Mechanism	Plant observed	Percentage (%)
Anemophily (A)	6	20
Entomophily (E)	17	56.66
Amphiphily (A/E)	7	23.33

Results and Discussions: The investigation reveals that the Pollen production in terms of number per anther and per flower varied widely in the selected plant taxa. The highest pollen production was observed in *Ailanthus excelsa* (1337850 pollen/ flower) followed by *Bauhinia variegata (844645 pollen/flower), Ricinus communis* (599040 pollen /flower), *Phoenix sylvestris (541272 pollen/ flower), Argemone mexicana (463400* pollen / flower), *Cassia fistula* (456960 pollen /flower), etc.

The allergenic pollen grains are present in the great abundance in the air and the higher concentration of the pollen of these plants have been reflected in *Ailanthus excelsa* .The behavior of the some of the selected taxa is however in contrast with the previous observations as there is incidence of relatively high pollen production despite of being entomophilous like *Bauhinia variegata, Cassia fistula, Ipomoea fistulosa,* etc.

Plants like *Casuarina equisetifoila* (1061), *Lantana camara* (1835), *Alstonia scholaris* (4240), *Croton bonplandiarum* (5475), *Azadirachta indica* (6040) etc. even produce extremely low amount of pollen and the low concentration is capable of inducing allergic reactions. The lower productivity could be due to their entomophilous nature and less elaborate flower display features that results into limited pollen dispersal mechanism.

Correlation Between Anther Length and Pollen Production: The pollen production is directly correlated to the anther length. In other words species possessing large anthers have higher rate of pollen production. A positive significant correlation has been found between the anther length and the number of pollen grains produced per anther (r= 0.156, P-Value = 0.410)

Cucurbita maxima , Cocos nucifera, Bauhinia variegta, , Cassia fistula, where high pollen productivity could be correlated to their large anther size. The lower pollen production is generally seen in the taxa with comparatively smaller anther size as in *Croton bonplandianum, Mangifera indica, Casuarina equisetifolia,* etc.

There was a proportionate increase in the degree of pollen production with the increase in the length of stamen in some taxa like *Cassia tora* and *Arachis hypogea* of Leguminoceae. Agnihotri and Singh[4] suggested that the total production of pollen depends directly on the size and length of the anther.

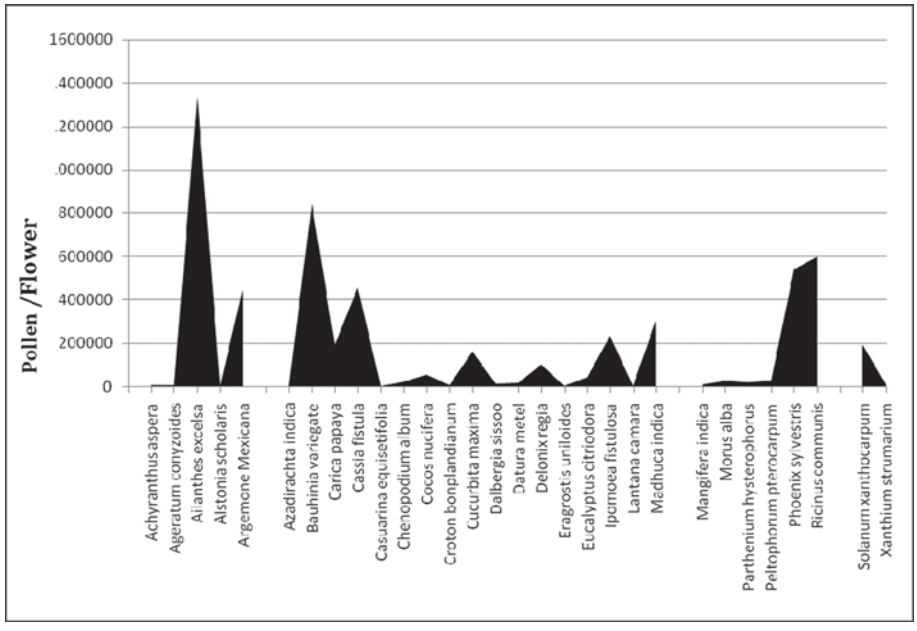

Fig:1 Pollen Production of Selected Taxa

Correlation Between Anther Number Per Flower and Total Pollen Production : The total pollen production is directly correlated to the number of anther per flower. There is significant positive and linear correlation between the number of pollen grains and of anther number per flower (r=0.258). *Ricinus communis, Argemone mexicana, Madhuca indica,* etc rank the top most

