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STUDY OF POLLEN VIABILITY IN EXOTIC VARIETIES OF GOLDEN SWEET POTATO (*Ipomoea batatas* L.)

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Abstract: A field experiment conducted in the experimental farm of the "Participatory Rural Development Foundation (PRDF)" located at 59 Canal Road, Shivpur-Shahbazganj, Gorakhpur and Uttar Pradesh during July 2023 to February 2024 to study the pollen viability of exotic varieties of Golden Sweet Potato (*Ipomoea batatas* L.). A randomized block design (RBD) was used in this study with three replications and plot size was 3x1 m^2 per plot. The significant difference found in pollen viability percentage and all the phenotypic coefficient of variance was higher than genotypic coefficient of variance with high heritability (99.99) and high genetic advance (90.44) for pollen viability at 7 A.M. The coefficient of variance found higher in pollen viability at 7 A.M., 8 A.M. and 10:30 A.M. Thus the best time for pollination in flowering plant found pollen viability at during 7 A.M. to 10:30 A.M.

Keywords: Golden sweet potato, heritability, genetic advance, genotypic/phenotypic coefficient, pollen viability.

INTRODUCTION

Sweet potato, also known as *Ipomoea batatas* (L.) Lam, is a highly valued food crop which belongs to the Convolvulaceae family. *Ipomoea* plants produce tuberous roots, which are used as a staple food and industrial raw material in many operations (Meira *et al*., 2012; Mu *et al*., 2017; Singh, 2019). The varieties of golden sweet potatoes are hermaphrodite. They are heavily cross-pollinated, heterozygous, herbaceous, and perennial, with constant change in numerous features. It does not withstand frost and thrives at an average temperature of 24°C, with plenty of sunshine and mild evenings. Sweet potatoes grow on well-drained sandy loam soils with a pH ranging from 4.5 to 7.0 since they are not water-loving plants. Propagation occurs by stem or root cuttings or adventitious branches known as slips. The commercial element of sweet potatoes is the modified root. The majority of cultivars grow store roots at the nodes of underground mother stem cuttings. Spreading cultivars generate store roots, or nodes that come into contact with soil. Sweet potatoes are high in proteins, fats, fiber, vitamins, and minerals such as potassium, making them an excellent energy source. They are heavy in starch, which accounts for more than half of the carbohydrate

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components, which is unusual for other forms of tubers. Sweet potatoes have the largest root dry matter content for human consumption, accounting for 70% of the dry weight. High dry matter content is a key feature of a high-quality sweet potato variety. This plant provides nutrients and is utilized for starch, alcohol, and animal feed. It is cultivated in 117 countries, producing 90 million tons of tubers from 1.22 lakh ha area in India. However, research on sweet potato lags behind that of major diploid crops due to its complex genetic makeup. Golden Sweet Potato germplasm was introduced by Participatory Rural Development Foundation (PRDF), Gorakhpur from the Kenya Centre of International Potato Centre (CIP) to combat rampant vitamin A deficiency (Chaudhary *et al*. 2016 a, b) in India, especially in Uttar Pradesh and Bihar. Golden Sweet Potato is bio-fortified and with Vitamin A in form of β carotene (Chaudhary and Sahani 2017 a, b; Singh *et al*. 2018).

MATERIALS AND METHODS

Experimental site and layout

The study was conducted at the experimental farm PRDF located on 59 Canal Road, Shivpur-Shahbazganj, Gorakhpur, India, situated at 26° 47' 11.652"N latitude and 83° 23' 37.824"E longitude. Three replications in *Kharif* season 2023-2024 recommended cultural practices with a spacing of 60×20 cm. The climate is sub-tropical monsoon with an annual average rainfall of 1814 mm.

Experimental Materials

List and sources for 9 varieties of golden sweet potato were used out of 6 varieties were introduced from International Potato Centre (CIP) Kenya Centre (PRDF – I – 2, PRDF – I – 5, PRDF – I – 6, PRDF – I – 7, PRDF – I –10 and PRDF – I – 12). One variety CIP440127 was obtained from International Potato Centre, Peru. The two varieties ST – 14 and VA – 43 were introduced by Central Tuber Crops Research Institute (CTCRI), Bhubaneswar and Thiruvananthapuram respectively. The check variety Local was introduced from PRDF Gorakhpur.

Experimental Layout

The experiment conducted at PRDF, 59 Canal Road, Shivpur-Shahbazganj, Gorakhpur, U.P. and India in the year 2023 – 2024 in a randomized block design with 3 replications.

