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ASH PERCENTAGE AND MINERAL COMPOSITION OF PEARL MILLET POLLEN

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Pollen from three inbreds WJR, PDP and Vg 272 and a single cross hybrid (Vg 272 x PDP) of Pearl Millet was ashed and the contents of various mineral elements were determined using atomic absorption spectrophotometer and flame emission spectrophotometer. The ash percentage was 2.73, 2.43, 2.58 and 2.45 respectively for WJR, PDP, Vg 272 and the hybrid. These differences were significant among themselves. Composition of twelve elements of these four lines were estimated in their pollen. Zn was the only element that varied significantly among the inbreds. When inbreds as a group were compared to the hybrid, the elements Na and Ba were found to be significantly higher in the hybrid (on dry weight basis) while K and Mn were also more than in the inbreds when ash weight of the pollen was considered. These observations were discussed in light of such studies in other crops.

Keywords : Pearl millet; Pollen; Mineral Elements.

Introduction

Although mineral assays of plants and plant parts were known long back most of the studies were limited to lower groups of plants. Mineral assay of pollen would contribute to our understanding of their role in germination, tube elongation and fertilization. *In vitro* pollen germination studies by Pfahler[1,2,3] and Pfahler and Linskens[4] in maize have revealed that elements like calcium and boron would influence pollen germination. The role of not only these elements but several other factors on germination and growth of pearl millet pollen were studied in considerable detail in our laboratory (Raju unpublished). While previous studies in maize were confined to only inbreds, it was Pfahler and Linskens[5] who extended them to single cross hybrids. Such an information is not known so far in pearl millet. This paper describes the results of mineral content of twelve elements in the pollen of three inbreds and a simple cross hybrid in pearl millet.

Materials and Methods

Four genotypes - three inbreds (WJR, PDP and Vg 272) and a single cross hybrid (Vg 272 x PDP) of Pearl Millet were used in this study. Pollen was collected from 50-100 plants at random at the time of anthesis. Immediately after collection, the sample was air dried at 30^{0}C and weighted which was considered as the dry weight of the pollen. The dried pollen thus obtained was then subjected to ashing. The ashing procedure involved placing the dried pollen in a platinum bowl and heating for 1 hour at 200^{0}C followed by further heating for 8 hours at 450^{0}C - 500^{0}C in a Muffle furnace. The platinum bowls were allowed to cool slowly; the resulting white ash was dissolved in a few ml of 1N HCl - 1N HNO_3 taken in a Teflon crucible and was kept on a hot water bath for 6 hours and was made up to 50ml. For each sample this solution was preserved in a polyethylene bottle till further use. The contents of K, Na and Ca were determined on a flame emission spectrophotometer while contents of the elements Ba, Fe, Cr, Co, Zn, Cu, Mg, Ni and Mn were determined on a Shimadzu atomic absorption spectrophotometer. The content of each element was determined following the procedure given in the technical manual supplied with the equipment by Shimadzu company, Japan and that of Pfahler and Linskens[5]. The ash percentage differed among the four genotypes and hence the content of each element was expressed as micrograms/gm dry weight and micrograms/gm ash weight of the pollen.

Results and Discussion

Ash percentage of the pollen in the three inbreds and the single hybrid were presented in Table 1. Differences in the means among all these four genotypes were tested in all s t-test and significanas were determined based on the probability values (Statistical Methods by G. W. Snedecor & W. G. Cochran).

Significant differences in ash percentage were observed among the inbreds and between the inbreds as a group and the single cross hybrid (Table 1) indicating genotypic influence on ash percentage. Among the inherds, ash percentage was significantly higher in WJR and Vg 272 than in PDP; of the three inbreds, only WJR significantly deviated from the hybrid. The ash percentage, though significantly differed between the parents (Vg 272 and PDP), the hybrid (Vg 272 x PDP) has an intermediate value but not significant from either parent.