Table:4 Pollen Character and Pollen Production of Selected Plant Taxa

Plant	No. of anther	Anther length (mm)	Pollen size		Pollen/ Anther		Log of Pollen/ Anther	Pollen/ Flower
			Mean	Range	Mean	Range		
Achyranthus aspera	5	1.6-2.0	20	18-22	1045	1036-1053	3.01	5225
Ageratum conyzoides	5	1.5-2.5	21	17-25	965	958-972	2.98	4825
Ailanthes excelsa	5	1.5-2.2	41	39-42	267570	267564 -267576	5.42	1337850
Alstonia scholaris	5	1.9-2.3	44.5	42-47	848	844-852	2.92	4240
Argemone mexicana	40(mean)	2.0-2.5	27	23-31	11585	11575-11596	4.06	463400
Azadirachta indica	10	1.3-1.6	39	35-43	604	598-610	2.78	6040
Bauhinia variegata	5	4.1-5.2	29	28-30	168929	168929-168936	5.23	844645
Carica papaya	10	2.6-3.1	31.5	30-33	19210	19205-19215	4.28	192100
Cassia fistula	7	5.1-5.6	46.5	45-48	65281	65275-65287	4.81	456960
Casuarina equisetifolia	1	2.2-2.6	21	18-24	1061	1058-1064	3.03	1061
Chenopodium album	5	1.6-2.1	26.5	26-27	4158	4156-4160	3.61	20790
Cocos nucifera	5	5.1-7.5	55	48-62	11346	11342-11350	4.75	56730
Croton bonplandianum	15	1.4-1.8	49	43-56	365	362-368	2.56	5475
Cucurbita maxima	5 (fused)	7.8-10.2	49.5	45-54	32153	32149-32157	4.51	160765
Dalbergia sissoo	9	1.0-1.5	26	24-28	1290	1286-1294	3.11	11610
Datura metel	5	5.5-6.4	29	23-36	3195	3191-3199	3.50	15975
Delonix regia	7	4.1-4.4	71	67-75	14340	14336-14346	4.12	100380
Eragrostis uniloides	3	1.6-2.3	32	29-36	596	593-599	2.77	1788
Eucalyptus citriodora	32 (mean)	1.8-2.3	57	52-66	1282	1279-1285	3.11	41024
Ipomoea fistulosa	5	6.0-6.5	28	25-31	46524	96521-96528	4.66	232620
Lantana camara	5	2.5-2.7	26	20-31	367	365-369	2.56	1835
Madhuca indica	24(mean)	2.7-3.4	51	46-56	12609	12608-12610	4.10	302616
Mangifera indica	5	1.5-2.6	25	24-26	1713	1709-1718	3.23	8565
Morus alba	4	2.6-3.7	49	43-55	6286	6285-6287	3.80	25144
Parthenium hysterophorus	5	0.8-1.1	22	21-23	3698	3695-3701	3.56	18490
Peltophorum pterocarpum	10	2.6-3.7	52	47-57	2553	2550-2556	3.41	25530
Phoenix sylvestris	6	3.2-4.1	71	68-74	90212	90210-90214	4.96	541272
Ricinus communis	520(mean)	1.2-1.6	30	27-33	1152	1149-1155	3.06	599040
Solanum xanthocarpum	5	3.7-4.7	42	34-50	38680	38665-38695	4.59	193400
Xanthium strumarium	5	2.3-2.9	34.5	32-37	1610	1606-1614	3.2	8050

pollen producers with their high anther number. The plants like *Casuarina equisetifolia, Lantana camara* are comparatively less pollen producer in respect of their number of anther per flower. The pollen production data when supported by information as to the number of flowers per plant indicate the relative capability of each species to charge the ambient air with their pollen.