Land Preparation

The plot was ploughed to a depth of 15-20 cm and fertilized & leveled with Farm Yard Manure. The plot size was 3x1m^2, with 60 cm spacing between replications and 90 cm between genotypes. The planting of vines were spaced at 60x25cm spacing.

Pollen viability

Viability of pollen was recorded after flowering. The data were recorded by using Iodine with concentration at 1% under microscope. The dark colored pollen was viable and non colored was non-viable. Their values were calculated in percentage at different time from 4 A.M. to 6 P.M.

Statistical analysis

For every character, an ANOVA was performed, and the significance was assessed using the 1967 Panse and Sukhatme technique. Variance analysis was performed on the mean genotype data using the 'F' test at significance levels of 5% and 1%.

RESULT AND DISCUSSION

Pollen viability was recorded by timing pollen grain is with 1% Iodine. Data recorded are presented in Table 1. The analysis of variance for quantitative characters indicates highly significance for all the characters of sweet potato. All the characters studied of pollen viability at different time. The flower of sweet potato immensely flowered in some species. The flower came in the genotypes namely; Local, PRDF-I-2, PRDF-I-10, PRDF-I-6, CIP-440127, PRDF-I-12 and ST-14. The inflorescence in golden sweet potato is a cyme with two auxiliary peduncles, producing a biparous cyme. The flower is bisexual, with stamens and pistils. Flowering requires a short photoperiod and slight humidity. The color of flower varies from green to purple. Similar result observed in Rodríguez *et al*. (2023). The study found that the variability in characters in sweet potato plants is sufficient and can be enhanced through simple selection methods. The range of variation observed for all characters indicates the existence of variation. The study found that the variability in characters in sweet potato plants is sufficient and can be enhanced through simple selection methods. The range of variation observed for all characters indicates the existence of variation among genotypes with maximum range in pollen viability at 8 A.M. and pollen viability at 10:30 A.M. Coefficient of variance of both phenotypic and genotypic observed highly (>20) for all traits like pollen viability at different time 7 A.M., 8 A.M., 10:30 A.M., 2 P.M., 6 P.M. The findings are in accordance by Rodríguez *et al*. (2023) for pollen viability. Chatterjee and Nagbiswas (1952) found that pollen fertility is high, ranging from 76.5 to 100%. The stigma is susceptible to sweet potatoes in the early hours. Bees are primarily responsible for morning pollination (Montaldo, 1991; Huamán, 1999; Martí *et al*., 2014). The stigma receptivity test on I. papa revealed that it was responsive between 0635 and 0100 h. Pollen grains have the peak vitality between 0635 and 0700 h, but remain viable throughout the day until the bloom closes

(Terada *et al*. 2005). In I. cairica, Xiaocheng *et al*. (2007) found that pollen viability and stigma receptivity maintained above 90% on the first day of flowering. Adi *et al*. (2013) reported that pollen viability in sweet potato has a range of 70.25 to 91.52%.

Table 1. Mean Pollen Viability of different genotypes after flowering

Genotype	7 A.M.	8 A.M.	10:30 A.M.	2 P.M.	6 P.M.
CIP 440127	99.54	99.08	95.25	13.69	2.86
PRDF I 2	99.92	98.04	95.40	18.21	3.96
PRDF I 5	0.00	0.00	0.00	0.00	0.00
PRDF I 6	99.59	99.04	96.43	11.98	1.34
PRDF I 7	0.00	0.00	0.00	0.00	0.00
PRDF I 10	99.59	98.62	94.39	10.02	2.28
PRDF I 12	99.56	98.47	83.00	11.65	3.57
ST 14	99.17	97.55	86.06	7.81	4.10
VA 43	0.00	0.00	0.00	0.00	0.00
Local	99.62	95.26	87.97	15.63	3.28
Maximum	99.92	99.08	96.43	18.21	4.10
Minimum	0.00	0.00	0.00	0.00	0.00
Mean	72.45	71.38	66.81	9.75	2.32
SD	41.395	40.760	38.178	6.0002	1.503
SE(d)	0.287	0.408	0.929	0.636	0.515
C.D.	0.860	1.226	2.7853	1.90	1.544
C.V.	0.571	0.571	0.571	0.615	0.648

Table 2. ANOVA (mean squares) in sweet potato for different characters (*Significant at 5% level, **Significant at 1% level)