Element content

Dry weight basis : The four genotypes differed from each other in terms of quantity of the elements studied (Table 2). The content of potassium was highest constituting about 75% of the total while the elements nickel, cobalt and chromium were present only in traces in all these four genotypes. Next to potassium, such higher quantities were seen in case of magnesium and sodium. The contents in hybrid were slightly greater than in the inbreds for most of the elements. Analysis of variance for each element among the four genotypes indicated that only the elements K and Zn altered with the genotype suggesting genotypic influence on these two elements only. Similarly analysis of variance among the inbreds has shown that zinc was the only element which differed significantly. In addition, zinc was the only element whose content differed significantly between the two parents PDP and Vg 272 ($t=3.35$; $df=7$; $p=0.05$); but the hybrid did not differ from either parent in respect to this element. Instead, hybrid had a significantly higher quantity of sodium compared to PDP (t-2.52; $df=7$; $p=0.05$) and of barium compared to the other parent Vg 272 ($t=9.06$; $df=6$; $p=0.05$). When the inbreds as a group were compared to the single hybrid, contents of sodium and barium were higher in the latter than in the former.

Ash weight basis : Results based on ash weight of the tissue were almost similar to

Table 1. Ash percentage of pollen in three inbreds and one hybrid of pearl millet.

Genotype	Replicates	Ash percentage Mean ± S.E	't' value	p-value
Vg 272 x PDP	4	2.45 ± 0.07	0.77^{a}	0.5 - 0.3
Vg 272	4	2.58 ± 0.13	3.60^{b}	0.05
PDP	5	2.43 ± 0.12	2.80^{c}	0.05
WJR	3	2.73 ± 0.30	1.18^{d}	0.03 - 0.1
			2.68^{e}	0.05
			0.68^{f}	0.7 - 0.5

a = hybrid vs Vg 272; b = Vg 272 vs PDP; c = PDP vs WJR;
d = WJR vs Vg 272; e = WJR vs hybrid and f = PDP vs hybrid

Table 2. Quantities of mineral elements (A - micrograms / gm dry weight; B = micrograms / gm ash weight) in the pollen of four genotypes of pearl millet.

Genotype	WJR		PDP		Vg 272		Vg 272 x PDP	
Element	A	B	A	B	A	B	A	B
K	7.942 ± 2.61	270 ± 77.88	6.541 ± 1.49	276.8 ± 66.49	8.805 ± 1.60	337.7 ± 42.89	11.804 ± 1.60	482.50±62.70
Mg	1.367 ± 0.22	49.3 ± 2.97	1.132 ± 0.13	47.7 ± 6.88	1.369 ± 0.14	47.1 ± 6.42	1.369 ± 0.14	55.9 ± 5.31
Na	0.647 ± 0.06	24.4 ± 2.98	0.553 ± 0.09	23.5 ± 4.06	1.106 ± 0.19	24.0 ± 5.63	1.106 ± 0.19	44.9 ± 7.06
Ca	0.270 ± 0.07	9.31 ± 1.87	0.209 ± 0.02	8.79 ± 1.10	0.258 ± 0.02	8.20 ± 0.72	0.258 ± 0.02	10.57 ± 0.99
Ba	0.182 ± 0.01	6.94 ± 0.78	0.171 ± 0.04	7.24 ± 1.73	0.256 ± 0.01	5.47 ± 0.39	0.256 ± 0.01	10.46 ± 0.20
Fe	0.134 ± 0.05	4.51 ± 1.56	0.150 ± 0.03	6.40 ± 1.15	0.158 ± 0.001	7.40 ± 1.07	0.158 ± 0.001	6.45 ± 0.29
Cr	0.004 ± 0.002	0.19 ± 0.13	0.007 ± 0.003	0.31 ± 0.14	0.005 ± 0.002	0.26 ± 0.14	0.005 ± 0.002	0.20 ± 0.10
Co	0.0001 ± 0.00007	0.006 ± 0.004	0.0002 ± 0.00005	0.006 ± 0.002	0.0002±0.00004	0.011 ± 0.006	0.0002±0.00004	0.007 ± 0.002
Zn	0.079 ± 0.001	2.90 ± 0.08	0.063 ± 0.01	2.67 ± 0.37	0.094±0.01	4.38 ± 0.61	0.094 ± 0.01	3.84 ± 0.39
Cu	0.009 ± 0.002	0.30 ± 0.05	0.007 ± 0.001	0.30 ± 0.04	0.011±0.01	0.35 ± 0.03	0.011 ± 0.01	0.43 ± 0.04
Ni	0.001 ± 0.002	0.049 ± 0.014	0.001 ± 0.002	0.034 ± 0.-85	0.0003±0.00003	0.039 ± 0.008	0.0003±0.00003	0.014 ± 0.001
Mn	0.029 ± 0.008	0.996 ± 0.22	0.025 ± 0.003	1.037 ± 0.16	0.048±0.009	1.183 ± 0.06	0.048 ± 0.009	1.937 ± 0.03
Total	10.664	368.901	8.859	374.787	15.109	435.733	15.109	617.208