Correlation Between Pollen Size and Pollen Production: In the present investigation mixed types of pollen grains are found possesing smaller sized pollen grain(<20 ìm) to medium sized pollen grains (25 - 49 ìm) and little higher sized pollen grains (50-71 ìm). Very big sized pollen grains are not present in the investigated taxa. Pollen production is not only dependent on the anther size but also on the pollen grain size. In the present study direct correlation was found in relation to pollen production and pollen size (r=0.114) where medium anther length with small sized pollen grains could be correlated with moderate

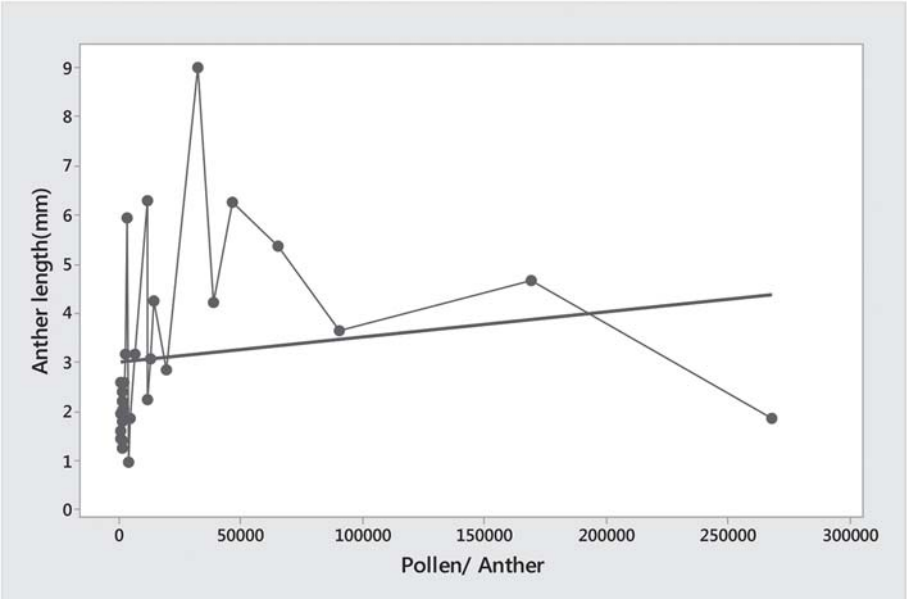

Fig. 2: Correlation Between Anther Length and Pollen Production (Per Anther)

pollen production and higher pollen production with moderately higher sized pollen grains.

The species possessing large anthers and small pollen grains had comparatively higher pollen production. In other words, pollen production was directly related to anther size and inversely related to pollen grain size. However, grain size seems to be of no importance in Poaceae, Cyperaceae, and Amaranthaceae-Chenopodiaceae members.

Pollen Production and Mode of Pollination: Out of the 30 investigated taxa 17 taxa (56.66%) showed entomophilous, 6 taxa (20%) showed Anemophilous and 7 taxa (23.33%) showed Amphiphilous mode of pollination.It is found that inspite of being entomophilous many plants produce copious amount of pollen grains found in air. It has also been found that allergenic pollen grains are produced in abundance. However, in contrast some of the anemophilous plants produce less pollen grain as their low concentration also induces pollinosis.

From the pollen production figures obtained from the present investigation**,** it is evident that pollen production in terms of number per anther and number per flower varies widely between genus, species to species even within the same genus. Variations in pollen production were also reported by other workers[5-8].

Variation is also found in individual anther of a flower, in diploids and tetraploids in anther, flower and plant with reference to dispersal, in anther and flower, in anther, flower and whole plant and in terms of number per anther along with the anther length, filament length, pollen grains size and mode of anther dehiscence[8]. The figures of pollen production per anther, flower, inflorescence and branch are also mentioned by the scientists[9-12]. However, it is evident that pollen production per flower in a taxon not only depends on the size of anther or the size of the pollen grains but it is also controlled by many other factors such as periodicity, response to light, nutrient availability, year to year, etc.