Sl. No.	Source of variation (character)	Replication	Genotype	Error sum of square	S.EM±	C.D (5%)
	Degree of freedom	**2**	**9**	**18**		
1.	Pollen Viability at 7 A.M.	0.4	5783.4**	0.2	0.2871	0.8607
2.	Pollen Viability at 8 A.M.	0.1	5607.2**	0.5	0.4089	1.226
3.	Pollen Viability at 10:30 A.M.	1.5	4919.4**	2.6	0.929	2.7853
4.	Pollen Viability at 2 P.M.	0.679	121.511**	1.214	0.636	1.9068
5.	Pollen Viability at 6 P.M.	1.1588	7.6337**	0.7961	0.5152	1.5444

Table 3. Different variability parameters for pollen viability in golden sweet potato genotypes

Sl. No.	Characters	Mean	Range	GV	PV	PCV	GCV	h^2 (%)	GA	GA (% of Mean)
1.	Pollen Viability at 7 A.M.	77.443	100	1927.711	1927.959	56.697	56.694	99.99	90.44	116.782
2.	Pollen Viability at 8 A.M.	76.228	99.6	1868.907	1869.41	56.719	56.712	99.97	89.043	116.811
3.	Pollen Viability at 10:30 A.M.	70.945	98.32	1638.939	1641.529	57.108	57.062	99.84	83.330	117.456
4.	Pollen Viability at 2 P.M.	9.887	19.91	40.099	41.312	65.004	64.042	97.06	12.851	129.975
5.	Pollen Viability at 6 P.M.	2.377	4.97	2.279	3.075	73.747	63.448	74.11	2.677	112.593

Table 4. Genotypic Correlation values for pollen viability in golden sweet potato

Time	7 A.M.	8 A.M.	10:30 A.M.	2 P.M.	6 P.M.
7 A.M.		0.999**	0.993**	0.886**	0.892**
8 A.M.			0.994**	0.881**	0.886**
10:30 A.M.				0.898**	0.848**
2 P.M.					0.826**

(*Significant at 5% level, **Significant at 1% level)

Table 5. Phenotypic Correlation values for pollen viability in golden sweet potato

Time	7 A.M.	8 A.M.	10:30 A.M.	2 P.M.	6 P.M.
7 A.M.		0.999**	0.992**	0.874**	0.768**
8 A.M.			0.993**	0.868**	0.762**
10:30 A.M.				0.885**	0.731**
2 P.M.					0.715**

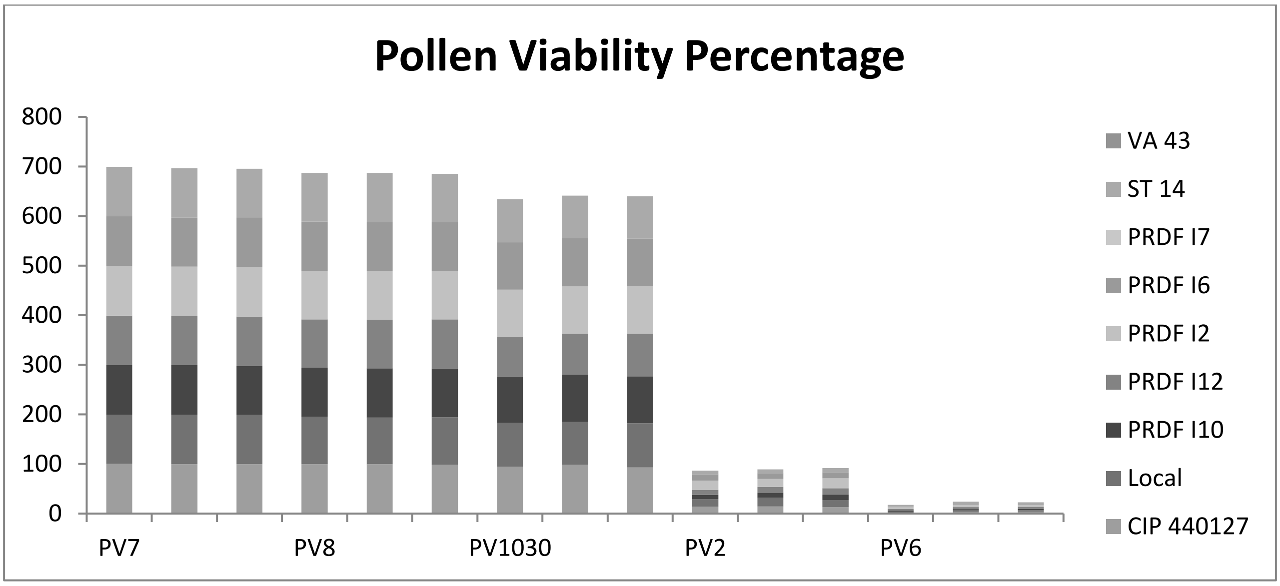

Figure 1. Percentage graph of viable grain of pollen in flower

Figure 2: Materials and eqipments for assessing pollen viability *viz*., Iodine sol.(1% con.), Microscope(5X), Niddle, Scissor, Slide glass, Dropper, Forcep and Flower of sweet potato