those observed on dry weight basis of pollen (Table 2). While potassium and zinc were influenced by genotype on dry weight basis, there was no such genotypic influence on any element in the data on ash weight basis (as evident from the analysis of variance) because of significant differences in the ash composition of the four genotypes. The differences of all the elements between the two parent inbreds PDP and Vg 272 were insignificant. However, hybrid had significantly higher quantity of sodium than PDP (t=2.43, df=7, p=0.5) and of barium than in Vg 272 (t=9.95; df=7; p=0.05). When the inbreds as a group were compared with the hybrid, in addition to sodium and barium, manganese and potassium were also higher in the hybrid while the content of nikel was less than in the inbreds.

Genotypeic influence of ash percentage in maize was attributed by Pfhler and Linskens[5] to the level of heterozygosity in the pollen rather than to the genetic factor. In the present study, the observed genetypic influence suggest some role of the genetic factors because of high ash percentage in WJR and the minimum in the hybrid. Total ash ranged between 2.5 to 6.5% of pollen dry weight in many plant species with much higher values in lower plants. In pearl millet it ranged from 2.45 to 2.73% and closely correlates with the related maize rather than the lower plants. When the quantities of elements, common to maize[5] and pearl millet were compared with each other the relative differences among these elements in the profile were similar in both although the contents were far more in maize inspite of the more or less similar ash compsotion and suggest high degree of variability to exist among crop plants.

There are evidences that calcium and boron would influence *in vitro* pollen geminiation. *In vitro* pollen germination among the inbreds differed significantly while calcium content was not influenced by genotype of the present study. Hence the complex relationships between genotype, mineral content, *in vitro* germination characteristics and fertilization ability required further study for a better understanding of the mechanism of these processes. Sukhachain and Phul[6] reported complete dominance and duplicate epistatis for low ash content in peral millet grains; but the observed negative correlation between total mineral content and grain yield and grain size deprives production of superior inbreds. Recently, Singh and Nainawatee[7] reported the influence of these mineral elements on qualtity of food preparations and emphasized the need for further study in different organs for purpose of exploiting them for commercial production.

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References

1. Pfahler P L 1968, *Can. J. Bot.* **46** 235
2. Pfahler P L 1970, *Can. J. Bot.* **48** 111
3. Pfahler P L 1971, Can. J. Bot. **49** 55
4. Pfahler P L and Linskens 1972, *Theor Appl. Genet.* **42** 136
5. Pfahler P L and Linskens 1974, *Theor Appl. Genet.* 45 32
6. Sukhachain and Phul PSA 1990, *Crop Improvement* **17** 70
7. Singh F and Nainawatee H T 1999, *In "Pearl millet Breeding.* Oxford IBH Publications.