The pollen production also may be influenced by other factors such as periodicity, response to light and nutrient availability. The amount of pollen in the atmosphere depends not only on pollen production but also on the duration of the flowering season and on environmental factors[12-13].

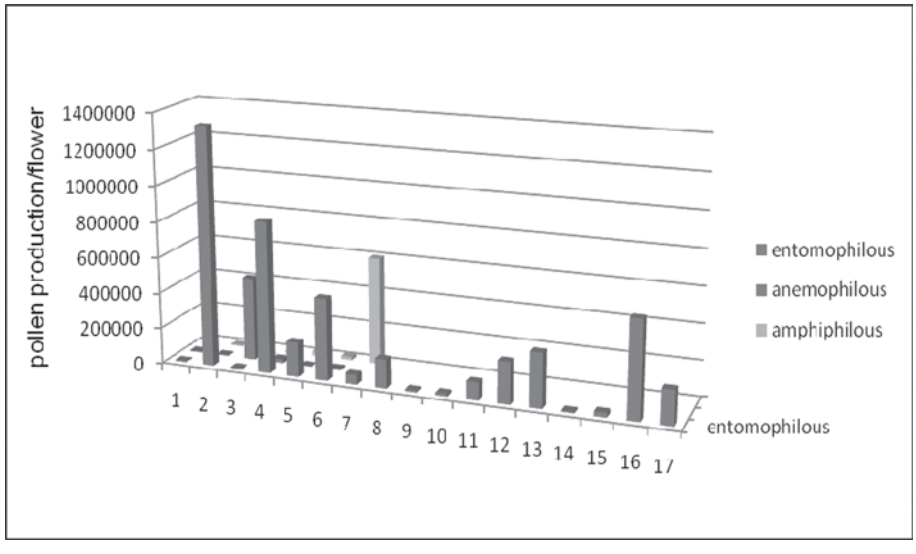

Fig. 3: Pollen Production/Flower for Entomophilos, Anemophilous and Amphiphilous Plants

A comparison of data of pollen production of investigated plants with their anther length appeared to be directly related to pollen production. The correlation between the size of the anther and the quantity of pollen grains they contain has already been demonstrated by other authors[4,8]. There is a positive association between anther size and pollen produced per anther. In *Oryza sativa* polyploidy causes the number of pollen grains and the size of the anthers to increase. The size of pollen and length of the anther is small then the numbers of pollen produced by particular taxon is lowest. It is evident from the present investigation where *Casuarina equisetifolia* shows very low pollen productivity where the pollen size and anther length is comparatively low. The grain size seems to be of no importance for some families viz., Poaceae, Cyperaceae and Amaranthaceae - Chenopodiaceae.

According to the researchers[14,15], there existed a correlation between pollen production and habit of the plant. An increase in pollen production from herb to shrubs and to trees can be witnessed here with the data of the investigated taxa. The anemophilous species are known to produce pollen in huge quantity. Their capacity to produce pollen is primarily under genetic and physiological control. The amount of pollen might be genetically fixed. Even varieties among cultivated species differ from one another in their pollen production and the diploids produce more pollen than corresponding tetraploids. The variation if any permitted by the genetic make-up may sometimes be enhanced by variations in environmental factors. The pollen production in a taxon is not only dependent on size of the anther or pollen grain but is also controlled by the other factors like periodicity, nutrient availability, response to light intensity, etc.

Conclusion: The quantitative estimation of the pollen grain productivity has a significant role in interpretation of data on pollen content of the atmosphere. Atmospheric pollen grains are the source of respiratory allergy when present in great abundance, hence plants with higher pollen productivity are more significant for pollen allergic symptoms. Thus the results of pollen productivity can easily be correlated to find their significant role in respiratory allergy.

The knowledge of quantitative production of pollen grain gives some idea about the frequency of presence of particular plant pollen grains in the atmosphere in particular season. Studies on pollen production helps to locate the differences in the biological potential of individual flower in an inflorescence. Data of Pollen productivity expresses the vegetative pattern of the locality. So pollen productivity is also useful as an index of the local flora. ❐

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