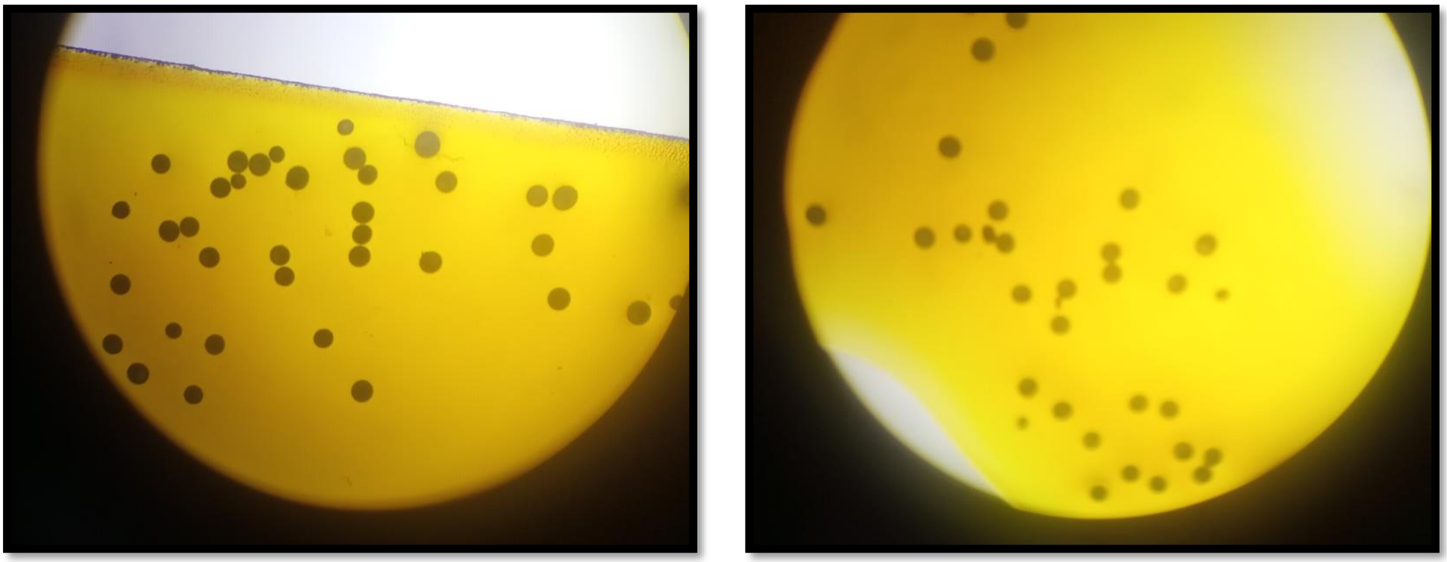

Figure 3: Photographs of pollen grain; Dark black (viable) and Light black (non – viable)

They observed 100% receptivity of the pistil and 80 to 100% dehiscence of the anther. High heritability values were observed in the present investigation like pollen viability at 7 A.M. (99.99), pollen viability at 8 A.M. (99.97), and pollen viability at 10:30 A.M. (99.84). Johnson *et al*. (1955) found that heritability estimates combined with genetic advance are the most effective tool for selection in crop improvement. Panse and Sukhatme (1985) suggest that non-additive gene effects lead to low expected genetic advance (GA), while additive gene effects may lead to high genetic advance. All the traits are positively highly significant for all the characters in genotypic and phenotypic correlation. The pollen viability at 7A.M. is also positively correlated with growth parameters are considered for selection of superior genotypes. The findings were done by several scientists: Rui Zhang *et al*. (2024), Placide *et al*. (2015).

Conclusion

The results allowed a better knowledge of the pollen viability and genetic factors, correlation studies suggested that for crossing superior genotypes, the key emphasis should be pollen viability time, the best time varied for pollination in flowering plant found pollen viability at 7 A.M., 8 A.M. and 10:30 A.M. The pollen presented viability percentages above 90% from 7 to 10:30 A.M.

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